LINK_POD

Holistic Design Approach

The housing affordability problem is structural rather than cyclical. It is not simply a matter of building more dwellings to meet the demand as our endangered environments will not allow us to do so. To deal with the long-lasting problem, we need a systematic solution and to work with a holistic approach to the life-cycle of buildings. We propose a medium-density modular housing that is moveable, comfortable, affordable and adaptable for our target customers. Particularly, we focus on the demand from people who need short-term living places from 6 months to 2 years. Our target customers are overseas students, travellers having working holidays, families experiencing domestic violence, business man and professionals working away from home. Traditional housing supply such as student flats and rental units are not flexible and affordable enough to accommodate these ever changing demand.

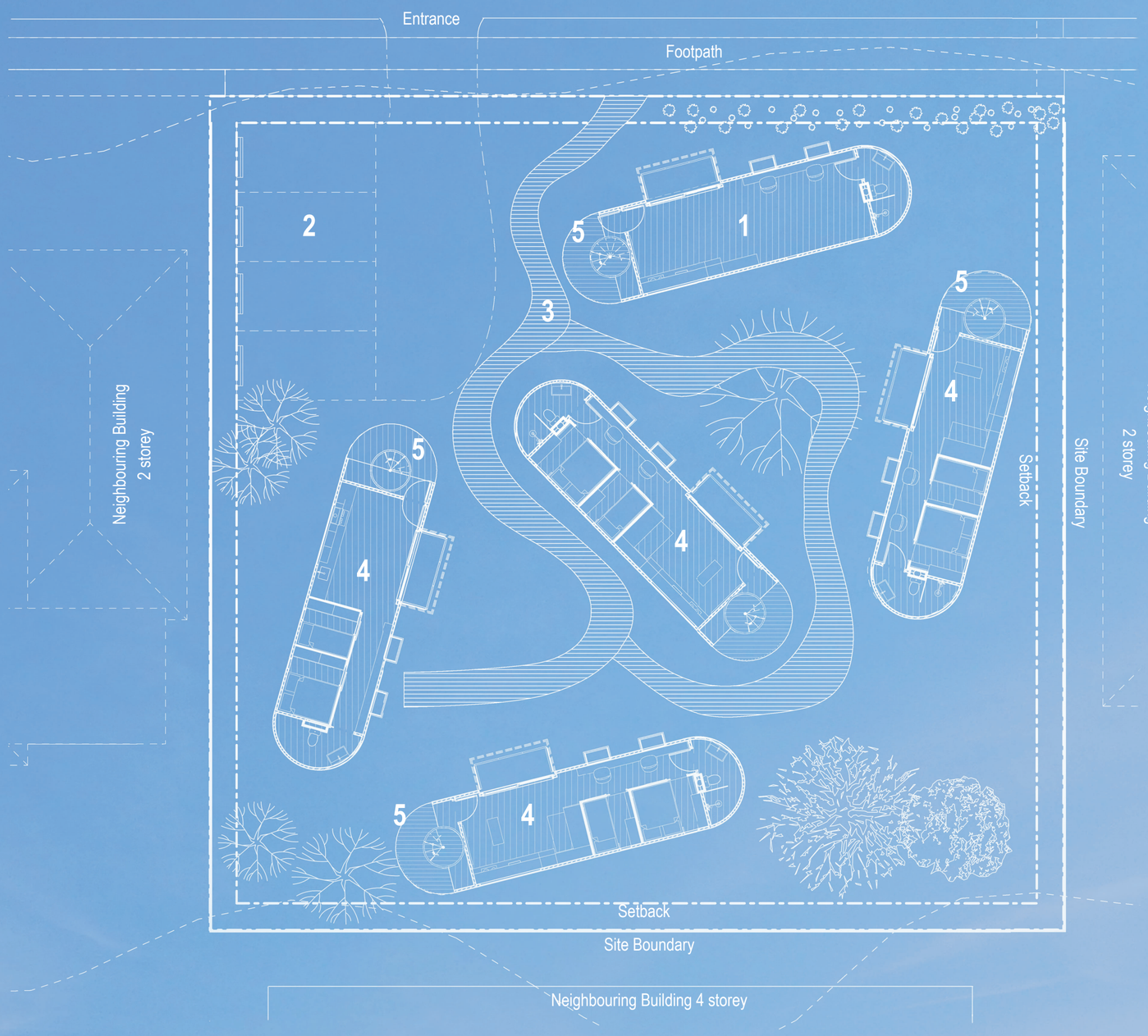
Our proposal of fully-finished prefabricated modules will bring the housing demand and industry 4.0 manufacturing process together. Our modular design aims to increase the efficiency of construction, reduce duration and associated costs of development, minimise our carbon footprint and create a sense of community.

The rotating modular system provides the flexibility and diversity to the overall arrangement of the modular complex. It can easily form a few options for a potential site. The spacial relationship and appearance from outside can be very different from one option to another. There are endless possible combinations of modules.

Modules are designed to be easily assembled and disassembled and transportable to other places. Therefore, precious land don't have to be bought before construction starts, which significantly reduces the initial capital expenditure for developers. Purpose-designed structural connectors make the module strong and durable while engineered wood product - Bamboo is chosen for its high performance and low embedded emission.

Residents can have easy access to greenery and outdoor space from the pod. The space is private and cosy inside, while it can be opened up for residents to socialise with their neighbours. Roof garden and balcony provide passive surveillance and a sense of community.

An on-line platform is also proposed to connect potential customers, manufacturers, developers all together and create a database from post-occupancy data that are collected by sensors embedded in the module.



Site Plan

1 Common Room with Laundry Services
2 Parking - on grade
3 Footpath - on grade
4 2-bedroom modules
5 Stair access to upper storey

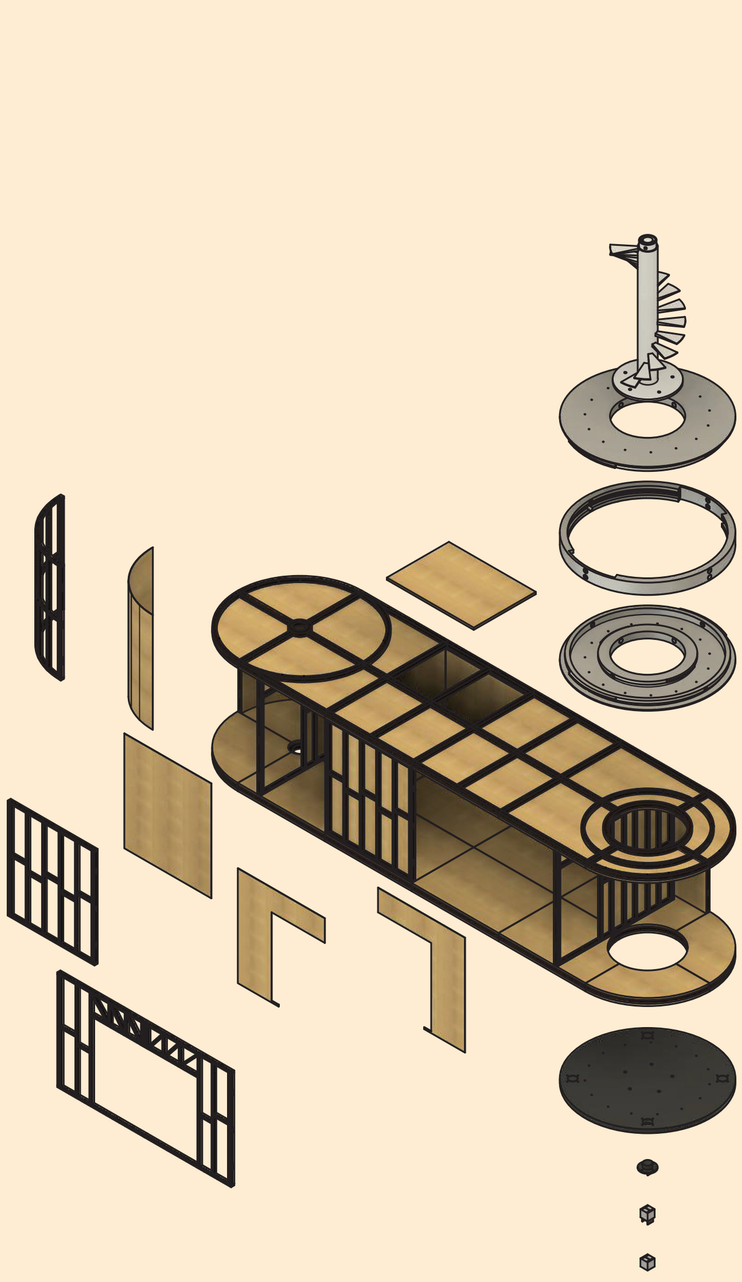
N

0 3 5 10m 1:150

Sectional Perspective*

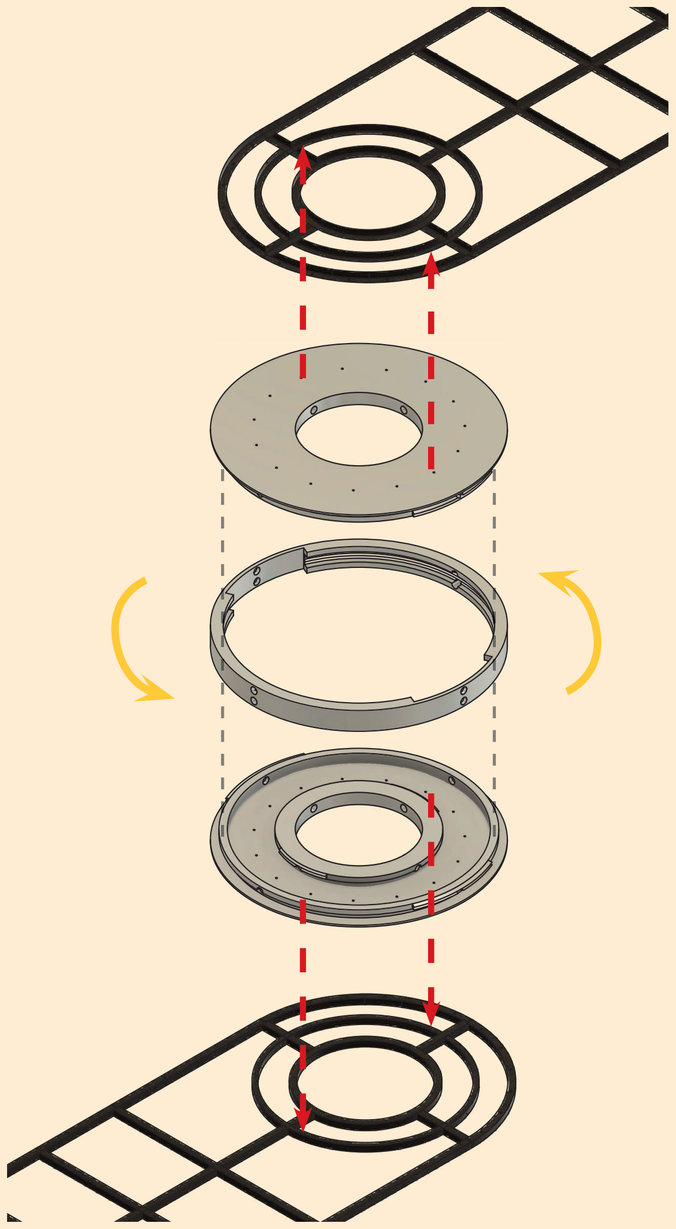
0 1 3 5m

*For illustration purpose, the section is based on a generic arrangement, not specific to this site plan and renders



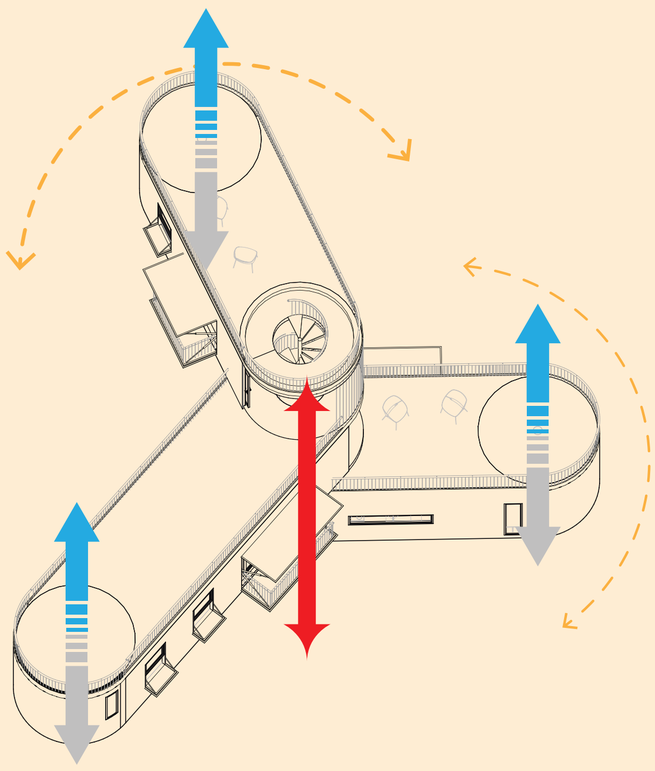
Exploded structure diagram

+ Design for Manufacture and Assembly (DfMA) is the main principle of the structural design. Although special fixings and connectors require low tolerance in manufacture and assembly, it is achievable with prefabrication and industrial 4.0.
+ The module is not only designed for quick connections between two residential units, but for easy maintenance of individual structural panels and elements. At the end of life cycle of the module, DfMA makes it possible to recycle and reuse the entire building. In this circumstance, both economic and environmental benefits are maximised.
+ We choose Engineered Wood Product (EWP)- Bamboo for its low embedded carbon emission and superior structural property.



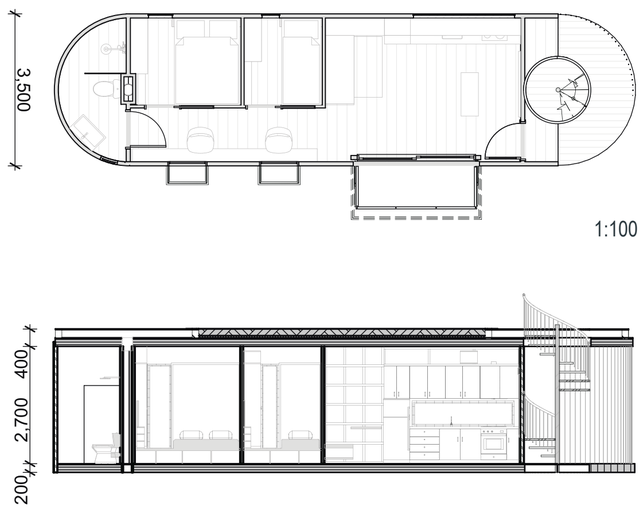
Ring Connection Details

+ This is a self-designed connector for this competition design concept. Due to the specific shape of this connector, we called it a ‘Pineapple ring’. The inside hollow is designed for the staircase. This connector can divide into three parts, the top and bottom are connected with upper and lower modules by using 15*M12 bolts with 15 Sihga IF304. By rotating the ring in the middle by 90 degrees, the upper and lower module will be locked, and several M100 bolts will then be placed to avoid further movements.

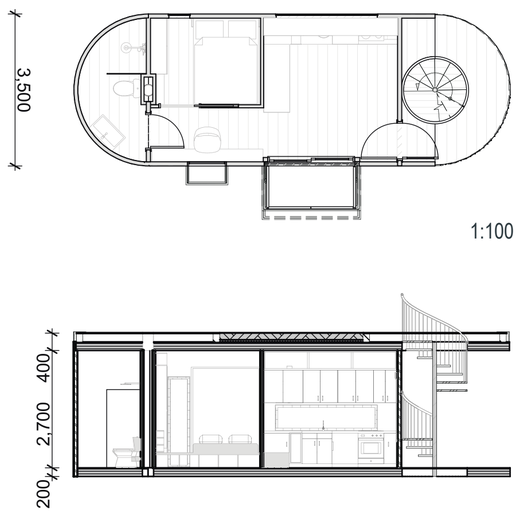


Service Risers and Circulation

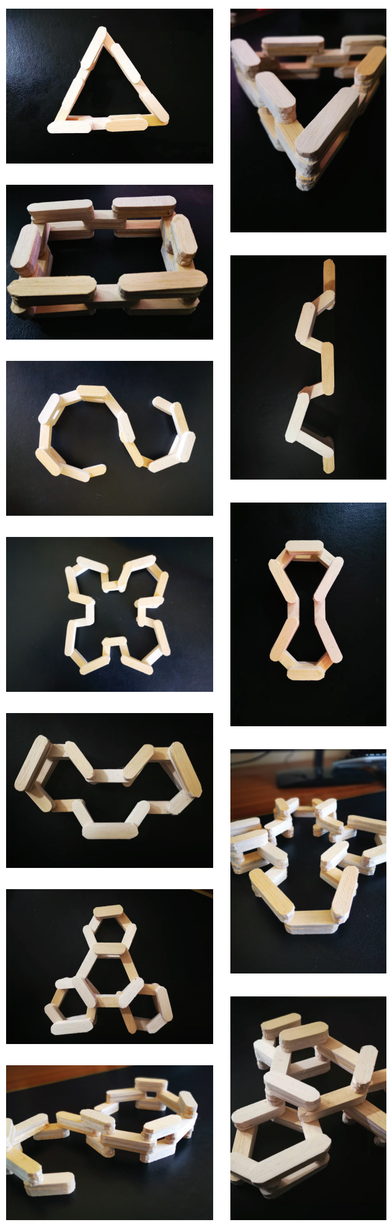
+ The angle between one module and the other up or below can be adjusted to adapt to obstacles on site. It also gives potentials to a variety of design options and spacial relationships among modules.
+ Service core and circulation stairs are located at the centre of the rotating circle. With our purpose-designed connection rings, the integrity of services and structure is maintained while the module is rotated. Therefore, during installation or disassembly, plumbing, electricity and telecommunication services can be easily connected or disconnected.



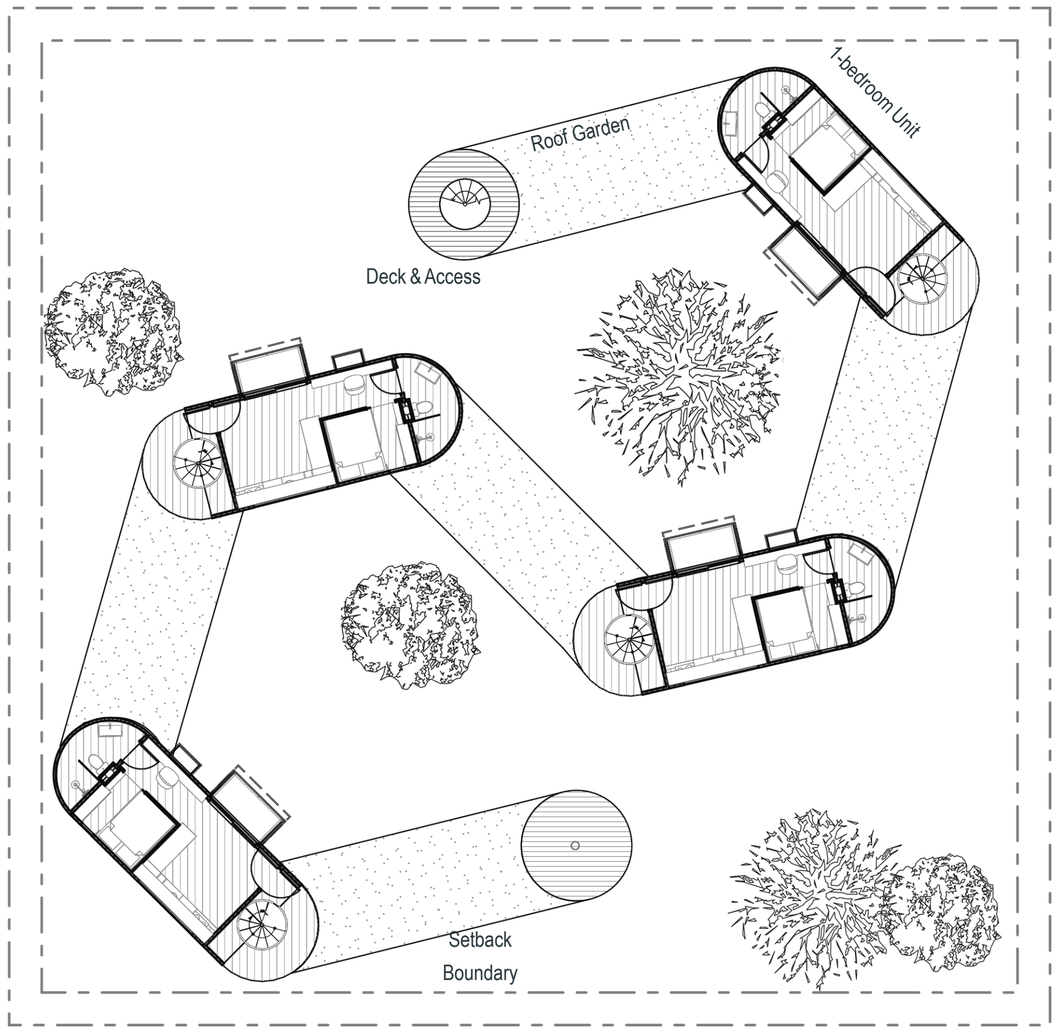
Module Type 1 - 13.35 meters



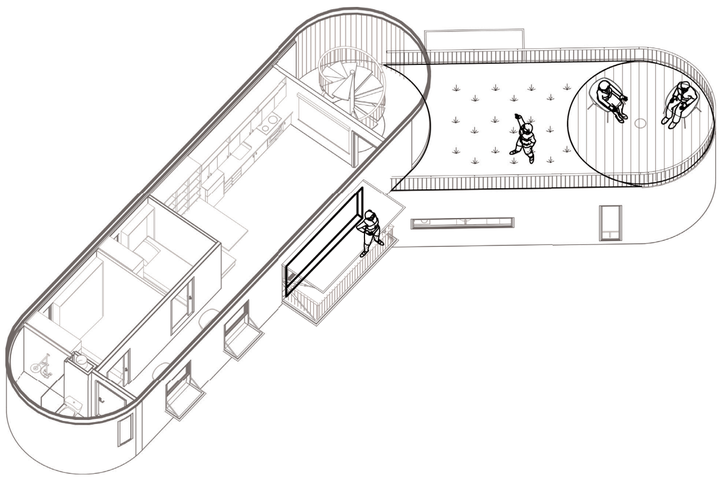
Module Type 2 - 10 meters



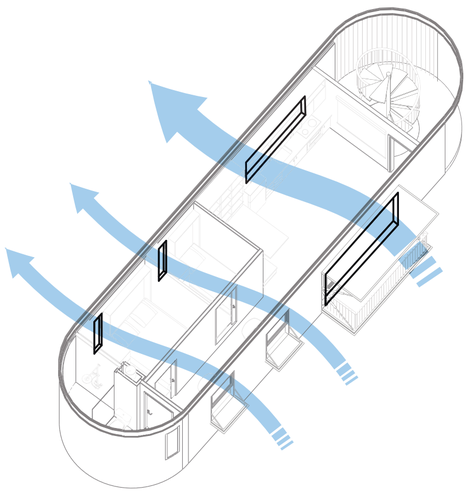
Possible Arrangement



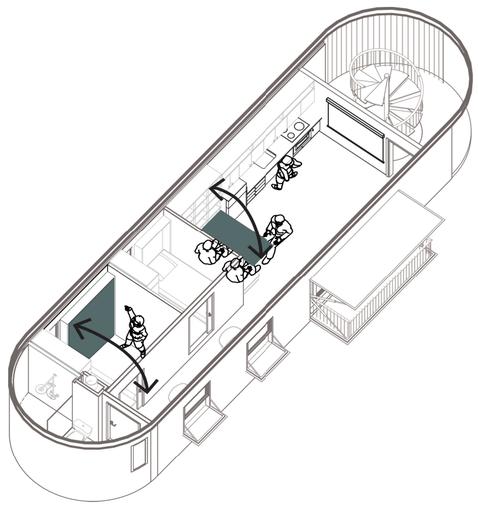
Floor Plan- Level 1



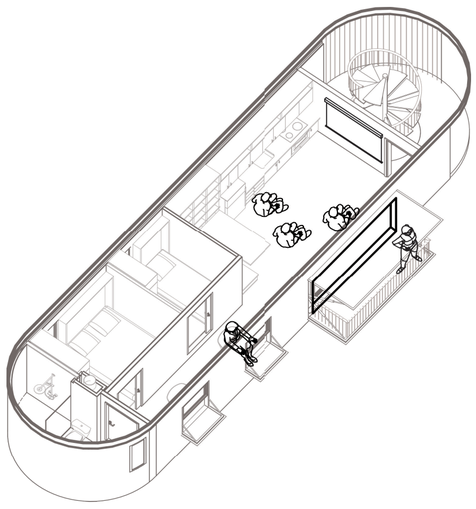
Outdoor Living



Cross Ventilation



Space Saving Furniture



Small but Smart

LINK_POD

Affordability

Modular Design

Industry 4.0

Transport and Installation

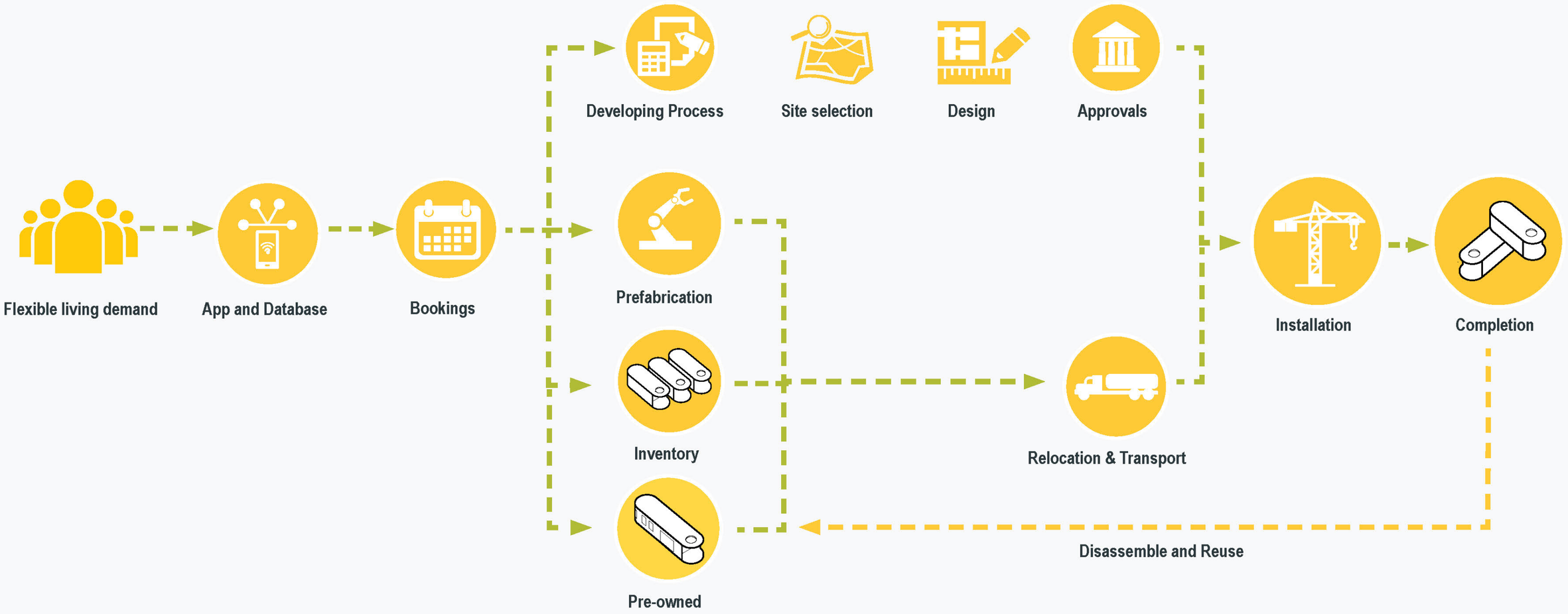
Adaptability

Sustainability

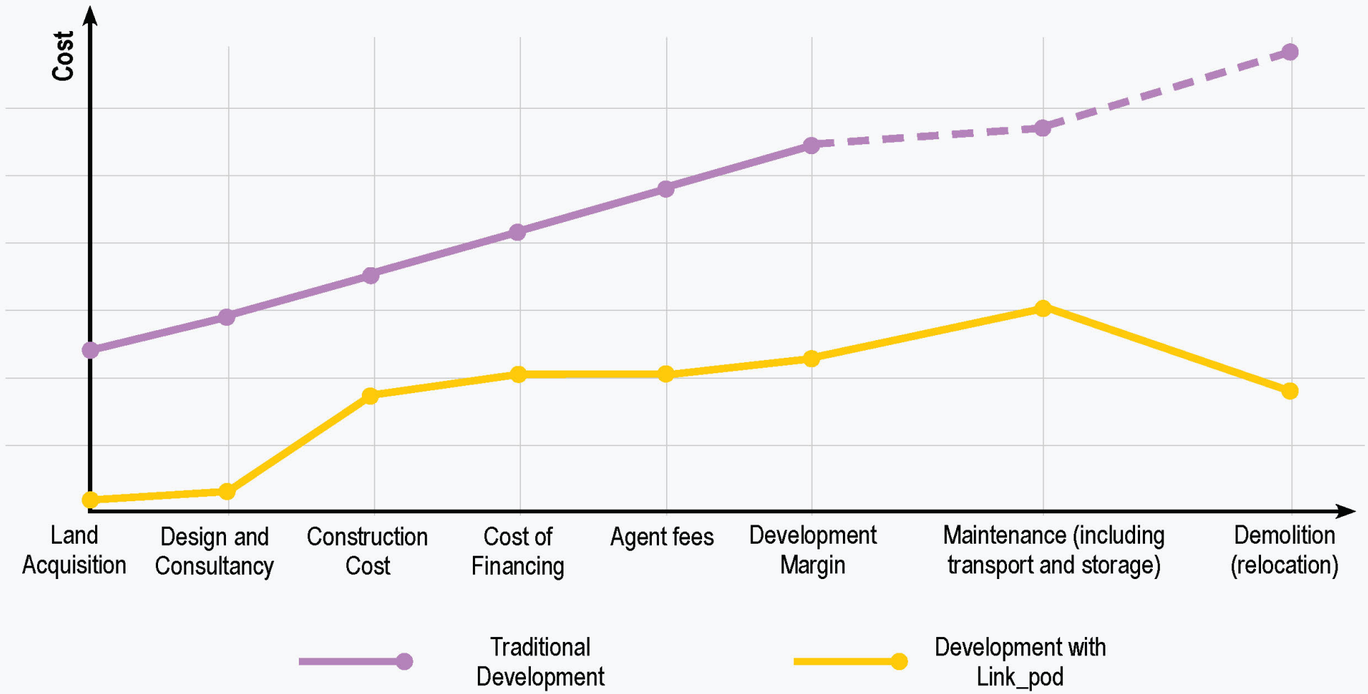
A HOLISTIC APPROACH

+ Short-term living demand
+ Separation of land and dwelling
+ On-line platform with real-time demand
+ Automated production line
+ 2 variations of modules
+ Prefabricated and fully finished unit
+ Design for manufacture and assembly
+ Design for transport
+ Lightweight structure
+ Adaptable to site conditions
+ Flexible layout
+ Embedded sensor for structure
+ Engineered Wood Product- Bamboo
+ Smart design with folding furniture
+ Balcony and operable windows
+ Roof garden
+ Cross ventilation
+ Passive surveillance
+ High thermal and acoustic performance
+ Post-occupancy data collection
+ Disassembly and relocation
+ Reuse and recycle

OVERALL SCHEME



COST EVALUATION



Estimated Cost for 2-bed module

Material Cost	$26,599.26
Delivery Cost	$904.72
Installation Cost	$26,680.50
Total Cost	$54,184.48

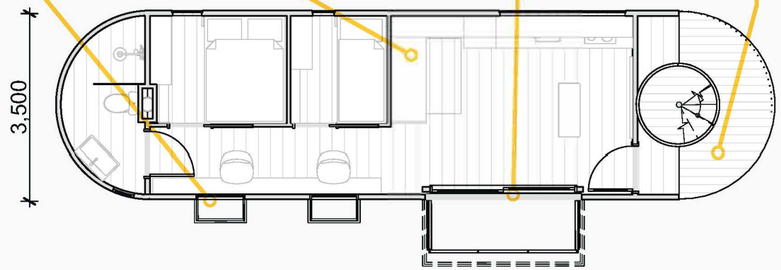
- Material Cost: Incudes Material and Connectors (without insulation infill, roof garden and cladding)
- Delivery Cost: Referred to the data from MODEhouse in 2017, the final price in 2020 which is inflated.
- Estimated as 2 bedrooms, 1 kitchen $ living area.
- For more detailed calculations please check in the report.

Cost Saving Strategies:

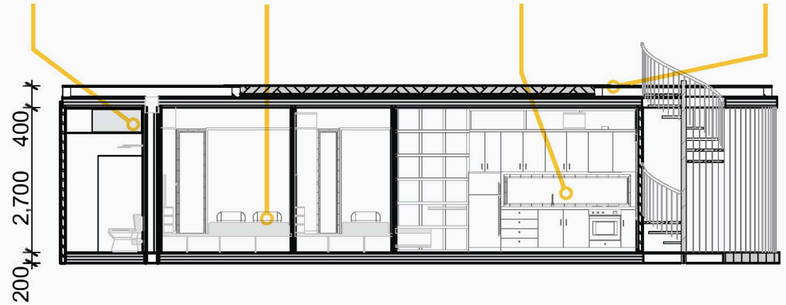
Investment | Function | Prefabrication | App and Database | Reduced risks and period | Standardised parts | Relocation & Transport

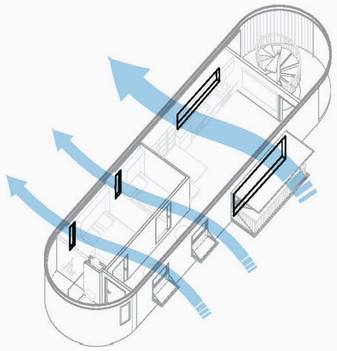
MODULAR DESIGN

+ Folding window shutter with operable window.
+ Built-in dinning table and bench
+ Operable shutter can be opened up as balcony.
+ Open-air circulation space

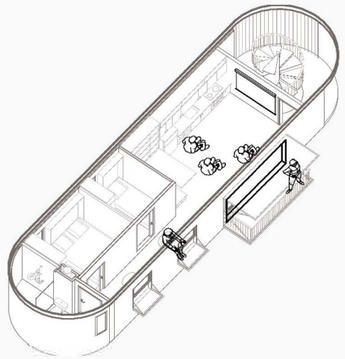


+ Service riser and water tank
+ Elevated floor for storage
+ Murphy bed
+ Built-in appliance
+ Operable window
+ Connection unit
+ Rooftop garden

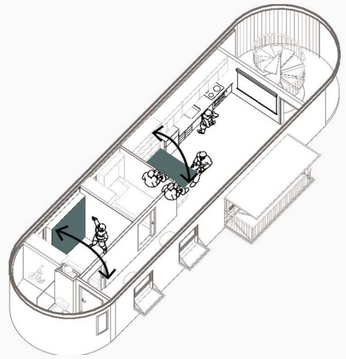




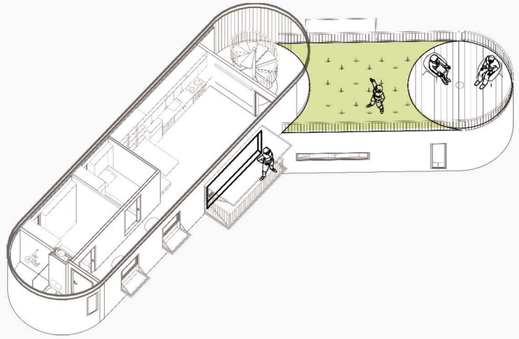
Cross Ventilation



Space Saving Furniture

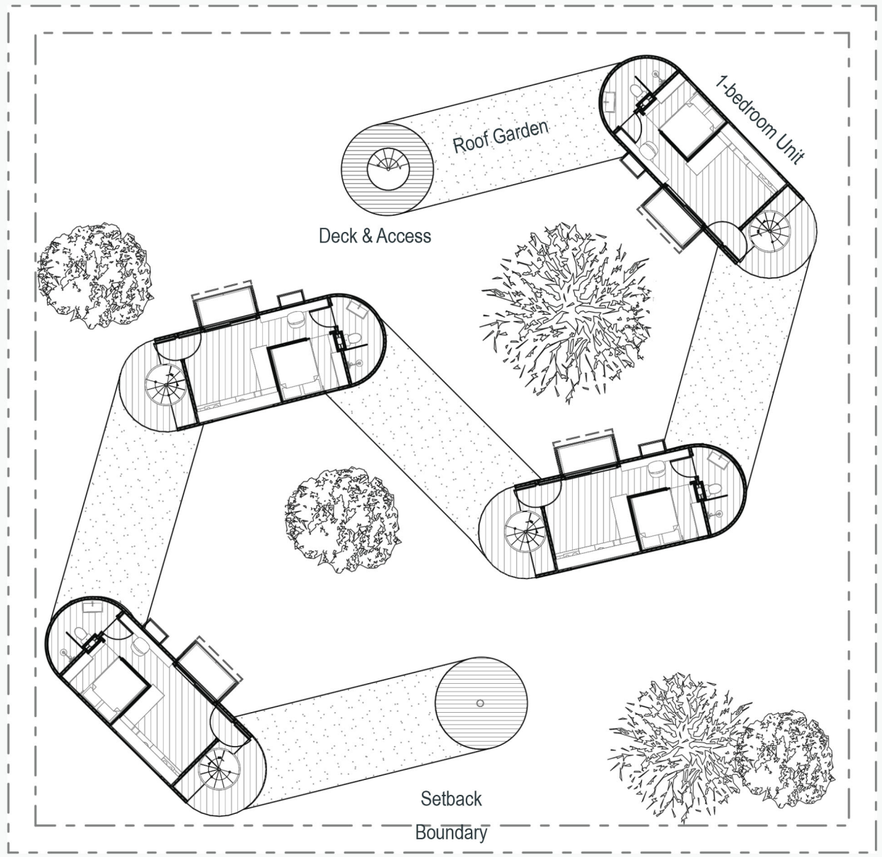


Small but Functional

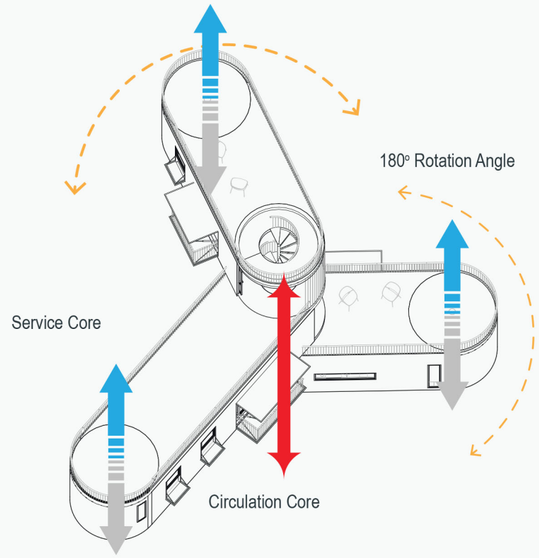


Outdoor Living

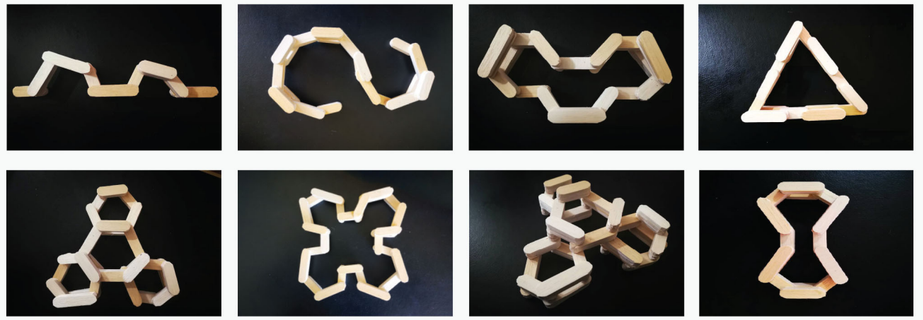
ADAPTABILITY



Floor Plan- Level 1

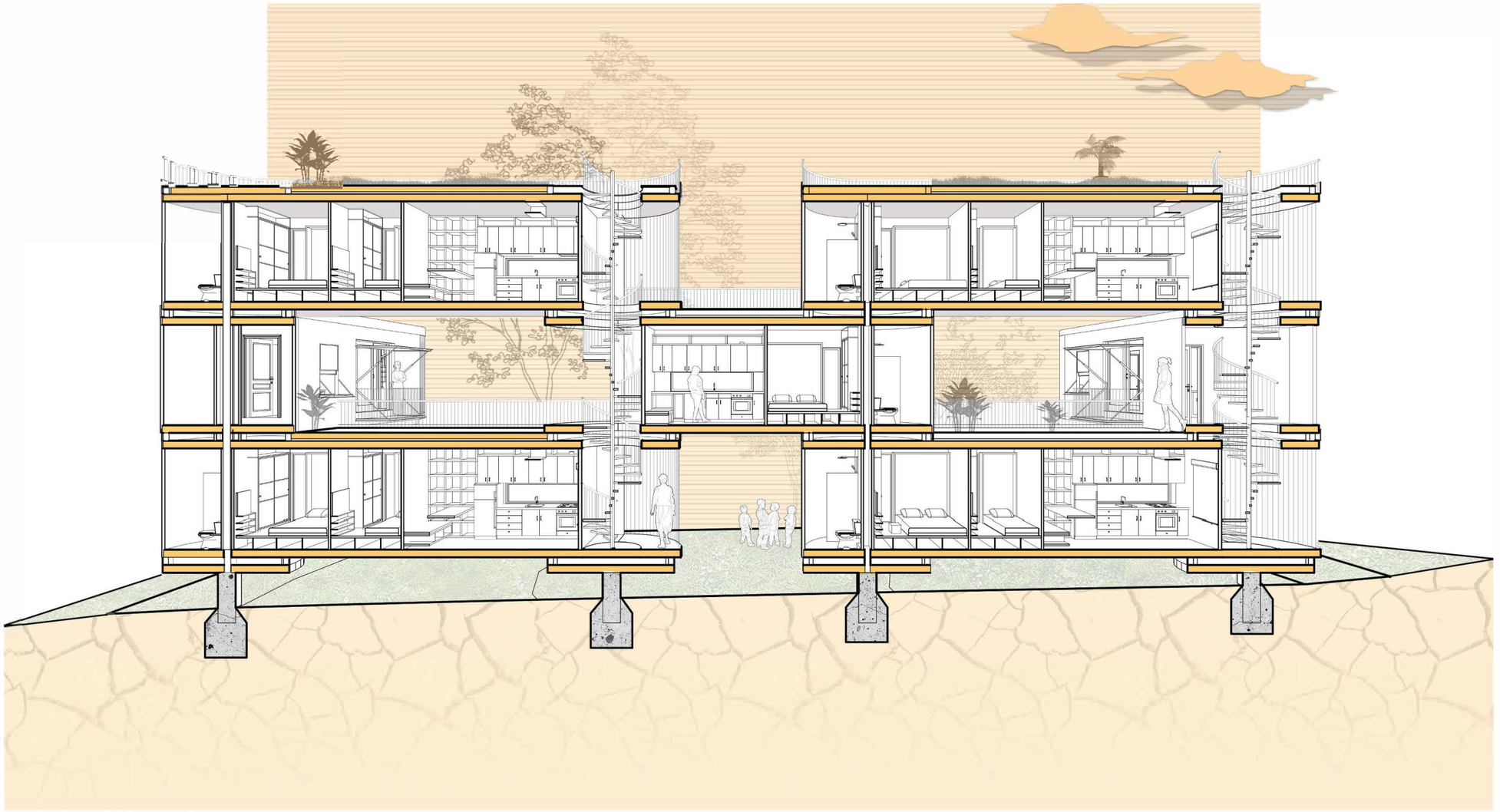


Service Riser and circulation



Working Models

DESIGN FOR COMMUNITY AND OUTDOOR LIVING



Structural Design: Material

- 'Wooden Bamboo (Engineered Bamboo Product) is selected for structural frame and panels, which is a new material that innovated from the 'Timber Institute of the Chinese Academy of Forestry'. It is a kind of 'high-performance bamboo-based fibre composite material".

- Through the authoritative testing:
✓ The bending strength of this material is **≥350MPa**,
✓ The tensile strength is **≥360MPa**,
✓ The compressive strength is **≥140MPa**,
✓ The modulus of elasticity is **≥30GPa**,
✓ The boiling expansion rate is **≤5%**, and
✓ The strength per unit weight can reach **2.5 times** that of steel.

- However, since neither Australia standard nor **ARCOTIM** provides relevant standards/calculation methods, thus, for the rest of the design concept, we would assume to use Engineered Wooden Product (EWP) as a conservative assumption.

- The conventional size of 'wooden bamboo' is 2500mm (L) * 70-90mm (W) * 30-50mm (T), which is close to the size of Australian machined grade pine (MGP).

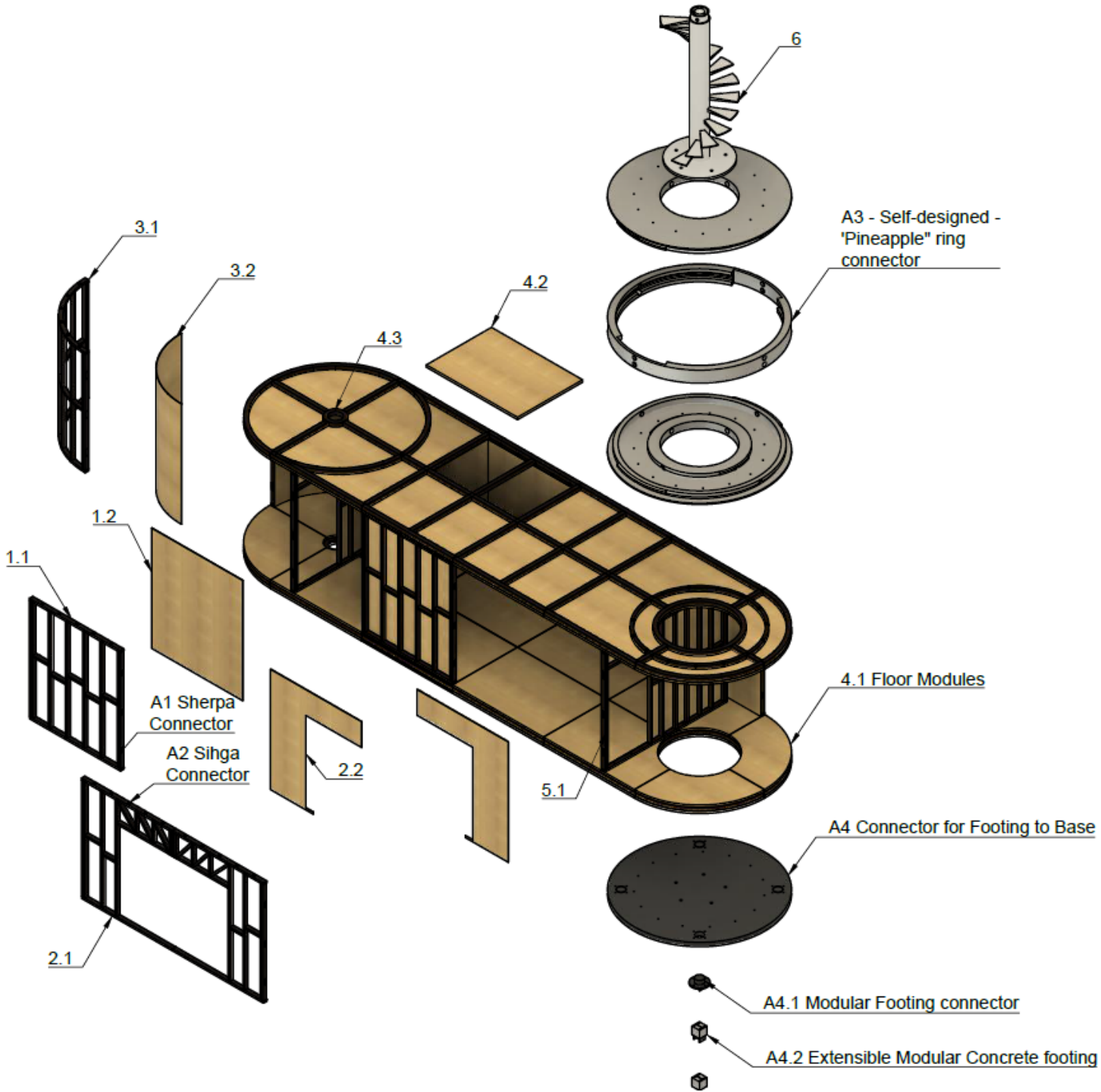
- Therefore, the civil design team will be choosing **MGP10 - 45*90mm (the most commonly used in Australia timber-framed construction)** as the primary structural material and taking into the design/calculations.

Benefit of Bamboo:

- Is sustainable carbon-negative material – the annual quantity of carbon storage per hectare of the bamboo forest is up to 5 tonnes, which is 1.46 times that of fir/pine
- Shorter time to grow compared to the trees;
- Greater potential and benefits; and etc.

- Wooden Bamboo

- MGP10 45*90mm



Structural Design & Layout

- Design for Manufacture and Assembly +Disassembly (DfMA+D) is the main principle of the structural design.
- With industry 4.0 and proposed automated production line, this principle is possible to be applied to our structural design as special fixings and connectors require low tolerance in manufacture and assembly.
- The module is not only designed for quick connections between two residential units, but for easy maintenance of individual structural panels and elements.
- This concept of design is aiming at transport the whole module in once. However, on the distance of the relocated place, the module can be downsized/disassembled to relatively smaller panels (as 1.1-3.2 states).
- These panels are fully reversible, to offer easy maintenance/reuse/recycle and achieve the circular economy. At the end of life cycle of the module, design for disassembly makes it possible to recycle and reuse the entire building. In this circumstance, both economic and environmental benefits are maximised (Akanbi et al., 2018).
- The integral timber technical structure design were checked accordingly ARCOTIM TimberTech.
- Please check the report for more justifications about the building components.

A1 - SHERPA M20

A2 - SIHGA IF304

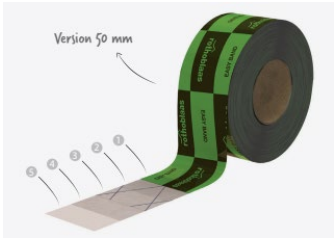
ROTHOBLAAS
LOCKT50175

A3 - Self-designed
'PINEAPPLE-RING'
CONNECTOR

Self-designed
FOOTING PLATE

A4 - Self-designed
'MODULAR FOOTING'

Please see in Appendix A for more detailed drawings



Building Components Connectors

A1 – Sherpa M20 connector with 20 pcs of 6.5*85mm long screws, is an innovative product from Sherpa, Austria.

- This connector has two dove-tailed metal slots that are separately embedded into each structural member in the connection.
- However, in comparison with Sherpa, RothoBlaas is also having an alternative solution - LOCKT50175 with 7mm*80mm screws. In which the LOCKT is also providing a functional withdrawal capacity,

A2 – Sihga IF304 with 8*GoFix HK 34mm, is also an innovative product from Sihga, Austria.

- This connector is used in timber-to-timber connections. The connector needs to accommodate into a 27mm recess of the timber member, as well as it contains 8 screws and imbedded downward at 45 degrees and forms a circle. An M12 bolt loads the connector in tension or by shearing forces.

A3 – is a self-designed connector for this competition design concept. Due to the specific shape of this connector, we called it a 'Pineapple ring'. The inside hollow is designed for the staircase.

A4 – Modular footing + connector system, which is also a self-designed. A4 is used to connect the staircase, and bottom foundation supports. The modular footing which consists of male and female concrete footing blocks with built-in I-columns (150UC37.2).

The gaps between panel-to-panel will be sealed by using RothoBlaas' EASY BAND universal tape and TRASPIR 135 membrane as a protective layer.

The integral timber technical structure design reports were generated by TimberTech ACROTIM and attached in the report.

Thank you.

For more detailed information, please check our report and poster.

DESIGN REPORT

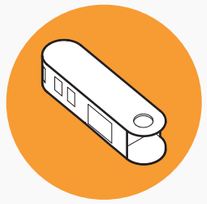
LINK_POD

CHALLENGE CUP COMPETITION 2020

OUR APPROACH

EXECUTIVE SUMMARY

+ Housing affordability problem is not simply a matter of building more dwellings or building cheap houses. It is a systematic problem closely related many factors, such as the prolonged development period, compromised design, inefficient construction process, waste of building materials, shortage of labours, speculators of property market, agent and asymmetrical information, complex planning regulations and more. We need a holistic approach to the housing affordability problem.
+ In this proposal, we focus on the demand from people who need short-term living places from 6 months to 2 years. Our target customers are overseas students, travellers having working holidays, families experiencing domestic violence, business people and professionals working away from home. Traditional housing supply such as student flats and rental properties are not flexible and affordable enough to accommodate these ever changing demand. It is not only because these buildings take a long time to build and cost developers a significant amount of capital expenditure, service providers also need to charge at a higher rate to compensate the risk associated with the fluctuation of demand.
+ Our proposal of fully-finished prefabricated modules will bring the housing demand and industry 4.0 manufacturing process together to solve these issues. We aim to increase the efficiency of construction, reduce associated costs of development, minimise our carbon footprint and create a sense of community.
+ Modules are designed to be easily assembled and disassembled and to be relocated to other places, therefore, precious land don't have to be owned by developers or residents, which significantly reduces the initial capital expenditure for developers.
+ Then modules are made to demand in an automated factory environment, thanks to the industry 4.0 revolution and the on-line platform which makes the whole process transparent and efficient for potential customers.
+ The design of the module minimises on-site construction period and earth work needed as in conventional build. The complete prefabricated units only take days to be installed which significantly reduces the uncertainty and cost of developments.
+ By reducing all those costs associated with development, the benefit can be passed on to people who live in the community and achieve affordable housing supply for target customers.



Modular Design

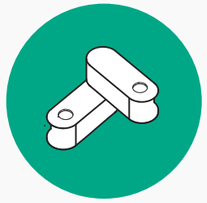
+ There are two variations of modules: 13.35 meters X 3.5 meters as two-bedroom unit and 10 meters X 3.5 meters as one-bedroom unit. Both modules are 3.3 meters in height with adjustable connection unit.
+ Kitchen unit, appliances, bed frames, wardrobes and storages are prefabricated and built into the module for minimal on-site installation and maximum quality control.
+ The module has provisions of service connection on one end (electricity, water, drainage and telecommunication) and vertical circulations on the other end. Our custom designed connection unit enables rotations between two adjacent modules while maintains the structural and service integrity.
+ Standard design with lots of built-ins will improve the efficiency of manufacturing while have a standardised quality benchmark for all units. Maintenance is also easier than traditional building, as all parts of building are standard and mass-produced. This ensures the quality of every module meet potential customers' expectation.
+ In conventional modular construction, one module is stacked on top of the other. Floor and roof structure are doubling and wasted. In our modular design, roof tops are designed to carry garden beds and decks which provides luxury outdoor space for residents. Meanwhile, it improves thermal performance of the module as plants and soil work as an extra insulation layer.
+ The module uses zinc sheets as weather shield for its appearance, light weight and durability. Part of the exterior cladding can be opened to form a balcony. It is important for people who lives in the "capsule" to connect with the surrounding natural environment and other "capsule" dwellers. The design aims to create a sense of community while maintains privacy that needed.

Industry 4.0

+ Smart Factory - The module is standardised built by the factory's complete production line with the assembly machine, which involves a combination of both automated and manual manufacture processes. The fully reversible assembling design requires low tolerance in manufacturing and installation processes as novel connectors and Engineered Wood Product - bamboo are preferred to conventional framing. Thus, production lines equipped with automated machine arms are critical to provide high accuracy and efficiency on production. Automatic production line would also provide better quality and time control. It reduces the need for labours which benefits countries like Australia from shortage of skilled labours.
+ Smart homes - Sensors are embedded in the laminated bamboo during the production of panels and frames. The sensor comprises the monitoring of moisture content, vibrations, strains, displacements and loads. A specific serial number is assigned to each structural elements to track/repair/replace during the life cycle of the module. Other sensors are installed to monitor daily consumptions (water and electricity), building performance (temp. and moisture) or for safety reasons. Those information is available to both residents and manufacturers as a database for analysis and research.
+ Efficient production – As there are only two variations of modular design with similar structure, the production can be highly efficient as parts are standardised and mass produced. It is also easy to control the quality in production and have repair/replace parts available in future. The cost of the module itself would be much less than conventional construction since less labours are used and less materials are wasted.

Transport and Installation

+ The largest overall dimension of our module is 3.5m x 12m x 3.3m (Width/Length/Height). It generally does not require pilot or escort in urban area (refer to Vic, Qld and SA escorting guideline), which minimise the cost and complexity for transport.
+ The balcony and window shutter are operable. During transportation, they can be seamlessly folded up to the wall and protect the windows and glass doors behind.
+ As modules can be added on or relocated during its life cycle, the structure, fixings and connection units of the module are specifically designed to cope with assembling and disassembling issues.
+ Each module is a complete and weather proofed unit. It can be stored at anywhere that has a levelled ground before transported to site. After site preparation and having required footings done, it only takes days or even hours to position the module into place and fasten the connection units. It minimises the construction time and reduces interruptions of unexpected events (ie. weather) during on-site installation.
+ The module uses light-weight materials and bamboo frames which minimise the gross weight of the module for ease of transport and installation.



Adaptability

+ We designed circular connection unit to enable rotations between two adjacent modules. Therefore, The angle between one module and the other up or below can be adjusted to adapt to site specific conditions (such as protected trees and obstacles). More importantly, it provides developers multiple options of overall configuration without changing the design and structure of the module.
+ The module is designed to sit off the ground with point connections to footings. It can adapt to sites where there are extensive slopes, level of moistures and surface runoff. This reduces the needs for costly retaining walls, concrete slabs and related stormwater drains.
+ It has the potential to occupy some trickiest sites in urban area, such as sites with large underground infrastructures around the city. Because of its light weight, flexible layout and temporary nature, it may provide an affordable solution to various restrictions.
+ The height of the circular connection can be adjusted between 200mm to 400mm which gives adequate tolerance to both design and on-site installation.

Sustainability

+ This modular design takes a holistic approach in order to provide the maximum environmental benefit of selected materials and assembly/disassembly process in each life cycle stage of the building.
+ The module built by Engineered Wood Product- Bamboo (EWP), acts as a balancing agent for the greenhouse gas emissions of the urban area, therefore the module acts like a carbon pool. The whole-of-life role of the modular design in future Australian urban development contributes to the balance of urban carbon emissions.
+ EWP-Bamboo removes (sequester) carbon as they grow. Carbon is stored inside the structure for a long-term until the building reach the end of life. EWP-Bamboo has a lower embodied emission but superior structural performance compared to conventional constructional materials including timber, concrete and steel.
+ EWP-Bamboo frames and panels are protected by zinc cladding to maximise its life in different climate. The embedded sensors may also extend the life of the whole structure by locating and replacing the specific parts rather than the whole module.
+ Buildings start to release carbon before they physically exist, and carbon emission extends across the presence of the building. The proposed industry 4.0 manufacturing process minimises the carbon emission during material manufacturing and assembling process.
+ The module is designed with light-weight structure and specific sizes for easy transport and installation. The design also minimises the use of construction equipments on-site. Therefore the carbon spike during the construction process is reduced and the GHG emission due to transport is minimised.
+ At the end of life cycle, the biggest part of superstructure, EWP-Bamboo- can be recycled with the minimum wastage factor due to novel connection between the components.

OVERALL SCHEME

BUILD ON DEMAND

Target customers with short-term living demand (3 - 24 months)

+ University/college students
+ Travellers/Working holiday
+ Families experiencing domestic violence
+ Business man and professionals who work away from home

Online Platform

+ Collect and manage potential users' preference of location, transport and other housing demand.
+ Generate options for users to submit their interests and deposit.
+ Sending orders to development and prefabrication department.

Developing Process

+ Land lease agreement is signed by developers to start the process of design and approvals.
+ The length of the lease agreement is negotiated and agreed by potential end users in our booking system

Manufacturing process

+ In the meantime, orders are sent to factory and existing inventory system to meet the specific demand and delivery date.
+ Modules can be quickly replicated by automatic production line. Labour is partially replaced by robotic arms for better quality control.

Relocation & Transport

+ Dimensions of the unit is designed to be transportable by typical fleet without escorting.
+ Each module is weather proofed and self-supported with no need of assembling on site

Fast Installation/Uninstallation

+ Each module can be easily fixed onto footings or the other module through connection unit.
+ Services and fit-outs are completed in factory and the module is ready to move in directly after installation.

THE HOUSING AFFORDABILITY PROBLEM

As identified by Australian Parliament inquiry in 2008, the housing affordability problem is structural rather than cyclical. It means it is not simply a matter of building more dwellings to meet the demand. The problem is systematic, and closely related to the prolonged development period, inefficient construction process, compromised design, speculators of property market, and complex planning regulations.

Affordable housing is not about building cheap and small houses, but to have a solution that deals with all the above issues. For short-term living demand like students, visitors and working based housing demand, it is temporary and fast-changing. Traditional development and building solution are not flexible and adaptive enough to meet those demand. It is costly and also wastes valuable resources during the process. Industries and authorities should promote diversified housing supply and adaptive models to accommodate this ever-changing demand. Our proposal will tackle the problem from the following aspects:

+ This proposal brings mobile architecture and prefabrication industry together to separate the pure function of a dwelling from its conventionally attached land ownership.
+ The module is fully functional as a normal unit and is as durable as conventional houses. The two types of modular units can form numerous combinations and adaptive living complex which can be relocated and reconfigured after a period of time.
+ The purpose is to create a product for those people who need a temporary habitat at specific place and time rather than an investment product. While the land ownership, which is often treated as an investment facility and sensitive to monetary policies and taxation, can be separated from the dwelling.

Design and Feasibility

+ The concept of mobile architecture will remove the hassle of purchasing and holding a piece of land. The absence of associated risks with land acquisition will significantly reduce the upfront cost and required margin of developments.
+ The modular complex can be adaptive to temporary sites and be movable to other locations at the end of the lease agreement.
+ The module is designed with built-in furnitures and integrated service connections. This will minimise on-site installation works and reduce unexpected delays and site related risks.
+ The modular design of only two major variations in length will significantly increase the efficiency of fabrication, transportation and installation process.

Safety and Labour

+ The shortage of skilled labour in construction industry has been identified as a concern of housing affordability problem. (Australian Parliament , 2008). This proposal provides a solution to mitigate the issue by prefabrication and industry 4.0
+ Modern manufacturing process with computer controlled machinery will significantly increase the efficiency of construction and reduce the need of low skilled labours.
+ It will have better quality and time control on labourers due to pre-set manufacturing procedures. Well considered procedures will also reduce unnecessary waste of building materials which is an important part of pursuing sustainable construction.
+ The safety of employees and tradies will be insured by a better and controlled indoor environment than on-site construction.

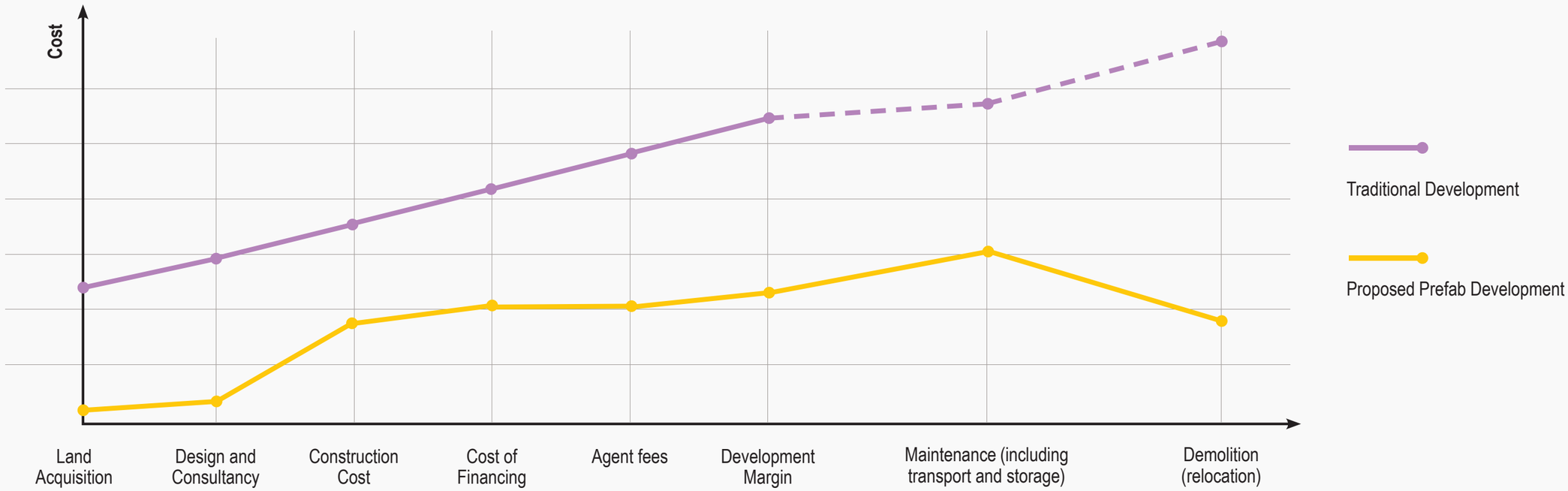
Policy and Regulation

+ The proposal will challenge the current planning schemes, building regulations and even tax policies for potential buyers.
+ The modular complex is applicable to sites that are conventionally not feasible to be built on, such as state-owned land reserves for future infrastructures, land with temporary or seasonal flood risks, and any other temporarily available sites around fast expanding urban area.
+ Council should consider concession rates of connections to sewer and electricity and city council levy for this new type of development. Because of the temporary nature of the modular homes, it is not reasonable to pay as same rates as traditional units.
+ Government should also consider to give buyers who want to own the modular home some grants, similar to first home grants for typical first-home buyers. This is because the modular home provides an innovative solution to the demand and contributes to diverse housing supplies.

Sources:

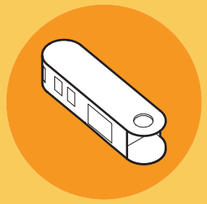
Parliament of Australia, 2008, Inquiry of the problem of housing affordability, https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Former_Committees/hsaf/index, assessed on 22 July 2020.

COST EVALUATION



+ In traditional development, developers need put down a large amount of initial deposit for land acquisition. Owning the land for development of a length period of time will incur significant amount of holding cost and financial cost.
+ Our proposed modules and development model will only need land lease agreement which significantly reduces initial capital expenditure and associated holding costs.
+ The modular design is adaptive to different site geometry and topography. The design is simply repeated and applied within pre-set rules. The extent of works by other consultancies and related fees are reduced.
+ An online platform is developed for booking and data collection
+ Real demand is confirmed before development started. Risks of market uncertainty and costs of selling units are minimised as all modules are pre-booked
+ Refer to engineer's estimation (Appendix B), hard costs of the module itself, transport and installation are significantly lower than traditional construction as it requires less labour and materials. However, the overall cost will depend on the number of modules produced if we take the cost of building the production line into consideration. The economics of scale will eventually bring down the cost of investment in industrial 4.0
+ Developer's margin is reduced because of shorter period of development and less uncertainties of construction.
+ Although it needs extra costs for module's transport and maintenance, developers/owners can recycle and reuse all modules and most materials after lease ends. This is a preferable and sustainable solution comparing with demolition and landfills of traditional building.
+ By reducing all those costs and margins associated with development, the benefit can be passed on to people who live in the community rather than investors and speculators of real-estate. Therefore, this proposal provides people with flexible, affordable and sustainable housing solution.

MODULAR DESIGN



The overarching idea is to design a space that is small but smart. Small in size doesn't mean we will compromise comfort and function. What we want is to reduce our carbon footprint by reducing daily energy consumptions, spaces that are wasted in our homes and embedded energy of construction and materials.

We want people who live in the pod can have easy access to greenery and outdoor space. We create a capsule that is private and cosy inside, while it can be opened up for residents to socialise with their neighbours. Moreover, roof garden and balcony provide passive surveillance and a sense of community. It is important for people to be connected because people have to set new relationships and get used to a new environment quickly in temporary living.

Even though the module is designed for short term living, the performance of the building is not compromised. All bedrooms have operable windows and cross ventilation. All walls are cladded with profiled zinc sheet, framed with EWP - Bamboo and filled with acoustic insulation. Glazing and floors are also thermally and acoustically insulated. Thermal performance is further improved as roof garden works as an extra layer to insulate the module. The quality and performance of the module is built to last long and to adapt to diverse environment from urban areas to remote regions.

+ Folding window shutter together with sash window are used to allow cross ventilation and provide extra space for study.

+ Dinning table can be folded on to wall unit when it's not used.
+ Seating bench, shelves, and kitchen unit are fixed onto structure for ease of transport & installation.

+ Operable shutter can be opened up as balcony. Fence is installed after. It expands the limited interior space to exterior.
+ It can be folded back onto exterior wall during transport.

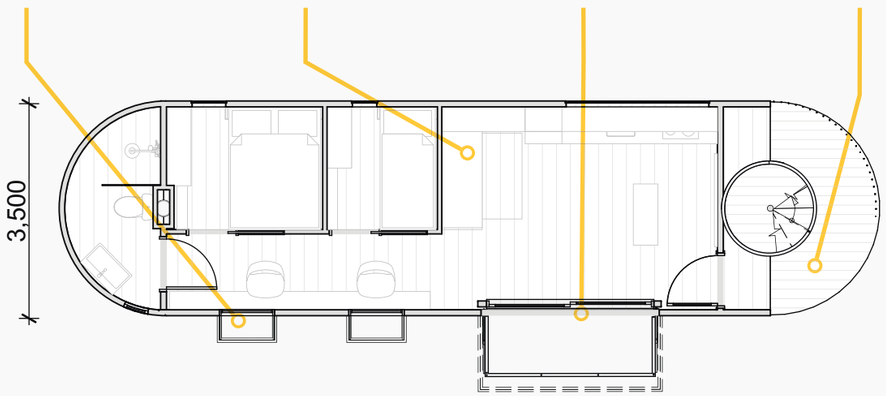
+ The circulation space is open to air and connects with the rooftop garden of the adjacent module.
+ This communal space is where daily conversations can happen among residents.

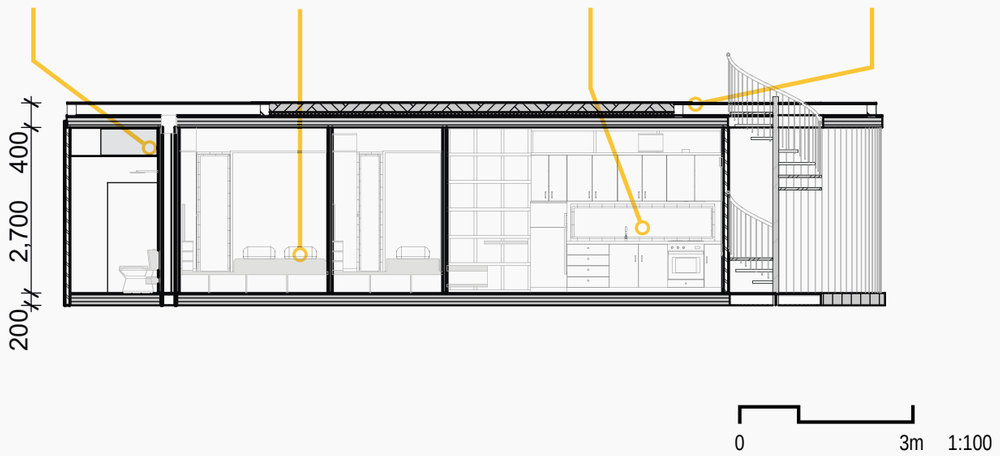
+ Service riser is located at the centre of rotating circle. Service can be easily connected while modules can be rotated to adapt to site condition.
+ Water tank and boiler locates on ceiling

+ Bedroom is elevated to give space for storage.
+ Mattress can be folded on to wall unit to give space for daytime use.
+ Operable full height window allows natural ventilation

+ Appliances such as stove, oven, and fridge are built into the kitchen unit with considerations for transport.
+ Operable window at kitchen allows for cross ventilation

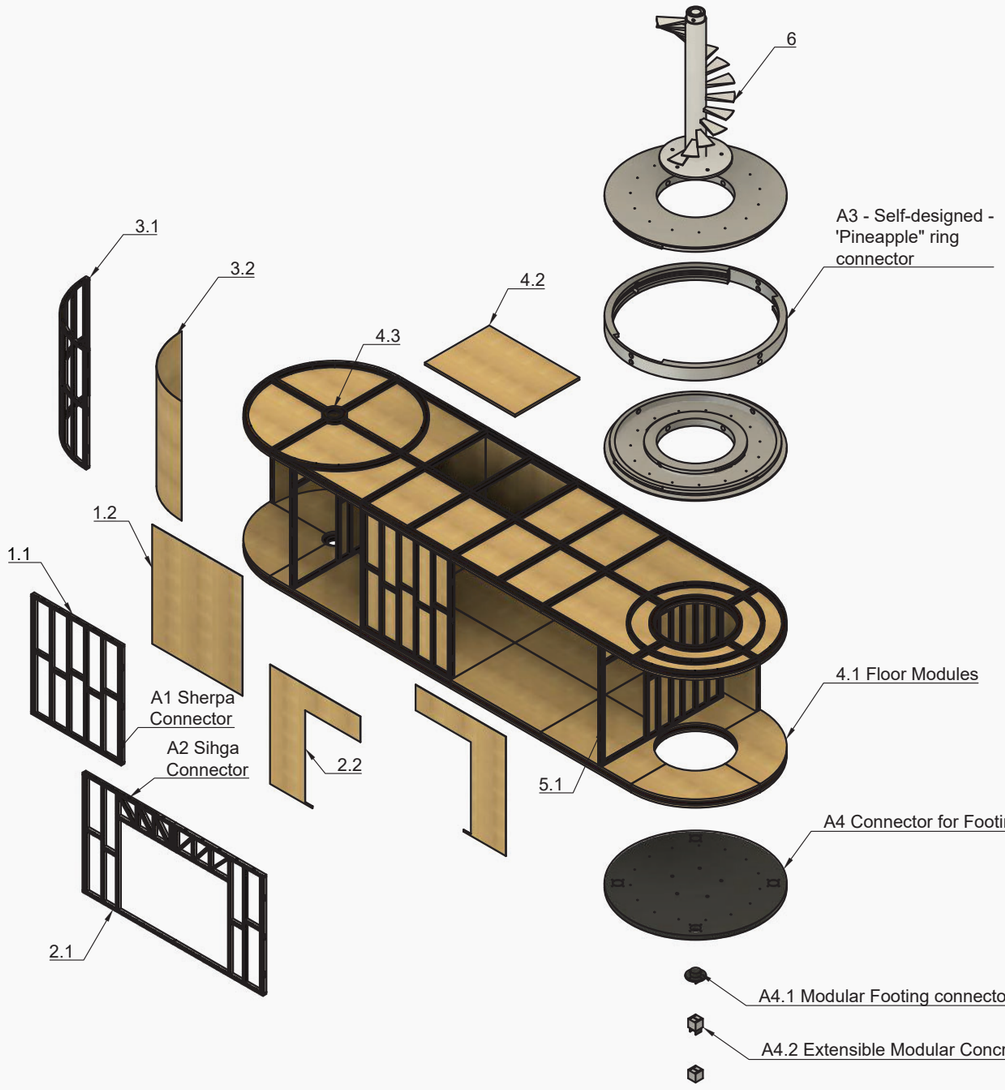
+ On rooftop, the area between the two connection rings is designed to hold 100mm soil for gardening. It connects to the living space for people who live on top.





STRUCTURAL DESIGN

Design for Manufacture and Assembly (DfMA) is the main principle of the structural design. With industry 4.0 and proposed automated production line, this principle is possible to be applied to our structural design as special fixings and connectors require low tolerance in manufacture and assembly. The module is not only designed for quick connections between two residential units, but for easy maintenance of individual structural panels and elements. This concept of design is aiming at transport the whole module in once. However, on the distance of the relocated place, the module can be downsized/disassembled to relatively smaller panels. These panels are fully reversible, to offer easy maintenance/reuse/recycle and achieve the circular economy. At the end of life cycle of the module, design for disassembly makes it possible to recycle and reuse the entire building. In this circumstance, both economic and environmental benefits are maximised (Akanbi et al., 2018). The integral timber technical structure design were checked accordingly ARCOTIM TimberTech.



+ Wooden - Bamboo is selected for structural frame and panels. Bamboo is a sustainable carbon-negative material
+ The annual quantity of carbon storage per hectare of the bamboo forest is up to 5 tonnes, which is 1.46 times that of fir/pine and 1.33 times that of tropical rain forests. Moreover, compared with trees, bamboo takes a much shorter time to grow. Therefore, the application of engineered bamboo has great potential and benefi ts.
+ The called as ‘wooden bamboo’, which is a new material that innovated from the ‘Timber Institute of the Chinese Academy of Forestry’. It is a kind of ‘high-performance bamboo-based fibre composite material”. This new technology reduced the material waste generated during manufacturing and increased the utilisation rate of bamboo to more than 95%. Through the authoritative testing: the bending strength of this material is ≥350MPa, the tensile strength is ≥360MPa, the compressive strength is ≥140MPa, the modulus of elasticity is ≥30GPa, the boiling expansion rate is ≤5%, and the strength per unit weight can reach 2.5 times that of steel. However, since neither Australia standard nor ARCOTIM provides relevant standards/calculation methods, thus, for the rest of the design concept, we would assume to use Engineered Wooden Product (EWP) as a conservative assumption. The conventional size of ‘wooden bamboo’ is 2500mm (L) * 70-90mm (W) * 30-50mm (T), which is close to the size of Australian machined grade pine (MGP). Therefore, the civil design team will be choosing MGP10 - 45*90mm (the most commonly used in Australia timber-framed construction) as the primary structural material and taking into the design/calculations.
+ 1.1 Standardised panel – Manufactured in industry 4.0 assembly line. The material has set as MGP10 –

45mm*90mm in TimberTech for integral structure calculations. The modular panel pre-built-in 3 ‘Sherpa M20’ connectors (A1) on each side and 3 Sihga’s IF 304 connectors (A2) on both the top and bottom plate. Double external studs for allocating Sherpa M20’s long screws. Average stud spacing is 410mm. The panels will include a series of structural health monitoring sensors. The gaps between panel-to-panel will be sealed by using Roth-oBlaas’ EASY BAND universal tape and TRASPIR 135 membrane as a protective layer.

+ 1.2 Single-layer plywood/bamboo on one side only and act as part of interior finish. F14 plywood – Pinus species with the thickness of 15mm, by using RothoBlaas’ threaded nails (Ring nail/coils 2.8/3.1*60) to control the frame
+ 2.1-3.2, 5.1 are using the same techniques as standardised panel as well as the numbers of A1, A2 connectors.#2.1 consists of two half-opened gate panels and the leaving space are for installation of sliding door. And #3.1 is hot pressing/bending curved panel, in which this form is unlikely to achieving in MGP10 but except ‘wooden bamboo’ or LVL, therefore, in TimberTech’s model will be assuming to have 9 small straight panels instead of two curved panels (The drawings of TimberTech model can be found in Appendix D, E and F).
+ 4.1-4.2 The floor and roof are designed as Joist type which also builds with MGP10. M12 bolts will be use d to connect floor/roof to the Sihga’s IF304 that located inside of the modular panels.
+ 4.3 A 300mm hole used as a service core to connect water/electricity/gas, etc. The right side is a 1600mm hole for staircase #6.
+ + 6 Modular staircase, connect with basement steel plate by using 5*M25 bolts. The top of the stairs is designed as a stackable concept that can be extended up to Level 3.

CONNECTORS

+ A1 – Sherpa M20 connector with 20 pcs of 6.5*85mm long screws (that’s why needs double studs on external edge), is an innovative product from Sherpa, Austria. This connector has two dove-tailed metal slots that are separately embedded into each structural member in the connection. Instead of typical long screws being used, many smaller screws are used at various angles. This connector has been well developed in Europe with European timber (C24), in which can provide up to 10 kN in panels’ windward direction and 16.6 kN in withdrawal (Austrian Institute of Construction Engineering, 2017; Kowal & Augustin, 2016; Sherpa, 2013, 2018). However, in comparison with Sherpa, RothoBlaas is also having an alternative solution - LOCKT50175 with 7mm*80mm. In which the LOCKT is also providing a functional withdrawal capacity, however, due to the specific shape of itself, the capacity in the windward direction of the panel is relatively weaker than Sherpa’s M20.
+ A2 – Sihga IF304 with 8*GoFix HK 34mm, is also an innovative product from Sihga, Austria. This connector is used in timber-to-timber connections. The connector needs to accommodate into a 27mm recess of the timber member, as well as it contains 8 screws and downward at 45 degrees and forms a circle. An M12 bolt loads the connector in tension or by shearing forces. This connector has also been well developed under Eurocode 5 and ETA-14/0160 (ETA-Danmark, 2014). After several studies on ETA-14/160, the civil team has assumeD the capacity of Sihga IF304 is according to the density of the timber member, therefore, the tension capacity of this connector is regarded as 22.58kN (based on a design density of MGP10 from AS1720 – 500kg/m^3).
+ A3 – is a self-designed connector for this competition design concept. Due to the specific shape of this connector, we called it a ‘Pineapple ring’. The inside hollow is designed for the staircase. This connector can divide into three parts, the top and bottom are connected with upper and lower modules by using 15*M12 bolts with 15 Sihga IF304. By rotating the ring in the middle by 90 degrees, the upper and lower module will be locked, and several M100 bolts will then be placed to avoid further movements. This connector has been checked accordingly by using FEA analysis.
+ A4 – Modular footing + connector system, which is also a self-designed. A4 is used to connect the staircase, and bottom foundation supports. A4.2 is an extendable modular footing which consists of male and female concrete footing blocks with built-in I-columns (150UC37.2). These modules are aiming to provide a different depth of foundation footing to meeting all soil conditions in different locations. However, this design concept has not been

Please see in Appendix A for more detailed drawings

checked by using Australian Standards.

ENGINEERING CALCULATIONS AND LIMITATIONS

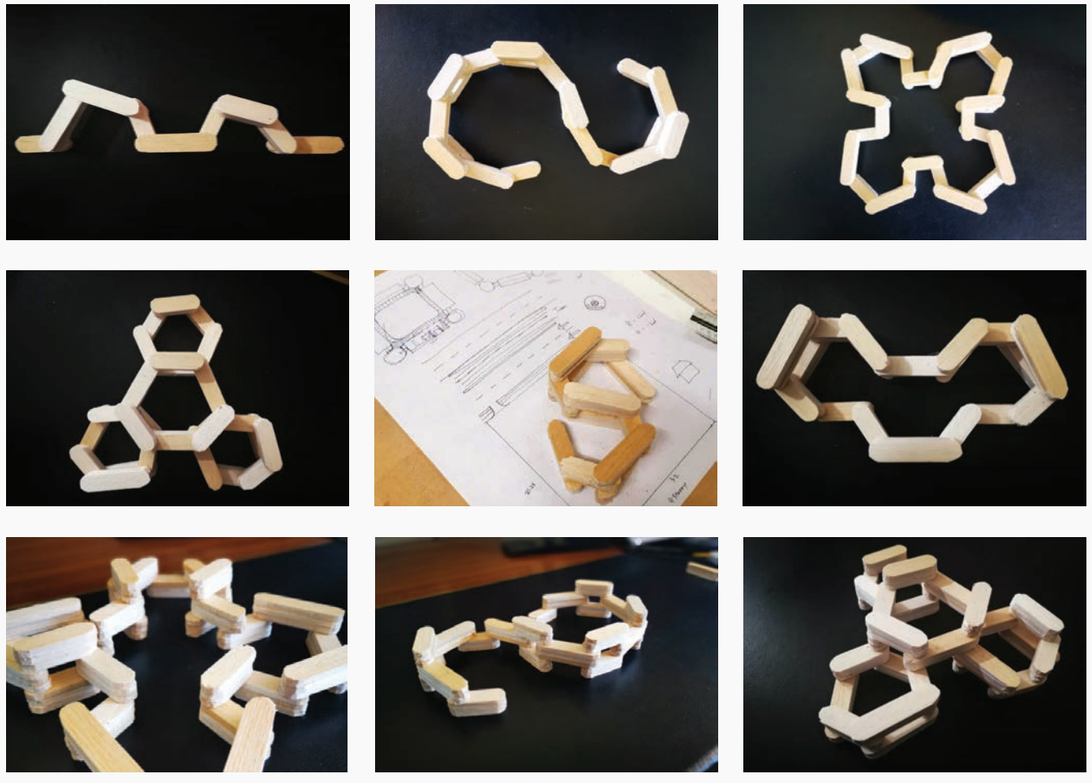
+ Both Serviceability and Ultimate wind/seismic/snow load actions are checked accordingly, which based on AS1170.1-4. The detailed calculations and the statement of the calculate limitations can be found in Appendix. The integral timber construction design has separated in three reports which regard to three different elevations - one module only (ground level), two modules mounted together, and three modules installed together. However, due to the lack of time, the civil design team has only positioned these modules without a rotated angle.
+ Since the ARCOTIM TimberTech does not provide Sherpa/Sihga connectors, the civil design team can only be used alternative connectors that has been listed in the software. The integral timber technical structure design reports can be found in Appendix D, E and F.
+ The current panel design is under an assumption of using MGP10 (which has been Australia's main timber material for framed structures for years) instead of wooden bamboo. The EWP is a conservative solution since wooden bamboo would offer a better characteristic capacity. For both of timber and bamboo are fibric material which always offering a better load capacity on the direction of perpendicular to the grain. The current panel structural design is based on the stud-to-plate connection. However, according to a study report's experiment results, the stud-to-stud connections offered better improvement of load-bearing/carrying capacity for the panels under compression (Alinoori et al., 2020). Therefore, due to the full module/panels will be tied down to a truck and will also experience a deliver trip, for the further improvement, a stud-to stud connection of the panel would be considered and re-designed.

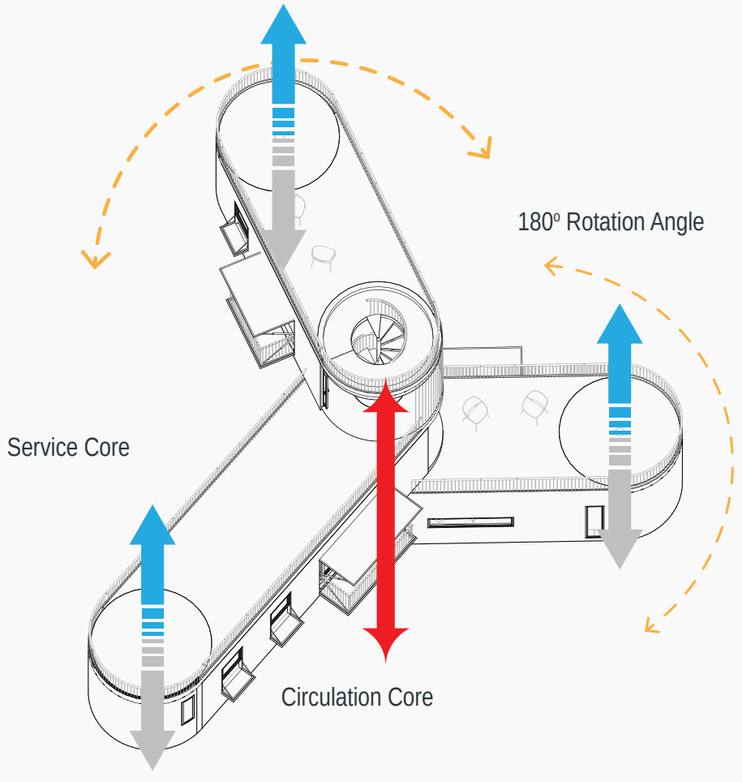
ADAPTABILITY

Acceptance of prefabricated building by general public is the most crucial challenges (Gibb, 2001). The prefab housing is associated with stigma of undesirable, cheap and inferior quality due to associations with temporary emergency housing, site offices, mining accommodation, and so on.

One of our design tasks is to break this stereotype of conventional boxed modular construction. The challenge is obvious, how to create a modular unit that can form endless arrangements, which is to say, each project can have a unique design by using the same modular units. So we designed the rotating modular system to provide the flexibility and diversity to the overall arrangement. It can easily form a few options for a potential site. The spacial relationship and appearance from outside can be very different from one to another. There are endless possible combinations of modules.

More importantly, this modular system has the adaptability to diverse site conditions. The angle between one module and the other up or below can be adjusted to adapt to trees and obstacles on site. Service core and circulation stairs are located at the centre of the rotating circle. Our purpose-designed connection rings ensure the integrity of services and structure while the module is rotated.





REFERENCE

1. Akanbi, L. A., Oyedele, L. O., Akinade, O. O., Ajayi, A. O., Davila Delgado, M., Bilal, M., & Bello, S. A. (2018). Salvaging building materials in a circular economy: A BIM-based whole-life performance estimator. Resources, Conservation and Recycling, 129(November 2017), 175–186. https://doi.org/10.1016/j.resconrec.2017.10.026

2. Alinoori, F., Sharafi, P., Moshiri, F., & Samali, B. (2020). Experimental investigation on load bearing capacity of full scaled light timber framed wall for mid-rise buildings. Construction and Building Materials, 231, 117069. https:// doi.org/10.1016/j.conbuildmat.2019.117069

3. Austrian Institute of Construction Engineering. (2017). European technical assessment ETA-12/0067.

4. ETA-Danmark. (2014). European Technical Assessment ETA-14/0160 of 26/06/2014. In Technical Assessment Body. https://doi.org/10.1017/CBO9781107415324.004

5. Gibb, A. G. F. (2001). Standardization and pre-assembly- distinguishing myth from reality using case study research. Construction Management and Economics, 19(3), 307–315. https:// doi.org/10.1080/01446190010020435

6. Government of Queensland. (2019). Queensland Access Conditions Guide. 4(July).

7. Government of South Australia. (2020). Escorting guidelines for oversize and overmass vehicles and loads in South Australia.

8. Government of Victoria. (2015). Pilot and Escort Graph Guide Over. 1, 60.

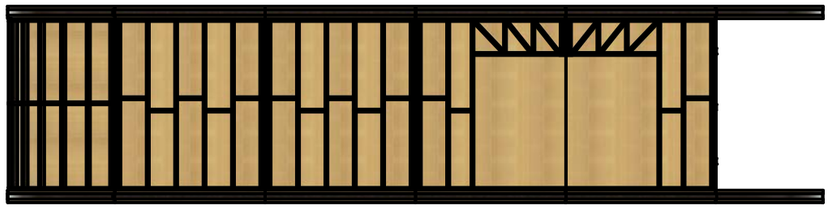
9. Kowal, J., & Augustin, M. (2016). Sherpa - Standardized timber connection system based on aluminium plates and inclined fully threaded screws. In WCTE 2016 - World Conference on Timber Engineering.

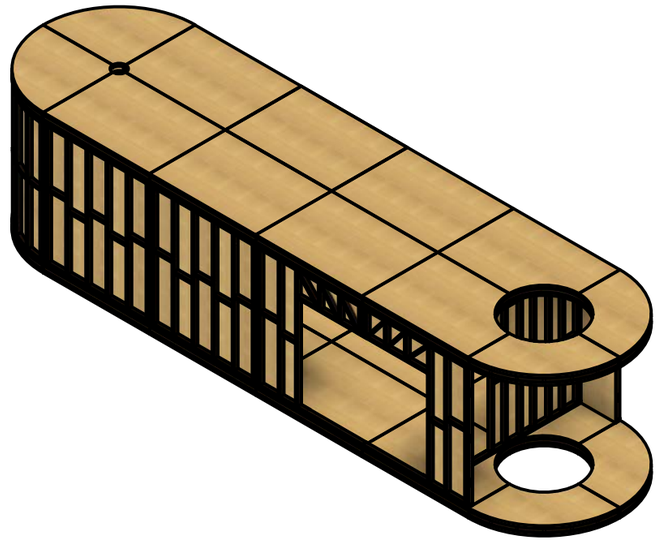
10. Sherpa. (2013). Sherpa Manual.

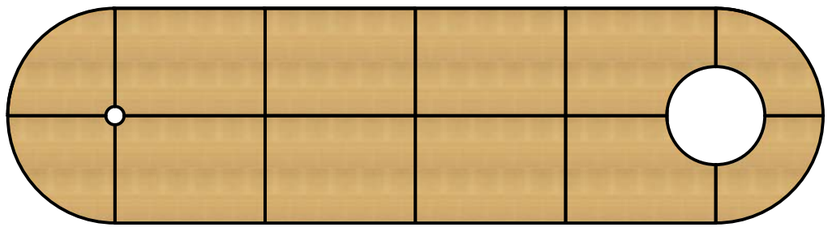
11. Sherpa. (2018). Design Guide.

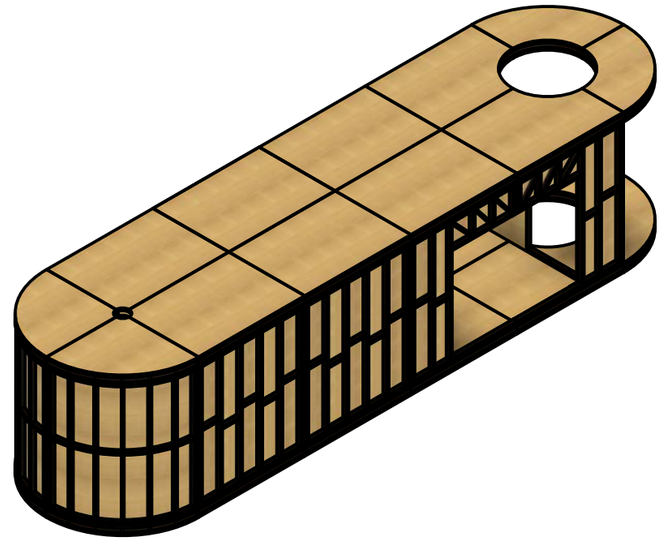
APPENDIX A

Detailed drawings for building components in next pages.

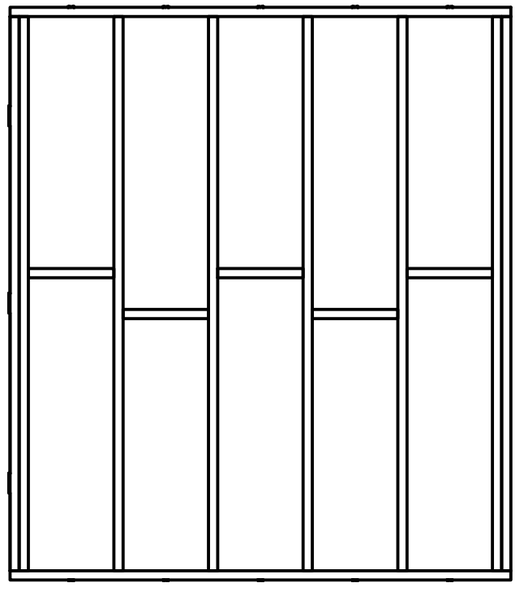


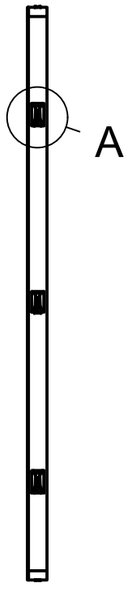


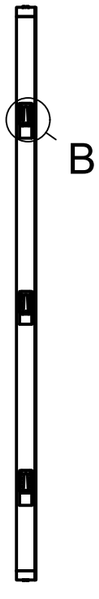


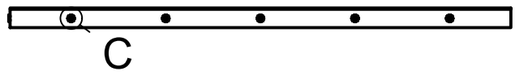


Dept.	Technical reference	Created by	Approved by
		9/08/2020	
		Document type	Document status
		Title	DWG No.
		9800mm Double house	
			Rev. / Date of issue / Sheet 1/1



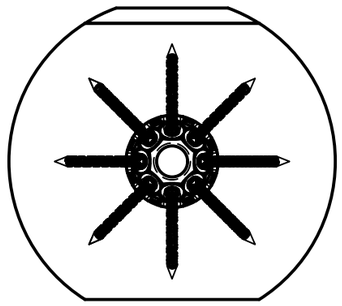






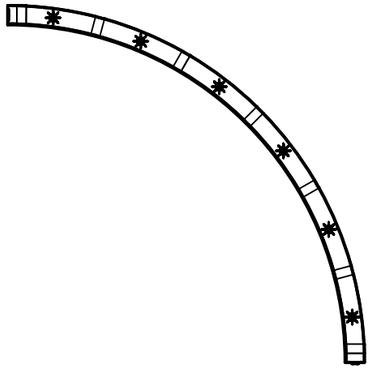
A (1:5)

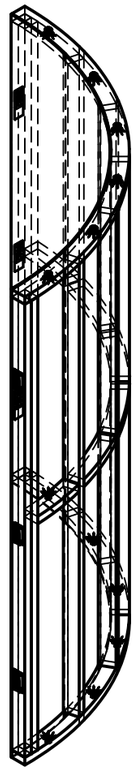
B (1:5)

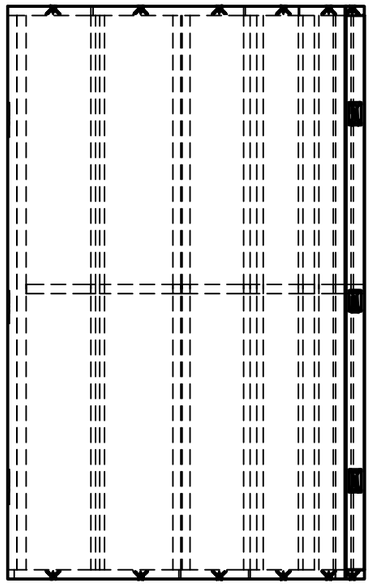


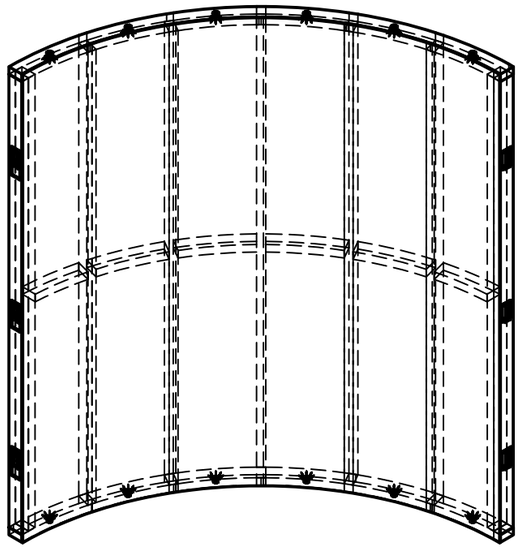
C (1:2)

Dept.	Technical reference	Created by 9/08/2020	Approved by
		Document type	Document status
		Title: Panel	DWG No.
			Rev. / Date of issue / Sheet 1/1

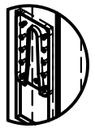




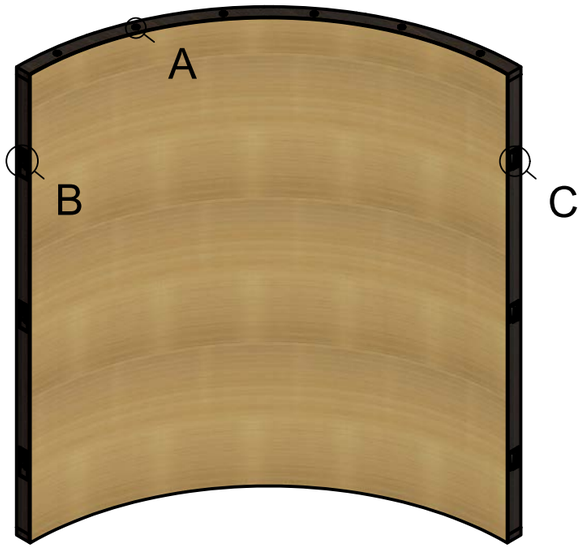




A (1:4)

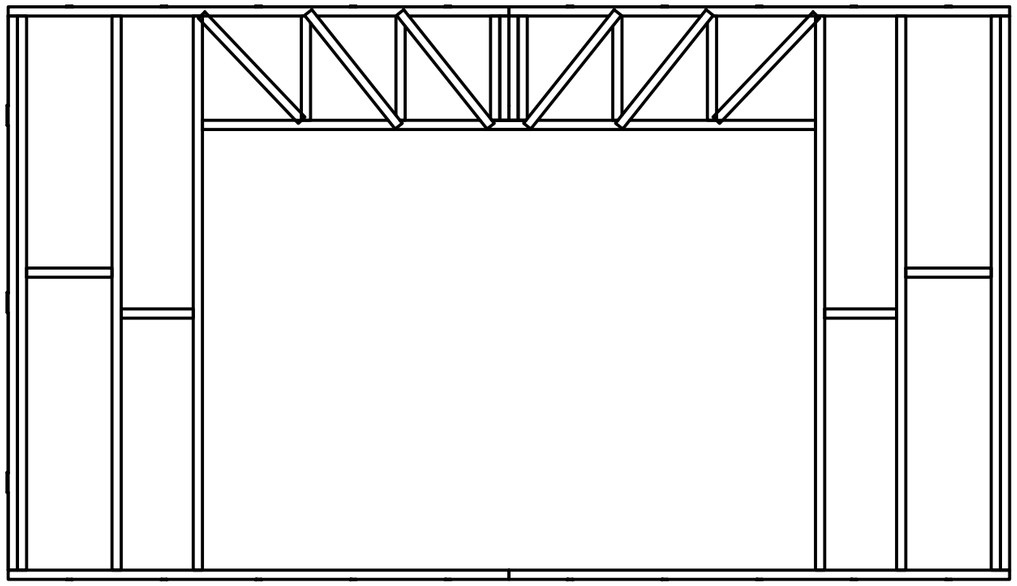


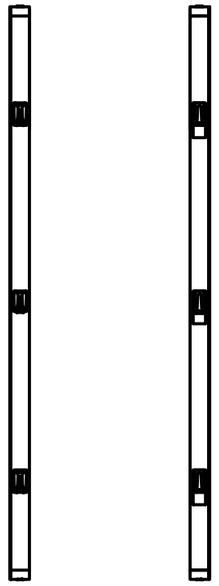
B (1:8)

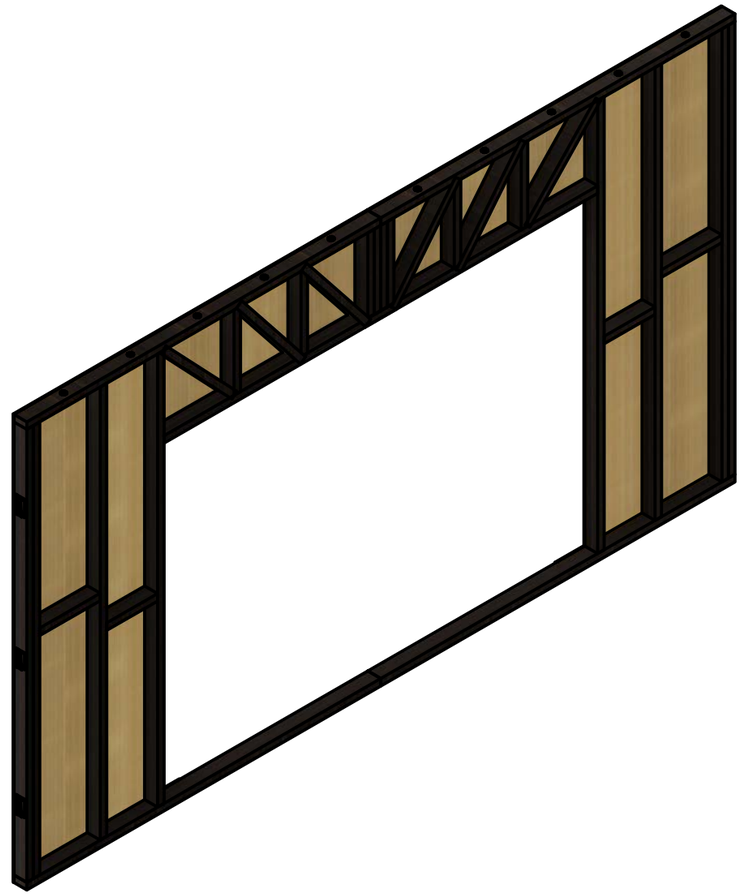


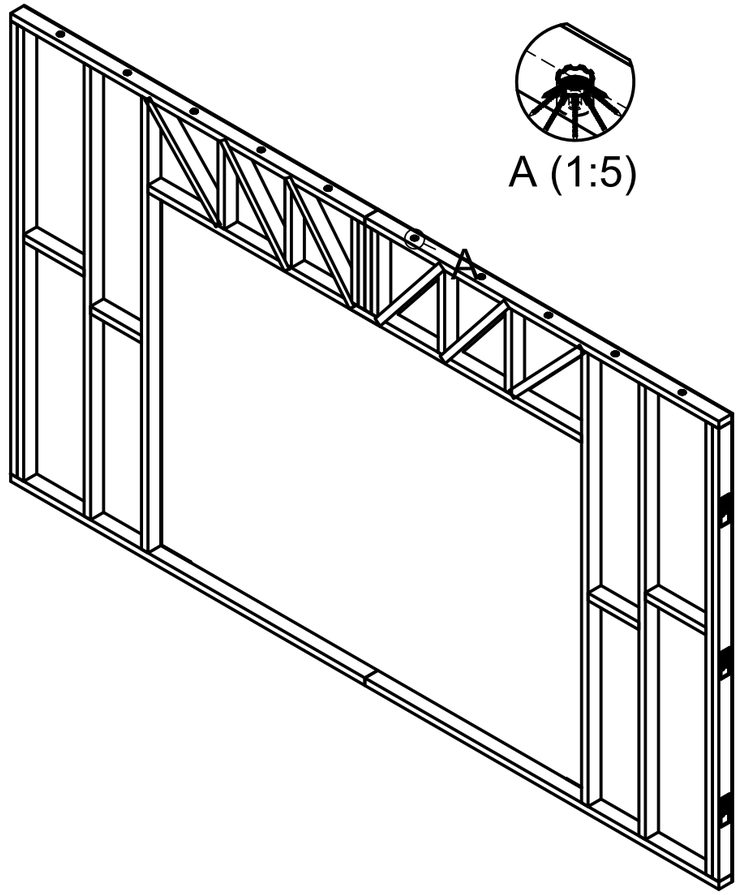
C (1:8)

Dept.	Technical reference	Created by	Approved by
		9/08/2020	
		Document type	Document status
		Title: Curve Panel	DWG No.
			Rev. / Date of issue / Sheet: 1/1



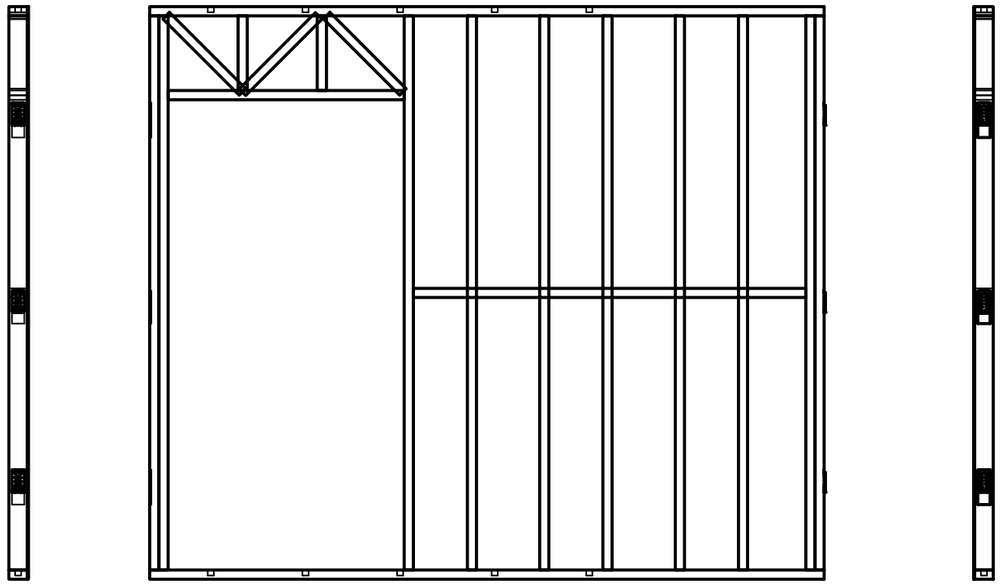


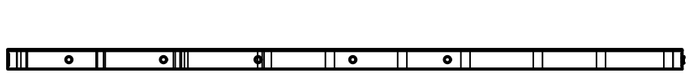


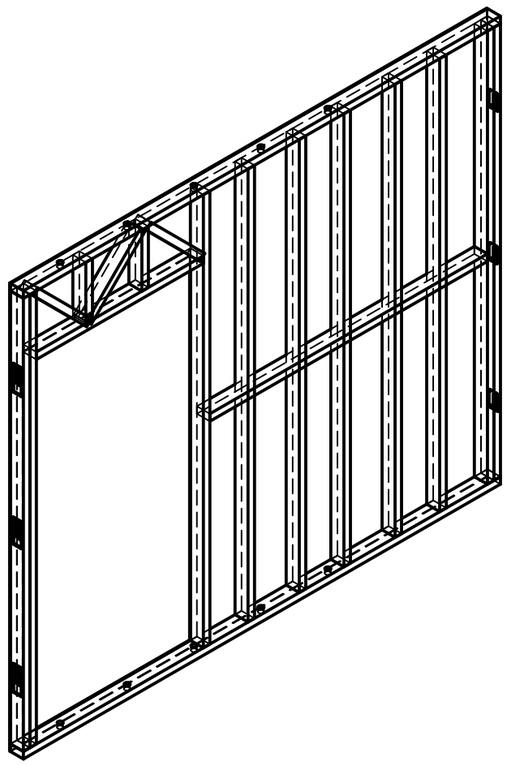


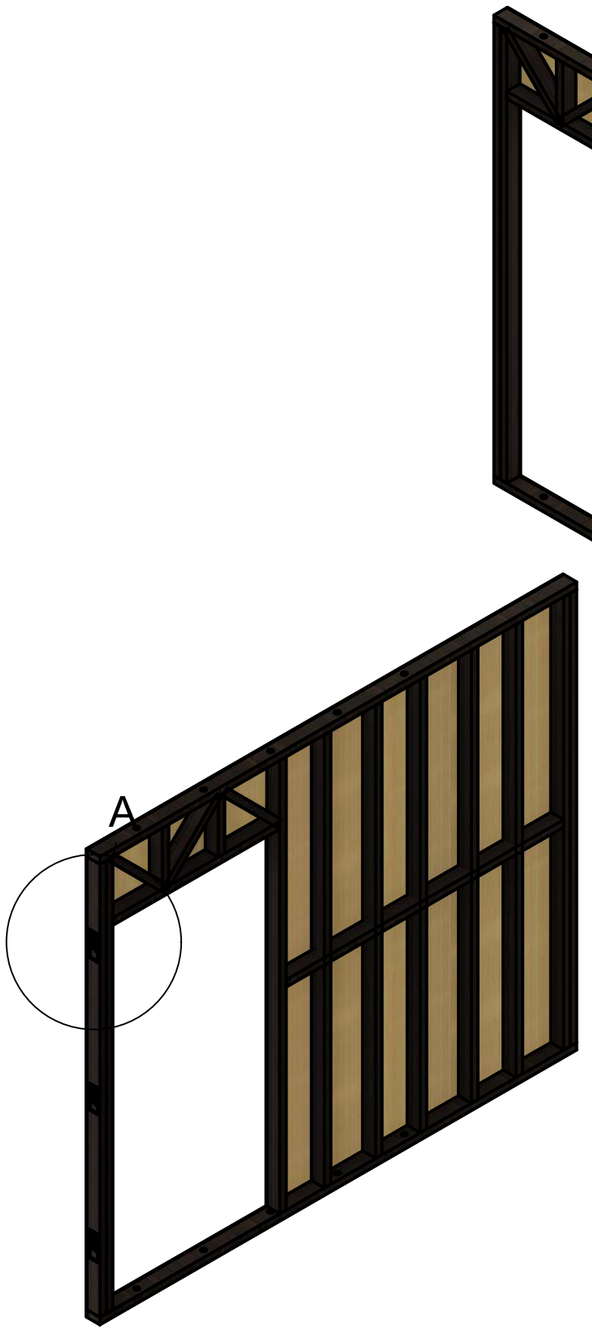
A (1:5)

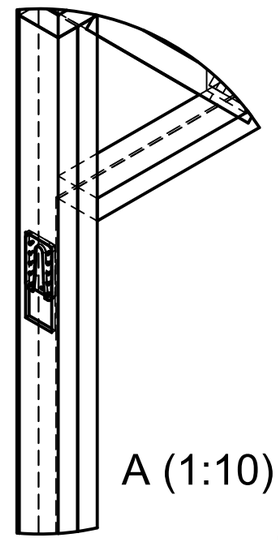
Dept.	Technical reference	Created by 9/08/2020	Approved by
		Document type	Document status
		Title **Gate Panel**	DWG No.
			Rev. / Date of issue / Sheet 1/1



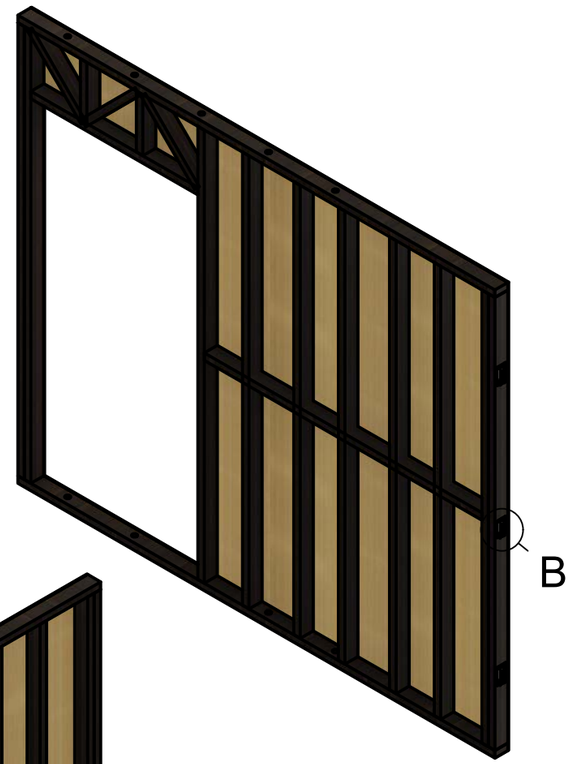


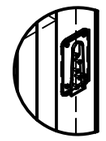






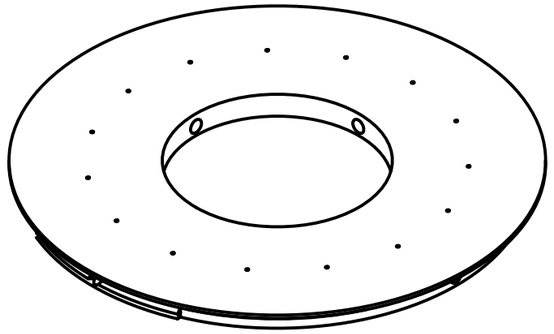
A (1:10)

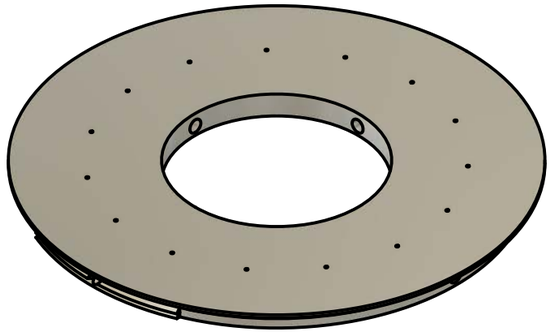


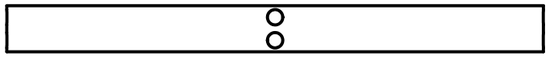


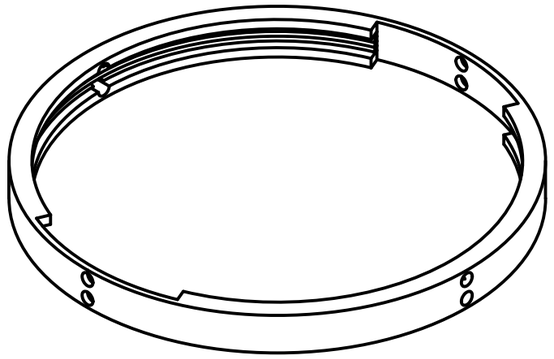
B (1:10)

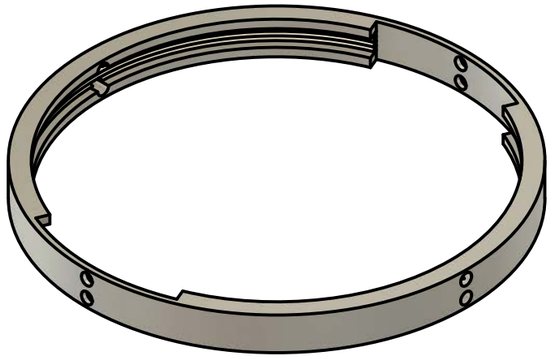
Dept.	Technical reference	Created by 9/08/2020	Approved by
		Document type	Document status
		Title **Gate panel 1**	DWG No.
			Rev. / Date of issue / Sheet 1/1

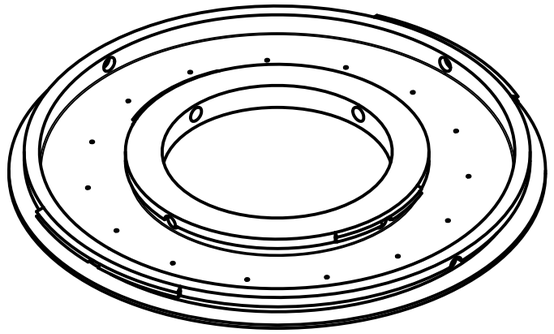


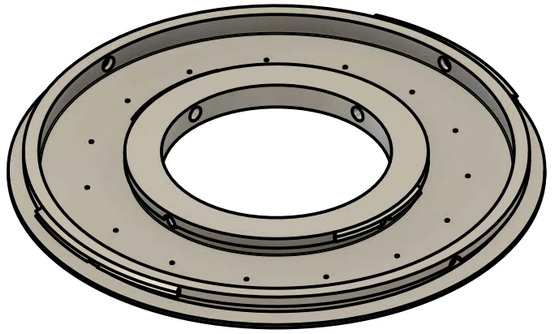


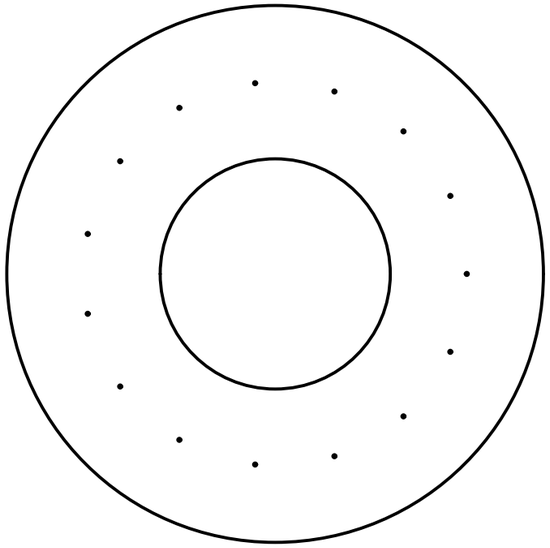




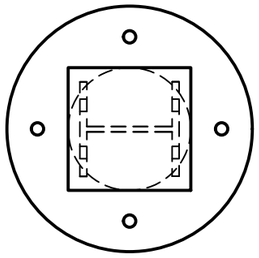


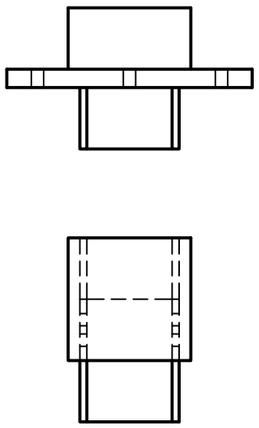


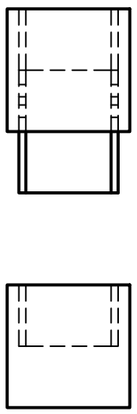


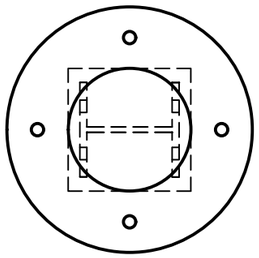


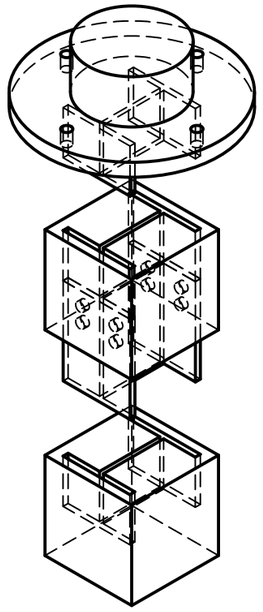
Dept.	Technical reference	Created by 9/08/2020	Approved by
		Document type	Document status
		Title: Ring Connector	DWG No.
			Rev. / Date of issue / Sheet 1/1

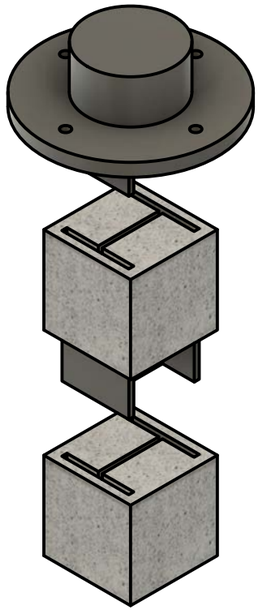


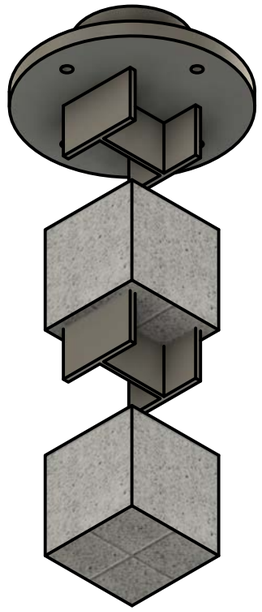




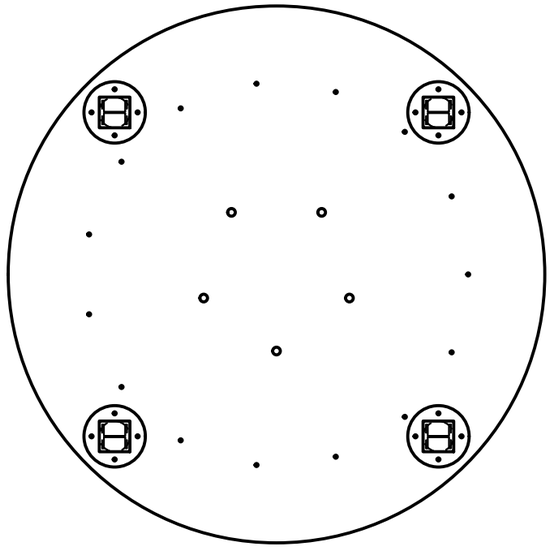


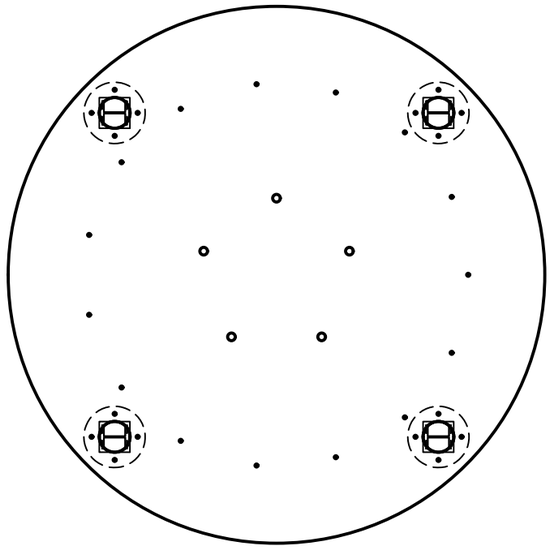


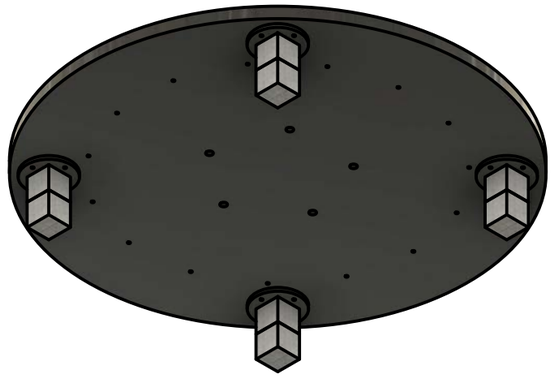


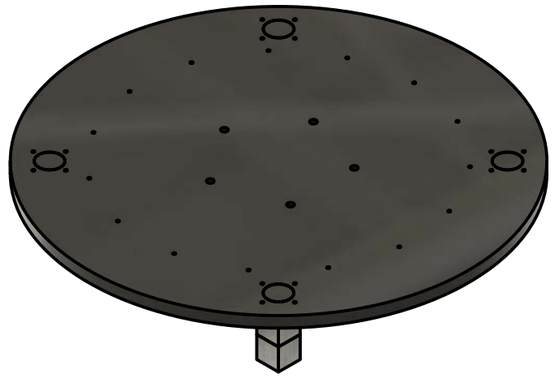


Dept.	Technical reference	Created by	Approved by
		9/08/2020	
		Document type	Document status
		Title: Footing	DWG No.
			Rev. / Date of issue / Sheet: 1/1

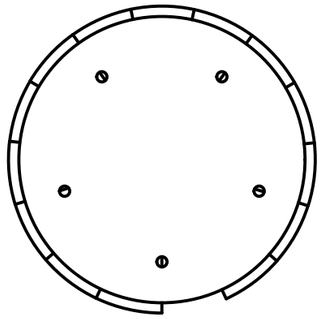


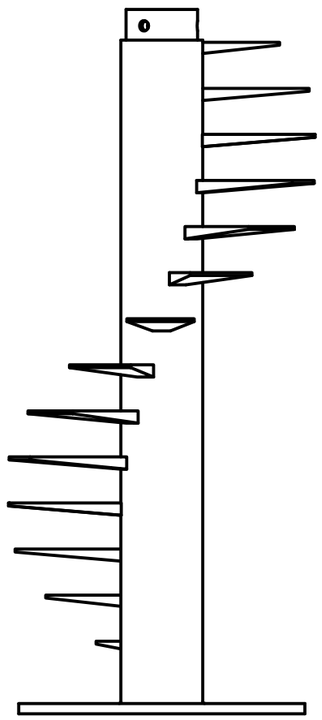


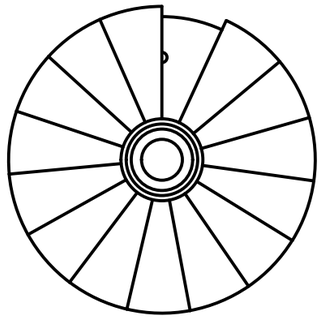


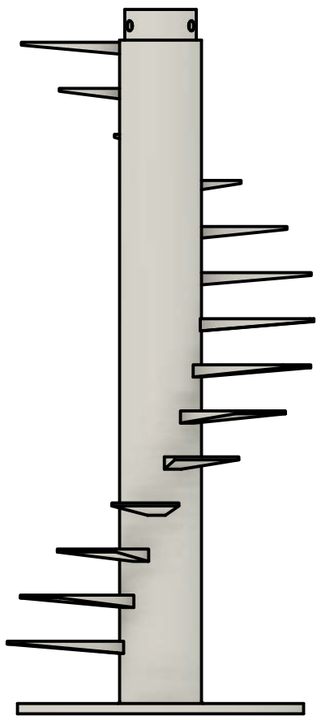


Dept.	Technical reference	Created by 9/08/2020	Approved by
		Document type	Document status
		Title **Bottem plate**	DWG No.
			Rev. / Date of issue / Sheet 1/1

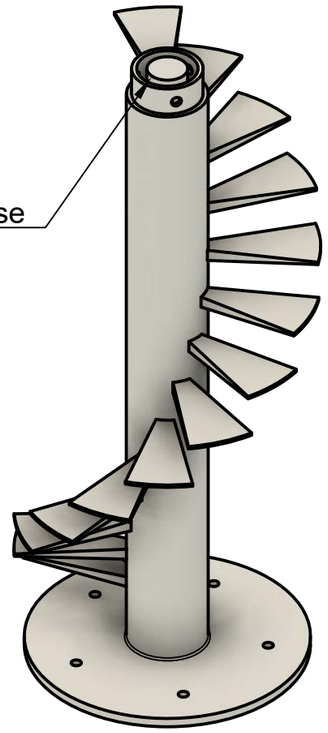




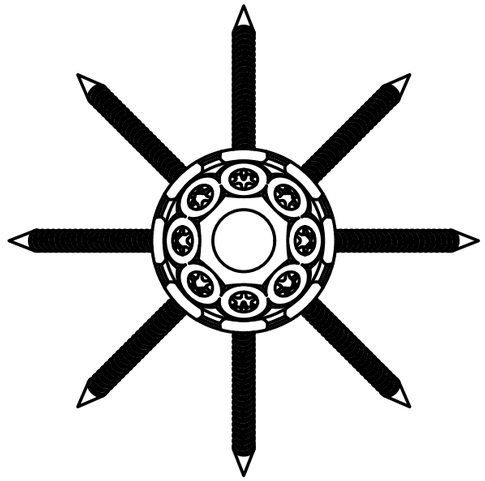


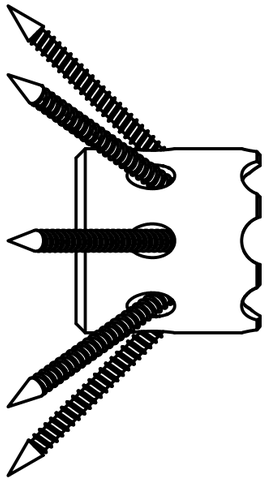


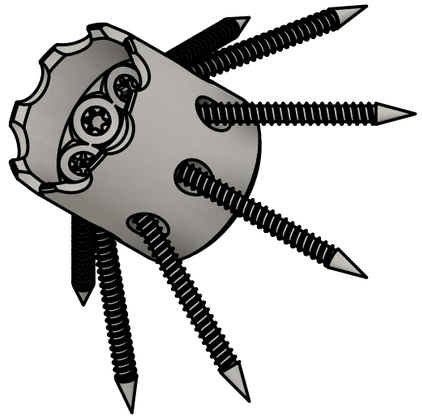
Stackable staircase

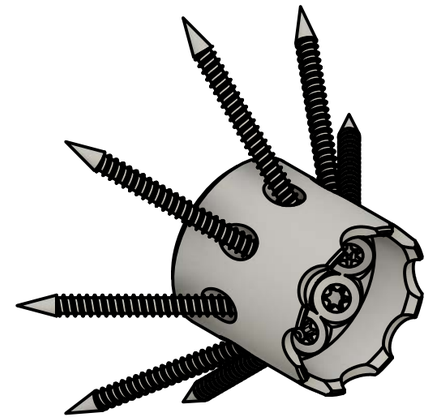


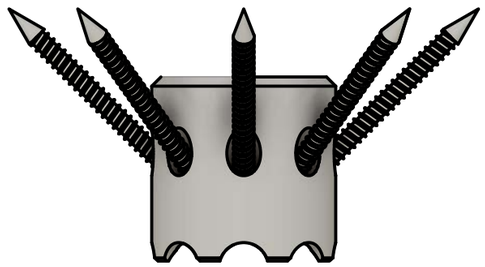
Dept.	Technical reference	Created by 9/08/2020	Approved by
		Document type	Document status
		Title: Stair	DWG No.
			Rev. / Date of issue / Sheet 1/1



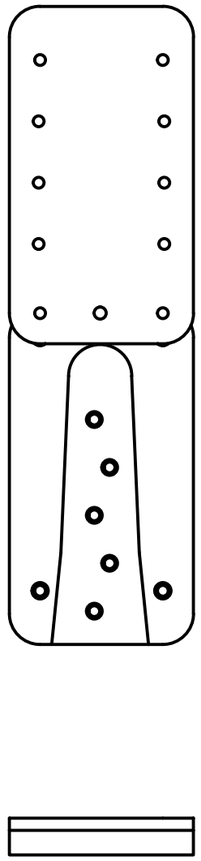


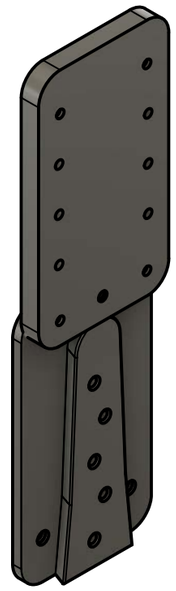


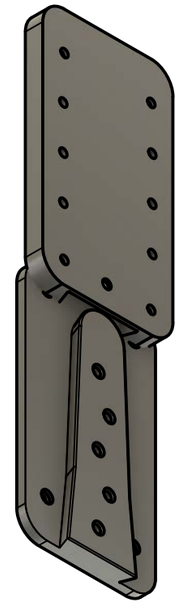




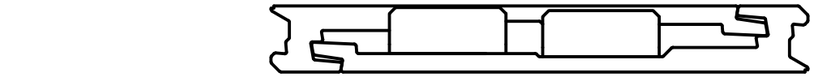
Dept.	Technical reference	Created by 9/08/2020	Approved by
		Document type	Document status
		Title **Sihga IF304**	DWG No.
			Rev. / Date of issue / Sheet 1/1

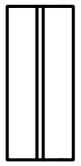


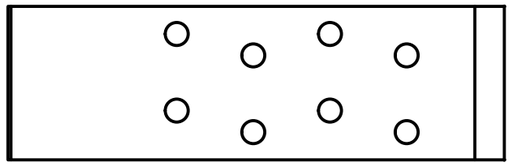


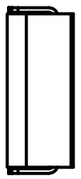


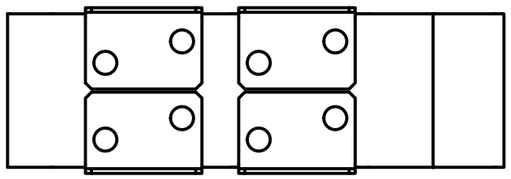
Dept.	Technical reference	Created by 9/08/2020	Approved by
		Document type	Document status
		Title **Sherpa M20**	DWG No.
			Rev. / Date of issue / Sheet 1/1

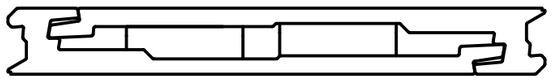


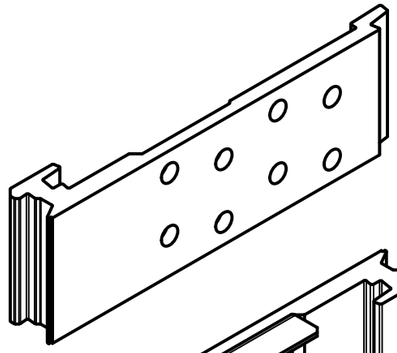


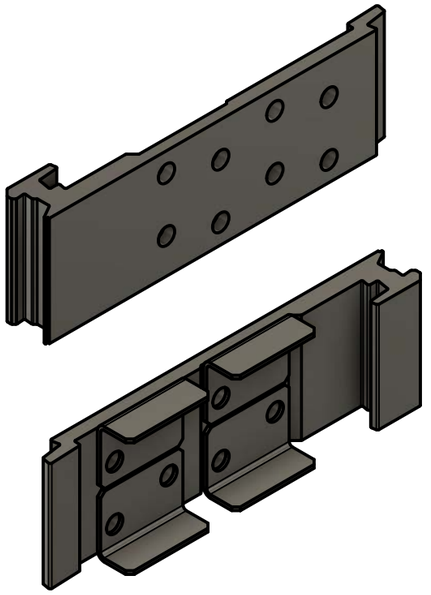












Dept.	Technical reference	Created by 9/08/2020	Approved by
		Document type	Document status
		Title LOCK T 50175	DWG No.
			Rev. / Date of issue / Sheet 1/1

Appendix B General Cost Estimation

Id	Supplier	Product Code	Description		Volume (m³)	Length (m)	Unit price	Amount
1	Rawlinson 2020 Construction Handbook		Framed wall elements - MGP 10	Wall 1	0.12	29.63	$3.50	$103.70
				Wall 2	0.12	29.63	$3.50	$103.70
				Wall 3	0.12	29.63	$3.50	$103.70
				Wall 4	0.12	29.63	$3.50	$103.70
				Wall 5	0.12	29.63	$3.50	$103.70
				Wall 6	0.12	29.63	$3.50	$103.70
				Wall 7	0.12	29.63	$3.50	$103.70
				Wall 8	0.12	29.63	$3.50	$103.70
				Wall 9	0.12	29.63	$3.50	$103.70
				Wall 10	0.18	44.44	$3.50	$155.56
				Wall 11	0.18	44.44	$3.50	$155.56
				Wall 12	0.18	44.44	$3.50	$155.56
				Wall 13	0.18	44.44	$3.50	$155.56
				Wall 14	0.18	44.44	$3.50	$155.56
				Wall 15	0.18	44.44	$3.50	$155.56
				Wall 16	0.18	44.44	$3.50	$155.56
				Wall 17	0.12	29.63	$3.50	$103.70
				Wall 18	0.18	44.44	$3.50	$155.56
				Wall 19	0.12	29.63	$3.50	$103.70
				Wall 20	0.10	24.69	$3.50	$86.42
				Wall 21	0.17	41.98	$3.50	$146.91
				Wall 22	0.18	44.44	$3.50	$155.56
				Wall 23	0.18	44.44	$3.50	$155.56
				Wall 24	0.15	37.04	$3.50	$129.63
				Wall 25	0.18	44.44	$3.50	$155.56
				TOTAL	**3.72**	918.52		**$3,214.81**
2	Rawlinson 2020 Construction Handbook		Joist floor - MGP 10 - 90 x 45 - 45 x 90 mm - Spacing 100 mm					
				Floor 1	1.77	437.04	$3.50	$1,529.63
				TOTAL	**1.77**			**$1,529.63**
3	Rawlinson 2020 Construction Handbook		F14 Plywood - Pinus species - Thickness: 15 mm				$/sqrm	
				Wall 1	1.95		$34.50	$67.28
				Wall 2	1.92		$34.50	$66.24
				Wall 3	1.95		$34.50	$67.28
				Wall 4	1.95		$34.50	$67.28
				Wall 5	1.92		$34.50	$66.24
				Wall 6	1.95		$34.50	$67.28
				Wall 7	1.95		$34.50	$67.28
				Wall 8	1.92		$34.50	$66.24
				Wall 9	1.95		$34.50	$67.28
				Wall 10	7.84		$34.50	$270.48
				Wall 11	7.84		$34.50	$270.48
				Wall 12	7.84		$34.50	$270.48
				Wall 13	7.84		$34.50	$270.48
				Wall 14	8.00		$34.50	$276.00
				Wall 15	7.84		$34.50	$270.48
				Wall 16	7.84		$34.50	$270.48
				Wall 17	1.86		$34.50	$64.17
				Wall 18	8.00		$34.50	$276.00
				Wall 19	1.60		$34.50	$55.20
				Wall 20	1.47		$34.50	$50.72
				Wall 21	5.98		$34.50	$206.31
				Wall 22	7.84		$34.50	$270.48
				Wall 23	8.00		$34.50	$276.00
				Wall 24	4.16		$34.50	$143.52
				Wall 25	7.97		$34.50	$274.97
				TOTAL	**119.38**			**$4,118.61**
4	Sihga		IF304		#Quantity		Retail Unit Price	Total Price
	:if-304-beschichtet-sc-6-im-montagepack/HL1066296/?pmzr=10089&itemId=7001107296				51		$23.58	$1,202.75
				TOTAL	**51.00**			**$1,202.75**
6	Rotho Blass	FE210116	INA - 5.8 - M12 x 160					
					2.00			
				TOTAL	**102.00**		**$2.03**	**$207.06**
7	Rotho Blass	FE210116	INA - 5.8 - M16 x 160					
				Wall 10	26.00			
				TOTAL	**26.00**		**$3.98**	**$103.48**
8	Rotho Blaas	HH10502003	Ring nail (coils) 2.8/3.1 x 60	Wall 1	77.00			
				Wall 2	77.00			
				Wall 3	77.00			
				Wall 4	77.00			
				Wall 5	77.00			
				Wall 6	77.00			
				Wall 7	77.00			
				Wall 8	77.00			
				Wall 9	77.00			
				Wall 10	289.00			
				Wall 11	289.00			
				Wall 12	289.00			
				Wall 13	289.00			
				Wall 14	338.00			
				Wall 15	289.00			
				Wall 16	289.00			
				Wall 17	77.00			
				Wall 18	338.00			
				Wall 19	92.00			
				Wall 20	75.00			
				Wall 21	262.00			
				Wall 22	289.00			
				Wall 23	338.00			
				Wall 24	186.00			
				Wall 25	338.00			
				TOTAL	4,760.00	1 box		$224.63
9	Sherpa				#Quantity		Retail Unit Price	Total Price
		83024190	M20		78		$57.38	$4,475.64
		73181290	Screw 6.5*85mm		780		$0.77	$600.60
10	RothoBlaas		Easy Band 60 (EASY60)		#Quantity		Retail Unit Price	Total Price
			Sealing the panels		5 Rolls		$49.28	$246.40
11	RothoBlaas		Traspir 135 (T135)					
			For air-tightness and water resistance		2 Rolls		$304.92	$609.84

The retail price for the products from RothoBlaas and Sherpa were accordingly checked with the techinical sales respresentative

							TOTAL	$26,599.26 GST INCLUDED
10	Delivery + crane Cost		Within 100km and no more than 3.5m width		$850	After 3 years inflation		$904.72
	https://www.modehomes.com.au/how-much-will-it-cost-to-transport-and-crane-my-modular-home/							
11	Estimated Cost for Supply $ Installation		Estimated as 2 bedrooms, 1 kitchen $ living area (56m^2)					$26,680.50
	https://i-build.b-cdn.net/wp-content/uploads/pdf/modularhomes/iBUILD%20Modular%20Product%20Price%20List%202020-05-01.pdf						TOTAL	$27,585.22 GST INCLUDED

Incudes Material and Connectors (without insulation infill, roof garden and cladding)
Referred to the data from MODEhouse in 2017, the final price in 2020 which is inflated.
Estimated as 2 bedrooms, 1 kitchen $ living area (56m^2)

Material Cost	$26,599.26
Delivery Cost	$904.72
Installation Cost	$26,680.50
Total Cost	$54,184.48

Appendix C Calculation report of load actions and statements of limitations

Summary: Wind Design

Table 1: Windward loading

Height m	Shape factors	Design Pressure (SLS) kN	Design Pressure (ULS) kN
3	0.64	351.85	537.95
6	0.64	351.85	537.95
9	0.64	351.85	537.95
10.4	0.56	307.87	470.70

Table 2: Leeward loadings along length

Height m	Shape factors	Design Pressure (SLS) kN	Design Pressure (ULS) kN
3	-0.192	-105.56	-161.38
6	-0.192	-105.56	-161.38
9	-0.192	-105.56	-161.38
10.4	-0.192	-105.56	-161.38

Table 3: Leeward loadings along width

Height m	Shape factors	Design Pressure (SLS) kN	Design Pressure (ULS) kN
3	-0.32	-175.93	-268.97
6	-0.32	-175.93	-268.97
9	-0.32	-175.93	-268.97
10.4	-0.32	-175.93	-268.97

Table 4: Uplift/Racking Force

Upper & lower floor racking force (unit 1)		Upper & lower floor racking force (unit 2)	
Wind on side (kN)	35.75	**WIND ON SIDE (KN)**	27.15
Wind on end (kN)	10.98	**WIND ON END (KN)**	10.98

Calculation of necessary parameters can be found in appendix 1, with these factors we can obtain the design wind pressure values using equations provided in As1170.2 and AS4055. Tables 1 to 3 show the summary of parameters for each surface.

Design wind speed obtained for Serviceability Limit state (SLS) was 29.96 m/s and for ultimate limit state (ULS) was 37.04 m/s. regional wind speed was selected as per Region A5 since it is approximately within 70 km of Melbourne G.P.O. Considering the ULS, our structure is classified to “Ordinary” and

assumed to have design working life of 50 years**.** Hence, we shall adopt the annual probability of exceedance equivalent to 1/500. Hence, the corresponding value of our VR is 45 m/s and similarly for SLS VR = 39 m/s. the site location can be classified as "Category 2" assuming that we have a uniform terrain category for each wind direction. The site location is situated in a suburban area with nearby structures therefore, we can assume the Ms = 0.92.

Summary: Earthquake Design

Table 5 Seismic Design

Story	Height (m)	Force (kN)
1	3.2	0.94
2	6.4	2.08
3	10.4	3.66

Earthquake design uses a force-based design method, which attempts to represent the inertial loads applied to a structure (over its height) through earthquake induced base accelerations (velocities and displacements) as equivalent static forces. Limitation of the design is that AS1170.4 does NOT consider ground failure actions, only shaking.

Summary: Snow Design

Table 6 Snow action design

Ground Snow load (kN/m^2)	*72.82*
Design snow load (kN/m^2)	38.23

The structure is assumed to ne able to be relocated to any part of Australia therefore, snow loads designed for worst case scenario. The exposure reduction factor (Ce) was given as 0,75 for semi sheltered roof. The snow load shape coefficient is given as 0.7 as per the figure AS1170.3. (7.2) The Ground snow load was designed for the most alpine conditions in Australia giving a load of 72.82 (kN/m^2), this was done as the structure can be relocated to such conditions. For further calculations see Appendix.

Detailed Design Calculations - Wind

Wind design calculations as per AS4055 and AS 1170.2

Wind region – A5 (Melbourne inner suburbs)

Importance Level - 2

Topographic Class – TO

Ultimate limit State (ULS) = 500 years

Serviceability Limit State (SLS) = 50 years

$P, f = (0.5 \cdot \rho_{air})\left[V_{des,\theta}\right]^2 \cdot C_{fig} \cdot C_{dyn}$
2.4.2

$F = \sum([P, f] \cdot A)$

Site wind speed 2.2

$$V_{sit,\beta} = V_R \cdot M_d \cdot (M_{z,cat} \cdot M_s \cdot M_T)$$

ULS, $V_R = 45$

SLS, $V_R = 39$ Non- cyclonic

Wind Direction multiplier (M_d)

Any direction $M_d = 1$

Terrain height multiplier ($M_{z,cat}$) 4.2

Category 3 – suburban area (TC3)

H = 10.4 ∴ $M_{z,cat} = 0.835$ SLS

$M_{z,cat} = 0.8948$ ULS

Shielding Multiplier (M_s) 4.3

$$M_s = 0.92$$

Topographic Multiplier (M_T) 4.4

$$Max(M_h, M_{lee})$$

$$M_h = 1 \quad for \frac{H}{2LU} < 0.05$$

$$M_{lee} = 1 \qquad as\ per\ cl4.4.4$$

$$\therefore$$

$$V_{sit,\beta} = V_R \cdot M_d \cdot (M_{z,cat} \cdot M_s \cdot M_T)$$

SLS

$$V_{sit,\beta} = 37 \cdot 1 \cdot (0.835 \cdot 0.92 \cdot 1) = 29.9598$$

ULS

$$V_{sit,\beta} = 45 \cdot 1 \cdot (0.8948 \cdot 0.92 \cdot 1) = 37.04472$$

$$\therefore$$

SLS $V_{des} = 29.96\, m/s$

ULS $V_{des} = 37.04\, m/s$

Aerodynamic Shape Factor - C_{fig} 5.2

External ($C_{fig,e}$)

$$C_{fig,e} = C_{p,e} \cdot K_a \cdot K_{c,e} \cdot K_l \cdot K_p$$

Height (m)	$C_{p,e}$ (windward)	$C_{p,e}$ (leeward along length)	$C_{p,e}$ (leeward along length)
3	0.8	-0.3	-0.5
6	0.8	-0.3	0.5
9	0.8	-0.3	0.5
10.4	0.7	-0.3	0.5

$$C_{p,e}\ side\ wall = -0.65$$

Roof Surface	$C_{p,e}$
Upwind	-0.913, -0.406
Down wind	-0.503
Cross Wind	-0.354

Area reduction factor (Ka) 5.4

$$K_a = 0.8$$

Tributary area $\geq 100m^2$

Local Pressure Factor (K_l)
5.4.4

$$\frac{h}{d} = 0.3556$$

K_l for positive pressures = 1

K_l for negative pressures = 2

Permeable Cladding Factors (K_p) 5.8

$$K_p = 1$$

Windward loading

Height m	Shape factors	Design Pressure (SLS) kN	Design Pressure (ULS) kN
3	0.64	351.85	537.95
6	0.64	351.85	537.95
9	0.64	351.85	537.95
10.4	0.56	307.87	470.70

Leeward loadings along length

Height m	Shape factors	Design Pressure (SLS) kN	Design Pressure (ULS) kN
3	-0.192	-105.56	-161.38
6	-0.192	-105.56	-161.38
9	-0.192	-105.56	-161.38
10.4	-0.192	-105.56	-161.38

Leeward loadings along width

Height m	Shape factors	Design Pressure (SLS) kN	Design Pressure (ULS) kN
3	-0.32	-175.93	-268.97
6	-0.32	-175.93	-268.97
9	-0.32	-175.93	-268.97
10.4	-0.32	-175.93	-268.97

Uplift/Racking Force AS4055

Wind class = N2

Pressure = 0.92 kPa (table 5.1)

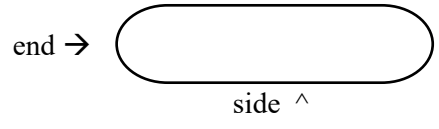
Width = 3.5m tables for not specify force for width of 3.5 m therefore assume 4m

Roof pitch = 0º

<u>Upper floor</u>

Wind on side = 0.84 kPa

Wind on end = 0.92 kPa



<u>Lower floor</u>

Wind on side = 0.84 kPa

Wind on end = 0.92 kPa

UNIT 1

Area (side) $3.2 \times (9.8 + 3.5) = 42.56\, m^2$

Area (end) $3.2 \times 3.5 = 11.2\, m^2$

Therefore

Upper floor racking force

Side $42.56 \times 0.84 = 35.7505\, kN$

End $11.2 \times 0.92 = 10.976\ kN$

Similar for lower floor

UNIT 1

Area (side) $3.2 \times (6.6 + 3.5) = 32.32\, m^2$

Area (end) $3.2 \times 3.5 = 11.2\, m^2$

Therefore

Upper floor racking force

Side $32.32 \times 0.84 = 27.1488\, kN$

End $11.2 \times 0.92 = 10.976\ kN$

Similar for lower floor

Detailed Design Calculations - Earthquake

Earthquake design as per AS1170.4

Seismic Hazard

Importance level 2, D = 1/500

$$KpZ = 1 \cdot 0.11 = 0.11$$

Subsoil class (site period: 0.5s) = Ce

Structural Properties

Natural period cl 6.2.3

$$T_1 = 1.25 \cdot K_t \cdot H_n^{0.75}$$
$$T_1 = 1.25 \cdot 0.05 \cdot 10.4^{0.75}$$
$$T_1 = 0.362\ (s)$$

Ductility & performance factor table 6.4

$$\mu = 2$$
$$s_p = 0.77$$

Spectral shape factor cl 6.4

$$C_hT = 3.2$$

Seismic Weight

$$Wi = G + \varphi_e Q$$

$\varphi_e = 0.3$ $Q = 13kPa$ $G = 12.6\ kN$

$$Wi = 12.6 + 0.3 * 13$$
$$Wi = 16.5kN$$

Base Shear

$$V = \left(KpZ \cdot Ch(T) \cdot \frac{Sp}{\mu}\right) Wt$$
$$\mathrm{V} = \left(0.11 \cdot 3.2 \cdot \frac{0.77}{2}\right) \cdot (3 \cdot 16.5)$$
$$V = 6.70824\ (kN)$$

Storey	hj	W	Wj Kj^k	Kfi	Fi (kN)
1	3.2	16.5	62.1377	0.14	0.939
2	6.4	16.5	136.94	0.31	2.0796
3	10.4	16.5	238.178	0.545	3.656
		Total	437.256		

Fi = V *Kfi

Detailed Design Calculations - Snow

Snow loads as per AS1170.3

Roof Snow load

4.2.1

$$S = Sg \cdot Ce \cdot \mu_i$$

$Ce = 0.75$ Semi-sheltered 4.2.2

Annual probability for exceedance (Pi)

P =1/250

Therefore probability factor table 5.1

Kp = 1.65

Ground snow load for Alpine

$$Sg = Kp \cdot Kt \left[\frac{h_o}{1000}\right]^{4.4}$$

Kt = 1.3 net increase in ground snow depth

$h_o = 2228$ table 5.2

$$Sg = 1.65 \cdot 1.3 \left[\frac{2228}{1000}\right]^{4.4} = 72.821\ kN/m^2$$

$\gamma = 2.9\ kN/m^2$ avg. weight density of snow.

$$\mu_i = \frac{0.7(60-\theta)}{50} = \frac{0.7(60-0)}{50} = 0.84$$

$$\theta = slope\ of\ roof = 0$$

However according to figure 7.3 flat roof. $\mu_i = 0.7$

Therefore

$$S = Sg \cdot Ce \cdot \mu_i$$

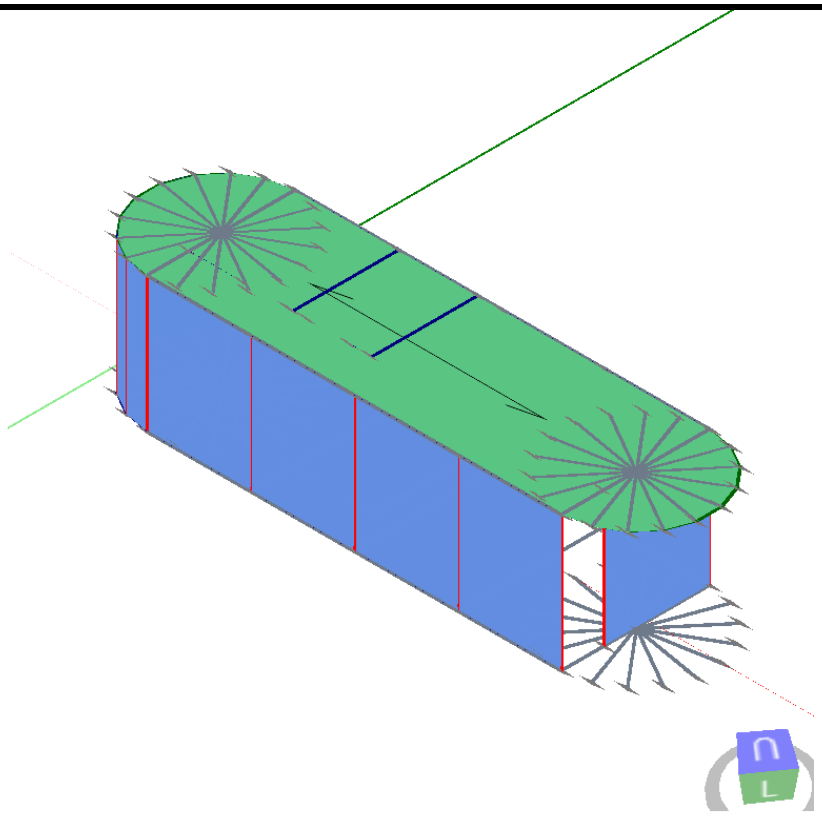
$$S = 72.821 \cdot 0.75 \cdot 0.7$$

$$S = 38.231\ kN/m^2$$

Appendix D

TECHNICAL DESIGN CALCULATION REPORT

Design of Timber Structures



Project: The Challenge Cup – One module on the ground

Design codes and standards

The analysis has been carried out according to:

1. **AS/NZS 1170.0:2002 – Structural Design Actions**

   Part 0: General principles

2. **AS/NZS 1170.1:2002 – Structural Design Actions**

   Part 1: Permanent, imposed and other actions

3. **AS/NZS 1170.2:2011 – Structural Design Actions**

   Part 2: Wind actions

4. **AS/NZS 1170.3:2003 – Structural Design Actions**

   Part 3: Snow and ice actions

5. **AS 1170.4-2007 – Structural Design Actions**

   Part 4: Earthquake actions in Australia

6. **AS 1720.1-2010 – Timber Structures**

   Part 1: Design methods

7. **AS 1720.2-2006 – Timber Structures**

   Part 2: Timber properties

General description of the building

Location

Address: Melbourne City

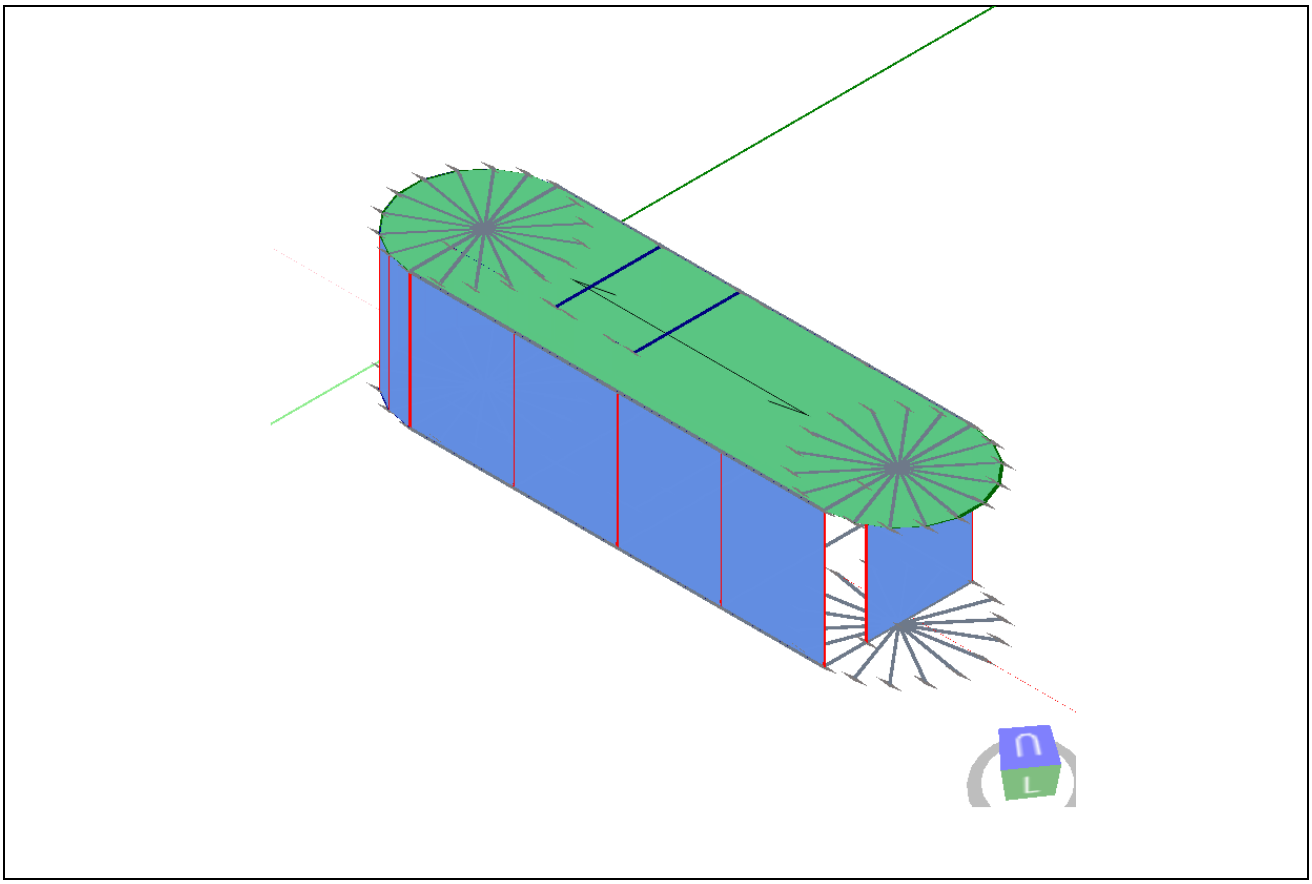
Description

Building length: 3.5 m

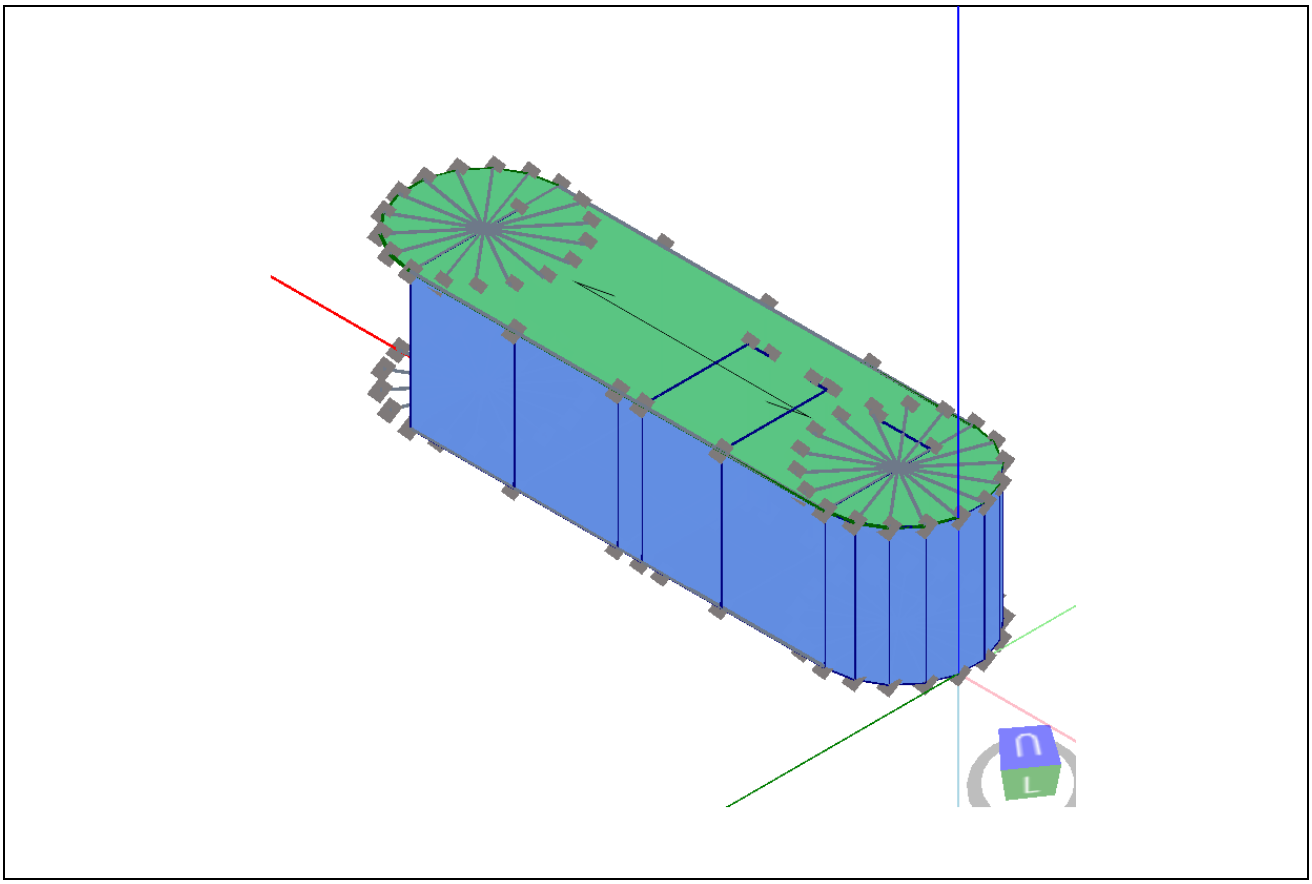
Building width: 13.25 m

Building height: 3.2 m

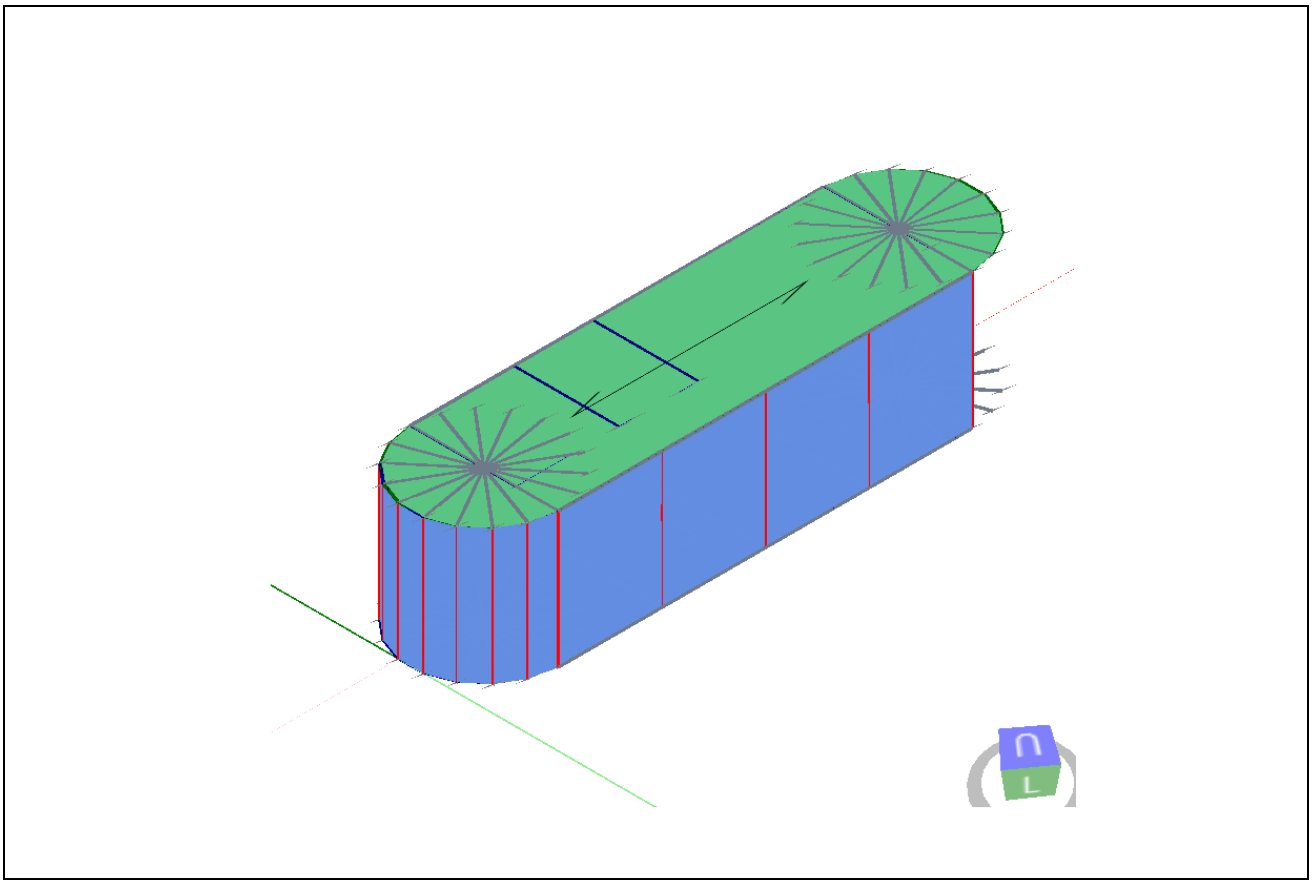
Three-dimensional Southeast view



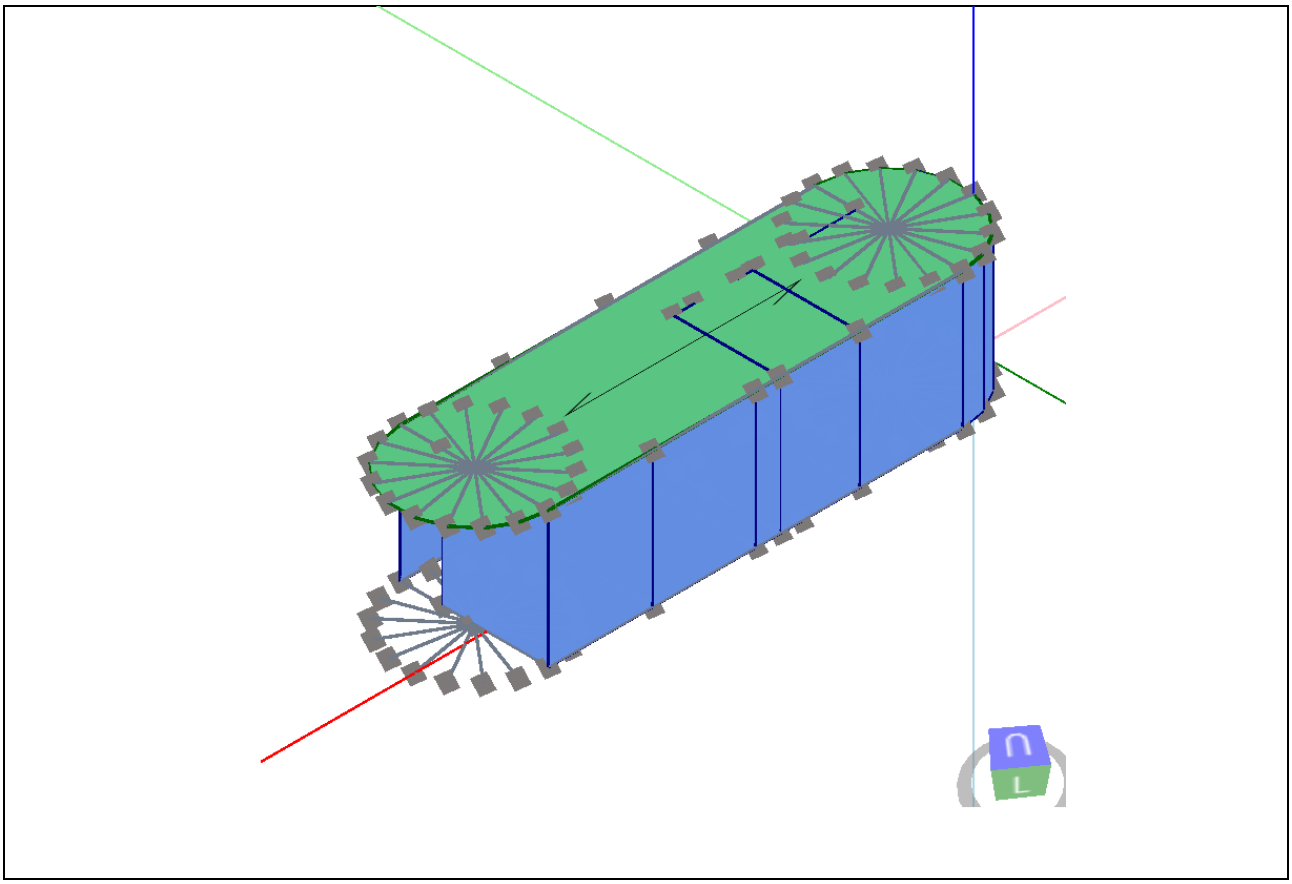
Three-dimensional Northwest view



Three-dimensional South West view



Three-dimensional North East view



Materials

Wooden materials

The materials used in the project are listed in the following tables.

f'_b Characteristic bending strength

f'_t Characteristic tensile strength parallel to grain

f'_c Characteristic compressive strength parallel to grain

f'_s Characteristic shear strength

E Short duration average modulus of elasticity parallel to the grain

G Short duration average modulus of rigidity

ρ Average minimum density

MGP

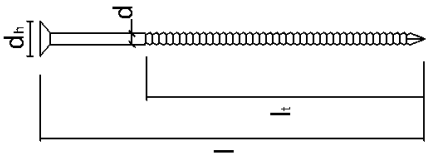
Descr	Joint group	f'_b [MPa]	f'_t [MPa]	f'_c [MPa]	f'_s [MPa]	E [MPa]	G [MPa]	ρ [kg/m^3]
MGP 10 - 90 x 45	JD5	17	7.7	18	2.6	10000	670	380.00000004

Plywood

Grade	Species	Joint group	f'_s [MPa]	G [MPa]	ρ [kg/m^3]
F14	Pinus species	JD4	4.8	625	480

Metal fasteners

Threaded nails



Manufacturer	Code	Descr.	l [mm]	l_t [mm]	d [mm]	d_h [mm]	f_{uk} [MPa]
Rotho Blaas	HH10502003	Ring nail (coils) 2.8/3.1 x 60	60	40	2.8	4.3	600

Calculation method and numerical model

Model Description

Hypothesis adopted for the elements

The timber walls are constrained at the base by means of connection systems capable of transmitting both in-plane and out-of-plane actions action on the wall.

In the analysis, in presence of horizontal loads, some elements may be defined as “secondary”: this mean that their strength and stiffness are neglected in the calculation of the response of the building. In the model these elements are represented in terms of mass and they are designed only for vertical loads.

Rigid body rocking – Forces on hold-down / tie-down

The hold-down or tie-down systems are used to prevent the rotation of the wall caused by the overturning moment of the horizontal force. The hold-down, placed on the in-tension edge of the wall, is loaded by a force equal to

$$T = \begin{cases} \left(\frac{M_{3-3}}{b} - \frac{N}{2}\right) \cdot \frac{1}{n_{anc}} & for\ active\ hold-down \\ 0 & for\ inactive\ hold-down \end{cases}$$

where:

b is the lever arm for the internal couple assumed equal to *l*, where *l* is the wall length

N is the axial vertical load acting on the wall

M_{3-3} is the moment acting in the plane of the wall

n_{anc} is the number of connections present at each end of the wall

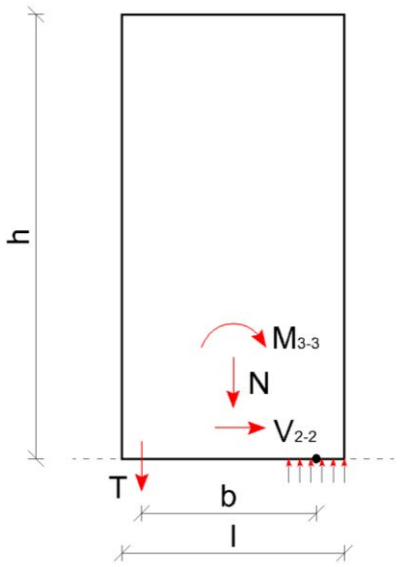


Figure: Calculation model of tensile force acting on the hold-down

Structural elements

The following table shows the positions of the individual walls. The last four columns show the coordinates of the ends of each wall.

X1 e Y1 indicate the coordinates of the starting point of the wall

X2 e Y2 indicate the coordinates of the end point of the wall

Wall name	Type of wall	Element resistant to horizontal loads	Height [m]	Length [m]	Altitude [m]	X1 [m]	Y1 [m]	X2 [m]	Y2 [m]
Wall 1	Frame	No	3.2	0.61	0	1.72	1.45	1.12	1.34
Wall 10	Frame	Yes	3.2	2.45	0	1.72	-2.05	4.17	-2.05
Wall 11	Frame	Yes	3.2	2.45	0	4.17	-2.05	6.62	-2.05
Wall 12	Frame	Yes	3.2	2.45	0	6.62	-2.05	9.07	-2.05
Wall 13	Frame	Yes	3.2	2.45	0	9.07	-2.05	11.52	-2.05
Wall 14	Frame	Yes	3.2	2.5	0	11.52	-1.05	11.52	1.45
Wall 15	Frame	Yes	3.2	2.45	0	11.52	1.45	9.07	1.45
Wall 16	Frame	Yes	3.2	2.45	0	9.07	1.45	6.62	1.45
Wall 17	Frame	No	3.2	0.58	0	6.62	1.45	6.04	1.45
Wall 18	Frame	Yes	3.2	2.5	0	6.04	1.45	6.04	-1.05
Wall 19	Frame	No	3.2	0.5	0	6.04	-1.05	5.54	-1.05
Wall 2	Frame	No	3.2	0.6	0	1.12	1.34	0.6	1.04
Wall 20	Frame	No	3.2	0.46	0	4.54	-1.04	4.08	-1.04
Wall 21	Frame	Yes	3.2	1.87	0	6.04	1.45	4.17	1.45
Wall 22	Frame	Yes	3.2	2.45	0	4.17	1.45	1.72	1.45
Wall 23	Frame	Yes	3.2	2.5	0	1.72	1.45	1.72	-1.05
Wall 24	Frame	Yes	3.2	1.3	0	1.72	-1.05	3.02	-1.05
Wall 25	Frame	Yes	3.2	2.49	0	4.17	1.45	4.17	-1.04
Wall 3	Frame	No	3.2	0.61	0	0.6	1.04	0.21	0.57
Wall 4	Frame	No	3.2	0.61	0	0.21	0.57	0	0
Wall 5	Frame	No	3.2	0.6	0	0	0	0	-0.6
Wall 6	Frame	No	3.2	0.61	0	0	-0.6	0.21	-1.17
Wall 7	Frame	No	3.2	0.61	0	0.21	-1.17	0.6	-1.64
Wall 8	Frame	No	3.2	0.6	0	0.6	-1.64	1.12	-1.94
Wall 9	Frame	No	3.2	0.61	0	1.12	-1.94	1.72	-2.05

Wall horizontal stiffness

The wall stiffness can be estimated considering the contributions of all the components, as shown below.

Timber framed shear walls

In the case of framed walls the overall stiffness is calculated taking into account the contribution of the following components:

- sheeting boards (k_s)
- sheet-to-frame nailing (k_c)
- shear connections (k_a)
- tensile connections (k_h)

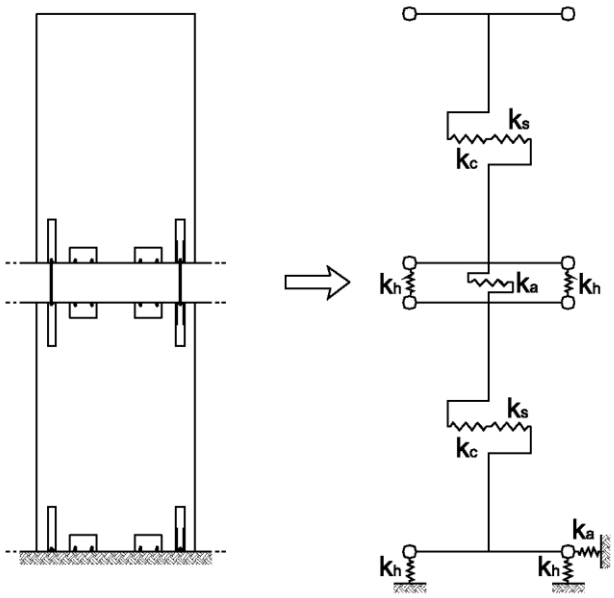


Figure: Mechanical model for framed walls overall stiffness

In case of metal-braced framed walls, the k_s and k_c contributions are replaced by a single term that takes into account the stiffness contribution of the metal bracing.

The following table indicates the positions of the walls and their equivalent shear stiffness.

Wall name	Type of wall	Element resistant to horizontal loads	Heigth [m]	Lenght [m]	Equivalent shear stiffness [kN/m]
Wall 1	Frame	No	3.2	0.61	0
Wall 10	Frame	Yes	3.2	2.45	1390
Wall 11	Frame	Yes	3.2	2.45	1390
Wall 12	Frame	Yes	3.2	2.45	1390
Wall 13	Frame	Yes	3.2	2.45	1390
Wall 14	Frame	Yes	3.2	2.5	1424
Wall 15	Frame	Yes	3.2	2.45	1390
Wall 16	Frame	Yes	3.2	2.45	1390
Wall 17	Frame	No	3.2	0.58	0
Wall 18	Frame	Yes	3.2	2.5	1424
Wall 19	Frame	No	3.2	0.5	0
Wall 2	Frame	No	3.2	0.6	0
Wall 20	Frame	No	3.2	0.46	0
Wall 21	Frame	Yes	3.2	1.87	1023
Wall 22	Frame	Yes	3.2	2.45	1390
Wall 23	Frame	Yes	3.2	2.5	1424
Wall 24	Frame	Yes	3.2	1.3	667
Wall 25	Frame	Yes	3.2	2.49	1415
Wall 3	Frame	No	3.2	0.61	0
Wall 4	Frame	No	3.2	0.61	0
Wall 5	Frame	No	3.2	0.6	0
Wall 6	Frame	No	3.2	0.61	0
Wall 7	Frame	No	3.2	0.61	0
Wall 8	Frame	No	3.2	0.6	0
Wall 9	Frame	No	3.2	0.61	0

Types of structural elements and sign conventions

*L*inear elements

The linear elements are used to model beams and columns. They have a local reference system with respect to which stress/force components are shown. The sign convention adopted is shown in the figure below.

Force	Description	Unit of measure
N	Axial force	kN
M_{3-3}	Bending moment about local axis 3	kN m
V_2	Shear along local axis 2	kN
M_{2-2}	Bending moment about local axis 2	kN m
V_3	Shear along local axis 3	kN

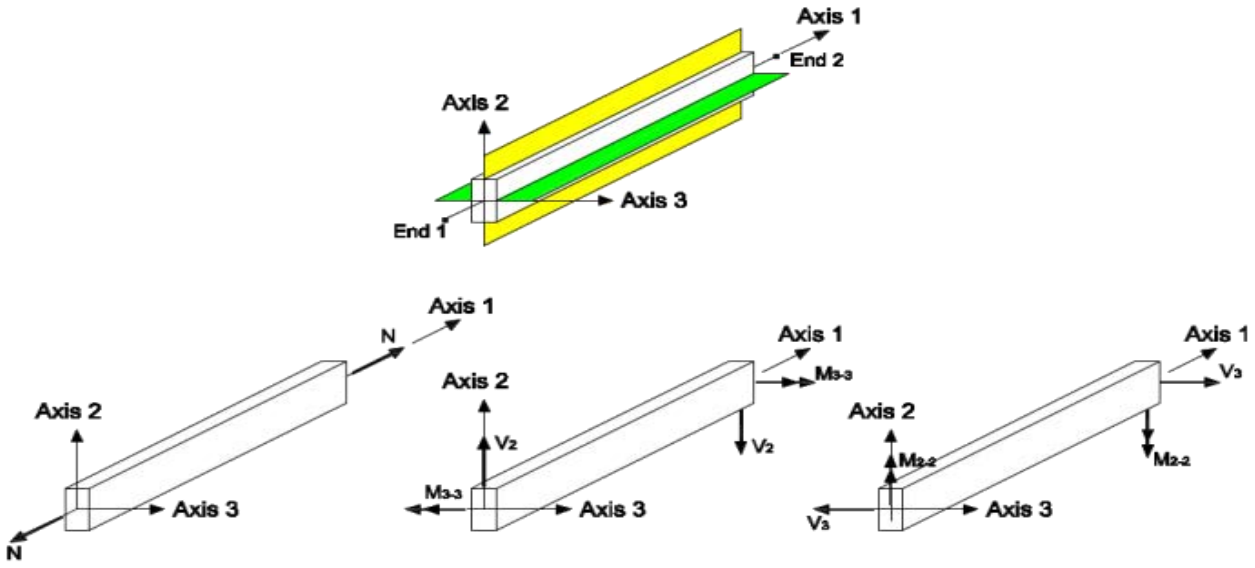


Figure: sign conventions for beams

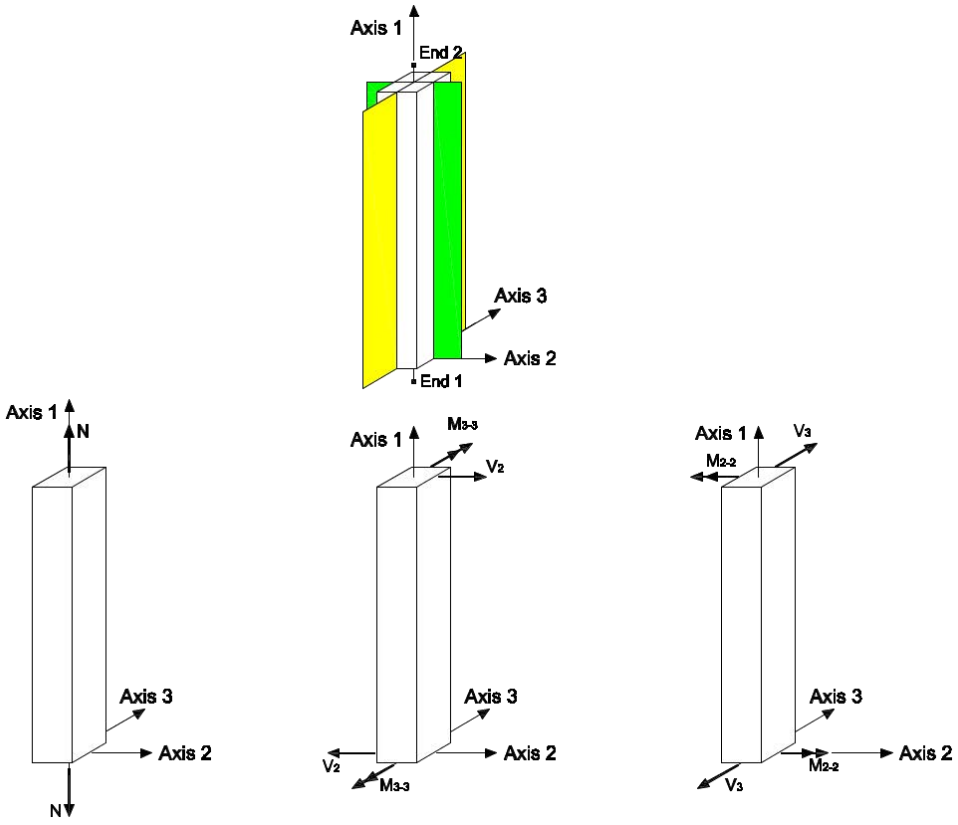


Figure: sign conventions for columns

Wall elements

The walls, regardless of type, have the following sign conventions.

	Stress	Description	Unit of measure
In-plane stresses	**n**	Axial stress (per unit length)	kN/m
	m_{3-3}	Bending moment about local axis 3 (per unit length)	kNm/m
	v_2	Shear along local axis 2 (per unit length)	kN/m
Out-of-plane stresses (plate)	**m_{2-2}**	Bending moment about local axis 2 (per unit length)	kNm/m
	v_3	Shear along local axis 3 (per unit length)	kN/m

	Force	Description	Unit of measure
In-plane stresses	**N**	Total axial force	kN
	M_{3-3}	Bending moment about local axis 3	kNm
	V_2	Shear along local axis 2	kN
Out-of-plane stresses (plate)	**M_{2-2}**	Bending moment about local axis 3	kNm
	V_3	Shear along local axis 2	kN

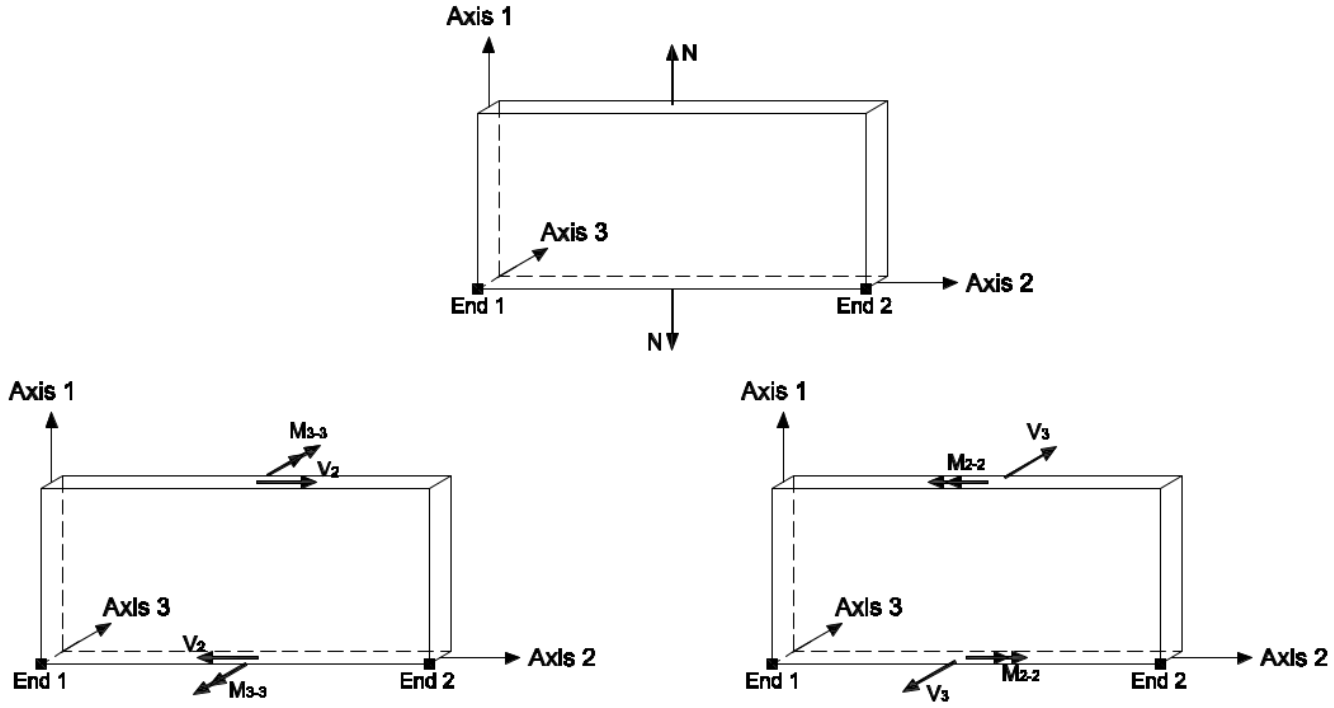


Figure: sign conventions for walls

Actions and design loads

Self-weight of structural materials

The weights of the structural materials are shown in the table below in kN/m^3

Description	Specific weight γ [kN/m^3]
MGP 10 - 90 x 45	5
F14 Plywood - Pinus species	5.5

Loads acting on the walls

The following table shows the loads acting on the walls.

Load name: Load ID

Position: Position of the wall: internal or external

g_{sw}: Self-weight

g_{ns}: Non-structural permanent loads

w_u: ULS wind load

Wall name	Position	Load name	g_{sw} [kN/m^2]	g_{ns} [kN/m^2]	w_u leeward [kN/m^2]	w_u windward [kN/m^2]
Wall 1	External	External walls load	0.35	0.6	-0.27	0.42
Wall 2	External	External walls load	0.36	0.6	-0.27	0.42
Wall 3	External	External walls load	0.35	0.6	-0.27	0.42
Wall 4	External	External walls load	0.35	0.6	-0.27	0.42
Wall 5	External	External walls load	0.36	0.6	-0.27	0.42
Wall 6	External	External walls load	0.35	0.6	-0.27	0.42
Wall 7	External	External walls load	0.35	0.6	-0.27	0.42
Wall 8	External	External walls load	0.36	0.6	-0.27	0.42
Wall 9	External	External walls load	0.35	0.6	-0.27	0.42
Wall 10	External	External walls load	0.2	0.6	-0.27	0.42
Wall 11	External	External walls load	0.2	0.6	-0.27	0.42
Wall 12	External	External walls load	0.2	0.6	-0.27	0.42
Wall 13	External	External walls load	0.2	0.6	-0.27	0.42
Wall 14	External	External walls load	0.2	0.6	-0.27	0.42
Wall 15	External	External walls load	0.2	0.6	-0.27	0.42
Wall 16	External	External walls load	0.2	0.6	-0.27	0.42
Wall 17	External	External walls load	0.37	0.6	-0.27	0.42
Wall 18	External	External walls load	0.2	0.6	-0.27	0.42
Wall 19	External	External walls load	0.41	0.6	-0.27	0.42
Wall 20	External	External walls load	0.44	0.6	-0.27	0.42
Wall 21	External	External walls load	0.22	0.6	-0.27	0.42
Wall 22	External	External walls load	0.2	0.6	-0.27	0.42
Wall 23	External	External walls load	0.2	0.6	-0.27	0.42
Wall 24	External	External walls load	0.25	0.6	-0.27	0.42
Wall 25	External	External walls load	0.2	0.6	-0.27	0.42

Loads acting on the floors

The following table shows the characteristic values of the loads acting on the decks.

Load name: Load ID

Position: Position of the floor: internal or external

Technical Design Calculation Report

Environment: Load type

α: Roof pitch angle

g_{sw}: Self-weight

g_{ns}: Non-structural permanent loads

q: Imposed actions

f_{sn}: Snow load

w_u: ULS wind load

w_s: SLS wind load

Floor name	Position	α [°]	Load name	Environment	g_{sw} [kN/m^2]	g_{ns} [kN/m^2]	q [kN/m^2]	f_{sn} [kN/m^2]	w_u leeward [kN/m^2]	w_u windward [kN/m^2]	w_s leeward [kN/m^2]	w_s windward [kN/m^2]
Floor 1	Internal floor	0	Floor load: residential	Other - General areas, bedrooms, hospital wards, hotel rooms, toilet areas	0.2	1	2	0	0	0	0	0

Seismic actions

The seismic actions are defined according to the AS 1170.4 - 2007. The earthquake motion at a given point on the surface is represented by an elastic ground acceleration response spectrum.

The response spectra are calculated according to the following parameters:

- the probability factor k_p for the annual probability of exceedance defined according to the importance level for the structure;
- the hazard factor Z that depends on the location of the building;
- the site sub-soil class.

The above-mentioned parameters are reported below:

Annual probability of exceedance	
Probability factor k_p	1.25
Hazard factor Z	0.09
Site sub-soil class	A

Horizontal elastic response spectrum

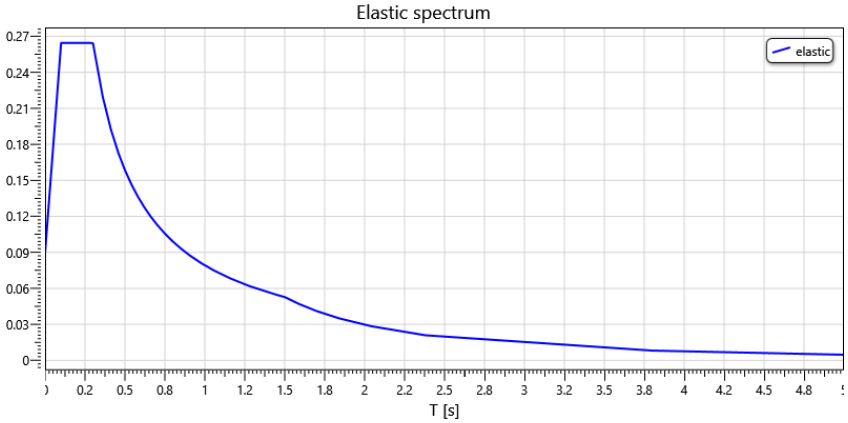
The values of the spectral shape factor $C_h(T)$ are defined by the following expressions in accordance to the site sub-soil class:

Site sub-soil class	$0 < T \leq 0.1\ s$	$0.1\ s < T \leq 1.5\ s$	$T > 1.5\ s$
A_e – Strong rock	$0.8 + 15.5\,T$	$\max(0.704/T\,;2.35)$	$1.056/T^2$
B_e – Rock	$1.0 + 19.4\,T$	$\max(0.88/T\,;2.94)$	$1.32/T^2$
C_e – Shallow soil	$1.3 + 23.8\,T$	$\max(1.25/T\,;3.68)$	$1.874/T^2$
D_e – Deep or soft soil	$1.1 + 25.8\,T$	$\max(1.98/T\,;3.68)$	$2.97/T^2$
E_e – Very soft soil	$1.1 + 25.8\,T$	$\max(3.08/T\,;3.68)$	$4.62/T^2$

The values of the elastic size hazard spectrum $C(T)$ depend on the above-defined spectral shape factor and on the values of the probability factor k_p and of the hazard factor Z according to the following equation:

$$C(T) = k_p \cdot Z \cdot C_h(T)$$

The resultant horizontal elastic site hazard spectrum is reported below



Design spectrum for elastic analysis

To avoid explicit inelastic structural analysis in design, the structural performance and its capacity to dissipate energy, through mainly ductile behavior of its elements and/or other mechanisms, is taken into account by performing an elastic analysis based on a response spectrum reduced with respect to the elastic one, henceforth called a "design spectrum".

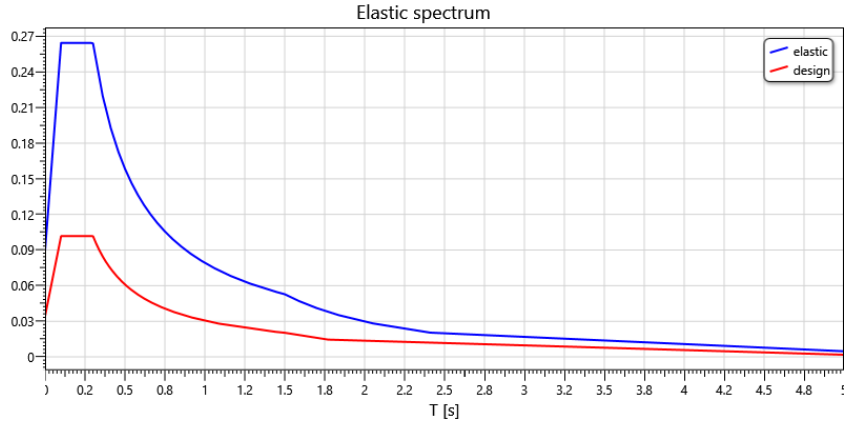
This reduction is accomplished by introducing the structural performance factor S_p and the structural ductility factor μ related to the structural system adopted.

Structural system	LF buildings - Thin bracing panels
Structural performance factor S_p	0.77
Structural ductility factor μ	2.00
μ/S_p	2.60

The design spectrum is defined by the following expressions:

$$C_d(T) = C(T) \cdot S_p/\mu = k_p \cdot Z \cdot C_h(T) \cdot S_p/\mu$$

The horizontal elastic response spectrum and the horizontal design spectrum (Ultimate Limit State) are shown below:



Sections of the structural elements

Framed walls

Frame geometric characteristics

t: *thickness of the frame*

h_b: *thickness of top and sole plates*

$b_{s,int}$: *width of the internal studs*

$b_{s,ext}$: *width of the external studs*

i_m: *average studs spacing*

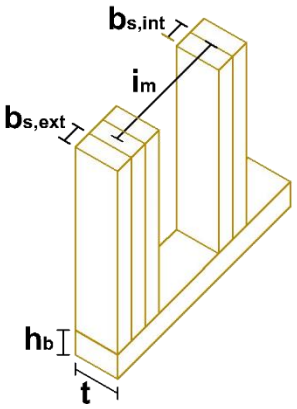


Figure: dimensions of the frame elements

The characteristics of the frame of each wall type are reported below.

Section name	# sides with bracing	Material	Frame thickness t [mm]	Thickness of top and sole plates h_b [mm]	Width of the internal studs $b_{s,int}$ [mm]	# elements for each internal stud	Width of the external studs $b_{s,ext}$ [mm]	# elements for each external stud	Average studs spacing i_m [mm]
Frame 1	1.00	MGP 10 - 90 x 45	90	45	45	1	45	4	409

Sheet-bracing geometrical characteristics

b_s: *sheeting boards width*

$s_{c,b}$: *spacing of fasteners along the perimeter of every sheet*

$s_{c,i}$: *spacing of internal fasteners*

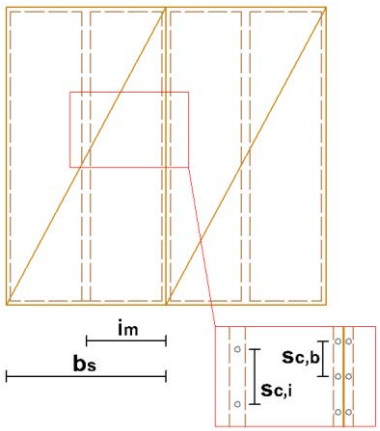


Figure: dimensions of the *sheeting boards and fasteners spacing*

The characteristics of the sheet-bracing are reported below.

Section name	Side	Material	Sheeting board thickness t_s [mm]	Sheeting boards width b_s [mm]	Frame-sheeting board fastener	Perimeter fasteners spacing $S_{c,b}$ [mm]	Internal fasteners spacing i $S_{c,i}$ [mm]
Frame 1	1	F14 Plywood - Pinus species	15	818	Ring nail (coils) 2.8/3.1 x 60	100	200

Floors with timber joists

Elements geometric characteristics

h_b: *Cross section height*

b_b: *Cross section width*

i_b: *Joists spacing*

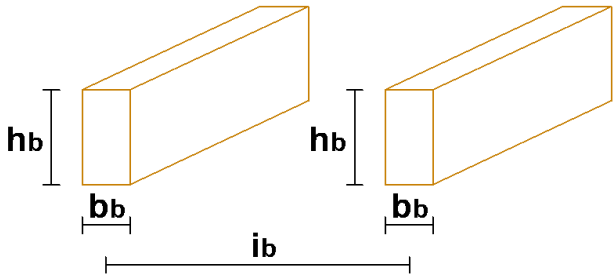


Figure: geometric characteristics of the floor

The following table sets out the details concerning the floor with joists.

Section name	Material	Cross section height h_b [mm]	Cross section width b_b [mm]	Joists spacing i_b [mm]
Joists floor 1	MGP 10 - 90 x 45	90	45	100

Connections

Hold Down

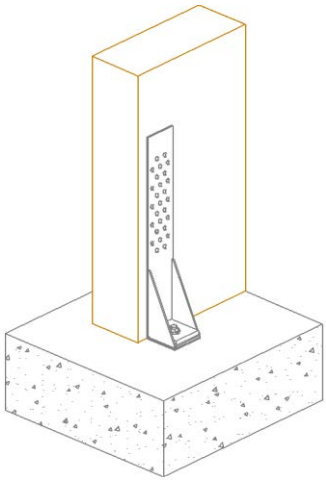


Figure: graphical representation of a hold-down in a base connection (timber wall – foundation connection)

Connection name	Connection position	Manufacturer	Description	Fasteners number	Fastener typology	Threaded rod / Anchor	Chemical anchor type	Number of hold-down at each wall end
Ground connection - hold down - bracket	Ground connection	Rotho Blass	WHT 340	14	Anker nail - LBA 4.0 X 40	INA - 5.8 - M16 x 160	EPOPLUS chemical anchor	1

Timber-reinforced concrete connection

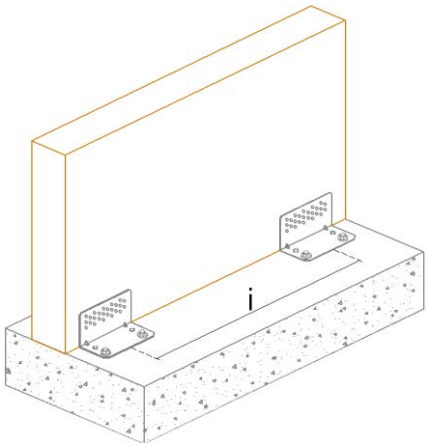


Figure: graphical representation of the shear connection with angle brackets

Connection name	Connection position	Manufacturer	Description	Fasteners number on the vertical plate	Fastener typology	Anchors number	Threaded rod / Anchor	Chemical anchor tipe	Number of sides	Angle brackets spacing i [mm]
Ground connection - hold down - bracket	Ground connection	Rotho Blaas	Titan N - TCN 200	30	Anker nail - LBA 4.0 X 60	2	INA - 5.8 - M12 x 130	VINYLPRO chemical anchor	1.00	500

Technical Design Calculation Report

Combinations of actions

The combinations for the ultimate limit states used in checking strength are as follows.

(a)	$E_d = [1.35 \cdot (G_{sw} + G_{ns})]$	Permanent action only
(b)	$E_d = [1.2 \cdot (G_{sw} + G_{ns}),\ 1.5 \cdot Q]$	Permanent and imposed action
(c)	$E_d = [1.2 \cdot (G_{sw} + G_{ns}),\ 1.5 \cdot \psi_l \cdot Q]$	Permanent and long-term imposed action
(d)	$E_d = [1.2 \cdot (G_{sw} + G_{ns}),\ W_u,\ \psi_c \cdot Q]$	Permanent, wind and imposed action
(e)	$E_d = [0.9 \cdot (G_{sw} + G_{ns}),\ W_u]$	Permanent and wind action reversal
(f)	$E_d = [(G_{sw} + G_{ns}),\ E_u,\ \psi_E \cdot Q]$	Permanent, earthquake and imposed action
(g)	$E_d = [1.2 \cdot (G_{sw} + G_{ns}),\ F_{sn},\ \psi_c \cdot Q]$	Permanent, snow and imposed action

The combinations for the ultimate limit states used in checking stability are as follows.

For combinations that produce net stabilizing effects:

o	$E_{d,stb} = [0.9 \cdot (G_{sw} + G_{ns})]$	Permanent action only

For combinations that produce net destabilizing effects

(iv)	$E_{d,dst} = [1.2 \cdot (G_{sw} + G_{ns}),\ W_u,\ \psi_c \cdot Q]$	Permanent, wind and imposed action
(v)	$E_{d,dst} = [(G_{sw} + G_{ns}),\ E_u,\ \psi_E \cdot Q]$	Permanent, earthquake and imposed action

The combinations for the serviceability limit states are as follows.

- o $(G_{sw} + G_{ns}) + \psi_l \cdot Q$
- o $(G_{sw} + G_{ns}) + \psi_s \cdot Q$
- o $\psi_s \cdot Q$
- o W_s

being:

G_{sw} permanent actions: self weight

G_{ns} non-structural permanent actions

Q imposed actions

W_u Wind action for ULS

W_s Wind action for SLS

E_u earthquake action

F_{sn} snow action

ψ_s short-term factor

ψ_l long-term factor

ψ_c combination factor

ψ_E earthquake combination factor

The following table presents the values of the factors used.

Action name	Description	Duration	ψ_s	ψ_l	ψ_c	ψ_E
Q type A	Type A: Domestic and residential activities	5 months	0.7	0.4	0.4	0.3
Q type Asf	Type Asf: Non-habitable roof spaces for residential activities	5 months	1	0.6	0.6	0.6
Q type B	Type B: Offices and work areas not covered elsewhere	5 months	0.7	0.4	0.4	0.3
Q type C	Type C: Areas where people may congregate	5 days	0.7	0.4	0.4	0.3
Q type Cff	Type Cff: Areas where people may congregate - fixed furniture	5 days	1	0.6	0.6	0.6
Q type D	Type D: Shopping areas	5 months	0.7	0.4	0.4	0.3
Q type E	Type E: Warehousing, storage areas, areas for plant	5 months	1	0.6	0.6	0.6
Q type F	Type F: Light vehicle traffic areas	5 months	0.7	0.4	0.4	0.3
Q type G	Type G: Medium vehicle traffic areas	5 months	0.7	0.4	0.4	0.3
Q type R1	Type R1: Street awnings	5 days	0.7	0	0	0
Q type R2	Type R2: Other roofs	5 days	0.7	0	0	0
Q type R-A	Type R-A: Domestic and residential activities	5 months	0.7	0.4	0.4	0.3
Q type R-B	Type R-B: Offices and work areas not covered elsewhere	5 months	0.7	0.4	0.4	0.3
Q type R-C	Type R-C: Areas where people may congregate	5 days	0.7	0.4	0.4	0.3
Q type R-D	Type R-D: Shopping areas	5 months	0.7	0.4	0.4	0.3

Q type R-E	Type R-E: Warehousing, storage areas, areas for plant	5 months	1	0.6	0.6	0.6
Q type R-F	Type R-F: Light vehicle traffic areas	5 months	0.7	0.4	0.4	0.3
Q type R-G	Type R-G: Medium vehicle traffic areas	5 months	0.7	0.4	0.4	0.3
Ortho wind ULS	Wind pressure ULS	5 seconds	0	0	0	0
Ortho wind SLS	Wind pressure SLS	5 seconds	0	0	0	0
Snow	Snow action for alpine areas	5 months	0	0	0	0
Snow	Snow action for sub-alpine areas	5 days	0	0	0	0

Combinations of actions used

Vertical ULS combinations of actions

The following table shows the combinations of actions for Ultimate Limit States relevant for verifications in the case of vertical actions.

The action of the wind is considered as a uniform load orthogonal to the roof and to each external wall.

Name	Duration	G(sw)	G(ns)	Q type A	Ortho wind ULS down	Ortho wind ULS up	Wind X	Wind Y	Seismic dynamic X	Seismic dynamic Y
ULS 1	50+ years	1.35	1.35	0	0	0	0	0	0	0
ULS 2	50+ years	1.2	1.2	0	0	0	0	0	0	0
ULS 3	5 months	1.2	1.2	1.5	0	0	0	0	0	0
ULS 4	50+ years	1.2	1.2	0.6	0	0	0	0	0	0
ULS 5	5 seconds	1.2	1.2	0.4	1	0	0	0	0	0
ULS 6	5 seconds	0.9	0.9	0	0	1	0	0	0	0

Wind ULS combinations of actions

The following table shows the combinations of actions for Ultimate Limit States relevant for verifications in the case of horizontal wind actions.

The action of the wind is considered as a uniform load orthogonal to each external wall that acts separately in the directions X, -X, Y, -Y and as a uniform load orthogonal to the roof.

Name	Duration	G(sw)	G(ns)	Q type A	Ortho wind ULS down	Ortho wind ULS up	Wind X	Wind Y	Seismic dynamic X	Seismic dynamic Y
ULS Wind 1	5 seconds	1.2	1.2	0.4	1	0	1	0	0	0
ULS Wind 2	5 seconds	1.2	1.2	0.4	1	0	-1	0	0	0
ULS Wind 3	5 seconds	0.9	0.9	0	0	1	1	0	0	0
ULS Wind 4	5 seconds	0.9	0.9	0	0	1	-1	0	0	0
ULS Wind 5	5 seconds	1.2	1.2	0.4	1	0	0	1	0	0
ULS Wind 6	5 seconds	1.2	1.2	0.4	1	0	0	-1	0	0
ULS Wind 7	5 seconds	0.9	0.9	0	0	1	0	1	0	0
ULS Wind 8	5 seconds	0.9	0.9	0	0	1	0	-1	0	0

SLS combinations of actions

The action of the wind is considered as a uniform load orthogonal to the roof.

Name	Duration	G(sw)	G(ns)	Q type A	Ortho wind ULS down	Ortho wind ULS up	Wind X	Wind Y	Seismic dynamic X	Seismic dynamic Y
SLS 1	50+ years	1	1	0.4	0	0	0	0	0	0
SLS 2	5 seconds	0	0	0.7	0	0	0	0	0	0
SLS 3	5 seconds	1	1	0.7	0	0	0	0	0	0

Seismic combinations of actions

The action effects due to the combination of the horizontal components of the seismic action are computed using the following combinations:

$$E_{u,X} + 0{,}3 \cdot E_{u,Y}$$

$$0{,}3 \cdot E_{u,X} + E_{u,Y}$$

Combinations of actions for seismic strength Ultimate Limit States

Name	Duration	G(sw)	G(ns)	Q type A	Ortho wind ULS down	Ortho wind ULS up	Wind X	Wind Y	Seismic dynamic X	Seismic dynamic Y
ULS earthquake strength 1 ex+ ey+	5 seconds	1	1	0.3	0	0	0	0	1	0.3
ULS earthquake strength 1 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	1	0.3
ULS earthquake strength 1 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	1	0.3
ULS earthquake strength 1 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	1	0.3
ULS earthquake strength 2 ex+ ey+	5 seconds	1	1	0.3	0	0	0	0	1	-0.3
ULS earthquake strength 2 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	1	-0.3
ULS earthquake strength 2 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	1	-0.3
ULS earthquake strength 2 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	1	-0.3
ULS earthquake strength 3 ex+ ey+	5 seconds	1	1	0.3	0	0	0	0	-1	0.3
ULS earthquake strength 3 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	-1	0.3
ULS earthquake strength 3 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	-1	0.3
ULS earthquake strength 3 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	-1	0.3
ULS earthquake strength 4 ex+ ey+	5 seconds	1	1	0.3	0	0	0	0	-1	-0.3
ULS earthquake strength 4 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	-1	-0.3
ULS earthquake strength 4 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	-1	-0.3
ULS earthquake strength 4 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	-1	-0.3
ULS earthquake strength 5 ex+ ey+	5 seconds	1	1	0.3	0	0	0	0	0.3	1
ULS earthquake strength 5 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	0.3	1
ULS earthquake strength 5 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	0.3	1
ULS earthquake strength 5 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	0.3	1
ULS earthquake strength 6 ex+ ey+	5 seconds	1	1	0.3	0	0	0	0	0.3	-1
ULS earthquake strength 6 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	0.3	-1
ULS earthquake strength 6 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	0.3	-1
ULS earthquake strength 6 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	0.3	-1
ULS earthquake strength 7 ex+	5 seconds	1	1	0.3	0	0	0	0	-0.3	1

ey+										
ULS earthquake strength 7 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	-0.3	1
ULS earthquake strength 7 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	-0.3	1
ULS earthquake strength 7 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	-0.3	1
ULS earthquake strength 8 ex+ ey+	5 seconds	1	1	0.3	0	0	0	0	-0.3	-1
ULS earthquake strength 8 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	-0.3	-1
ULS earthquake strength 8 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	-0.3	-1
ULS earthquake strength 8 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	-0.3	-1

Combinations of actions for seismic stability Ultimate Limit States

Name	Duration	G(sw)	G(ns)	Q type A	Ortho wind ULS down	Ortho wind ULS up	Wind X	Wind Y	Seismic dynamic X	Seismic dynamic Y
ULS earthquake stability 1 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	1	0.3
ULS earthquake stability 1 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	1	0.3
ULS earthquake stability 1 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	1	0.3
ULS earthquake stability 1 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	1	0.3
ULS earthquake stability 2 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	1	-0.3
ULS earthquake stability 2 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	1	-0.3
ULS earthquake stability 2 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	1	-0.3
ULS earthquake stability 2 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	1	-0.3
ULS earthquake stability 3 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	-1	0.3
ULS earthquake stability 3 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	-1	0.3
ULS earthquake stability 3 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	-1	0.3
ULS earthquake stability 3 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	-1	0.3
ULS earthquake stability 4 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	-1	-0.3
ULS earthquake stability 4 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	-1	-0.3
ULS earthquake stability 4 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	-1	-0.3
ULS earthquake stability 4 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	-1	-0.3
ULS earthquake stability 5 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	0.3	1
ULS earthquake stability 5 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	0.3	1
ULS earthquake stability 5 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	0.3	1
ULS earthquake stability 5 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	0.3	1
ULS earthquake stability 6 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	0.3	-1
ULS earthquake stability 6 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	0.3	-1
ULS earthquake stability 6 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	0.3	-1
ULS earthquake stability 6 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	0.3	-1
ULS earthquake stability 7 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	1

ULS earthquake stability 7 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	1
ULS earthquake stability 7 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	1
ULS earthquake stability 7 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	1
ULS earthquake stability 8 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	-1
ULS earthquake stability 8 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	-1
ULS earthquake stability 8 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	-1
ULS earthquake stability 8 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	-1

Combinations of actions for seismic drift Ultimate Limit States

Name	Duration	G(sw)	G(ns)	Q type A	Ortho wind ULS down	Ortho wind ULS up	Wind X	Wind Y	Seismic dynamic X	Seismic dynamic Y
ULS earthquake drift 1 ex+ ey+	5 seconds	0	0	0	0	0	0	0	1	0
ULS earthquake drift 1 ex+ ey-	5 seconds	0	0	0	0	0	0	0	1	0
ULS earthquake drift 1 ex- ey+	5 seconds	0	0	0	0	0	0	0	1	0
ULS earthquake drift 1 ex- ey-	5 seconds	0	0	0	0	0	0	0	1	0
ULS earthquake drift 2 ex+ ey+	5 seconds	0	0	0	0	0	0	0	-1	0
ULS earthquake drift 2 ex+ ey-	5 seconds	0	0	0	0	0	0	0	-1	0
ULS earthquake drift 2 ex- ey+	5 seconds	0	0	0	0	0	0	0	-1	0
ULS earthquake drift 2 ex- ey-	5 seconds	0	0	0	0	0	0	0	-1	0
ULS earthquake drift 3 ex+ ey+	5 seconds	0	0	0	0	0	0	0	0	1
ULS earthquake drift 3 ex+ ey-	5 seconds	0	0	0	0	0	0	0	0	1
ULS earthquake drift 3 ex- ey+	5 seconds	0	0	0	0	0	0	0	0	1
ULS earthquake drift 3 ex- ey-	5 seconds	0	0	0	0	0	0	0	0	1
ULS earthquake drift 4 ex+ ey+	5 seconds	0	0	0	0	0	0	0	0	-1
ULS earthquake drift 4 ex+ ey-	5 seconds	0	0	0	0	0	0	0	0	-1
ULS earthquake drift 4 ex- ey+	5 seconds	0	0	0	0	0	0	0	0	-1
ULS earthquake drift 4 ex- ey-	5 seconds	0	0	0	0	0	0	0	0	-1

Horizontal actions

Modal analysis

The modal analysis is used to determine the vibration modes of the structure, useful to understand the seismic behaviour of the building and to proceed with the linear dynamic analysis.

The modal analysis involves the solution of the generalized eigenvalue problem:

$$[\boldsymbol{K} - \boldsymbol{\Omega}^2 \boldsymbol{M}]\boldsymbol{\Phi} = \mathbf{0}$$

where $\boldsymbol{K}$ is the stiffness matrix, $\boldsymbol{M}$ the mass matrix, $\boldsymbol{\Omega}^2$ is the diagonal matrix of the eigenvalues and $\boldsymbol{\Phi}$ is the corresponding matrix of eigenvectors or modal shapes (normalized with respect to the mass matrix); the seismic masses of the diaphragms are calculated with the following combination of vertical loads:

$$\sum \left(G_{sw,j} + G_{ns,j}\right) + \sum \psi_{\mathrm{E,i}} \cdot \mathrm{Q}$$

where ψ_{Ei} is the earthquake combination factor for the imposed action *i.*

The eigenvalue, obtained from the solution of the generalized eigenvalue problem, is the square of the circular frequency $\boldsymbol{\omega}$ related to the period, *T*, and to the frequency, *f*, by the following equations:

$$T = \frac{1}{f} \text{ and } f = \frac{\omega}{2\pi}$$

The participating mass ratio for the mode *i-th*, corresponding to an acceleration in the global axis X and Y and to a rotational acceleration around the vertical axis Z, is given by:

$$M_x^i = \frac{m_x^i}{\sum m_{x,j}} \ [\%]$$

$$M_y^i = \frac{m_y^i}{\sum m_{y,j}} \ [\%]$$

$$M_z^i = \frac{m_z^i}{\sum I_{z,j}} \ [\%]$$

where:

$$m_x^i = \frac{\left(\left[\boldsymbol{\Phi}^{\boldsymbol{i}}\right]^{\boldsymbol{T}} \boldsymbol{M}\, \boldsymbol{R}_{\boldsymbol{x}}\right)^2}{[\boldsymbol{\Phi}^{\boldsymbol{i}}]^{\boldsymbol{T}} \boldsymbol{M}\, \boldsymbol{\Phi}^{\boldsymbol{i}}}$$

$$m_y^i = \frac{\left(\left[\boldsymbol{\Phi}^{\boldsymbol{i}}\right]^{\boldsymbol{T}} \boldsymbol{M}\, \boldsymbol{R}_{\boldsymbol{y}}\right)^2}{[\boldsymbol{\Phi}^{\boldsymbol{i}}]^{\boldsymbol{T}} \boldsymbol{M}\, \boldsymbol{\Phi}^{\boldsymbol{i}}}$$

$$m_z^i = \frac{\left(\left[\boldsymbol{\Phi}^{\boldsymbol{i}}\right]^{\boldsymbol{T}} \boldsymbol{M}\, \boldsymbol{R}_{\boldsymbol{z}}\right)^2}{[\boldsymbol{\Phi}^{\boldsymbol{i}}]^{\boldsymbol{T}} \boldsymbol{M}\, \boldsymbol{\Phi}^{\boldsymbol{i}}}$$

and where $\sum m_{x,j}$, $\sum m_{y,j}$ and $\sum I_{z,j}$ are the total masses acting in the axis X, Y and the total rotational inertia about the axis Z of the unrestrained *j-th* degrees of freedom.

Mode	Period [s]	Frequency [Hz]	M_X [%]	Sum M_X [%]	M_Y [%]	Sum M_Y [%]	M_Z [%]	Sum M_Z [%]
Mode 1	0.30	3.33	0.02	0.02	96.29	96.29	3.69	3.69
Mode 2	0.26	3.79	0.88	0.90	3.70	100.00	95.42	99.10
Mode 3	0.21	4.75	99.10	100.00	0.00	100.00	0.90	100.00

Dynamic linear analysis

The dynamic linear analysis consists of:

- the calculation of the seismic effects (the seismic action is represented by the design response spectrum), of each of the vibration modes calculated in the modal analysis;
- the combination of these effects.

The seismic effects of the structural model are obtained by the application of the following external loads:

$$\boldsymbol{F_x^i} = \Gamma_x^i S_d(T_i) \boldsymbol{M \Phi^i}$$

and

$$\boldsymbol{F_y^i} = \Gamma_y^i S_d(T_i) \boldsymbol{M \Phi^i}$$

where:

$\boldsymbol{F_x^i}$ and $\boldsymbol{F_y^i}$ are the external loads of the *i-th vibration mode* due to seismic action along X and Y

$S_d(T_i)$ is the spectrum value corresponding to the *i-th* period

$\boldsymbol{\Phi^i}$ is the *i-th modal shape*

$\Gamma_x^i \; and \; \Gamma_y^i$ are the participating modal factor of the *i-th mode* given by:

$$\Gamma_x^i = \frac{\left[\boldsymbol{\Phi^i}\right]^T \boldsymbol{M \, R_x}}{[\boldsymbol{\Phi^i}]^T \boldsymbol{M \, \Phi^i}} \text{ e } \Gamma_y^i = \frac{\left[\boldsymbol{\Phi^i}\right]^T \boldsymbol{M \, R_y}}{[\boldsymbol{\Phi^i}]^T \boldsymbol{M \, \Phi^i}}$$

The effects for a given direction of acceleration (along X or Y) and for each of the vibration modes are combined with the Complete Quadratic Combination technique defined as:

$$E = \left(\sum_j \sum_i \rho_{ij} \cdot E_i \cdot E_j \right)^{1/2}$$

where:

E_j is the effect of the j-th vibration mode;

ρ_{ij} is the correlation coefficient of the *i-th* mode and the *j-th* mode, given by:

$$\rho_{ij} = \frac{8\,\xi^2\beta_{ij}^{3/2}}{(1+\beta_{ij})\left[(1-\beta_{ij})\right]}$$

ξ is the damping ratio in the i-th and j-th modes;

$\beta_{ij} = T_j/T_i$).

The following table provides the diaphragms properties.

Diaphragm	Height above the base of the timber structure [m]	xG [m]	yG [m]	Mass i [kg]
1	3.20	6.08	-0.27	12856

The following table provides, for each of the vibration mode, the corresponding period and value of the response spectrum.

Mode	Period [s]	Spectrum value [g]
Mode 1	0.34	0.09
Mode 2	0.24	0.10
Mode 3	0.20	0.10

Wind

The table below illustrates the horizontal forces acting on the storeys due to the wind action and the coordinates of their respective application points.

Diaphragm	Height above the reference plane [m]	xG,wind [m]	yG,wind [m]	Fx [kN]	Fy [kN]
1	3.20	6.63	-0.30	3.87	14.65

The action effects

In this chapter the internal forces acting on the structural members and on their connections are reported with regard to the considered loads.

Walls

Wall name: Wall ID

N: Total axial force

V2: Shear force (in-plane)

V3: Shear force (out-of-plane)

M2-2: Bending moment (out-of-plane)

M3-3: Bending moment (in-plane)

Va: Shear force on the single connection

Ta: Tensile force on the single anchor

dr: Interstory drift

Load	Wall name	N [kN]	V2 [kN]	V3 [kN]	M2-2 [kNm]	M3-3 [kNm]	Va [kN]	Ta [kN]	dr [mm]
G(sw)	Wall 1	0.69	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 2	0.67	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 3	0.72	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 4	0.74	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 5	0.75	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 6	0.99	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 7	1.96	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 8	1.39	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 9	0.90	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 10	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 11	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 12	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 13	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 14	3.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 15	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 16	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 17	0.68	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 18	4.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 19	0.66	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 20	0.64	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 21	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 22	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 23	2.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 24	1.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 25	1.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 1	1.18	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 2	1.05	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 3	1.28	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 4	1.41	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 5	1.45	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 6	2.66	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 7	7.40	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 8	4.60	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 9	2.19	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 10	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 11	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 12	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 13	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 14	14.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 15	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 16	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 17	1.11	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 18	18.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 19	0.96	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 20	0.88	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 21	3.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 22	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 23	11.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 24	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00

G(ns)	Wall 25	5.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 1	0.02	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 2	-0.24	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 3	0.18	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 4	0.47	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 5	0.60	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 6	2.97	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 7	12.42	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 8	6.87	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 9	2.04	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 14	19.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 18	26.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 23	13.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 25	2.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 1	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 2	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 3	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 4	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 5	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 6	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 7	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 8	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 9	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 10	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 11	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 12	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 13	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 14	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 15	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 16	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 17	0.00	0.00	0.39	0.31	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 18	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 19	0.00	0.00	0.34	0.27	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 20	0.00	0.00	0.31	0.25	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 21	0.00	0.00	1.26	1.01	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 22	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 23	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 24	0.00	0.00	0.88	0.70	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 25	0.00	0.00	1.68	1.34	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 1	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 2	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 3	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 4	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 5	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 6	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 7	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 8	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 9	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 10	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 11	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 12	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 13	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 14	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 15	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 16	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 17	0.00	0.00	0.39	0.31	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 18	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 19	0.00	0.00	0.34	0.27	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 20	0.00	0.00	0.31	0.25	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 21	0.00	0.00	1.26	1.01	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 22	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 23	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 24	0.00	0.00	0.88	0.70	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 25	0.00	0.00	1.68	1.34	0.00	0.00	0.00	0.00
Wind X	Wall 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 10	0.00	0.46	0.00	0.00	1.48	0.00	0.00	0.33
Wind X	Wall 11	0.00	0.46	0.00	0.00	1.48	0.00	0.00	0.33
Wind X	Wall 12	0.00	0.46	0.00	0.00	1.48	0.00	0.00	0.33
Wind X	Wall 13	0.00	0.46	0.00	0.00	1.48	0.00	0.00	0.33
Wind X	Wall 14	0.00	0.03	0.00	0.00	0.09	0.00	0.00	0.02
Wind X	Wall 15	0.00	0.48	0.00	0.00	1.54	0.00	0.00	0.35
Wind X	Wall 16	0.00	0.48	0.00	0.00	1.54	0.00	0.00	0.35

Wind X	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind X	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 21	0.00	0.35	0.00	0.00	1.13	0.00	0.00	0.35
Wind X	Wall 22	0.00	0.48	0.00	0.00	1.54	0.00	0.00	0.35
Wind X	Wall 23	0.00	0.02	0.00	0.00	0.07	0.00	0.00	0.01
Wind X	Wall 24	0.00	0.22	0.00	0.00	0.72	0.00	0.00	0.34
Wind X	Wall 25	0.00	0.01	0.00	0.00	0.03	0.00	0.00	0.01
Wind Y	Wall 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 10	0.00	0.24	0.00	0.00	0.76	0.00	0.00	0.17
Wind Y	Wall 11	0.00	0.24	0.00	0.00	0.76	0.00	0.00	0.17
Wind Y	Wall 12	0.00	0.24	0.00	0.00	0.76	0.00	0.00	0.17
Wind Y	Wall 13	0.00	0.24	0.00	0.00	0.76	0.00	0.00	0.17
Wind Y	Wall 14	0.00	4.50	0.00	0.00	14.41	0.00	0.00	3.16
Wind Y	Wall 15	0.00	0.27	0.00	0.00	0.85	0.00	0.00	0.19
Wind Y	Wall 16	0.00	0.27	0.00	0.00	0.85	0.00	0.00	0.19
Wind Y	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 18	0.00	3.69	0.00	0.00	11.82	0.00	0.00	2.59
Wind Y	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 21	0.00	0.20	0.00	0.00	0.63	0.00	0.00	0.19
Wind Y	Wall 22	0.00	0.27	0.00	0.00	0.85	0.00	0.00	0.19
Wind Y	Wall 23	0.00	3.06	0.00	0.00	9.78	0.00	0.00	2.15
Wind Y	Wall 24	0.00	0.05	0.00	0.00	0.14	0.00	0.00	0.07
Wind Y	Wall 25	0.00	3.40	0.00	0.00	10.87	0.00	0.00	2.40
Seismic static X	Wall 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 10	0.00	1.56	0.00	0.00	4.98	0.00	0.00	2.91
Seismic static X	Wall 11	0.00	1.56	0.00	0.00	4.98	0.00	0.00	2.91
Seismic static X	Wall 12	0.00	1.56	0.00	0.00	4.98	0.00	0.00	2.91
Seismic static X	Wall 13	0.00	1.56	0.00	0.00	4.98	0.00	0.00	2.91
Seismic static X	Wall 14	0.00	0.13	0.00	0.00	0.42	0.00	0.00	0.24
Seismic static X	Wall 15	0.00	1.63	0.00	0.00	5.23	0.00	0.00	3.06
Seismic static X	Wall 16	0.00	1.63	0.00	0.00	5.23	0.00	0.00	3.06
Seismic static X	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 18	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01
Seismic static X	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 21	0.00	1.20	0.00	0.00	3.85	0.00	0.00	3.06
Seismic static X	Wall 22	0.00	1.63	0.00	0.00	5.23	0.00	0.00	3.06
Seismic static X	Wall 23	0.00	0.10	0.00	0.00	0.31	0.00	0.00	0.18
Seismic static X	Wall 24	0.00	0.76	0.00	0.00	2.42	0.00	0.00	2.95
Seismic static X	Wall 25	0.00	0.04	0.00	0.00	0.12	0.00	0.00	0.07
Seismic static Y	Wall 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 10	0.00	0.06	0.00	0.00	0.19	0.00	0.00	0.11
Seismic static Y	Wall 11	0.00	0.06	0.00	0.00	0.19	0.00	0.00	0.11
Seismic static Y	Wall 12	0.00	0.06	0.00	0.00	0.19	0.00	0.00	0.11
Seismic static Y	Wall 13	0.00	0.06	0.00	0.00	0.19	0.00	0.00	0.11
Seismic static Y	Wall 14	0.00	3.49	0.00	0.00	11.16	0.00	0.00	6.37
Seismic static Y	Wall 15	0.00	0.07	0.00	0.00	0.22	0.00	0.00	0.13
Seismic static Y	Wall 16	0.00	0.07	0.00	0.00	0.22	0.00	0.00	0.13
Seismic static Y	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 18	0.00	3.28	0.00	0.00	10.50	0.00	0.00	6.00
Seismic static Y	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 21	0.00	0.05	0.00	0.00	0.16	0.00	0.00	0.13
Seismic static Y	Wall 22	0.00	0.07	0.00	0.00	0.22	0.00	0.00	0.13
Seismic static Y	Wall 23	0.00	3.12	0.00	0.00	9.99	0.00	0.00	5.70
Seismic static Y	Wall 24	0.00	0.01	0.00	0.00	0.04	0.00	0.00	0.04
Seismic static Y	Wall 25	0.00	3.19	0.00	0.00	10.22	0.00	0.00	5.87
Seismic dynamic X	Wall 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D

Seismic dynamic X	Wall 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 10	0.00	1.49	0.00	0.00	4.76	0.00	0.00	2.78
Seismic dynamic X	Wall 11	0.00	1.49	0.00	0.00	4.76	0.00	0.00	2.78
Seismic dynamic X	Wall 12	0.00	1.49	0.00	0.00	4.76	0.00	0.00	2.78
Seismic dynamic X	Wall 13	0.00	1.49	0.00	0.00	4.76	0.00	0.00	2.78
Seismic dynamic X	Wall 14	0.00	0.68	0.00	0.00	2.18	0.00	0.00	1.25
Seismic dynamic X	Wall 15	0.00	1.31	0.00	0.00	4.20	0.00	0.00	2.46
Seismic dynamic X	Wall 16	0.00	1.31	0.00	0.00	4.20	0.00	0.00	2.46
Seismic dynamic X	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 18	0.00	0.72	0.00	0.00	2.30	0.00	0.00	1.31
Seismic dynamic X	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 21	0.00	0.97	0.00	0.00	3.09	0.00	0.00	2.46
Seismic dynamic X	Wall 22	0.00	1.31	0.00	0.00	4.20	0.00	0.00	2.46
Seismic dynamic X	Wall 23	0.00	1.49	0.00	0.00	4.77	0.00	0.00	2.72
Seismic dynamic X	Wall 24	0.00	0.68	0.00	0.00	2.16	0.00	0.00	2.63
Seismic dynamic X	Wall 25	0.00	1.03	0.00	0.00	3.29	0.00	0.00	1.89
Seismic dynamic Y	Wall 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 10	0.00	0.61	0.00	0.00	1.94	0.00	0.00	1.13
Seismic dynamic Y	Wall 11	0.00	0.61	0.00	0.00	1.94	0.00	0.00	1.13
Seismic dynamic Y	Wall 12	0.00	0.61	0.00	0.00	1.94	0.00	0.00	1.13
Seismic dynamic Y	Wall 13	0.00	0.61	0.00	0.00	1.94	0.00	0.00	1.13
Seismic dynamic Y	Wall 14	0.00	4.40	0.00	0.00	14.10	0.00	0.00	8.05
Seismic dynamic Y	Wall 15	0.00	1.08	0.00	0.00	3.45	0.00	0.00	2.01
Seismic dynamic Y	Wall 16	0.00	1.08	0.00	0.00	3.45	0.00	0.00	2.01
Seismic dynamic Y	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 18	0.00	2.30	0.00	0.00	7.36	0.00	0.00	4.20
Seismic dynamic Y	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 21	0.00	0.79	0.00	0.00	2.54	0.00	0.00	2.01
Seismic dynamic Y	Wall 22	0.00	1.08	0.00	0.00	3.45	0.00	0.00	2.01
Seismic dynamic Y	Wall 23	0.00	1.74	0.00	0.00	5.56	0.00	0.00	3.18
Seismic dynamic Y	Wall 24	0.00	0.15	0.00	0.00	0.47	0.00	0.00	0.57
Seismic dynamic Y	Wall 25	0.00	1.82	0.00	0.00	5.82	0.00	0.00	3.34

Floors

Floor name: Floor ID

V2: Maximum shear stress along the local axis 2 for the most stressed element of the floor

M3-3: Maximum bending moment around local axis 3 for the most stressed element of the floor

w_{ist}: Maximum deformation for the most stressed element of the floor

Load	Floor name	V2 [kN]	M3-3 [kNm]	w_{ist} [mm]
G(sw)	Floor 1	0.26	1.68	2549.13
G(ns)	Floor 1	1.29	8.30	12588.30
Q type A	Floor 1	2.57	16.59	25176.61
Ortho wind ULS down	Floor 1	0.00	0.00	0.00
Ortho wind ULS up	Floor 1	0.00	0.00	0.00
Wind X	Floor 1	0.00	0.00	0.00
Wind Y	Floor 1	0.00	0.00	0.00
Seismic static X	Floor 1	0.00	0.00	0.00
Seismic static Y	Floor 1	0.00	0.00	0.00
Seismic dynamic X	Floor 1	0.00	0.00	0.00

Seismic dynamic Y	Floor 1	0.00	0.00	0.00

Forces and moments acting at the base of the structure

In this chapter the values of the actions acting at the base of the walls and the columns of the ground floor are reported. With regard to the walls, the first row of the table shows the values of the actions related to the ULS combination that maximizes the axial force while the second row shows the values of the actions related to the horizontal ULS combination that maximizes the moment acting in the plane of the wall M3-3 and the shear force V2 (also acting in the plane of the wall) and that, at the same time, minimizes the axial force N.

In the other rows, the actions at the foot of the walls associated with the different loads considered individually are reported.

Walls

Wall name: Wall ID

N: Total axial force

V2: Shear force (in-plane)

V3: Shear force (out-of-plane)

M2-2: Bending moment (out-of-plane)

M3-3: Bending moment (in-plane)

Wall name	Length [m]	Load / Comb.	N [kN]	V2 [kN]	V3 [kN]	M2-2 [kNm]	M3-3 [kNm]
Wall 1	0.61	ULS 1	2.53	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	0.69	0.00	0.00	0.00	0.00
		G(ns)	1.18	0.00	0.00	0.00	0.00
		Q type A	0.02	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.33	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.33	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 2	0.60	ULS 1	2.33	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	0.67	0.00	0.00	0.00	0.00
		G(ns)	1.05	0.00	0.00	0.00	0.00
		Q type A	-0.24	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.32	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.32	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 3	0.61	ULS 1	2.70	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	0.72	0.00	0.00	0.00	0.00
		G(ns)	1.28	0.00	0.00	0.00	0.00
		Q type A	0.18	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.33	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.33	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00

		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 4	0.61	ULS 3	3.28	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	0.74	0.00	0.00	0.00	0.00
		G(ns)	1.41	0.00	0.00	0.00	0.00
		Q type A	0.47	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.33	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.33	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 5	0.60	ULS 3	3.55	0.00	0.00	0.00	0.00
		ULS earthquake drift 4 ex- ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	0.75	0.00	0.00	0.00	0.00
		G(ns)	1.45	0.00	0.00	0.00	0.00
		Q type A	0.60	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.32	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.32	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 6	0.61	ULS 3	8.84	0.00	0.00	0.00	0.00
		ULS earthquake drift 4 ex- ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	0.99	0.00	0.00	0.00	0.00
		G(ns)	2.66	0.00	0.00	0.00	0.00
		Q type A	2.97	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.33	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.33	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 7	0.61	ULS 3	29.87	0.00	0.00	0.00	0.00
		ULS earthquake drift 4 ex- ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	1.96	0.00	0.00	0.00	0.00
		G(ns)	7.40	0.00	0.00	0.00	0.00
		Q type A	12.42	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.33	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.33	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 8	0.60	ULS 3	17.50	0.00	0.00	0.00	0.00
		ULS earthquake drift 4 ex- ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	1.39	0.00	0.00	0.00	0.00
		G(ns)	4.60	0.00	0.00	0.00	0.00
		Q type A	6.87	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.32	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.32	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 9	0.61	ULS 3	6.77	0.00	0.00	0.00	0.00
		ULS earthquake drift 4 ex- ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	0.90	0.00	0.00	0.00	0.00
		G(ns)	2.19	0.00	0.00	0.00	0.00
		Q type A	2.04	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.33	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.33	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00

		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 10	2.45	ULS 1	8.48	0.00	0.00	0.00	0.00
		ULS earthquake drift 2 ex- ey+	0.00	1.54	0.00	0.00	4.94
		G(sw)	1.57	0.00	0.00	0.00	0.00
		G(ns)	4.70	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.65	1.32	0.00
		Ortho wind ULS up	0.00	0.00	1.65	1.32	0.00
		Wind X	0.00	0.46	0.00	0.00	1.48
		Wind Y	0.00	0.24	0.00	0.00	0.76
		Seismic static X	0.00	1.56	0.00	0.00	4.98
		Seismic static Y	0.00	0.06	0.00	0.00	0.19
		Seismic dynamic X	0.00	1.49	0.00	0.00	4.76
		Seismic dynamic Y	0.00	0.61	0.00	0.00	1.94
Wall 11	2.45	ULS 1	8.48	0.00	0.00	0.00	0.00
		ULS earthquake drift 2 ex- ey+	0.00	1.54	0.00	0.00	4.94
		G(sw)	1.57	0.00	0.00	0.00	0.00
		G(ns)	4.70	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.65	1.32	0.00
		Ortho wind ULS up	0.00	0.00	1.65	1.32	0.00
		Wind X	0.00	0.46	0.00	0.00	1.48
		Wind Y	0.00	0.24	0.00	0.00	0.76
		Seismic static X	0.00	1.56	0.00	0.00	4.98
		Seismic static Y	0.00	0.06	0.00	0.00	0.19
		Seismic dynamic X	0.00	1.49	0.00	0.00	4.76
		Seismic dynamic Y	0.00	0.61	0.00	0.00	1.94
Wall 12	2.45	ULS 1	8.48	0.00	0.00	0.00	0.00
		ULS earthquake drift 2 ex- ey+	0.00	1.54	0.00	0.00	4.94
		G(sw)	1.57	0.00	0.00	0.00	0.00
		G(ns)	4.70	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.65	1.32	0.00
		Ortho wind ULS up	0.00	0.00	1.65	1.32	0.00
		Wind X	0.00	0.46	0.00	0.00	1.48
		Wind Y	0.00	0.24	0.00	0.00	0.76
		Seismic static X	0.00	1.56	0.00	0.00	4.98
		Seismic static Y	0.00	0.06	0.00	0.00	0.19
		Seismic dynamic X	0.00	1.49	0.00	0.00	4.76
		Seismic dynamic Y	0.00	0.61	0.00	0.00	1.94
Wall 13	2.45	ULS 1	8.48	0.00	0.00	0.00	0.00
		ULS earthquake drift 2 ex- ey+	0.00	1.54	0.00	0.00	4.94
		G(sw)	1.57	0.00	0.00	0.00	0.00
		G(ns)	4.70	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.65	1.32	0.00
		Ortho wind ULS up	0.00	0.00	1.65	1.32	0.00
		Wind X	0.00	0.46	0.00	0.00	1.48
		Wind Y	0.00	0.24	0.00	0.00	0.76
		Seismic static X	0.00	1.56	0.00	0.00	4.98
		Seismic static Y	0.00	0.06	0.00	0.00	0.19
		Seismic dynamic X	0.00	1.49	0.00	0.00	4.76
		Seismic dynamic Y	0.00	0.61	0.00	0.00	1.94
Wall 14	2.50	ULS 3	51.28	0.00	0.00	0.00	0.00
		ULS earthquake drift 4 ex+ ey-	0.00	4.45	0.00	0.00	14.22
		G(sw)	3.58	0.00	0.00	0.00	0.00
		G(ns)	14.62	0.00	0.00	0.00	0.00
		Q type A	19.63	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.69	1.35	0.00
		Ortho wind ULS up	0.00	0.00	1.69	1.35	0.00
		Wind X	0.00	0.03	0.00	0.00	0.09
		Wind Y	0.00	4.50	0.00	0.00	14.41
		Seismic static X	0.00	0.13	0.00	0.00	0.42
		Seismic static Y	0.00	3.49	0.00	0.00	11.16
		Seismic dynamic X	0.00	0.68	0.00	0.00	2.18
		Seismic dynamic Y	0.00	4.40	0.00	0.00	14.10
Wall 15	2.45	ULS 1	8.48	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex- ey-	0.00	1.61	0.00	0.00	5.15
		G(sw)	1.57	0.00	0.00	0.00	0.00
		G(ns)	4.70	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.65	1.32	0.00
		Ortho wind ULS up	0.00	0.00	1.65	1.32	0.00
		Wind X	0.00	0.48	0.00	0.00	1.54
		Wind Y	0.00	0.27	0.00	0.00	0.85
		Seismic static X	0.00	1.63	0.00	0.00	5.23

		Seismic static Y	0.00	0.07	0.00	0.00	0.22
		Seismic dynamic X	0.00	1.31	0.00	0.00	4.20
		Seismic dynamic Y	0.00	1.08	0.00	0.00	3.45
Wall 16	2.45	ULS 1	8.48	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex- ey-	0.00	1.61	0.00	0.00	5.15
		G(sw)	1.57	0.00	0.00	0.00	0.00
		G(ns)	4.70	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.65	1.32	0.00
		Ortho wind ULS up	0.00	0.00	1.65	1.32	0.00
		Wind X	0.00	0.48	0.00	0.00	1.54
		Wind Y	0.00	0.27	0.00	0.00	0.85
		Seismic static X	0.00	1.63	0.00	0.00	5.23
		Seismic static Y	0.00	0.07	0.00	0.00	0.22
		Seismic dynamic X	0.00	1.31	0.00	0.00	4.20
		Seismic dynamic Y	0.00	1.08	0.00	0.00	3.45
Wall 17	0.58	ULS 1	2.42	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	0.68	0.00	0.00	0.00	0.00
		G(ns)	1.11	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.39	0.31	0.00
		Ortho wind ULS up	0.00	0.00	0.39	0.31	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 18	2.50	ULS 3	66.85	0.00	0.00	0.00	0.00
		ULS Wind 8	20.17	3.69	1.69	1.35	11.82
		G(sw)	4.29	0.00	0.00	0.00	0.00
		G(ns)	18.12	0.00	0.00	0.00	0.00
		Q type A	26.64	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.69	1.35	0.00
		Ortho wind ULS up	0.00	0.00	1.69	1.35	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	3.69	0.00	0.00	11.82
		Seismic static X	0.00	0.00	0.00	0.00	0.01
		Seismic static Y	0.00	3.28	0.00	0.00	10.50
		Seismic dynamic X	0.00	0.72	0.00	0.00	2.30
		Seismic dynamic Y	0.00	2.30	0.00	0.00	7.36
Wall 19	0.50	ULS 1	2.18	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	0.66	0.00	0.00	0.00	0.00
		G(ns)	0.96	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.34	0.27	0.00
		Ortho wind ULS up	0.00	0.00	0.34	0.27	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 20	0.46	ULS 1	2.06	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	0.64	0.00	0.00	0.00	0.00
		G(ns)	0.88	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.31	0.25	0.00
		Ortho wind ULS up	0.00	0.00	0.31	0.25	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 21	1.87	ULS 1	6.65	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex- ey-	0.00	1.18	0.00	0.00	3.79
		G(sw)	1.33	0.00	0.00	0.00	0.00
		G(ns)	3.59	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.26	1.01	0.00
		Ortho wind ULS up	0.00	0.00	1.26	1.01	0.00
		Wind X	0.00	0.35	0.00	0.00	1.13
		Wind Y	0.00	0.20	0.00	0.00	0.63
		Seismic static X	0.00	1.20	0.00	0.00	3.85
		Seismic static Y	0.00	0.05	0.00	0.00	0.16

		Seismic dynamic X	0.00	0.97	0.00	0.00	3.09
		Seismic dynamic Y	0.00	0.79	0.00	0.00	2.54
Wall 22	2.45	ULS 1	8.48	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex- ey-	0.00	1.61	0.00	0.00	5.15
		G(sw)	1.57	0.00	0.00	0.00	0.00
		G(ns)	4.70	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.65	1.32	0.00
		Ortho wind ULS up	0.00	0.00	1.65	1.32	0.00
		Wind X	0.00	0.48	0.00	0.00	1.54
		Wind Y	0.00	0.27	0.00	0.00	0.85
		Seismic static X	0.00	1.63	0.00	0.00	5.23
		Seismic static Y	0.00	0.07	0.00	0.00	0.22
		Seismic dynamic X	0.00	1.31	0.00	0.00	4.20
		Seismic dynamic Y	0.00	1.08	0.00	0.00	3.45
Wall 23	2.50	ULS 3	37.28	0.00	0.00	0.00	0.00
		ULS earthquake drift 4 ex- ey-	0.00	3.84	0.00	0.00	12.28
		G(sw)	2.94	0.00	0.00	0.00	0.00
		G(ns)	11.46	0.00	0.00	0.00	0.00
		Q type A	13.33	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.69	1.35	0.00
		Ortho wind ULS up	0.00	0.00	1.69	1.35	0.00
		Wind X	0.00	0.02	0.00	0.00	0.07
		Wind Y	0.00	3.06	0.00	0.00	9.78
		Seismic static X	0.00	0.10	0.00	0.00	0.31
		Seismic static Y	0.00	3.12	0.00	0.00	9.99
		Seismic dynamic X	0.00	1.49	0.00	0.00	4.77
		Seismic dynamic Y	0.00	1.74	0.00	0.00	5.56
Wall 24	1.30	ULS 1	4.76	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex- ey-	0.00	0.72	0.00	0.00	2.29
		G(sw)	1.03	0.00	0.00	0.00	0.00
		G(ns)	2.50	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.88	0.70	0.00
		Ortho wind ULS up	0.00	0.00	0.88	0.70	0.00
		Wind X	0.00	0.22	0.00	0.00	0.72
		Wind Y	0.00	0.05	0.00	0.00	0.14
		Seismic static X	0.00	0.76	0.00	0.00	2.42
		Seismic static Y	0.00	0.01	0.00	0.00	0.04
		Seismic dynamic X	0.00	0.68	0.00	0.00	2.16
		Seismic dynamic Y	0.00	0.15	0.00	0.00	0.47
Wall 25	2.49	ULS 3	12.78	0.00	0.00	0.00	0.00
		ULS earthquake drift 4 ex- ey-	0.00	2.94	0.00	0.00	9.42
		G(sw)	1.82	0.00	0.00	0.00	0.00
		G(ns)	5.94	0.00	0.00	0.00	0.00
		Q type A	2.31	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.68	1.34	0.00
		Ortho wind ULS up	0.00	0.00	1.68	1.34	0.00
		Wind X	0.00	0.01	0.00	0.00	0.03
		Wind Y	0.00	3.40	0.00	0.00	10.87
		Seismic static X	0.00	0.04	0.00	0.00	0.12
		Seismic static Y	0.00	3.19	0.00	0.00	10.22
		Seismic dynamic X	0.00	1.03	0.00	0.00	3.29
		Seismic dynamic Y	0.00	1.82	0.00	0.00	5.82

Design of the structural elements

Joist floors

Bending strength

The checks are conducted according to § 3.2.1 of AS 1720.1. The following expression shall be satisfied:

$$M_d \geq M^*$$

with

$$M_d = \phi \cdot k_1 \cdot k_4 \cdot k_6 \cdot k_9 \cdot k_{12} \cdot f_b' \cdot Z$$

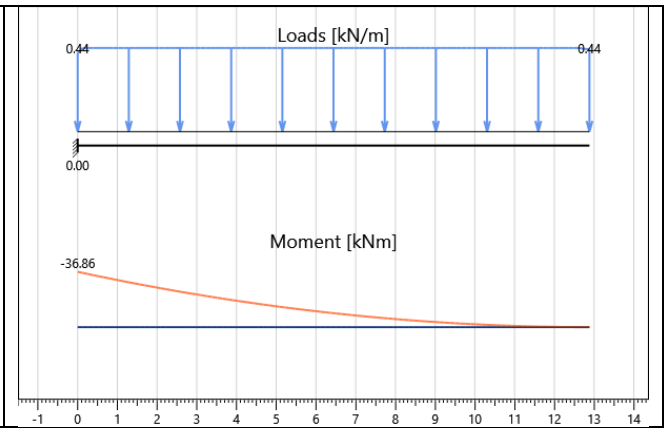
where

$M^* = M_{3-3\,max}$ is the design action effect in bending

ϕ	is the capacity factor
k_1	is the duration of load modification factor for strength
k_4	is the moisture condition modification factor for strength
k_6	is the temperature modification factor
k_9	is the strength sharing modification factor
k_{12}	is the stability factor
f_b'	is the characteristic value in bending for the section size
Z	is the section modulus of the beam about the axis of bending $Z = (bh^2/6)$

The following table illustrates the structural schemes and the envelopes of the bending moment diagram for the joist with the most severe checks of each floor.

Floor name	Combination	Duration	Diagram $M_{3\text{-}3}$

Floor 1	ULS 3	5 months	

The checks are summarized below in the form of a percentage value.

Floor name	Section	$M_{3\text{-}3\ max}$ [kNm]	Z [mm^3]	Comb.	k_1	k_4	k_6	k_9	k_{12}	ϕ	f'_b [MPa]	M_d [kNm]	Check
Floor 1	Joists floor 1	36.86	60750	ULS 3	0.8	1	1	1	1	0.9	17.00	0.74	4958%

Where f'_b for rectangular beam sections made of F-grades timber and greater than 300 mm in depth is obtained by multiplying the value of table H2.1 of AS 1720.1 by $(300/d)^{0.167}$.

Shear strength

The checks are conducted according to § 3.2.5 of AS 1720.1. The following expression shall be satisfied:

$$V_d \geq V^*$$

with

$$V_d = \phi \cdot k_1 \cdot k_4 \cdot k_6 \cdot f_s' \cdot A_s$$

where

$V^* = V_{2\,max}$ is the design action effect in shear

ϕ is the capacity factor

k_1 is the duration of load modification factor for strength

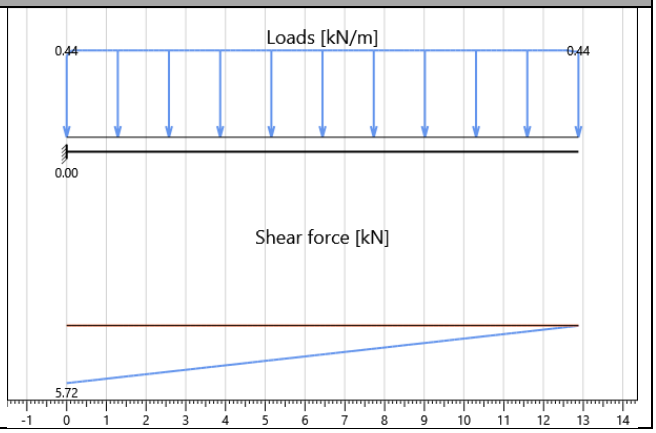
k_4 is the moisture condition modification factor for strength

k_6 is the temperature modification factor

f_s' is the characteristic value in shear

A_s is the shear plane area for a rectangular beam loaded about its major axis in bending $A_s = 2/3(bd)$

The following table illustrates the structural schemes and the envelopes of the shear force diagram for the joist of each floor with the most sever checks.

Floor name	Combination	Duration	Diagram V_2
Floor 1	ULS 3	5 months	

The checks are summarized below in the form of a percentage value.

Floor name	Section	$V_{2\,max}$ [kN]	A_s [mm^2]	Comb.	k_1	k_4	k_6	ϕ	f'_s [MPa]	V_d [kN]	Check
Floor 1	Joists floor 1	5.72	4050	ULS 3	0.8	1	1	0.9	2.60	5.05	113%

Technical Design Calculation Report

Floors deflections (SLS)

The final deflection below a straight line between the supports due to a single type of action, w_{creep}, is taken as:

$$w_{creep,i} = j_2 \cdot w_{short-term,i}$$

where:

$w_{creep,i}$ is the final deflection that includes the effect of creep on deformation

$w_{short-term,i}$ is the short-term deflection

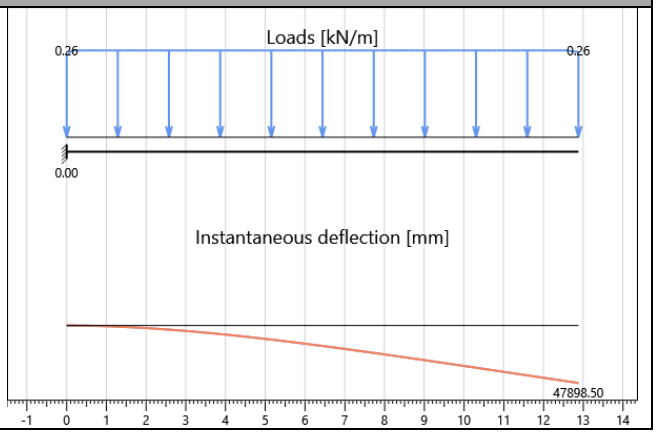
j_2 is the modification factor for creep

The limiting values for deflections of floors are assumed as shown in the following table according to the considered combination of actions.

	W_s	$\psi_s \cdot Q$	$G + \psi_s \cdot Q$	$G + \psi_l \cdot Q$
Internal spans	l/300	l/400	15 mm	l/300
Cantilever beams	l/150	l/200	30 mm	l/150

The value of deflection $w_{creep,i}$ is calculated for each type of load in the considered combination of actions and the final value $w_{creep,i}$ is defined as the sum of these deflections.

The following table shows the maximum deformation of each floor (relative to the element in which the deformation checks are the most severe).

Floor name	Combination	Deflection
Floor 1	SLS 3	

The table shows the deflection checks of the floor elements.

Floor name	Section	Combination	Most restrictive check	W_{creep} [mm]	Deflection limit [mm]	Check
Floor 1	Joists floor 1	SLS 3	Cantilever beams	47898.50	30.00	159662%

Framed Walls

Combined bending and compression of the studs

The checks are conducted according to § 3.5.1 of AS 1720.1 on the most loaded internal and external stud of each wall. The following expressions shall be satisfied:

$$\left(\frac{M^*_{out-of-plane}}{M_{d,out-of-plane}}\right)^2 + \frac{N^*_c}{N_{d,c,in-plane}} \leq 1$$

$$\frac{M^*_{out-of-plane}}{M_{d,out-of-plane}} + \frac{N^*_c}{N_{d,c,out-of-plane}} \leq 1$$

with

$M^*_{out-of-plane} = M_{2-2}$ is the design action effect in bending out of the plane of the wall

$M_{d,out-of-plane}$ is the design capacity in bending out of the plane of the wall

$N^*_c = N$ is the design action effect in compression

$N_{d,c,out-of-plane}$ is the design capacity in compression for buckling out of the plane of the wall

$N_{d,c,in-plane}$ is the design capacity in compression for buckling in the plane of the wall

The design capacity of each stud in bending out-of-the-plane of the wall is calculated according to the following equation:

$$M_{d,out-of-plane} = \phi \cdot k_1 \cdot k_4 \cdot k_6 \cdot k_9 \cdot k_{12} \cdot f'_b \cdot Z$$

where

ϕ is the capacity factor

k_1 is the duration of load modification factor for strength

k_4 is the moisture condition modification factor for strength

k_6 is the temperature modification factor

k_9 is the strength sharing modification factor

k_{12} is the stability factor

f'_b is the characteristic value in bending for the section size

Z is the section modulus of the stud about the axis of bending $Z = (bt^2/6)$

The design capacity of each stud in compression is calculated according to the following equation:

$$N_{d,c} = \phi \cdot k_1 \cdot k_4 \cdot k_6 \cdot k_{12} \cdot f_c' \cdot A_c$$

where

ϕ	is the capacity factor
k_1	is the duration of load modification factor for strength
k_4	is the moisture condition modification factor for strength
k_6	is the temperature modification factor
k_{12}	is the relevant stability factor for buckling in or out of the plane of the wall
f_c'	is the characteristic value in compression parallel to grain
A_c	is the cross-sectional area of the stud

The stability factor k_{12} takes into account the reduced compressive strength due to lateral buckling.

The factor value is calculated according to § 3.3.3 of AS 1720.1 as follows:

(a) For $\rho_c \cdot S \leq 10$ → $k_{12} = 1.0$

(b) For $10 \leq \rho_c \cdot S \leq 20$ → $k_{12} = 1.5 - 0.05 \cdot \rho_c \cdot S$

(c) For $\rho_c \cdot S \geq 20$ → $k_{12} = \frac{200}{(\rho_c \cdot S)^2}$

Where S is the relevant slenderness coefficient for buckling under compression and ρ_c is the material constant for columns.

The slenderness coefficient for buckling out of the plane of the wall is evaluated according to the following equations that is consistent with those provided in section 3.3.2.2 of AS 1720.1:

$$S_{out-of-plane} = \frac{g_{13} \cdot L}{t}$$

where

L	is the height of the stud
t	is the thickness of the frame (dimension of the stud cross-section perpendicular to the wall plane)
g_{13}	is the effective length factor equal to 0.85 for studs in light framing when plates and studs are made of the same timber grade

The slenderness coefficient for buckling in the plane of the wall is equal to 0 when an effective restraint system act continuously along both edges of the stud (i.e. sheeting boards on both the faces of the frame).

When the sheeting board provides an effective restraint along one edge only of the stud, the slenderness coefficient for buckling in the plane of the wall is evaluated according to the following equations that is consistent to those provided in section 3.3.2.2 of AS 1720.1:

$$S_{in-plane} = \frac{3.5 \cdot t}{b}$$

where

t is the thickness of the frame (dimension of the stud cross-section perpendicular to the wall plane)

b is the dimension of the stud cross-section parallel to the wall plane

In case of walls braced through steel braces, the slenderness coefficient for buckling in the plane of the wall is evaluated according to the following equations that is consistent with those provided in section 3.3.2.2 of AS 1720.1:

$$S_{in-plane} = \frac{g_{13} \cdot L}{b}$$

where

L is the height of the stud

b is the dimension of the stud cross-section parallel to the wall plane

g_{13} is the effective length factor equal to 0.85 for studs in light framing when plates and studs are made of the same timber grade

The material constant values for each material are defined according to equations E2(3) and E2(4) of AS 1720.1 assuming $r = 0.25$:

(a) Columns of seasoned timber $\rho_c = 11.39 \left(\frac{E}{f_c'}\right)^{-0.408} r^{-0.074}$

(b) Columns of unseasoned timber $\rho_c = 9.29 \left(\frac{E}{f_c'}\right)^{-0.367} r^{-0.146}$

The values of the actions in the tables below are related, for each wall, to the most severe combination of load for the Ultimate Limit State of combined bending and compression.

Wall name	Length [m]	Combination	Duration	N [kN]	M2-2 [kNm]
Wall 1	0.61	ULS 5	5 seconds	2.26	0.33
Wall 2	0.60	ULS 5	5 seconds	1.98	0.32
Wall 3	0.61	ULS 5	5 seconds	2.48	0.33
Wall 4	0.61	ULS 5	5 seconds	2.76	0.33
Wall 5	0.60	ULS 5	5 seconds	2.88	0.32
Wall 6	0.61	ULS 5	5 seconds	5.57	0.33
Wall 7	0.61	ULS 3	5 months	29.87	0.00
Wall 8	0.60	ULS 3	5 months	17.50	0.00
Wall 9	0.61	ULS 5	5 seconds	4.53	0.33
Wall 10	2.45	ULS 5	5 seconds	7.53	1.32
Wall 11	2.45	ULS 5	5 seconds	7.53	1.32
Wall 12	2.45	ULS 5	5 seconds	7.53	1.32
Wall 13	2.45	ULS 5	5 seconds	7.53	1.32
Wall 14	2.50	ULS 3	5 months	51.28	0.00
Wall 15	2.45	ULS 5	5 seconds	7.53	1.32

Wall 16	2.45	ULS 5	5 seconds	7.53	1.32
Wall 17	0.58	ULS 5	5 seconds	2.15	0.31
Wall 18	2.50	ULS 3	5 months	66.85	0.00
Wall 19	0.50	ULS 5	5 seconds	1.94	0.27
Wall 20	0.46	ULS 5	5 seconds	1.83	0.25
Wall 21	1.87	ULS 5	5 seconds	5.91	1.01
Wall 22	2.45	ULS 5	5 seconds	7.53	1.32
Wall 23	2.50	ULS 3	5 months	37.28	0.00
Wall 24	1.30	ULS 5	5 seconds	4.23	0.70
Wall 25	2.49	ULS 5	5 seconds	10.23	1.34

The relevant values for the calculation of the stability factors in bending and compression are reported in the following table.

Wall name	Section	Stud	L [m]	$k_{12,\ bending,\ o\text{-}o\text{-}p}$	$S_{compression,\ o\text{-}o\text{-}p}$	$S_{compression,\ i\text{-}p}$	ρ_c	$k_{compression,\ 12,\ o\text{-}o\text{-}p}$	$k_{compression,\ 12,\ i\text{-}p}$
Wall 1	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 1	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 2	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 2	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 3	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 3	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 4	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 4	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 5	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 5	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 6	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 6	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 7	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 7	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 8	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 8	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 9	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 9	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 10	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 10	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 11	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 11	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 12	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 12	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 13	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 13	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 14	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 14	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 15	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 15	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 16	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 16	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 17	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 17	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 18	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 18	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 19	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 19	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 20	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 21	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 21	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 22	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 22	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 23	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 23	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 24	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 24	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 25	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 25	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00

The checks are summarized below in the form of a percentage value

Wall name	Section	Stud	$M_{2\text{-}2}$ [kNm]	N [kN]	Z [mm^3]	A_c [mm^2]	Comb.	k_1	k_4	k_6	ϕ	f'_b [MPa]	f'_c [MPa]	M_d [kNm]	$N_{d,c,o\text{-}o\text{-}p}$ [kN]	$N_{d,c,i\text{-}p}$ [kN]	Check
Wall 1	Frame 1	Internal	0.15	1.05	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	23%
Wall 1	Frame 1	External	0.12	0.80	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 2	Frame 1	Internal	0.15	0.95	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	22%
Wall 2	Frame 1	External	0.12	0.63	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 3	Frame 1	Internal	0.15	1.16	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	24%
Wall 3	Frame 1	External	0.12	0.83	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 4	Frame 1	Internal	0.15	1.30	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	25%
Wall 4	Frame 1	External	0.12	0.95	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 5	Frame 1	Internal	0.15	1.33	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	25%
Wall 5	Frame 1	External	0.12	1.04	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 6	Frame 1	Internal	0.15	1.79	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	28%
Wall 6	Frame 1	External	0.06	2.77	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 7	Frame 1	Internal	0.00	13.23	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	106%
Wall 7	Frame 1	External	0.00	11.43	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	23%
Wall 8	Frame 1	Internal	0.00	8.37	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	67%
Wall 8	Frame 1	External	0.00	6.02	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	12%
Wall 9	Frame 1	Internal	0.15	2.20	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	30%

Wall 9	Frame 1	External	0.12	1.45	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 10	Frame 1	Internal	0.22	1.26	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 10	Frame 1	External	0.12	0.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 11	Frame 1	Internal	0.22	1.26	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 11	Frame 1	External	0.12	0.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 12	Frame 1	Internal	0.22	1.26	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 12	Frame 1	External	0.12	0.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 13	Frame 1	Internal	0.22	1.26	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 13	Frame 1	External	0.12	0.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 14	Frame 1	Internal	0.00	9.10	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	73%
Wall 14	Frame 1	External	0.00	4.62	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	9%
Wall 15	Frame 1	Internal	0.22	1.26	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 15	Frame 1	External	0.12	0.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 16	Frame 1	Internal	0.22	1.26	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 16	Frame 1	External	0.12	0.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 17	Frame 1	Internal	0.14	0.99	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	22%
Wall 17	Frame 1	External	0.12	0.80	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 18	Frame 1	Internal	0.00	11.10	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	89%
Wall 18	Frame 1	External	0.00	6.29	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	13%
Wall 19	Frame 1	Internal	0.12	0.88	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	19%
Wall 19	Frame 1	External	0.12	0.84	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 20	Frame 1	External	0.12	0.92	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 21	Frame 1	Internal	0.22	1.29	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 21	Frame 1	External	0.12	0.68	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 22	Frame 1	Internal	0.22	1.26	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 22	Frame 1	External	0.12	0.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 23	Frame 1	Internal	0.00	6.20	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	49%
Wall 23	Frame 1	External	0.00	3.58	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	7%
Wall 24	Frame 1	Internal	0.22	1.33	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 24	Frame 1	External	0.12	0.70	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 25	Frame 1	Internal	0.22	1.79	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	35%
Wall 25	Frame 1	External	0.13	1.01	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%

Bearing perpendicular to the grain

The studs are supported at the base by the bottom plate which is stressed by compression forces perpendicular to the grain.

The following expression shall be satisfied:

$$N_{d,p} \geq N_p^*$$

with

$$N_{d,p} = \phi \cdot k_1 \cdot k_4 \cdot k_6 \cdot k_7 \cdot f_p' \cdot A_p$$

where

$N_p^* = N$ is the design action effect in compression

ϕ is the capacity factor

k_1 is the duration of load modification factor for strength

k_4 is the moisture condition modification factor

k_6 is the temperature modification factor

k_7 is the length of bearing factor

f_p' is the characteristic value in bearing perpendicular to grain

A_p is the bearing area for loading perpendicular to grain

The length of bearing factor k_7 allows to increase the characteristic capacity in bearing perpendicular to the grain where rectangular bearing areas are located 75 mm or more from the end of the bottom plate.

The values of the actions in the tables below are related, for each wall, to the most severe combination of actions for the bearing Ultimate Limit State.

Wall name	Length [m]	Combination	Duration	N [kN]
Wall 1	0.61	ULS 1	50+ years	2.53
Wall 2	0.60	ULS 1	50+ years	2.33
Wall 3	0.61	ULS 1	50+ years	2.70
Wall 4	0.61	ULS 1	50+ years	2.90
Wall 5	0.60	ULS 4	50+ years	3.00
Wall 6	0.61	ULS 4	50+ years	6.16
Wall 7	0.61	ULS 3	5 months	29.87
Wall 8	0.60	ULS 3	5 months	17.50
Wall 9	0.61	ULS 4	50+ years	4.93
Wall 10	2.45	ULS 1	50+ years	8.48
Wall 11	2.45	ULS 1	50+ years	8.48
Wall 12	2.45	ULS 1	50+ years	8.48
Wall 13	2.45	ULS 1	50+ years	8.48
Wall 14	2.50	ULS 3	5 months	51.28
Wall 15	2.45	ULS 1	50+ years	8.48
Wall 16	2.45	ULS 1	50+ years	8.48
Wall 17	0.58	ULS 1	50+ years	2.42
Wall 18	2.50	ULS 3	5 months	66.85
Wall 19	0.50	ULS 1	50+ years	2.18
Wall 20	0.46	ULS 1	50+ years	2.06
Wall 21	1.87	ULS 1	50+ years	6.65
Wall 22	2.45	ULS 1	50+ years	8.48
Wall 23	2.50	ULS 3	5 months	37.28
Wall 24	1.30	ULS 1	50+ years	4.76
Wall 25	2.49	ULS 4	50+ years	10.70

The following table summarizes the bearing (perpendicular to the grain) checks for the plates of the framed walls.

Wall name	Section	Stud	N [kN]	A_p [mm^2]	Combination	k_1	k_4	k_6	k_7	ϕ	f'_p [MPa]	$N_{d,p}$ [kN]	Check
Wall 1	Frame 1	Internal	1.17	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 1	Frame 1	External	0.89	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 2	Frame 1	Internal	1.11	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	4%
Wall 2	Frame 1	External	0.78	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 3	Frame 1	Internal	1.26	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 3	Frame 1	External	0.92	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 4	Frame 1	Internal	1.35	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 4	Frame 1	External	1.01	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 5	Frame 1	Internal	1.39	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 5	Frame 1	External	1.08	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 6	Frame 1	Internal	1.93	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	7%
Wall 6	Frame 1	External	3.19	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	4%
Wall 7	Frame 1	Internal	13.23	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	37%
Wall 7	Frame 1	External	11.43	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	10%
Wall 8	Frame 1	Internal	8.37	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	23%
Wall 8	Frame 1	External	6.02	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	5%
Wall 9	Frame 1	Internal	2.41	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	9%
Wall 9	Frame 1	External	1.57	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 10	Frame 1	Internal	1.41	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 10	Frame 1	External	0.75	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 11	Frame 1	Internal	1.41	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 11	Frame 1	External	0.75	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 12	Frame 1	Internal	1.41	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 12	Frame 1	External	0.75	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 13	Frame 1	Internal	1.41	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 13	Frame 1	External	0.75	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 14	Frame 1	Internal	9.10	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	25%
Wall 14	Frame 1	External	4.62	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	4%
Wall 15	Frame 1	Internal	1.41	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 15	Frame 1	External	0.75	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 16	Frame 1	Internal	1.41	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 16	Frame 1	External	0.75	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 17	Frame 1	Internal	1.12	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	4%
Wall 17	Frame 1	External	0.90	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 18	Frame 1	Internal	11.10	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	31%
Wall 18	Frame 1	External	6.29	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	5%
Wall 19	Frame 1	Internal	0.99	4050	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	20.78	5%
Wall 19	Frame 1	External	0.94	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 20	Frame 1	External	1.03	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 21	Frame 1	Internal	1.45	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	6%
Wall 21	Frame 1	External	0.77	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 22	Frame 1	Internal	1.41	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 22	Frame 1	External	0.75	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 23	Frame 1	Internal	6.20	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	17%
Wall 23	Frame 1	External	3.58	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	3%
Wall 24	Frame 1	Internal	1.50	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	6%
Wall 24	Frame 1	External	0.79	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 25	Frame 1	Internal	1.88	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	7%
Wall 25	Frame 1	External	1.06	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%

The shear strength of framed shear walls

The values of the actions in the tables below are related, for each wall, to the most severe combination of load for the Ultimate Limit States.

Wall name	Length [m]	Combination	Duration	V2 [kN]
Wall 10	2.45	ULS earthquake strength 1 ex+ ey-	5 seconds	1.71
Wall 11	2.45	ULS earthquake strength 1 ex+ ey-	5 seconds	1.71
Wall 12	2.45	ULS earthquake strength 1 ex+ ey-	5 seconds	1.71
Wall 13	2.45	ULS earthquake strength 1 ex+ ey-	5 seconds	1.71
Wall 14	2.50	ULS earthquake strength 5 ex+ ey+	5 seconds	4.61
Wall 15	2.45	ULS earthquake strength 4 ex- ey-	5 seconds	1.82
Wall 16	2.45	ULS earthquake strength 4 ex- ey-	5 seconds	1.82
Wall 18	2.50	ULS Wind 6	5 seconds	3.69
Wall 21	1.87	ULS earthquake strength 4 ex- ey-	5 seconds	1.34
Wall 22	2.45	ULS earthquake strength 4 ex- ey-	5 seconds	1.82
Wall 23	2.50	ULS earthquake strength 8 ex- ey+	5 seconds	3.96
Wall 24	1.30	ULS earthquake strength 4	5 seconds	0.77

		ex- ey-		
Wall 25	2.49	ULS Wind 6	5 seconds	3.40

Sheet-braced framed walls

Lateral load-carrying capacity of metal fasteners

The design load-carrying capacity of a cantilevered panel secured against uplift is determined according to a plastic model based on the lower bound method (static theorem) that assumes the load-displacement relationships of the sheathing-to-frame joints as completely in the plastic field.

For a wall made up of several wall panels, the design racking load-carrying capacity of a wall is calculated from:

$$F_{v,Rd} = \sum_i F_{i,v,Rd}$$

where:

$F_{i,v,Rd}$ is the design racking load-carrying capacity of a single wall panel as specified in the following.

Wall panels which contain a door or window opening shall not be considered to contribute to the racking load-carrying capacity.

The design racking load-carrying capacity of each wall panel, $F_{i,v,Rd}$, is calculated from:

$$F_{i,v,Rd} = \frac{F_{t,Rd} \cdot b_i \cdot c_i}{s}$$

where:

$F_{t,Rd}$ is the lateral design capacity of an individual fastener, modified by a factor of 1.2

b_i is the wall panel width

s is the fastener spacing

c_i a coefficient dependent on the ratio between base and height of a single wall panel.

For wall panels with sheets on both sides the following rules apply:

- if the sheets and fasteners are of the same type and dimension then the total racking load carrying capacity of the wall should be taken as the sum of the racking load-carrying capacities of the individual sides

- if different types of sheets are used, 75 % of the racking load-carrying capacity of the weaker side may, unless some other value is shown to be valid, be taken into consideration if fasteners with similar slip moduli are used. In other cases not more than 50 % should be taken into consideration.

Fastener strength

The resistance of each fastener is estimated according to the Johansen theory of timber connections with dowel-type fasteners for panel-to-timber connections in single shear.

The characteristic load-carrying capacity for nails, staples, bolts, dowels and screws per shear plane per fastener, should be taken as the minimum value found from the following expressions

$$F_{v,Rk,a} = f_{h,1,k} \cdot t_1 \cdot d$$

$$F_{v,Rk,b} = f_{h,2,k} \cdot t_2 \cdot d$$

$$F_{v,Rk,c} = \frac{f_{h,1,k} \cdot t_1 \cdot d}{1+\beta} \cdot \left[\sqrt{\beta + 2\beta^2 \left[1 + \frac{t_2}{t_1} + \left(\frac{t_2}{t_1} \right)^2 \right]} + \beta^3 \left(\frac{t_2}{t_1} \right)^2 - \beta \left(1 + \frac{t_2}{t_1} \right) \right] + \frac{F_{ax,Rk}}{4}$$

$$F_{v,Rk,d} = 1{,}05 \cdot \frac{f_{h,1,k} \cdot t_1 \cdot d}{2+\beta} \cdot \left[\sqrt{2\beta(1+\beta) + \frac{4\beta(2+\beta) M_{y,Rk}}{f_{h,1,k} \cdot d \cdot t_1^2}} - \beta \right] + \frac{F_{ax,Rk}}{4}$$

$$F_{v,Rk,e} = 1{,}05 \cdot \frac{f_{h,1,k} \cdot t_2 \cdot d}{1+2\beta} \cdot \left[\sqrt{2\beta^2(1+\beta) + \frac{4\beta(1+2\beta) M_{y,Rk}}{f_{h,1,k} \cdot d \cdot t_2^2}} - \beta \right] + \frac{F_{ax,Rk}}{4}$$

$$F_{v,Rk,f} = 1{,}15 \cdot \sqrt{\frac{2\beta}{1+\beta}} \sqrt{2 \cdot M_{y,Rk} \cdot f_{h,1,k} \cdot d} + \frac{F_{ax,Rk}}{4}$$

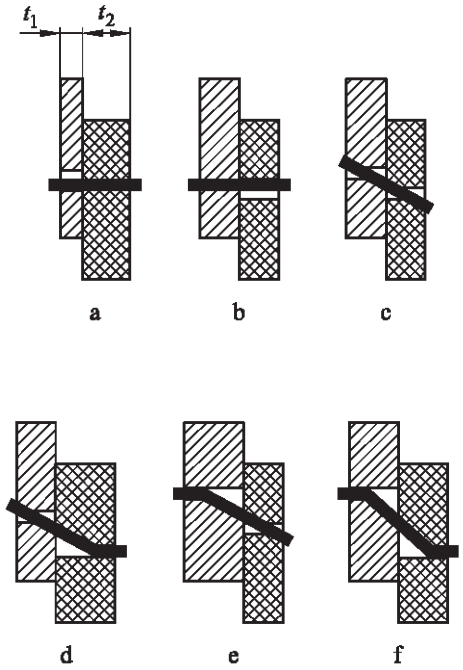


Figure: Failure modes for timber and panel connections.

In the expressions above, the first term on the right hand side is the load-carrying capacity according to the Johansen yield theory, whilst the second term $\frac{F_{ax,Rk}}{4}$ is the contribution from the rope effect.

Characteristic withdrawal capacity

The characteristic withdrawal capacity of nails, $F_{ax,Rk}$, should be taken as the smaller of the values found from the following expressions:

- For smooth nails:

$$F_{ax,Rk} = \begin{cases} f_{ax,k,tip}\, d\, t_{pen,frame} \\ f_{ax,k,head}\, d\, t + f_{head,k}\, d_h^2 \end{cases}$$

- For nails with improved adherence:

$$F_{ax,Rk} = \begin{cases} f_{ax,k,tip}\, d\, t_{pen,frame} = f_{ax,k,350} \left(\frac{\rho_{k,tip}}{350} \right)^{0.8} d\, t_{pen,frame} \\ f_{head,k}\, d_h^2 = f_{head,k,350} \left(\frac{\rho_{k,head}}{350} \right)^{0.8} d_h^2 \end{cases}$$

where:

$f_{ax,k,tip}$ is the characteristic pointside withdrawal strength;

$f_{ax,k,head}$ is the characteristic headside withdrawal strength;

$f_{head,k}$ is the characteristic headside pull-through strength;

d is the nail diameter;

d_h is the nail head diameter;

$t_{pen,frame}$ is the minimum value between the pointside penetration length and the length of the threaded part in the pointside member;

t is the thickness of the headside member.

For smooth nails, the pointside penetration should be at least 8d. For nails with a pointside penetration smaller than 12d the withdrawal capacity should be multiplied by $\frac{t_{pen}}{4d} - 2$.

For threaded nails, the pointside penetration should be at least 6d. For nails with a pointside penetration smaller than 8d the withdrawal capacity should be multiplied by $\frac{t_{pen}}{2d} - 3$.

In the following table, the calculations for the characteristic pointside withdrawal strength (Fax,k,tip) and for the characteristic headside pull-through strength (Fax,k,head) are reported.

Section	Side	Fasteners	$\rho_{k,frame}$ [kg/m³]	$f_{ax,k,tip}$ [MPa]	d [mm]	$t_{pen,frame}$ [mm]	$F_{ax,k,tip}$ [N]	$\rho_{k,panel}$ [kg/m³]	$f_{ax,k,head}$ [MPa]	$f_{head,k}$ [MPa]	d_h [mm]	t [mm]	$F_{ax,k,head}$ [N]
Frame 1	1	Ring nail (coils) 2.8/3.1 x 60	317	6.02	2.80	40.00	674	400	0.00	30.16	4.30	-	558

Lateral load-carrying capacity

The following table shows the resistances of the fasteners used to assemble the panels of the walls.

$F_{ax,Rk}$ is the characteristic axial withdrawal capacity of the fastener

Rope effect limit is the rope effect limited to a percentage of Johansen part

$F_{v,Rk}$ is the characteristic load-carrying capacity per shear plane per fastener

Section	Side	Fasteners	K_{ser} [N/mm]	Failure mode	$F_{ax,Rk}$ [N]	Rope effect limit	$F_{v,Rk}$ [N]
Frame 1	1	Ring nail (coils) 2.8/3.1 x 60	670	d	558	50%	717

Check of the bearing capacity of the walls related to the lateral load-carrying capacity of metal fasteners

The following table summarizes the geometric characteristics of the wall panels and their load-bearing capacity Fi,v,Rk. This table also indicates whether the width of each sheet is at least equal to h/4 as required by the calculation model.

Wall name	Section	Panel	b_i [mm]	N panels	c_i	Sheet width ≥ h/4	s [mm]	$F_{i,v,Rk}$ side 1 [kN]	$F_{i,v,Rk}$ side 2 [kN]
Wall 10	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 10	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 11	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 11	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 12	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 12	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 13	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 13	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 14	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 14	Frame 1	Junction	46.00	1	0.03	no	100	0.00	0.00
Wall 15	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 15	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 16	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 16	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 18	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 18	Frame 1	Junction	46.00	1	0.03	no	100	0.00	0.00
Wall 21	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 21	Frame 1	Junction	234.00	1	0.15	no	100	0.00	0.00

Wall 22	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 22	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 23	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 23	Frame 1	Junction	46.00	1	0.03	no	100	0.00	0.00
Wall 24	Frame 1	Full	818.00	1	0.51	ok	100	3.60	0.00
Wall 24	Frame 1	Junction	482.00	1	0.30	no	100	0.00	0.00
Wall 25	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 25	Frame 1	Junction	36.00	1	0.02	no	100	0.00	0.00

The following table shows the checks with reference to the most significant load combinations according to the expression:

$$F_{v,Rd} \geq F_{v,Ed}$$

Wall name	Section	Comb.	$F_{v,Ed}$ [kN]	k_1	k_{13}	k_{14}	k_{16}	k_{17}	ϕ	$F_{v,Rd}$ [kN]	Check
Wall 10	Frame 1	ULS earthquake strength 1 ex+ ey-	1.71	1.14	1	1	1	1	0.85	10.43	16%
Wall 11	Frame 1	ULS earthquake strength 1 ex+ ey-	1.71	1.14	1	1	1	1	0.85	10.43	16%
Wall 12	Frame 1	ULS earthquake strength 1 ex+ ey-	1.71	1.14	1	1	1	1	0.85	10.43	16%
Wall 13	Frame 1	ULS earthquake strength 1 ex+ ey-	1.71	1.14	1	1	1	1	0.85	10.43	16%
Wall 14	Frame 1	ULS earthquake strength 5 ex+ ey+	4.61	1.14	1	1	1	1	0.85	10.46	44%
Wall 15	Frame 1	ULS earthquake strength 4 ex- ey-	1.82	1.14	1	1	1	1	0.85	10.43	17%
Wall 16	Frame 1	ULS earthquake strength 4 ex- ey-	1.82	1.14	1	1	1	1	0.85	10.43	17%
Wall 18	Frame 1	ULS Wind 6	3.69	1.14	1	1	1	1	0.85	10.46	35%
Wall 21	Frame 1	ULS earthquake strength 4 ex- ey-	1.34	1.14	1	1	1	1	0.85	6.97	19%
Wall 22	Frame 1	ULS earthquake strength 4 ex- ey-	1.82	1.14	1	1	1	1	0.85	10.43	17%
Wall 23	Frame 1	ULS earthquake strength 8 ex- ey+	3.96	1.14	1	1	1	1	0.85	10.46	38%
Wall 24	Frame 1	ULS earthquake strength 4 ex- ey-	0.77	1.14	1	1	1	1	0.85	3.49	22%
Wall 25	Frame 1	ULS Wind 6	3.40	1.14	1	1	1	1	0.85	10.46	32%

Shear buckling of the sheet

The model assumes that the shear buckling of the sheet may be disregarded, provided that

$$\frac{b_{net}}{t} \leq 100$$

where

b_{net} *is the clear distance between studs*

t *is the thickness of the sheet*

Technical Design Calculation Report

Connections

Hold Down – Connections at the base of the structure

The design resistance R_d of the hold-downs is determined as the minimum value among the resistances relating to the following failure modes:

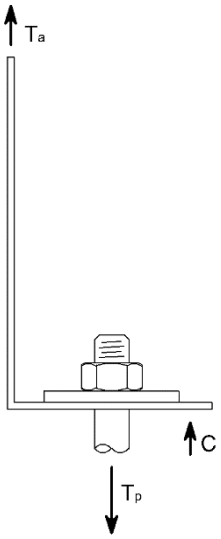
- Nailing failure
- Hold-downs steel failure
- Failure of the anchor
- Extraction of the anchor

Forces on the hold-downs

The tension force acting on the hold down (T_a) is evaluated as described in paragraph “Model Description”.

The tension force acting on the anchor is calculated taking into account the additional moment due to the non-alignment between the external force acting on the vertical flange of the hold down and the anchor itself using a coefficient, indicated as k_t.

$$T_p = T_a \cdot k_t$$



Wall name	Length [m]	Connection name	N° of anchors at each wall end	Combination	Duration	N [kN]	M_{3-3} [kNm]	Ta [kN]	kt	Tp [kN]
Wall 10	2.45	Ground connection - hold down - bracket	1	ULS Wind 6	5 seconds	7.53	0.76	0.00	1	0.00
Wall 11	2.45	Ground connection - hold down - bracket	1	ULS Wind 6	5 seconds	7.53	0.76	0.00	1	0.00
Wall 12	2.45	Ground connection - hold down - bracket	1	ULS Wind 6	5 seconds	7.53	0.76	0.00	1	0.00
Wall 13	2.45	Ground connection - hold down - bracket	1	ULS Wind 6	5 seconds	7.53	0.76	0.00	1	0.00
Wall 14	2.50	Ground connection - hold down - bracket	1	ULS Wind 6	5 seconds	29.69	14.41	0.00	1	0.00
Wall 15	2.45	Ground connection - hold down - bracket	1	ULS Wind 6	5 seconds	7.53	0.85	0.00	1	0.00
Wall 16	2.45	Ground connection - hold down - bracket	1	ULS Wind 6	5 seconds	7.53	0.85	0.00	1	0.00
Wall 18	2.50	Ground connection - hold down - bracket	1	ULS Wind 6	5 seconds	37.55	11.82	0.00	1	0.00
Wall 21	1.87	Ground connection - hold down - bracket	1	ULS earthquake stability 1 ex-ey-	5 seconds	4.43	4.28	0.07	1	0.07
Wall 22	2.45	Ground connection - hold down - bracket	1	ULS Wind 6	5 seconds	7.53	0.85	0.00	1	0.00
Wall 23	2.50	Ground connection - hold down - bracket	1	ULS Wind 6	5 seconds	22.62	9.78	0.00	1	0.00
Wall 24	1.30	Ground connection - hold down - bracket	1	ULS earthquake stability 1 ex-ey-	5 seconds	3.17	2.48	0.32	1	0.32
Wall 25	2.49	Ground connection - hold down - bracket	1	ULS Wind 8	5 seconds	6.98	10.87	0.88	1	0.88

Nailing resistance

The design value of the load-bearing capacity of the nailing is given by the following expression

$$R_{c,d} = \phi \cdot k_1 \cdot k_{13} \cdot k_{14} \cdot R_{c,k,dens}$$

where

$R_{c,k,dens}$ is the characteristic value of the nailing resistance. It already considers the effect of multiple nails in the joint and the effect of the restraint against the rotation of the fastener head. This value is reduced by the k_{dens} factor when the density of the material used is less than 350 kg/m3. k_{dens} can be evaluated using the formula $R_{c,k,dens} = R_{c,k} \cdot \left(\frac{\rho_k}{350}\right)^2$.

ϕ is the capacity factor for nails and screws

k_1 is the modification factor for duration of load for joints

k_{13} is equal to 1 for fasteners in side grain

k_{14} is equal to 1 for fasteners in single shear

Hold-down steel resistance

The tensile design strength of the steel of the hold-down can be evaluated according to the formula

$$R_{s,d} = \phi \cdot R_{s,k}$$

where

$R_{s,k}$ *is the characteristic value of the resistance of the hold down in axial tension*

ϕ *is the capacity factor for steel in tension*

Tension resistance of the anchor

The tension resistance of the anchor is evaluated as reported in section 9.3.2.2 of AS 4100 - 1998 according to the following formula

$$R_{t,d} = \phi \cdot R_{t,k} = \phi \cdot A_s \cdot f_{uf}$$

being:

f_{uf} *is the ultimate tensile strength of the anchor*

A_s *the tensile stress area of the anchor*

ϕ *is the capacity factor for bolts in tension*

Pull-out resistance of the anchor

The characteristic value of pull-out resistance refers to a single anchor regardless of the effects due to the spacing or distances from the edges. Moreover concrete is considered to be non-cracked, dry and at a standard temperature for the actual depth of anchorage.

The design pull-out resistance can be calculated as

$$R_{pull,d} = \phi \cdot R_{pull,k}$$

where

$R_{pull,k}$ is the *characteristic value of the pull-out resistance*

ϕ is the capacity factor provided by manufacturers

The checks are summarized in the following tables according to each failure mode.

Name: Name of the connection in which the hold-down is used

Comb.: The most severe combination of load

$T_{a,d}$: Design value of the tensile force acting on the hold down

$T_{p,d}$: Design value of the tensile force acting on the anchor

$R_{a,d}$: Design value of the hold down resistance, assumed to be the lower of the values of the design resistance of all the failure mechanisms associated with it

$R_{p,d}$: Design value of the anchor resistance, assumed to be the lower of the values of the design resistance of all the failure mechanisms associated with it

$$T_{a,d} \leq \mathrm{R}_{a,d} = min\left(R_{c,d}; R_{s,d}\right)$$

$$T_{p,d} \leq \mathrm{R}_{p,d} = min\left(R_{t,d}; R_{pull,d}\right)$$

Wall name	Connection name	Comb.	$T_{a,d}$ [kN]	$R_{c,k,dens}$ [kN]	k_1	ϕ	$R_{c,d}$ [kN]	$R_{s,k}$ [kN]	ϕ	$R_{s,d}$ [kN]	$R_{a,d}$ [kN]	$T_{p,d}$ [kN]	$R_{t,k}$ [kN]	ϕ	$R_{t,d}$ [kN]	$R_{pull,k}$ [kN]	ϕ	$R_{pull,d}$ [kN]	$R_{p,d}$ [kN]	Failure mode	Check
Wall 10	Ground connection - hold down - bracket	ULS Wind 6	0.00	17.99	1.14	0.85	17.43	42	0.9	37.8	-	0.00	78.5	0.8	62.8	35.94	0.5	17.97	-	-	0%
Wall 11	Ground connection - hold down - bracket	ULS Wind 6	0.00	17.99	1.14	0.85	17.43	42	0.9	37.8	-	0.00	78.5	0.8	62.8	35.94	0.5	17.97	-	-	0%
Wall 12	Ground connection - hold down - bracket	ULS Wind 6	0.00	17.99	1.14	0.85	17.43	42	0.9	37.8	-	0.00	78.5	0.8	62.8	35.94	0.5	17.97	-	-	0%
Wall 13	Ground connection - hold down - bracket	ULS Wind 6	0.00	17.99	1.14	0.85	17.43	42	0.9	37.8	-	0.00	78.5	0.8	62.8	35.94	0.5	17.97	-	-	0%
Wall 14	Ground connection - hold down - bracket	ULS Wind 6	0.00	17.99	1.14	0.85	17.43	42	0.9	37.8	-	0.00	78.5	0.8	62.8	35.94	0.5	17.97	-	-	0%
Wall 15	Ground connection -	ULS Wind 6	0.00	17.99	1.14	0.85	17.43	42	0.9	37.8	-	0.00	78.5	0.8	62.8	35.94	0.5	17.97	-	-	0%

	hold down - bracket																				
Wall 16	Ground connection - hold down - bracket	ULS Wind 6	0.00	17.99	1.14	0.85	17.43	42	0.9	37.8	-	0.00	78.5	0.8	62.8	35.94	0.5	17.97	-	-	0%
Wall 18	Ground connection - hold down - bracket	ULS Wind 6	0.00	17.99	1.14	0.85	17.43	42	0.9	37.8	-	0.00	78.5	0.8	62.8	35.94	0.5	17.97	-	-	0%
Wall 21	Ground connection - hold down - bracket	ULS earthquake stability 1 ex- ey-	0.07	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	0.07	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	0%
Wall 22	Ground connection - hold down - bracket	ULS Wind 6	0.00	17.99	1.14	0.85	17.43	42	0.9	37.8	-	0.00	78.5	0.8	62.8	35.94	0.5	17.97	-	-	0%
Wall 23	Ground connection - hold down - bracket	ULS Wind 6	0.00	17.99	1.14	0.85	17.43	42	0.9	37.8	-	0.00	78.5	0.8	62.8	35.94	0.5	17.97	-	-	0%
Wall 24	Ground connection - hold down - bracket	ULS earthquake stability 1 ex- ey-	0.32	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	0.32	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	2%
Wall 25	Ground connection - hold down - bracket	ULS Wind 8	0.88	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	0.88	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	5%

Angle brackets with anchors – timber to concrete shear connections

The design resistance R_d of an angle bracket is determined as the minimum value among the resistances relating to the following failure modes:

- Shear failure of the angle and/or of the group of fasteners of the connection
- Shear failure of the anchors connecting the concrete

Shear forces

The shear force acting on the single angle bracket is calculated by dividing the total shear force V_2 by the number of angle brackets present in the wall (taking into account the possible presence of angle brackets on both sides of the structural element).

$$V_a = \frac{V_2}{n_{anc}}$$

where

V_2 is the design shear force on the considered wall

n_{anc} is the number of shear connections present in the wall

The shear force acting on the most loaded anchor is calculated taking into account the additional moment due to the non-alignment between the external forces acting on the vertical flange of the angle bracket and the anchor itself using a coefficient, indicated as k_t.

$$V_p = V_a \cdot k_t$$

Wall name	Length [m]	Connection name	N of connections	Combination	Duration	V_2 [kN]	Va [kN]	kt	Vp [kN]
Wall 10	2.45	Ground connection - hold down - bracket	4	ULS earthquake stability 1 ex+ ey-	5 seconds	1.71	0.43	0.97	0.42
Wall 11	2.45	Ground connection - hold down - bracket	4	ULS earthquake stability 1 ex+ ey-	5 seconds	1.71	0.43	0.97	0.42
Wall 12	2.45	Ground connection - hold down - bracket	4	ULS earthquake stability 1 ex+ ey-	5 seconds	1.71	0.43	0.97	0.42
Wall 13	2.45	Ground connection - hold down - bracket	4	ULS earthquake stability 1 ex+ ey-	5 seconds	1.71	0.43	0.97	0.42
Wall 14	2.50	Ground connection - hold down - bracket	5	ULS earthquake stability 8 ex+ ey+	5 seconds	4.61	0.92	0.97	0.89
Wall 15	2.45	Ground connection - hold down - bracket	4	ULS earthquake stability 1 ex- ey-	5 seconds	1.82	0.45	0.97	0.44
Wall 16	2.45	Ground connection - hold down - bracket	4	ULS earthquake stability 1 ex- ey-	5 seconds	1.82	0.45	0.97	0.44
Wall 18	2.50	Ground connection - hold down - bracket	5	ULS Wind 6	5 seconds	3.69	0.74	0.97	0.72
Wall 21	1.87	Ground connection - hold down - bracket	3	ULS earthquake stability 1 ex- ey-	5 seconds	1.34	0.45	0.97	0.43
Wall 22	2.45	Ground connection - hold down - bracket	4	ULS earthquake stability 1 ex- ey-	5 seconds	1.82	0.45	0.97	0.44
Wall 23	2.50	Ground connection - hold down - bracket	5	ULS earthquake stability 5 ex- ey+	5 seconds	3.96	0.79	0.97	0.77
Wall 24	1.30	Ground connection - hold down - bracket	2	ULS earthquake stability 1 ex- ey-	5 seconds	0.77	0.39	0.97	0.38
Wall 25	2.49	Ground connection - hold down - bracket	4	ULS Wind 6	5 seconds	3.40	0.85	0.97	0.82

Angle bracket *bearing capacity*

The design value of the shear bearing capacity of the angle bracket can be estimated from the characteristic value by means of the following expression

$$R_{a,d} = \phi \cdot \mathrm{k}_1 \cdot \mathrm{k}_{13} \cdot \mathrm{k}_{14} \cdot \mathrm{R}_{\mathrm{a,k,dens}}$$

where

$\mathrm{R}_{\mathrm{a,k,dens}}$ is the characteristic value of the nailing resistance. It already considers the effect of multiple nails in the joint and the effect of the restraint against the rotation of the fastener head. This value is reduced by the k_{dens} factor when the density of the material used is less than 350 kg/m3. k_{dens} can be evaluated using the formula $\mathrm{R}_{\mathrm{c,k,dens}} = \mathrm{R}_{\mathrm{c,k}} \cdot \left(\frac{\rho_{\mathrm{k}}}{350}\right)^2$.

ϕ is the capacity factor for nails and screws

k_1 is the modification factor for duration of load for joints

k_{13} is equal to 1 for fasteners in side grain

k_{14} is equal to 1 for fasteners in single shear

Anchor *bearing capacity*

The design value of the shear strength of the anchor is evaluated as

$$R_{p,d} = \phi \cdot \mathrm{R}_{\mathrm{p,k}}$$

where

$R_{p,k}$ is the characteristic value of the shear strength of the anchor

ϕ is the capacity factor provided by manufacturers

The checks are summarized in the following tables according to each failure mode.

Name: Name of the connection in which the angle bracket is used

Comb.: The most severe combination of load

$V_{a,d}$: Shear force acting on the angle bracket

$V_{p,d}$: Shear force acting on the most stressed anchor

$$V_{a,d} \leq R_{a,d}$$

$$V_{p,d} \leq R_{p,d}$$

Wall name	Connection name	Comb.	$V_{a,d}$ [kN]	$R_{a,k,dens}$ [kN]	k_1	ϕ	$R_{a,d}$ [kN]	Check – angle brackets	$V_{p,d}$ [kN]	$R_{p,k}$ [kN]	ϕ	$R_{p,d}$ [kN]	Check - anchor
Wall 10	Ground connection - hold down - bracket	ULS earthquake stability 1 ex+ ey-	0.43	18.09	1.14	0.85	17.53	2%	0.42	21	0.8	16.8	2%
Wall 11	Ground connection - hold down - bracket	ULS earthquake stability 1 ex+ ey-	0.43	18.09	1.14	0.85	17.53	2%	0.42	21	0.8	16.8	2%
Wall 12	Ground connection - hold down - bracket	ULS earthquake stability 1 ex+ ey-	0.43	18.09	1.14	0.85	17.53	2%	0.42	21	0.8	16.8	2%
Wall 13	Ground connection - hold down - bracket	ULS earthquake stability 1 ex+ ey-	0.43	18.09	1.14	0.85	17.53	2%	0.42	21	0.8	16.8	2%
Wall 14	Ground connection - hold down - bracket	ULS earthquake stability 8 ex+ ey+	0.92	18.09	1.14	0.85	17.53	5%	0.89	21	0.8	16.8	5%
Wall 15	Ground connection - hold down - bracket	ULS earthquake stability 1 ex- ey-	0.45	18.09	1.14	0.85	17.53	3%	0.44	21	0.8	16.8	3%
Wall 16	Ground connection - hold down - bracket	ULS earthquake stability 1 ex- ey-	0.45	18.09	1.14	0.85	17.53	3%	0.44	21	0.8	16.8	3%
Wall 18	Ground connection - hold down - bracket	ULS Wind 6	0.74	18.09	1.14	0.85	17.53	4%	0.72	21	0.8	16.8	4%
Wall 21	Ground connection - hold down - bracket	ULS earthquake stability 1 ex- ey-	0.45	18.09	1.14	0.85	17.53	3%	0.43	21	0.8	16.8	3%
Wall 22	Ground connection - hold down - bracket	ULS earthquake stability 1 ex- ey-	0.45	18.09	1.14	0.85	17.53	3%	0.44	21	0.8	16.8	3%
Wall 23	Ground connection - hold down - bracket	ULS earthquake stability 5 ex- ey+	0.79	18.09	1.14	0.85	17.53	5%	0.77	21	0.8	16.8	5%
Wall 24	Ground connection - hold down - bracket	ULS earthquake stability 1 ex- ey-	0.39	18.09	1.14	0.85	17.53	2%	0.38	21	0.8	16.8	2%
Wall 25	Ground connection - hold down - bracket	ULS Wind 6	0.85	18.09	1.14	0.85	17.53	5%	0.82	21	0.8	16.8	5%

Inter-storey drift checks

The inter-storey drifts at the ultimate limit state calculated from the relevant seismic forces are limited in accordance to the following equation:

$$d_i < d_{\mathrm{i,lim}} = 0.015\ \mathrm{h}$$

where

d_i is the inelastic inter-storey drift obtained by multiplying the value determined by an elastic analysis by μ/S_p

h is the storey height

The table below shows the drift checks for each wall.

Wall name: Wall ID

h: Storey height

Comb.: The most severe combination of load

d_i: Evaluated inter-storey drift

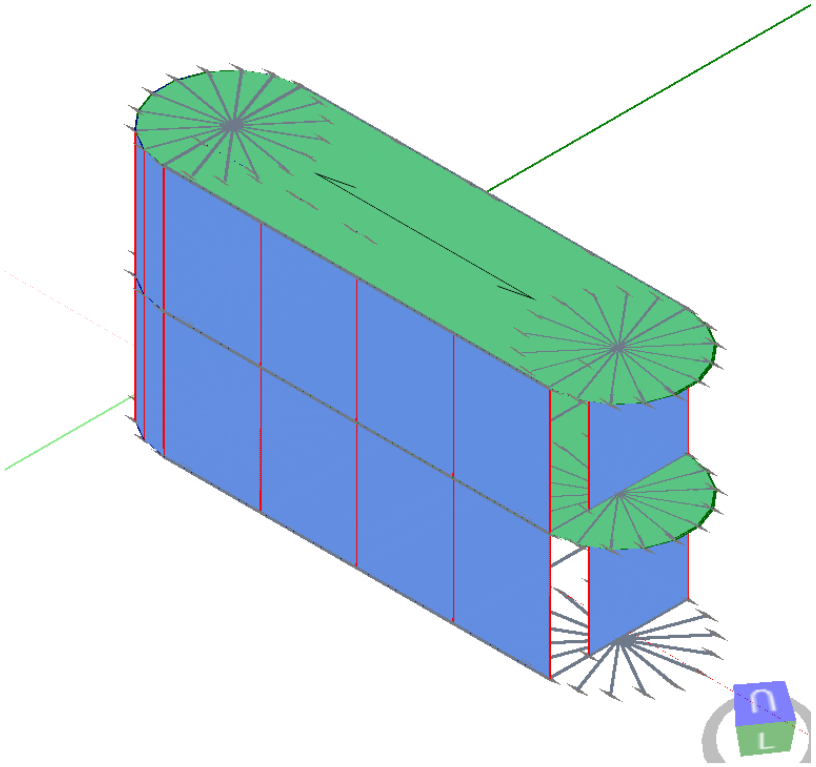
$d_{i,lim}$: Inter-storey drift limit

The table provides the Drift checks in the case of Dynamic Linear Analysis.

Wall	h [m]	Comb.	d_r [mm]	d_{lim} [mm]	Check
Wall 10	3.20	ULS earthquake drift 2 ex- ey+	2.89	48.00	6%
Wall 11	3.20	ULS earthquake drift 2 ex- ey+	2.89	48.00	6%
Wall 12	3.20	ULS earthquake drift 2 ex- ey+	2.89	48.00	6%
Wall 13	3.20	ULS earthquake drift 2 ex- ey+	2.89	48.00	6%
Wall 14	3.20	ULS earthquake drift 4 ex+ ey-	8.12	48.00	17%
Wall 15	3.20	ULS earthquake drift 1 ex- ey-	3.01	48.00	6%
Wall 16	3.20	ULS earthquake drift 1 ex- ey-	3.01	48.00	6%
Wall 18	3.20	ULS earthquake drift 4 ex- ey-	4.37	48.00	9%
Wall 21	3.20	ULS earthquake drift 1 ex- ey-	3.01	48.00	6%
Wall 22	3.20	ULS earthquake drift 1 ex- ey-	3.01	48.00	6%
Wall 23	3.20	ULS earthquake drift 4 ex- ey-	7.01	48.00	15%
Wall 24	3.20	ULS earthquake drift 1 ex- ey-	2.79	48.00	6%
Wall 25	3.20	ULS earthquake drift 4 ex- ey-	5.41	48.00	11%

Appendix E
TECHNICAL DESIGN CALCULATION REPORT

Design of Timber Structures



Project: The Challenge Cup – Two modules

Design codes and standards

The analysis has been carried out according to:

1. **AS/NZS 1170.0:2002 – Structural Design Actions**

   Part 0: General principles

2. **AS/NZS 1170.1:2002 – Structural Design Actions**

   Part 1: Permanent, imposed and other actions

3. **AS/NZS 1170.2:2011 – Structural Design Actions**

   Part 2: Wind actions

4. **AS/NZS 1170.3:2003 – Structural Design Actions**

   Part 3: Snow and ice actions

5. **AS 1170.4-2007 – Structural Design Actions**

   Part 4: Earthquake actions in Australia

6. **AS 1720.1-2010 – Timber Structures**

   Part 1: Design methods

7. **AS 1720.2-2006 – Timber Structures**

   Part 2: Timber properties

General description of the building

Location

Address: Melbourne City

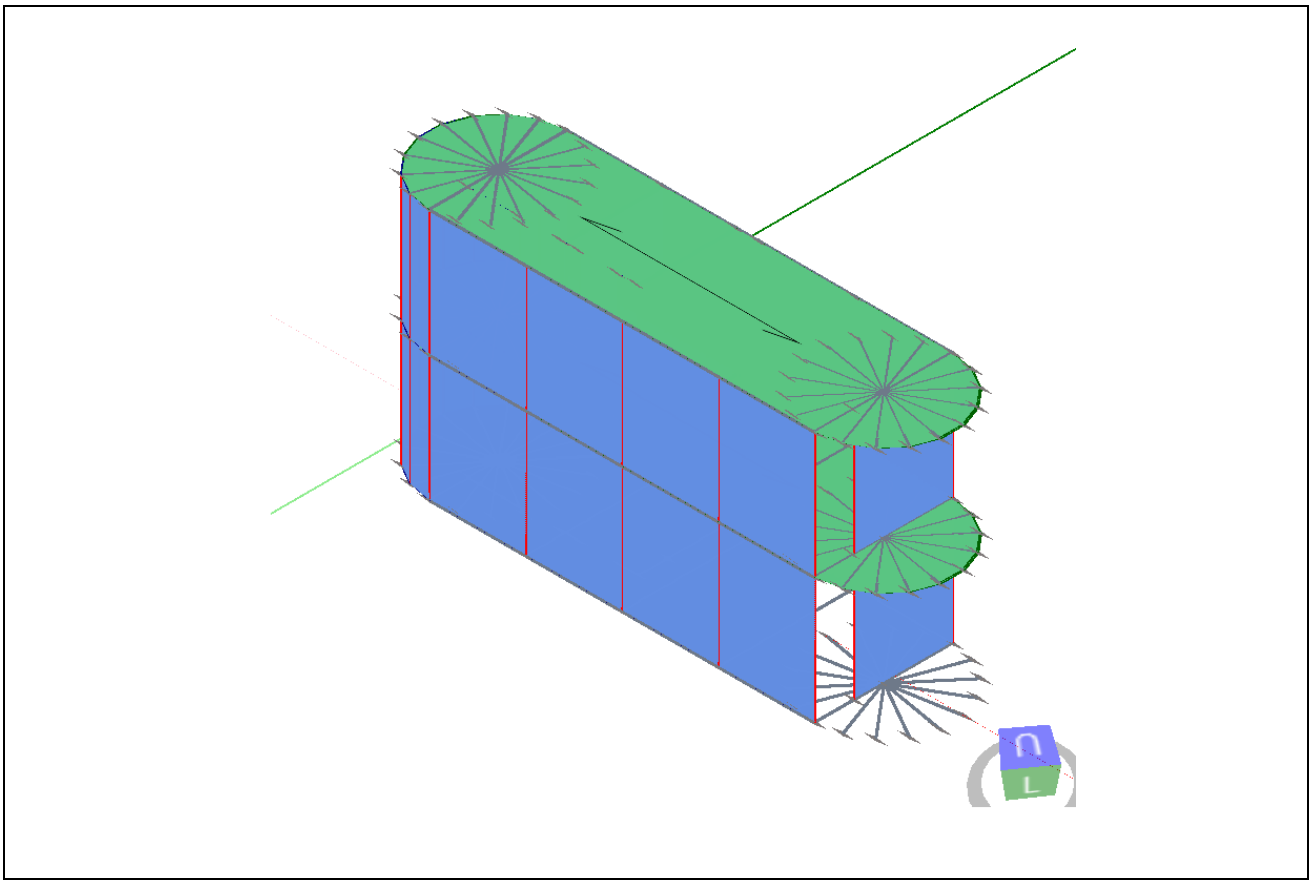
Description

Building length: 3.5 m

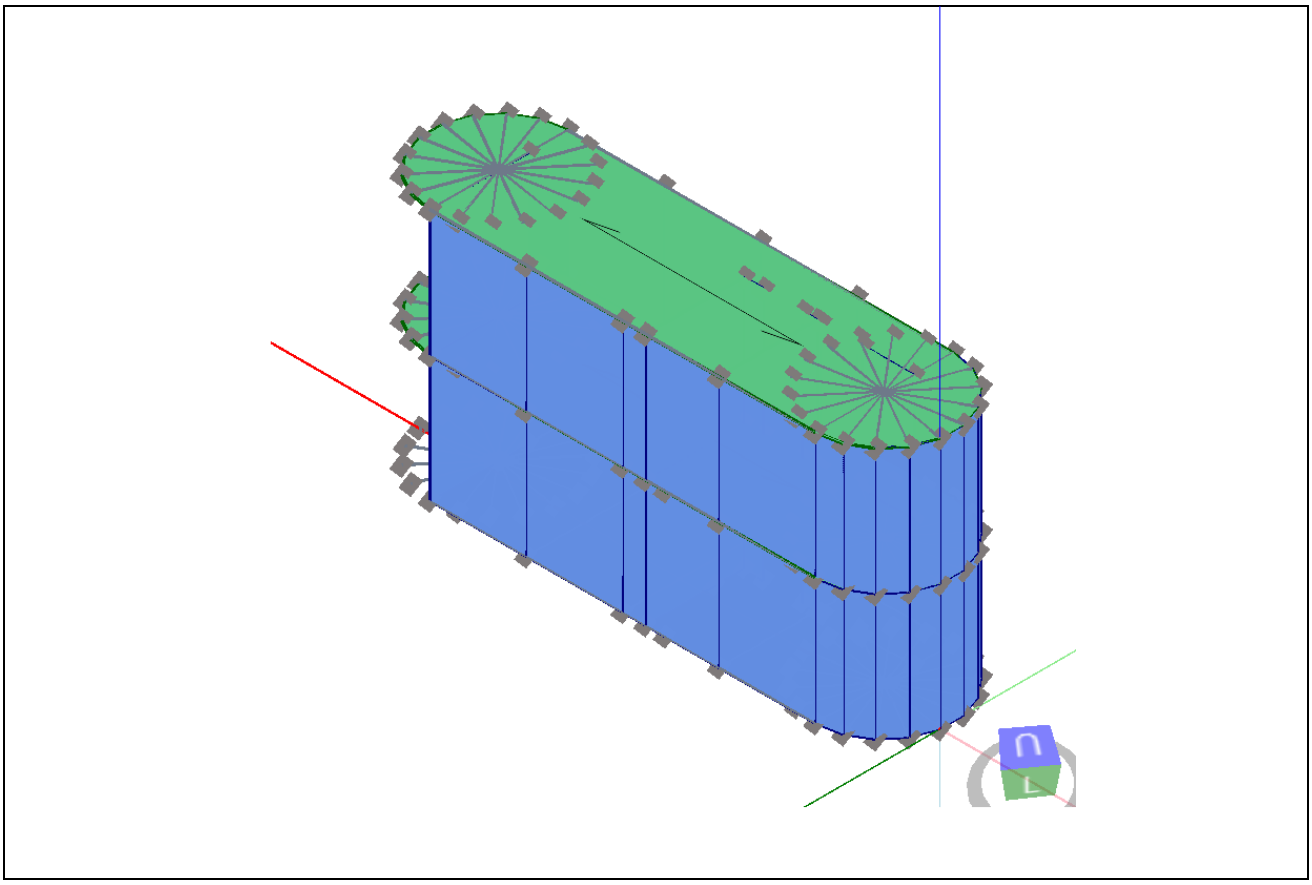
Building width: 13.25 m

Building height: 6.4 m

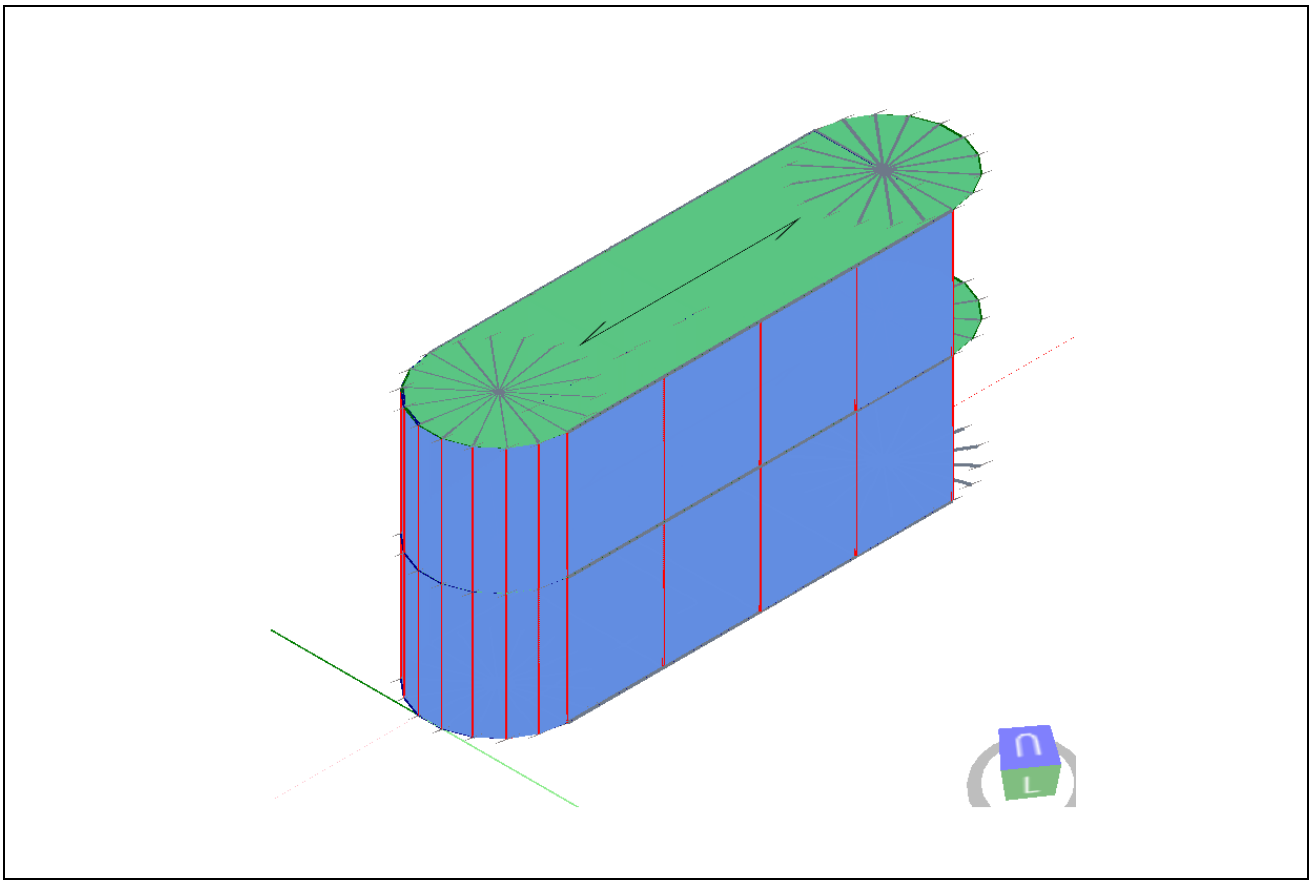
Three-dimensional Southeast view



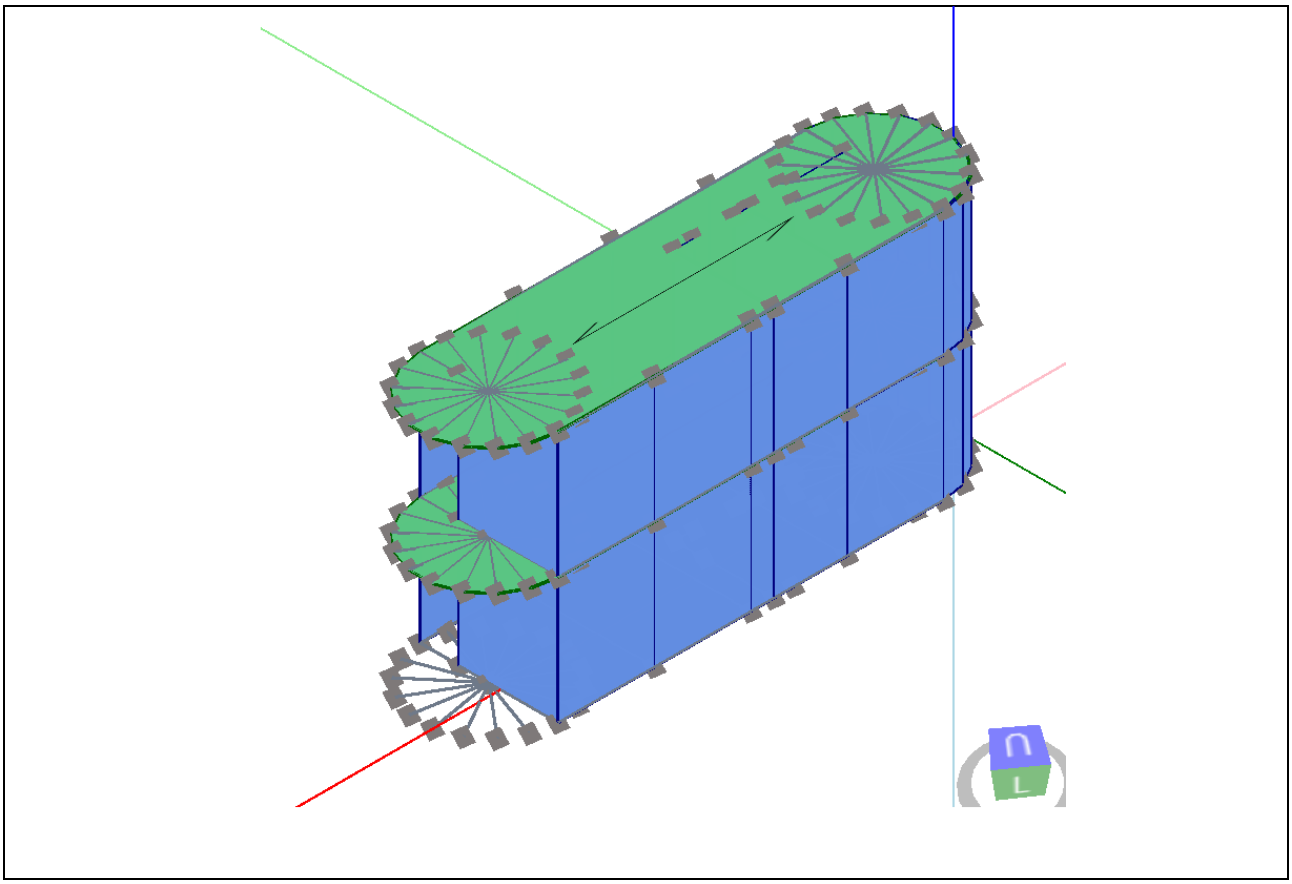
Three-dimensional Northwest view



Three-dimensional South West view



Three-dimensional North East view



Materials

Wooden materials

The materials used in the project are listed in the following tables.

f'_b Characteristic bending strength

f'_t Characteristic tensile strength parallel to grain

f'_c Characteristic compressive strength parallel to grain

f'_s Characteristic shear strength

E Short duration average modulus of elasticity parallel to the grain

G Short duration average modulus of rigidity

ρ Average minimum density

MGP

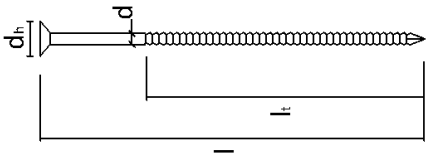
Descr	Joint group	f'_b [MPa]	f'_t [MPa]	f'_c [MPa]	f'_s [MPa]	E [MPa]	G [MPa]	ρ [kg/m^3]
MGP 10 - 90 x 45	JD5	17	7.7	18	2.6	10000	670	380.00000004

Plywood

Grade	Species	Joint group	f'_s [MPa]	G [MPa]	ρ [kg/m^3]
F14	Pinus species	JD4	4.8	625	480

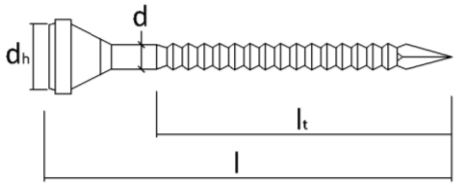
Metal fasteners

Threaded nails



Manufacturer	Code	Descr.	l [mm]	l_t [mm]	d [mm]	d_h [mm]	f_{uk} [MPa]
Rotho Blaas	HH10502003	Ring nail (coils) 2.8/3.1 x 60	60	40	2.8	4.3	600

Anker nails



Manufacturer	Code	Descr.	l [mm]	l_t [mm]	d [mm]	d_h [mm]	f_{uk} [MPa]
Rotho Blaas	PF601460	Anker nail - LBA 4.0 X 60	60	50	4	5.4	600

Calculation method and numerical model

Model Description

Hypothesis adopted for the elements

The timber walls are constrained at the base by means of connection systems capable of transmitting both in-plane and out-of-plane actions action on the wall.

In the analysis, in presence of horizontal loads, some elements may be defined as “secondary”: this mean that their strength and stiffness are neglected in the calculation of the response of the building. In the model these elements are represented in terms of mass and they are designed only for vertical loads.

Rigid body rocking – Forces on hold-down / tie-down

The hold-down or tie-down systems are used to prevent the rotation of the wall caused by the overturning moment of the horizontal force. The hold-down, placed on the in-tension edge of the wall, is loaded by a force equal to

$$T = \begin{cases} \left(\frac{M_{3-3}}{b} - \frac{N}{2}\right) \cdot \frac{1}{n_{anc}} & for\ active\ hold-down \\ 0 & for\ inactive\ hold-down \end{cases}$$

where:

b is the lever arm for the internal couple assumed equal to *l*, where *l* is the wall length

N is the axial vertical load acting on the wall

M_{3-3} is the moment acting in the plane of the wall

n_{anc} is the number of connections present at each end of the wall

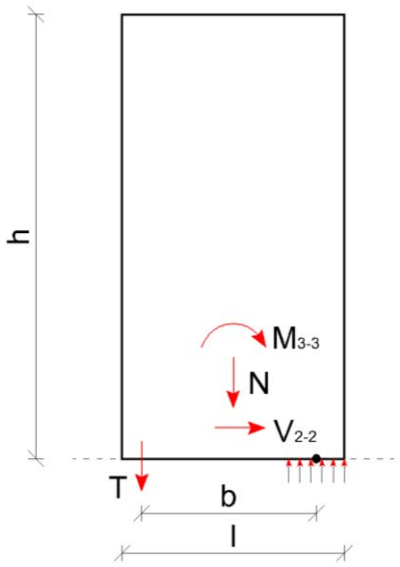


Figure: Calculation model of tensile force acting on the hold-down

Structural elements

The following table shows the positions of the individual walls. The last four columns show the coordinates of the ends of each wall.

X1 e Y1 indicate the coordinates of the starting point of the wall

X2 e Y2 indicate the coordinates of the end point of the wall

Wall name	Type of wall	Element resistant to horizontal loads	Height [m]	Length [m]	Altitude [m]	X1 [m]	Y1 [m]	X2 [m]	Y2 [m]
Wall 1	Frame	No	3.2	0.61	0	1.72	1.45	1.12	1.34
Wall 10	Frame	Yes	3.2	2.45	0	1.72	-2.05	4.17	-2.05
Wall 11	Frame	Yes	3.2	2.45	0	4.17	-2.05	6.62	-2.05
Wall 12	Frame	Yes	3.2	2.45	0	6.62	-2.05	9.07	-2.05
Wall 13	Frame	Yes	3.2	2.45	0	9.07	-2.05	11.52	-2.05
Wall 14	Frame	Yes	3.2	2.5	0	11.52	-1.05	11.52	1.45
Wall 15	Frame	Yes	3.2	2.45	0	11.52	1.45	9.07	1.45
Wall 16	Frame	Yes	3.2	2.45	0	9.07	1.45	6.62	1.45
Wall 17	Frame	No	3.2	0.58	0	6.62	1.45	6.04	1.45
Wall 18	Frame	Yes	3.2	2.5	0	6.04	1.45	6.04	-1.05
Wall 19	Frame	No	3.2	0.5	0	6.04	-1.05	5.54	-1.05
Wall 2	Frame	No	3.2	0.6	0	1.12	1.34	0.6	1.04
Wall 20	Frame	No	3.2	0.46	0	4.54	-1.04	4.08	-1.04
Wall 21	Frame	Yes	3.2	1.87	0	6.04	1.45	4.17	1.45
Wall 22	Frame	Yes	3.2	2.45	0	4.17	1.45	1.72	1.45
Wall 23	Frame	Yes	3.2	2.5	0	1.72	1.45	1.72	-1.05
Wall 24	Frame	Yes	3.2	1.3	0	1.72	-1.05	3.02	-1.05
Wall 25	Frame	Yes	3.2	2.49	0	4.17	1.45	4.17	-1.04
Wall 26	Frame	No	3.2	0.61	3.2	1.72	1.45	1.12	1.34
Wall 27	Frame	No	3.2	0.6	3.2	1.12	1.34	0.6	1.04
Wall 28	Frame	No	3.2	0.61	3.2	0.6	1.04	0.21	0.57
Wall 29	Frame	No	3.2	0.61	3.2	0.21	0.57	0	0
Wall 3	Frame	No	3.2	0.61	0	0.6	1.04	0.21	0.57
Wall 30	Frame	No	3.2	0.6	3.2	0	0	0	-0.6
Wall 31	Frame	No	3.2	0.61	3.2	0	-0.6	0.21	-1.17
Wall 32	Frame	No	3.2	0.61	3.2	0.21	-1.17	0.6	-1.64
Wall 33	Frame	No	3.2	0.6	3.2	0.6	-1.64	1.12	-1.94
Wall 34	Frame	No	3.2	0.61	3.2	1.12	-1.94	1.72	-2.05
Wall 35	Frame	Yes	3.2	2.45	3.2	1.72	-2.05	4.17	-2.05
Wall 36	Frame	Yes	3.2	2.45	3.2	4.17	-2.05	6.62	-2.05
Wall 37	Frame	Yes	3.2	2.45	3.2	6.62	-2.05	9.07	-2.05
Wall 38	Frame	Yes	3.2	2.45	3.2	9.07	-2.05	11.52	-2.05
Wall 39	Frame	Yes	3.2	2.5	3.2	11.52	-1.05	11.52	1.45
Wall 4	Frame	No	3.2	0.61	0	0.21	0.57	0	0
Wall 40	Frame	Yes	3.2	2.45	3.2	11.52	1.45	9.07	1.45
Wall 41	Frame	Yes	3.2	2.45	3.2	9.07	1.45	6.62	1.45
Wall 42	Frame	No	3.2	0.58	3.2	6.62	1.45	6.04	1.45
Wall 43	Frame	Yes	3.2	2.5	3.2	6.04	1.45	6.04	-1.05
Wall 44	Frame	No	3.2	0.5	3.2	6.04	-1.05	5.54	-1.05
Wall 45	Frame	No	3.2	0.46	3.2	4.54	-1.04	4.08	-1.04
Wall 46	Frame	Yes	3.2	1.87	3.2	6.04	1.45	4.17	1.45
Wall 47	Frame	Yes	3.2	2.45	3.2	4.17	1.45	1.72	1.45
Wall 48	Frame	Yes	3.2	2.5	3.2	1.72	1.45	1.72	-1.05
Wall 49	Frame	Yes	3.2	1.3	3.2	1.72	-1.05	3.02	-1.05
Wall 5	Frame	No	3.2	0.6	0	0	0	0	-0.6
Wall 50	Frame	Yes	3.2	2.49	3.2	4.17	1.45	4.17	-1.04
Wall 6	Frame	No	3.2	0.61	0	0	-0.6	0.21	-1.17
Wall 7	Frame	No	3.2	0.61	0	0.21	-1.17	0.6	-1.64
Wall 8	Frame	No	3.2	0.6	0	0.6	-1.64	1.12	-1.94
Wall 9	Frame	No	3.2	0.61	0	1.12	-1.94	1.72	-2.05

Wall horizontal stiffness

The wall stiffness can be estimated considering the contributions of all the components, as shown below.

Timber framed shear walls

In the case of framed walls the overall stiffness is calculated taking into account the contribution of the following components:

- sheeting boards (k_s)
- sheet-to-frame nailing (k_c)
- shear connections (k_a)
- tensile connections (k_h)

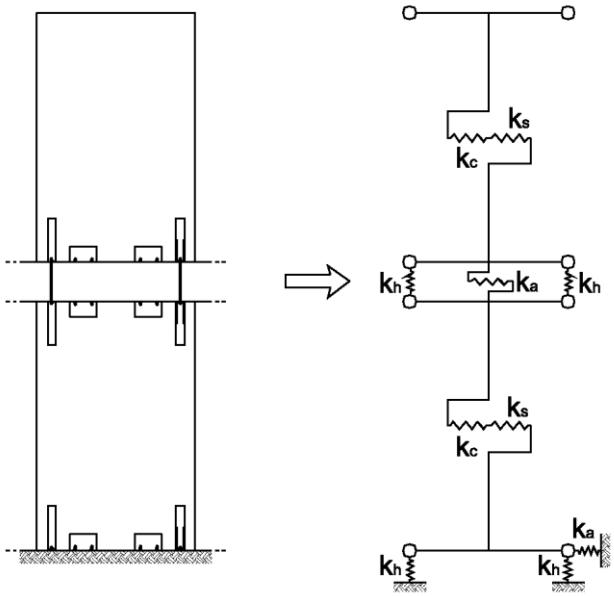


Figure: Mechanical model for framed walls overall stiffness

In case of metal-braced framed walls, the k_s and k_c contributions are replaced by a single term that takes into account the stiffness contribution of the metal bracing.

The following table indicates the positions of the walls and their equivalent shear stiffness.

Wall name	Type of wall	Element resistant to horizontal loads	Heigth [m]	Lenght [m]	Equivalent shear stiffness [kN/m]
Wall 1	Frame	No	3.2	0.61	0
Wall 10	Frame	Yes	3.2	2.45	1390
Wall 11	Frame	Yes	3.2	2.45	1390
Wall 12	Frame	Yes	3.2	2.45	1390
Wall 13	Frame	Yes	3.2	2.45	1390
Wall 14	Frame	Yes	3.2	2.5	1424
Wall 15	Frame	Yes	3.2	2.45	1390
Wall 16	Frame	Yes	3.2	2.45	1390
Wall 17	Frame	No	3.2	0.58	0
Wall 18	Frame	Yes	3.2	2.5	1424
Wall 19	Frame	No	3.2	0.5	0
Wall 2	Frame	No	3.2	0.6	0
Wall 20	Frame	No	3.2	0.46	0
Wall 21	Frame	Yes	3.2	1.87	1023
Wall 22	Frame	Yes	3.2	2.45	1390
Wall 23	Frame	Yes	3.2	2.5	1424
Wall 24	Frame	Yes	3.2	1.3	667
Wall 25	Frame	Yes	3.2	2.49	1415
Wall 26	Frame	No	3.2	0.61	0
Wall 27	Frame	No	3.2	0.6	0
Wall 28	Frame	No	3.2	0.61	0
Wall 29	Frame	No	3.2	0.61	0

Wall 3	Frame	No	3.2	0.61	0
Wall 30	Frame	No	3.2	0.6	0
Wall 31	Frame	No	3.2	0.61	0
Wall 32	Frame	No	3.2	0.61	0
Wall 33	Frame	No	3.2	0.6	0
Wall 34	Frame	No	3.2	0.61	0
Wall 35	Frame	Yes	3.2	2.45	1420
Wall 36	Frame	Yes	3.2	2.45	1420
Wall 37	Frame	Yes	3.2	2.45	1420
Wall 38	Frame	Yes	3.2	2.45	1420
Wall 39	Frame	Yes	3.2	2.5	1455
Wall 4	Frame	No	3.2	0.61	0
Wall 40	Frame	Yes	3.2	2.45	1420
Wall 41	Frame	Yes	3.2	2.45	1420
Wall 42	Frame	No	3.2	0.58	0
Wall 43	Frame	Yes	3.2	2.5	1455
Wall 44	Frame	No	3.2	0.5	0
Wall 45	Frame	No	3.2	0.46	0
Wall 46	Frame	Yes	3.2	1.87	1053
Wall 47	Frame	Yes	3.2	2.45	1420
Wall 48	Frame	Yes	3.2	2.5	1455
Wall 49	Frame	Yes	3.2	1.3	695
Wall 5	Frame	No	3.2	0.6	0
Wall 50	Frame	Yes	3.2	2.49	1445
Wall 6	Frame	No	3.2	0.61	0
Wall 7	Frame	No	3.2	0.61	0
Wall 8	Frame	No	3.2	0.6	0
Wall 9	Frame	No	3.2	0.61	0

Types of structural elements and sign conventions

*L*inear elements

The linear elements are used to model beams and columns. They have a local reference system with respect to which stress/force components are shown. The sign convention adopted is shown in the figure below.

Force	Description	Unit of measure
N	Axial force	kN
M_{3-3}	Bending moment about local axis 3	kN m
V_2	Shear along local axis 2	kN
M_{2-2}	Bending moment about local axis 2	kN m
V_3	Shear along local axis 3	kN

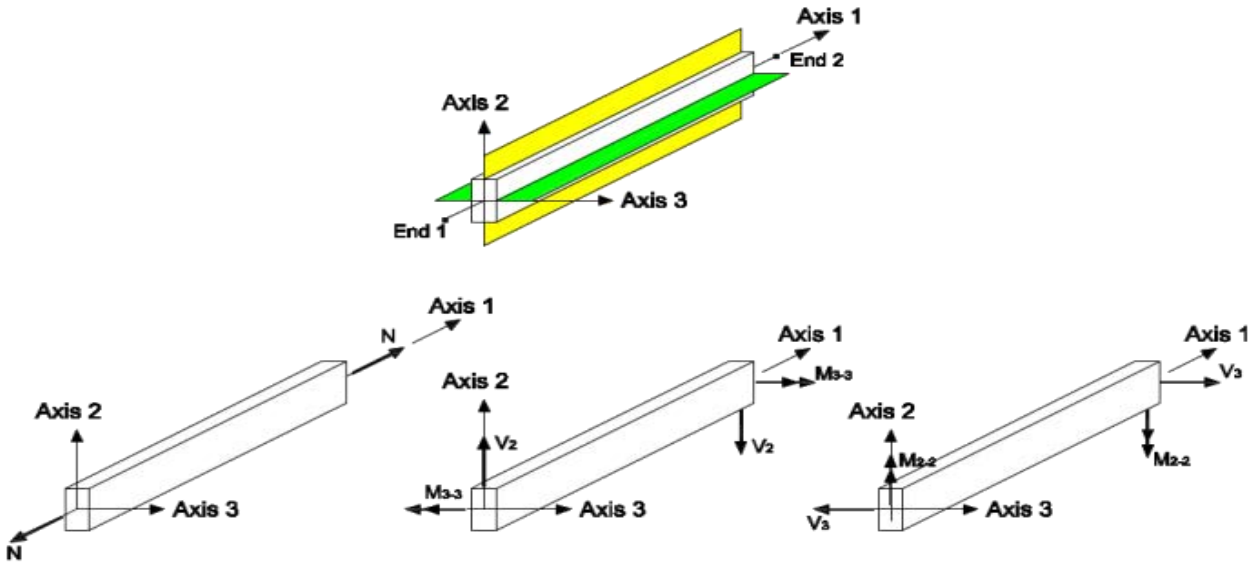


Figure: sign conventions for beams

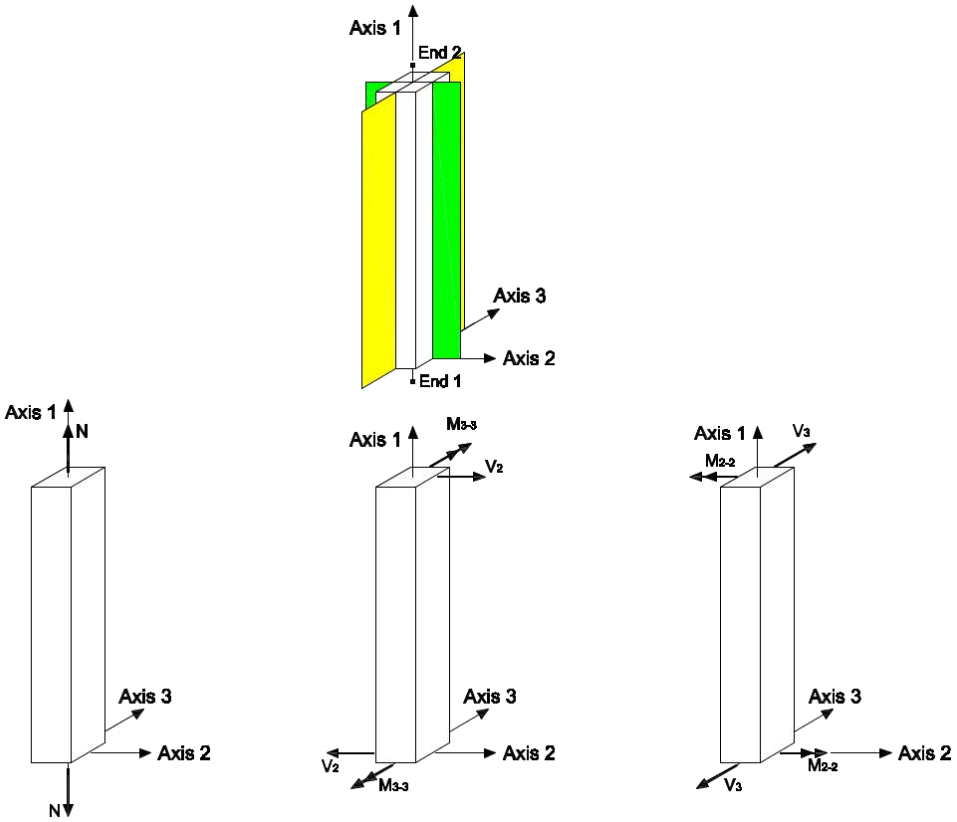


Figure: sign conventions for columns

Wall elements

The walls, regardless of type, have the following sign conventions.

	Stress	Description	Unit of measure
In-plane stresses	**n**	Axial stress (per unit length)	kN/m
	m_{3-3}	Bending moment about local axis 3 (per unit length)	kNm/m
	v_2	Shear along local axis 2 (per unit length)	kN/m
Out-of-plane stresses (plate)	**m_{2-2}**	Bending moment about local axis 2 (per unit length)	kNm/m
	v_3	Shear along local axis 3 (per unit length)	kN/m

	Force	Description	Unit of measure
In-plane stresses	**N**	Total axial force	kN
	M_{3-3}	Bending moment about local axis 3	kNm
	V_2	Shear along local axis 2	kN
Out-of-plane stresses (plate)	**M_{2-2}**	Bending moment about local axis 3	kNm
	V_3	Shear along local axis 2	kN

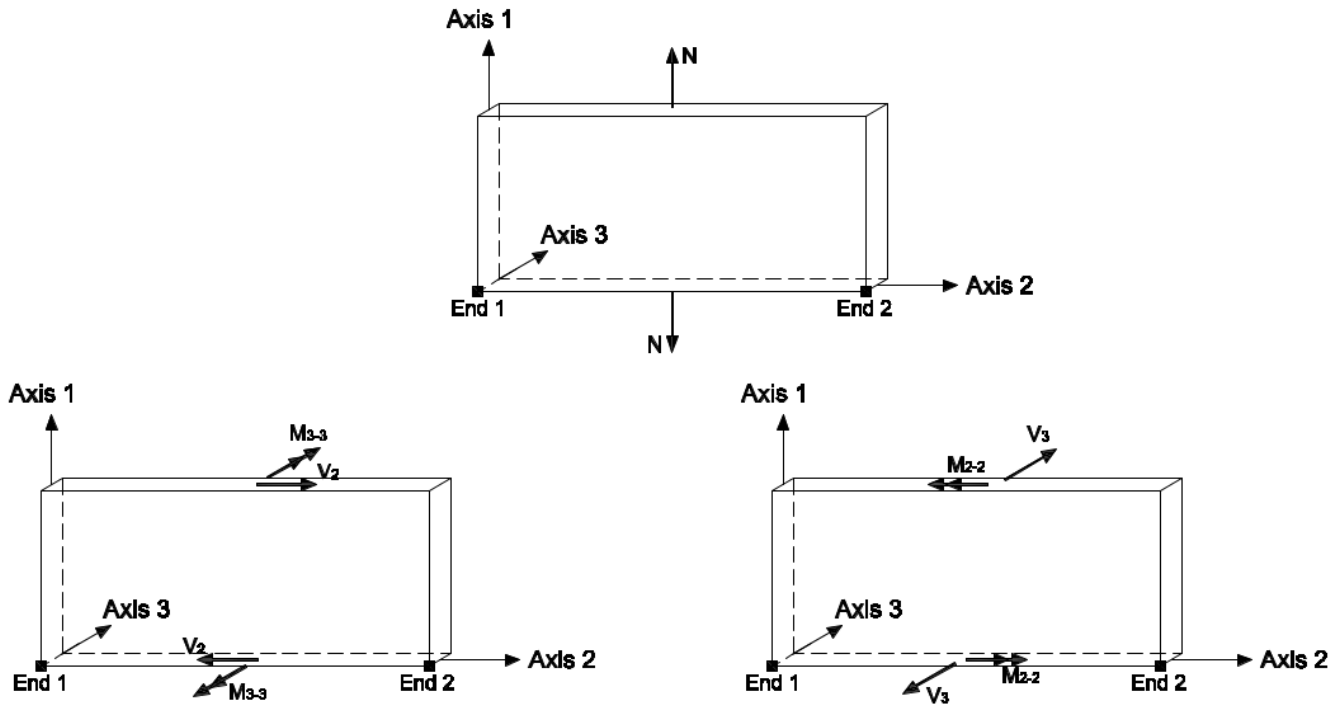


Figure: sign conventions for walls

Actions and design loads

Self-weight of structural materials

The weights of the structural materials are shown in the table below in kN/m^3

Description	Specific weight γ [kN/m^3]
MGP 10 - 90 x 45	5
F14 Plywood - Pinus species	5.5

Loads acting on the walls

The following table shows the loads acting on the walls.

Load name: Load ID

Position: Position of the wall: internal or external

g_{sw}: Self-weight

g_{ns}: Non-structural permanent loads

w_u: ULS wind load

Wall name	Position	Load name	g_{sw} [kN/m^2]	g_{ns} [kN/m^2]	w_u leeward [kN/m^2]	w_u windward [kN/m^2]
Wall 1	External	External walls load	0.35	0.6	-0.27	0.42
Wall 2	External	External walls load	0.36	0.6	-0.27	0.42
Wall 3	External	External walls load	0.35	0.6	-0.27	0.42
Wall 4	External	External walls load	0.35	0.6	-0.27	0.42
Wall 5	External	External walls load	0.36	0.6	-0.27	0.42
Wall 6	External	External walls load	0.35	0.6	-0.27	0.42
Wall 7	External	External walls load	0.35	0.6	-0.27	0.42
Wall 8	External	External walls load	0.36	0.6	-0.27	0.42
Wall 9	External	External walls load	0.35	0.6	-0.27	0.42
Wall 10	External	External walls load	0.2	0.6	-0.27	0.42
Wall 11	External	External walls load	0.2	0.6	-0.27	0.42
Wall 12	External	External walls load	0.2	0.6	-0.27	0.42
Wall 13	External	External walls load	0.2	0.6	-0.27	0.42
Wall 14	External	External walls load	0.2	0.6	-0.27	0.42
Wall 15	External	External walls load	0.2	0.6	-0.27	0.42
Wall 16	External	External walls load	0.2	0.6	-0.27	0.42
Wall 17	External	External walls load	0.37	0.6	-0.27	0.42
Wall 18	External	External walls load	0.2	0.6	-0.27	0.42
Wall 19	External	External walls load	0.41	0.6	-0.27	0.42
Wall 20	External	External walls load	0.44	0.6	-0.27	0.42
Wall 21	External	External walls load	0.22	0.6	-0.27	0.42
Wall 22	External	External walls load	0.2	0.6	-0.27	0.42
Wall 23	External	External walls load	0.2	0.6	-0.27	0.42
Wall 24	External	External walls load	0.25	0.6	-0.27	0.42
Wall 25	External	External walls load	0.2	0.6	-0.27	0.42
Wall 26	External	External walls load	0.35	0.6	-0.27	0.42
Wall 27	External	External walls load	0.36	0.6	-0.27	0.42
Wall 28	External	External walls load	0.35	0.6	-0.27	0.42
Wall 29	External	External walls load	0.35	0.6	-0.27	0.42
Wall 30	External	External walls load	0.36	0.6	-0.27	0.42
Wall 31	External	External walls load	0.35	0.6	-0.27	0.42
Wall 32	External	External walls load	0.35	0.6	-0.27	0.42
Wall 33	External	External walls load	0.36	0.6	-0.27	0.42
Wall 34	External	External walls load	0.35	0.6	-0.27	0.42
Wall 35	External	External walls load	0.2	0.6	-0.27	0.42
Wall 36	External	External walls load	0.2	0.6	-0.27	0.42
Wall 37	External	External walls load	0.2	0.6	-0.27	0.42
Wall 38	External	External walls load	0.2	0.6	-0.27	0.42
Wall 39	External	External walls load	0.2	0.6	-0.27	0.42
Wall 40	External	External walls load	0.2	0.6	-0.27	0.42
Wall 41	External	External walls load	0.2	0.6	-0.27	0.42
Wall 42	External	External walls load	0.37	0.6	-0.27	0.42
Wall 43	External	External walls load	0.2	0.6	-0.27	0.42

Wall 44	External	External walls load	0.41	0.6	-0.27	0.42
Wall 45	External	External walls load	0.44	0.6	-0.27	0.42
Wall 46	External	External walls load	0.22	0.6	-0.27	0.42
Wall 47	External	External walls load	0.2	0.6	-0.27	0.42
Wall 48	External	External walls load	0.2	0.6	-0.27	0.42
Wall 49	External	External walls load	0.25	0.6	-0.27	0.42
Wall 50	External	External walls load	0.2	0.6	-0.27	0.42

Loads acting on the floors

The following table shows the characteristic values of the loads acting on the decks.

Load name: Load ID

Position: Position of the floor: internal or external

Environment: Load type

α: Roof pitch angle

g_{sw}: Self-weight

g_{ns}: Non-structural permanent loads

q: Imposed actions

f_{sn}: Snow load

w_u: ULS wind load

w_s: SLS wind load

Floor name	Position	α [°]	Load name	Environment	g_{sw} [kN/m^2]	g_{ns} [kN/m^2]	q [kN/m^2]	f_{sn} [kN/m^2]	w_u leeward [kN/m^2]	w_u windward [kN/m^2]	w_s leeward [kN/m^2]	w_s windward [kN/m^2]
Floor 1	Internal floor	0	Floor load: residential	Other - General areas, bedrooms, hospital wards, hotel rooms, toilet areas	0.2	1	2	0	0	0	0	0
Floor 2	Internal floor	0	Floor load: residential	Other - General areas, bedrooms, hospital wards, hotel rooms, toilet areas	0.2	1	2	0	0	0	0	0

Seismic actions

The seismic actions are defined according to the AS 1170.4 - 2007. The earthquake motion at a given point on the surface is represented by an elastic ground acceleration response spectrum.

The response spectra are calculated according to the following parameters:

- the probability factor k_p for the annual probability of exceedance defined according to the importance level for the structure;
- the hazard factor Z that depends on the location of the building;
- the site sub-soil class.

The above-mentioned parameters are reported below:

Annual probability of exceedance	
Probability factor k_p	1.25
Hazard factor Z	0.09
Site sub-soil class	A

Horizontal elastic response spectrum

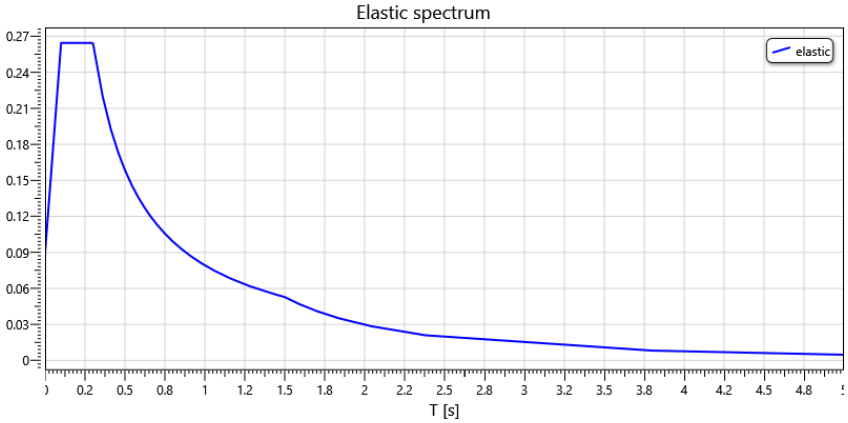
The values of the spectral shape factor $C_h(T)$ are defined by the following expressions in accordance to the site sub-soil class:

Site sub-soil class	$0 < T \leq 0.1\ s$	$0.1\ s < T \leq 1.5\ s$	$T > 1.5\ s$
A_e – Strong rock	$0.8 + 15.5\,T$	$\max(0.704/T\,;2.35)$	$1.056/T^2$
B_e – Rock	$1.0 + 19.4\,T$	$\max(0.88/T\,;2.94)$	$1.32/T^2$
C_e – Shallow soil	$1.3 + 23.8\,T$	$\max(1.25/T\,;3.68)$	$1.874/T^2$
D_e – Deep or soft soil	$1.1 + 25.8\,T$	$\max(1.98/T\,;3.68)$	$2.97/T^2$
E_e – Very soft soil	$1.1 + 25.8\,T$	$\max(3.08/T\,;3.68)$	$4.62/T^2$

The values of the elastic size hazard spectrum $C(T)$ depend on the above-defined spectral shape factor and on the values of the probability factor k_p and of the hazard factor Z according to the following equation:

$$C(T) = k_p \cdot Z \cdot C_h(T)$$

The resultant horizontal elastic site hazard spectrum is reported below



Design spectrum for elastic analysis

To avoid explicit inelastic structural analysis in design, the structural performance and its capacity to dissipate energy, through mainly ductile behavior of its elements and/or other mechanisms, is taken into account by performing an elastic analysis based on a response spectrum reduced with respect to the elastic one, henceforth called a "design spectrum".

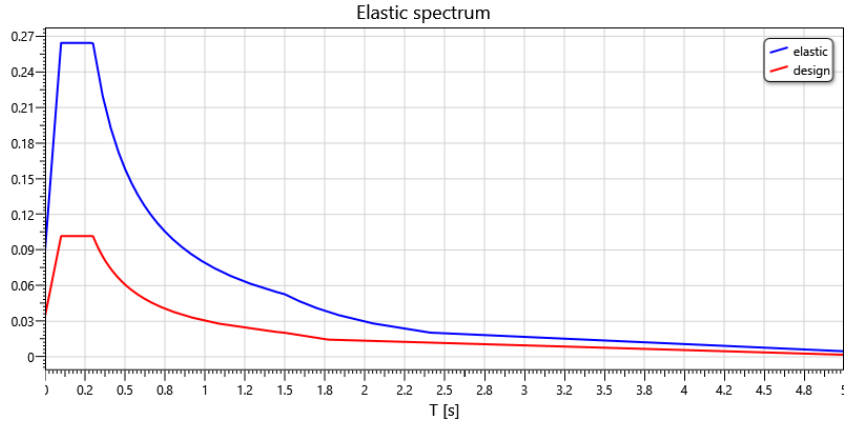
This reduction is accomplished by introducing the structural performance factor S_p and the structural ductility factor μ related to the structural system adopted.

Structural system	LF buildings - Thin bracing panels
Structural performance factor S_p	0.77
Structural ductility factor μ	2.00
μ/S_p	2.60

The design spectrum is defined by the following expressions:

$$C_d(T) = C(T) \cdot S_p/\mu = k_p \cdot Z \cdot C_h(T) \cdot S_p/\mu$$

The horizontal elastic response spectrum and the horizontal design spectrum (Ultimate Limit State) are shown below:



Sections of the structural elements

Framed walls

Frame geometric characteristics

t: *thickness of the frame*

h_b: *thickness of top and sole plates*

$b_{s,int}$: *width of the internal studs*

$b_{s,ext}$: *width of the external studs*

i_m: *average studs spacing*

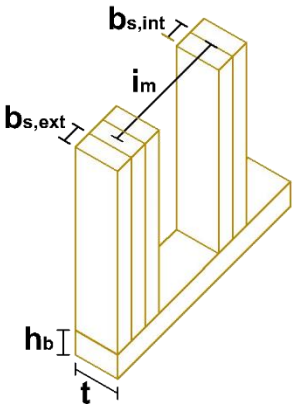


Figure: dimensions of the frame elements

The characteristics of the frame of each wall type are reported below.

Section name	# sides with bracing	Material	Frame thickness t [mm]	Thickness of top and sole plates h_b [mm]	Width of the internal studs $b_{s,int}$ [mm]	# elements for each internal stud	Width of the external studs $b_{s,ext}$ [mm]	# elements for each external stud	Average studs spacing i_m [mm]
Frame 1	1.00	MGP 10 - 90 x 45	90	45	45	1	45	4	409

Sheet-bracing geometrical characteristics

b_s: *sheeting boards width*

$s_{c,b}$: *spacing of fasteners along the perimeter of every sheet*

$s_{c,i}$: *spacing of internal fasteners*

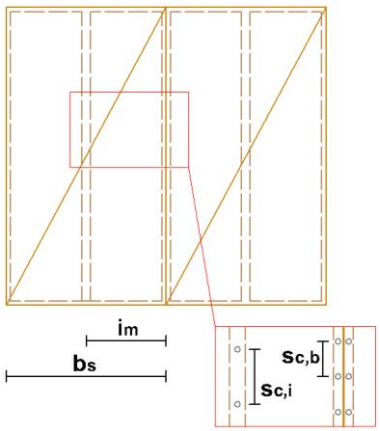


Figure: dimensions of the *sheeting boards and fasteners spacing*

The characteristics of the sheet-bracing are reported below.

Section name	Side	Material	Sheeting board thickness t_s [mm]	Sheeting boards width b_s [mm]	Frame-sheeting board fastener	Perimeter fasteners spacing $S_{c,b}$ [mm]	Internal fasteners spacing i $S_{c,i}$ [mm]
Frame 1	1	F14 Plywood - Pinus species	15	818	Ring nail (coils) 2.8/3.1 x 60	100	200

Floors with timber joists

Elements geometric characteristics

h_b: *Cross section height*

b_b: *Cross section width*

i_b: *Joists spacing*

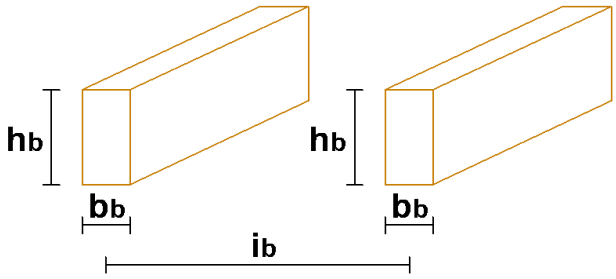


Figure: geometric characteristics of the floor

The following table sets out the details concerning the floor with joists.

Section name	Material	Cross section height h_b [mm]	Cross section width b_b [mm]	Joists spacing i_b [mm]
Joists floor 1	MGP 10 - 90 x 45	90	45	100

Connections

Hold Down

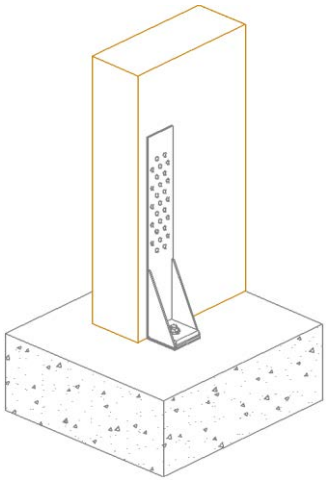


Figure: graphical representation of a hold-down in a base connection (timber wall – foundation connection)

Connection name	Connection position	Manufacturer	Description	Fasteners number	Fastener typology	Threaded rod / Anchor	Chemical anchor type	Number of hold-down at each wall end
Ground connection - hold down - bracket	Ground connection	Rotho Blass	WHT 340	14	Anker nail - LBA 4.0 X 40	INA - 5.8 - M16 x 160	EPOPLUS chemical anchor	1

Timber-reinforced concrete connection

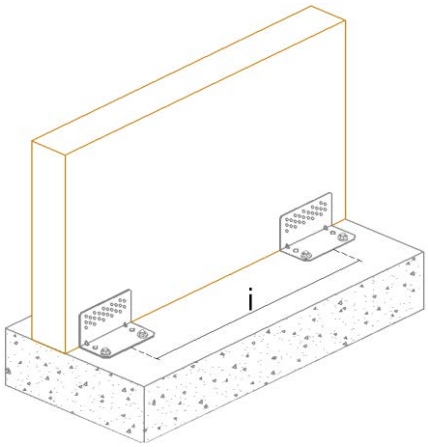


Figure: graphical representation of the shear connection with angle brackets

Connection name	Connection position	Manufacturer	Description	Fasteners number on the vertical plate	Fastener typology	Anchors number	Threaded rod / Anchor	Chemical anchor tipe	Number of sides	Angle brackets spacing i [mm]
Ground connection - hold down - bracket	Ground connection	Rotho Blaas	Titan N - TCN 200	30	Anker nail - LBA 4.0 X 60	2	INA - 5.8 - M12 x 130	VINYLPRO chemical anchor	1.00	500

Punched metal plate/Punched strap for tension force

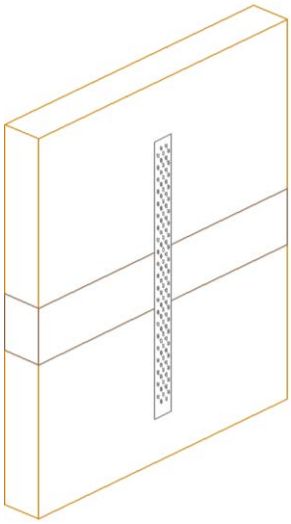
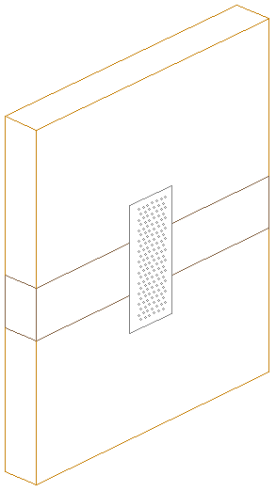


Figure: graphical representation of a punched strap

Connection name	Connection position	Manufacturer	Description	Width [mm]	Length [mm]	Thickness [mm]	Steel grade	Number of fasteners at each end	Fasteners typology	Number of connections at each wall end
Upper levels - tensile plate - shear plate	Upper level	Rotho Blaas	Perforated plate 60x600 thk. 1.5 mm	60	600	1.5	S250	30	Anker nail - LBA 4.0 X 60	1

Punched metal plate/Punched strap for shear force



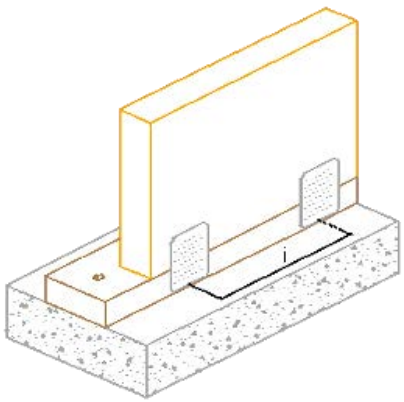


Figure: graphical representations of timber to timber shear connection with punched metal plates

Connection name	Connection position	Manufacturer	Description	Width [mm]	Lenght [mm]	Thickness [mm]	Steel grade	Number of fasteners at each end	Fasteners typology	Metal paltes spacing i [mm]
Upper levels - tensile plate - shear plate	Upper level	Rotho Blaas	Perforated plate 200x300 thk. 2 mm	200	300	2	S250	30	Anker nail - LBA 4.0 X 60	500

Combinations of actions

The combinations for the ultimate limit states used in checking strength are as follows.

(a)	$E_d = [1.35 \cdot (G_{sw} + G_{ns})]$	Permanent action only
(b)	$E_d = [1.2 \cdot (G_{sw} + G_{ns}),\ 1.5 \cdot Q]$	Permanent and imposed action
(c)	$E_d = [1.2 \cdot (G_{sw} + G_{ns}),\ 1.5 \cdot \psi_l \cdot Q]$	Permanent and long-term imposed action
(d)	$E_d = [1.2 \cdot (G_{sw} + G_{ns}),\ W_u,\ \psi_c \cdot Q]$	Permanent, wind and imposed action
(e)	$E_d = [0.9 \cdot (G_{sw} + G_{ns}),\ W_u]$	Permanent and wind action reversal
(f)	$E_d = [(G_{sw} + G_{ns}),\ E_u,\ \psi_E \cdot Q]$	Permanent, earthquake and imposed action
(g)	$E_d = [1.2 \cdot (G_{sw} + G_{ns}),\ F_{sn},\ \psi_c \cdot Q]$	Permanent, snow and imposed action

The combinations for the ultimate limit states used in checking stability are as follows.

For combinations that produce net stabilizing effects:

o	$E_{d,stb} = [0.9 \cdot (G_{sw} + G_{ns})]$	Permanent action only

For combinations that produce net destabilizing effects

(iv)	$E_{d,dst} = [1.2 \cdot (G_{sw} + G_{ns}),\ W_u,\ \psi_c \cdot Q]$	Permanent, wind and imposed action
(v)	$E_{d,dst} = [(G_{sw} + G_{ns}),\ E_u,\ \psi_E \cdot Q]$	Permanent, earthquake and imposed action

The combinations for the serviceability limit states are as follows.

- o $(G_{sw} + G_{ns}) + \psi_l \cdot Q$
- o $(G_{sw} + G_{ns}) + \psi_s \cdot Q$
- o $\psi_s \cdot Q$
- o W_s

being:

G_{sw} permanent actions: self weight

G_{ns} non-structural permanent actions

Q imposed actions

W_u Wind action for ULS

W_s Wind action for SLS

E_u earthquake action

F_{sn} snow action

ψ_s short-term factor

ψ_l long-term factor

ψ_c combination factor

ψ_E earthquake combination factor

The following table presents the values of the factors used.

Action name	Description	Duration	ψ_s	ψ_l	ψ_c	ψ_E
Q type A	Type A: Domestic and residential activities	5 months	0.7	0.4	0.4	0.3
Q type Asf	Type Asf: Non-habitable roof spaces for residential activities	5 months	1	0.6	0.6	0.6
Q type B	Type B: Offices and work areas not covered elsewhere	5 months	0.7	0.4	0.4	0.3
Q type C	Type C: Areas where people may congregate	5 days	0.7	0.4	0.4	0.3
Q type Cff	Type Cff: Areas where people may congregate - fixed furniture	5 days	1	0.6	0.6	0.6
Q type D	Type D: Shopping areas	5 months	0.7	0.4	0.4	0.3
Q type E	Type E: Warehousing, storage areas, areas for plant	5 months	1	0.6	0.6	0.6
Q type F	Type F: Light vehicle traffic areas	5 months	0.7	0.4	0.4	0.3
Q type G	Type G: Medium vehicle traffic areas	5 months	0.7	0.4	0.4	0.3
Q type R1	Type R1: Street awnings	5 days	0.7	0	0	0
Q type R2	Type R2: Other roofs	5 days	0.7	0	0	0
Q type R-A	Type R-A: Domestic and residential activities	5 months	0.7	0.4	0.4	0.3
Q type R-B	Type R-B: Offices and work areas not covered elsewhere	5 months	0.7	0.4	0.4	0.3
Q type R-C	Type R-C: Areas where people may congregate	5 days	0.7	0.4	0.4	0.3
Q type R-D	Type R-D: Shopping areas	5 months	0.7	0.4	0.4	0.3

Q type R-E	Type R-E: Warehousing, storage areas, areas for plant	5 months	1	0.6	0.6	0.6
Q type R-F	Type R-F: Light vehicle traffic areas	5 months	0.7	0.4	0.4	0.3
Q type R-G	Type R-G: Medium vehicle traffic areas	5 months	0.7	0.4	0.4	0.3
Ortho wind ULS	Wind pressure ULS	5 seconds	0	0	0	0
Ortho wind SLS	Wind pressure SLS	5 seconds	0	0	0	0
Snow	Snow action for alpine areas	5 months	0	0	0	0
Snow	Snow action for sub-alpine areas	5 days	0	0	0	0

Combinations of actions used

Vertical ULS combinations of actions

The following table shows the combinations of actions for Ultimate Limit States relevant for verifications in the case of vertical actions.

The action of the wind is considered as a uniform load orthogonal to the roof and to each external wall.

Name	Duration	G(sw)	G(ns)	Q type A	Ortho wind ULS down	Ortho wind ULS up	Wind X	Wind Y	Seismic dynamic X	Seismic dynamic Y
ULS 1	50+ years	1.35	1.35	0	0	0	0	0	0	0
ULS 2	50+ years	1.2	1.2	0	0	0	0	0	0	0
ULS 3	5 months	1.2	1.2	1.5	0	0	0	0	0	0
ULS 4	50+ years	1.2	1.2	0.6	0	0	0	0	0	0
ULS 5	5 seconds	1.2	1.2	0.4	1	0	0	0	0	0
ULS 6	5 seconds	0.9	0.9	0	0	1	0	0	0	0

Wind ULS combinations of actions

The following table shows the combinations of actions for Ultimate Limit States relevant for verifications in the case of horizontal wind actions.

The action of the wind is considered as a uniform load orthogonal to each external wall that acts separately in the directions X, -X, Y, -Y and as a uniform load orthogonal to the roof.

Name	Duration	G(sw)	G(ns)	Q type A	Ortho wind ULS down	Ortho wind ULS up	Wind X	Wind Y	Seismic dynamic X	Seismic dynamic Y
ULS Wind 1	5 seconds	1.2	1.2	0.4	1	0	1	0	0	0
ULS Wind 2	5 seconds	1.2	1.2	0.4	1	0	-1	0	0	0
ULS Wind 3	5 seconds	0.9	0.9	0	0	1	1	0	0	0
ULS Wind 4	5 seconds	0.9	0.9	0	0	1	-1	0	0	0
ULS Wind 5	5 seconds	1.2	1.2	0.4	1	0	0	1	0	0
ULS Wind 6	5 seconds	1.2	1.2	0.4	1	0	0	-1	0	0
ULS Wind 7	5 seconds	0.9	0.9	0	0	1	0	1	0	0
ULS Wind 8	5 seconds	0.9	0.9	0	0	1	0	-1	0	0

SLS combinations of actions

The action of the wind is considered as a uniform load orthogonal to the roof.

Name	Duration	G(sw)	G(ns)	Q type A	Ortho wind ULS down	Ortho wind ULS up	Wind X	Wind Y	Seismic dynamic X	Seismic dynamic Y
SLS 1	50+ years	1	1	0.4	0	0	0	0	0	0
SLS 2	5 seconds	0	0	0.7	0	0	0	0	0	0
SLS 3	5 seconds	1	1	0.7	0	0	0	0	0	0

Seismic combinations of actions

The action effects due to the combination of the horizontal components of the seismic action are computed using the following combinations:

$$E_{u,X} + 0{,}3 \cdot E_{u,Y}$$

$$0{,}3 \cdot E_{u,X} + E_{u,Y}$$

Combinations of actions for seismic strength Ultimate Limit States

Name	Duration	G(sw)	G(ns)	Q type A	Ortho wind ULS down	Ortho wind ULS up	Wind X	Wind Y	Seismic dynamic X	Seismic dynamic Y
ULS earthquake strength 1 ex+ ey+	5 seconds	1	1	0.3	0	0	0	0	1	0.3
ULS earthquake strength 1 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	1	0.3
ULS earthquake strength 1 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	1	0.3
ULS earthquake strength 1 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	1	0.3
ULS earthquake strength 2 ex+ ey+	5 seconds	1	1	0.3	0	0	0	0	1	-0.3
ULS earthquake strength 2 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	1	-0.3
ULS earthquake strength 2 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	1	-0.3
ULS earthquake strength 2 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	1	-0.3
ULS earthquake strength 3 ex+ ey+	5 seconds	1	1	0.3	0	0	0	0	-1	0.3
ULS earthquake strength 3 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	-1	0.3
ULS earthquake strength 3 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	-1	0.3
ULS earthquake strength 3 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	-1	0.3
ULS earthquake strength 4 ex+ ey+	5 seconds	1	1	0.3	0	0	0	0	-1	-0.3
ULS earthquake strength 4 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	-1	-0.3
ULS earthquake strength 4 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	-1	-0.3
ULS earthquake strength 4 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	-1	-0.3
ULS earthquake strength 5 ex+ ey+	5 seconds	1	1	0.3	0	0	0	0	0.3	1
ULS earthquake strength 5 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	0.3	1
ULS earthquake strength 5 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	0.3	1
ULS earthquake strength 5 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	0.3	1
ULS earthquake strength 6 ex+ ey+	5 seconds	1	1	0.3	0	0	0	0	0.3	-1
ULS earthquake strength 6 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	0.3	-1
ULS earthquake strength 6 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	0.3	-1
ULS earthquake strength 6 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	0.3	-1
ULS earthquake strength 7 ex+	5 seconds	1	1	0.3	0	0	0	0	-0.3	1

ey+										
ULS earthquake strength 7 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	-0.3	1
ULS earthquake strength 7 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	-0.3	1
ULS earthquake strength 7 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	-0.3	1
ULS earthquake strength 8 ex+ ey+	5 seconds	1	1	0.3	0	0	0	0	-0.3	-1
ULS earthquake strength 8 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	-0.3	-1
ULS earthquake strength 8 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	-0.3	-1
ULS earthquake strength 8 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	-0.3	-1

Combinations of actions for seismic stability Ultimate Limit States

Name	Duration	G(sw)	G(ns)	Q type A	Ortho wind ULS down	Ortho wind ULS up	Wind X	Wind Y	Seismic dynamic X	Seismic dynamic Y
ULS earthquake stability 1 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	1	0.3
ULS earthquake stability 1 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	1	0.3
ULS earthquake stability 1 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	1	0.3
ULS earthquake stability 1 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	1	0.3
ULS earthquake stability 2 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	1	-0.3
ULS earthquake stability 2 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	1	-0.3
ULS earthquake stability 2 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	1	-0.3
ULS earthquake stability 2 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	1	-0.3
ULS earthquake stability 3 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	-1	0.3
ULS earthquake stability 3 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	-1	0.3
ULS earthquake stability 3 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	-1	0.3
ULS earthquake stability 3 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	-1	0.3
ULS earthquake stability 4 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	-1	-0.3
ULS earthquake stability 4 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	-1	-0.3
ULS earthquake stability 4 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	-1	-0.3
ULS earthquake stability 4 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	-1	-0.3
ULS earthquake stability 5 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	0.3	1
ULS earthquake stability 5 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	0.3	1
ULS earthquake stability 5 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	0.3	1
ULS earthquake stability 5 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	0.3	1
ULS earthquake stability 6 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	0.3	-1
ULS earthquake stability 6 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	0.3	-1
ULS earthquake stability 6 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	0.3	-1
ULS earthquake stability 6 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	0.3	-1
ULS earthquake stability 7 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	1

ULS earthquake stability 7 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	1
ULS earthquake stability 7 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	1
ULS earthquake stability 7 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	1
ULS earthquake stability 8 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	-1
ULS earthquake stability 8 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	-1
ULS earthquake stability 8 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	-1
ULS earthquake stability 8 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	-1

Combinations of actions for seismic drift Ultimate Limit States

Name	Duration	G(sw)	G(ns)	Q type A	Ortho wind ULS down	Ortho wind ULS up	Wind X	Wind Y	Seismic dynamic X	Seismic dynamic Y
ULS earthquake drift 1 ex+ ey+	5 seconds	0	0	0	0	0	0	0	1	0
ULS earthquake drift 1 ex+ ey-	5 seconds	0	0	0	0	0	0	0	1	0
ULS earthquake drift 1 ex- ey+	5 seconds	0	0	0	0	0	0	0	1	0
ULS earthquake drift 1 ex- ey-	5 seconds	0	0	0	0	0	0	0	1	0
ULS earthquake drift 2 ex+ ey+	5 seconds	0	0	0	0	0	0	0	-1	0
ULS earthquake drift 2 ex+ ey-	5 seconds	0	0	0	0	0	0	0	-1	0
ULS earthquake drift 2 ex- ey+	5 seconds	0	0	0	0	0	0	0	-1	0
ULS earthquake drift 2 ex- ey-	5 seconds	0	0	0	0	0	0	0	-1	0
ULS earthquake drift 3 ex+ ey+	5 seconds	0	0	0	0	0	0	0	0	1
ULS earthquake drift 3 ex+ ey-	5 seconds	0	0	0	0	0	0	0	0	1
ULS earthquake drift 3 ex- ey+	5 seconds	0	0	0	0	0	0	0	0	1
ULS earthquake drift 3 ex- ey-	5 seconds	0	0	0	0	0	0	0	0	1
ULS earthquake drift 4 ex+ ey+	5 seconds	0	0	0	0	0	0	0	0	-1
ULS earthquake drift 4 ex+ ey-	5 seconds	0	0	0	0	0	0	0	0	-1
ULS earthquake drift 4 ex- ey+	5 seconds	0	0	0	0	0	0	0	0	-1
ULS earthquake drift 4 ex- ey-	5 seconds	0	0	0	0	0	0	0	0	-1

Horizontal actions

Modal analysis

The modal analysis is used to determine the vibration modes of the structure, useful to understand the seismic behaviour of the building and to proceed with the linear dynamic analysis.

The modal analysis involves the solution of the generalized eigenvalue problem:

$$[\boldsymbol{K} - \boldsymbol{\Omega}^2 \boldsymbol{M}]\boldsymbol{\Phi} = \mathbf{0}$$

where $\boldsymbol{K}$ is the stiffness matrix, $\boldsymbol{M}$ the mass matrix, $\boldsymbol{\Omega}^2$ is the diagonal matrix of the eigenvalues and $\boldsymbol{\Phi}$ is the corresponding matrix of eigenvectors or modal shapes (normalized with respect to the mass matrix); the seismic masses of the diaphragms are calculated with the following combination of vertical loads:

$$\sum \left(G_{sw,j} + G_{ns,j}\right) + \sum \psi_{\mathrm{E,i}} \cdot \mathrm{Q}$$

where ψ_{Ei} is the earthquake combination factor for the imposed action *i.*

The eigenvalue, obtained from the solution of the generalized eigenvalue problem, is the square of the circular frequency $\boldsymbol{\omega}$ related to the period, *T*, and to the frequency, *f*, by the following equations:

$$T = \frac{1}{f} \text{ and } f = \frac{\omega}{2\pi}$$

The participating mass ratio for the mode *i-th*, corresponding to an acceleration in the global axis X and Y and to a rotational acceleration around the vertical axis Z, is given by:

$$M_x^i = \frac{m_x^i}{\sum m_{x,j}} \ [\%]$$

$$M_y^i = \frac{m_y^i}{\sum m_{y,j}} \ [\%]$$

$$M_z^i = \frac{m_z^i}{\sum I_{z,j}} \ [\%]$$

where:

$$m_x^i = \frac{\left(\left[\boldsymbol{\Phi}^{\boldsymbol{i}}\right]^{\boldsymbol{T}} \boldsymbol{M}\, \boldsymbol{R}_{\boldsymbol{x}}\right)^2}{[\boldsymbol{\Phi}^{\boldsymbol{i}}]^{\boldsymbol{T}} \boldsymbol{M}\, \boldsymbol{\Phi}^{\boldsymbol{i}}}$$

$$m_y^i = \frac{\left(\left[\boldsymbol{\Phi}^{\boldsymbol{i}}\right]^{\boldsymbol{T}} \boldsymbol{M}\, \boldsymbol{R}_{\boldsymbol{y}}\right)^2}{[\boldsymbol{\Phi}^{\boldsymbol{i}}]^{\boldsymbol{T}} \boldsymbol{M}\, \boldsymbol{\Phi}^{\boldsymbol{i}}}$$

$$m_z^i = \frac{\left(\left[\boldsymbol{\Phi}^{\boldsymbol{i}}\right]^{\boldsymbol{T}} \boldsymbol{M}\, \boldsymbol{R}_{\boldsymbol{z}}\right)^2}{[\boldsymbol{\Phi}^{\boldsymbol{i}}]^{\boldsymbol{T}} \boldsymbol{M}\, \boldsymbol{\Phi}^{\boldsymbol{i}}}$$

and where $\sum m_{x,j}$, $\sum m_{y,j}$ and $\sum I_{z,j}$ are the total masses acting in the axis X, Y and the total rotational inertia about the axis Z of the unrestrained *j-th* degrees of freedom.

Mode	Period [s]	Frequency [Hz]	M_X [%]	Sum M_X [%]	M_Y [%]	Sum M_Y [%]	M_Z [%]	Sum M_Z [%]
Mode 1	0.51	1.96	0.01	0.01	94.39	94.39	1.29	1.29
Mode 2	0.45	2.22	0.91	0.92	1.50	95.89	93.56	94.85
Mode 3	0.36	2.79	94.97	95.89	0.00	95.89	0.90	95.75
Mode 4	0.20	4.89	0.00	95.89	4.11	99.99	0.25	96.00
Mode 5	0.18	5.51	0.04	95.93	0.01	100.00	3.95	99.95
Mode 6	0.14	6.95	4.07	100.00	0.00	100.00	0.05	100.00

Dynamic linear analysis

The dynamic linear analysis consists of:

- the calculation of the seismic effects (the seismic action is represented by the design response spectrum), of each of the vibration modes calculated in the modal analysis;
- the combination of these effects.

The seismic effects of the structural model are obtained by the application of the following external loads:

$$\boldsymbol{F_x^i} = \Gamma_x^i S_d(T_i) \boldsymbol{M \Phi^i}$$

and

$$\boldsymbol{F_y^i} = \Gamma_y^i S_d(T_i) \boldsymbol{M \Phi^i}$$

where:

$\boldsymbol{F_x^i}$ and $\boldsymbol{F_y^i}$ are the external loads of the *i-th vibration mode* due to seismic action along X and Y

$S_d(T_i)$ is the spectrum value corresponding to the *i-th* period

$\boldsymbol{\Phi^i}$ is the *i-th modal shape*

$\Gamma_x^i \; and \; \Gamma_y^i$ are the participating modal factor of the *i-th mode* given by:

$$\Gamma_x^i = \frac{\left[\boldsymbol{\Phi^i}\right]^T \boldsymbol{M \, R_x}}{[\boldsymbol{\Phi^i}]^T \boldsymbol{M \, \Phi^i}} \text{ e } \Gamma_y^i = \frac{\left[\boldsymbol{\Phi^i}\right]^T \boldsymbol{M \, R_y}}{[\boldsymbol{\Phi^i}]^T \boldsymbol{M \, \Phi^i}}$$

The effects for a given direction of acceleration (along X or Y) and for each of the vibration modes are combined with the Complete Quadratic Combination technique defined as:

$$E = \left(\sum_j \sum_i \rho_{ij} \cdot E_i \cdot E_j \right)^{1/2}$$

where:

E_j is the effect of the j-th vibration mode;

ρ_{ij} is the correlation coefficient of the *i-th* mode and the *j-th* mode, given by:

$$\rho_{ij} = \frac{8\,\xi^2\beta_{ij}^{3/2}}{(1+\beta_{ij})\left[(1-\beta_{ij})\right]}$$

ξ is the damping ratio in the i-th and j-th modes;

$\beta_{ij} = T_j/T_i$).

The following table provides the diaphragms properties.

Diaphragm	Height above the base of the timber structure [m]	xG [m]	yG [m]	Mass i [kg]
1	3.20	5.84	-0.25	17833
2	6.40	6.08	-0.27	12856

The following table provides, for each of the vibration mode, the corresponding period and value of the response spectrum.

Mode	Period [s]	Spectrum value [g]
Mode 1	0.58	0.05
Mode 2	0.41	0.07
Mode 3	0.35	0.09
Mode 4	0.23	0.10
Mode 5	0.16	0.10
Mode 6	0.14	0.10

Wind

The table below illustrates the horizontal forces acting on the storeys due to the wind action and the coordinates of their respective application points.

Diaphragm	Height above the reference plane [m]	xG,wind [m]	yG,wind [m]	Fx [kN]	Fy [kN]
1	3.20	6.63	-0.30	7.74	29.30
2	6.40	6.63	-0.30	3.87	14.65

The action effects

In this chapter the internal forces acting on the structural members and on their connections are reported with regard to the considered loads.

Walls

Wall name: Wall ID

N: Total axial force

V2: Shear force (in-plane)

V3: Shear force (out-of-plane)

M2-2: Bending moment (out-of-plane)

M3-3: Bending moment (in-plane)

Va: Shear force on the single connection

Ta: Tensile force on the single anchor

dr: Interstory drift

Load	Wall name	N [kN]	V2 [kN]	V3 [kN]	M2-2 [kNm]	M3-3 [kNm]	Va [kN]	Ta [kN]	dr [mm]
G(sw)	Wall 1	1.38	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 2	1.34	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 3	1.43	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 4	1.48	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 5	1.50	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 6	1.99	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 7	3.89	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 8	2.76	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 9	1.79	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 10	3.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 11	3.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 12	3.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 13	3.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 14	7.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 15	3.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 16	3.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 17	1.36	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 18	8.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 19	1.31	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 20	1.29	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 21	2.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 22	3.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 23	5.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 24	2.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 25	3.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 26	0.69	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 27	0.67	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 28	0.72	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 29	0.74	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 30	0.75	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 31	0.99	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 32	1.96	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 33	1.39	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 34	0.90	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 35	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 36	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 37	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 38	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 39	3.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 40	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 41	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 42	0.68	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 43	4.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 44	0.66	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 45	0.64	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 46	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 47	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 48	2.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 49	1.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 50	1.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00

G(ns)	Wall 1	2.36	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 2	2.09	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 3	2.54	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 4	2.81	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 5	2.91	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 6	5.31	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 7	14.69	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 8	9.13	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 9	4.39	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 10	9.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 11	9.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 12	9.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 13	9.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 14	29.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 15	9.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 16	9.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 17	2.23	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 18	36.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 19	1.92	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 20	1.77	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 21	7.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 22	9.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 23	22.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 24	4.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 25	11.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 26	1.18	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 27	1.05	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 28	1.28	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 29	1.41	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 30	1.45	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 31	2.66	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 32	7.40	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 33	4.60	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 34	2.19	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 35	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 36	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 37	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 38	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 39	14.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 40	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 41	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 42	1.11	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 43	18.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 44	0.96	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 45	0.88	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 46	3.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 47	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 48	11.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 49	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 50	5.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 1	0.04	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 2	-0.47	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 3	0.37	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 4	0.94	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 5	1.21	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 6	5.94	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 7	24.66	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 8	13.62	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 9	4.09	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 14	39.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 18	53.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 23	26.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 25	4.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 26	0.02	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 27	-0.24	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 28	0.18	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 29	0.47	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 30	0.60	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 31	2.97	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 32	12.42	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 33	6.87	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 34	2.04	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 39	19.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 43	26.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D

Q type A	Wall 45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 48	13.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 50	2.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 1	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 2	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 3	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 4	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 5	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 6	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 7	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 8	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 9	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 10	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 11	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 12	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 13	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 14	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 15	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 16	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 17	0.00	0.00	0.39	0.31	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 18	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 19	0.00	0.00	0.34	0.27	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 20	0.00	0.00	0.31	0.25	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 21	0.00	0.00	1.26	1.01	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 22	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 23	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 24	0.00	0.00	0.88	0.70	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 25	0.00	0.00	1.68	1.34	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 26	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 27	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 28	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 29	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 30	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 31	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 32	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 33	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 34	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 35	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 36	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 37	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 38	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 39	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 40	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 41	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 42	0.00	0.00	0.39	0.31	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 43	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 44	0.00	0.00	0.34	0.27	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 45	0.00	0.00	0.31	0.25	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 46	0.00	0.00	1.26	1.01	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 47	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 48	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 49	0.00	0.00	0.88	0.70	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 50	0.00	0.00	1.68	1.34	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 1	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 2	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 3	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 4	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 5	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 6	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 7	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 8	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 9	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 10	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 11	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 12	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 13	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 14	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 15	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 16	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 17	0.00	0.00	0.39	0.31	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 18	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 19	0.00	0.00	0.34	0.27	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 20	0.00	0.00	0.31	0.25	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 21	0.00	0.00	1.26	1.01	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 22	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 23	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 24	0.00	0.00	0.88	0.70	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 25	0.00	0.00	1.68	1.34	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 26	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 27	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 28	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 29	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 30	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 31	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 32	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 33	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 34	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 35	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 36	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 37	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 38	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00

Ortho wind ULS up	Wall 39	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 40	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 41	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 42	0.00	0.00	0.39	0.31	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 43	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 44	0.00	0.00	0.34	0.27	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 45	0.00	0.00	0.31	0.25	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 46	0.00	0.00	1.26	1.01	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 47	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 48	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 49	0.00	0.00	0.88	0.70	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 50	0.00	0.00	1.68	1.34	0.00	0.00	0.00	0.00
Wind X	Wall 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 10	0.00	1.39	0.00	0.00	5.92	0.00	0.00	1.00
Wind X	Wall 11	0.00	1.39	0.00	0.00	5.92	0.00	0.00	1.00
Wind X	Wall 12	0.00	1.39	0.00	0.00	5.92	0.00	0.00	1.00
Wind X	Wall 13	0.00	1.39	0.00	0.00	5.92	0.00	0.00	1.00
Wind X	Wall 14	0.00	0.09	0.00	0.00	0.37	0.00	0.00	0.06
Wind X	Wall 15	0.00	1.44	0.00	0.00	6.14	0.00	0.00	1.04
Wind X	Wall 16	0.00	1.44	0.00	0.00	6.14	0.00	0.00	1.04
Wind X	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 18	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Wind X	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 21	0.00	1.06	0.00	0.00	4.53	0.00	0.00	1.04
Wind X	Wall 22	0.00	1.44	0.00	0.00	6.14	0.00	0.00	1.04
Wind X	Wall 23	0.00	0.06	0.00	0.00	0.27	0.00	0.00	0.04
Wind X	Wall 24	0.00	0.67	0.00	0.00	2.89	0.00	0.00	1.01
Wind X	Wall 25	0.00	0.03	0.00	0.00	0.11	0.00	0.00	0.02
Wind X	Wall 26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 35	0.00	0.46	0.00	0.00	1.48	0.00	0.00	0.33
Wind X	Wall 36	0.00	0.46	0.00	0.00	1.48	0.00	0.00	0.33
Wind X	Wall 37	0.00	0.46	0.00	0.00	1.48	0.00	0.00	0.33
Wind X	Wall 38	0.00	0.46	0.00	0.00	1.48	0.00	0.00	0.33
Wind X	Wall 39	0.00	0.03	0.00	0.00	0.09	0.00	0.00	0.02
Wind X	Wall 40	0.00	0.48	0.00	0.00	1.53	0.00	0.00	0.34
Wind X	Wall 41	0.00	0.48	0.00	0.00	1.53	0.00	0.00	0.34
Wind X	Wall 42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind X	Wall 44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 46	0.00	0.36	0.00	0.00	1.14	0.00	0.00	0.34
Wind X	Wall 47	0.00	0.48	0.00	0.00	1.53	0.00	0.00	0.34
Wind X	Wall 48	0.00	0.02	0.00	0.00	0.07	0.00	0.00	0.01
Wind X	Wall 49	0.00	0.23	0.00	0.00	0.73	0.00	0.00	0.33
Wind X	Wall 50	0.00	0.01	0.00	0.00	0.03	0.00	0.00	0.01
Wind Y	Wall 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 10	0.00	0.71	0.00	0.00	3.05	0.00	0.00	0.51
Wind Y	Wall 11	0.00	0.71	0.00	0.00	3.05	0.00	0.00	0.51
Wind Y	Wall 12	0.00	0.71	0.00	0.00	3.05	0.00	0.00	0.51
Wind Y	Wall 13	0.00	0.71	0.00	0.00	3.05	0.00	0.00	0.51
Wind Y	Wall 14	0.00	13.51	0.00	0.00	57.64	0.00	0.00	9.49
Wind Y	Wall 15	0.00	0.80	0.00	0.00	3.41	0.00	0.00	0.58
Wind Y	Wall 16	0.00	0.80	0.00	0.00	3.41	0.00	0.00	0.58
Wind Y	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 18	0.00	11.08	0.00	0.00	47.28	0.00	0.00	7.78
Wind Y	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 21	0.00	0.59	0.00	0.00	2.52	0.00	0.00	0.58
Wind Y	Wall 22	0.00	0.80	0.00	0.00	3.41	0.00	0.00	0.58
Wind Y	Wall 23	0.00	9.17	0.00	0.00	39.11	0.00	0.00	6.44
Wind Y	Wall 24	0.00	0.14	0.00	0.00	0.58	0.00	0.00	0.20
Wind Y	Wall 25	0.00	10.19	0.00	0.00	43.48	0.00	0.00	7.20
Wind Y	Wall 26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D

Wind Y	Wall 33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 35	0.00	0.24	0.00	0.00	0.76	0.00	0.00	0.17
Wind Y	Wall 36	0.00	0.24	0.00	0.00	0.76	0.00	0.00	0.17
Wind Y	Wall 37	0.00	0.24	0.00	0.00	0.76	0.00	0.00	0.17
Wind Y	Wall 38	0.00	0.24	0.00	0.00	0.76	0.00	0.00	0.17
Wind Y	Wall 39	0.00	4.50	0.00	0.00	14.41	0.00	0.00	3.10
Wind Y	Wall 40	0.00	0.27	0.00	0.00	0.85	0.00	0.00	0.19
Wind Y	Wall 41	0.00	0.27	0.00	0.00	0.85	0.00	0.00	0.19
Wind Y	Wall 42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 43	0.00	3.69	0.00	0.00	11.82	0.00	0.00	2.54
Wind Y	Wall 44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 46	0.00	0.20	0.00	0.00	0.63	0.00	0.00	0.19
Wind Y	Wall 47	0.00	0.27	0.00	0.00	0.85	0.00	0.00	0.19
Wind Y	Wall 48	0.00	3.06	0.00	0.00	9.78	0.00	0.00	2.10
Wind Y	Wall 49	0.00	0.05	0.00	0.00	0.15	0.00	0.00	0.07
Wind Y	Wall 50	0.00	3.39	0.00	0.00	10.86	0.00	0.00	2.35
Seismic static X	Wall 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 10	0.00	3.71	0.00	0.00	18.87	0.00	0.00	6.94
Seismic static X	Wall 11	0.00	3.71	0.00	0.00	18.87	0.00	0.00	6.94
Seismic static X	Wall 12	0.00	3.71	0.00	0.00	18.87	0.00	0.00	6.94
Seismic static X	Wall 13	0.00	3.71	0.00	0.00	18.87	0.00	0.00	6.94
Seismic static X	Wall 14	0.00	0.33	0.00	0.00	1.63	0.00	0.00	0.60
Seismic static X	Wall 15	0.00	3.91	0.00	0.00	19.86	0.00	0.00	7.31
Seismic static X	Wall 16	0.00	3.91	0.00	0.00	19.86	0.00	0.00	7.31
Seismic static X	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 18	0.00	0.01	0.00	0.00	0.05	0.00	0.00	0.02
Seismic static X	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 21	0.00	2.88	0.00	0.00	14.66	0.00	0.00	7.31
Seismic static X	Wall 22	0.00	3.91	0.00	0.00	19.86	0.00	0.00	7.31
Seismic static X	Wall 23	0.00	0.24	0.00	0.00	1.20	0.00	0.00	0.44
Seismic static X	Wall 24	0.00	1.81	0.00	0.00	9.26	0.00	0.00	7.04
Seismic static X	Wall 25	0.00	0.10	0.00	0.00	0.49	0.00	0.00	0.18
Seismic static X	Wall 26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 35	0.00	2.19	0.00	0.00	7.00	0.00	0.00	4.01
Seismic static X	Wall 36	0.00	2.19	0.00	0.00	7.00	0.00	0.00	4.01
Seismic static X	Wall 37	0.00	2.19	0.00	0.00	7.00	0.00	0.00	4.01
Seismic static X	Wall 38	0.00	2.19	0.00	0.00	7.00	0.00	0.00	4.01
Seismic static X	Wall 39	0.00	0.18	0.00	0.00	0.59	0.00	0.00	0.33
Seismic static X	Wall 40	0.00	2.30	0.00	0.00	7.36	0.00	0.00	4.21
Seismic static X	Wall 41	0.00	2.30	0.00	0.00	7.36	0.00	0.00	4.21
Seismic static X	Wall 42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 43	0.00	0.01	0.00	0.00	0.02	0.00	0.00	0.01
Seismic static X	Wall 44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 46	0.00	1.71	0.00	0.00	5.46	0.00	0.00	4.21
Seismic static X	Wall 47	0.00	2.30	0.00	0.00	7.36	0.00	0.00	4.21
Seismic static X	Wall 48	0.00	0.13	0.00	0.00	0.43	0.00	0.00	0.24
Seismic static X	Wall 49	0.00	1.09	0.00	0.00	3.48	0.00	0.00	4.07
Seismic static X	Wall 50	0.00	0.05	0.00	0.00	0.18	0.00	0.00	0.10
Seismic static Y	Wall 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 10	0.00	0.08	0.00	0.00	0.52	0.00	0.00	0.15
Seismic static Y	Wall 11	0.00	0.08	0.00	0.00	0.52	0.00	0.00	0.15
Seismic static Y	Wall 12	0.00	0.08	0.00	0.00	0.52	0.00	0.00	0.15
Seismic static Y	Wall 13	0.00	0.08	0.00	0.00	0.52	0.00	0.00	0.15
Seismic static Y	Wall 14	0.00	8.09	0.00	0.00	41.63	0.00	0.00	14.78
Seismic static Y	Wall 15	0.00	0.09	0.00	0.00	0.58	0.00	0.00	0.16
Seismic static Y	Wall 16	0.00	0.09	0.00	0.00	0.58	0.00	0.00	0.16
Seismic static Y	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 18	0.00	7.83	0.00	0.00	39.86	0.00	0.00	14.30
Seismic static Y	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 21	0.00	0.06	0.00	0.00	0.43	0.00	0.00	0.16
Seismic static Y	Wall 22	0.00	0.09	0.00	0.00	0.58	0.00	0.00	0.16
Seismic static Y	Wall 23	0.00	7.62	0.00	0.00	38.47	0.00	0.00	13.92
Seismic static Y	Wall 24	0.00	0.01	0.00	0.00	0.10	0.00	0.00	0.06
Seismic static Y	Wall 25	0.00	7.69	0.00	0.00	39.01	0.00	0.00	14.13
Seismic static Y	Wall 26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D

Seismic static Y	Wall 27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 35	0.00	0.08	0.00	0.00	0.27	0.00	0.00	0.15
Seismic static Y	Wall 36	0.00	0.08	0.00	0.00	0.27	0.00	0.00	0.15
Seismic static Y	Wall 37	0.00	0.08	0.00	0.00	0.27	0.00	0.00	0.15
Seismic static Y	Wall 38	0.00	0.08	0.00	0.00	0.27	0.00	0.00	0.15
Seismic static Y	Wall 39	0.00	4.92	0.00	0.00	15.73	0.00	0.00	8.78
Seismic static Y	Wall 40	0.00	0.09	0.00	0.00	0.30	0.00	0.00	0.17
Seismic static Y	Wall 41	0.00	0.09	0.00	0.00	0.30	0.00	0.00	0.17
Seismic static Y	Wall 42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 43	0.00	4.63	0.00	0.00	14.81	0.00	0.00	8.27
Seismic static Y	Wall 44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 46	0.00	0.07	0.00	0.00	0.23	0.00	0.00	0.17
Seismic static Y	Wall 47	0.00	0.09	0.00	0.00	0.30	0.00	0.00	0.17
Seismic static Y	Wall 48	0.00	4.40	0.00	0.00	14.08	0.00	0.00	7.86
Seismic static Y	Wall 49	0.00	0.02	0.00	0.00	0.05	0.00	0.00	0.06
Seismic static Y	Wall 50	0.00	4.50	0.00	0.00	14.39	0.00	0.00	8.09
Seismic dynamic X	Wall 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 10	0.00	2.95	0.00	0.00	14.37	0.00	0.00	5.52
Seismic dynamic X	Wall 11	0.00	2.95	0.00	0.00	14.37	0.00	0.00	5.52
Seismic dynamic X	Wall 12	0.00	2.95	0.00	0.00	14.37	0.00	0.00	5.52
Seismic dynamic X	Wall 13	0.00	2.95	0.00	0.00	14.37	0.00	0.00	5.52
Seismic dynamic X	Wall 14	0.00	1.09	0.00	0.00	5.51	0.00	0.00	1.99
Seismic dynamic X	Wall 15	0.00	2.47	0.00	0.00	11.95	0.00	0.00	4.62
Seismic dynamic X	Wall 16	0.00	2.47	0.00	0.00	11.95	0.00	0.00	4.62
Seismic dynamic X	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 18	0.00	1.20	0.00	0.00	5.68	0.00	0.00	2.19
Seismic dynamic X	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 21	0.00	1.82	0.00	0.00	8.82	0.00	0.00	4.62
Seismic dynamic X	Wall 22	0.00	2.47	0.00	0.00	11.95	0.00	0.00	4.62
Seismic dynamic X	Wall 23	0.00	2.61	0.00	0.00	12.55	0.00	0.00	4.77
Seismic dynamic X	Wall 24	0.00	1.33	0.00	0.00	6.51	0.00	0.00	5.18
Seismic dynamic X	Wall 25	0.00	1.78	0.00	0.00	8.50	0.00	0.00	3.27
Seismic dynamic X	Wall 26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 35	0.00	1.57	0.00	0.00	5.01	0.00	0.00	2.87
Seismic dynamic X	Wall 36	0.00	1.57	0.00	0.00	5.01	0.00	0.00	2.87
Seismic dynamic X	Wall 37	0.00	1.57	0.00	0.00	5.01	0.00	0.00	2.87
Seismic dynamic X	Wall 38	0.00	1.57	0.00	0.00	5.01	0.00	0.00	2.87
Seismic dynamic X	Wall 39	0.00	0.65	0.00	0.00	2.07	0.00	0.00	1.15
Seismic dynamic X	Wall 40	0.00	1.29	0.00	0.00	4.14	0.00	0.00	2.37
Seismic dynamic X	Wall 41	0.00	1.29	0.00	0.00	4.14	0.00	0.00	2.37
Seismic dynamic X	Wall 42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 43	0.00	0.59	0.00	0.00	1.90	0.00	0.00	1.06
Seismic dynamic X	Wall 44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 46	0.00	0.96	0.00	0.00	3.07	0.00	0.00	2.37
Seismic dynamic X	Wall 47	0.00	1.29	0.00	0.00	4.14	0.00	0.00	2.37
Seismic dynamic X	Wall 48	0.00	1.34	0.00	0.00	4.29	0.00	0.00	2.39
Seismic dynamic X	Wall 49	0.00	0.72	0.00	0.00	2.30	0.00	0.00	2.68
Seismic dynamic X	Wall 50	0.00	0.90	0.00	0.00	2.87	0.00	0.00	1.61
Seismic dynamic Y	Wall 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 10	0.00	0.85	0.00	0.00	4.18	0.00	0.00	1.59
Seismic dynamic Y	Wall 11	0.00	0.85	0.00	0.00	4.18	0.00	0.00	1.59
Seismic dynamic Y	Wall 12	0.00	0.85	0.00	0.00	4.18	0.00	0.00	1.59
Seismic dynamic Y	Wall 13	0.00	0.85	0.00	0.00	4.18	0.00	0.00	1.59
Seismic dynamic Y	Wall 14	0.00	5.87	0.00	0.00	28.79	0.00	0.00	10.72
Seismic dynamic Y	Wall 15	0.00	1.59	0.00	0.00	7.74	0.00	0.00	2.97
Seismic dynamic Y	Wall 16	0.00	1.59	0.00	0.00	7.74	0.00	0.00	2.97
Seismic dynamic Y	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 18	0.00	3.26	0.00	0.00	15.84	0.00	0.00	5.96
Seismic dynamic Y	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D

Seismic dynamic Y	Wall 21	0.00	1.17	0.00	0.00	5.71	0.00	0.00	2.97
Seismic dynamic Y	Wall 22	0.00	1.59	0.00	0.00	7.74	0.00	0.00	2.97
Seismic dynamic Y	Wall 23	0.00	3.05	0.00	0.00	14.63	0.00	0.00	5.57
Seismic dynamic Y	Wall 24	0.00	0.24	0.00	0.00	1.19	0.00	0.00	0.94
Seismic dynamic Y	Wall 25	0.00	2.84	0.00	0.00	13.68	0.00	0.00	5.22
Seismic dynamic Y	Wall 26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 35	0.00	0.48	0.00	0.00	1.52	0.00	0.00	0.87
Seismic dynamic Y	Wall 36	0.00	0.48	0.00	0.00	1.52	0.00	0.00	0.87
Seismic dynamic Y	Wall 37	0.00	0.48	0.00	0.00	1.52	0.00	0.00	0.87
Seismic dynamic Y	Wall 38	0.00	0.48	0.00	0.00	1.52	0.00	0.00	0.87
Seismic dynamic Y	Wall 39	0.00	3.28	0.00	0.00	10.50	0.00	0.00	5.86
Seismic dynamic Y	Wall 40	0.00	0.86	0.00	0.00	2.76	0.00	0.00	1.58
Seismic dynamic Y	Wall 41	0.00	0.86	0.00	0.00	2.76	0.00	0.00	1.58
Seismic dynamic Y	Wall 42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 43	0.00	1.76	0.00	0.00	5.64	0.00	0.00	3.15
Seismic dynamic Y	Wall 44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 46	0.00	0.64	0.00	0.00	2.05	0.00	0.00	1.58
Seismic dynamic Y	Wall 47	0.00	0.86	0.00	0.00	2.76	0.00	0.00	1.58
Seismic dynamic Y	Wall 48	0.00	1.56	0.00	0.00	4.99	0.00	0.00	2.79
Seismic dynamic Y	Wall 49	0.00	0.13	0.00	0.00	0.42	0.00	0.00	0.50
Seismic dynamic Y	Wall 50	0.00	1.48	0.00	0.00	4.75	0.00	0.00	2.67

Floors

Floor name: Floor ID

V2: Maximum shear stress along the local axis 2 for the most stressed element of the floor

M3-3: Maximum bending moment around local axis 3 for the most stressed element of the floor

w_{ist}: Maximum deformation for the most stressed element of the floor

Load	Floor name	V2 [kN]	M3-3 [kNm]	w_{ist} [mm]
G(sw)	Floor 1	0.26	1.68	2549.13
G(sw)	Floor 2	0.26	1.68	2549.13
G(ns)	Floor 1	1.29	8.30	12588.30
G(ns)	Floor 2	1.29	8.30	12588.30
Q type A	Floor 1	2.57	16.59	25176.61
Q type A	Floor 2	2.57	16.59	25176.61
Ortho wind ULS down	Floor 1	0.00	0.00	0.00
Ortho wind ULS down	Floor 2	0.00	0.00	0.00
Ortho wind ULS up	Floor 1	0.00	0.00	0.00
Ortho wind ULS up	Floor 2	0.00	0.00	0.00
Wind X	Floor 1	0.00	0.00	0.00
Wind X	Floor 2	0.00	0.00	0.00
Wind Y	Floor 1	0.00	0.00	0.00
Wind Y	Floor 2	0.00	0.00	0.00
Seismic static X	Floor 1	0.00	0.00	0.00
Seismic static X	Floor 2	0.00	0.00	0.00
Seismic static Y	Floor 1	0.00	0.00	0.00
Seismic static Y	Floor 2	0.00	0.00	0.00
Seismic dynamic X	Floor 1	0.00	0.00	0.00
Seismic dynamic X	Floor 2	0.00	0.00	0.00
Seismic dynamic Y	Floor 1	0.00	0.00	0.00
Seismic dynamic Y	Floor 2	0.00	0.00	0.00

Technical Design Calculation Report

Forces and moments acting at the base of the structure

In this chapter the values of the actions acting at the base of the walls and the columns of the ground floor are reported. With regard to the walls, the first row of the table shows the values of the actions related to the ULS combination that maximizes the axial force while the second row shows the values of the actions related to the horizontal ULS combination that maximizes the moment acting in the plane of the wall M3-3 and the shear force V2 (also acting in the plane of the wall) and that, at the same time, minimizes the axial force N.

In the other rows, the actions at the foot of the walls associated with the different loads considered individually are reported.

Walls

Wall name: Wall ID

N: Total axial force

V2: Shear force (in-plane)

V3: Shear force (out-of-plane)

M2-2: Bending moment (out-of-plane)

M3-3: Bending moment (in-plane)

Wall name	Length [m]	Load / Comb.	N [kN]	V2 [kN]	V3 [kN]	M2-2 [kNm]	M3-3 [kNm]
Wall 1	0.61	ULS 1	5.06	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	1.38	0.00	0.00	0.00	0.00
		G(ns)	2.36	0.00	0.00	0.00	0.00
		Q type A	0.04	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.33	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.33	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 2	0.60	ULS 1	4.62	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	1.34	0.00	0.00	0.00	0.00
		G(ns)	2.09	0.00	0.00	0.00	0.00
		Q type A	-0.47	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.32	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.32	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 3	0.61	ULS 1	5.36	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	1.43	0.00	0.00	0.00	0.00
		G(ns)	2.54	0.00	0.00	0.00	0.00
		Q type A	0.37	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.33	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.33	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00

		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 4	0.61	ULS 3	6.56	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	1.48	0.00	0.00	0.00	0.00
		G(ns)	2.81	0.00	0.00	0.00	0.00
		Q type A	0.94	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.33	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.33	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 5	0.60	ULS 3	7.10	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	1.50	0.00	0.00	0.00	0.00
		G(ns)	2.91	0.00	0.00	0.00	0.00
		Q type A	1.21	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.32	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.32	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 6	0.61	ULS 3	17.67	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	1.99	0.00	0.00	0.00	0.00
		G(ns)	5.31	0.00	0.00	0.00	0.00
		Q type A	5.94	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.33	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.33	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 7	0.61	ULS 3	59.28	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	3.89	0.00	0.00	0.00	0.00
		G(ns)	14.69	0.00	0.00	0.00	0.00
		Q type A	24.66	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.33	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.33	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 8	0.60	ULS 3	34.70	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	2.76	0.00	0.00	0.00	0.00
		G(ns)	9.13	0.00	0.00	0.00	0.00
		Q type A	13.62	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.32	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.32	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 9	0.61	ULS 3	13.55	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	1.79	0.00	0.00	0.00	0.00
		G(ns)	4.39	0.00	0.00	0.00	0.00
		Q type A	4.09	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.33	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.33	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00

		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 10	2.45	ULS 1	16.95	0.00	0.00	0.00	0.00
		ULS earthquake drift 2 ex- ey+	0.00	3.01	0.00	0.00	14.64
		G(sw)	3.15	0.00	0.00	0.00	0.00
		G(ns)	9.41	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.65	1.32	0.00
		Ortho wind ULS up	0.00	0.00	1.65	1.32	0.00
		Wind X	0.00	1.39	0.00	0.00	5.92
		Wind Y	0.00	0.71	0.00	0.00	3.05
		Seismic static X	0.00	3.71	0.00	0.00	18.87
		Seismic static Y	0.00	0.08	0.00	0.00	0.52
		Seismic dynamic X	0.00	2.95	0.00	0.00	14.37
		Seismic dynamic Y	0.00	0.85	0.00	0.00	4.18
Wall 11	2.45	ULS 1	16.95	0.00	0.00	0.00	0.00
		ULS earthquake drift 2 ex- ey+	0.00	3.01	0.00	0.00	14.64
		G(sw)	3.15	0.00	0.00	0.00	0.00
		G(ns)	9.41	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.65	1.32	0.00
		Ortho wind ULS up	0.00	0.00	1.65	1.32	0.00
		Wind X	0.00	1.39	0.00	0.00	5.92
		Wind Y	0.00	0.71	0.00	0.00	3.05
		Seismic static X	0.00	3.71	0.00	0.00	18.87
		Seismic static Y	0.00	0.08	0.00	0.00	0.52
		Seismic dynamic X	0.00	2.95	0.00	0.00	14.37
		Seismic dynamic Y	0.00	0.85	0.00	0.00	4.18
Wall 12	2.45	ULS 1	16.95	0.00	0.00	0.00	0.00
		ULS earthquake drift 2 ex- ey+	0.00	3.01	0.00	0.00	14.64
		G(sw)	3.15	0.00	0.00	0.00	0.00
		G(ns)	9.41	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.65	1.32	0.00
		Ortho wind ULS up	0.00	0.00	1.65	1.32	0.00
		Wind X	0.00	1.39	0.00	0.00	5.92
		Wind Y	0.00	0.71	0.00	0.00	3.05
		Seismic static X	0.00	3.71	0.00	0.00	18.87
		Seismic static Y	0.00	0.08	0.00	0.00	0.52
		Seismic dynamic X	0.00	2.95	0.00	0.00	14.37
		Seismic dynamic Y	0.00	0.85	0.00	0.00	4.18
Wall 13	2.45	ULS 1	16.95	0.00	0.00	0.00	0.00
		ULS earthquake drift 2 ex- ey+	0.00	3.01	0.00	0.00	14.64
		G(sw)	3.15	0.00	0.00	0.00	0.00
		G(ns)	9.41	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.65	1.32	0.00
		Ortho wind ULS up	0.00	0.00	1.65	1.32	0.00
		Wind X	0.00	1.39	0.00	0.00	5.92
		Wind Y	0.00	0.71	0.00	0.00	3.05
		Seismic static X	0.00	3.71	0.00	0.00	18.87
		Seismic static Y	0.00	0.08	0.00	0.00	0.52
		Seismic dynamic X	0.00	2.95	0.00	0.00	14.37
		Seismic dynamic Y	0.00	0.85	0.00	0.00	4.18
Wall 14	2.50	ULS 3	102.57	0.00	0.00	0.00	0.00
		ULS Wind 8	32.75	13.51	1.69	1.35	57.64
		G(sw)	7.15	0.00	0.00	0.00	0.00
		G(ns)	29.23	0.00	0.00	0.00	0.00
		Q type A	39.27	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.69	1.35	0.00
		Ortho wind ULS up	0.00	0.00	1.69	1.35	0.00
		Wind X	0.00	0.09	0.00	0.00	0.37
		Wind Y	0.00	13.51	0.00	0.00	57.64
		Seismic static X	0.00	0.33	0.00	0.00	1.63
		Seismic static Y	0.00	8.09	0.00	0.00	41.63
		Seismic dynamic X	0.00	1.09	0.00	0.00	5.51
		Seismic dynamic Y	0.00	5.87	0.00	0.00	28.79
Wall 15	2.45	ULS 1	16.95	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex- ey-	0.00	3.10	0.00	0.00	15.05
		G(sw)	3.15	0.00	0.00	0.00	0.00
		G(ns)	9.41	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.65	1.32	0.00
		Ortho wind ULS up	0.00	0.00	1.65	1.32	0.00
		Wind X	0.00	1.44	0.00	0.00	6.14
		Wind Y	0.00	0.80	0.00	0.00	3.41
		Seismic static X	0.00	3.91	0.00	0.00	19.86
		Seismic static Y	0.00	0.09	0.00	0.00	0.58

		Seismic dynamic X	0.00	2.47	0.00	0.00	11.95
		Seismic dynamic Y	0.00	1.59	0.00	0.00	7.74
Wall 16	2.45	ULS 1	16.95	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex- ey-	0.00	3.10	0.00	0.00	15.05
		G(sw)	3.15	0.00	0.00	0.00	0.00
		G(ns)	9.41	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.65	1.32	0.00
		Ortho wind ULS up	0.00	0.00	1.65	1.32	0.00
		Wind X	0.00	1.44	0.00	0.00	6.14
		Wind Y	0.00	0.80	0.00	0.00	3.41
		Seismic static X	0.00	3.91	0.00	0.00	19.86
		Seismic static Y	0.00	0.09	0.00	0.00	0.58
		Seismic dynamic X	0.00	2.47	0.00	0.00	11.95
		Seismic dynamic Y	0.00	1.59	0.00	0.00	7.74
Wall 17	0.58	ULS 1	4.84	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	1.36	0.00	0.00	0.00	0.00
		G(ns)	2.23	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.39	0.31	0.00
		Ortho wind ULS up	0.00	0.00	0.39	0.31	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 18	2.50	ULS 3	133.71	0.00	0.00	0.00	0.00
		ULS Wind 8	40.33	11.08	1.69	1.35	47.28
		G(sw)	8.57	0.00	0.00	0.00	0.00
		G(ns)	36.24	0.00	0.00	0.00	0.00
		Q type A	53.29	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.69	1.35	0.00
		Ortho wind ULS up	0.00	0.00	1.69	1.35	0.00
		Wind X	0.00	0.00	0.00	0.00	0.01
		Wind Y	0.00	11.08	0.00	0.00	47.28
		Seismic static X	0.00	0.01	0.00	0.00	0.05
		Seismic static Y	0.00	7.83	0.00	0.00	39.86
		Seismic dynamic X	0.00	1.20	0.00	0.00	5.68
		Seismic dynamic Y	0.00	3.26	0.00	0.00	15.84
Wall 19	0.50	ULS 1	4.36	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	1.31	0.00	0.00	0.00	0.00
		G(ns)	1.92	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.34	0.27	0.00
		Ortho wind ULS up	0.00	0.00	0.34	0.27	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 20	0.46	ULS 1	4.12	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	1.29	0.00	0.00	0.00	0.00
		G(ns)	1.77	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.31	0.25	0.00
		Ortho wind ULS up	0.00	0.00	0.31	0.25	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 21	1.87	ULS 1	13.29	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex- ey-	0.00	2.28	0.00	0.00	11.11
		G(sw)	2.66	0.00	0.00	0.00	0.00
		G(ns)	7.18	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.26	1.01	0.00
		Ortho wind ULS up	0.00	0.00	1.26	1.01	0.00
		Wind X	0.00	1.06	0.00	0.00	4.53
		Wind Y	0.00	0.59	0.00	0.00	2.52
		Seismic static X	0.00	2.88	0.00	0.00	14.66
		Seismic static Y	0.00	0.06	0.00	0.00	0.43
		Seismic dynamic X	0.00	1.82	0.00	0.00	8.82

		Seismic dynamic Y	0.00	1.17	0.00	0.00	5.71
Wall 22	2.45	ULS 1	16.95	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex- ey-	0.00	3.10	0.00	0.00	15.05
		G(sw)	3.15	0.00	0.00	0.00	0.00
		G(ns)	9.41	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.65	1.32	0.00
		Ortho wind ULS up	0.00	0.00	1.65	1.32	0.00
		Wind X	0.00	1.44	0.00	0.00	6.14
		Wind Y	0.00	0.80	0.00	0.00	3.41
		Seismic static X	0.00	3.91	0.00	0.00	19.86
		Seismic static Y	0.00	0.09	0.00	0.00	0.58
		Seismic dynamic X	0.00	2.47	0.00	0.00	11.95
		Seismic dynamic Y	0.00	1.59	0.00	0.00	7.74
Wall 23	2.50	ULS 3	74.56	0.00	0.00	0.00	0.00
		ULS Wind 8	25.93	9.17	1.69	1.35	39.11
		G(sw)	5.88	0.00	0.00	0.00	0.00
		G(ns)	22.93	0.00	0.00	0.00	0.00
		Q type A	26.66	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.69	1.35	0.00
		Ortho wind ULS up	0.00	0.00	1.69	1.35	0.00
		Wind X	0.00	0.06	0.00	0.00	0.27
		Wind Y	0.00	9.17	0.00	0.00	39.11
		Seismic static X	0.00	0.24	0.00	0.00	1.20
		Seismic static Y	0.00	7.62	0.00	0.00	38.47
		Seismic dynamic X	0.00	2.61	0.00	0.00	12.55
		Seismic dynamic Y	0.00	3.05	0.00	0.00	14.63
Wall 24	1.30	ULS 1	9.52	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex- ey-	0.00	1.37	0.00	0.00	6.73
		G(sw)	2.06	0.00	0.00	0.00	0.00
		G(ns)	4.99	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.88	0.70	0.00
		Ortho wind ULS up	0.00	0.00	0.88	0.70	0.00
		Wind X	0.00	0.67	0.00	0.00	2.89
		Wind Y	0.00	0.14	0.00	0.00	0.58
		Seismic static X	0.00	1.81	0.00	0.00	9.26
		Seismic static Y	0.00	0.01	0.00	0.00	0.10
		Seismic dynamic X	0.00	1.33	0.00	0.00	6.51
		Seismic dynamic Y	0.00	0.24	0.00	0.00	1.19
Wall 25	2.49	ULS 3	25.55	0.00	0.00	0.00	0.00
		ULS Wind 8	13.96	10.19	1.68	1.34	43.48
		G(sw)	3.64	0.00	0.00	0.00	0.00
		G(ns)	11.87	0.00	0.00	0.00	0.00
		Q type A	4.62	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.68	1.34	0.00
		Ortho wind ULS up	0.00	0.00	1.68	1.34	0.00
		Wind X	0.00	0.03	0.00	0.00	0.11
		Wind Y	0.00	10.19	0.00	0.00	43.48
		Seismic static X	0.00	0.10	0.00	0.00	0.49
		Seismic static Y	0.00	7.69	0.00	0.00	39.01
		Seismic dynamic X	0.00	1.78	0.00	0.00	8.50
		Seismic dynamic Y	0.00	2.84	0.00	0.00	13.68

Design of the structural elements

Joist floors

Bending strength

The checks are conducted according to § 3.2.1 of AS 1720.1. The following expression shall be satisfied:

$$M_d \geq M^*$$

with

$$M_d = \phi \cdot k_1 \cdot k_4 \cdot k_6 \cdot k_9 \cdot k_{12} \cdot f_b' \cdot Z$$

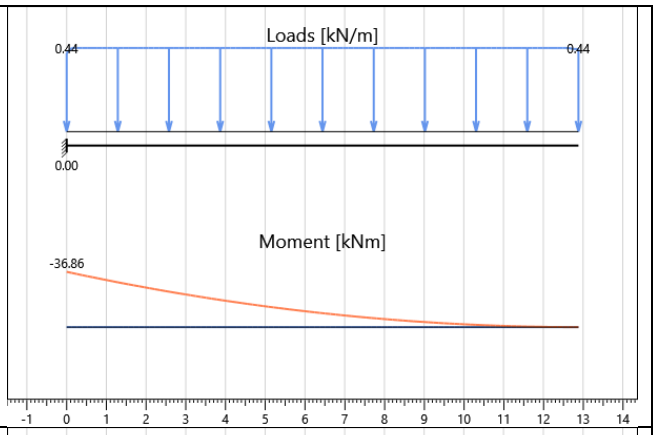
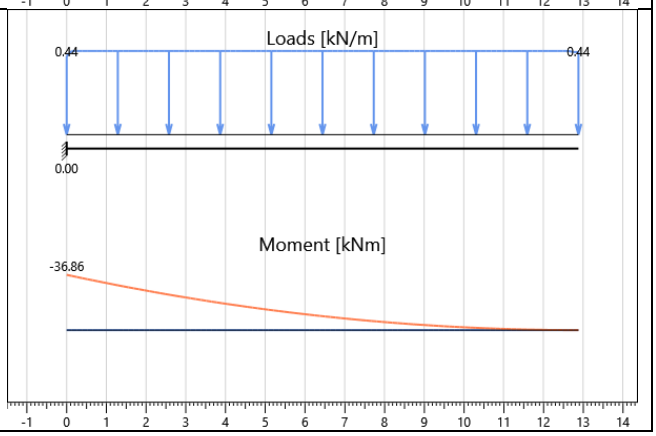
where

$M^* = M_{3-3\,max}$ is the design action effect in bending

ϕ	is the capacity factor
k_1	is the duration of load modification factor for strength
k_4	is the moisture condition modification factor for strength
k_6	is the temperature modification factor
k_9	is the strength sharing modification factor
k_{12}	is the stability factor
f_b'	is the characteristic value in bending for the section size
Z	is the section modulus of the beam about the axis of bending $Z = (bh^2/6)$

The following table illustrates the structural schemes and the envelopes of the bending moment diagram for the joist with the most severe checks of each floor.

Floor name	Combination	Duration	Diagram $M_{3\text{-}3}$

Floor 1	ULS 3	5 months	
Floor 2	ULS 3	5 months	

The checks are summarized below in the form of a percentage value.

Floor name	Section	$M_{3\text{-}3\ max}$ [kNm]	Z [mm^3]	Comb.	k_1	k_4	k_6	k_9	k_{12}	ϕ	f'_b [MPa]	M_d [kNm]	Check
Floor 1	Joists floor 1	36.86	60750	ULS 3	0.8	1	1	1	1	0.9	17.00	0.74	4958%
Floor 2	Joists floor 1	36.86	60750	ULS 3	0.8	1	1	1	1	0.9	17.00	0.74	4958%

Where f'_b for rectangular beam sections made of F-grades timber and greater than 300 mm in depth is obtained by multiplying the value of table H2.1 of AS 1720.1 by $(300/d)^{0.167}$.

Shear strength

The checks are conducted according to § 3.2.5 of AS 1720.1. The following expression shall be satisfied:

$$V_d \geq V^*$$

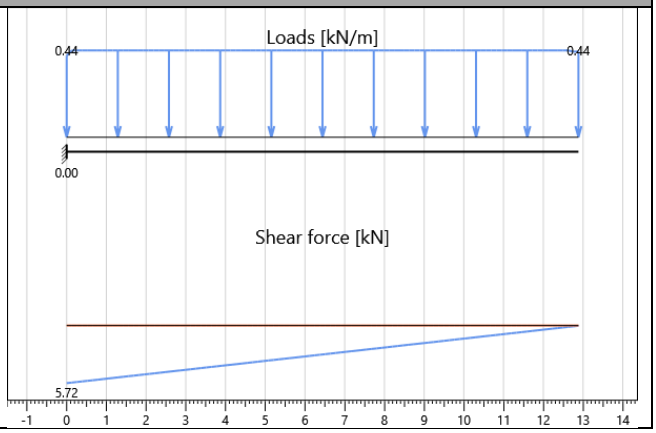
with

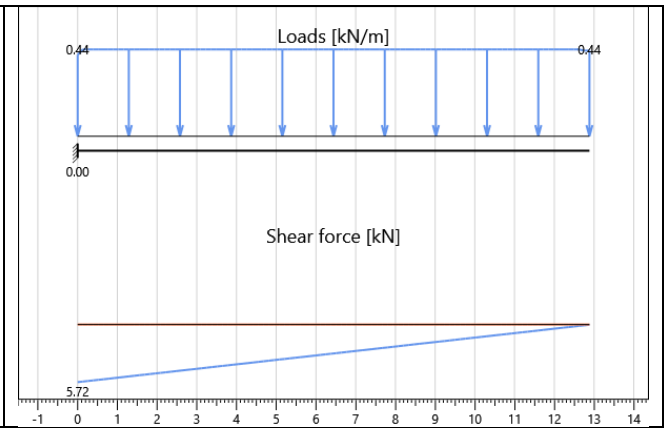
$$V_d = \phi \cdot k_1 \cdot k_4 \cdot k_6 \cdot f_s' \cdot A_s$$

where

$V^* = V_{2\,max}$	is the design action effect in shear
ϕ	is the capacity factor
k_1	is the duration of load modification factor for strength
k_4	is the moisture condition modification factor for strength
k_6	is the temperature modification factor
f_s'	is the characteristic value in shear
A_s	is the shear plane area for a rectangular beam loaded about its major axis in bending $A_s = 2/3(bd)$

The following table illustrates the structural schemes and the envelopes of the shear force diagram for the joist of each floor with the most sever checks.

Floor name	Combination	Duration	Diagram V_2
Floor 1	ULS 3	5 months	

Floor 2	ULS 3	5 months	

The checks are summarized below in the form of a percentage value.

Floor name	Section	$V_{2\,max}$ [kN]	A_s [mm^2]	Comb.	k_1	k_4	k_6	ϕ	f'_s [MPa]	V_d [kN]	Check
Floor 1	Joists floor 1	5.72	4050	ULS 3	0.8	1	1	0.9	2.60	5.05	113%
Floor 2	Joists floor 1	5.72	4050	ULS 3	0.8	1	1	0.9	2.60	5.05	113%

Floors deflections (SLS)

The final deflection below a straight line between the supports due to a single type of action, w_{creep}, is taken as:

$$w_{creep,i} = j_2 \cdot w_{short-term,i}$$

where:

$w_{creep,i}$ is the final deflection that includes the effect of creep on deformation

$w_{short-term,i}$ is the short-term deflection

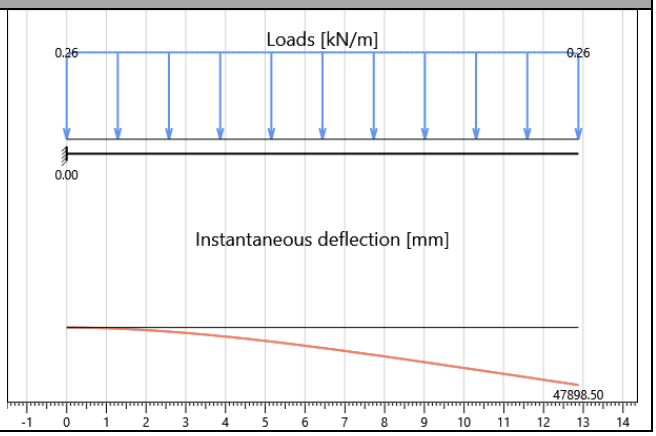
j_2 is the modification factor for creep

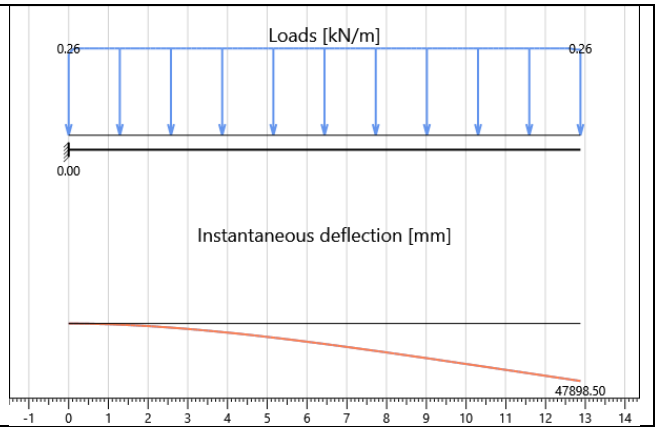
The limiting values for deflections of floors are assumed as shown in the following table according to the considered combination of actions.

	W_s	$\psi_s \cdot Q$	$G + \psi_s \cdot Q$	$G + \psi_l \cdot Q$
Internal spans	l/300	l/400	15 mm	l/300
Cantilever beams	l/150	l/200	30 mm	l/150

The value of deflection $w_{creep,i}$ is calculated for each type of load in the considered combination of actions and the final value $w_{creep,i}$ is defined as the sum of these deflections.

The following table shows the maximum deformation of each floor (relative to the element in which the deformation checks are the most severe).

Floor name	Combination	Deflection
Floor 1	SLS 3	

Floor 2	SLS 3	

The table shows the deflection checks of the floor elements.

Floor name	Section	Combination	Most restrictive check	W_{creep} [mm]	Deflection limit [mm]	Check
Floor 1	Joists floor 1	SLS 3	Cantilever beams	47898.50	30.00	159662%
Floor 2	Joists floor 1	SLS 3	Cantilever beams	47898.50	30.00	159662%

Framed Walls

Combined bending and compression of the studs

The checks are conducted according to § 3.5.1 of AS 1720.1 on the most loaded internal and external stud of each wall. The following expressions shall be satisfied:

$$\left(\frac{M^*_{out-of-plane}}{M_{d,out-of-plane}}\right)^2 + \frac{N^*_c}{N_{d,c,in-plane}} \leq 1$$

$$\frac{M^*_{out-of-plane}}{M_{d,out-of-plane}} + \frac{N^*_c}{N_{d,c,out-of-plane}} \leq 1$$

with

$M^*_{out-of-plane} = M_{2-2}$ is the design action effect in bending out of the plane of the wall

$M_{d,out-of-plane}$ is the design capacity in bending out of the plane of the wall

$N^*_c = N$ is the design action effect in compression

$N_{d,c,out-of-plane}$ is the design capacity in compression for buckling out of the plane of the wall

$N_{d,c,in-plane}$ is the design capacity in compression for buckling in the plane of the wall

The design capacity of each stud in bending out-of-the-plane of the wall is calculated according to the following equation:

$$M_{d,out-of-plane} = \phi \cdot k_1 \cdot k_4 \cdot k_6 \cdot k_9 \cdot k_{12} \cdot f_b' \cdot Z$$

where

ϕ	is the capacity factor
k_1	is the duration of load modification factor for strength
k_4	is the moisture condition modification factor for strength
k_6	is the temperature modification factor
k_9	is the strength sharing modification factor
k_{12}	is the stability factor
f_b'	is the characteristic value in bending for the section size
Z	is the section modulus of the stud about the axis of bending $Z = (bt^2/6)$

The design capacity of each stud in compression is calculated according to the following equation:

$$N_{d,c} = \phi \cdot k_1 \cdot k_4 \cdot k_6 \cdot k_{12} \cdot f_c' \cdot A_c$$

where

ϕ	is the capacity factor
k_1	is the duration of load modification factor for strength
k_4	is the moisture condition modification factor for strength
k_6	is the temperature modification factor
k_{12}	is the relevant stability factor for buckling in or out of the plane of the wall
f_c'	is the characteristic value in compression parallel to grain
A_c	is the cross-sectional area of the stud

The stability factor k_{12} takes into account the reduced compressive strength due to lateral buckling.

The factor value is calculated according to § 3.3.3 of AS 1720.1 as follows:

(a) For $\rho_c \cdot S \leq 10$ → $k_{12} = 1.0$

(b) For $10 \leq \rho_c \cdot S \leq 20$ → $k_{12} = 1.5 - 0.05 \cdot \rho_c \cdot S$

(c) For $\rho_c \cdot S \geq 20$ → $k_{12} = \frac{200}{(\rho_c \cdot S)^2}$

Where S is the relevant slenderness coefficient for buckling under compression and ρ_c is the material constant for columns.

The slenderness coefficient for buckling out of the plane of the wall is evaluated according to the following equations that is consistent with those provided in section 3.3.2.2 of AS 1720.1:

$$S_{out-of-plane} = \frac{g_{13} \cdot L}{t}$$

where

L is the height of the stud

t is the thickness of the frame (dimension of the stud cross-section perpendicular to the wall plane)

g_{13} is the effective length factor equal to 0.85 for studs in light framing when plates and studs are made of the same timber grade

The slenderness coefficient for buckling in the plane of the wall is equal to 0 when an effective restraint system act continuously along both edges of the stud (i.e. sheeting boards on both the faces of the frame).

When the sheeting board provides an effective restraint along one edge only of the stud, the slenderness coefficient for buckling in the plane of the wall is evaluated according to the following equations that is consistent to those provided in section 3.3.2.2 of AS 1720.1:

$$S_{in-plane} = \frac{3.5 \cdot t}{b}$$

where

t is the thickness of the frame (dimension of the stud cross-section perpendicular to the wall plane)

b is the dimension of the stud cross-section parallel to the wall plane

In case of walls braced through steel braces, the slenderness coefficient for buckling in the plane of the wall is evaluated according to the following equations that is consistent with those provided in section 3.3.2.2 of AS 1720.1:

$$S_{in-plane} = \frac{g_{13} \cdot L}{b}$$

where

L is the height of the stud

b is the dimension of the stud cross-section parallel to the wall plane

g_{13} is the effective length factor equal to 0.85 for studs in light framing when plates and studs are made of the same timber grade

The material constant values for each material are defined according to equations E2(3) and E2(4) of AS 1720.1 assuming $r = 0.25$:

(a) Columns of seasoned timber $\rho_c = 11.39\left(\frac{E}{f_c'}\right)^{-0.408} r^{-0.074}$

(b) Columns of unseasoned timber $\rho_c = 9.29\left(\frac{E}{f_c'}\right)^{-0.367} r^{-0.146}$

The values of the actions in the tables below are related, for each wall, to the most severe combination of load for the Ultimate Limit State of combined bending and compression.

Wall name	Length [m]	Combination	Duration	N [kN]	M2-2 [kNm]
Wall 1	0.61	ULS 5	5 seconds	4.51	0.33
Wall 2	0.60	ULS 5	5 seconds	3.92	0.32
Wall 3	0.61	ULS 5	5 seconds	4.91	0.33
Wall 4	0.61	ULS 5	5 seconds	5.53	0.33
Wall 5	0.60	ULS 5	5 seconds	5.77	0.32
Wall 6	0.61	ULS 4	50+ years	12.33	0.00
Wall 7	0.61	ULS 3	5 months	59.28	0.00
Wall 8	0.60	ULS 3	5 months	34.70	0.00
Wall 9	0.61	ULS 4	50+ years	9.87	0.00
Wall 10	2.45	ULS 5	5 seconds	15.07	1.32
Wall 11	2.45	ULS 5	5 seconds	15.07	1.32
Wall 12	2.45	ULS 5	5 seconds	15.07	1.32
Wall 13	2.45	ULS 5	5 seconds	15.07	1.32
Wall 14	2.50	ULS 3	5 months	102.57	0.00
Wall 15	2.45	ULS 5	5 seconds	15.07	1.32
Wall 16	2.45	ULS 5	5 seconds	15.07	1.32
Wall 17	0.58	ULS 5	5 seconds	4.31	0.31
Wall 18	2.50	ULS 3	5 months	133.71	0.00
Wall 19	0.50	ULS 5	5 seconds	3.88	0.27
Wall 20	0.46	ULS 5	5 seconds	3.67	0.25
Wall 21	1.87	ULS 5	5 seconds	11.81	1.01
Wall 22	2.45	ULS 5	5 seconds	15.07	1.32
Wall 23	2.50	ULS 3	5 months	74.56	0.00
Wall 24	1.30	ULS 5	5 seconds	8.46	0.70
Wall 25	2.49	ULS 5	5 seconds	20.47	1.34
Wall 26	0.61	ULS 5	5 seconds	2.26	0.33
Wall 27	0.60	ULS 5	5 seconds	1.98	0.32
Wall 28	0.61	ULS 5	5 seconds	2.48	0.33
Wall 29	0.61	ULS 5	5 seconds	2.76	0.33
Wall 30	0.60	ULS 5	5 seconds	2.88	0.32
Wall 31	0.61	ULS 5	5 seconds	5.57	0.33
Wall 32	0.61	ULS 3	5 months	29.87	0.00
Wall 33	0.60	ULS 3	5 months	17.50	0.00
Wall 34	0.61	ULS 5	5 seconds	4.53	0.33
Wall 35	2.45	ULS 5	5 seconds	7.53	1.32
Wall 36	2.45	ULS 5	5 seconds	7.53	1.32
Wall 37	2.45	ULS 5	5 seconds	7.53	1.32
Wall 38	2.45	ULS 5	5 seconds	7.53	1.32
Wall 39	2.50	ULS 3	5 months	51.28	0.00
Wall 40	2.45	ULS 5	5 seconds	7.53	1.32
Wall 41	2.45	ULS 5	5 seconds	7.53	1.32
Wall 42	0.58	ULS 5	5 seconds	2.15	0.31
Wall 43	2.50	ULS 3	5 months	66.85	0.00
Wall 44	0.50	ULS 5	5 seconds	1.94	0.27
Wall 45	0.46	ULS 5	5 seconds	1.83	0.25
Wall 46	1.87	ULS 5	5 seconds	5.91	1.01
Wall 47	2.45	ULS 5	5 seconds	7.53	1.32
Wall 48	2.50	ULS 3	5 months	37.28	0.00
Wall 49	1.30	ULS 5	5 seconds	4.23	0.70
Wall 50	2.49	ULS 5	5 seconds	10.23	1.34

The relevant values for the calculation of the stability factors in bending and compression are reported in the following table.

Wall name	Section	Stud	L [m]	$k_{12,\ bending,\ o\text{-}o\text{-}p}$	$S_{compression,\ o\text{-}o\text{-}p}$	$S_{compression,\ i\text{-}p}$	ρ_c	$k_{compression,\ 12,\ o\text{-}o\text{-}p}$	$k_{compression,\ 12,\ i\text{-}p}$
Wall 1	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 1	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 2	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 2	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 3	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 3	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 4	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 4	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 5	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00

Wall 5	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 6	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 6	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 7	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 7	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 8	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 8	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 9	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 9	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 10	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 10	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 11	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 11	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 12	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 12	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 13	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 13	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 14	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 14	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 15	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 15	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 16	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 16	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 17	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 17	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 18	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 18	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 19	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 19	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 20	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 21	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 21	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 22	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 22	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 23	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 23	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 24	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 24	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 25	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 25	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 26	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 26	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 27	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 27	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 28	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 28	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 29	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 29	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 30	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 30	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 31	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 31	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 32	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 32	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 33	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 33	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 34	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 34	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 35	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 35	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 36	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 36	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 37	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 37	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 38	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 38	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 39	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 39	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 40	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 40	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 41	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 41	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 42	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 42	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 43	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 43	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 44	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 44	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 45	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 46	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 46	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 47	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 47	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 48	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 48	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 49	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 49	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 50	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 50	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00

The checks are summarized below in the form of a percentage value

Technical Design Calculation Report

Wall name	Section	Stud	$M_{2\text{-}2}$ [kNm]	N [kN]	Z [mm^3]	A_c [mm^2]	Comb.	k_1	k_4	k_6	ϕ	f'_b [MPa]	f'_c [MPa]	M_d [kNm]	$N_{d,c,o\text{-}o\text{-}p}$ [kN]	$N_{d,c,i\text{-}p}$ [kN]	Check
Wall 1	Frame 1	Internal	0.15	2.10	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	30%
Wall 1	Frame 1	External	0.12	1.60	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 2	Frame 1	Internal	0.15	1.91	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	28%
Wall 2	Frame 1	External	0.12	1.27	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 3	Frame 1	Internal	0.15	2.32	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	31%
Wall 3	Frame 1	External	0.12	1.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 4	Frame 1	Internal	0.15	2.59	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	33%
Wall 4	Frame 1	External	0.12	1.90	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 5	Frame 1	Internal	0.15	2.67	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	33%
Wall 5	Frame 1	External	0.12	2.07	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 6	Frame 1	Internal	0.00	3.86	60750	4050	ULS 4	0.57	1.00	1.00	0.90	17.00	18.00	0.53	8.93	37.40	43%
Wall 6	Frame 1	External	0.00	6.37	243000	16200	ULS 4	0.57	1.00	1.00	0.90	17.00	18.00	2.12	35.71	149.59	18%
Wall 7	Frame 1	Internal	0.00	26.50	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	211%
Wall 7	Frame 1	External	0.00	22.85	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	46%
Wall 8	Frame 1	Internal	0.00	16.75	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	134%
Wall 8	Frame 1	External	0.00	12.05	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	24%
Wall 9	Frame 1	Internal	0.00	4.82	60750	4050	ULS 4	0.57	1.00	1.00	0.90	17.00	18.00	0.53	8.93	37.40	54%
Wall 9	Frame 1	External	0.00	3.14	243000	16200	ULS 4	0.57	1.00	1.00	0.90	17.00	18.00	2.12	35.71	149.59	9%
Wall 10	Frame 1	Internal	0.22	2.52	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	40%
Wall 10	Frame 1	External	0.12	1.33	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 11	Frame 1	Internal	0.22	2.52	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	40%
Wall 11	Frame 1	External	0.12	1.33	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 12	Frame 1	Internal	0.22	2.52	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	40%
Wall 12	Frame 1	External	0.12	1.33	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 13	Frame 1	Internal	0.22	2.52	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	40%
Wall 13	Frame 1	External	0.12	1.33	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 14	Frame 1	Internal	0.00	18.19	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	145%
Wall 14	Frame 1	External	0.00	9.24	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	18%
Wall 15	Frame 1	Internal	0.22	2.52	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	40%
Wall 15	Frame 1	External	0.12	1.33	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 16	Frame 1	Internal	0.22	2.52	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	40%
Wall 16	Frame 1	External	0.12	1.33	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 17	Frame 1	Internal	0.14	1.99	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	28%
Wall 17	Frame 1	External	0.12	1.60	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 18	Frame 1	Internal	0.00	22.20	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	177%
Wall 18	Frame 1	External	0.00	12.57	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	25%
Wall 19	Frame 1	Internal	0.12	1.76	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	24%
Wall 19	Frame 1	External	0.12	1.67	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 20	Frame 1	External	0.12	1.83	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 21	Frame 1	Internal	0.22	2.58	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	40%
Wall 21	Frame 1	External	0.12	1.36	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 22	Frame 1	Internal	0.22	2.52	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	40%
Wall 22	Frame 1	External	0.12	1.33	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 23	Frame 1	Internal	0.00	12.40	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	99%
Wall 23	Frame 1	External	0.00	7.16	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	14%
Wall 24	Frame 1	Internal	0.22	2.66	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	41%
Wall 24	Frame 1	External	0.12	1.40	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 25	Frame 1	Internal	0.22	3.57	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	47%
Wall 25	Frame 1	External	0.13	2.01	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	7%
Wall 26	Frame 1	Internal	0.15	1.05	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	23%
Wall 26	Frame 1	External	0.12	0.80	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 27	Frame 1	Internal	0.15	0.95	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	22%
Wall 27	Frame 1	External	0.12	0.63	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 28	Frame 1	Internal	0.15	1.16	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	24%
Wall 28	Frame 1	External	0.12	0.83	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 29	Frame 1	Internal	0.15	1.30	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	25%
Wall 29	Frame 1	External	0.12	0.95	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 30	Frame 1	Internal	0.15	1.33	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	25%
Wall 30	Frame 1	External	0.12	1.04	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 31	Frame 1	Internal	0.15	1.79	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	28%
Wall 31	Frame 1	External	0.06	2.77	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 32	Frame 1	Internal	0.00	13.23	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	106%
Wall 32	Frame 1	External	0.00	11.43	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	23%
Wall 33	Frame 1	Internal	0.00	8.37	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	67%
Wall 33	Frame 1	External	0.00	6.02	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	12%
Wall 34	Frame 1	Internal	0.15	2.20	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	30%
Wall 34	Frame 1	External	0.12	1.45	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 35	Frame 1	Internal	0.22	1.26	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 35	Frame 1	External	0.12	0.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 36	Frame 1	Internal	0.22	1.26	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 36	Frame 1	External	0.12	0.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 37	Frame 1	Internal	0.22	1.26	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 37	Frame 1	External	0.12	0.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 38	Frame 1	Internal	0.22	1.26	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 38	Frame 1	External	0.12	0.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 39	Frame 1	Internal	0.00	9.10	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	73%
Wall 39	Frame 1	External	0.00	4.62	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	9%
Wall 40	Frame 1	Internal	0.22	1.26	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 40	Frame 1	External	0.12	0.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 41	Frame 1	Internal	0.22	1.26	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 41	Frame 1	External	0.12	0.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 42	Frame 1	Internal	0.14	0.99	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	22%
Wall 42	Frame 1	External	0.12	0.80	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 43	Frame 1	Internal	0.00	11.10	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	89%
Wall 43	Frame 1	External	0.00	6.29	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	13%
Wall 44	Frame 1	Internal	0.12	0.88	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	19%
Wall 44	Frame 1	External	0.12	0.84	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 45	Frame 1	External	0.12	0.92	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 46	Frame 1	Internal	0.22	1.29	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 46	Frame 1	External	0.12	0.68	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 47	Frame 1	Internal	0.22	1.26	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 47	Frame 1	External	0.12	0.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 48	Frame 1	Internal	0.00	6.20	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	49%
Wall 48	Frame 1	External	0.00	3.58	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	7%

Wall 49	Frame 1	Internal	0.22	1.33	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 49	Frame 1	External	0.12	0.70	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 50	Frame 1	Internal	0.22	1.79	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	35%
Wall 50	Frame 1	External	0.13	1.01	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%

Bearing perpendicular to the grain

The studs are supported at the base by the bottom plate which is stressed by compression forces perpendicular to the grain.

The following expression shall be satisfied:

$$N_{d,p} \geq N_p^*$$

with

$$N_{d,p} = \phi \cdot k_1 \cdot k_4 \cdot k_6 \cdot k_7 \cdot f_p' \cdot A_p$$

where

$N_p^* = N$ is the design action effect in compression

ϕ is the capacity factor

k_1 is the duration of load modification factor for strength

k_4 is the moisture condition modification factor

k_6 is the temperature modification factor

k_7 is the length of bearing factor

f_p' is the characteristic value in bearing perpendicular to grain

A_p is the bearing area for loading perpendicular to grain

The length of bearing factor k_7 allows to increase the characteristic capacity in bearing perpendicular to the grain where rectangular bearing areas are located 75 mm or more from the end of the bottom plate.

The values of the actions in the tables below are related, for each wall, to the most severe combination of actions for the bearing Ultimate Limit State.

Wall name	Length [m]	Combination	Duration	N [kN]
Wall 1	0.61	ULS 1	50+ years	5.06
Wall 2	0.60	ULS 1	50+ years	4.62
Wall 3	0.61	ULS 1	50+ years	5.36
Wall 4	0.61	ULS 1	50+ years	5.79
Wall 5	0.60	ULS 4	50+ years	6.01
Wall 6	0.61	ULS 4	50+ years	12.33
Wall 7	0.61	ULS 3	5 months	59.28
Wall 8	0.60	ULS 3	5 months	34.70
Wall 9	0.61	ULS 4	50+ years	9.87
Wall 10	2.45	ULS 1	50+ years	16.95
Wall 11	2.45	ULS 1	50+ years	16.95
Wall 12	2.45	ULS 1	50+ years	16.95
Wall 13	2.45	ULS 1	50+ years	16.95
Wall 14	2.50	ULS 3	5 months	102.57
Wall 15	2.45	ULS 1	50+ years	16.95
Wall 16	2.45	ULS 1	50+ years	16.95
Wall 17	0.58	ULS 1	50+ years	4.84
Wall 18	2.50	ULS 3	5 months	133.71
Wall 19	0.50	ULS 1	50+ years	4.36
Wall 20	0.46	ULS 1	50+ years	4.12
Wall 21	1.87	ULS 1	50+ years	13.29
Wall 22	2.45	ULS 1	50+ years	16.95
Wall 23	2.50	ULS 3	5 months	74.56
Wall 24	1.30	ULS 1	50+ years	9.52
Wall 25	2.49	ULS 4	50+ years	21.39

Wall 26	0.61	ULS 1	50+ years	2.53
Wall 27	0.60	ULS 1	50+ years	2.33
Wall 28	0.61	ULS 1	50+ years	2.70
Wall 29	0.61	ULS 1	50+ years	2.90
Wall 30	0.60	ULS 4	50+ years	3.00
Wall 31	0.61	ULS 4	50+ years	6.16
Wall 32	0.61	ULS 3	5 months	29.87
Wall 33	0.60	ULS 3	5 months	17.50
Wall 34	0.61	ULS 4	50+ years	4.93
Wall 35	2.45	ULS 1	50+ years	8.48
Wall 36	2.45	ULS 1	50+ years	8.48
Wall 37	2.45	ULS 1	50+ years	8.48
Wall 38	2.45	ULS 1	50+ years	8.48
Wall 39	2.50	ULS 3	5 months	51.28
Wall 40	2.45	ULS 1	50+ years	8.48
Wall 41	2.45	ULS 1	50+ years	8.48
Wall 42	0.58	ULS 1	50+ years	2.42
Wall 43	2.50	ULS 3	5 months	66.85
Wall 44	0.50	ULS 1	50+ years	2.18
Wall 45	0.46	ULS 1	50+ years	2.06
Wall 46	1.87	ULS 1	50+ years	6.65
Wall 47	2.45	ULS 1	50+ years	8.48
Wall 48	2.50	ULS 3	5 months	37.28
Wall 49	1.30	ULS 1	50+ years	4.76
Wall 50	2.49	ULS 4	50+ years	10.70

The following table summarizes the bearing (perpendicular to the grain) checks for the plates of the framed walls.

Wall name	Section	Stud	N [kN]	A_p [mm^2]	Combination	k_1	k_4	k_6	k_7	ϕ	f'_p [MPa]	$N_{d,p}$ [kN]	Check
Wall 1	Frame 1	Internal	2.35	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	9%
Wall 1	Frame 1	External	1.79	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 2	Frame 1	Internal	2.22	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	9%
Wall 2	Frame 1	External	1.56	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 3	Frame 1	Internal	2.52	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	10%
Wall 3	Frame 1	External	1.84	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 4	Frame 1	Internal	2.71	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	11%
Wall 4	Frame 1	External	2.01	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 5	Frame 1	Internal	2.78	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	11%
Wall 5	Frame 1	External	2.16	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	3%
Wall 6	Frame 1	Internal	3.86	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	15%
Wall 6	Frame 1	External	6.37	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	8%
Wall 7	Frame 1	Internal	26.50	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	73%
Wall 7	Frame 1	External	22.85	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	20%
Wall 8	Frame 1	Internal	16.75	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	46%
Wall 8	Frame 1	External	12.05	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	10%
Wall 9	Frame 1	Internal	4.82	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	19%
Wall 9	Frame 1	External	3.14	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	4%
Wall 10	Frame 1	Internal	2.83	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	11%
Wall 10	Frame 1	External	1.49	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 11	Frame 1	Internal	2.83	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	11%
Wall 11	Frame 1	External	1.49	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 12	Frame 1	Internal	2.83	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	11%
Wall 12	Frame 1	External	1.49	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 13	Frame 1	Internal	2.83	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	11%
Wall 13	Frame 1	External	1.49	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 14	Frame 1	Internal	18.19	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	50%
Wall 14	Frame 1	External	9.24	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	8%
Wall 15	Frame 1	Internal	2.83	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	11%
Wall 15	Frame 1	External	1.49	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 16	Frame 1	Internal	2.83	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	11%
Wall 16	Frame 1	External	1.49	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 17	Frame 1	Internal	2.23	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	9%
Wall 17	Frame 1	External	1.80	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 18	Frame 1	Internal	22.20	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	61%
Wall 18	Frame 1	External	12.57	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	11%
Wall 19	Frame 1	Internal	1.99	4050	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	20.78	10%
Wall 19	Frame 1	External	1.88	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 20	Frame 1	External	2.06	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 21	Frame 1	Internal	2.91	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	11%
Wall 21	Frame 1	External	1.53	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 22	Frame 1	Internal	2.83	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	11%
Wall 22	Frame 1	External	1.49	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 23	Frame 1	Internal	12.40	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	34%
Wall 23	Frame 1	External	7.16	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	6%
Wall 24	Frame 1	Internal	2.99	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	12%
Wall 24	Frame 1	External	1.58	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 25	Frame 1	Internal	3.76	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	15%
Wall 25	Frame 1	External	2.11	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	3%
Wall 26	Frame 1	Internal	1.17	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 26	Frame 1	External	0.89	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 27	Frame 1	Internal	1.11	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	4%
Wall 27	Frame 1	External	0.78	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 28	Frame 1	Internal	1.26	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 28	Frame 1	External	0.92	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 29	Frame 1	Internal	1.35	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 29	Frame 1	External	1.01	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 30	Frame 1	Internal	1.39	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 30	Frame 1	External	1.08	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 31	Frame 1	Internal	1.93	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	7%

Wall 31	Frame 1	External	3.19	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	4%
Wall 32	Frame 1	Internal	13.23	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	37%
Wall 32	Frame 1	External	11.43	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	10%
Wall 33	Frame 1	Internal	8.37	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	23%
Wall 33	Frame 1	External	6.02	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	5%
Wall 34	Frame 1	Internal	2.41	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	9%
Wall 34	Frame 1	External	1.57	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 35	Frame 1	Internal	1.41	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 35	Frame 1	External	0.75	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 36	Frame 1	Internal	1.41	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 36	Frame 1	External	0.75	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 37	Frame 1	Internal	1.41	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 37	Frame 1	External	0.75	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 38	Frame 1	Internal	1.41	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 38	Frame 1	External	0.75	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 39	Frame 1	Internal	9.10	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	25%
Wall 39	Frame 1	External	4.62	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	4%
Wall 40	Frame 1	Internal	1.41	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 40	Frame 1	External	0.75	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 41	Frame 1	Internal	1.41	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 41	Frame 1	External	0.75	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 42	Frame 1	Internal	1.12	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	4%
Wall 42	Frame 1	External	0.90	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 43	Frame 1	Internal	11.10	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	31%
Wall 43	Frame 1	External	6.29	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	5%
Wall 44	Frame 1	Internal	0.99	4050	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	20.78	5%
Wall 44	Frame 1	External	0.94	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 45	Frame 1	External	1.03	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 46	Frame 1	Internal	1.45	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	6%
Wall 46	Frame 1	External	0.77	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 47	Frame 1	Internal	1.41	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 47	Frame 1	External	0.75	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 48	Frame 1	Internal	6.20	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	17%
Wall 48	Frame 1	External	3.58	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	3%
Wall 49	Frame 1	Internal	1.50	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	6%
Wall 49	Frame 1	External	0.79	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 50	Frame 1	Internal	1.88	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	7%
Wall 50	Frame 1	External	1.06	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%

The shear strength of framed shear walls

The values of the actions in the tables below are related, for each wall, to the most severe combination of load for the Ultimate Limit States.

Wall name	Length [m]	Combination	Duration	V2 [kN]
Wall 10	2.45	ULS earthquake strength 4 ex- ey+	5 seconds	3.25
Wall 11	2.45	ULS earthquake strength 4 ex- ey+	5 seconds	3.25
Wall 12	2.45	ULS earthquake strength 4 ex- ey+	5 seconds	3.25
Wall 13	2.45	ULS earthquake strength 4 ex- ey+	5 seconds	3.25
Wall 14	2.50	ULS Wind 6	5 seconds	13.51
Wall 15	2.45	ULS earthquake strength 4 ex- ey-	5 seconds	3.40
Wall 16	2.45	ULS earthquake strength 4 ex- ey-	5 seconds	3.40
Wall 18	2.50	ULS Wind 6	5 seconds	11.08
Wall 21	1.87	ULS earthquake strength 4 ex- ey-	5 seconds	2.51
Wall 22	2.45	ULS earthquake strength 4 ex- ey-	5 seconds	3.40
Wall 23	2.50	ULS Wind 6	5 seconds	9.17
Wall 24	1.30	ULS earthquake strength 1 ex+ ey-	5 seconds	1.46
Wall 25	2.49	ULS Wind 6	5 seconds	10.19
Wall 35	2.45	ULS earthquake strength 4 ex- ey+	5 seconds	1.71
Wall 36	2.45	ULS earthquake strength 4 ex- ey+	5 seconds	1.71
Wall 37	2.45	ULS earthquake strength 4 ex- ey+	5 seconds	1.71
Wall 38	2.45	ULS earthquake strength 4 ex- ey+	5 seconds	1.71
Wall 39	2.50	ULS Wind 6	5 seconds	4.50
Wall 40	2.45	ULS earthquake strength 1 ex+ ey-	5 seconds	1.80
Wall 41	2.45	ULS earthquake strength 1 ex+ ey-	5 seconds	1.80
Wall 43	2.50	ULS Wind 6	5 seconds	3.69
Wall 46	1.87	ULS earthquake strength 1 ex+ ey-	5 seconds	1.33
Wall 47	2.45	ULS earthquake strength 1 ex+ ey-	5 seconds	1.80
Wall 48	2.50	ULS Wind 6	5 seconds	3.06
Wall 49	1.30	ULS earthquake strength 1 ex+ ey-	5 seconds	0.79
Wall 50	2.49	ULS Wind 6	5 seconds	3.39

Sheet-braced framed walls

Lateral load-carrying capacity of metal fasteners

The design load-carrying capacity of a cantilevered panel secured against uplift is determined according to a plastic model based on the lower bound method (static theorem) that assumes the load-displacement relationships of the sheathing-to-frame joints as completely in the plastic field.

For a wall made up of several wall panels, the design racking load-carrying capacity of a wall is calculated from:

$$F_{v,Rd} = \sum_i F_{i,v,Rd}$$

where:

$F_{i,v,Rd}$ is the design racking load-carrying capacity of a single wall panel as specified in the following.

Wall panels which contain a door or window opening shall not be considered to contribute to the racking load-carrying capacity.

The design racking load-carrying capacity of each wall panel, $F_{i,v,Rd}$, is calculated from:

$$F_{i,v,Rd} = \frac{F_{t,Rd} \cdot b_i \cdot c_i}{s}$$

where:

$F_{t,Rd}$ is the lateral design capacity of an individual fastener, modified by a factor of 1.2

b_i is the wall panel width

s is the fastener spacing

c_i a coefficient dependent on the ratio between base and height of a single wall panel.

For wall panels with sheets on both sides the following rules apply:

- if the sheets and fasteners are of the same type and dimension then the total racking load carrying capacity of the wall should be taken as the sum of the racking load-carrying capacities of the individual sides

- if different types of sheets are used, 75 % of the racking load-carrying capacity of the weaker side may, unless some other value is shown to be valid, be taken into consideration if fasteners with similar slip moduli are used. In other cases not more than 50 % should be taken into consideration.

Fastener strength

The resistance of each fastener is estimated according to the Johansen theory of timber connections with dowel-type fasteners for panel-to-timber connections in single shear.

The characteristic load-carrying capacity for nails, staples, bolts, dowels and screws per shear plane per fastener, should be taken as the minimum value found from the following expressions

$$F_{v,Rk,a} = f_{h,1,k} \cdot t_1 \cdot d$$

$$F_{v,Rk,b} = f_{h,2,k} \cdot t_2 \cdot d$$

$$F_{v,Rk,c} = \frac{f_{h,1,k} \cdot t_1 \cdot d}{1+\beta} \cdot \left[\sqrt{\beta + 2\beta^2 \left[1 + \frac{t_2}{t_1} + \left(\frac{t_2}{t_1} \right)^2 \right]} + \beta^3 \left(\frac{t_2}{t_1} \right)^2 - \beta \left(1 + \frac{t_2}{t_1} \right) \right] + \frac{F_{ax,Rk}}{4}$$

$$F_{v,Rk,d} = 1{,}05 \cdot \frac{f_{h,1,k} \cdot t_1 \cdot d}{2+\beta} \cdot \left[\sqrt{2\beta(1+\beta) + \frac{4\beta(2+\beta) M_{y,Rk}}{f_{h,1,k} \cdot d \cdot t_1^2}} - \beta \right] + \frac{F_{ax,Rk}}{4}$$

$$F_{v,Rk,e} = 1{,}05 \cdot \frac{f_{h,1,k} \cdot t_2 \cdot d}{1+2\beta} \cdot \left[\sqrt{2\beta^2(1+\beta) + \frac{4\beta(1+2\beta) M_{y,Rk}}{f_{h,1,k} \cdot d \cdot t_2^2}} - \beta \right] + \frac{F_{ax,Rk}}{4}$$

$$F_{v,Rk,f} = 1{,}15 \cdot \sqrt{\frac{2\beta}{1+\beta}} \sqrt{2 \cdot M_{y,Rk} \cdot f_{h,1,k} \cdot d} + \frac{F_{ax,Rk}}{4}$$

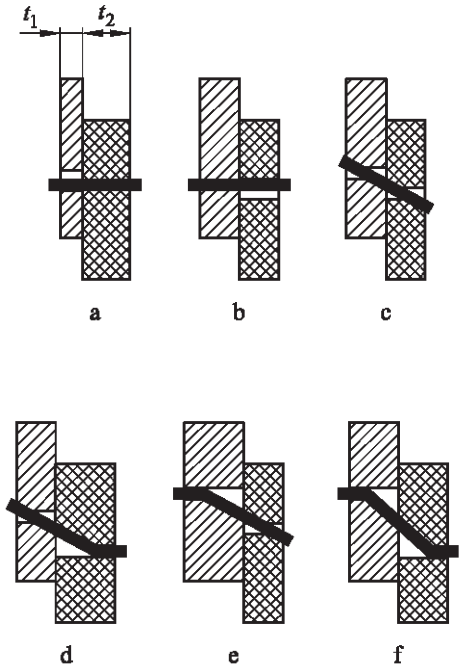


Figure: Failure modes for timber and panel connections.

In the expressions above, the first term on the right hand side is the load-carrying capacity according to the Johansen yield theory, whilst the second term $\frac{F_{ax,Rk}}{4}$ is the contribution from the rope effect.

Characteristic withdrawal capacity

The characteristic withdrawal capacity of nails, $F_{ax,Rk}$, should be taken as the smaller of the values found from the following expressions:

- For smooth nails:

$$F_{ax,Rk} = \begin{cases} f_{ax,k,tip}\, d\, t_{pen,frame} \\ f_{ax,k,head}\, d\, t + f_{head,k}\, d_h^2 \end{cases}$$

- For nails with improved adherence:

$$F_{ax,Rk} = \begin{cases} f_{ax,k,tip}\, d\, t_{pen,frame} = f_{ax,k,350} \left(\frac{\rho_{k,tip}}{350} \right)^{0.8} d\, t_{pen,frame} \\ f_{head,k}\, d_h^2 = f_{head,k,350} \left(\frac{\rho_{k,head}}{350} \right)^{0.8} d_h^2 \end{cases}$$

where:

$f_{ax,k,tip}$ is the characteristic pointside withdrawal strength;

$f_{ax,k,head}$ is the characteristic headside withdrawal strength;

$f_{head,k}$ is the characteristic headside pull-through strength;

d is the nail diameter;

d_h is the nail head diameter;

$t_{pen,frame}$ is the minimum value between the pointside penetration length and the length of the threaded part in the pointside member;

t is the thickness of the headside member.

For smooth nails, the pointside penetration should be at least 8d. For nails with a pointside penetration smaller than 12d the withdrawal capacity should be multiplied by $\frac{t_{pen}}{4d} - 2$.

For threaded nails, the pointside penetration should be at least 6d. For nails with a pointside penetration smaller than 8d the withdrawal capacity should be multiplied by $\frac{t_{pen}}{2d} - 3$.

In the following table, the calculations for the characteristic pointside withdrawal strength (Fax,k,tip) and for the characteristic headside pull-through strength (Fax,k,head) are reported.

Section	Side	Fasteners	$\rho_{k,frame}$ [kg/m³]	$f_{ax,k,tip}$ [MPa]	d [mm]	$t_{pen,frame}$ [mm]	$F_{ax,k,tip}$ [N]	$\rho_{k,panel}$ [kg/m³]	$f_{ax,k,head}$ [MPa]	$f_{head,k}$ [MPa]	d_h [mm]	t [mm]	$F_{ax,k,head}$ [N]
Frame 1	1	Ring nail (coils) 2.8/3.1 x 60	317	6.02	2.80	40.00	674	400	0.00	30.16	4.30	-	558

Lateral load-carrying capacity

The following table shows the resistances of the fasteners used to assemble the panels of the walls.

$F_{ax,Rk}$ is the characteristic axial withdrawal capacity of the fastener

Rope effect limit is the rope effect limited to a percentage of Johansen part

$F_{v,Rk}$ is the characteristic load-carrying capacity per shear plane per fastener

Section	Side	Fasteners	K_{ser} [N/mm]	Failure mode	$F_{ax,Rk}$ [N]	Rope effect limit	$F_{v,Rk}$ [N]
Frame 1	1	Ring nail (coils) 2.8/3.1 x 60	670	d	558	50%	717

Check of the bearing capacity of the walls related to the lateral load-carrying capacity of metal fasteners

The following table summarizes the geometric characteristics of the wall panels and their load-bearing capacity Fi,v,Rk. This table also indicates whether the width of each sheet is at least equal to h/4 as required by the calculation model.

Wall name	Section	Panel	b_i [mm]	N panels	c_i	Sheet width ≥ h/4	s [mm]	$F_{i,v,Rk}$ side 1 [kN]	$F_{i,v,Rk}$ side 2 [kN]
Wall 10	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 10	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 11	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 11	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 12	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 12	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 13	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 13	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 14	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 14	Frame 1	Junction	46.00	1	0.03	no	100	0.00	0.00
Wall 15	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 15	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 16	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 16	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 18	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 18	Frame 1	Junction	46.00	1	0.03	no	100	0.00	0.00
Wall 21	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 21	Frame 1	Junction	234.00	1	0.15	no	100	0.00	0.00

Wall 22	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 22	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 23	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 23	Frame 1	Junction	46.00	1	0.03	no	100	0.00	0.00
Wall 24	Frame 1	Full	818.00	1	0.51	ok	100	3.60	0.00
Wall 24	Frame 1	Junction	482.00	1	0.30	no	100	0.00	0.00
Wall 25	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 25	Frame 1	Junction	36.00	1	0.02	no	100	0.00	0.00
Wall 35	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 35	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 36	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 36	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 37	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 37	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 38	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 38	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 39	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 39	Frame 1	Junction	46.00	1	0.03	no	100	0.00	0.00
Wall 40	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 40	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 41	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 41	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 43	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 43	Frame 1	Junction	46.00	1	0.03	no	100	0.00	0.00
Wall 46	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 46	Frame 1	Junction	234.00	1	0.15	no	100	0.00	0.00
Wall 47	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 47	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 48	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 48	Frame 1	Junction	46.00	1	0.03	no	100	0.00	0.00
Wall 49	Frame 1	Full	818.00	1	0.51	ok	100	3.60	0.00
Wall 49	Frame 1	Junction	482.00	1	0.30	no	100	0.00	0.00
Wall 50	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 50	Frame 1	Junction	36.00	1	0.02	no	100	0.00	0.00

The following table shows the checks with reference to the most significant load combinations according to the expression:

$$F_{v,Rd} \geq F_{v,Ed}$$

Wall name	Section	Comb.	$F_{v,Ed}$ [kN]	k_1	k_{13}	k_{14}	k_{16}	k_{17}	ϕ	$F_{v,Rd}$ [kN]	Check
Wall 10	Frame 1	ULS earthquake strength 4 ex- ey+	3.25	1.14	1	1	1	1	0.85	10.43	31%
Wall 11	Frame 1	ULS earthquake strength 4 ex- ey+	3.25	1.14	1	1	1	1	0.85	10.43	31%
Wall 12	Frame 1	ULS earthquake strength 4 ex- ey+	3.25	1.14	1	1	1	1	0.85	10.43	31%
Wall 13	Frame 1	ULS earthquake strength 4 ex- ey+	3.25	1.14	1	1	1	1	0.85	10.43	31%
Wall 14	Frame 1	ULS Wind 6	13.51	1.14	1	1	1	1	0.85	10.46	129%
Wall 15	Frame 1	ULS earthquake strength 4 ex- ey-	3.40	1.14	1	1	1	1	0.85	10.43	33%
Wall 16	Frame 1	ULS earthquake strength 4 ex- ey-	3.40	1.14	1	1	1	1	0.85	10.43	33%
Wall 18	Frame 1	ULS Wind 6	11.08	1.14	1	1	1	1	0.85	10.46	106%
Wall 21	Frame 1	ULS earthquake strength 4 ex- ey-	2.51	1.14	1	1	1	1	0.85	6.97	36%
Wall 22	Frame 1	ULS earthquake strength 4 ex- ey-	3.40	1.14	1	1	1	1	0.85	10.43	33%
Wall 23	Frame 1	ULS Wind 6	9.17	1.14	1	1	1	1	0.85	10.46	88%
Wall 24	Frame 1	ULS earthquake strength 1 ex+ ey-	1.46	1.14	1	1	1	1	0.85	3.49	42%
Wall 25	Frame 1	ULS Wind 6	10.19	1.14	1	1	1	1	0.85	10.46	97%
Wall 35	Frame 1	ULS earthquake strength 4 ex- ey+	1.71	1.14	1	1	1	1	0.85	10.43	16%
Wall 36	Frame 1	ULS earthquake strength 4 ex- ey+	1.71	1.14	1	1	1	1	0.85	10.43	16%
Wall 37	Frame 1	ULS earthquake strength 4 ex- ey+	1.71	1.14	1	1	1	1	0.85	10.43	16%
Wall 38	Frame 1	ULS earthquake strength 4 ex- ey+	1.71	1.14	1	1	1	1	0.85	10.43	16%
Wall 39	Frame 1	ULS Wind 6	4.50	1.14	1	1	1	1	0.85	10.46	43%
Wall 40	Frame 1	ULS earthquake strength 1 ex+ ey-	1.80	1.14	1	1	1	1	0.85	10.43	17%
Wall 41	Frame 1	ULS earthquake strength 1 ex+ ey-	1.80	1.14	1	1	1	1	0.85	10.43	17%
Wall 43	Frame 1	ULS Wind 6	3.69	1.14	1	1	1	1	0.85	10.46	35%
Wall 46	Frame 1	ULS earthquake strength 1 ex+ ey-	1.33	1.14	1	1	1	1	0.85	6.97	19%
Wall 47	Frame 1	ULS earthquake strength 1 ex+ ey-	1.80	1.14	1	1	1	1	0.85	10.43	17%
Wall 48	Frame 1	ULS Wind 6	3.06	1.14	1	1	1	1	0.85	10.46	29%
Wall 49	Frame 1	ULS earthquake strength 1 ex+ ey-	0.79	1.14	1	1	1	1	0.85	3.49	23%
Wall 50	Frame 1	ULS Wind 6	3.39	1.14	1	1	1	1	0.85	10.46	32%

Shear buckling of the sheet

The model assumes that the shear buckling of the sheet may be disregarded, provided that

$$\frac{b_{net}}{t} \leq 100$$

where

b_{net} *is the clear distance between studs*

t *is the thickness of the sheet*

Technical Design Calculation Report

Connections

Hold Down – Connections at the base of the structure

The design resistance R_d of the hold-downs is determined as the minimum value among the resistances relating to the following failure modes:

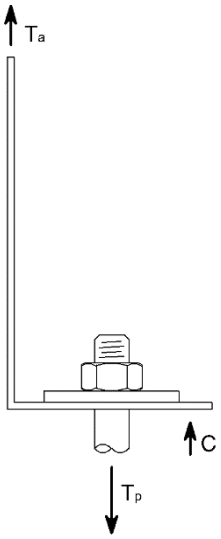
- Nailing failure
- Hold-downs steel failure
- Failure of the anchor
- Extraction of the anchor

Forces on the hold-downs

The tension force acting on the hold down (T_a) is evaluated as described in paragraph “Model Description”.

The tension force acting on the anchor is calculated taking into account the additional moment due to the non-alignment between the external force acting on the vertical flange of the hold down and the anchor itself using a coefficient, indicated as k_t.

$$T_p = T_a \cdot k_t$$



Wall name	Length [m]	Connection name	N° of anchors at each wall end	Combination	Duration	N [kN]	M_{3-3} [kNm]	Ta [kN]	kt	Tp [kN]
Wall 10	2.45	Ground connection - hold down - bracket	1	ULS earthquake stability 4 ex- ey+	5 seconds	11.30	15.75	0.78	1	0.78
Wall 11	2.45	Ground connection - hold down - bracket	1	ULS earthquake stability 4 ex- ey+	5 seconds	11.30	15.75	0.78	1	0.78
Wall 12	2.45	Ground connection - hold down - bracket	1	ULS earthquake stability 4 ex- ey+	5 seconds	11.30	15.75	0.78	1	0.78
Wall 13	2.45	Ground connection - hold down - bracket	1	ULS earthquake stability 4 ex- ey+	5 seconds	11.30	15.75	0.78	1	0.78
Wall 14	2.50	Ground connection - hold down - bracket	1	ULS Wind 8	5 seconds	32.75	57.64	6.68	1	6.68
Wall 15	2.45	Ground connection - hold down - bracket	1	ULS earthquake stability 1 ex+ ey-	5 seconds	11.30	16.50	1.08	1	1.08
Wall 16	2.45	Ground connection - hold down - bracket	1	ULS earthquake stability 1 ex+ ey-	5 seconds	11.30	16.50	1.08	1	1.08
Wall 18	2.50	Ground connection - hold down - bracket	1	ULS Wind 6	5 seconds	75.09	47.28	0.00	1	0.00
Wall 21	1.87	Ground connection - hold down - bracket	1	ULS earthquake stability 1 ex+	5 seconds	8.86	12.18	2.08	1	2.08

				ey-						
Wall 22	2.45	Ground connection - hold down - bracket	1	ULS earthquake stability 1 ex+ ey-	5 seconds	11.30	16.50	1.08	1	1.08
Wall 23	2.50	Ground connection - hold down - bracket	1	ULS Wind 8	5 seconds	25.93	39.11	2.68	1	2.68
Wall 24	1.30	Ground connection - hold down - bracket	1	ULS earthquake stability 1 ex+ ey-	5 seconds	6.35	7.15	2.33	1	2.33
Wall 25	2.49	Ground connection - hold down - bracket	1	ULS Wind 8	5 seconds	13.96	43.48	10.48	1	10.48

Nailing resistance

The design value of the load-bearing capacity of the nailing is given by the following expression

$$R_{c,d} = \phi \cdot k_1 \cdot k_{13} \cdot k_{14} \cdot R_{c,k,dens}$$

where

$R_{c,k,dens}$ is the characteristic value of the nailing resistance. It already considers the effect of multiple nails in the joint and the effect of the restraint against the rotation of the fastener head. This value is reduced by the k_{dens} factor when the density of the material used is less than 350 kg/m3. k_{dens} can be evaluated using the formula $R_{c,k,dens} = R_{c,k} \cdot \left(\frac{\rho_k}{350}\right)^2$.

ϕ is the capacity factor for nails and screws

k_1 is the modification factor for duration of load for joints

k_{13} is equal to 1 for fasteners in side grain

k_{14} is equal to 1 for fasteners in single shear

Hold-down steel resistance

The tensile design strength of the steel of the hold-down can be evaluated according to the formula

$$R_{s,d} = \phi \cdot R_{s,k}$$

where

$R_{s,k}$ *is the characteristic value of the resistance of the hold down in axial tension*

ϕ *is the capacity factor for steel in tension*

Tension resistance of the anchor

The tension resistance of the anchor is evaluated as reported in section 9.3.2.2 of AS 4100 - 1998 according to the following formula

$$R_{t,d} = \phi \cdot R_{t,k} = \phi \cdot A_s \cdot f_{uf}$$

being:

f_{uf} *is the ultimate tensile strength of the anchor*

A_s *the tensile stress area of the anchor*

ϕ *is the capacity factor for bolts in tension*

Pull-out resistance of the anchor

The characteristic value of pull-out resistance refers to a single anchor regardless of the effects due to the spacing or distances from the edges. Moreover concrete is considered to be non-cracked, dry and at a standard temperature for the actual depth of anchorage.

The design pull-out resistance can be calculated as

$$R_{pull,d} = \phi \cdot R_{pull,k}$$

where

$R_{pull,k}$ is the *characteristic value of the pull-out resistance*

ϕ is the capacity factor provided by manufacturers

The checks are summarized in the following tables according to each failure mode.

Name: Name of the connection in which the hold-down is used

Comb.: The most severe combination of load

$T_{a,d}$: Design value of the tensile force acting on the hold down

$T_{p,d}$: Design value of the tensile force acting on the anchor

$R_{a,d}$: Design value of the hold down resistance, assumed to be the lower of the values of the design resistance of all the failure mechanisms associated with it

$R_{p,d}$: Design value of the anchor resistance, assumed to be the lower of the values of the design resistance of all the failure mechanisms associated with it

$$T_{a,d} \leq R_{a,d} = min(R_{c,d}; R_{s,d})$$

$$T_{p,d} \leq R_{p,d} = min(R_{t,d}; R_{pull,d})$$

Wall name	Connection name	Comb.	$T_{a,d}$ [kN]	$R_{c,k,dens}$ [kN]	k_1	ϕ	$R_{c,d}$ [kN]	$R_{s,k}$ [kN]	ϕ	$R_{s,d}$ [kN]	$R_{a,d}$ [kN]	$T_{p,d}$ [kN]	$R_{t,k}$ [kN]	ϕ	$R_{t,d}$ [kN]	$R_{pull,k}$ [kN]	ϕ	$R_{pull,d}$ [kN]	$R_{p,d}$ [kN]	Failure mode	Check
Wall 10	Ground connection - hold down - bracket	ULS earthquake stability 4 ex- ey+	0.78	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	0.78	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	4%
Wall 11	Ground connection - hold down -	ULS earthquake	0.78	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	0.78	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	4%

	bracket	stability 4 ex- ey+																			
Wall 12	Ground connection - hold down - bracket	ULS earthquake stability 4 ex- ey+	0.78	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	0.78	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	4%
Wall 13	Ground connection - hold down - bracket	ULS earthquake stability 4 ex- ey+	0.78	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	0.78	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	4%
Wall 14	Ground connection - hold down - bracket	ULS Wind 8	6.68	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	6.68	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	38%
Wall 15	Ground connection - hold down - bracket	ULS earthquake stability 1 ex+ ey-	1.08	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	1.08	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	6%
Wall 16	Ground connection - hold down - bracket	ULS earthquake stability 1 ex+ ey-	1.08	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	1.08	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	6%
Wall 18	Ground connection - hold down - bracket	ULS Wind 6	0.00	17.99	1.14	0.85	17.43	42	0.9	37.8	-	0.00	78.5	0.8	62.8	35.94	0.5	17.97	-	-	0%
Wall 21	Ground connection - hold down - bracket	ULS earthquake stability 1 ex+ ey-	2.08	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	2.08	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	12%
Wall 22	Ground connection - hold down - bracket	ULS earthquake stability 1 ex+ ey-	1.08	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	1.08	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	6%
Wall 23	Ground connection - hold down - bracket	ULS Wind 8	2.68	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	2.68	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	15%
Wall 24	Ground connection - hold down - bracket	ULS earthquake stability 1 ex+ ey-	2.33	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	2.33	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	13%
Wall 25	Ground connection - hold down - bracket	ULS Wind 8	10.48	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	10.48	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	60%

Connections with punched metal plate/punched strap

The design resistance R_d of a punched strap is determined as the minimum value among the resistances relating to the following failure modes:

- Nailing failure
- Punched strap steel failure

Forces on the tie-downs

Wall name	Length [m]	Connection name	N° of connections at each wall end	Comb.	Dur.	N [kN]	M_{3-3} [kNm]	Ta [kN]
Wall 35	2.45	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	7.53	0.76	0.00
Wall 36	2.45	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	7.53	0.76	0.00
Wall 37	2.45	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	7.53	0.76	0.00
Wall 38	2.45	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	7.53	0.76	0.00
Wall 39	2.50	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	29.69	14.41	0.00
Wall 40	2.45	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	7.53	0.85	0.00
Wall 41	2.45	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	7.53	0.85	0.00
Wall 43	2.50	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	37.55	11.82	0.00
Wall 46	1.87	Upper levels - tensile plate - shear plate	1	ULS earthquake stability 1 ex+ ey-	5 seconds	4.43	4.27	0.07
Wall 47	2.45	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	7.53	0.85	0.00
Wall 48	2.50	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	22.62	9.78	0.00
Wall 49	1.30	Upper levels - tensile plate - shear plate	1	ULS earthquake stability 1 ex+ ey-	5 seconds	3.17	2.52	0.35
Wall 50	2.49	Upper levels - tensile plate - shear plate	1	ULS Wind 8	5 seconds	6.98	10.86	0.87

Punched strap tensile resistance

The tensile resistance of the punched element is evaluated on the basis of the indications of sections 7.1 and 7.2 of AS 4100-1998. For sections with holes the design tension resistance N^* should be taken as the smaller of the design plastic resistance of the gross cross-section and the design ultimate resistance of the net cross-section.

The design plastic resistance of the gross cross-section is calculated as

$$N_{pl}^{*} = \phi \cdot N_{t,pl} = \phi \cdot A_g \cdot f_y$$

where

ϕ is the capacity factor for steel in tension

A_g is the gross area of the steel cross-section

f_y is the nominal value of the yield strength of the steel

The net cross section resistance can be evaluated using the following expression by assuming an uniform distribution of the stress:

$$N_{u}^{*} = \phi \cdot N_{t,u} = \phi \cdot 0.85 \cdot A_n \cdot f_u$$

where

ϕ is the capacity factor for steel in tension

$\mathrm{A_n}$ is the net area of the steel cross-section

$\mathrm{f_u}$ is the ultimate value of the tensile strength of the steel

Nailing resistance

The design capacity of Type 1 joints with nails and screws is given by the following equation:

$$\mathrm{R_{c,d}} = \phi \cdot \mathrm{k_1} \cdot \mathrm{k_{13}} \cdot \mathrm{k_{14}} \cdot \mathrm{k_{16}} \cdot \mathrm{k_{17}} \cdot \mathrm{n} \cdot \mathrm{R_{c,k}}$$

where

ϕ is the capacity factor for nails and screws

k_1 is the modification factor for the duration of load for joints

k_{13} is equal to 1 for fasteners in side grain

k_{14} is equal to 1 for fasteners in single shear

k_{16} is assumed equal to 1 since its contribution is already considered in the $R_{c,k}$ value

k_{17} is the modification factor for multiple nailed and screwed joints

n is the total number of fasteners in the joint resisting the design action

$R_{c,k}$ is the characteristic capacity of a single fastener estimated according to the Johansen theory of timber connections with dowel-type fasteners for steel-to-timber connections in single shear.

Wall name	Connection name	Number of rows	Number of fasteners in a row	Combination	Rc,k [N]	k_1	k_{13}	k_{14}	k_{16}	k_{17}	n	ϕ	Rc,d [kN]
Wall 35	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 36	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 37	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 38	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 39	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 40	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 41	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 43	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 46	Upper levels - tensile	10	3	ULS earthquake stability 1 ex+	1840.55	1.14	1	1	1	0.90	30	0.85	48.15

	plate - shear plate			ey-									
Wall 47	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 48	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 49	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex+ ey-	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 50	Upper levels - tensile plate - shear plate	10	3	ULS Wind 8	1840.55	1.14	1	1	1	0.90	30	0.85	48.15

The checks are summarized in the following table which shows the characteristic and design values of resistance associated with the different failure modes of the components.

Wall name	Connection name	Combination	T_{Ed} [kN]	$R_{c,d}$ [kN]	$N_{t,pl}$ [kN]	ϕ	N^*_{pl} [kN]	$N_{t,u}$ [kN]	ϕ	N^*_u [kN]	Failure mode	Check
Wall 35	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 36	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 37	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 38	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 39	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 40	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 41	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 43	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 46	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex+ ey-	0.07	48.15	22.5	0.9	20.25	18.93	0.9	17.037	Tension failure of the net cross-section	0%
Wall 47	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 48	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 49	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex+ ey-	0.35	48.15	22.5	0.9	20.25	18.93	0.9	17.037	Tension failure of the net cross-section	2%
Wall 50	Upper levels - tensile plate - shear plate	ULS Wind 8	0.87	48.15	22.5	0.9	20.25	18.93	0.9	17.037	Tension failure of the net cross-section	5%

Angle brackets with anchors – timber to concrete shear connections

The design resistance R_d of an angle bracket is determined as the minimum value among the resistances relating to the following failure modes:

- Shear failure of the angle and/or of the group of fasteners of the connection
- Shear failure of the anchors connecting the concrete

Shear forces

The shear force acting on the single angle bracket is calculated by dividing the total shear force V_2 by the number of angle brackets present in the wall (taking into account the possible presence of angle brackets on both sides of the structural element).

$$V_a = \frac{V_2}{n_{anc}}$$

where

V_2 is the design shear force on the considered wall

n_{anc} is the number of shear connections present in the wall

The shear force acting on the most loaded anchor is calculated taking into account the additional moment due to the non-alignment between the external forces acting on the vertical flange of the angle bracket and the anchor itself using a coefficient, indicated as k_t.

$$V_p = V_a \cdot k_t$$

Wall name	Length [m]	Connection name	N of connections	Combination	Duration	V_2 [kN]	Va [kN]	kt	Vp [kN]
Wall 10	2.45	Ground connection - hold down - bracket	4	ULS earthquake stability 4 ex- ey+	5 seconds	3.25	0.81	0.97	0.79
Wall 11	2.45	Ground connection - hold down - bracket	4	ULS earthquake stability 4 ex- ey+	5 seconds	3.25	0.81	0.97	0.79
Wall 12	2.45	Ground connection - hold down - bracket	4	ULS earthquake stability 4 ex- ey+	5 seconds	3.25	0.81	0.97	0.79
Wall 13	2.45	Ground connection - hold down - bracket	4	ULS earthquake stability 4 ex- ey+	5 seconds	3.25	0.81	0.97	0.79
Wall 14	2.50	Ground connection - hold down - bracket	5	ULS Wind 6	5 seconds	13.51	2.70	0.97	2.62
Wall 15	2.45	Ground connection - hold down - bracket	4	ULS earthquake stability 1 ex- ey-	5 seconds	3.40	0.85	0.97	0.83
Wall 16	2.45	Ground connection - hold down - bracket	4	ULS earthquake stability 1 ex- ey-	5 seconds	3.40	0.85	0.97	0.83
Wall 18	2.50	Ground connection - hold down - bracket	5	ULS Wind 6	5 seconds	11.08	2.22	0.97	2.15
Wall 21	1.87	Ground connection - hold down - bracket	3	ULS earthquake stability 1 ex- ey-	5 seconds	2.51	0.84	0.97	0.81
Wall 22	2.45	Ground connection - hold down - bracket	4	ULS earthquake stability 1 ex- ey-	5 seconds	3.40	0.85	0.97	0.83
Wall 23	2.50	Ground connection - hold down - bracket	5	ULS Wind 6	5 seconds	9.17	1.83	0.97	1.78
Wall 24	1.30	Ground connection - hold down - bracket	2	ULS earthquake stability 1 ex+ ey-	5 seconds	1.46	0.73	0.97	0.71
Wall 25	2.49	Ground connection - hold down - bracket	4	ULS Wind 6	5 seconds	10.19	2.55	0.97	2.47

Angle bracket *bearing capacity*

The design value of the shear bearing capacity of the angle bracket can be estimated from the characteristic value by means of the following expression

$$R_{a,d} = \phi \cdot \mathrm{k}_1 \cdot \mathrm{k}_{13} \cdot \mathrm{k}_{14} \cdot \mathrm{R}_{\mathrm{a,k,dens}}$$

where

$\mathrm{R}_{\mathrm{a,k,dens}}$ is the characteristic value of the nailing resistance. It already considers the effect of multiple nails in the joint and the effect of the restraint against the rotation of the fastener head. This value is reduced by the k_{dens} factor when the density of the material used is less than 350 kg/m3. k_{dens} can be evaluated using the formula $\mathrm{R}_{\mathrm{c,k,dens}} = \mathrm{R}_{\mathrm{c,k}} \cdot \left(\frac{\rho_{\mathrm{k}}}{350}\right)^2$.

ϕ is the capacity factor for nails and screws

k_1 is the modification factor for duration of load for joints

k_{13} is equal to 1 for fasteners in side grain

k_{14} is equal to 1 for fasteners in single shear

Anchor *bearing capacity*

The design value of the shear strength of the anchor is evaluated as

$$R_{p,d} = \phi \cdot \mathrm{R}_{\mathrm{p,k}}$$

where

$R_{p,k}$ is the characteristic value of the shear strength of the anchor

ϕ is the capacity factor provided by manufacturers

The checks are summarized in the following tables according to each failure mode.

Name: Name of the connection in which the angle bracket is used

Comb.: The most severe combination of load

$V_{a,d}$: Shear force acting on the angle bracket

$V_{p,d}$: Shear force acting on the most stressed anchor

$$V_{a,d} \leq R_{a,d}$$

$$V_{p,d} \leq R_{p,d}$$

Wall name	Connection name	Comb.	$V_{a,d}$ [kN]	$R_{a,k,dens}$ [kN]	k_1	ϕ	$R_{a,d}$ [kN]	Check – angle brackets	$V_{p,d}$ [kN]	$R_{p,k}$ [kN]	ϕ	$R_{p,d}$ [kN]	Check - anchor
Wall 10	Ground connection - hold down - bracket	ULS earthquake stability 4 ex- ey+	0.81	18.09	1.14	0.85	17.53	5%	0.79	21	0.8	16.8	5%
Wall 11	Ground connection - hold down - bracket	ULS earthquake stability 4 ex- ey+	0.81	18.09	1.14	0.85	17.53	5%	0.79	21	0.8	16.8	5%
Wall 12	Ground connection - hold down - bracket	ULS earthquake stability 4 ex- ey+	0.81	18.09	1.14	0.85	17.53	5%	0.79	21	0.8	16.8	5%
Wall 13	Ground connection - hold down - bracket	ULS earthquake stability 4 ex- ey+	0.81	18.09	1.14	0.85	17.53	5%	0.79	21	0.8	16.8	5%
Wall 14	Ground connection - hold down - bracket	ULS Wind 6	2.70	18.09	1.14	0.85	17.53	15%	2.62	21	0.8	16.8	16%
Wall 15	Ground connection - hold down - bracket	ULS earthquake stability 1 ex- ey-	0.85	18.09	1.14	0.85	17.53	5%	0.83	21	0.8	16.8	5%
Wall 16	Ground connection - hold down - bracket	ULS earthquake stability 1 ex- ey-	0.85	18.09	1.14	0.85	17.53	5%	0.83	21	0.8	16.8	5%
Wall 18	Ground connection - hold down - bracket	ULS Wind 6	2.22	18.09	1.14	0.85	17.53	13%	2.15	21	0.8	16.8	13%
Wall 21	Ground connection - hold down - bracket	ULS earthquake stability 1 ex- ey-	0.84	18.09	1.14	0.85	17.53	5%	0.81	21	0.8	16.8	5%
Wall 22	Ground connection - hold down - bracket	ULS earthquake stability 1 ex- ey-	0.85	18.09	1.14	0.85	17.53	5%	0.83	21	0.8	16.8	5%
Wall 23	Ground connection - hold down - bracket	ULS Wind 6	1.83	18.09	1.14	0.85	17.53	10%	1.78	21	0.8	16.8	11%
Wall 24	Ground connection - hold down - bracket	ULS earthquake stability 1 ex+ ey-	0.73	18.09	1.14	0.85	17.53	4%	0.71	21	0.8	16.8	4%
Wall 25	Ground connection - hold down - bracket	ULS Wind 6	2.55	18.09	1.14	0.85	17.53	15%	2.47	21	0.8	16.8	15%

Shear connections with punched metal plate

The design resistance R_d of a punched metal plate is determined as the minimum value among the resistances relating to the following failure modes:

- Shear failure of the metal plate
- Shear failure of the group of fasteners of the connection

Shear forces

The shear force acting on the single metal plate is calculated by dividing the total shear force V_2 by the number of metal plates in the wall (taking into account the possible presence of angle brackets on both sides of the structural element).

$$V_a = \frac{V_2}{n_{anc}}$$

where

V_2 is the design shear force on the considered wall

n_{anc} is the number of shear connections present in the wall

Wall name	Length [m]	Connection name	N of connections	Comb.	Dur.	V_2 [kN]	Va [kN]
Wall 35	2.45	Upper levels - tensile plate - shear plate	4	ULS earthquake stability 4 ex- ey+	5 seconds	1.71	0.43
Wall 36	2.45	Upper levels - tensile plate - shear plate	4	ULS earthquake stability 4 ex- ey+	5 seconds	1.71	0.43
Wall 37	2.45	Upper levels - tensile plate - shear plate	4	ULS earthquake stability 4 ex- ey+	5 seconds	1.71	0.43
Wall 38	2.45	Upper levels - tensile plate - shear plate	4	ULS earthquake stability 4 ex- ey+	5 seconds	1.71	0.43
Wall 39	2.50	Upper levels - tensile plate - shear plate	5	ULS Wind 6	5 seconds	4.50	0.90
Wall 40	2.45	Upper levels - tensile plate - shear plate	4	ULS earthquake stability 1 ex+ ey-	5 seconds	1.80	0.45
Wall 41	2.45	Upper levels - tensile plate - shear plate	4	ULS earthquake stability 1 ex+ ey-	5 seconds	1.80	0.45
Wall 43	2.50	Upper levels - tensile plate - shear plate	5	ULS Wind 6	5 seconds	3.69	0.74
Wall 46	1.87	Upper levels - tensile plate - shear plate	3	ULS earthquake stability 1 ex+ ey-	5 seconds	1.33	0.44
Wall 47	2.45	Upper levels - tensile plate - shear plate	4	ULS earthquake stability 1 ex+ ey-	5 seconds	1.80	0.45
Wall 48	2.50	Upper levels - tensile plate - shear plate	5	ULS Wind 6	5 seconds	3.06	0.61
Wall 49	1.30	Upper levels - tensile plate - shear plate	2	ULS earthquake stability 1 ex+ ey-	5 seconds	0.79	0.39
Wall 50	2.49	Upper levels - tensile plate - shear plate	4	ULS Wind 6	5 seconds	3.39	0.85

Metal plate *shear capacity*

The design value of the shear strength of single metal plate is calculated according to the following expression by assuming an uniform distribution of the stress:

$$\mathrm{V}^* = \phi \cdot \mathrm{V_u} = \phi \cdot 0.6 \cdot \mathrm{f_y} \cdot \mathrm{A_v}$$

where

ϕ is the capacity factor for steel in shear

A_v is the net shear area

f_y is the nominal value of the yield strength of the steel

Nailing *capacity*

The design capacity of Type 1 joints with nails and screws is given by the following equation:

$$R_{c,d} = \phi \cdot k_1 \cdot k_{13} \cdot k_{14} \cdot k_{16} \cdot k_{17} \cdot n \cdot R_{c,k}$$

where

ϕ is the capacity factor for nails and screws

k_1 is the modification factor for the duration of load for joints

k_{13} is equal to 1 for fasteners in side grain

k_{14} is equal to 1 for fasteners in single shear

k_{16} is assumed equal to 1 since its contribution is already considered in the $R_{c,k}$ value

k_{17} is the modification factor for multiple nailed and screwed joints

n is the total number of fasteners in the joint resisting the design action

$R_{c,k}$ is the characteristic capacity of a single fastener estimated according to the Johansen theory of timber connections with dowel-type fasteners for steel-to-timber connections in single shear.

Wall name	Connection name	Number of rows	Number of fasteners in a row	Combination	Rc,k [N]	k_1	k_{13}	k_{14}	k_{16}	k_{17}	n	ϕ	$R_{c,d}$ [kN]
Wall 35	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 4 ex- ey+	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 36	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 4 ex- ey+	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 37	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 4 ex- ey+	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 38	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 4 ex- ey+	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 39	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 40	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex+ ey-	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 41	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex+ ey-	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 43	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 46	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex+ ey-	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 47	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex+ ey-	1840.55	1.14	1	1	1	0.90	30	0.85	48.15

Wall 48	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 49	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex+ ey-	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 50	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	1840.55	1.14	1	1	1	0.90	30	0.85	48.15

The checks are summarized in the following table which shows the characteristic and design values of resistance associated with the different failure modes of the components.

Wall name	Connection name	Combination	$V_{a,Ed}$ [kN]	$R_{c,d}$ [kN]	Fasteners check	V_u [kN]	ϕ	V* [kN]	Metal plate check
Wall 35	Upper levels - tensile plate - shear plate	ULS earthquake stability 4 ex- ey+	0.43	48.15	1%	45	0.9	40.5	1%
Wall 36	Upper levels - tensile plate - shear plate	ULS earthquake stability 4 ex- ey+	0.43	48.15	1%	45	0.9	40.5	1%
Wall 37	Upper levels - tensile plate - shear plate	ULS earthquake stability 4 ex- ey+	0.43	48.15	1%	45	0.9	40.5	1%
Wall 38	Upper levels - tensile plate - shear plate	ULS earthquake stability 4 ex- ey+	0.43	48.15	1%	45	0.9	40.5	1%
Wall 39	Upper levels - tensile plate - shear plate	ULS Wind 6	0.90	48.15	2%	45	0.9	40.5	2%
Wall 40	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex+ ey-	0.45	48.15	1%	45	0.9	40.5	1%
Wall 41	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex+ ey-	0.45	48.15	1%	45	0.9	40.5	1%
Wall 43	Upper levels - tensile plate - shear plate	ULS Wind 6	0.74	48.15	2%	45	0.9	40.5	2%
Wall 46	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex+ ey-	0.44	48.15	1%	45	0.9	40.5	1%
Wall 47	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex+ ey-	0.45	48.15	1%	45	0.9	40.5	1%
Wall 48	Upper levels - tensile plate - shear plate	ULS Wind 6	0.61	48.15	1%	45	0.9	40.5	2%
Wall 49	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex+ ey-	0.39	48.15	1%	45	0.9	40.5	1%
Wall 50	Upper levels - tensile plate - shear plate	ULS Wind 6	0.85	48.15	2%	45	0.9	40.5	2%

Inter-storey drift checks

The inter-storey drifts at the ultimate limit state calculated from the relevant seismic forces are limited in accordance to the following equation:

$$d_i < d_{\mathrm{i,lim}} = 0.015\ \mathrm{h}$$

where

d_i is the inelastic inter-storey drift obtained by multiplying the value determined by an elastic analysis by μ/S_p

h is the storey height

The table below shows the drift checks for each wall.

Wall name: Wall ID

h: Storey height

Comb.: The most severe combination of load

d_i: Evaluated inter-storey drift

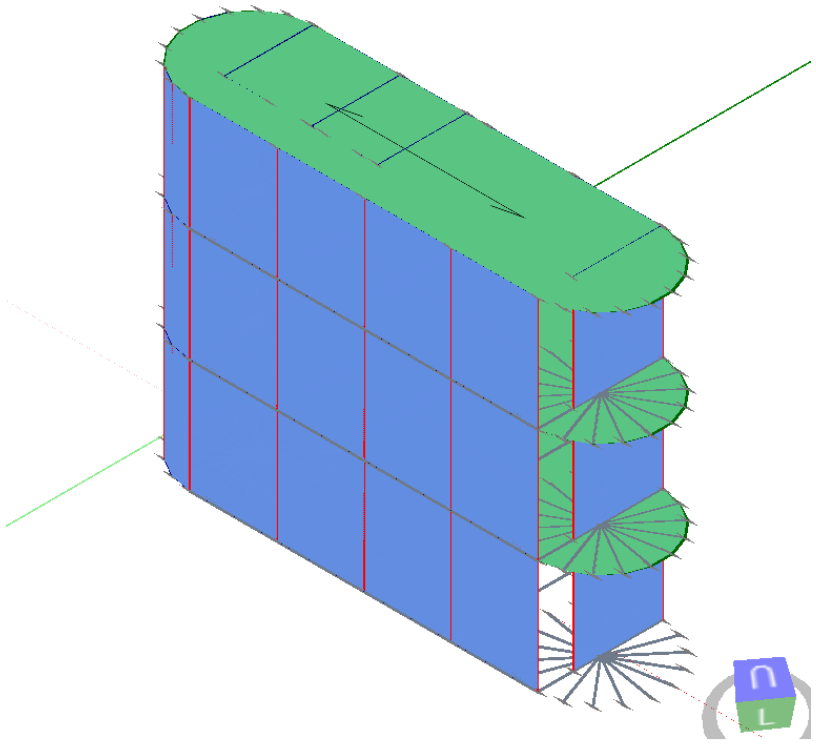
$d_{i,lim}$: Inter-storey drift limit

The table provides the Drift checks in the case of Dynamic Linear Analysis.

Wall	h [m]	Comb.	d_r [mm]	d_{lim} [mm]	Check
Wall 10	3.20	ULS earthquake drift 2 ex- ey+	5.64	48.00	12%
Wall 11	3.20	ULS earthquake drift 2 ex- ey+	5.64	48.00	12%
Wall 12	3.20	ULS earthquake drift 2 ex- ey+	5.64	48.00	12%
Wall 13	3.20	ULS earthquake drift 2 ex- ey+	5.64	48.00	12%
Wall 14	3.20	ULS earthquake drift 4 ex+ ey-	10.83	48.00	23%
Wall 15	3.20	ULS earthquake drift 1 ex- ey-	5.80	48.00	12%
Wall 16	3.20	ULS earthquake drift 1 ex- ey-	5.80	48.00	12%
Wall 18	3.20	ULS earthquake drift 4 ex+ ey-	6.04	48.00	13%
Wall 21	3.20	ULS earthquake drift 1 ex- ey-	5.80	48.00	12%
Wall 22	3.20	ULS earthquake drift 1 ex- ey-	5.80	48.00	12%
Wall 23	3.20	ULS earthquake drift 4 ex- ey-	9.54	48.00	20%
Wall 24	3.20	ULS earthquake drift 1 ex- ey-	5.36	48.00	11%
Wall 25	3.20	ULS earthquake drift 4 ex- ey-	7.34	48.00	15%
Wall 35	3.20	ULS earthquake drift 2 ex- ey+	2.91	48.00	6%
Wall 36	3.20	ULS earthquake drift 2 ex- ey+	2.91	48.00	6%
Wall 37	3.20	ULS earthquake drift 2 ex- ey+	2.91	48.00	6%
Wall 38	3.20	ULS earthquake drift 2 ex- ey+	2.91	48.00	6%
Wall 39	3.20	ULS earthquake drift 4 ex+ ey-	5.93	48.00	12%
Wall 40	3.20	ULS earthquake drift 1 ex- ey-	2.99	48.00	6%
Wall 41	3.20	ULS earthquake drift 1 ex- ey-	2.99	48.00	6%
Wall 43	3.20	ULS earthquake drift 4 ex+ ey-	3.19	48.00	7%
Wall 46	3.20	ULS earthquake drift 1 ex- ey-	2.99	48.00	6%
Wall 47	3.20	ULS earthquake drift 1 ex- ey-	2.99	48.00	6%
Wall 48	3.20	ULS earthquake drift 4 ex- ey-	4.90	48.00	10%
Wall 49	3.20	ULS earthquake drift 1 ex- ey-	2.77	48.00	6%
Wall 50	3.20	ULS earthquake drift 4 ex- ey-	3.80	48.00	8%

Appendix F
TECHNICAL DESIGN CALCULATION REPORT

Design of Timber Structures



Project: The Challenge Cup – Three modules

Design codes and standards

The analysis have been carried out according to:

1. **AS/NZS 1170.0:2002 – Structural Design Actions**

   Part 0: General principles

2. **AS/NZS 1170.1:2002 – Structural Design Actions**

   Part 1: Permanent, imposed and other actions

3. **AS/NZS 1170.2:2011 – Structural Design Actions**

   Part 2: Wind actions

4. **AS/NZS 1170.3:2003 – Structural Design Actions**

   Part 3: Snow and ice actions

5. **AS 1170.4-2007 – Structural Design Actions**

   Part 4: Earthquake actions in Australia

6. **AS 1720.1-2010 – Timber Structures**

   Part 1: Design methods

7. **AS 1720.2-2006 – Timber Structures**

   Part 2: Timber properties

General description of the building

Location

Address: Melbourne City

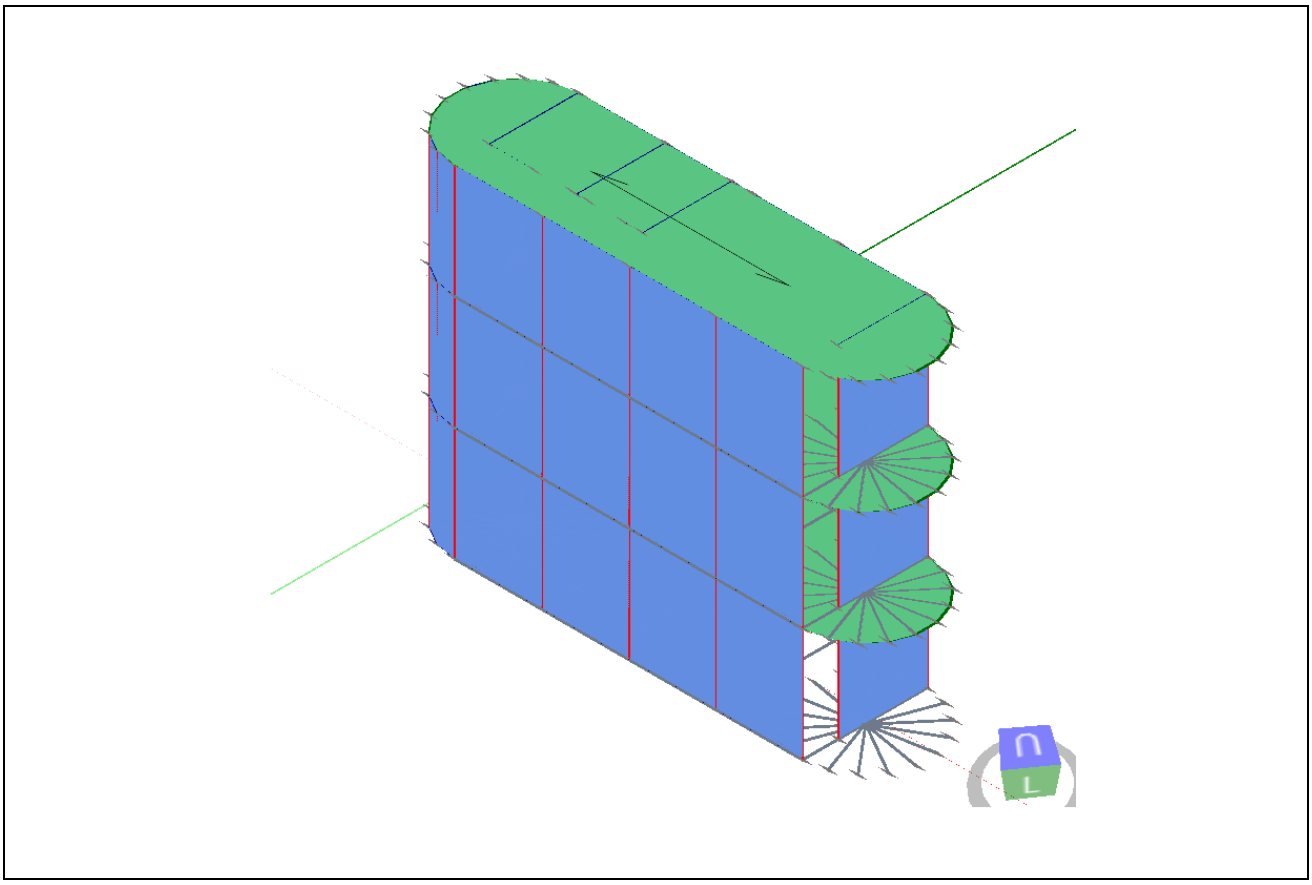
Description

Building length: 3.5 m

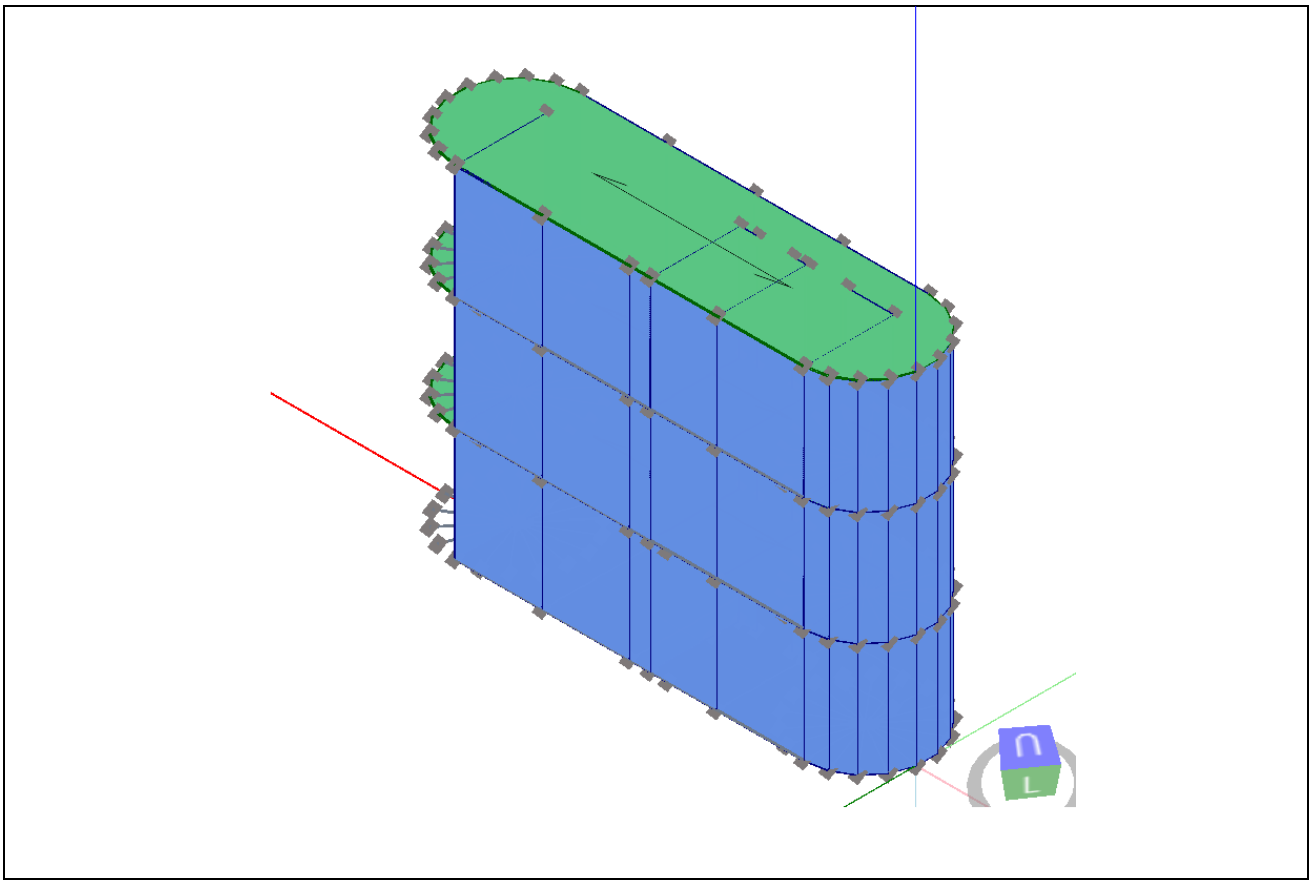
Building width: 13.25 m

Building height: 9.6 m

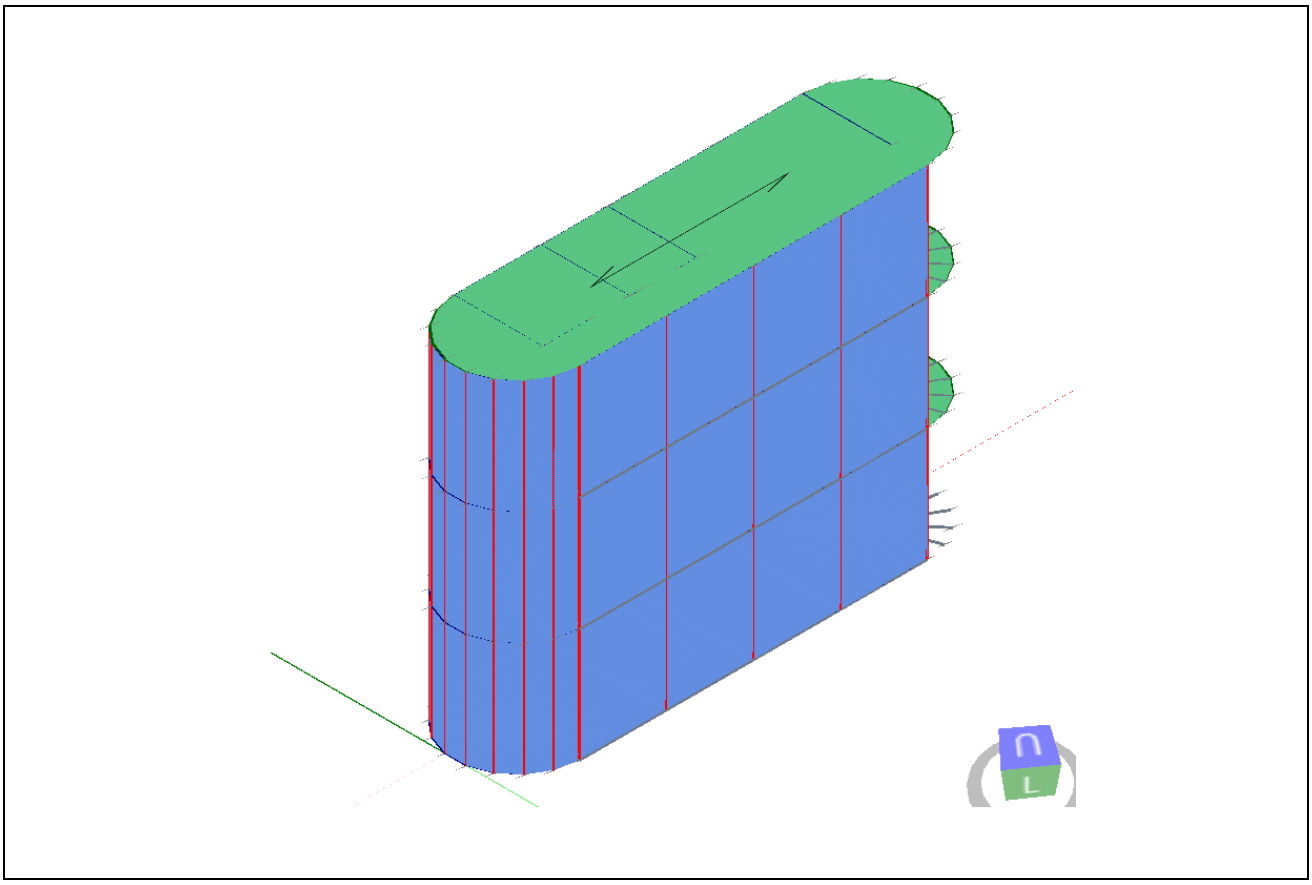
Three-dimensional Southeast view



Three-dimensional Northwest view



Three-dimensional South West view



Three-dimensional North East view

Materials

Wooden materials

The materials used in the project are listed in the following tables.

f'_b Characteristic bending strength

f'_t Characteristic tensile strength parallel to grain

f'_c Characteristic compressive strength parallel to grain

f'_s Characteristic shear strength

E Short duration average modulus of elasticity parallel to the grain

G Short duration average modulus of rigidity

ρ Average minimum density

MGP

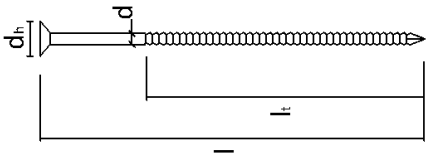
Descr	Joint group	f'_b [MPa]	f'_t [MPa]	f'_c [MPa]	f'_s [MPa]	E [MPa]	G [MPa]	ρ [kg/m^3]
MGP 10 - 90 x 45	JD5	17	7.7	18	2.6	10000	670	380.00000004

Plywood

Grade	Species	Joint group	f'_s [MPa]	G [MPa]	ρ [kg/m^3]
F14	Pinus species	JD4	4.8	625	480

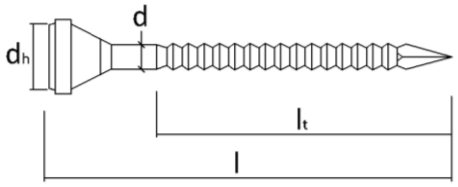
Metal fasteners

Threaded nails



Manufacturer	Code	Descr.	l [mm]	l_t [mm]	d [mm]	d_h [mm]	f_{uk} [MPa]
Rotho Blaas	HH10502003	Ring nail (coils) 2.8/3.1 x 60	60	40	2.8	4.3	600

Anker nails



Manufacturer	Code	Descr.	l [mm]	l_t [mm]	d [mm]	d_h [mm]	f_{uk} [MPa]
Rotho Blaas	PF601460	Anker nail - LBA 4.0 X 60	60	50	4	5.4	600

Calculation method and numerical model

Model Description

Hypothesis adopted for the elements

The timber walls are constrained at the base by means of connection systems capable of transmitting both in-plane and out-of-plane actions action on the wall.

In the analysis, in presence of horizontal loads, some elements may be defined as “secondary”: this mean that their strength and stiffness are neglected in the calculation of the response of the building. In the model these elements are represented in terms of mass and they are designed only for vertical loads.

Rigid body rocking – Forces on hold-down / tie-down

The hold-down or tie-down systems are used to prevent the rotation of the wall caused by the overturning moment of the horizontal force. The hold-down, placed on the in-tension edge of the wall, is loaded by a force equal to

$$T = \begin{cases} \left(\frac{M_{3-3}}{b} - \frac{N}{2}\right) \cdot \frac{1}{n_{anc}} & for\ active\ hold-down \\ 0 & for\ inactive\ hold-down \end{cases}$$

where:

b is the lever arm for the internal couple assumed equal to *l*, where *l* is the wall length

N is the axial vertical load acting on the wall

M_{3-3} is the moment acting in the plane of the wall

n_{anc} is the number of connections present at each end of the wall

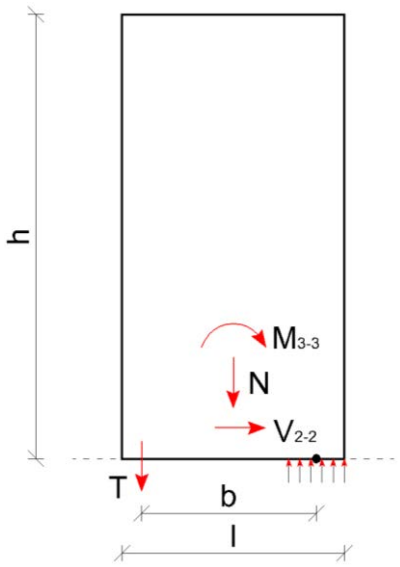


Figure: Calculation model of tensile force acting on the hold-down

Structural elements

The following table shows the positions of the individual walls. The last four columns show the coordinates of the ends of each wall.

X1 e Y1 indicate the coordinates of the starting point of the wall

X2 e Y2 indicate the coordinates of the end point of the wall

Wall name	Type of wall	Element resistant to horizontal loads	Height [m]	Length [m]	Altitude [m]	X1 [m]	Y1 [m]	X2 [m]	Y2 [m]
Wall 1	Frame	No	3.2	0.61	0	1.72	1.45	1.12	1.34
Wall 10	Frame	Yes	3.2	2.45	0	1.72	-2.05	4.17	-2.05
Wall 11	Frame	Yes	3.2	2.45	0	4.17	-2.05	6.62	-2.05
Wall 12	Frame	Yes	3.2	2.45	0	6.62	-2.05	9.07	-2.05
Wall 13	Frame	Yes	3.2	2.45	0	9.07	-2.05	11.52	-2.05
Wall 14	Frame	Yes	3.2	2.5	0	11.52	-1.05	11.52	1.45
Wall 15	Frame	Yes	3.2	2.45	0	11.52	1.45	9.07	1.45
Wall 16	Frame	Yes	3.2	2.45	0	9.07	1.45	6.62	1.45
Wall 17	Frame	No	3.2	0.58	0	6.62	1.45	6.04	1.45
Wall 18	Frame	Yes	3.2	2.5	0	6.04	1.45	6.04	-1.05
Wall 19	Frame	No	3.2	0.5	0	6.04	-1.05	5.54	-1.05
Wall 2	Frame	No	3.2	0.6	0	1.12	1.34	0.6	1.04
Wall 20	Frame	No	3.2	0.46	0	4.54	-1.04	4.08	-1.04
Wall 21	Frame	Yes	3.2	1.87	0	6.04	1.45	4.17	1.45
Wall 22	Frame	Yes	3.2	2.45	0	4.17	1.45	1.72	1.45
Wall 23	Frame	Yes	3.2	2.5	0	1.72	1.45	1.72	-1.05
Wall 24	Frame	Yes	3.2	1.3	0	1.72	-1.05	3.02	-1.05
Wall 25	Frame	Yes	3.2	2.49	0	4.17	1.45	4.17	-1.04
Wall 26	Frame	No	3.2	0.61	3.2	1.72	1.45	1.12	1.34
Wall 27	Frame	No	3.2	0.6	3.2	1.12	1.34	0.6	1.04
Wall 28	Frame	No	3.2	0.61	3.2	0.6	1.04	0.21	0.57
Wall 29	Frame	No	3.2	0.61	3.2	0.21	0.57	0	0
Wall 3	Frame	No	3.2	0.61	0	0.6	1.04	0.21	0.57
Wall 30	Frame	No	3.2	0.6	3.2	0	0	0	-0.6
Wall 31	Frame	No	3.2	0.61	3.2	0	-0.6	0.21	-1.17
Wall 32	Frame	No	3.2	0.61	3.2	0.21	-1.17	0.6	-1.64
Wall 33	Frame	No	3.2	0.6	3.2	0.6	-1.64	1.12	-1.94
Wall 34	Frame	No	3.2	0.61	3.2	1.12	-1.94	1.72	-2.05
Wall 35	Frame	Yes	3.2	2.45	3.2	1.72	-2.05	4.17	-2.05
Wall 36	Frame	Yes	3.2	2.45	3.2	4.17	-2.05	6.62	-2.05
Wall 37	Frame	Yes	3.2	2.45	3.2	6.62	-2.05	9.07	-2.05
Wall 38	Frame	Yes	3.2	2.45	3.2	9.07	-2.05	11.52	-2.05
Wall 39	Frame	Yes	3.2	2.5	3.2	11.52	-1.05	11.52	1.45
Wall 4	Frame	No	3.2	0.61	0	0.21	0.57	0	0
Wall 40	Frame	Yes	3.2	2.45	3.2	11.52	1.45	9.07	1.45
Wall 41	Frame	Yes	3.2	2.45	3.2	9.07	1.45	6.62	1.45
Wall 42	Frame	No	3.2	0.58	3.2	6.62	1.45	6.04	1.45
Wall 43	Frame	Yes	3.2	2.5	3.2	6.04	1.45	6.04	-1.05
Wall 44	Frame	No	3.2	0.5	3.2	6.04	-1.05	5.54	-1.05
Wall 45	Frame	No	3.2	0.46	3.2	4.54	-1.04	4.08	-1.04
Wall 46	Frame	Yes	3.2	1.87	3.2	6.04	1.45	4.17	1.45
Wall 47	Frame	Yes	3.2	2.45	3.2	4.17	1.45	1.72	1.45
Wall 48	Frame	Yes	3.2	2.5	3.2	1.72	1.45	1.72	-1.05
Wall 49	Frame	Yes	3.2	1.3	3.2	1.72	-1.05	3.02	-1.05
Wall 5	Frame	No	3.2	0.6	0	0	0	0	-0.6
Wall 50	Frame	Yes	3.2	2.49	3.2	4.17	1.45	4.17	-1.04
Wall 51	Frame	No	3.2	0.61	6.4	1.72	1.45	1.12	1.34
Wall 52	Frame	No	3.2	0.6	6.4	1.12	1.34	0.6	1.04
Wall 53	Frame	No	3.2	0.61	6.4	0.6	1.04	0.21	0.57
Wall 54	Frame	No	3.2	0.61	6.4	0.21	0.57	0	0
Wall 55	Frame	No	3.2	0.6	6.4	0	0	0	-0.6
Wall 56	Frame	No	3.2	0.61	6.4	0	-0.6	0.21	-1.17
Wall 57	Frame	No	3.2	0.61	6.4	0.21	-1.17	0.6	-1.64
Wall 58	Frame	No	3.2	0.6	6.4	0.6	-1.64	1.12	-1.94
Wall 59	Frame	No	3.2	0.61	6.4	1.12	-1.94	1.72	-2.05
Wall 6	Frame	No	3.2	0.61	0	0	-0.6	0.21	-1.17
Wall 60	Frame	Yes	3.2	2.45	6.4	1.72	-2.05	4.17	-2.05
Wall 61	Frame	Yes	3.2	2.45	6.4	4.17	-2.05	6.62	-2.05
Wall 62	Frame	Yes	3.2	2.45	6.4	6.62	-2.05	9.07	-2.05
Wall 63	Frame	Yes	3.2	2.45	6.4	9.07	-2.05	11.52	-2.05
Wall 64	Frame	Yes	3.2	2.5	6.4	11.52	-1.05	11.52	1.45
Wall 65	Frame	Yes	3.2	2.45	6.4	11.52	1.45	9.07	1.45
Wall 66	Frame	Yes	3.2	2.45	6.4	9.07	1.45	6.62	1.45
Wall 67	Frame	No	3.2	0.58	6.4	6.62	1.45	6.04	1.45
Wall 68	Frame	Yes	3.2	2.5	6.4	6.04	1.45	6.04	-1.05
Wall 69	Frame	No	3.2	0.5	6.4	6.04	-1.05	5.54	-1.05
Wall 7	Frame	No	3.2	0.61	0	0.21	-1.17	0.6	-1.64
Wall 70	Frame	No	3.2	0.46	6.4	4.54	-1.04	4.08	-1.04
Wall 71	Frame	Yes	3.2	1.87	6.4	6.04	1.45	4.17	1.45
Wall 72	Frame	Yes	3.2	2.45	6.4	4.17	1.45	1.72	1.45
Wall 73	Frame	Yes	3.2	2.5	6.4	1.72	1.45	1.72	-1.05
Wall 74	Frame	Yes	3.2	1.3	6.4	1.72	-1.05	3.02	-1.05
Wall 75	Frame	Yes	3.2	2.49	6.4	4.17	1.45	4.17	-1.04
Wall 8	Frame	No	3.2	0.6	0	0.6	-1.64	1.12	-1.94
Wall 9	Frame	No	3.2	0.61	0	1.12	-1.94	1.72	-2.05

Wall horizontal stiffness

The wall stiffness can be estimated considering the contributions of all the components, as shown below.

Timber framed shear walls

In the case of framed walls the overall stiffness is calculated taking into account the contribution of the following components:

- sheeting boards (k_s)
- sheet-to-frame nailing (k_c)
- shear connections (k_a)
- tensile connections (k_h)

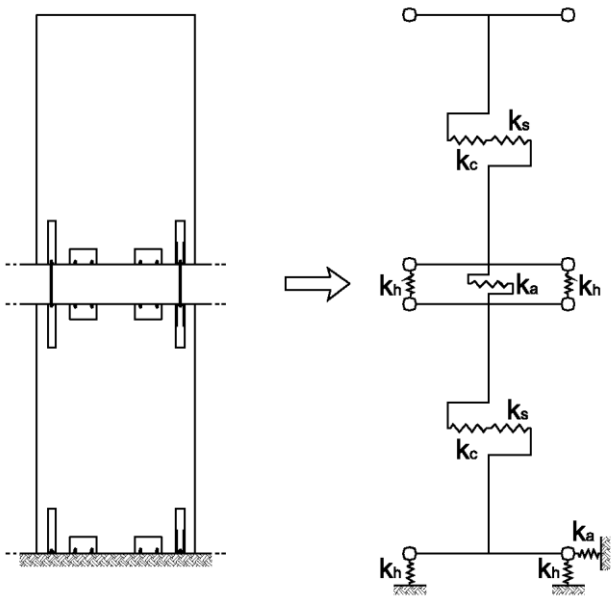


Figure: Mechanical model for framed walls overall stiffness

In case of metal-braced framed walls, the k_s and k_c contributions are replaced by a single term that takes into account the stiffness contribution of the metal bracing.

The following table indicates the positions of the walls and their equivalent shear stiffness.

Wall name	Type of wall	Element resistant to horizontal loads	Heigth [m]	Lenght [m]	Equivalent shear stiffness [kN/m]
Wall 1	Frame	No	3.2	0.61	0
Wall 10	Frame	Yes	3.2	2.45	1390
Wall 11	Frame	Yes	3.2	2.45	1390
Wall 12	Frame	Yes	3.2	2.45	1390
Wall 13	Frame	Yes	3.2	2.45	1390
Wall 14	Frame	Yes	3.2	2.5	1424
Wall 15	Frame	Yes	3.2	2.45	1390
Wall 16	Frame	Yes	3.2	2.45	1390
Wall 17	Frame	No	3.2	0.58	0

Wall 18	Frame	Yes	3.2	2.5	1424
Wall 19	Frame	No	3.2	0.5	0
Wall 2	Frame	No	3.2	0.6	0
Wall 20	Frame	No	3.2	0.46	0
Wall 21	Frame	Yes	3.2	1.87	1023
Wall 22	Frame	Yes	3.2	2.45	1390
Wall 23	Frame	Yes	3.2	2.5	1424
Wall 24	Frame	Yes	3.2	1.3	667
Wall 25	Frame	Yes	3.2	2.49	1415
Wall 26	Frame	No	3.2	0.61	0
Wall 27	Frame	No	3.2	0.6	0
Wall 28	Frame	No	3.2	0.61	0
Wall 29	Frame	No	3.2	0.61	0
Wall 3	Frame	No	3.2	0.61	0
Wall 30	Frame	No	3.2	0.6	0
Wall 31	Frame	No	3.2	0.61	0
Wall 32	Frame	No	3.2	0.61	0
Wall 33	Frame	No	3.2	0.6	0
Wall 34	Frame	No	3.2	0.61	0
Wall 35	Frame	Yes	3.2	2.45	1420
Wall 36	Frame	Yes	3.2	2.45	1420
Wall 37	Frame	Yes	3.2	2.45	1420
Wall 38	Frame	Yes	3.2	2.45	1420
Wall 39	Frame	Yes	3.2	2.5	1455
Wall 4	Frame	No	3.2	0.61	0
Wall 40	Frame	Yes	3.2	2.45	1420
Wall 41	Frame	Yes	3.2	2.45	1420
Wall 42	Frame	No	3.2	0.58	0
Wall 43	Frame	Yes	3.2	2.5	1455
Wall 44	Frame	No	3.2	0.5	0
Wall 45	Frame	No	3.2	0.46	0
Wall 46	Frame	Yes	3.2	1.87	1053
Wall 47	Frame	Yes	3.2	2.45	1420
Wall 48	Frame	Yes	3.2	2.5	1455
Wall 49	Frame	Yes	3.2	1.3	695
Wall 5	Frame	No	3.2	0.6	0
Wall 50	Frame	Yes	3.2	2.49	1445
Wall 51	Frame	No	3.2	0.61	0
Wall 52	Frame	No	3.2	0.6	0
Wall 53	Frame	No	3.2	0.61	0
Wall 54	Frame	No	3.2	0.61	0
Wall 55	Frame	No	3.2	0.6	0
Wall 56	Frame	No	3.2	0.61	0
Wall 57	Frame	No	3.2	0.61	0
Wall 58	Frame	No	3.2	0.6	0
Wall 59	Frame	No	3.2	0.61	0
Wall 6	Frame	No	3.2	0.61	0
Wall 60	Frame	Yes	3.2	2.45	1420
Wall 61	Frame	Yes	3.2	2.45	1420
Wall 62	Frame	Yes	3.2	2.45	1420
Wall 63	Frame	Yes	3.2	2.45	1420
Wall 64	Frame	Yes	3.2	2.5	1455
Wall 65	Frame	Yes	3.2	2.45	1420
Wall 66	Frame	Yes	3.2	2.45	1420
Wall 67	Frame	No	3.2	0.58	0
Wall 68	Frame	Yes	3.2	2.5	1455
Wall 69	Frame	No	3.2	0.5	0
Wall 7	Frame	No	3.2	0.61	0
Wall 70	Frame	No	3.2	0.46	0
Wall 71	Frame	Yes	3.2	1.87	1053
Wall 72	Frame	Yes	3.2	2.45	1420
Wall 73	Frame	Yes	3.2	2.5	1455
Wall 74	Frame	Yes	3.2	1.3	695
Wall 75	Frame	Yes	3.2	2.49	1445
Wall 8	Frame	No	3.2	0.6	0
Wall 9	Frame	No	3.2	0.61	0

Types of structural elements and sign conventions

*L*inear elements

The linear elements are used to model beams and columns. They have a local reference system with respect to which stress/force components are shown. The sign convention adopted is shown in the figure below.

Force	Description	Unit of measure
N	Axial force	kN
M_{3-3}	Bending moment about local axis 3	kN m
V_2	Shear along local axis 2	kN
M_{2-2}	Bending moment about local axis 2	kN m
V_3	Shear along local axis 3	kN

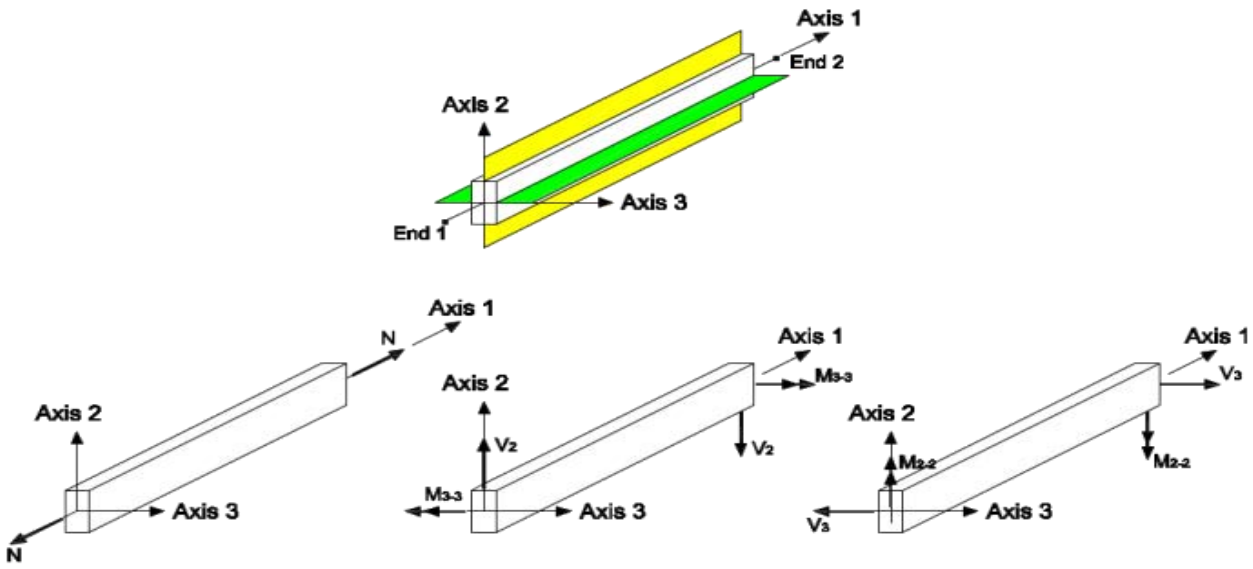


Figure: sign conventions for beams

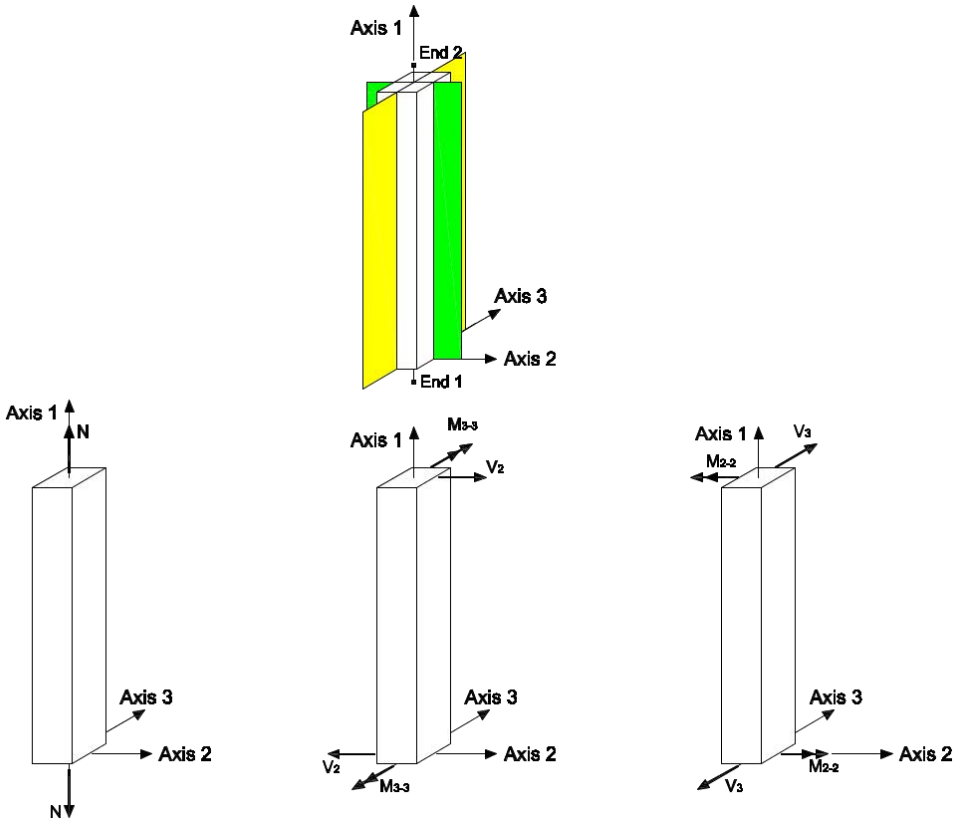


Figure: sign conventions for columns

Wall elements

The walls, regardless of type, have the following sign conventions.

	Stress	Description	Unit of measure
In-plane stresses	**n**	Axial stress (per unit length)	kN/m
	m_{3-3}	Bending moment about local axis 3 (per unit length)	kNm/m
	v_2	Shear along local axis 2 (per unit length)	kN/m

Out-of-plane stresses (plate)	m_{2-2}	Bending moment about local axis 2 (per unit length)	kNm/m
	v_3	Shear along local axis 3 (per unit length)	kN/m

	Force	Description	Unit of measure
In-plane stresses	N	Total axial force	kN
	M_{3-3}	Bending moment about local axis 3	kNm
	V_2	Shear along local axis 2	kN
Out-of-plane stresses (plate)	M_{2-2}	Bending moment about local axis 3	kNm
	V_3	Shear along local axis 2	kN

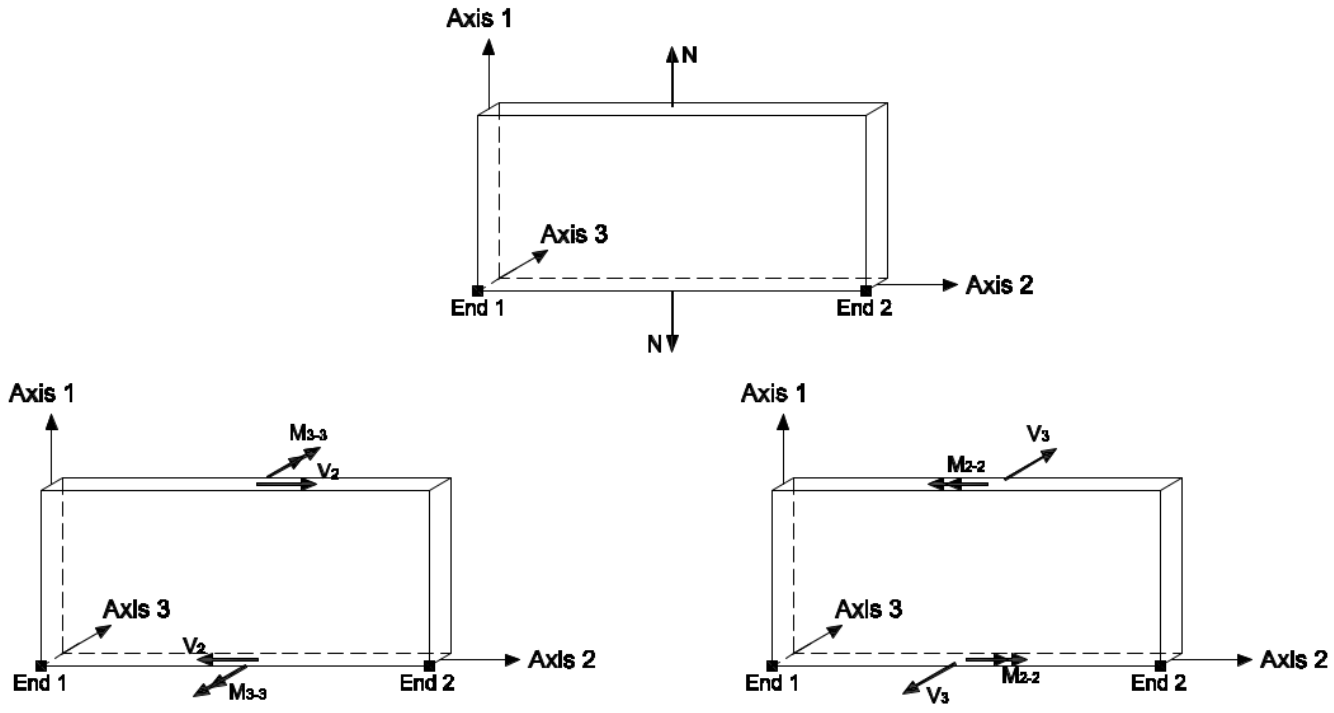


Figure: sign conventions for walls

Actions and design loads

Self-weight of structural materials

The weights of the structural materials are shown in the table below in kN/m^3

Description	Specific weight γ [kN/m^3]
MGP 10 - 90 x 45	5
F14 Plywood - Pinus species	5.5

Loads acting on the walls

The following table shows the loads acting on the walls.

Load name: Load ID

Position: Position of the wall: internal or external

g_{sw}: Self-weight

g_{ns}: Non-structural permanent loads

w_u: ULS wind load

Wall name	Position	Load name	g_{sw} [kN/m^2]	g_{ns} [kN/m^2]	w_u leeward [kN/m^2]	w_u windward [kN/m^2]
Wall 1	External	External walls load	0.35	0.6	-0.27	0.42
Wall 2	External	External walls load	0.36	0.6	-0.27	0.42
Wall 3	External	External walls load	0.35	0.6	-0.27	0.42
Wall 4	External	External walls load	0.35	0.6	-0.27	0.42
Wall 5	External	External walls load	0.36	0.6	-0.27	0.42
Wall 6	External	External walls load	0.35	0.6	-0.27	0.42
Wall 7	External	External walls load	0.35	0.6	-0.27	0.42
Wall 8	External	External walls load	0.36	0.6	-0.27	0.42
Wall 9	External	External walls load	0.35	0.6	-0.27	0.42
Wall 10	External	External walls load	0.2	0.6	-0.27	0.42
Wall 11	External	External walls load	0.2	0.6	-0.27	0.42
Wall 12	External	External walls load	0.2	0.6	-0.27	0.42
Wall 13	External	External walls load	0.2	0.6	-0.27	0.42
Wall 14	External	External walls load	0.2	0.6	-0.27	0.42
Wall 15	External	External walls load	0.2	0.6	-0.27	0.42
Wall 16	External	External walls load	0.2	0.6	-0.27	0.42
Wall 17	External	External walls load	0.37	0.6	-0.27	0.42
Wall 18	External	External walls load	0.2	0.6	-0.27	0.42
Wall 19	External	External walls load	0.41	0.6	-0.27	0.42
Wall 20	External	External walls load	0.44	0.6	-0.27	0.42
Wall 21	External	External walls load	0.22	0.6	-0.27	0.42
Wall 22	External	External walls load	0.2	0.6	-0.27	0.42
Wall 23	External	External walls load	0.2	0.6	-0.27	0.42
Wall 24	External	External walls load	0.25	0.6	-0.27	0.42
Wall 25	External	External walls load	0.2	0.6	-0.27	0.42
Wall 26	External	External walls load	0.35	0.6	-0.27	0.42
Wall 27	External	External walls load	0.36	0.6	-0.27	0.42
Wall 28	External	External walls load	0.35	0.6	-0.27	0.42
Wall 29	External	External walls load	0.35	0.6	-0.27	0.42
Wall 30	External	External walls load	0.36	0.6	-0.27	0.42
Wall 31	External	External walls load	0.35	0.6	-0.27	0.42
Wall 32	External	External walls load	0.35	0.6	-0.27	0.42
Wall 33	External	External walls load	0.36	0.6	-0.27	0.42
Wall 34	External	External walls load	0.35	0.6	-0.27	0.42
Wall 35	External	External walls load	0.2	0.6	-0.27	0.42
Wall 36	External	External walls load	0.2	0.6	-0.27	0.42
Wall 37	External	External walls load	0.2	0.6	-0.27	0.42
Wall 38	External	External walls load	0.2	0.6	-0.27	0.42
Wall 39	External	External walls load	0.2	0.6	-0.27	0.42
Wall 40	External	External walls load	0.2	0.6	-0.27	0.42
Wall 41	External	External walls load	0.2	0.6	-0.27	0.42
Wall 42	External	External walls load	0.37	0.6	-0.27	0.42
Wall 43	External	External walls load	0.2	0.6	-0.27	0.42

Wall 44	External	External walls load	0.41	0.6	-0.27	0.42
Wall 45	External	External walls load	0.44	0.6	-0.27	0.42
Wall 46	External	External walls load	0.22	0.6	-0.27	0.42
Wall 47	External	External walls load	0.2	0.6	-0.27	0.42
Wall 48	External	External walls load	0.2	0.6	-0.27	0.42
Wall 49	External	External walls load	0.25	0.6	-0.27	0.42
Wall 50	External	External walls load	0.2	0.6	-0.27	0.42
Wall 51	External	External walls load	0.35	0.6	-0.27	0.42
Wall 52	External	External walls load	0.36	0.6	-0.27	0.42
Wall 53	External	External walls load	0.35	0.6	-0.27	0.42
Wall 54	External	External walls load	0.35	0.6	-0.27	0.42
Wall 55	External	External walls load	0.36	0.6	-0.27	0.42
Wall 56	External	External walls load	0.35	0.6	-0.27	0.42
Wall 57	External	External walls load	0.35	0.6	-0.27	0.42
Wall 58	External	External walls load	0.36	0.6	-0.27	0.42
Wall 59	External	External walls load	0.35	0.6	-0.27	0.42
Wall 60	External	External walls load	0.2	0.6	-0.27	0.42
Wall 61	External	External walls load	0.2	0.6	-0.27	0.42
Wall 62	External	External walls load	0.2	0.6	-0.27	0.42
Wall 63	External	External walls load	0.2	0.6	-0.27	0.42
Wall 64	External	External walls load	0.2	0.6	-0.27	0.42
Wall 65	External	External walls load	0.2	0.6	-0.27	0.42
Wall 66	External	External walls load	0.2	0.6	-0.27	0.42
Wall 67	External	External walls load	0.37	0.6	-0.27	0.42
Wall 68	External	External walls load	0.2	0.6	-0.27	0.42
Wall 69	External	External walls load	0.41	0.6	-0.27	0.42
Wall 70	External	External walls load	0.44	0.6	-0.27	0.42
Wall 71	External	External walls load	0.22	0.6	-0.27	0.42
Wall 72	External	External walls load	0.2	0.6	-0.27	0.42
Wall 73	External	External walls load	0.2	0.6	-0.27	0.42
Wall 74	External	External walls load	0.25	0.6	-0.27	0.42
Wall 75	External	External walls load	0.2	0.6	-0.27	0.42

Loads acting on the floors

The following table shows the characteristic values of the loads acting on the decks.

Load name: Load ID

Position: Position of the floor: internal or external

Environment: Load type

α: Roof pitch angle

g_{sw}: Self-weight

g_{ns}: Non-structural permanent loads

q: Imposed actions

f_{sn}: Snow load

w_u: ULS wind load

w_s: SLS wind load

Floor name	Position	α [°]	Load name	Environment	g_{sw} [kN/m^2]	g_{ns} [kN/m^2]	q [kN/m^2]	f_{sn} [kN/m^2]	w_u leeward [kN/m^2]	w_u windward [kN/m^2]	w_s leeward [kN/m^2]	w_s windward [kN/m^2]
Floor 1	Internal floor	0	Floor load: residential	Other - General areas, bedrooms, hospital wards, hotel rooms, toilet areas	0.2	1	2	0	0	0	0	0
Floor 2	Internal floor	0	Floor load: residential	Other - General areas, bedrooms, hospital wards, hotel rooms, toilet areas	0.2	1	2	0	0	0	0	0
Floor 3	Internal floor	0	Floor load: residential	Other - General areas, bedrooms, hospital wards, hotel rooms, toilet areas	0.2	1	2	0	0	0	0	0

Technical Design Calculation Report

Seismic actions

The seismic actions are defined according to the AS 1170.4 - 2007. The earthquake motion at a given point on the surface is represented by an elastic ground acceleration response spectrum.

The response spectra are calculated according to the following parameters:

- the probability factor k_p for the annual probability of exceedance defined according to the importance level for the structure;
- the hazard factor Z that depends on the location of the building;
- the site sub-soil class.

The above-mentioned parameters are reported below:

Annual probability of exceedance	
Probability factor k_p	1.25
Hazard factor Z	0.09
Site sub-soil class	A

Horizontal elastic response spectrum

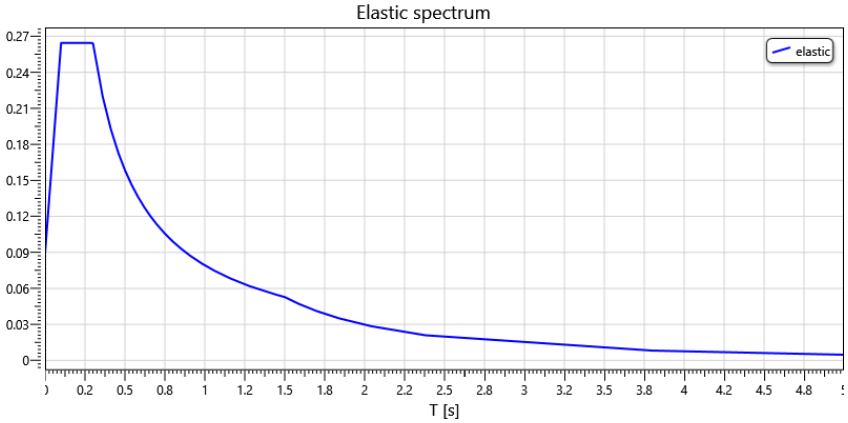
The values of the spectral shape factor $C_h(T)$ are defined by the following expressions in accordance to the site sub-soil class:

Site sub-soil class	$0 < T \leq 0.1\ s$	$0.1\ s < T \leq 1.5\ s$	$T > 1.5\ s$
A_e – Strong rock	$0.8 + 15.5\,T$	$\max(0.704/T\,;2.35)$	$1.056/T^2$
B_e – Rock	$1.0 + 19.4\,T$	$\max(0.88/T\,;2.94)$	$1.32/T^2$
C_e – Shallow soil	$1.3 + 23.8\,T$	$\max(1.25/T\,;3.68)$	$1.874/T^2$
D_e – Deep or soft soil	$1.1 + 25.8\,T$	$\max(1.98/T\,;3.68)$	$2.97/T^2$
E_e – Very soft soil	$1.1 + 25.8\,T$	$\max(3.08/T\,;3.68)$	$4.62/T^2$

The values of the elastic size hazard spectrum $C(T)$ depend on the above-defined spectral shape factor and on the values of the probability factor k_p and of the hazard factor Z according to the following equation:

$$C(T) = k_p \cdot Z \cdot C_h(T)$$

The resultant horizontal elastic site hazard spectrum is reported below



Design spectrum for elastic analysis

To avoid explicit inelastic structural analysis in design, the structural performance and its capacity to dissipate energy, through mainly ductile behavior of its elements and/or other mechanisms, is taken into account by performing an elastic analysis based on a response spectrum reduced with respect to the elastic one, henceforth called a "design spectrum".

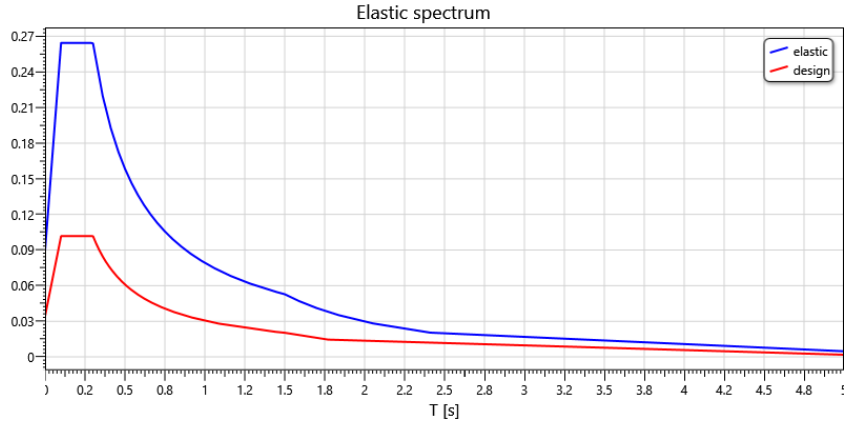
This reduction is accomplished by introducing the structural performance factor S_p and the structural ductility factor μ related to the structural system adopted.

Structural system	LF buildings - Thin bracing panels
Structural performance factor S_p	0.77
Structural ductility factor μ	2.00
μ/S_p	2.60

The design spectrum is defined by the following expressions:

$$C_d(T) = C(T) \cdot S_p/\mu = k_p \cdot Z \cdot C_h(T) \cdot S_p/\mu$$

The horizontal elastic response spectrum and the horizontal design spectrum (Ultimate Limit State) are shown below:



Sections of the structural elements

Framed walls

Frame geometric characteristics

t: *thickness of the frame*

h_b: *thickness of top and sole plates*

$b_{s,int}$: *width of the internal studs*

$b_{s,ext}$: *width of the external studs*

i_m: *average studs spacing*

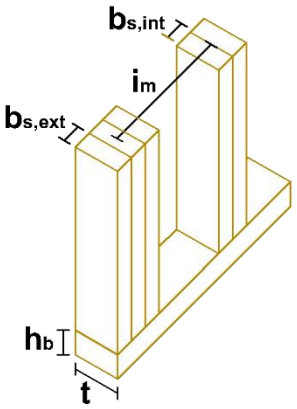


Figure: dimensions of the frame elements

The characteristics of the frame of each wall type are reported below.

Section name	# sides with bracing	Material	Frame thickness t [mm]	Thickness of top and sole plates h_b [mm]	Width of the internal studs $b_{s,int}$ [mm]	# elements for each internal stud	Width of the external studs $b_{s,ext}$ [mm]	# elements for each external stud	Average studs spacing i_m [mm]
Frame 1	1.00	MGP 10 - 90 x 45	90	45	45	1	45	4	409

Sheet-bracing geometrical characteristics

b_s: *sheeting boards width*

$s_{c,b}$: *spacing of fasteners along the perimeter of every sheet*

$s_{c,i}$: *spacing of internal fasteners*

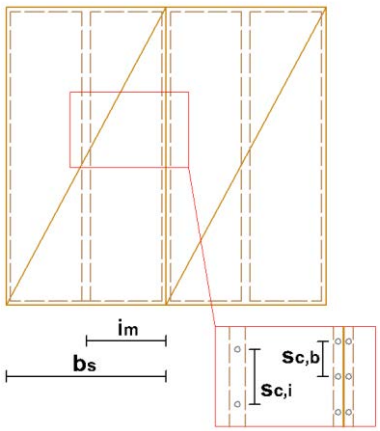


Figure: dimensions of the *sheeting boards and fasteners spacing*

The characteristics of the sheet-bracing are reported below.

Section name	Side	Material	Sheeting board thickness t_s [mm]	Sheeting boards width b_s [mm]	Frame-sheeting board fastener	Perimeter fasteners spacing $S_{c,b}$ [mm]	Internal fasteners spacing i $S_{c,i}$ [mm]
Frame 1	1	F14 Plywood - Pinus species	15	818	Ring nail (coils) 2.8/3.1 x 60	100	200

Floors with timber joists

Elements geometric characteristics

h_b: *Cross section height*

b_b: *Cross section width*

i_b: *Joists spacing*

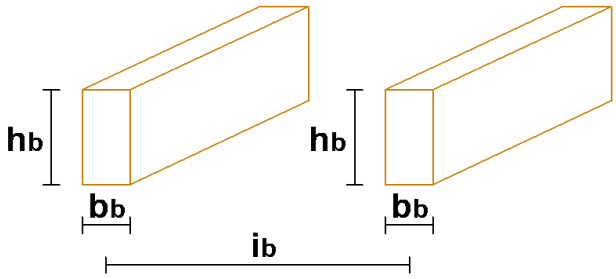


Figure: geometric characteristics of the floor

The following table sets out the details concerning the floor with joists.

Section name	Material	Cross section height h_b [mm]	Cross section width b_b [mm]	Joists spacing i_b [mm]
Joists floor 1	MGP 10 - 90 x 45	90	45	100

Connections

Hold Down

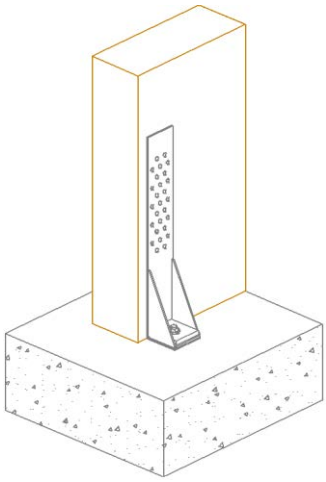


Figure: graphical representation of a hold-down in a base connection (timber wall – foundation connection)

Connection name	Connection position	Manufacturer	Description	Fasteners number	Fastener typology	Threaded rod / Anchor	Chemical anchor type	Number of hold-down at each wall end
Ground connection - hold down - bracket	Ground connection	Rotho Blass	WHT 340	14	Anker nail - LBA 4.0 X 40	INA - 5.8 - M16 x 160	EPOPLUS chemical anchor	1

Timber-reinforced concrete connection

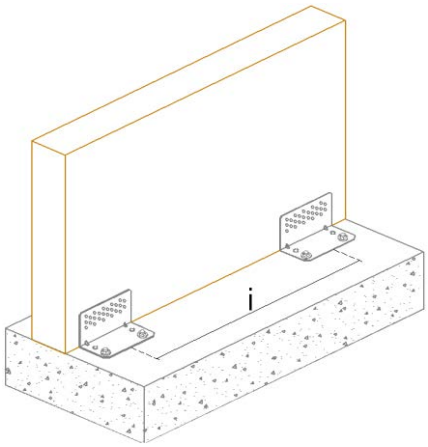


Figure: graphical representation of the shear connection with angle brackets

Connection name	Connection position	Manufacturer	Description	Fasteners number on the vertical plate	Fastener typology	Anchors number	Threaded rod / Anchor	Chemical anchor tipe	Number of sides	Angle brackets spacing i [mm]
Ground connection - hold down - bracket	Ground connection	Rotho Blaas	Titan N - TCN 200	30	Anker nail - LBA 4.0 X 60	2	INA - 5.8 - M12 x 130	VINYLPRO chemical anchor	1.00	500

Punched metal plate/Punched strap for tension force

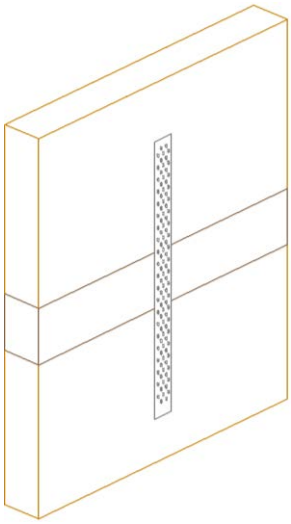
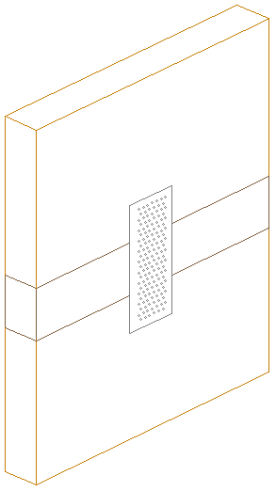


Figure: graphical representation of a punched strap

Connection name	Connection position	Manufacturer	Description	Width [mm]	Length [mm]	Thickness [mm]	Steel grade	Number of fasteners at each end	Fasteners typology	Number of connections at each wall end
Upper levels - tensile plate - shear plate	Upper level	Rotho Blaas	Perforated plate 60x600 thk. 1.5 mm	60	600	1.5	S250	30	Anker nail - LBA 4.0 X 60	1

Punched metal plate/Punched strap for shear force



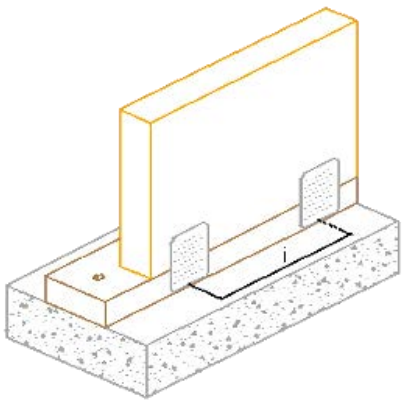


Figure: graphical representations of timber to timber shear connection with punched metal plates

Connection name	Connection position	Manufacturer	Description	Width [mm]	Lenght [mm]	Thickness [mm]	Steel grade	Number of fasteners at each end	Fasteners typology	Metal paltes spacing i [mm]
Upper levels - tensile plate - shear plate	Upper level	Rotho Blaas	Perforated plate 200x300 thk. 2 mm	200	300	2	S250	30	Anker nail - LBA 4.0 X 60	500

Combinations of actions

The combinations for the ultimate limit states used in checking strength are as follows.

(a) $E_d = [1.35 \cdot (G_{sw} + G_{ns})]$ Permanent action only

(b) $E_d = [1.2 \cdot (G_{sw} + G_{ns}),\ 1.5 \cdot Q]$ Permanent and imposed action

(c) $E_d = [1.2 \cdot (G_{sw} + G_{ns}),\ 1.5 \cdot \psi_l \cdot Q]$ Permanent and long-term imposed action

(d) $E_d = [1.2 \cdot (G_{sw} + G_{ns}),\ W_u,\ \psi_c \cdot Q]$ Permanent, wind and imposed action

(e) $E_d = [0.9 \cdot (G_{sw} + G_{ns}),\ W_u]$ Permanent and wind action reversal

(f) $E_d = [(G_{sw} + G_{ns}),\ E_u,\ \psi_E \cdot Q]$ Permanent, earthquake and imposed action

(g) $E_d = [1.2 \cdot (G_{sw} + G_{ns}),\ F_{sn},\ \psi_c \cdot Q]$ Permanent, snow and imposed action

The combinations for the ultimate limit states used in checking stability are as follows.

For combinations that produce net stabilizing effects:

o $E_{d,stb} = [0.9 \cdot (G_{sw} + G_{ns})]$ Permanent action only

For combinations that produce net destabilizing effects

(iv) $E_{d,dst} = [1.2 \cdot (G_{sw} + G_{ns}),\ W_u,\ \psi_c \cdot Q]$ Permanent, wind and imposed action

(v) $E_{d,dst} = [(G_{sw} + G_{ns}),\ E_u,\ \psi_E \cdot Q]$ Permanent, earthquake and imposed action

The combinations for the serviceability limit states are as follows.

o $(G_{sw} + G_{ns}) + \psi_l \cdot Q$

o $(G_{sw} + G_{ns}) + \psi_s \cdot Q$

o $\psi_s \cdot Q$

o W_s

being:

G_{sw} permanent actions: self weight

G_{ns} non-structural permanent actions

Q imposed actions

W_u Wind action for ULS

W_s Wind action for SLS

E_u earthquake action

F_{sn} snow action

ψ_s short-term factor

ψ_l long-term factor

ψ_c combination factor

ψ_E earthquake combination factor

The following table presents the values of the factors used.

Action name	Description	Duration	ψ_s	ψ_l	ψ_c	ψ_E
Q type A	Type A: Domestic and residential activities	5 months	0.7	0.4	0.4	0.3
Q type Asf	Type Asf: Non-habitable roof spaces for residential activities	5 months	1	0.6	0.6	0.6
Q type B	Type B: Offices and work areas not covered elsewhere	5 months	0.7	0.4	0.4	0.3
Q type C	Type C: Areas where people may congregate	5 days	0.7	0.4	0.4	0.3
Q type Cff	Type Cff: Areas where people may congregate - fixed furniture	5 days	1	0.6	0.6	0.6
Q type D	Type D: Shopping areas	5 months	0.7	0.4	0.4	0.3
Q type E	Type E: Warehousing, storage areas, areas for plant	5 months	1	0.6	0.6	0.6
Q type F	Type F: Light vehicle traffic areas	5 months	0.7	0.4	0.4	0.3
Q type G	Type G: Medium vehicle traffic areas	5 months	0.7	0.4	0.4	0.3
Q type R1	Type R1: Street awnings	5 days	0.7	0	0	0
Q type R2	Type R2: Other roofs	5 days	0.7	0	0	0
Q type R-A	Type R-A: Domestic and residential activities	5 months	0.7	0.4	0.4	0.3
Q type R-B	Type R-B: Offices and work areas not covered elsewhere	5 months	0.7	0.4	0.4	0.3
Q type R-C	Type R-C: Areas where people may congregate	5 days	0.7	0.4	0.4	0.3
Q type R-D	Type R-D: Shopping areas	5 months	0.7	0.4	0.4	0.3

Q type R-E	Type R-E: Warehousing, storage areas, areas for plant	5 months	1	0.6	0.6	0.6
Q type R-F	Type R-F: Light vehicle traffic areas	5 months	0.7	0.4	0.4	0.3
Q type R-G	Type R-G: Medium vehicle traffic areas	5 months	0.7	0.4	0.4	0.3
Ortho wind ULS	Wind pressure ULS	5 seconds	0	0	0	0
Ortho wind SLS	Wind pressure SLS	5 seconds	0	0	0	0
Snow	Snow action for alpine areas	5 months	0	0	0	0
Snow	Snow action for sub-alpine areas	5 days	0	0	0	0

Combinations of actions used

Vertical ULS combinations of actions

The following table shows the combinations of actions for Ultimate Limit States relevant for verifications in the case of vertical actions.

The action of the wind is considered as a uniform load orthogonal to the roof and to each external wall.

Name	Duration	G(sw)	G(ns)	Q type A	Ortho wind ULS down	Ortho wind ULS up	Wind X	Wind Y	Seismic dynamic X	Seismic dynamic Y
ULS 1	50+ years	1.35	1.35	0	0	0	0	0	0	0
ULS 2	50+ years	1.2	1.2	0	0	0	0	0	0	0
ULS 3	5 months	1.2	1.2	1.5	0	0	0	0	0	0
ULS 4	50+ years	1.2	1.2	0.6	0	0	0	0	0	0
ULS 5	5 seconds	1.2	1.2	0.4	1	0	0	0	0	0
ULS 6	5 seconds	0.9	0.9	0	0	1	0	0	0	0

Wind ULS combinations of actions

The following table shows the combinations of actions for Ultimate Limit States relevant for verifications in the case of horizontal wind actions.

The action of the wind is considered as a uniform load orthogonal to each external wall that acts separately in the directions X, -X, Y, -Y and as a uniform load orthogonal to the roof.

Name	Duration	G(sw)	G(ns)	Q type A	Ortho wind ULS down	Ortho wind ULS up	Wind X	Wind Y	Seismic dynamic X	Seismic dynamic Y
ULS Wind 1	5 seconds	1.2	1.2	0.4	1	0	1	0	0	0
ULS Wind 2	5 seconds	1.2	1.2	0.4	1	0	-1	0	0	0
ULS Wind 3	5 seconds	0.9	0.9	0	0	1	1	0	0	0
ULS Wind 4	5 seconds	0.9	0.9	0	0	1	-1	0	0	0
ULS Wind 5	5 seconds	1.2	1.2	0.4	1	0	0	1	0	0
ULS Wind 6	5 seconds	1.2	1.2	0.4	1	0	0	-1	0	0
ULS Wind 7	5 seconds	0.9	0.9	0	0	1	0	1	0	0
ULS Wind 8	5 seconds	0.9	0.9	0	0	1	0	-1	0	0

SLS combinations of actions

The action of the wind is considered as a uniform load orthogonal to the roof.

Name	Duration	G(sw)	G(ns)	Q type A	Ortho wind ULS down	Ortho wind ULS up	Wind X	Wind Y	Seismic dynamic X	Seismic dynamic Y
SLS 1	50+ years	1	1	0.4	0	0	0	0	0	0
SLS 2	5 seconds	0	0	0.7	0	0	0	0	0	0
SLS 3	5 seconds	1	1	0.7	0	0	0	0	0	0

Seismic combinations of actions

The action effects due to the combination of the horizontal components of the seismic action are computed using the following combinations:

$$E_{u,X} + 0{,}3 \cdot E_{u,Y}$$

$$0{,}3 \cdot E_{u,X} + E_{u,Y}$$

Combinations of actions for seismic strength Ultimate Limit States

Name	Duration	G(sw)	G(ns)	Q type A	Ortho wind ULS down	Ortho wind ULS up	Wind X	Wind Y	Seismic dynamic X	Seismic dynamic Y
ULS earthquake strength 1 ex+ ey+	5 seconds	1	1	0.3	0	0	0	0	1	0.3
ULS earthquake strength 1 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	1	0.3
ULS earthquake strength 1 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	1	0.3
ULS earthquake strength 1 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	1	0.3
ULS earthquake strength 2 ex+ ey+	5 seconds	1	1	0.3	0	0	0	0	1	-0.3
ULS earthquake strength 2 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	1	-0.3
ULS earthquake strength 2 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	1	-0.3
ULS earthquake strength 2 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	1	-0.3
ULS earthquake strength 3 ex+ ey+	5 seconds	1	1	0.3	0	0	0	0	-1	0.3
ULS earthquake strength 3 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	-1	0.3
ULS earthquake strength 3 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	-1	0.3
ULS earthquake strength 3 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	-1	0.3
ULS earthquake strength 4 ex+ ey+	5 seconds	1	1	0.3	0	0	0	0	-1	-0.3
ULS earthquake strength 4 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	-1	-0.3
ULS earthquake strength 4 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	-1	-0.3
ULS earthquake strength 4 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	-1	-0.3
ULS earthquake strength 5 ex+ ey+	5 seconds	1	1	0.3	0	0	0	0	0.3	1
ULS earthquake strength 5 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	0.3	1
ULS earthquake strength 5 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	0.3	1
ULS earthquake strength 5 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	0.3	1
ULS earthquake strength 6 ex+ ey+	5 seconds	1	1	0.3	0	0	0	0	0.3	-1
ULS earthquake strength 6 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	0.3	-1
ULS earthquake strength 6 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	0.3	-1
ULS earthquake strength 6 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	0.3	-1
ULS earthquake strength 7 ex+	5 seconds	1	1	0.3	0	0	0	0	-0.3	1

ey+										
ULS earthquake strength 7 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	-0.3	1
ULS earthquake strength 7 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	-0.3	1
ULS earthquake strength 7 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	-0.3	1
ULS earthquake strength 8 ex+ ey+	5 seconds	1	1	0.3	0	0	0	0	-0.3	-1
ULS earthquake strength 8 ex- ey+	5 seconds	1	1	0.3	0	0	0	0	-0.3	-1
ULS earthquake strength 8 ex+ ey-	5 seconds	1	1	0.3	0	0	0	0	-0.3	-1
ULS earthquake strength 8 ex- ey-	5 seconds	1	1	0.3	0	0	0	0	-0.3	-1

Combinations of actions for seismic stability Ultimate Limit States

Name	Duration	G(sw)	G(ns)	Q type A	Ortho wind ULS down	Ortho wind ULS up	Wind X	Wind Y	Seismic dynamic X	Seismic dynamic Y
ULS earthquake stability 1 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	1	0.3
ULS earthquake stability 1 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	1	0.3
ULS earthquake stability 1 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	1	0.3
ULS earthquake stability 1 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	1	0.3
ULS earthquake stability 2 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	1	-0.3
ULS earthquake stability 2 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	1	-0.3
ULS earthquake stability 2 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	1	-0.3
ULS earthquake stability 2 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	1	-0.3
ULS earthquake stability 3 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	-1	0.3
ULS earthquake stability 3 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	-1	0.3
ULS earthquake stability 3 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	-1	0.3
ULS earthquake stability 3 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	-1	0.3
ULS earthquake stability 4 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	-1	-0.3
ULS earthquake stability 4 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	-1	-0.3
ULS earthquake stability 4 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	-1	-0.3
ULS earthquake stability 4 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	-1	-0.3
ULS earthquake stability 5 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	0.3	1
ULS earthquake stability 5 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	0.3	1
ULS earthquake stability 5 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	0.3	1
ULS earthquake stability 5 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	0.3	1
ULS earthquake stability 6 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	0.3	-1
ULS earthquake stability 6 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	0.3	-1
ULS earthquake stability 6 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	0.3	-1
ULS earthquake stability 6 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	0.3	-1
ULS earthquake stability 7 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	1

ULS earthquake stability 7 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	1
ULS earthquake stability 7 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	1
ULS earthquake stability 7 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	1
ULS earthquake stability 8 ex+ ey+	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	-1
ULS earthquake stability 8 ex- ey+	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	-1
ULS earthquake stability 8 ex+ ey-	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	-1
ULS earthquake stability 8 ex- ey-	5 seconds	0.9	0.9	0	0	0	0	0	-0.3	-1

Combinations of actions for seismic drift Ultimate Limit States

Name	Duration	G(sw)	G(ns)	Q type A	Ortho wind ULS down	Ortho wind ULS up	Wind X	Wind Y	Seismic dynamic X	Seismic dynamic Y
ULS earthquake drift 1 ex+ ey+	5 seconds	0	0	0	0	0	0	0	1	0
ULS earthquake drift 1 ex+ ey-	5 seconds	0	0	0	0	0	0	0	1	0
ULS earthquake drift 1 ex- ey+	5 seconds	0	0	0	0	0	0	0	1	0
ULS earthquake drift 1 ex- ey-	5 seconds	0	0	0	0	0	0	0	1	0
ULS earthquake drift 2 ex+ ey+	5 seconds	0	0	0	0	0	0	0	-1	0
ULS earthquake drift 2 ex+ ey-	5 seconds	0	0	0	0	0	0	0	-1	0
ULS earthquake drift 2 ex- ey+	5 seconds	0	0	0	0	0	0	0	-1	0
ULS earthquake drift 2 ex- ey-	5 seconds	0	0	0	0	0	0	0	-1	0
ULS earthquake drift 3 ex+ ey+	5 seconds	0	0	0	0	0	0	0	0	1
ULS earthquake drift 3 ex+ ey-	5 seconds	0	0	0	0	0	0	0	0	1
ULS earthquake drift 3 ex- ey+	5 seconds	0	0	0	0	0	0	0	0	1
ULS earthquake drift 3 ex- ey-	5 seconds	0	0	0	0	0	0	0	0	1
ULS earthquake drift 4 ex+ ey+	5 seconds	0	0	0	0	0	0	0	0	-1
ULS earthquake drift 4 ex+ ey-	5 seconds	0	0	0	0	0	0	0	0	-1
ULS earthquake drift 4 ex- ey+	5 seconds	0	0	0	0	0	0	0	0	-1
ULS earthquake drift 4 ex- ey-	5 seconds	0	0	0	0	0	0	0	0	-1

Horizontal actions

Modal analysis

The modal analysis is used to determine the vibration modes of the structure, useful to understand the seismic behaviour of the building and to proceed with the linear dynamic analysis.

The modal analysis involves the solution of the generalized eigenvalue problem:

$$[\boldsymbol{K} - \boldsymbol{\Omega}^2 \boldsymbol{M}]\boldsymbol{\Phi} = \mathbf{0}$$

where $\boldsymbol{K}$ is the stiffness matrix, $\boldsymbol{M}$ the mass matrix, $\boldsymbol{\Omega}^2$ is the diagonal matrix of the eigenvalues and $\boldsymbol{\Phi}$ is the corresponding matrix of eigenvectors or modal shapes (normalized with respect to the mass matrix); the seismic masses of the diaphragms are calculated with the following combination of vertical loads:

$$\sum \left(G_{sw,j} + G_{ns,j}\right) + \sum \psi_{\mathrm{E,i}} \cdot \mathrm{Q}$$

where ψ_{Ei} is the earthquake combination factor for the imposed action *i.*

The eigenvalue, obtained from the solution of the generalized eigenvalue problem, is the square of the circular frequency $\boldsymbol{\omega}$ related to the period, *T*, and to the frequency, *f*, by the following equations:

$$T = \frac{1}{f} \text{ and } f = \frac{\omega}{2\pi}$$

The participating mass ratio for the mode *i-th*, corresponding to an acceleration in the global axis X and Y and to a rotational acceleration around the vertical axis Z, is given by:

$$M_x^i = \frac{m_x^i}{\sum m_{x,j}} \ [\%]$$

$$M_y^i = \frac{m_y^i}{\sum m_{y,j}} \ [\%]$$

$$M_z^i = \frac{m_z^i}{\sum I_{z,j}} \ [\%]$$

where:

$$m_x^i = \frac{\left(\left[\boldsymbol{\Phi}^{\boldsymbol{i}}\right]^{\boldsymbol{T}} \boldsymbol{M}\, \boldsymbol{R}_{\boldsymbol{x}}\right)^2}{[\boldsymbol{\Phi}^{\boldsymbol{i}}]^{\boldsymbol{T}} \boldsymbol{M}\, \boldsymbol{\Phi}^{\boldsymbol{i}}}$$

$$m_y^i = \frac{\left(\left[\boldsymbol{\Phi}^{\boldsymbol{i}}\right]^{\boldsymbol{T}} \boldsymbol{M}\, \boldsymbol{R}_{\boldsymbol{y}}\right)^2}{[\boldsymbol{\Phi}^{\boldsymbol{i}}]^{\boldsymbol{T}} \boldsymbol{M}\, \boldsymbol{\Phi}^{\boldsymbol{i}}}$$

$$m_z^i = \frac{\left(\left[\boldsymbol{\Phi}^{\boldsymbol{i}}\right]^{\boldsymbol{T}} \boldsymbol{M}\, \boldsymbol{R}_{\boldsymbol{z}}\right)^2}{[\boldsymbol{\Phi}^{\boldsymbol{i}}]^{\boldsymbol{T}} \boldsymbol{M}\, \boldsymbol{\Phi}^{\boldsymbol{i}}}$$

and where $\sum m_{x,j}$, $\sum m_{y,j}$ and $\sum I_{z,j}$ are the total masses acting in the axis X, Y and the total rotational inertia about the axis Z of the unrestrained *j-th* degrees of freedom.

Mode	Period [s]	Frequency [Hz]	M_X [%]	Sum M_X [%]	M_Y [%]	Sum M_Y [%]	M_Z [%]	Sum M_Z [%]
Mode 1	0.73	1.38	0.00	0.00	91.67	91.67	0.53	0.53
Mode 2	0.64	1.55	0.91	0.91	0.64	92.30	90.76	91.29
Mode 3	0.51	1.96	91.41	92.32	0.00	92.30	0.90	92.19
Mode 4	0.26	3.79	0.00	92.32	6.84	99.15	0.20	92.38
Mode 5	0.23	4.27	0.07	92.38	0.03	99.18	6.71	99.09
Mode 6	0.19	5.30	0.02	92.40	0.82	100.00	0.00	99.10
Mode 7	0.19	5.38	6.78	99.18	0.00	100.00	0.07	99.17
Mode 8	0.17	5.96	0.01	99.19	0.00	100.00	0.82	99.99
Mode 9	0.13	7.52	0.81	100.00	0.00	100.00	0.01	100.00

Dynamic linear analysis

The dynamic linear analysis consists of:

- the calculation of the seismic effects (the seismic action is represented by the design response spectrum), of each of the vibration modes calculated in the modal analysis;
- the combination of these effects.

The seismic effects of the structural model are obtained by the application of the following external loads:

$$\boldsymbol{F_x^i} = \Gamma_x^i S_d(T_i) \boldsymbol{M \Phi^i}$$

and

$$\boldsymbol{F_y^i} = \Gamma_y^i S_d(T_i) \boldsymbol{M \Phi^i}$$

where:

$\boldsymbol{F_x^i}$ and $\boldsymbol{F_y^i}$ are the external loads of the *i-th vibration mode* due to seismic action along X and Y

$S_d(T_i)$ is the spectrum value corresponding to the *i-th* period

$\boldsymbol{\Phi^i}$ is the *i-th modal shape*

$\Gamma_x^i \; and \; \Gamma_y^i$ are the participating modal factor of the *i-th mode* given by:

$$\Gamma_x^i = \frac{\left[\boldsymbol{\Phi^i}\right]^T \boldsymbol{M \, R_x}}{[\boldsymbol{\Phi^i}]^T \boldsymbol{M \, \Phi^i}} \text{ e } \Gamma_y^i = \frac{\left[\boldsymbol{\Phi^i}\right]^T \boldsymbol{M \, R_y}}{[\boldsymbol{\Phi^i}]^T \boldsymbol{M \, \Phi^i}}$$

The effects for a given direction of acceleration (along X or Y) and for each of the vibration modes are combined with the Complete Quadratic Combination technique defined as:

$$E = \left(\sum_j \sum_i \rho_{ij} \cdot E_i \cdot E_j \right)^{1/2}$$

where:

E_j is the effect of the j-th vibration mode;

ρ_{ij} is the correlation coefficient of the *i-th* mode and the *j-th* mode, given by:

$$\rho_{ij} = \frac{8\,\xi^2\beta_{ij}^{3/2}}{(1+\beta_{ij})\left[(1-\beta_{ij})\right]}$$

ξ is the damping ratio in the i-th and j-th modes;

$\beta_{ij} = T_j/T_i$).

The following table provides the diaphragms properties.

Diaphragm	Height above the base of the timber structure [m]	xG [m]	yG [m]	Mass i [kg]
1	3.20	5.84	-0.25	17833
2	6.40	5.84	-0.25	17833
3	9.60	6.08	-0.27	12856

The following table provides, for each of the vibration mode, the corresponding period and value of the response spectrum.

Mode	Period [s]	Spectrum value [g]
Mode 1	0.82	0.04
Mode 2	0.58	0.05
Mode 3	0.50	0.06
Mode 4	0.30	0.10
Mode 5	0.21	0.10
Mode 6	0.21	0.10
Mode 7	0.18	0.10
Mode 8	0.15	0.10
Mode 9	0.13	0.10

Wind

The table below illustrates the horizontal forces acting on the storeys due to the wind action and the coordinates of their respective application points.

Diaphragm	Height above the reference plane [m]	xG,wind [m]	yG,wind [m]	Fx [kN]	Fy [kN]
1	3.20	6.63	-0.30	7.74	29.30
2	6.40	6.63	-0.30	7.74	29.30
3	9.60	6.63	-0.30	3.87	14.65

The action effects

In this chapter the internal forces acting on the structural members and on their connections are reported with regard to the considered loads.

Walls

Wall name: Wall ID

N: Total axial force

V2: Shear force (in-plane)

V3: Shear force (out-of-plane)

M2-2: Bending moment (out-of-plane)

M3-3: Bending moment (in-plane)

Va: Shear force on the single connection

Ta: Tensile force on the single anchor

dr: Interstory drift

Load	Wall name	N [kN]	V2 [kN]	V3 [kN]	M2-2 [kNm]	M3-3 [kNm]	Va [kN]	Ta [kN]	dr [mm]
G(sw)	Wall 1	2.08	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 2	1.99	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 3	2.12	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 4	2.22	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 5	2.24	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 6	2.98	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 7	5.78	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 8	4.11	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 9	2.69	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 10	4.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 11	4.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 12	4.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 13	4.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 14	10.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 15	4.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 16	4.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 17	2.04	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 18	12.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 19	1.97	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 20	1.93	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 21	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 22	4.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 23	8.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 24	3.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 25	5.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 26	1.38	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 27	1.34	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 28	1.43	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 29	1.48	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 30	1.50	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 31	1.99	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 32	3.89	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 33	2.76	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 34	1.79	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 35	3.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 36	3.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 37	3.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 38	3.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 39	7.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 40	3.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 41	3.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 42	1.36	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 43	8.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 44	1.31	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 45	1.29	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 46	2.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 47	3.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 48	5.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 49	2.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 50	3.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00

G(sw)	Wall 51	0.69	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 52	0.67	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 53	0.72	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 54	0.74	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 55	0.75	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 56	0.99	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 57	1.96	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 58	1.39	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 59	0.90	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 60	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 61	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 62	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 63	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 64	3.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 65	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 66	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 67	0.68	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 68	4.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 69	0.66	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 70	0.64	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(sw)	Wall 71	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 72	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 73	2.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 74	1.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(sw)	Wall 75	1.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 1	3.54	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 2	3.10	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 3	3.79	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 4	4.22	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 5	4.36	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 6	7.97	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 7	21.86	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 8	13.58	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 9	6.58	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 10	14.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 11	14.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 12	14.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 13	14.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 14	43.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 15	14.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 16	14.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 17	3.34	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 18	54.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 19	2.88	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 20	2.65	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 21	10.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 22	14.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 23	34.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 24	7.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 25	17.81	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 26	2.36	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 27	2.09	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 28	2.54	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 29	2.81	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 30	2.91	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 31	5.31	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 32	14.69	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 33	9.13	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 34	4.39	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 35	9.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 36	9.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 37	9.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 38	9.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 39	29.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 40	9.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 41	9.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 42	2.23	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 43	36.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 44	1.92	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 45	1.77	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 46	7.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 47	9.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 48	22.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 49	4.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 50	11.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 51	1.18	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 52	1.05	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 53	1.28	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 54	1.41	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 55	1.45	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 56	2.66	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 57	7.40	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 58	4.60	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 59	2.19	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 60	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 61	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 62	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 63	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 64	14.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 65	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 66	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 67	1.11	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 68	18.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 69	0.96	0.00	0.00	0.00	0.00	0.00	0.00	N/D
G(ns)	Wall 70	0.88	0.00	0.00	0.00	0.00	0.00	0.00	N/D

G(ns)	Wall 71	3.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 72	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 73	11.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 74	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
G(ns)	Wall 75	5.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 1	0.06	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 2	-0.70	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 3	0.55	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 4	1.41	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 5	1.81	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 6	8.92	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 7	36.70	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 8	20.26	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 9	6.13	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 14	58.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 18	79.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 23	39.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 25	6.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 26	0.04	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 27	-0.47	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 28	0.37	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 29	0.94	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 30	1.21	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 31	5.94	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 32	24.66	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 33	13.62	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 34	4.09	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 39	39.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 43	53.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 48	26.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 50	4.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 51	0.02	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 52	-0.24	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 53	0.18	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 54	0.47	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 55	0.60	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 56	2.97	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 57	12.42	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 58	6.87	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 59	2.04	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 64	19.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 68	26.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Q type A	Wall 71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 73	13.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Q type A	Wall 75	2.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 1	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 2	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 3	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 4	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 5	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 6	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 7	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 8	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 9	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 10	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 11	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 12	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 13	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 14	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00

Ortho wind ULS down	Wall 15	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 16	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 17	0.00	0.00	0.39	0.31	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 18	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 19	0.00	0.00	0.34	0.27	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 20	0.00	0.00	0.31	0.25	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 21	0.00	0.00	1.26	1.01	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 22	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 23	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 24	0.00	0.00	0.88	0.70	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 25	0.00	0.00	1.68	1.34	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 26	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 27	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 28	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 29	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 30	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 31	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 32	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 33	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 34	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 35	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 36	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 37	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 38	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 39	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 40	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 41	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 42	0.00	0.00	0.39	0.31	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 43	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 44	0.00	0.00	0.34	0.27	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 45	0.00	0.00	0.31	0.25	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 46	0.00	0.00	1.26	1.01	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 47	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 48	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 49	0.00	0.00	0.88	0.70	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 50	0.00	0.00	1.68	1.34	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 51	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 52	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 53	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 54	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 55	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 56	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 57	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 58	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 59	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 60	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 61	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 62	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 63	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 64	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 65	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 66	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 67	0.00	0.00	0.39	0.31	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 68	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 69	0.00	0.00	0.34	0.27	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 70	0.00	0.00	0.31	0.25	0.00	0.00	0.00	N/D
Ortho wind ULS down	Wall 71	0.00	0.00	1.26	1.01	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 72	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 73	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 74	0.00	0.00	0.88	0.70	0.00	0.00	0.00	0.00
Ortho wind ULS down	Wall 75	0.00	0.00	1.68	1.34	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 1	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 2	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 3	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 4	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 5	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 6	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 7	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 8	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 9	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 10	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 11	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 12	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 13	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 14	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 15	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 16	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 17	0.00	0.00	0.39	0.31	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 18	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 19	0.00	0.00	0.34	0.27	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 20	0.00	0.00	0.31	0.25	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 21	0.00	0.00	1.26	1.01	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 22	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 23	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 24	0.00	0.00	0.88	0.70	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 25	0.00	0.00	1.68	1.34	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 26	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 27	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 28	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 29	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 30	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 31	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 32	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 33	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 34	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D

Ortho wind ULS up	Wall 35	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 36	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 37	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 38	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 39	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 40	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 41	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 42	0.00	0.00	0.39	0.31	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 43	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 44	0.00	0.00	0.34	0.27	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 45	0.00	0.00	0.31	0.25	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 46	0.00	0.00	1.26	1.01	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 47	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 48	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 49	0.00	0.00	0.88	0.70	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 50	0.00	0.00	1.68	1.34	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 51	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 52	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 53	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 54	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 55	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 56	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 57	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 58	0.00	0.00	0.41	0.32	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 59	0.00	0.00	0.41	0.33	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 60	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 61	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 62	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 63	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 64	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 65	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 66	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 67	0.00	0.00	0.39	0.31	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 68	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 69	0.00	0.00	0.34	0.27	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 70	0.00	0.00	0.31	0.25	0.00	0.00	0.00	N/D
Ortho wind ULS up	Wall 71	0.00	0.00	1.26	1.01	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 72	0.00	0.00	1.65	1.32	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 73	0.00	0.00	1.69	1.35	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 74	0.00	0.00	0.88	0.70	0.00	0.00	0.00	0.00
Ortho wind ULS up	Wall 75	0.00	0.00	1.68	1.34	0.00	0.00	0.00	0.00
Wind X	Wall 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 10	0.00	2.31	0.00	0.00	13.32	0.00	0.00	1.66
Wind X	Wall 11	0.00	2.31	0.00	0.00	13.32	0.00	0.00	1.66
Wind X	Wall 12	0.00	2.31	0.00	0.00	13.32	0.00	0.00	1.66
Wind X	Wall 13	0.00	2.31	0.00	0.00	13.32	0.00	0.00	1.66
Wind X	Wall 14	0.00	0.15	0.00	0.00	0.83	0.00	0.00	0.10
Wind X	Wall 15	0.00	2.40	0.00	0.00	13.82	0.00	0.00	1.73
Wind X	Wall 16	0.00	2.40	0.00	0.00	13.82	0.00	0.00	1.73
Wind X	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 18	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
Wind X	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 21	0.00	1.77	0.00	0.00	10.21	0.00	0.00	1.73
Wind X	Wall 22	0.00	2.40	0.00	0.00	13.82	0.00	0.00	1.73
Wind X	Wall 23	0.00	0.11	0.00	0.00	0.61	0.00	0.00	0.07
Wind X	Wall 24	0.00	1.12	0.00	0.00	6.52	0.00	0.00	1.68
Wind X	Wall 25	0.00	0.04	0.00	0.00	0.25	0.00	0.00	0.03
Wind X	Wall 26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 35	0.00	1.39	0.00	0.00	5.91	0.00	0.00	0.98
Wind X	Wall 36	0.00	1.39	0.00	0.00	5.91	0.00	0.00	0.98
Wind X	Wall 37	0.00	1.39	0.00	0.00	5.91	0.00	0.00	0.98
Wind X	Wall 38	0.00	1.39	0.00	0.00	5.91	0.00	0.00	0.98
Wind X	Wall 39	0.00	0.09	0.00	0.00	0.37	0.00	0.00	0.06
Wind X	Wall 40	0.00	1.44	0.00	0.00	6.14	0.00	0.00	1.01
Wind X	Wall 41	0.00	1.44	0.00	0.00	6.14	0.00	0.00	1.01
Wind X	Wall 42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 43	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Wind X	Wall 44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 46	0.00	1.07	0.00	0.00	4.55	0.00	0.00	1.01
Wind X	Wall 47	0.00	1.44	0.00	0.00	6.14	0.00	0.00	1.01
Wind X	Wall 48	0.00	0.06	0.00	0.00	0.27	0.00	0.00	0.04
Wind X	Wall 49	0.00	0.69	0.00	0.00	2.93	0.00	0.00	0.99
Wind X	Wall 50	0.00	0.03	0.00	0.00	0.11	0.00	0.00	0.02
Wind X	Wall 51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D

Wind X	Wall 55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 60	0.00	0.46	0.00	0.00	1.48	0.00	0.00	0.33
Wind X	Wall 61	0.00	0.46	0.00	0.00	1.48	0.00	0.00	0.33
Wind X	Wall 62	0.00	0.46	0.00	0.00	1.48	0.00	0.00	0.33
Wind X	Wall 63	0.00	0.46	0.00	0.00	1.48	0.00	0.00	0.33
Wind X	Wall 64	0.00	0.03	0.00	0.00	0.09	0.00	0.00	0.02
Wind X	Wall 65	0.00	0.48	0.00	0.00	1.53	0.00	0.00	0.34
Wind X	Wall 66	0.00	0.48	0.00	0.00	1.53	0.00	0.00	0.34
Wind X	Wall 67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wind X	Wall 69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind X	Wall 71	0.00	0.36	0.00	0.00	1.14	0.00	0.00	0.34
Wind X	Wall 72	0.00	0.48	0.00	0.00	1.53	0.00	0.00	0.34
Wind X	Wall 73	0.00	0.02	0.00	0.00	0.07	0.00	0.00	0.01
Wind X	Wall 74	0.00	0.23	0.00	0.00	0.73	0.00	0.00	0.33
Wind X	Wall 75	0.00	0.01	0.00	0.00	0.03	0.00	0.00	0.01
Wind Y	Wall 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 10	0.00	1.19	0.00	0.00	6.85	0.00	0.00	0.86
Wind Y	Wall 11	0.00	1.19	0.00	0.00	6.85	0.00	0.00	0.86
Wind Y	Wall 12	0.00	1.19	0.00	0.00	6.85	0.00	0.00	0.86
Wind Y	Wall 13	0.00	1.19	0.00	0.00	6.85	0.00	0.00	0.86
Wind Y	Wall 14	0.00	22.52	0.00	0.00	129.69	0.00	0.00	15.82
Wind Y	Wall 15	0.00	1.33	0.00	0.00	7.68	0.00	0.00	0.96
Wind Y	Wall 16	0.00	1.33	0.00	0.00	7.68	0.00	0.00	0.96
Wind Y	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 18	0.00	18.47	0.00	0.00	106.39	0.00	0.00	12.97
Wind Y	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 21	0.00	0.98	0.00	0.00	5.67	0.00	0.00	0.96
Wind Y	Wall 22	0.00	1.33	0.00	0.00	7.68	0.00	0.00	0.96
Wind Y	Wall 23	0.00	15.28	0.00	0.00	88.01	0.00	0.00	10.73
Wind Y	Wall 24	0.00	0.23	0.00	0.00	1.31	0.00	0.00	0.34
Wind Y	Wall 25	0.00	16.99	0.00	0.00	97.81	0.00	0.00	12.00
Wind Y	Wall 26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 35	0.00	0.71	0.00	0.00	3.04	0.00	0.00	0.50
Wind Y	Wall 36	0.00	0.71	0.00	0.00	3.04	0.00	0.00	0.50
Wind Y	Wall 37	0.00	0.71	0.00	0.00	3.04	0.00	0.00	0.50
Wind Y	Wall 38	0.00	0.71	0.00	0.00	3.04	0.00	0.00	0.50
Wind Y	Wall 39	0.00	13.51	0.00	0.00	57.65	0.00	0.00	9.29
Wind Y	Wall 40	0.00	0.80	0.00	0.00	3.41	0.00	0.00	0.56
Wind Y	Wall 41	0.00	0.80	0.00	0.00	3.41	0.00	0.00	0.56
Wind Y	Wall 42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 43	0.00	11.08	0.00	0.00	47.29	0.00	0.00	7.62
Wind Y	Wall 44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 46	0.00	0.59	0.00	0.00	2.53	0.00	0.00	0.56
Wind Y	Wall 47	0.00	0.80	0.00	0.00	3.41	0.00	0.00	0.56
Wind Y	Wall 48	0.00	9.17	0.00	0.00	39.13	0.00	0.00	6.30
Wind Y	Wall 49	0.00	0.14	0.00	0.00	0.59	0.00	0.00	0.20
Wind Y	Wall 50	0.00	10.18	0.00	0.00	43.45	0.00	0.00	7.05
Wind Y	Wall 51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 60	0.00	0.24	0.00	0.00	0.76	0.00	0.00	0.17
Wind Y	Wall 61	0.00	0.24	0.00	0.00	0.76	0.00	0.00	0.17
Wind Y	Wall 62	0.00	0.24	0.00	0.00	0.76	0.00	0.00	0.17
Wind Y	Wall 63	0.00	0.24	0.00	0.00	0.76	0.00	0.00	0.17
Wind Y	Wall 64	0.00	4.50	0.00	0.00	14.41	0.00	0.00	3.10
Wind Y	Wall 65	0.00	0.27	0.00	0.00	0.85	0.00	0.00	0.19
Wind Y	Wall 66	0.00	0.27	0.00	0.00	0.85	0.00	0.00	0.19
Wind Y	Wall 67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 68	0.00	3.69	0.00	0.00	11.82	0.00	0.00	2.54
Wind Y	Wall 69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Wind Y	Wall 71	0.00	0.20	0.00	0.00	0.63	0.00	0.00	0.19
Wind Y	Wall 72	0.00	0.27	0.00	0.00	0.85	0.00	0.00	0.19
Wind Y	Wall 73	0.00	3.06	0.00	0.00	9.78	0.00	0.00	2.10
Wind Y	Wall 74	0.00	0.05	0.00	0.00	0.15	0.00	0.00	0.07

Wind Y	Wall 75	0.00	3.39	0.00	0.00	10.86	0.00	0.00	2.35
Seismic static X	Wall 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 10	0.00	5.15	0.00	0.00	36.66	0.00	0.00	9.63
Seismic static X	Wall 11	0.00	5.15	0.00	0.00	36.66	0.00	0.00	9.63
Seismic static X	Wall 12	0.00	5.15	0.00	0.00	36.66	0.00	0.00	9.63
Seismic static X	Wall 13	0.00	5.15	0.00	0.00	36.66	0.00	0.00	9.63
Seismic static X	Wall 14	0.00	0.46	0.00	0.00	3.24	0.00	0.00	0.84
Seismic static X	Wall 15	0.00	5.43	0.00	0.00	38.61	0.00	0.00	10.16
Seismic static X	Wall 16	0.00	5.43	0.00	0.00	38.61	0.00	0.00	10.16
Seismic static X	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 18	0.00	0.01	0.00	0.00	0.10	0.00	0.00	0.03
Seismic static X	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 21	0.00	4.00	0.00	0.00	28.54	0.00	0.00	10.16
Seismic static X	Wall 22	0.00	5.43	0.00	0.00	38.61	0.00	0.00	10.16
Seismic static X	Wall 23	0.00	0.34	0.00	0.00	2.37	0.00	0.00	0.62
Seismic static X	Wall 24	0.00	2.51	0.00	0.00	18.07	0.00	0.00	9.78
Seismic static X	Wall 25	0.00	0.14	0.00	0.00	0.96	0.00	0.00	0.25
Seismic static X	Wall 26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 35	0.00	4.15	0.00	0.00	20.17	0.00	0.00	7.59
Seismic static X	Wall 36	0.00	4.15	0.00	0.00	20.17	0.00	0.00	7.59
Seismic static X	Wall 37	0.00	4.15	0.00	0.00	20.17	0.00	0.00	7.59
Seismic static X	Wall 38	0.00	4.15	0.00	0.00	20.17	0.00	0.00	7.59
Seismic static X	Wall 39	0.00	0.37	0.00	0.00	1.76	0.00	0.00	0.66
Seismic static X	Wall 40	0.00	4.37	0.00	0.00	21.23	0.00	0.00	8.00
Seismic static X	Wall 41	0.00	4.37	0.00	0.00	21.23	0.00	0.00	8.00
Seismic static X	Wall 42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 43	0.00	0.01	0.00	0.00	0.05	0.00	0.00	0.02
Seismic static X	Wall 44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 46	0.00	3.24	0.00	0.00	15.75	0.00	0.00	8.00
Seismic static X	Wall 47	0.00	4.37	0.00	0.00	21.23	0.00	0.00	8.00
Seismic static X	Wall 48	0.00	0.27	0.00	0.00	1.29	0.00	0.00	0.48
Seismic static X	Wall 49	0.00	2.06	0.00	0.00	10.03	0.00	0.00	7.71
Seismic static X	Wall 50	0.00	0.11	0.00	0.00	0.52	0.00	0.00	0.20
Seismic static X	Wall 51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 60	0.00	2.16	0.00	0.00	6.90	0.00	0.00	3.95
Seismic static X	Wall 61	0.00	2.16	0.00	0.00	6.90	0.00	0.00	3.95
Seismic static X	Wall 62	0.00	2.16	0.00	0.00	6.90	0.00	0.00	3.95
Seismic static X	Wall 63	0.00	2.16	0.00	0.00	6.90	0.00	0.00	3.95
Seismic static X	Wall 64	0.00	0.18	0.00	0.00	0.58	0.00	0.00	0.32
Seismic static X	Wall 65	0.00	2.27	0.00	0.00	7.25	0.00	0.00	4.15
Seismic static X	Wall 66	0.00	2.27	0.00	0.00	7.25	0.00	0.00	4.15
Seismic static X	Wall 67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 68	0.00	0.01	0.00	0.00	0.02	0.00	0.00	0.01
Seismic static X	Wall 69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static X	Wall 71	0.00	1.68	0.00	0.00	5.38	0.00	0.00	4.15
Seismic static X	Wall 72	0.00	2.27	0.00	0.00	7.25	0.00	0.00	4.15
Seismic static X	Wall 73	0.00	0.13	0.00	0.00	0.43	0.00	0.00	0.24
Seismic static X	Wall 74	0.00	1.07	0.00	0.00	3.43	0.00	0.00	4.01
Seismic static X	Wall 75	0.00	0.05	0.00	0.00	0.17	0.00	0.00	0.10
Seismic static Y	Wall 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 10	0.00	0.07	0.00	0.00	0.73	0.00	0.00	0.13
Seismic static Y	Wall 11	0.00	0.07	0.00	0.00	0.73	0.00	0.00	0.13
Seismic static Y	Wall 12	0.00	0.07	0.00	0.00	0.73	0.00	0.00	0.13
Seismic static Y	Wall 13	0.00	0.07	0.00	0.00	0.73	0.00	0.00	0.13
Seismic static Y	Wall 14	0.00	11.11	0.00	0.00	79.95	0.00	0.00	20.30
Seismic static Y	Wall 15	0.00	0.08	0.00	0.00	0.82	0.00	0.00	0.15
Seismic static Y	Wall 16	0.00	0.08	0.00	0.00	0.82	0.00	0.00	0.15
Seismic static Y	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 18	0.00	10.87	0.00	0.00	77.47	0.00	0.00	19.86

Seismic static Y	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 21	0.00	0.06	0.00	0.00	0.60	0.00	0.00	0.15
Seismic static Y	Wall 22	0.00	0.08	0.00	0.00	0.82	0.00	0.00	0.15
Seismic static Y	Wall 23	0.00	10.69	0.00	0.00	75.52	0.00	0.00	19.52
Seismic static Y	Wall 24	0.00	0.01	0.00	0.00	0.14	0.00	0.00	0.05
Seismic static Y	Wall 25	0.00	10.73	0.00	0.00	76.13	0.00	0.00	19.71
Seismic static Y	Wall 26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 35	0.00	0.07	0.00	0.00	0.50	0.00	0.00	0.14
Seismic static Y	Wall 36	0.00	0.07	0.00	0.00	0.50	0.00	0.00	0.14
Seismic static Y	Wall 37	0.00	0.07	0.00	0.00	0.50	0.00	0.00	0.14
Seismic static Y	Wall 38	0.00	0.07	0.00	0.00	0.50	0.00	0.00	0.14
Seismic static Y	Wall 39	0.00	9.03	0.00	0.00	44.39	0.00	0.00	16.13
Seismic static Y	Wall 40	0.00	0.08	0.00	0.00	0.57	0.00	0.00	0.15
Seismic static Y	Wall 41	0.00	0.08	0.00	0.00	0.57	0.00	0.00	0.15
Seismic static Y	Wall 42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 43	0.00	8.77	0.00	0.00	42.67	0.00	0.00	15.68
Seismic static Y	Wall 44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 46	0.00	0.06	0.00	0.00	0.42	0.00	0.00	0.15
Seismic static Y	Wall 47	0.00	0.08	0.00	0.00	0.57	0.00	0.00	0.15
Seismic static Y	Wall 48	0.00	8.57	0.00	0.00	41.32	0.00	0.00	15.32
Seismic static Y	Wall 49	0.00	0.01	0.00	0.00	0.10	0.00	0.00	0.05
Seismic static Y	Wall 50	0.00	8.63	0.00	0.00	41.79	0.00	0.00	15.52
Seismic static Y	Wall 51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 60	0.00	0.08	0.00	0.00	0.27	0.00	0.00	0.15
Seismic static Y	Wall 61	0.00	0.08	0.00	0.00	0.27	0.00	0.00	0.15
Seismic static Y	Wall 62	0.00	0.08	0.00	0.00	0.27	0.00	0.00	0.15
Seismic static Y	Wall 63	0.00	0.08	0.00	0.00	0.27	0.00	0.00	0.15
Seismic static Y	Wall 64	0.00	4.85	0.00	0.00	15.51	0.00	0.00	8.66
Seismic static Y	Wall 65	0.00	0.09	0.00	0.00	0.30	0.00	0.00	0.17
Seismic static Y	Wall 66	0.00	0.09	0.00	0.00	0.30	0.00	0.00	0.17
Seismic static Y	Wall 67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 68	0.00	4.56	0.00	0.00	14.60	0.00	0.00	8.15
Seismic static Y	Wall 69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic static Y	Wall 71	0.00	0.07	0.00	0.00	0.22	0.00	0.00	0.17
Seismic static Y	Wall 72	0.00	0.09	0.00	0.00	0.30	0.00	0.00	0.17
Seismic static Y	Wall 73	0.00	4.34	0.00	0.00	13.89	0.00	0.00	7.75
Seismic static Y	Wall 74	0.00	0.02	0.00	0.00	0.05	0.00	0.00	0.06
Seismic static Y	Wall 75	0.00	4.43	0.00	0.00	14.19	0.00	0.00	7.98
Seismic dynamic X	Wall 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 10	0.00	3.18	0.00	0.00	21.44	0.00	0.00	5.95
Seismic dynamic X	Wall 11	0.00	3.18	0.00	0.00	21.44	0.00	0.00	5.95
Seismic dynamic X	Wall 12	0.00	3.18	0.00	0.00	21.44	0.00	0.00	5.95
Seismic dynamic X	Wall 13	0.00	3.18	0.00	0.00	21.44	0.00	0.00	5.95
Seismic dynamic X	Wall 14	0.00	1.20	0.00	0.00	8.32	0.00	0.00	2.20
Seismic dynamic X	Wall 15	0.00	2.65	0.00	0.00	17.76	0.00	0.00	4.96
Seismic dynamic X	Wall 16	0.00	2.65	0.00	0.00	17.76	0.00	0.00	4.96
Seismic dynamic X	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 18	0.00	1.26	0.00	0.00	8.29	0.00	0.00	2.29
Seismic dynamic X	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 21	0.00	1.95	0.00	0.00	13.13	0.00	0.00	4.96
Seismic dynamic X	Wall 22	0.00	2.65	0.00	0.00	17.76	0.00	0.00	4.96
Seismic dynamic X	Wall 23	0.00	2.77	0.00	0.00	18.45	0.00	0.00	5.06
Seismic dynamic X	Wall 24	0.00	1.43	0.00	0.00	9.74	0.00	0.00	5.58
Seismic dynamic X	Wall 25	0.00	1.88	0.00	0.00	12.44	0.00	0.00	3.45
Seismic dynamic X	Wall 26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 35	0.00	2.43	0.00	0.00	11.57	0.00	0.00	4.46
Seismic dynamic X	Wall 36	0.00	2.43	0.00	0.00	11.57	0.00	0.00	4.46
Seismic dynamic X	Wall 37	0.00	2.43	0.00	0.00	11.57	0.00	0.00	4.46
Seismic dynamic X	Wall 38	0.00	2.43	0.00	0.00	11.57	0.00	0.00	4.46

Seismic dynamic X	Wall 39	0.00	0.95	0.00	0.00	4.67	0.00	0.00	1.70
Seismic dynamic X	Wall 40	0.00	2.02	0.00	0.00	9.57	0.00	0.00	3.70
Seismic dynamic X	Wall 41	0.00	2.02	0.00	0.00	9.57	0.00	0.00	3.70
Seismic dynamic X	Wall 42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 43	0.00	0.94	0.00	0.00	4.43	0.00	0.00	1.69
Seismic dynamic X	Wall 44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 46	0.00	1.50	0.00	0.00	7.09	0.00	0.00	3.70
Seismic dynamic X	Wall 47	0.00	2.02	0.00	0.00	9.57	0.00	0.00	3.70
Seismic dynamic X	Wall 48	0.00	2.11	0.00	0.00	9.93	0.00	0.00	3.76
Seismic dynamic X	Wall 49	0.00	1.12	0.00	0.00	5.30	0.00	0.00	4.17
Seismic dynamic X	Wall 50	0.00	1.42	0.00	0.00	6.67	0.00	0.00	2.55
Seismic dynamic X	Wall 51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 60	0.00	1.22	0.00	0.00	3.89	0.00	0.00	2.23
Seismic dynamic X	Wall 61	0.00	1.22	0.00	0.00	3.89	0.00	0.00	2.23
Seismic dynamic X	Wall 62	0.00	1.22	0.00	0.00	3.89	0.00	0.00	2.23
Seismic dynamic X	Wall 63	0.00	1.22	0.00	0.00	3.89	0.00	0.00	2.23
Seismic dynamic X	Wall 64	0.00	0.52	0.00	0.00	1.68	0.00	0.00	0.94
Seismic dynamic X	Wall 65	0.00	1.00	0.00	0.00	3.20	0.00	0.00	1.83
Seismic dynamic X	Wall 66	0.00	1.00	0.00	0.00	3.20	0.00	0.00	1.83
Seismic dynamic X	Wall 67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 68	0.00	0.47	0.00	0.00	1.51	0.00	0.00	0.84
Seismic dynamic X	Wall 69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic X	Wall 71	0.00	0.74	0.00	0.00	2.37	0.00	0.00	1.83
Seismic dynamic X	Wall 72	0.00	1.00	0.00	0.00	3.20	0.00	0.00	1.83
Seismic dynamic X	Wall 73	0.00	1.04	0.00	0.00	3.33	0.00	0.00	1.86
Seismic dynamic X	Wall 74	0.00	0.56	0.00	0.00	1.78	0.00	0.00	2.08
Seismic dynamic X	Wall 75	0.00	0.70	0.00	0.00	2.24	0.00	0.00	1.26
Seismic dynamic Y	Wall 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 10	0.00	0.90	0.00	0.00	6.10	0.00	0.00	1.68
Seismic dynamic Y	Wall 11	0.00	0.90	0.00	0.00	6.10	0.00	0.00	1.68
Seismic dynamic Y	Wall 12	0.00	0.90	0.00	0.00	6.10	0.00	0.00	1.68
Seismic dynamic Y	Wall 13	0.00	0.90	0.00	0.00	6.10	0.00	0.00	1.68
Seismic dynamic Y	Wall 14	0.00	6.37	0.00	0.00	42.88	0.00	0.00	11.64
Seismic dynamic Y	Wall 15	0.00	1.70	0.00	0.00	11.46	0.00	0.00	3.18
Seismic dynamic Y	Wall 16	0.00	1.70	0.00	0.00	11.46	0.00	0.00	3.18
Seismic dynamic Y	Wall 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 18	0.00	3.56	0.00	0.00	23.69	0.00	0.00	6.50
Seismic dynamic Y	Wall 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 21	0.00	1.25	0.00	0.00	8.47	0.00	0.00	3.18
Seismic dynamic Y	Wall 22	0.00	1.70	0.00	0.00	11.46	0.00	0.00	3.18
Seismic dynamic Y	Wall 23	0.00	3.29	0.00	0.00	21.79	0.00	0.00	6.00
Seismic dynamic Y	Wall 24	0.00	0.25	0.00	0.00	1.71	0.00	0.00	0.97
Seismic dynamic Y	Wall 25	0.00	3.09	0.00	0.00	20.47	0.00	0.00	5.68
Seismic dynamic Y	Wall 26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 35	0.00	0.70	0.00	0.00	3.41	0.00	0.00	1.28
Seismic dynamic Y	Wall 36	0.00	0.70	0.00	0.00	3.41	0.00	0.00	1.28
Seismic dynamic Y	Wall 37	0.00	0.70	0.00	0.00	3.41	0.00	0.00	1.28
Seismic dynamic Y	Wall 38	0.00	0.70	0.00	0.00	3.41	0.00	0.00	1.28
Seismic dynamic Y	Wall 39	0.00	4.91	0.00	0.00	24.10	0.00	0.00	8.78
Seismic dynamic Y	Wall 40	0.00	1.30	0.00	0.00	6.33	0.00	0.00	2.38
Seismic dynamic Y	Wall 41	0.00	1.30	0.00	0.00	6.33	0.00	0.00	2.38
Seismic dynamic Y	Wall 42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 43	0.00	2.73	0.00	0.00	13.15	0.00	0.00	4.88
Seismic dynamic Y	Wall 44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 46	0.00	0.97	0.00	0.00	4.70	0.00	0.00	2.38
Seismic dynamic Y	Wall 47	0.00	1.30	0.00	0.00	6.33	0.00	0.00	2.38
Seismic dynamic Y	Wall 48	0.00	2.50	0.00	0.00	11.74	0.00	0.00	4.46
Seismic dynamic Y	Wall 49	0.00	0.20	0.00	0.00	0.94	0.00	0.00	0.73
Seismic dynamic Y	Wall 50	0.00	2.36	0.00	0.00	11.18	0.00	0.00	4.24
Seismic dynamic Y	Wall 51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 52	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D

Seismic dynamic Y	Wall 59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 60	0.00	0.39	0.00	0.00	1.25	0.00	0.00	0.72
Seismic dynamic Y	Wall 61	0.00	0.39	0.00	0.00	1.25	0.00	0.00	0.72
Seismic dynamic Y	Wall 62	0.00	0.39	0.00	0.00	1.25	0.00	0.00	0.72
Seismic dynamic Y	Wall 63	0.00	0.39	0.00	0.00	1.25	0.00	0.00	0.72
Seismic dynamic Y	Wall 64	0.00	2.80	0.00	0.00	8.97	0.00	0.00	5.01
Seismic dynamic Y	Wall 65	0.00	0.73	0.00	0.00	2.33	0.00	0.00	1.33
Seismic dynamic Y	Wall 66	0.00	0.73	0.00	0.00	2.33	0.00	0.00	1.33
Seismic dynamic Y	Wall 67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 68	0.00	1.45	0.00	0.00	4.64	0.00	0.00	2.59
Seismic dynamic Y	Wall 69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/D
Seismic dynamic Y	Wall 71	0.00	0.54	0.00	0.00	1.73	0.00	0.00	1.33
Seismic dynamic Y	Wall 72	0.00	0.73	0.00	0.00	2.33	0.00	0.00	1.33
Seismic dynamic Y	Wall 73	0.00	1.21	0.00	0.00	3.87	0.00	0.00	2.16
Seismic dynamic Y	Wall 74	0.00	0.10	0.00	0.00	0.32	0.00	0.00	0.37
Seismic dynamic Y	Wall 75	0.00	1.18	0.00	0.00	3.77	0.00	0.00	2.12

Floors

Floor name: Floor ID

V2: Maximum shear stress along the local axis 2 for the most stressed element of the floor

M3-3: Maximum bending moment around local axis 3 for the most stressed element of the floor

w_{ist}: Maximum deformation for the most stressed element of the floor

Load	Floor name	V2 [kN]	M3-3 [kNm]	w_{ist} [mm]
G(sw)	Floor 1	0.26	1.68	2549.13
G(sw)	Floor 2	0.26	1.68	2549.13
G(sw)	Floor 3	0.26	1.68	2549.13
G(ns)	Floor 1	1.29	8.30	12588.30
G(ns)	Floor 2	1.29	8.30	12588.30
G(ns)	Floor 3	1.29	8.30	12588.30
Q type A	Floor 1	2.57	16.59	25176.61
Q type A	Floor 2	2.57	16.59	25176.61
Q type A	Floor 3	2.57	16.59	25176.61
Ortho wind ULS down	Floor 1	0.00	0.00	0.00
Ortho wind ULS down	Floor 2	0.00	0.00	0.00
Ortho wind ULS down	Floor 3	0.00	0.00	0.00
Ortho wind ULS up	Floor 1	0.00	0.00	0.00
Ortho wind ULS up	Floor 2	0.00	0.00	0.00
Ortho wind ULS up	Floor 3	0.00	0.00	0.00
Wind X	Floor 1	0.00	0.00	0.00
Wind X	Floor 2	0.00	0.00	0.00
Wind X	Floor 3	0.00	0.00	0.00
Wind Y	Floor 1	0.00	0.00	0.00
Wind Y	Floor 2	0.00	0.00	0.00
Wind Y	Floor 3	0.00	0.00	0.00
Seismic static X	Floor 1	0.00	0.00	0.00
Seismic static X	Floor 2	0.00	0.00	0.00
Seismic static X	Floor 3	0.00	0.00	0.00
Seismic static Y	Floor 1	0.00	0.00	0.00
Seismic static Y	Floor 2	0.00	0.00	0.00
Seismic static Y	Floor 3	0.00	0.00	0.00
Seismic dynamic X	Floor 1	0.00	0.00	0.00
Seismic dynamic X	Floor 2	0.00	0.00	0.00
Seismic dynamic X	Floor 3	0.00	0.00	0.00
Seismic dynamic Y	Floor 1	0.00	0.00	0.00
Seismic dynamic Y	Floor 2	0.00	0.00	0.00
Seismic dynamic Y	Floor 3	0.00	0.00	0.00

Technical Design Calculation Report

Forces and moments acting at the base of the structure

In this chapter the values of the actions acting at the base of the walls and the columns of the ground floor are reported. With regard to the walls, the first row of the table shows the values of the actions related to the ULS combination that maximizes the axial force while the second row shows the values of the actions related to the horizontal ULS combination that maximizes the moment acting in the plane of the wall M3-3 and the shear force V2 (also acting in the plane of the wall) and that, at the same time, minimizes the axial force N.

In the other rows, the actions at the foot of the walls associated with the different loads considered individually are reported.

Walls

Wall name: Wall ID

N: Total axial force

V2: Shear force (in-plane)

V3: Shear force (out-of-plane)

M2-2: Bending moment (out-of-plane)

M3-3: Bending moment (in-plane)

Wall name	Length [m]	Load / Comb.	N [kN]	V2 [kN]	V3 [kN]	M2-2 [kNm]	M3-3 [kNm]
Wall 1	0.61	ULS 1	7.59	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	2.08	0.00	0.00	0.00	0.00
		G(ns)	3.54	0.00	0.00	0.00	0.00
		Q type A	0.06	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.33	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.33	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 2	0.60	ULS 1	6.87	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	1.99	0.00	0.00	0.00	0.00
		G(ns)	3.10	0.00	0.00	0.00	0.00
		Q type A	-0.70	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.32	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.32	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 3	0.61	ULS 1	7.98	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	2.12	0.00	0.00	0.00	0.00
		G(ns)	3.79	0.00	0.00	0.00	0.00
		Q type A	0.55	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.33	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.33	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00

		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 4	0.61	ULS 3	9.84	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	2.22	0.00	0.00	0.00	0.00
		G(ns)	4.22	0.00	0.00	0.00	0.00
		Q type A	1.41	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.33	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.33	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 5	0.60	ULS 3	10.64	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	2.24	0.00	0.00	0.00	0.00
		G(ns)	4.36	0.00	0.00	0.00	0.00
		Q type A	1.81	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.32	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.32	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 6	0.61	ULS 3	26.51	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	2.98	0.00	0.00	0.00	0.00
		G(ns)	7.97	0.00	0.00	0.00	0.00
		Q type A	8.92	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.33	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.33	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 7	0.61	ULS 3	88.23	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	5.78	0.00	0.00	0.00	0.00
		G(ns)	21.86	0.00	0.00	0.00	0.00
		Q type A	36.70	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.33	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.33	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 8	0.60	ULS 3	51.62	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	4.11	0.00	0.00	0.00	0.00
		G(ns)	13.58	0.00	0.00	0.00	0.00
		Q type A	20.26	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.32	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.32	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 9	0.61	ULS 3	20.32	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	2.69	0.00	0.00	0.00	0.00
		G(ns)	6.58	0.00	0.00	0.00	0.00
		Q type A	6.13	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.41	0.33	0.00
		Ortho wind ULS up	0.00	0.00	0.41	0.33	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00

		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 10	2.45	ULS 1	25.43	0.00	0.00	0.00	0.00
		ULS earthquake drift 2 ex- ey+	0.00	3.22	0.00	0.00	21.69
		G(sw)	4.72	0.00	0.00	0.00	0.00
		G(ns)	14.11	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.65	1.32	0.00
		Ortho wind ULS up	0.00	0.00	1.65	1.32	0.00
		Wind X	0.00	2.31	0.00	0.00	13.32
		Wind Y	0.00	1.19	0.00	0.00	6.85
		Seismic static X	0.00	5.15	0.00	0.00	36.66
		Seismic static Y	0.00	0.07	0.00	0.00	0.73
		Seismic dynamic X	0.00	3.18	0.00	0.00	21.44
		Seismic dynamic Y	0.00	0.90	0.00	0.00	6.10
Wall 11	2.45	ULS 1	25.43	0.00	0.00	0.00	0.00
		ULS earthquake drift 2 ex- ey+	0.00	3.22	0.00	0.00	21.69
		G(sw)	4.72	0.00	0.00	0.00	0.00
		G(ns)	14.11	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.65	1.32	0.00
		Ortho wind ULS up	0.00	0.00	1.65	1.32	0.00
		Wind X	0.00	2.31	0.00	0.00	13.32
		Wind Y	0.00	1.19	0.00	0.00	6.85
		Seismic static X	0.00	5.15	0.00	0.00	36.66
		Seismic static Y	0.00	0.07	0.00	0.00	0.73
		Seismic dynamic X	0.00	3.18	0.00	0.00	21.44
		Seismic dynamic Y	0.00	0.90	0.00	0.00	6.10
Wall 12	2.45	ULS 1	25.43	0.00	0.00	0.00	0.00
		ULS earthquake drift 2 ex- ey+	0.00	3.22	0.00	0.00	21.69
		G(sw)	4.72	0.00	0.00	0.00	0.00
		G(ns)	14.11	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.65	1.32	0.00
		Ortho wind ULS up	0.00	0.00	1.65	1.32	0.00
		Wind X	0.00	2.31	0.00	0.00	13.32
		Wind Y	0.00	1.19	0.00	0.00	6.85
		Seismic static X	0.00	5.15	0.00	0.00	36.66
		Seismic static Y	0.00	0.07	0.00	0.00	0.73
		Seismic dynamic X	0.00	3.18	0.00	0.00	21.44
		Seismic dynamic Y	0.00	0.90	0.00	0.00	6.10
Wall 13	2.45	ULS 1	25.43	0.00	0.00	0.00	0.00
		ULS earthquake drift 2 ex- ey+	0.00	3.22	0.00	0.00	21.69
		G(sw)	4.72	0.00	0.00	0.00	0.00
		G(ns)	14.11	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.65	1.32	0.00
		Ortho wind ULS up	0.00	0.00	1.65	1.32	0.00
		Wind X	0.00	2.31	0.00	0.00	13.32
		Wind Y	0.00	1.19	0.00	0.00	6.85
		Seismic static X	0.00	5.15	0.00	0.00	36.66
		Seismic static Y	0.00	0.07	0.00	0.00	0.73
		Seismic dynamic X	0.00	3.18	0.00	0.00	21.44
		Seismic dynamic Y	0.00	0.90	0.00	0.00	6.10
Wall 14	2.50	ULS 3	153.85	0.00	0.00	0.00	0.00
		ULS Wind 8	49.12	22.52	1.69	1.35	129.69
		G(sw)	10.73	0.00	0.00	0.00	0.00
		G(ns)	43.85	0.00	0.00	0.00	0.00
		Q type A	58.90	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.69	1.35	0.00
		Ortho wind ULS up	0.00	0.00	1.69	1.35	0.00
		Wind X	0.00	0.15	0.00	0.00	0.83
		Wind Y	0.00	22.52	0.00	0.00	129.69
		Seismic static X	0.00	0.46	0.00	0.00	3.24
		Seismic static Y	0.00	11.11	0.00	0.00	79.95
		Seismic dynamic X	0.00	1.20	0.00	0.00	8.32
		Seismic dynamic Y	0.00	6.37	0.00	0.00	42.88
Wall 15	2.45	ULS 1	25.43	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex- ey-	0.00	3.33	0.00	0.00	22.36
		G(sw)	4.72	0.00	0.00	0.00	0.00
		G(ns)	14.11	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.65	1.32	0.00
		Ortho wind ULS up	0.00	0.00	1.65	1.32	0.00
		Wind X	0.00	2.40	0.00	0.00	13.82
		Wind Y	0.00	1.33	0.00	0.00	7.68
		Seismic static X	0.00	5.43	0.00	0.00	38.61
		Seismic static Y	0.00	0.08	0.00	0.00	0.82

		Seismic dynamic X	0.00	2.65	0.00	0.00	17.76
		Seismic dynamic Y	0.00	1.70	0.00	0.00	11.46
Wall 16	2.45	ULS 1	25.43	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex- ey-	0.00	3.33	0.00	0.00	22.36
		G(sw)	4.72	0.00	0.00	0.00	0.00
		G(ns)	14.11	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.65	1.32	0.00
		Ortho wind ULS up	0.00	0.00	1.65	1.32	0.00
		Wind X	0.00	2.40	0.00	0.00	13.82
		Wind Y	0.00	1.33	0.00	0.00	7.68
		Seismic static X	0.00	5.43	0.00	0.00	38.61
		Seismic static Y	0.00	0.08	0.00	0.00	0.82
		Seismic dynamic X	0.00	2.65	0.00	0.00	17.76
		Seismic dynamic Y	0.00	1.70	0.00	0.00	11.46
Wall 17	0.58	ULS 1	7.27	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	2.04	0.00	0.00	0.00	0.00
		G(ns)	3.34	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.39	0.31	0.00
		Ortho wind ULS up	0.00	0.00	0.39	0.31	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 18	2.50	ULS 3	200.56	0.00	0.00	0.00	0.00
		ULS Wind 8	60.50	18.47	1.69	1.35	106.39
		G(sw)	12.86	0.00	0.00	0.00	0.00
		G(ns)	54.36	0.00	0.00	0.00	0.00
		Q type A	79.93	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.69	1.35	0.00
		Ortho wind ULS up	0.00	0.00	1.69	1.35	0.00
		Wind X	0.00	0.00	0.00	0.00	0.03
		Wind Y	0.00	18.47	0.00	0.00	106.39
		Seismic static X	0.00	0.01	0.00	0.00	0.10
		Seismic static Y	0.00	10.87	0.00	0.00	77.47
		Seismic dynamic X	0.00	1.26	0.00	0.00	8.29
		Seismic dynamic Y	0.00	3.56	0.00	0.00	23.69
Wall 19	0.50	ULS 1	6.55	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	1.97	0.00	0.00	0.00	0.00
		G(ns)	2.88	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.34	0.27	0.00
		Ortho wind ULS up	0.00	0.00	0.34	0.27	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 20	0.46	ULS 1	6.18	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex+ ey-	0.00	0.00	0.00	0.00	0.00
		G(sw)	1.93	0.00	0.00	0.00	0.00
		G(ns)	2.65	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.31	0.25	0.00
		Ortho wind ULS up	0.00	0.00	0.31	0.25	0.00
		Wind X	0.00	0.00	0.00	0.00	0.00
		Wind Y	0.00	0.00	0.00	0.00	0.00
		Seismic static X	0.00	0.00	0.00	0.00	0.00
		Seismic static Y	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic X	0.00	0.00	0.00	0.00	0.00
		Seismic dynamic Y	0.00	0.00	0.00	0.00	0.00
Wall 21	1.87	ULS 1	19.94	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex- ey-	0.00	2.45	0.00	0.00	16.53
		G(sw)	4.00	0.00	0.00	0.00	0.00
		G(ns)	10.77	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.26	1.01	0.00
		Ortho wind ULS up	0.00	0.00	1.26	1.01	0.00
		Wind X	0.00	1.77	0.00	0.00	10.21
		Wind Y	0.00	0.98	0.00	0.00	5.67
		Seismic static X	0.00	4.00	0.00	0.00	28.54
		Seismic static Y	0.00	0.06	0.00	0.00	0.60
		Seismic dynamic X	0.00	1.95	0.00	0.00	13.13

		Seismic dynamic Y	0.00	1.25	0.00	0.00	8.47
Wall 22	2.45	ULS 1	25.43	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex- ey-	0.00	3.33	0.00	0.00	22.36
		G(sw)	4.72	0.00	0.00	0.00	0.00
		G(ns)	14.11	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.65	1.32	0.00
		Ortho wind ULS up	0.00	0.00	1.65	1.32	0.00
		Wind X	0.00	2.40	0.00	0.00	13.82
		Wind Y	0.00	1.33	0.00	0.00	7.68
		Seismic static X	0.00	5.43	0.00	0.00	38.61
		Seismic static Y	0.00	0.08	0.00	0.00	0.82
		Seismic dynamic X	0.00	2.65	0.00	0.00	17.76
		Seismic dynamic Y	0.00	1.70	0.00	0.00	11.46
Wall 23	2.50	ULS 3	111.83	0.00	0.00	0.00	0.00
		ULS Wind 8	38.89	15.28	1.69	1.35	88.01
		G(sw)	8.82	0.00	0.00	0.00	0.00
		G(ns)	34.39	0.00	0.00	0.00	0.00
		Q type A	39.99	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.69	1.35	0.00
		Ortho wind ULS up	0.00	0.00	1.69	1.35	0.00
		Wind X	0.00	0.11	0.00	0.00	0.61
		Wind Y	0.00	15.28	0.00	0.00	88.01
		Seismic static X	0.00	0.34	0.00	0.00	2.37
		Seismic static Y	0.00	10.69	0.00	0.00	75.52
		Seismic dynamic X	0.00	2.77	0.00	0.00	18.45
		Seismic dynamic Y	0.00	3.29	0.00	0.00	21.79
Wall 24	1.30	ULS 1	14.28	0.00	0.00	0.00	0.00
		ULS earthquake drift 1 ex- ey-	0.00	1.48	0.00	0.00	10.04
		G(sw)	3.09	0.00	0.00	0.00	0.00
		G(ns)	7.49	0.00	0.00	0.00	0.00
		Q type A	0.00	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	0.88	0.70	0.00
		Ortho wind ULS up	0.00	0.00	0.88	0.70	0.00
		Wind X	0.00	1.12	0.00	0.00	6.52
		Wind Y	0.00	0.23	0.00	0.00	1.31
		Seismic static X	0.00	2.51	0.00	0.00	18.07
		Seismic static Y	0.00	0.01	0.00	0.00	0.14
		Seismic dynamic X	0.00	1.43	0.00	0.00	9.74
		Seismic dynamic Y	0.00	0.25	0.00	0.00	1.71
Wall 25	2.49	ULS 3	38.33	0.00	0.00	0.00	0.00
		ULS Wind 8	20.94	16.99	1.68	1.34	97.81
		G(sw)	5.46	0.00	0.00	0.00	0.00
		G(ns)	17.81	0.00	0.00	0.00	0.00
		Q type A	6.94	0.00	0.00	0.00	0.00
		Ortho wind ULS down	0.00	0.00	1.68	1.34	0.00
		Ortho wind ULS up	0.00	0.00	1.68	1.34	0.00
		Wind X	0.00	0.04	0.00	0.00	0.25
		Wind Y	0.00	16.99	0.00	0.00	97.81
		Seismic static X	0.00	0.14	0.00	0.00	0.96
		Seismic static Y	0.00	10.73	0.00	0.00	76.13
		Seismic dynamic X	0.00	1.88	0.00	0.00	12.44
		Seismic dynamic Y	0.00	3.09	0.00	0.00	20.47

Design of the structural elements

Joist floors

Bending strength

The checks are conducted according to § 3.2.1 of AS 1720.1. The following expression shall be satisfied:

$$M_d \geq M^*$$

with

$$M_d = \phi \cdot k_1 \cdot k_4 \cdot k_6 \cdot k_9 \cdot k_{12} \cdot f_b' \cdot Z$$

where

$M^* = M_{3-3\,max}$ is the design action effect in bending

ϕ is the capacity factor

k_1 is the duration of load modification factor for strength

k_4 is the moisture condition modification factor for strength

k_6 is the temperature modification factor

k_9 is the strength sharing modification factor

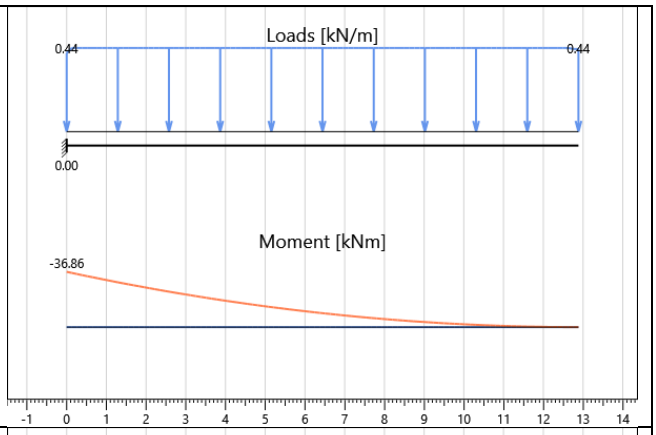
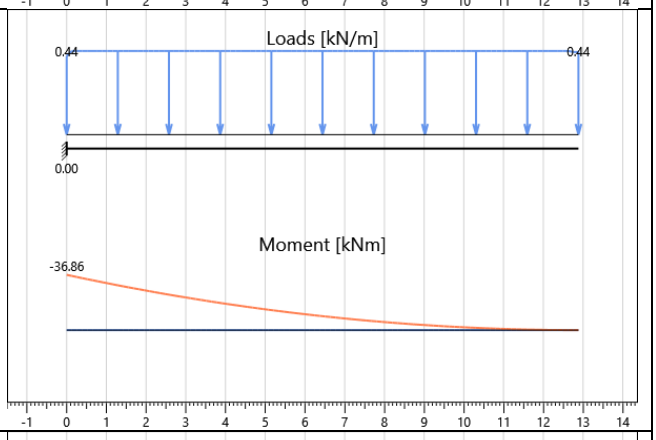
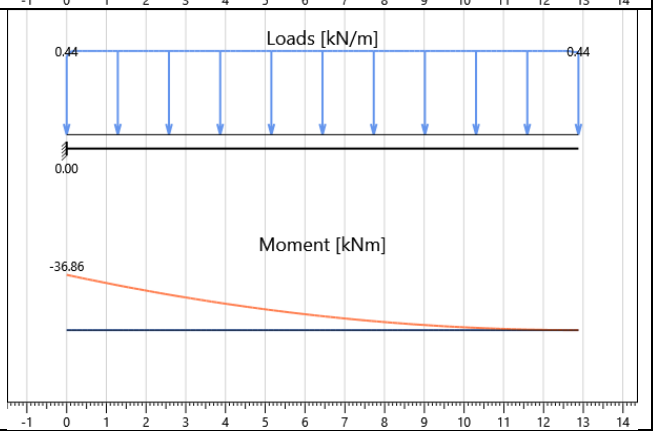
k_{12} is the stability factor

f_b' is the characteristic value in bending for the section size

Z is the section modulus of the beam about the axis of bending $Z = (bh^2/6)$

The following table illustrates the structural schemes and the envelopes of the bending moment diagram for the joist with the most severe checks of each floor.

Floor name	Combination	Duration	Diagram $M_{3\text{-}3}$

Floor 1	ULS 3	5 months	
Floor 2	ULS 3	5 months	
Floor 3	ULS 3	5 months	

The checks are summarized below in the form of a percentage value.

Floor name	Section	$M_{3\text{-}3\ max}$ [kNm]	Z [mm^3]	Comb.	k_1	k_4	k_6	k_9	k_{12}	ϕ	f'_b [MPa]	M_d [kNm]	Check
Floor 1	Joists floor 1	36.86	60750	ULS 3	0.8	1	1	1	1	0.9	17.00	0.74	4958%
Floor 2	Joists floor 1	36.86	60750	ULS 3	0.8	1	1	1	1	0.9	17.00	0.74	4958%
Floor 3	Joists floor 1	36.86	60750	ULS 3	0.8	1	1	1	1	0.9	17.00	0.74	4958%

Where f'_b for rectangular beam sections made of F-grades timber and greater than 300 mm in depth is obtained by multiplying the value of table H2.1 of AS 1720.1 by $(300/d)^{0.167}$.

Shear strength

The checks are conducted according to § 3.2.5 of AS 1720.1. The following expression shall be satisfied:

$$V_d \geq V^*$$

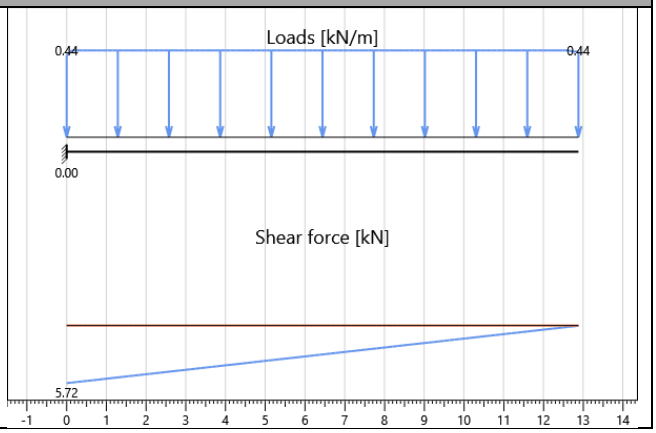
with

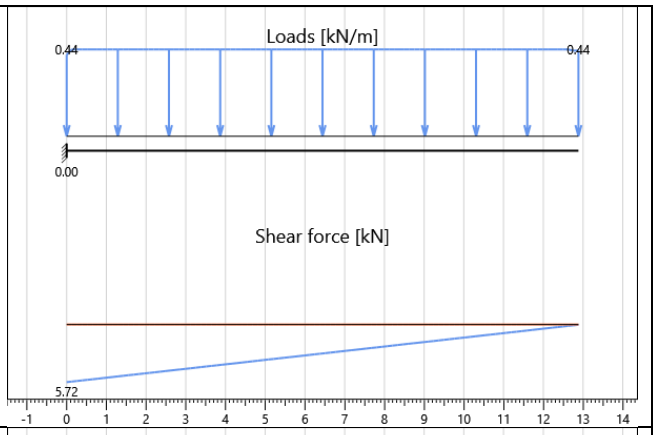
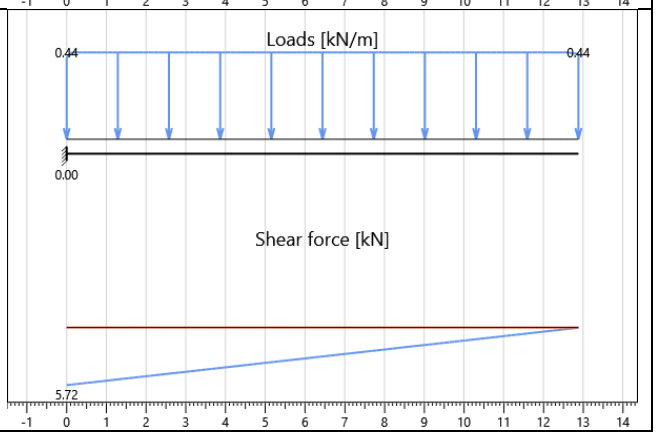
$$V_d = \phi \cdot k_1 \cdot k_4 \cdot k_6 \cdot f_s' \cdot A_s$$

where

$V^* = V_{2\,max}$	is the design action effect in shear
ϕ	is the capacity factor
k_1	is the duration of load modification factor for strength
k_4	is the moisture condition modification factor for strength
k_6	is the temperature modification factor
f_s'	is the characteristic value in shear
A_s	is the shear plane area for a rectangular beam loaded about its major axis in bending $A_s = 2/3(bd)$

The following table illustrates the structural schemes and the envelopes of the shear force diagram for the joist of each floor with the most sever checks.

Floor name	Combination	Duration	Diagram V_2
Floor 1	ULS 3	5 months	

Floor 2	ULS 3	5 months	
Floor 3	ULS 3	5 months	

The checks are summarized below in the form of a percentage value.

Floor name	Section	$V_{2\,max}$ [kN]	A_s [mm^2]	Comb.	k_1	k_4	k_6	ϕ	f'_s [MPa]	V_d [kN]	Check
Floor 1	Joists floor 1	5.72	4050	ULS 3	0.8	1	1	0.9	2.60	5.05	113%
Floor 2	Joists floor 1	5.72	4050	ULS 3	0.8	1	1	0.9	2.60	5.05	113%
Floor 3	Joists floor 1	5.72	4050	ULS 3	0.8	1	1	0.9	2.60	5.05	113%

Floors deflections (SLS)

The final deflection below a straight line between the supports due to a single type of action, w_{creep}, is taken as:

$$w_{creep,i} = j_2 \cdot w_{short-term,i}$$

where:

$w_{creep,i}$ is the final deflection that includes the effect of creep on deformation

$w_{short-term,i}$ is the short-term deflection

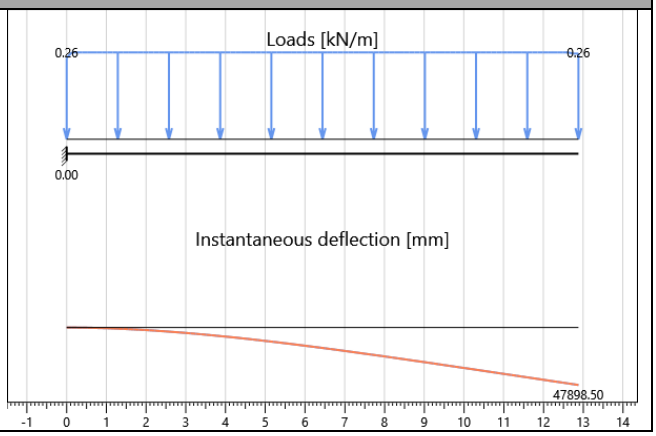
j_2 is the modification factor for creep

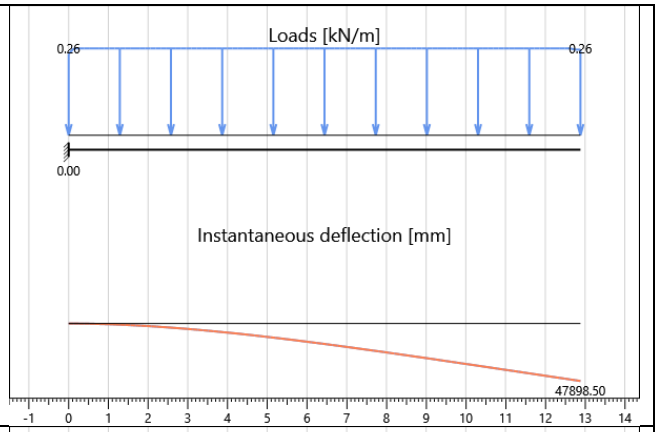
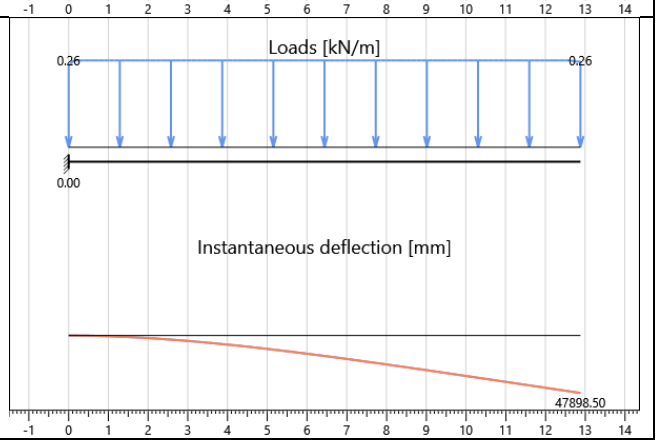
The limiting values for deflections of floors are assumed as shown in the following table according to the considered combination of actions.

	W_s	$\psi_s \cdot Q$	$G + \psi_s \cdot Q$	$G + \psi_l \cdot Q$
Internal spans	l/300	l/400	15 mm	l/300
Cantilever beams	l/150	l/200	30 mm	l/150

The value of deflection $w_{creep,i}$ is calculated for each type of load in the considered combination of actions and the final value $w_{creep,i}$ is defined as the sum of these deflections.

The following table shows the maximum deformation of each floor (relative to the element in which the deformation checks are the most severe).

Floor name	Combination	Deflection
Floor 1	SLS 3	

Floor 2	SLS 3	
Floor 3	SLS 3	

The table shows the deflection checks of the floor elements.

Floor name	Section	Combination	Most restrictive check	W_{creep} [mm]	Deflection limit [mm]	Check
Floor 1	Joists floor 1	SLS 3	Cantilever beams	47898.50	30.00	159662%
Floor 2	Joists floor 1	SLS 3	Cantilever beams	47898.50	30.00	159662%
Floor 3	Joists floor 1	SLS 3	Cantilever beams	47898.50	30.00	159662%

Framed Walls

Combined bending and compression of the studs

The checks are conducted according to § 3.5.1 of AS 1720.1 on the most loaded internal and external stud of each wall. The following expressions shall be satisfied:

$$\left(\frac{M^*_{out-of-plane}}{M_{d,out-of-plane}}\right)^2 + \frac{N^*_c}{N_{d,c,in-plane}} \leq 1$$

$$\frac{M^*_{out-of-plane}}{M_{d,out-of-plane}} + \frac{N^*_c}{N_{d,c,out-of-plane}} \leq 1$$

with

$M^*_{out-of-plane} = M_{2-2}$ is the design action effect in bending out of the plane of the wall

$M_{d,out-of-plane}$ is the design capacity in bending out of the plane of the wall

$N^*_c = N$ is the design action effect in compression

$N_{d,c,out-of-plane}$ is the design capacity in compression for buckling out of the plane of the wall

$N_{d,c,in-plane}$ is the design capacity in compression for buckling in the plane of the wall

The design capacity of each stud in bending out-of-the-plane of the wall is calculated according to the following equation:

$$M_{d,out-of-plane} = \phi \cdot k_1 \cdot k_4 \cdot k_6 \cdot k_9 \cdot k_{12} \cdot f'_b \cdot Z$$

where

ϕ is the capacity factor

k_1 is the duration of load modification factor for strength

k_4 is the moisture condition modification factor for strength

k_6 is the temperature modification factor

k_9 is the strength sharing modification factor

k_{12} is the stability factor

f'_b is the characteristic value in bending for the section size

Z is the section modulus of the stud about the axis of bending $Z = (bt^2/6)$

The design capacity of each stud in compression is calculated according to the following equation:

$$N_{d,c} = \phi \cdot k_1 \cdot k_4 \cdot k_6 \cdot k_{12} \cdot f'_c \cdot A_c$$

where

ϕ is the capacity factor

k_1 is the duration of load modification factor for strength

k_4 is the moisture condition modification factor for strength

k_6 is the temperature modification factor

k_{12} is the relevant stability factor for buckling in or out of the plane of the wall

f'_c is the characteristic value in compression parallel to grain

A_c is the cross-sectional area of the stud

The stability factor k_{12} takes into account the reduced compressive strength due to lateral buckling.

The factor value is calculated according to § 3.3.3 of AS 1720.1 as follows:

(a) For $\rho_c \cdot S \leq 10$ → $k_{12} = 1.0$

(b) For $10 \leq \rho_c \cdot S \leq 20$ → $k_{12} = 1.5 - 0.05 \cdot \rho_c \cdot S$

(c) For $\rho_c \cdot S \geq 20$ → $k_{12} = \frac{200}{(\rho_c \cdot S)^2}$

Where S is the relevant slenderness coefficient for buckling under compression and ρ_c is the material constant for columns.

The slenderness coefficient for buckling out of the plane of the wall is evaluated according to the following equations that is consistent with those provided in section 3.3.2.2 of AS 1720.1:

$$S_{out-of-plane} = \frac{g_{13} \cdot L}{t}$$

where

L is the height of the stud

t is the thickness of the frame (dimension of the stud cross-section perpendicular to the wall plane)

g_{13} is the effective length factor equal to 0.85 for studs in light framing when plates and studs are made of the same timber grade

The slenderness coefficient for buckling in the plane of the wall is equal to 0 when an effective restraint system act continuously along both edges of the stud (i.e. sheeting boards on both the faces of the frame).

When the sheeting board provides an effective restraint along one edge only of the stud, the slenderness coefficient for buckling in the plane of the wall is evaluated according to the following equations that is consistent to those provided in section 3.3.2.2 of AS 1720.1:

$$S_{in-plane} = \frac{3.5 \cdot t}{b}$$

where

t is the thickness of the frame (dimension of the stud cross-section perpendicular to the wall plane)

b is the dimension of the stud cross-section parallel to the wall plane

In case of walls braced through steel braces, the slenderness coefficient for buckling in the plane of the wall is evaluated according to the following equations that is consistent with those provided in section 3.3.2.2 of AS 1720.1:

$$S_{in-plane} = \frac{g_{13} \cdot L}{b}$$

where

L is the height of the stud

b is the dimension of the stud cross-section parallel to the wall plane

g_{13} is the effective length factor equal to 0.85 for studs in light framing when plates and studs are made of the same timber grade

The material constant values for each material are defined according to equations E2(3) and E2(4) of AS 1720.1 assuming $r = 0.25$:

(a) Columns of seasoned timber $\rho_c = 11.39\left(\frac{E}{f_c'}\right)^{-0.408} r^{-0.074}$

(b) Columns of unseasoned timber $\rho_c = 9.29\left(\frac{E}{f_c'}\right)^{-0.367} r^{-0.146}$

The values of the actions in the tables below are related, for each wall, to the most severe combination of load for the Ultimate Limit State of combined bending and compression.

Wall name	Length [m]	Combination	Duration	N [kN]	M2-2 [kNm]
Wall 1	0.61	ULS 1	50+ years	7.59	0.00
Wall 2	0.60	ULS 1	50+ years	6.87	0.00
Wall 3	0.61	ULS 1	50+ years	7.98	0.00
Wall 4	0.61	ULS 1	50+ years	8.69	0.00
Wall 5	0.60	ULS 4	50+ years	9.01	0.00
Wall 6	0.61	ULS 4	50+ years	18.49	0.00
Wall 7	0.61	ULS 3	5 months	88.23	0.00
Wall 8	0.60	ULS 3	5 months	51.62	0.00
Wall 9	0.61	ULS 4	50+ years	14.80	0.00
Wall 10	2.45	ULS 5	5 seconds	22.60	1.32
Wall 11	2.45	ULS 5	5 seconds	22.60	1.32
Wall 12	2.45	ULS 5	5 seconds	22.60	1.32
Wall 13	2.45	ULS 5	5 seconds	22.60	1.32
Wall 14	2.50	ULS 3	5 months	153.85	0.00
Wall 15	2.45	ULS 5	5 seconds	22.60	1.32
Wall 16	2.45	ULS 5	5 seconds	22.60	1.32
Wall 17	0.58	ULS 1	50+ years	7.27	0.00
Wall 18	2.50	ULS 3	5 months	200.56	0.00
Wall 19	0.50	ULS 1	50+ years	6.55	0.00
Wall 20	0.46	ULS 1	50+ years	6.18	0.00
Wall 21	1.87	ULS 1	50+ years	19.94	0.00
Wall 22	2.45	ULS 5	5 seconds	22.60	1.32
Wall 23	2.50	ULS 3	5 months	111.83	0.00
Wall 24	1.30	ULS 1	50+ years	14.28	0.00
Wall 25	2.49	ULS 4	50+ years	32.09	0.00
Wall 26	0.61	ULS 5	5 seconds	4.51	0.33
Wall 27	0.60	ULS 5	5 seconds	3.92	0.32
Wall 28	0.61	ULS 5	5 seconds	4.91	0.33
Wall 29	0.61	ULS 5	5 seconds	5.53	0.33
Wall 30	0.60	ULS 5	5 seconds	5.77	0.32
Wall 31	0.61	ULS 4	50+ years	12.33	0.00
Wall 32	0.61	ULS 3	5 months	59.28	0.00
Wall 33	0.60	ULS 3	5 months	34.70	0.00
Wall 34	0.61	ULS 4	50+ years	9.87	0.00
Wall 35	2.45	ULS 5	5 seconds	15.07	1.32
Wall 36	2.45	ULS 5	5 seconds	15.07	1.32
Wall 37	2.45	ULS 5	5 seconds	15.07	1.32
Wall 38	2.45	ULS 5	5 seconds	15.07	1.32
Wall 39	2.50	ULS 3	5 months	102.57	0.00
Wall 40	2.45	ULS 5	5 seconds	15.07	1.32
Wall 41	2.45	ULS 5	5 seconds	15.07	1.32
Wall 42	0.58	ULS 5	5 seconds	4.31	0.31
Wall 43	2.50	ULS 3	5 months	133.71	0.00
Wall 44	0.50	ULS 5	5 seconds	3.88	0.27
Wall 45	0.46	ULS 5	5 seconds	3.67	0.25
Wall 46	1.87	ULS 5	5 seconds	11.81	1.01
Wall 47	2.45	ULS 5	5 seconds	15.07	1.32
Wall 48	2.50	ULS 3	5 months	74.56	0.00
Wall 49	1.30	ULS 5	5 seconds	8.46	0.70
Wall 50	2.49	ULS 5	5 seconds	20.47	1.34
Wall 51	0.61	ULS 5	5 seconds	2.26	0.33
Wall 52	0.60	ULS 5	5 seconds	1.98	0.32

Wall 53	0.61	ULS 5	5 seconds	2.48	0.33
Wall 54	0.61	ULS 5	5 seconds	2.76	0.33
Wall 55	0.60	ULS 5	5 seconds	2.88	0.32
Wall 56	0.61	ULS 5	5 seconds	5.57	0.33
Wall 57	0.61	ULS 3	5 months	29.87	0.00
Wall 58	0.60	ULS 3	5 months	17.50	0.00
Wall 59	0.61	ULS 5	5 seconds	4.53	0.33
Wall 60	2.45	ULS 5	5 seconds	7.53	1.32
Wall 61	2.45	ULS 5	5 seconds	7.53	1.32
Wall 62	2.45	ULS 5	5 seconds	7.53	1.32
Wall 63	2.45	ULS 5	5 seconds	7.53	1.32
Wall 64	2.50	ULS 3	5 months	51.28	0.00
Wall 65	2.45	ULS 5	5 seconds	7.53	1.32
Wall 66	2.45	ULS 5	5 seconds	7.53	1.32
Wall 67	0.58	ULS 5	5 seconds	2.15	0.31
Wall 68	2.50	ULS 3	5 months	66.85	0.00
Wall 69	0.50	ULS 5	5 seconds	1.94	0.27
Wall 70	0.46	ULS 5	5 seconds	1.83	0.25
Wall 71	1.87	ULS 5	5 seconds	5.91	1.01
Wall 72	2.45	ULS 5	5 seconds	7.53	1.32
Wall 73	2.50	ULS 3	5 months	37.28	0.00
Wall 74	1.30	ULS 5	5 seconds	4.23	0.70
Wall 75	2.49	ULS 5	5 seconds	10.23	1.34

The relevant values for the calculation of the stability factors in bending and compression are reported in the following table.

Wall name	Section	Stud	L [m]	$k_{12,\ bending,\ o\text{-}o\text{-}p}$	$S_{compression,\ o\text{-}o\text{-}p}$	$S_{compression,\ i\text{-}p}$	ρ_c	$k_{compression,\ 12,\ o\text{-}o\text{-}p}$	$k_{compression,\ 12,\ i\text{-}p}$
Wall 1	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 1	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 2	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 2	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 3	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 3	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 4	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 4	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 5	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 5	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 6	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 6	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 7	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 7	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 8	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 8	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 9	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 9	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 10	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 10	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 11	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 11	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 12	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 12	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 13	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 13	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 14	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 14	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 15	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 15	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 16	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 16	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 17	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 17	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 18	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 18	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 19	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 19	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 20	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 21	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 21	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 22	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 22	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 23	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 23	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 24	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 24	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 25	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 25	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 26	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 26	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 27	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 27	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 28	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 28	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 29	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 29	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 30	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 30	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 31	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 31	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 32	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00

Wall 32	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 33	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 33	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 34	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 34	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 35	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 35	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 36	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 36	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 37	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 37	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 38	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 38	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 39	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 39	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 40	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 40	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 41	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 41	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 42	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 42	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 43	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 43	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 44	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 44	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 45	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 46	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 46	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 47	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 47	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 48	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 48	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 49	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 49	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 50	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 50	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 51	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 51	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 52	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 52	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 53	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 53	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 54	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 54	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 55	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 55	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 56	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 56	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 57	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 57	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 58	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 58	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 59	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 59	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 60	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 60	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 61	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 61	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 62	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 62	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 63	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 63	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 64	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 64	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 65	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 65	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 66	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 66	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 67	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 67	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 68	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 68	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 69	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 69	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 70	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 71	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 71	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 72	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 72	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 73	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 73	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 74	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 74	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 75	Frame 1	Internal	3.2	1.00	30.22	7.00	0.96	0.24	1.00
Wall 75	Frame 1	External	3.2	1.00	30.22	7.00	0.96	0.24	1.00

The checks are summarized below in the form of a percentage value

Wall name	Section	Stud	M_{2-2} [kNm]	N [kN]	Z [mm^3]	A_c [mm^2]	Comb.	k_1	k_4	k_6	ϕ	f'_b [MPa]	f'_c [MPa]	M_d [kNm]	$N_{d,c,o-o-p}$ [kN]	$N_{d,c,i-p}$ [kN]	Check
Wall 1	Frame 1	Internal	0.00	3.52	60750	4050	ULS 1	0.57	1.00	1.00	0.90	17.00	18.00	0.53	8.93	37.40	39%
Wall 1	Frame 1	External	0.00	2.68	243000	16200	ULS 1	0.57	1.00	1.00	0.90	17.00	18.00	2.12	35.71	149.59	8%

Wall 2	Frame 1	Internal	0.00	3.33	60750	4050	ULS 1	0.57	1.00	1.00	0.90	17.00	18.00	0.53	8.93	37.40	37%
Wall 2	Frame 1	External	0.00	2.34	243000	16200	ULS 1	0.57	1.00	1.00	0.90	17.00	18.00	2.12	35.71	149.59	7%
Wall 3	Frame 1	Internal	0.00	3.79	60750	4050	ULS 1	0.57	1.00	1.00	0.90	17.00	18.00	0.53	8.93	37.40	42%
Wall 3	Frame 1	External	0.00	2.77	243000	16200	ULS 1	0.57	1.00	1.00	0.90	17.00	18.00	2.12	35.71	149.59	8%
Wall 4	Frame 1	Internal	0.00	4.06	60750	4050	ULS 1	0.57	1.00	1.00	0.90	17.00	18.00	0.53	8.93	37.40	45%
Wall 4	Frame 1	External	0.00	3.02	243000	16200	ULS 1	0.57	1.00	1.00	0.90	17.00	18.00	2.12	35.71	149.59	8%
Wall 5	Frame 1	Internal	0.00	4.17	60750	4050	ULS 4	0.57	1.00	1.00	0.90	17.00	18.00	0.53	8.93	37.40	47%
Wall 5	Frame 1	External	0.00	3.24	243000	16200	ULS 4	0.57	1.00	1.00	0.90	17.00	18.00	2.12	35.71	149.59	9%
Wall 6	Frame 1	Internal	0.00	5.78	60750	4050	ULS 4	0.57	1.00	1.00	0.90	17.00	18.00	0.53	8.93	37.40	65%
Wall 6	Frame 1	External	0.00	9.56	243000	16200	ULS 4	0.57	1.00	1.00	0.90	17.00	18.00	2.12	35.71	149.59	27%
Wall 7	Frame 1	Internal	0.00	39.79	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	318%
Wall 7	Frame 1	External	0.00	34.28	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	68%
Wall 8	Frame 1	Internal	0.00	25.16	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	201%
Wall 8	Frame 1	External	0.00	18.07	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	36%
Wall 9	Frame 1	Internal	0.00	7.23	60750	4050	ULS 4	0.57	1.00	1.00	0.90	17.00	18.00	0.53	8.93	37.40	81%
Wall 9	Frame 1	External	0.00	4.71	243000	16200	ULS 4	0.57	1.00	1.00	0.90	17.00	18.00	2.12	35.71	149.59	13%
Wall 10	Frame 1	Internal	0.22	3.77	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	48%
Wall 10	Frame 1	External	0.12	1.99	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 11	Frame 1	Internal	0.22	3.77	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	48%
Wall 11	Frame 1	External	0.12	1.99	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 12	Frame 1	Internal	0.22	3.77	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	48%
Wall 12	Frame 1	External	0.12	1.99	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 13	Frame 1	Internal	0.22	3.77	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	48%
Wall 13	Frame 1	External	0.12	1.99	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 14	Frame 1	Internal	0.00	27.29	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	218%
Wall 14	Frame 1	External	0.00	13.86	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	28%
Wall 15	Frame 1	Internal	0.22	3.77	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	48%
Wall 15	Frame 1	External	0.12	1.99	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 16	Frame 1	Internal	0.22	3.77	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	48%
Wall 16	Frame 1	External	0.12	1.99	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 17	Frame 1	Internal	0.00	3.35	60750	4050	ULS 1	0.57	1.00	1.00	0.90	17.00	18.00	0.53	8.93	37.40	38%
Wall 17	Frame 1	External	0.00	2.70	243000	16200	ULS 1	0.57	1.00	1.00	0.90	17.00	18.00	2.12	35.71	149.59	8%
Wall 18	Frame 1	Internal	0.00	33.30	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	266%
Wall 18	Frame 1	External	0.00	18.86	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	38%
Wall 19	Frame 1	Internal	0.00	2.98	60750	4050	ULS 1	0.57	1.00	1.00	0.90	17.00	18.00	0.53	8.93	37.40	33%
Wall 19	Frame 1	External	0.00	2.82	243000	16200	ULS 1	0.57	1.00	1.00	0.90	17.00	18.00	2.12	35.71	149.59	8%
Wall 20	Frame 1	External	0.00	3.09	243000	16200	ULS 1	0.57	1.00	1.00	0.90	17.00	18.00	2.12	35.71	149.59	9%
Wall 21	Frame 1	Internal	0.00	4.36	60750	4050	ULS 1	0.57	1.00	1.00	0.90	17.00	18.00	0.53	8.93	37.40	49%
Wall 21	Frame 1	External	0.00	2.30	243000	16200	ULS 1	0.57	1.00	1.00	0.90	17.00	18.00	2.12	35.71	149.59	6%
Wall 22	Frame 1	Internal	0.22	3.77	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	48%
Wall 22	Frame 1	External	0.12	1.99	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 23	Frame 1	Internal	0.00	18.60	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	148%
Wall 23	Frame 1	External	0.00	10.75	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	21%
Wall 24	Frame 1	Internal	0.00	4.49	60750	4050	ULS 1	0.57	1.00	1.00	0.90	17.00	18.00	0.53	8.93	37.40	50%
Wall 24	Frame 1	External	0.00	2.37	243000	16200	ULS 1	0.57	1.00	1.00	0.90	17.00	18.00	2.12	35.71	149.59	7%
Wall 25	Frame 1	Internal	0.00	5.65	60750	4050	ULS 4	0.57	1.00	1.00	0.90	17.00	18.00	0.53	8.93	37.40	63%
Wall 25	Frame 1	External	0.00	3.17	243000	16200	ULS 4	0.57	1.00	1.00	0.90	17.00	18.00	2.12	35.71	149.59	9%
Wall 26	Frame 1	Internal	0.15	2.10	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	30%
Wall 26	Frame 1	External	0.12	1.60	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 27	Frame 1	Internal	0.15	1.91	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	28%
Wall 27	Frame 1	External	0.12	1.27	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 28	Frame 1	Internal	0.15	2.32	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	31%
Wall 28	Frame 1	External	0.12	1.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 29	Frame 1	Internal	0.15	2.59	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	33%
Wall 29	Frame 1	External	0.12	1.90	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 30	Frame 1	Internal	0.15	2.67	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	33%
Wall 30	Frame 1	External	0.12	2.07	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 31	Frame 1	Internal	0.00	3.86	60750	4050	ULS 4	0.57	1.00	1.00	0.90	17.00	18.00	0.53	8.93	37.40	43%
Wall 31	Frame 1	External	0.00	6.37	243000	16200	ULS 4	0.57	1.00	1.00	0.90	17.00	18.00	2.12	35.71	149.59	18%
Wall 32	Frame 1	Internal	0.00	26.50	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	211%
Wall 32	Frame 1	External	0.00	22.85	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	46%
Wall 33	Frame 1	Internal	0.00	16.75	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	134%
Wall 33	Frame 1	External	0.00	12.05	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	24%
Wall 34	Frame 1	Internal	0.00	4.82	60750	4050	ULS 4	0.57	1.00	1.00	0.90	17.00	18.00	0.53	8.93	37.40	54%
Wall 34	Frame 1	External	0.00	3.14	243000	16200	ULS 4	0.57	1.00	1.00	0.90	17.00	18.00	2.12	35.71	149.59	9%
Wall 35	Frame 1	Internal	0.22	2.52	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	40%
Wall 35	Frame 1	External	0.12	1.33	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 36	Frame 1	Internal	0.22	2.52	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	40%
Wall 36	Frame 1	External	0.12	1.33	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 37	Frame 1	Internal	0.22	2.52	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	40%
Wall 37	Frame 1	External	0.12	1.33	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 38	Frame 1	Internal	0.22	2.52	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	40%
Wall 38	Frame 1	External	0.12	1.33	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 39	Frame 1	Internal	0.00	18.19	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	145%
Wall 39	Frame 1	External	0.00	9.24	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	18%
Wall 40	Frame 1	Internal	0.22	2.52	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	40%
Wall 40	Frame 1	External	0.12	1.33	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 41	Frame 1	Internal	0.22	2.52	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	40%
Wall 41	Frame 1	External	0.12	1.33	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 42	Frame 1	Internal	0.14	1.99	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	28%
Wall 42	Frame 1	External	0.12	1.60	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 43	Frame 1	Internal	0.00	22.20	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	177%
Wall 43	Frame 1	External	0.00	12.57	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	25%
Wall 44	Frame 1	Internal	0.12	1.76	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	24%
Wall 44	Frame 1	External	0.12	1.67	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 45	Frame 1	External	0.12	1.83	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 46	Frame 1	Internal	0.22	2.58	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	40%
Wall 46	Frame 1	External	0.12	1.36	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 47	Frame 1	Internal	0.22	2.52	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	40%
Wall 47	Frame 1	External	0.12	1.33	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 48	Frame 1	Internal	0.00	12.40	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	99%
Wall 48	Frame 1	External	0.00	7.16	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	14%
Wall 49	Frame 1	Internal	0.22	2.66	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	41%
Wall 49	Frame 1	External	0.12	1.40	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 50	Frame 1	Internal	0.22	3.57	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	47%
Wall 50	Frame 1	External	0.13	2.01	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	7%

Wall 51	Frame 1	Internal	0.15	1.05	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	23%
Wall 51	Frame 1	External	0.12	0.80	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 52	Frame 1	Internal	0.15	0.95	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	22%
Wall 52	Frame 1	External	0.12	0.63	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 53	Frame 1	Internal	0.15	1.16	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	24%
Wall 53	Frame 1	External	0.12	0.83	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 54	Frame 1	Internal	0.15	1.30	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	25%
Wall 54	Frame 1	External	0.12	0.95	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 55	Frame 1	Internal	0.15	1.33	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	25%
Wall 55	Frame 1	External	0.12	1.04	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 56	Frame 1	Internal	0.15	1.79	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	28%
Wall 56	Frame 1	External	0.06	2.77	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	6%
Wall 57	Frame 1	Internal	0.00	13.23	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	106%
Wall 57	Frame 1	External	0.00	11.43	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	23%
Wall 58	Frame 1	Internal	0.00	8.37	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	67%
Wall 58	Frame 1	External	0.00	6.02	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	12%
Wall 59	Frame 1	Internal	0.15	2.20	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	30%
Wall 59	Frame 1	External	0.12	1.45	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 60	Frame 1	Internal	0.22	1.26	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 60	Frame 1	External	0.12	0.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 61	Frame 1	Internal	0.22	1.26	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 61	Frame 1	External	0.12	0.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 62	Frame 1	Internal	0.22	1.26	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 62	Frame 1	External	0.12	0.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 63	Frame 1	Internal	0.22	1.26	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 63	Frame 1	External	0.12	0.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 64	Frame 1	Internal	0.00	9.10	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	73%
Wall 64	Frame 1	External	0.00	4.62	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	9%
Wall 65	Frame 1	Internal	0.22	1.26	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 65	Frame 1	External	0.12	0.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 66	Frame 1	Internal	0.22	1.26	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 66	Frame 1	External	0.12	0.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 67	Frame 1	Internal	0.14	0.99	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	22%
Wall 67	Frame 1	External	0.12	0.80	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 68	Frame 1	Internal	0.00	11.10	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	89%
Wall 68	Frame 1	External	0.00	6.29	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	13%
Wall 69	Frame 1	Internal	0.12	0.88	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	19%
Wall 69	Frame 1	External	0.12	0.84	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 70	Frame 1	External	0.12	0.92	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%
Wall 71	Frame 1	Internal	0.22	1.29	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 71	Frame 1	External	0.12	0.68	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 72	Frame 1	Internal	0.22	1.26	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 72	Frame 1	External	0.12	0.66	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 73	Frame 1	Internal	0.00	6.20	60750	4050	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	0.74	12.53	52.49	49%
Wall 73	Frame 1	External	0.00	3.58	243000	16200	ULS 3	0.8	1.00	1.00	0.90	17.00	18.00	2.97	50.12	209.95	7%
Wall 74	Frame 1	Internal	0.22	1.33	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	32%
Wall 74	Frame 1	External	0.12	0.70	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	4%
Wall 75	Frame 1	Internal	0.22	1.79	60750	4050	ULS 5	1	1.00	1.00	0.90	17.00	18.00	0.93	15.66	65.61	35%
Wall 75	Frame 1	External	0.13	1.01	243000	16200	ULS 5	1	1.00	1.00	0.90	17.00	18.00	3.72	62.65	262.44	5%

Bearing perpendicular to the grain

The studs are supported at the base by the bottom plate which is stressed by compression forces perpendicular to the grain.

The following expression shall be satisfied:

$$N_{d,p} \geq N_p^*$$

with

$$N_{d,p} = \phi \cdot k_1 \cdot k_4 \cdot k_6 \cdot k_7 \cdot f_p' \cdot A_p$$

where

$N_p^* = N$ is the design action effect in compression

ϕ is the capacity factor

k_1 is the duration of load modification factor for strength

k_4 is the moisture condition modification factor

k_6 is the temperature modification factor

k_7 is the length of bearing factor

f_p' is the characteristic value in bearing perpendicular to grain

A_p is the bearing area for loading perpendicular to grain

The length of bearing factor k_7 allows to increase the characteristic capacity in bearing perpendicular to the grain where rectangular bearing areas are located 75 mm or more from the end of the bottom plate.

The values of the actions in the tables below are related, for each wall, to the most severe combination of actions for the bearing Ultimate Limit State.

Wall name	Length [m]	Combination	Duration	N [kN]
Wall 1	0.61	ULS 1	50+ years	7.59
Wall 2	0.60	ULS 1	50+ years	6.87
Wall 3	0.61	ULS 1	50+ years	7.98
Wall 4	0.61	ULS 1	50+ years	8.69
Wall 5	0.60	ULS 4	50+ years	9.01
Wall 6	0.61	ULS 4	50+ years	18.49
Wall 7	0.61	ULS 3	5 months	88.23
Wall 8	0.60	ULS 3	5 months	51.62
Wall 9	0.61	ULS 4	50+ years	14.80
Wall 10	2.45	ULS 1	50+ years	25.43
Wall 11	2.45	ULS 1	50+ years	25.43
Wall 12	2.45	ULS 1	50+ years	25.43
Wall 13	2.45	ULS 1	50+ years	25.43
Wall 14	2.50	ULS 3	5 months	153.85
Wall 15	2.45	ULS 1	50+ years	25.43
Wall 16	2.45	ULS 1	50+ years	25.43
Wall 17	0.58	ULS 1	50+ years	7.27
Wall 18	2.50	ULS 3	5 months	200.56
Wall 19	0.50	ULS 1	50+ years	6.55
Wall 20	0.46	ULS 1	50+ years	6.18
Wall 21	1.87	ULS 1	50+ years	19.94
Wall 22	2.45	ULS 1	50+ years	25.43
Wall 23	2.50	ULS 3	5 months	111.83
Wall 24	1.30	ULS 1	50+ years	14.28
Wall 25	2.49	ULS 4	50+ years	32.09

Wall 26	0.61	ULS 1	50+ years	5.06
Wall 27	0.60	ULS 1	50+ years	4.62
Wall 28	0.61	ULS 1	50+ years	5.36
Wall 29	0.61	ULS 1	50+ years	5.79
Wall 30	0.60	ULS 4	50+ years	6.01
Wall 31	0.61	ULS 4	50+ years	12.33
Wall 32	0.61	ULS 3	5 months	59.28
Wall 33	0.60	ULS 3	5 months	34.70
Wall 34	0.61	ULS 4	50+ years	9.87
Wall 35	2.45	ULS 1	50+ years	16.95
Wall 36	2.45	ULS 1	50+ years	16.95
Wall 37	2.45	ULS 1	50+ years	16.95
Wall 38	2.45	ULS 1	50+ years	16.95
Wall 39	2.50	ULS 3	5 months	102.57
Wall 40	2.45	ULS 1	50+ years	16.95
Wall 41	2.45	ULS 1	50+ years	16.95
Wall 42	0.58	ULS 1	50+ years	4.84
Wall 43	2.50	ULS 3	5 months	133.71
Wall 44	0.50	ULS 1	50+ years	4.36
Wall 45	0.46	ULS 1	50+ years	4.12
Wall 46	1.87	ULS 1	50+ years	13.29
Wall 47	2.45	ULS 1	50+ years	16.95
Wall 48	2.50	ULS 3	5 months	74.56
Wall 49	1.30	ULS 1	50+ years	9.52
Wall 50	2.49	ULS 4	50+ years	21.39
Wall 51	0.61	ULS 1	50+ years	2.53
Wall 52	0.60	ULS 1	50+ years	2.33
Wall 53	0.61	ULS 1	50+ years	2.70
Wall 54	0.61	ULS 1	50+ years	2.90
Wall 55	0.60	ULS 4	50+ years	3.00
Wall 56	0.61	ULS 4	50+ years	6.16
Wall 57	0.61	ULS 3	5 months	29.87
Wall 58	0.60	ULS 3	5 months	17.50
Wall 59	0.61	ULS 4	50+ years	4.93
Wall 60	2.45	ULS 1	50+ years	8.48
Wall 61	2.45	ULS 1	50+ years	8.48
Wall 62	2.45	ULS 1	50+ years	8.48
Wall 63	2.45	ULS 1	50+ years	8.48
Wall 64	2.50	ULS 3	5 months	51.28
Wall 65	2.45	ULS 1	50+ years	8.48
Wall 66	2.45	ULS 1	50+ years	8.48
Wall 67	0.58	ULS 1	50+ years	2.42
Wall 68	2.50	ULS 3	5 months	66.85
Wall 69	0.50	ULS 1	50+ years	2.18
Wall 70	0.46	ULS 1	50+ years	2.06
Wall 71	1.87	ULS 1	50+ years	6.65
Wall 72	2.45	ULS 1	50+ years	8.48
Wall 73	2.50	ULS 3	5 months	37.28
Wall 74	1.30	ULS 1	50+ years	4.76
Wall 75	2.49	ULS 4	50+ years	10.70

The following table summarizes the bearing (perpendicular to the grain) checks for the plates of the framed walls.

Wall name	Section	Stud	N [kN]	A_p [mm^2]	Combination	k_1	k_4	k_6	k_7	ϕ	f'_p [MPa]	$N_{d,p}$ [kN]	Check
Wall 1	Frame 1	Internal	3.52	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	14%
Wall 1	Frame 1	External	2.68	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	3%
Wall 2	Frame 1	Internal	3.33	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	13%
Wall 2	Frame 1	External	2.34	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	3%
Wall 3	Frame 1	Internal	3.79	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	15%
Wall 3	Frame 1	External	2.77	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	3%
Wall 4	Frame 1	Internal	4.06	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	16%
Wall 4	Frame 1	External	3.02	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	4%
Wall 5	Frame 1	Internal	4.17	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	16%
Wall 5	Frame 1	External	3.24	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	4%
Wall 6	Frame 1	Internal	5.78	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	22%
Wall 6	Frame 1	External	9.56	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	12%
Wall 7	Frame 1	Internal	39.79	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	110%
Wall 7	Frame 1	External	34.28	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	29%
Wall 8	Frame 1	Internal	25.16	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	70%
Wall 8	Frame 1	External	18.07	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	15%
Wall 9	Frame 1	Internal	7.23	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	28%
Wall 9	Frame 1	External	4.71	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	6%
Wall 10	Frame 1	Internal	4.24	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	16%
Wall 10	Frame 1	External	2.24	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	3%
Wall 11	Frame 1	Internal	4.24	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	16%
Wall 11	Frame 1	External	2.24	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	3%
Wall 12	Frame 1	Internal	4.24	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	16%
Wall 12	Frame 1	External	2.24	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	3%
Wall 13	Frame 1	Internal	4.24	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	16%
Wall 13	Frame 1	External	2.24	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	3%
Wall 14	Frame 1	Internal	27.29	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	75%
Wall 14	Frame 1	External	13.86	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	12%
Wall 15	Frame 1	Internal	4.24	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	16%
Wall 15	Frame 1	External	2.24	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	3%
Wall 16	Frame 1	Internal	4.24	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	16%
Wall 16	Frame 1	External	2.24	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	3%
Wall 17	Frame 1	Internal	3.35	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	13%
Wall 17	Frame 1	External	2.70	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	3%
Wall 18	Frame 1	Internal	33.30	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	92%

Wall 18	Frame 1	External	18.86	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	16%
Wall 19	Frame 1	Internal	2.98	4050	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	20.78	14%
Wall 19	Frame 1	External	2.82	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	3%
Wall 20	Frame 1	External	3.09	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	4%
Wall 21	Frame 1	Internal	4.36	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	17%
Wall 21	Frame 1	External	2.30	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	3%
Wall 22	Frame 1	Internal	4.24	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	16%
Wall 22	Frame 1	External	2.24	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	3%
Wall 23	Frame 1	Internal	18.60	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	51%
Wall 23	Frame 1	External	10.75	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	9%
Wall 24	Frame 1	Internal	4.49	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	17%
Wall 24	Frame 1	External	2.37	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	3%
Wall 25	Frame 1	Internal	5.65	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	22%
Wall 25	Frame 1	External	3.17	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	4%
Wall 26	Frame 1	Internal	2.35	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	9%
Wall 26	Frame 1	External	1.79	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 27	Frame 1	Internal	2.22	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	9%
Wall 27	Frame 1	External	1.56	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 28	Frame 1	Internal	2.52	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	10%
Wall 28	Frame 1	External	1.84	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 29	Frame 1	Internal	2.71	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	11%
Wall 29	Frame 1	External	2.01	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 30	Frame 1	Internal	2.78	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	11%
Wall 30	Frame 1	External	2.16	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	3%
Wall 31	Frame 1	Internal	3.86	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	15%
Wall 31	Frame 1	External	6.37	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	8%
Wall 32	Frame 1	Internal	26.50	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	73%
Wall 32	Frame 1	External	22.85	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	20%
Wall 33	Frame 1	Internal	16.75	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	46%
Wall 33	Frame 1	External	12.05	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	10%
Wall 34	Frame 1	Internal	4.82	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	19%
Wall 34	Frame 1	External	3.14	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	4%
Wall 35	Frame 1	Internal	2.83	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	11%
Wall 35	Frame 1	External	1.49	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 36	Frame 1	Internal	2.83	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	11%
Wall 36	Frame 1	External	1.49	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 37	Frame 1	Internal	2.83	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	11%
Wall 37	Frame 1	External	1.49	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 38	Frame 1	Internal	2.83	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	11%
Wall 38	Frame 1	External	1.49	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 39	Frame 1	Internal	18.19	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	50%
Wall 39	Frame 1	External	9.24	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	8%
Wall 40	Frame 1	Internal	2.83	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	11%
Wall 40	Frame 1	External	1.49	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 41	Frame 1	Internal	2.83	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	11%
Wall 41	Frame 1	External	1.49	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 42	Frame 1	Internal	2.23	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	9%
Wall 42	Frame 1	External	1.80	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 43	Frame 1	Internal	22.20	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	61%
Wall 43	Frame 1	External	12.57	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	11%
Wall 44	Frame 1	Internal	1.99	4050	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	20.78	10%
Wall 44	Frame 1	External	1.88	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 45	Frame 1	External	2.06	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 46	Frame 1	Internal	2.91	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	11%
Wall 46	Frame 1	External	1.53	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 47	Frame 1	Internal	2.83	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	11%
Wall 47	Frame 1	External	1.49	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 48	Frame 1	Internal	12.40	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	34%
Wall 48	Frame 1	External	7.16	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	6%
Wall 49	Frame 1	Internal	2.99	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	12%
Wall 49	Frame 1	External	1.58	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 50	Frame 1	Internal	3.76	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	15%
Wall 50	Frame 1	External	2.11	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	3%
Wall 51	Frame 1	Internal	1.17	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 51	Frame 1	External	0.89	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 52	Frame 1	Internal	1.11	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	4%
Wall 52	Frame 1	External	0.78	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 53	Frame 1	Internal	1.26	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 53	Frame 1	External	0.92	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 54	Frame 1	Internal	1.35	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 54	Frame 1	External	1.01	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 55	Frame 1	Internal	1.39	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 55	Frame 1	External	1.08	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 56	Frame 1	Internal	1.93	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	7%
Wall 56	Frame 1	External	3.19	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	4%
Wall 57	Frame 1	Internal	13.23	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	37%
Wall 57	Frame 1	External	11.43	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	10%
Wall 58	Frame 1	Internal	8.37	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	23%
Wall 58	Frame 1	External	6.02	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	5%
Wall 59	Frame 1	Internal	2.41	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	9%
Wall 59	Frame 1	External	1.57	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	2%
Wall 60	Frame 1	Internal	1.41	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 60	Frame 1	External	0.75	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 61	Frame 1	Internal	1.41	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 61	Frame 1	External	0.75	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 62	Frame 1	Internal	1.41	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 62	Frame 1	External	0.75	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 63	Frame 1	Internal	1.41	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 63	Frame 1	External	0.75	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 64	Frame 1	Internal	9.10	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	25%
Wall 64	Frame 1	External	4.62	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	4%
Wall 65	Frame 1	Internal	1.41	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 65	Frame 1	External	0.75	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 66	Frame 1	Internal	1.41	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 66	Frame 1	External	0.75	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 67	Frame 1	Internal	1.12	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	4%

Wall 67	Frame 1	External	0.90	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 68	Frame 1	Internal	11.10	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	31%
Wall 68	Frame 1	External	6.29	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	5%
Wall 69	Frame 1	Internal	0.99	4050	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	20.78	5%
Wall 69	Frame 1	External	0.94	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 70	Frame 1	External	1.03	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 71	Frame 1	Internal	1.45	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	6%
Wall 71	Frame 1	External	0.77	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 72	Frame 1	Internal	1.41	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	5%
Wall 72	Frame 1	External	0.75	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 73	Frame 1	Internal	6.20	4050	ULS 3	0.8	1.00	1.00	1.24	0.90	10.00	36.16	17%
Wall 73	Frame 1	External	3.58	16200	ULS 3	0.8	1.00	1.00	1.00	0.90	10.00	116.64	3%
Wall 74	Frame 1	Internal	1.50	4050	ULS 1	0.57	1.00	1.00	1.24	0.90	10.00	25.76	6%
Wall 74	Frame 1	External	0.79	16200	ULS 1	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%
Wall 75	Frame 1	Internal	1.88	4050	ULS 4	0.57	1.00	1.00	1.24	0.90	10.00	25.76	7%
Wall 75	Frame 1	External	1.06	16200	ULS 4	0.57	1.00	1.00	1.00	0.90	10.00	83.11	1%

The shear strength of framed shear walls

The values of the actions in the tables below are related, for each wall, to the most severe combination of load for the Ultimate Limit States.

Wall name	Length [m]	Combination	Duration	V2 [kN]
Wall 10	2.45	ULS earthquake strength 4 ex- ey+	5 seconds	3.48
Wall 11	2.45	ULS earthquake strength 4 ex- ey+	5 seconds	3.48
Wall 12	2.45	ULS earthquake strength 4 ex- ey+	5 seconds	3.48
Wall 13	2.45	ULS earthquake strength 4 ex- ey+	5 seconds	3.48
Wall 14	2.50	ULS Wind 6	5 seconds	22.52
Wall 15	2.45	ULS earthquake strength 4 ex- ey-	5 seconds	3.66
Wall 16	2.45	ULS earthquake strength 4 ex- ey-	5 seconds	3.66
Wall 18	2.50	ULS Wind 6	5 seconds	18.47
Wall 21	1.87	ULS earthquake strength 4 ex- ey-	5 seconds	2.69
Wall 22	2.45	ULS earthquake strength 4 ex- ey-	5 seconds	3.66
Wall 23	2.50	ULS Wind 6	5 seconds	15.28
Wall 24	1.30	ULS earthquake strength 1 ex+ ey-	5 seconds	1.57
Wall 25	2.49	ULS Wind 6	5 seconds	16.99
Wall 35	2.45	ULS earthquake strength 4 ex- ey+	5 seconds	2.66
Wall 36	2.45	ULS earthquake strength 4 ex- ey+	5 seconds	2.66
Wall 37	2.45	ULS earthquake strength 4 ex- ey+	5 seconds	2.66
Wall 38	2.45	ULS earthquake strength 4 ex- ey+	5 seconds	2.66
Wall 39	2.50	ULS Wind 6	5 seconds	13.51
Wall 40	2.45	ULS earthquake strength 4 ex- ey-	5 seconds	2.79
Wall 41	2.45	ULS earthquake strength 4 ex- ey-	5 seconds	2.79
Wall 43	2.50	ULS Wind 6	5 seconds	11.08
Wall 46	1.87	ULS earthquake strength 4 ex- ey-	5 seconds	2.07
Wall 47	2.45	ULS earthquake strength 4 ex- ey-	5 seconds	2.79
Wall 48	2.50	ULS Wind 6	5 seconds	9.17
Wall 49	1.30	ULS earthquake strength 1 ex+ ey-	5 seconds	1.22
Wall 50	2.49	ULS Wind 6	5 seconds	10.18
Wall 60	2.45	ULS earthquake strength 1 ex+ ey+	5 seconds	1.33
Wall 61	2.45	ULS earthquake strength 1 ex+ ey+	5 seconds	1.33
Wall 62	2.45	ULS earthquake strength 1 ex+ ey+	5 seconds	1.33
Wall 63	2.45	ULS earthquake strength 1 ex+ ey+	5 seconds	1.33
Wall 64	2.50	ULS Wind 6	5 seconds	4.50
Wall 65	2.45	ULS earthquake strength 1 ex+ ey-	5 seconds	1.41
Wall 66	2.45	ULS earthquake strength 1 ex+ ey-	5 seconds	1.41
Wall 68	2.50	ULS Wind 6	5 seconds	3.69
Wall 71	1.87	ULS earthquake strength 1 ex+ ey-	5 seconds	1.05
Wall 72	2.45	ULS earthquake strength 1 ex+ ey-	5 seconds	1.41
Wall 73	2.50	ULS Wind 6	5 seconds	3.06
Wall 74	1.30	ULS earthquake strength 1 ex+ ey-	5 seconds	0.62
Wall 75	2.49	ULS Wind 6	5 seconds	3.39

Sheet-braced framed walls

Lateral load-carrying capacity of metal fasteners

The design load-carrying capacity of a cantilevered panel secured against uplift is determined according to a plastic model based on the lower bound method (static theorem) that assumes the load-displacement relationships of the sheathing-to-frame joints as completely in the plastic field.

For a wall made up of several wall panels, the design racking load-carrying capacity of a wall is calculated from:

$$F_{v,Rd} = \sum_i F_{i,v,Rd}$$

where:

$F_{i,v,Rd}$ is the design racking load-carrying capacity of a single wall panel as specified in the following.

Wall panels which contain a door or window opening shall not be considered to contribute to the racking load-carrying capacity.

The design racking load-carrying capacity of each wall panel, $F_{i,v,Rd}$, is calculated from:

$$F_{i,v,Rd} = \frac{F_{t,Rd} \cdot b_i \cdot c_i}{s}$$

where:

$F_{t,Rd}$ is the lateral design capacity of an individual fastener, modified by a factor of 1.2

b_i is the wall panel width

s is the fastener spacing

c_i a coefficient dependent on the ratio between base and height of a single wall panel.

For wall panels with sheets on both sides the following rules apply:

- if the sheets and fasteners are of the same type and dimension then the total racking load carrying capacity of the wall should be taken as the sum of the racking load-carrying capacities of the individual sides

- if different types of sheets are used, 75 % of the racking load-carrying capacity of the weaker side may, unless some other value is shown to be valid, be taken into consideration if fasteners with similar slip moduli are used. In other cases not more than 50 % should be taken into consideration.

Fastener strength

The resistance of each fastener is estimated according to the Johansen theory of timber connections with dowel-type fasteners for panel-to-timber connections in single shear.

The characteristic load-carrying capacity for nails, staples, bolts, dowels and screws per shear plane per fastener, should be taken as the minimum value found from the following expressions

$$F_{v,Rk,a} = f_{h,1,k} \cdot t_1 \cdot d$$

$$F_{v,Rk,b} = f_{h,2,k} \cdot t_2 \cdot d$$

$$F_{v,Rk,c} = \frac{f_{h,1,k} \cdot t_1 \cdot d}{1+\beta} \cdot \left[\sqrt{\beta + 2\beta^2 \left[1 + \frac{t_2}{t_1} + \left(\frac{t_2}{t_1} \right)^2 \right]} + \beta^3 \left(\frac{t_2}{t_1} \right)^2 - \beta \left(1 + \frac{t_2}{t_1} \right) \right] + \frac{F_{ax,Rk}}{4}$$

$$F_{v,Rk,d} = 1{,}05 \cdot \frac{f_{h,1,k} \cdot t_1 \cdot d}{2+\beta} \cdot \left[\sqrt{2\beta(1+\beta) + \frac{4\beta(2+\beta) M_{y,Rk}}{f_{h,1,k} \cdot d \cdot t_1^2}} - \beta \right] + \frac{F_{ax,Rk}}{4}$$

$$F_{v,Rk,e} = 1{,}05 \cdot \frac{f_{h,1,k} \cdot t_2 \cdot d}{1+2\beta} \cdot \left[\sqrt{2\beta^2(1+\beta) + \frac{4\beta(1+2\beta) M_{y,Rk}}{f_{h,1,k} \cdot d \cdot t_2^2}} - \beta \right] + \frac{F_{ax,Rk}}{4}$$

$$F_{v,Rk,f} = 1{,}15 \cdot \sqrt{\frac{2\beta}{1+\beta}} \sqrt{2 \cdot M_{y,Rk} \cdot f_{h,1,k} \cdot d} + \frac{F_{ax,Rk}}{4}$$

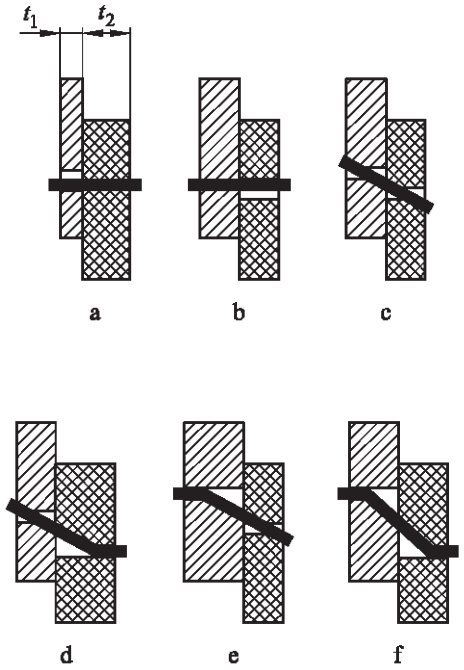


Figure: Failure modes for timber and panel connections.

In the expressions above, the first term on the right hand side is the load-carrying capacity according to the Johansen yield theory, whilst the second term $\frac{F_{ax,Rk}}{4}$ is the contribution from the rope effect.

Characteristic withdrawal capacity

The characteristic withdrawal capacity of nails, $F_{ax,Rk}$, should be taken as the smaller of the values found from the following expressions:

- For smooth nails:

$$F_{ax,Rk} = \begin{cases} f_{ax,k,tip}\, d\, t_{pen,frame} \\ f_{ax,k,head}\, d\, t + f_{head,k}\, d_h^2 \end{cases}$$

- For nails with improved adherence:

$$F_{ax,Rk} = \begin{cases} f_{ax,k,tip}\, d\, t_{pen,frame} = f_{ax,k,350} \left(\frac{\rho_{k,tip}}{350} \right)^{0.8} d\, t_{pen,frame} \\ f_{head,k}\, d_h^2 = f_{head,k,350} \left(\frac{\rho_{k,head}}{350} \right)^{0.8} d_h^2 \end{cases}$$

where:

$f_{ax,k,tip}$ is the characteristic pointside withdrawal strength;

$f_{ax,k,head}$ is the characteristic headside withdrawal strength;

$f_{head,k}$ is the characteristic headside pull-through strength;

d is the nail diameter;

d_h is the nail head diameter;

$t_{pen,frame}$ is the minimum value between the pointside penetration length and the length of the threaded part in the pointside member;

t is the thickness of the headside member.

For smooth nails, the pointside penetration should be at least 8d. For nails with a pointside penetration smaller than 12d the withdrawal capacity should be multiplied by $\frac{t_{pen}}{4d} - 2$.

For threaded nails, the pointside penetration should be at least 6d. For nails with a pointside penetration smaller than 8d the withdrawal capacity should be multiplied by $\frac{t_{pen}}{2d} - 3$.

In the following table, the calculations for the characteristic pointside withdrawal strength (Fax,k,tip) and for the characteristic headside pull-through strength (Fax,k,head) are reported.

Section	Side	Fasteners	$\rho_{k,frame}$ [kg/m³]	$f_{ax,k,tip}$ [MPa]	d [mm]	$t_{pen,frame}$ [mm]	$F_{ax,k,tip}$ [N]	$\rho_{k,panel}$ [kg/m³]	$f_{ax,k,head}$ [MPa]	$f_{head,k}$ [MPa]	d_h [mm]	t [mm]	$F_{ax,k,head}$ [N]
Frame 1	1	Ring nail (coils) 2.8/3.1 x 60	317	6.02	2.80	40.00	674	400	0.00	30.16	4.30	-	558

Lateral load-carrying capacity

The following table shows the resistances of the fasteners used to assemble the panels of the walls.

$F_{ax,Rk}$ is the characteristic axial withdrawal capacity of the fastener

Rope effect limit is the rope effect limited to a percentage of Johansen part

$F_{v,Rk}$ is the characteristic load-carrying capacity per shear plane per fastener

Section	Side	Fasteners	K_{ser} [N/mm]	Failure mode	$F_{ax,Rk}$ [N]	Rope effect limit	$F_{v,Rk}$ [N]
Frame 1	1	Ring nail (coils) 2.8/3.1 x 60	670	d	558	50%	717

Check of the bearing capacity of the walls related to the lateral load-carrying capacity of metal fasteners

The following table summarizes the geometric characteristics of the wall panels and their load-bearing capacity Fi,v,Rk. This table also indicates whether the width of each sheet is at least equal to h/4 as required by the calculation model.

Wall name	Section	Panel	b_i [mm]	N panels	c_i	Sheet width ≥ h/4	s [mm]	$F_{i,v,Rk}$ side 1 [kN]	$F_{i,v,Rk}$ side 2 [kN]
Wall 10	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 10	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 11	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 11	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 12	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 12	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 13	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 13	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 14	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 14	Frame 1	Junction	46.00	1	0.03	no	100	0.00	0.00
Wall 15	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 15	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 16	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 16	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 18	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 18	Frame 1	Junction	46.00	1	0.03	no	100	0.00	0.00
Wall 21	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 21	Frame 1	Junction	234.00	1	0.15	no	100	0.00	0.00

Wall 22	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 22	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 23	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 23	Frame 1	Junction	46.00	1	0.03	no	100	0.00	0.00
Wall 24	Frame 1	Full	818.00	1	0.51	ok	100	3.60	0.00
Wall 24	Frame 1	Junction	482.00	1	0.30	no	100	0.00	0.00
Wall 25	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 25	Frame 1	Junction	36.00	1	0.02	no	100	0.00	0.00
Wall 35	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 35	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 36	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 36	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 37	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 37	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 38	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 38	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 39	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 39	Frame 1	Junction	46.00	1	0.03	no	100	0.00	0.00
Wall 40	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 40	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 41	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 41	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 43	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 43	Frame 1	Junction	46.00	1	0.03	no	100	0.00	0.00
Wall 46	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 46	Frame 1	Junction	234.00	1	0.15	no	100	0.00	0.00
Wall 47	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 47	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 48	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 48	Frame 1	Junction	46.00	1	0.03	no	100	0.00	0.00
Wall 49	Frame 1	Full	818.00	1	0.51	ok	100	3.60	0.00
Wall 49	Frame 1	Junction	482.00	1	0.30	no	100	0.00	0.00
Wall 50	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 50	Frame 1	Junction	36.00	1	0.02	no	100	0.00	0.00
Wall 60	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 60	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 61	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 61	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 62	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 62	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 63	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 63	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 64	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 64	Frame 1	Junction	46.00	1	0.03	no	100	0.00	0.00
Wall 65	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 65	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 66	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 66	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 68	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 68	Frame 1	Junction	46.00	1	0.03	no	100	0.00	0.00
Wall 71	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 71	Frame 1	Junction	234.00	1	0.15	no	100	0.00	0.00
Wall 72	Frame 1	Full	818.00	2	0.51	ok	100	3.60	0.00
Wall 72	Frame 1	Junction	814.00	1	0.51	ok	100	3.56	0.00
Wall 73	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 73	Frame 1	Junction	46.00	1	0.03	no	100	0.00	0.00
Wall 74	Frame 1	Full	818.00	1	0.51	ok	100	3.60	0.00
Wall 74	Frame 1	Junction	482.00	1	0.30	no	100	0.00	0.00
Wall 75	Frame 1	Full	818.00	3	0.51	ok	100	3.60	0.00
Wall 75	Frame 1	Junction	36.00	1	0.02	no	100	0.00	0.00

The following table shows the checks with reference to the most significant load combinations according to the expression:

$$F_{v,Rd} \geq F_{v,Ed}$$

Wall name	Section	Comb.	$F_{v,Ed}$ [kN]	k_1	k_{13}	k_{14}	k_{16}	k_{17}	ϕ	$F_{v,Rd}$ [kN]	Check
Wall 10	Frame 1	ULS earthquake strength 4 ex- ey+	3.48	1.14	1	1	1	1	0.85	10.43	33%
Wall 11	Frame 1	ULS earthquake strength 4 ex- ey+	3.48	1.14	1	1	1	1	0.85	10.43	33%
Wall 12	Frame 1	ULS earthquake strength 4 ex- ey+	3.48	1.14	1	1	1	1	0.85	10.43	33%
Wall 13	Frame 1	ULS earthquake strength 4 ex- ey+	3.48	1.14	1	1	1	1	0.85	10.43	33%
Wall 14	Frame 1	ULS Wind 6	22.52	1.14	1	1	1	1	0.85	10.46	215%
Wall 15	Frame 1	ULS earthquake strength 4 ex- ey-	3.66	1.14	1	1	1	1	0.85	10.43	35%
Wall 16	Frame 1	ULS earthquake strength 4 ex- ey-	3.66	1.14	1	1	1	1	0.85	10.43	35%
Wall 18	Frame 1	ULS Wind 6	18.47	1.14	1	1	1	1	0.85	10.46	177%
Wall 21	Frame 1	ULS earthquake strength 4 ex- ey-	2.69	1.14	1	1	1	1	0.85	6.97	39%
Wall 22	Frame 1	ULS earthquake strength 4 ex- ey-	3.66	1.14	1	1	1	1	0.85	10.43	35%
Wall 23	Frame 1	ULS Wind 6	15.28	1.14	1	1	1	1	0.85	10.46	146%
Wall 24	Frame 1	ULS earthquake strength 1 ex+ ey-	1.57	1.14	1	1	1	1	0.85	3.49	45%
Wall 25	Frame 1	ULS Wind 6	16.99	1.14	1	1	1	1	0.85	10.46	162%

Wall 35	Frame 1	ULS earthquake strength 4 ex- ey+	2.66	1.14	1	1	1	1	0.85	10.43	25%
Wall 36	Frame 1	ULS earthquake strength 4 ex- ey+	2.66	1.14	1	1	1	1	0.85	10.43	25%
Wall 37	Frame 1	ULS earthquake strength 4 ex- ey+	2.66	1.14	1	1	1	1	0.85	10.43	25%
Wall 38	Frame 1	ULS earthquake strength 4 ex- ey+	2.66	1.14	1	1	1	1	0.85	10.43	25%
Wall 39	Frame 1	ULS Wind 6	13.51	1.14	1	1	1	1	0.85	10.46	129%
Wall 40	Frame 1	ULS earthquake strength 4 ex- ey-	2.79	1.14	1	1	1	1	0.85	10.43	27%
Wall 41	Frame 1	ULS earthquake strength 4 ex- ey-	2.79	1.14	1	1	1	1	0.85	10.43	27%
Wall 43	Frame 1	ULS Wind 6	11.08	1.14	1	1	1	1	0.85	10.46	106%
Wall 46	Frame 1	ULS earthquake strength 4 ex- ey-	2.07	1.14	1	1	1	1	0.85	6.97	30%
Wall 47	Frame 1	ULS earthquake strength 4 ex- ey-	2.79	1.14	1	1	1	1	0.85	10.43	27%
Wall 48	Frame 1	ULS Wind 6	9.17	1.14	1	1	1	1	0.85	10.46	88%
Wall 49	Frame 1	ULS earthquake strength 1 ex+ ey-	1.22	1.14	1	1	1	1	0.85	3.49	35%
Wall 50	Frame 1	ULS Wind 6	10.18	1.14	1	1	1	1	0.85	10.46	97%
Wall 60	Frame 1	ULS earthquake strength 1 ex+ ey+	1.33	1.14	1	1	1	1	0.85	10.43	13%
Wall 61	Frame 1	ULS earthquake strength 1 ex+ ey+	1.33	1.14	1	1	1	1	0.85	10.43	13%
Wall 62	Frame 1	ULS earthquake strength 1 ex+ ey+	1.33	1.14	1	1	1	1	0.85	10.43	13%
Wall 63	Frame 1	ULS earthquake strength 1 ex+ ey+	1.33	1.14	1	1	1	1	0.85	10.43	13%
Wall 64	Frame 1	ULS Wind 6	4.50	1.14	1	1	1	1	0.85	10.46	43%
Wall 65	Frame 1	ULS earthquake strength 1 ex+ ey-	1.41	1.14	1	1	1	1	0.85	10.43	14%
Wall 66	Frame 1	ULS earthquake strength 1 ex+ ey-	1.41	1.14	1	1	1	1	0.85	10.43	14%
Wall 68	Frame 1	ULS Wind 6	3.69	1.14	1	1	1	1	0.85	10.46	35%
Wall 71	Frame 1	ULS earthquake strength 1 ex+ ey-	1.05	1.14	1	1	1	1	0.85	6.97	15%
Wall 72	Frame 1	ULS earthquake strength 1 ex+ ey-	1.41	1.14	1	1	1	1	0.85	10.43	14%
Wall 73	Frame 1	ULS Wind 6	3.06	1.14	1	1	1	1	0.85	10.46	29%
Wall 74	Frame 1	ULS earthquake strength 1 ex+ ey-	0.62	1.14	1	1	1	1	0.85	3.49	18%
Wall 75	Frame 1	ULS Wind 6	3.39	1.14	1	1	1	1	0.85	10.46	32%

Shear buckling of the sheet

The model assumes that the shear buckling of the sheet may be disregarded, provided that

$$\frac{b_{net}}{t} \leq 100$$

where

b_{net} *is the clear distance between studs*

t *is the thickness of the sheet*

Technical Design Calculation Report

Connections

Hold Down – Connections at the base of the structure

The design resistance R_d of the hold-downs is determined as the minimum value among the resistances relating to the following failure modes:

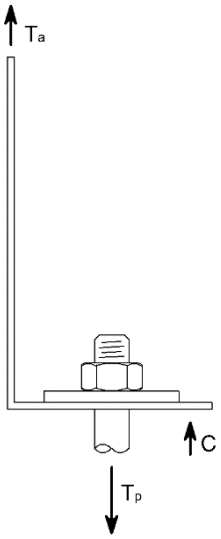
- Nailing failure
- Hold-downs steel failure
- Failure of the anchor
- Extraction of the anchor

Forces on the hold-downs

The tension force acting on the hold down (T_a) is evaluated as described in paragraph “Model Description”.

The tension force acting on the anchor is calculated taking into account the additional moment due to the non-alignment between the external force acting on the vertical flange of the hold down and the anchor itself using a coefficient, indicated as k_t.

$$T_p = T_a \cdot k_t$$



Wall name	Length [m]	Connection name	N° of anchors at each wall end	Combination	Duration	N [kN]	M_{3-3} [kNm]	Ta [kN]	kt	Tp [kN]
Wall 10	2.45	Ground connection - hold down - bracket	1	ULS earthquake stability 4 ex- ey+	5 seconds	16.95	23.38	1.07	1	1.07
Wall 11	2.45	Ground connection - hold down - bracket	1	ULS earthquake stability 4 ex- ey+	5 seconds	16.95	23.38	1.07	1	1.07
Wall 12	2.45	Ground connection - hold down - bracket	1	ULS earthquake stability 4 ex- ey+	5 seconds	16.95	23.38	1.07	1	1.07
Wall 13	2.45	Ground connection - hold down - bracket	1	ULS earthquake stability 4 ex- ey+	5 seconds	16.95	23.38	1.07	1	1.07
Wall 14	2.50	Ground connection - hold down - bracket	1	ULS Wind 8	5 seconds	49.12	129.69	27.32	1	27.32
Wall 15	2.45	Ground connection - hold down - bracket	1	ULS earthquake stability 1 ex+ ey-	5 seconds	16.95	24.55	1.54	1	1.54
Wall 16	2.45	Ground connection - hold down - bracket	1	ULS earthquake stability 1 ex+ ey-	5 seconds	16.95	24.55	1.54	1	1.54
Wall 18	2.50	Ground connection - hold down - bracket	1	ULS Wind 8	5 seconds	60.50	106.39	12.30	1	12.30
Wall 21	1.87	Ground connection - hold down - bracket	1	ULS earthquake stability 1 ex+	5 seconds	13.29	18.14	3.06	1	3.06

				ey-						
Wall 22	2.45	Ground connection - hold down - bracket	1	ULS earthquake stability 1 ex+ ey-	5 seconds	16.95	24.55	1.54	1	1.54
Wall 23	2.50	Ground connection - hold down - bracket	1	ULS Wind 8	5 seconds	38.89	88.01	15.76	1	15.76
Wall 24	1.30	Ground connection - hold down - bracket	1	ULS earthquake stability 1 ex+ ey-	5 seconds	9.52	10.68	3.45	1	3.45
Wall 25	2.49	Ground connection - hold down - bracket	1	ULS Wind 8	5 seconds	20.94	97.81	28.81	1	28.81

Nailing resistance

The design value of the load-bearing capacity of the nailing is given by the following expression

$$R_{c,d} = \phi \cdot \mathrm{k}_1 \cdot \mathrm{k}_{13} \cdot \mathrm{k}_{14} \cdot \mathrm{R}_{\mathrm{c,k,dens}}$$

where

$\mathrm{R}_{\mathrm{c,k,dens}}$ is the characteristic value of the nailing resistance. It already considers the effect of multiple nails in the joint and the effect of the restraint against the rotation of the fastener head. This value is reduced by the k_{dens} factor when the density of the material used is less than 350 kg/m3. k_{dens} can be evaluated using the formula $\mathrm{R}_{\mathrm{c,k,dens}} = \mathrm{R}_{\mathrm{c,k}} \cdot \left(\frac{\rho_{\mathrm{k}}}{350}\right)^2$.

ϕ is the capacity factor for nails and screws

k_1 is the modification factor for duration of load for joints

k_{13} is equal to 1 for fasteners in side grain

k_{14} is equal to 1 for fasteners in single shear

Hold-down steel resistance

The tensile design strength of the steel of the hold-down can be evaluated according to the formula

$$\mathrm{R}_{\mathrm{s,d}} = \phi \cdot \mathrm{R}_{\mathrm{s,k}}$$

where

$\mathrm{R}_{\mathrm{s,k}}$ *is the characteristic value of the resistance of the hold down in axial tension*

ϕ *is the capacity factor for steel in tension*

Tension resistance of the anchor

The tension resistance of the anchor is evaluated as reported in section 9.3.2.2 of AS 4100 - 1998 according to the following formula

$$\mathrm{R}_{\mathrm{t,d}} = \phi \cdot \mathrm{R}_{\mathrm{t,k}} = \phi \cdot \mathrm{A}_{\mathrm{s}} \cdot \mathrm{f}_{\mathrm{uf}}$$

being:

f_{uf} *is the ultimate tensile strength of the anchor*

A_s *the tensile stress area of the anchor*

ϕ *is the capacity factor for bolts in tension*

Pull-out resistance of the anchor

The characteristic value of pull-out resistance refers to a single anchor regardless of the effects due to the spacing or distances from the edges. Moreover concrete is considered to be non-cracked, dry and at a standard temperature for the actual depth of anchorage.

The design pull-out resistance can be calculated as

$$R_{pull,d} = \phi \cdot R_{pull,k}$$

where

$R_{pull,k}$ is the *characteristic value of the pull-out resistance*

ϕ is the capacity factor provided by manufacturers

The checks are summarized in the following tables according to each failure mode.

Name: Name of the connection in which the hold-down is used

Comb.: The most severe combination of load

$T_{a,d}$: Design value of the tensile force acting on the hold down

$T_{p,d}$: Design value of the tensile force acting on the anchor

$R_{a,d}$: Design value of the hold down resistance, assumed to be the lower of the values of the design resistance of all the failure mechanisms associated with it

$R_{p,d}$: Design value of the anchor resistance, assumed to be the lower of the values of the design resistance of all the failure mechanisms associated with it

$$T_{a,d} \leq R_{a,d} = min(R_{c,d}; R_{s,d})$$

$$T_{p,d} \leq R_{p,d} = min(R_{t,d}; R_{pull,d})$$

Wall name	Connection name	Comb.	$T_{a,d}$ [kN]	$R_{c,k,dens}$ [kN]	k_1	ϕ	$R_{c,d}$ [kN]	$R_{s,k}$ [kN]	ϕ	$R_{s,d}$ [kN]	$R_{a,d}$ [kN]	$T_{p,d}$ [kN]	$R_{t,k}$ [kN]	ϕ	$R_{t,d}$ [kN]	$R_{pull,k}$ [kN]	ϕ	$R_{pull,d}$ [kN]	$R_{p,d}$ [kN]	Failure mode	Check
Wall 10	Ground connection - hold down - bracket	ULS earthquake stability 4 ex- ey+	1.07	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	1.07	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	6%
Wall 11	Ground connection - hold down -	ULS earthquake	1.07	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	1.07	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	6%

	bracket	stability 4 ex- ey+																			
Wall 12	Ground connection - hold down - bracket	ULS earthquake stability 4 ex- ey+	1.07	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	1.07	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	6%
Wall 13	Ground connection - hold down - bracket	ULS earthquake stability 4 ex- ey+	1.07	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	1.07	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	6%
Wall 14	Ground connection - hold down - bracket	ULS Wind 8	27.32	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	27.32	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	157%
Wall 15	Ground connection - hold down - bracket	ULS earthquake stability 1 ex+ ey-	1.54	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	1.54	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	9%
Wall 16	Ground connection - hold down - bracket	ULS earthquake stability 1 ex+ ey-	1.54	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	1.54	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	9%
Wall 18	Ground connection - hold down - bracket	ULS Wind 8	12.30	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	12.30	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	71%
Wall 21	Ground connection - hold down - bracket	ULS earthquake stability 1 ex+ ey-	3.06	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	3.06	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	18%
Wall 22	Ground connection - hold down - bracket	ULS earthquake stability 1 ex+ ey-	1.54	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	1.54	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	9%
Wall 23	Ground connection - hold down - bracket	ULS Wind 8	15.76	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	15.76	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	90%
Wall 24	Ground connection - hold down - bracket	ULS earthquake stability 1 ex+ ey-	3.45	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	3.45	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	20%
Wall 25	Ground connection - hold down - bracket	ULS Wind 8	28.81	17.99	1.14	0.85	17.43	42	0.9	37.8	17.43	28.81	78.5	0.8	62.8	35.94	0.5	17.97	17.97	Nailed connection	165%

Connections with punched metal plate/punched strap

The design resistance R_d of a punched strap is determined as the minimum value among the resistances relating to the following failure modes:

- Nailing failure
- Punched strap steel failure

Forces on the tie-downs

Wall name	Length [m]	Connection name	N° of connections at each wall end	Comb.	Dur.	N [kN]	M_{3-3} [kNm]	Ta [kN]
Wall 35	2.45	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	15.07	3.04	0.00
Wall 36	2.45	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	15.07	3.04	0.00
Wall 37	2.45	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	15.07	3.04	0.00
Wall 38	2.45	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	15.07	3.04	0.00
Wall 39	2.50	Upper levels - tensile plate - shear plate	1	ULS Wind 8	5 seconds	32.75	57.65	6.68
Wall 40	2.45	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	15.07	3.41	0.00
Wall 41	2.45	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	15.07	3.41	0.00
Wall 43	2.50	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	75.09	47.29	0.00
Wall 46	1.87	Upper levels - tensile plate - shear plate	1	ULS earthquake stability 1 ex+ ey-	5 seconds	8.86	9.85	0.84
Wall 47	2.45	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	15.07	3.41	0.00
Wall 48	2.50	Upper levels - tensile plate - shear plate	1	ULS Wind 8	5 seconds	25.93	39.13	2.69
Wall 49	1.30	Upper levels - tensile plate - shear plate	1	ULS earthquake stability 1 ex+ ey-	5 seconds	6.35	5.82	1.30
Wall 50	2.49	Upper levels - tensile plate - shear plate	1	ULS Wind 8	5 seconds	13.96	43.45	10.47
Wall 60	2.45	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	7.53	0.76	0.00
Wall 61	2.45	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	7.53	0.76	0.00
Wall 62	2.45	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	7.53	0.76	0.00
Wall 63	2.45	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	7.53	0.76	0.00
Wall 64	2.50	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	29.69	14.41	0.00
Wall 65	2.45	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	7.53	0.85	0.00
Wall 66	2.45	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	7.53	0.85	0.00
Wall 68	2.50	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	37.55	11.82	0.00
Wall 71	1.87	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	5.91	0.63	0.00
Wall 72	2.45	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	7.53	0.85	0.00
Wall 73	2.50	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	22.62	9.78	0.00
Wall 74	1.30	Upper levels - tensile plate - shear plate	1	ULS Wind 6	5 seconds	4.23	0.15	0.00
Wall 75	2.49	Upper levels - tensile plate - shear plate	1	ULS Wind 8	5 seconds	6.98	10.86	0.87

Punched strap tensile resistance

The tensile resistance of the punched element is evaluated on the basis of the indications of sections 7.1 and 7.2 of AS 4100-1998. For sections with holes the design tension resistance N^* should be taken as the smaller of the design plastic resistance of the gross cross-section and the design ultimate resistance of the net cross-section.

The design plastic resistance of the gross cross-section is calculated as

$$N_{pl}^{*} = \phi \cdot N_{t,pl} = \phi \cdot A_g \cdot f_y$$

where

ϕ is the capacity factor for steel in tension

$\mathrm{A_g}$ is the gross area of the steel cross-section

$\mathrm{f_y}$ is the nominal value of the yield strength of the steel

The net cross section resistance can be evaluated using the following expression by assuming an uniform distribution of the stress:

$$\mathrm{N_u^*} = \phi \cdot \mathrm{N_{t,u}} = \phi \cdot 0.85 \cdot \mathrm{A_n} \cdot \mathrm{f_u}$$

where

ϕ is the capacity factor for steel in tension

$\mathrm{A_n}$ is the net area of the steel cross-section

$\mathrm{f_u}$ is the ultimate value of the tensile strength of the steel

Nailing resistance

The design capacity of Type 1 joints with nails and screws is given by the following equation:

$$\mathrm{R_{c,d}} = \phi \cdot \mathrm{k_1} \cdot \mathrm{k_{13}} \cdot \mathrm{k_{14}} \cdot \mathrm{k_{16}} \cdot \mathrm{k_{17}} \cdot \mathrm{n} \cdot \mathrm{R_{c,k}}$$

where

ϕ is the capacity factor for nails and screws

k_1 is the modification factor for the duration of load for joints

k_{13} is equal to 1 for fasteners in side grain

k_{14} is equal to 1 for fasteners in single shear

k_{16} is assumed equal to 1 since its contribution is already considered in the $R_{c,k}$ value

k_{17} is the modification factor for multiple nailed and screwed joints

n is the total number of fasteners in the joint resisting the design action

$R_{c,k}$ is the characteristic capacity of a single fastener estimated according to the Johansen theory of timber connections with dowel-type fasteners for steel-to-timber connections in single shear.

Wall name	Connection name	Number of rows	Number of fasteners in a row	Combination	Rc,k [N]	k_1	k_{13}	k_{14}	k_{16}	k_{17}	n	ϕ	Rc,d [kN]
Wall 35	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 36	Upper levels - tensile	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-

	plate - shear plate												
Wall 37	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 38	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 39	Upper levels - tensile plate - shear plate	10	3	ULS Wind 8	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 40	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 41	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 43	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 46	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex+ ey-	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 47	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 48	Upper levels - tensile plate - shear plate	10	3	ULS Wind 8	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 49	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex+ ey-	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 50	Upper levels - tensile plate - shear plate	10	3	ULS Wind 8	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 60	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 61	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 62	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 63	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 64	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 65	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 66	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 68	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 71	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 72	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 73	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 74	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	-	1.14	1	1	1	-	30	0.85	-
Wall 75	Upper levels - tensile plate - shear plate	10	3	ULS Wind 8	1840.55	1.14	1	1	1	0.90	30	0.85	48.15

The checks are summarized in the following table which shows the characteristic and design values of resistance associated with the different failure modes of the components.

Wall name	Connection name	Combination	T_{Ed} [kN]	$R_{c,d}$ [kN]	$N_{t,pl}$ [kN]	ϕ	N^*_{pl} [kN]	$N_{t,u}$ [kN]	ϕ	N^*_u [kN]	Failure mode	Check
Wall 35	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 36	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 37	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 38	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 39	Upper levels - tensile plate - shear plate	ULS Wind 8	6.68	48.15	22.5	0.9	20.25	18.93	0.9	17.037	Tension failure of the net cross-section	39%
Wall 40	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 41	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 43	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 46	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex+ ey-	0.84	48.15	22.5	0.9	20.25	18.93	0.9	17.037	Tension failure of the net cross-section	5%
Wall 47	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 48	Upper levels - tensile plate - shear plate	ULS Wind 8	2.69	48.15	22.5	0.9	20.25	18.93	0.9	17.037	Tension failure of the net cross-section	16%
Wall 49	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex+ ey-	1.30	48.15	22.5	0.9	20.25	18.93	0.9	17.037	Tension failure of the net cross-section	8%
Wall 50	Upper levels - tensile plate - shear plate	ULS Wind 8	10.47	48.15	22.5	0.9	20.25	18.93	0.9	17.037	Tension failure of the net cross-section	61%
Wall 60	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 61	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 62	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 63	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 64	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 65	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 66	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 68	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 71	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 72	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 73	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 74	Upper levels - tensile plate - shear plate	ULS Wind 6	0.00	-	22.5	0.9	20.25	18.93	0.9	17.037	-	0%
Wall 75	Upper levels - tensile plate - shear plate	ULS Wind 8	0.87	48.15	22.5	0.9	20.25	18.93	0.9	17.037	Tension failure of the net cross-section	5%

Angle brackets with anchors – timber to concrete shear connections

The design resistance R_d of an angle bracket is determined as the minimum value among the resistances relating to the following failure modes:

- Shear failure of the angle and/or of the group of fasteners of the connection
- Shear failure of the anchors connecting the concrete

Shear forces

The shear force acting on the single angle bracket is calculated by dividing the total shear force V_2 by the number of angle brackets present in the wall (taking into account the possible presence of angle brackets on both sides of the structural element).

$$V_a = \frac{V_2}{n_{anc}}$$

where

V_2 is the design shear force on the considered wall

n_{anc} is the number of shear connections present in the wall

The shear force acting on the most loaded anchor is calculated taking into account the additional moment due to the non-alignment between the external forces acting on the vertical flange of the angle bracket and the anchor itself using a coefficient, indicated as k_t.

$$V_p = V_a \cdot k_t$$

Wall name	Length [m]	Connection name	N of connections	Combination	Duration	V_2 [kN]	Va [kN]	kt	Vp [kN]
Wall 10	2.45	Ground connection - hold down - bracket	4	ULS earthquake stability 4 ex- ey+	5 seconds	3.48	0.87	0.97	0.84
Wall 11	2.45	Ground connection - hold down - bracket	4	ULS earthquake stability 4 ex- ey+	5 seconds	3.48	0.87	0.97	0.84
Wall 12	2.45	Ground connection - hold down - bracket	4	ULS earthquake stability 4 ex- ey+	5 seconds	3.48	0.87	0.97	0.84
Wall 13	2.45	Ground connection - hold down - bracket	4	ULS earthquake stability 4 ex- ey+	5 seconds	3.48	0.87	0.97	0.84
Wall 14	2.50	Ground connection - hold down - bracket	5	ULS Wind 6	5 seconds	22.52	4.50	0.97	4.37
Wall 15	2.45	Ground connection - hold down - bracket	4	ULS earthquake stability 1 ex- ey-	5 seconds	3.66	0.91	0.97	0.89
Wall 16	2.45	Ground connection - hold down - bracket	4	ULS earthquake stability 1 ex- ey-	5 seconds	3.66	0.91	0.97	0.89
Wall 18	2.50	Ground connection - hold down - bracket	5	ULS Wind 6	5 seconds	18.47	3.69	0.97	3.58
Wall 21	1.87	Ground connection - hold down - bracket	3	ULS earthquake stability 1 ex- ey-	5 seconds	2.69	0.90	0.97	0.87
Wall 22	2.45	Ground connection - hold down - bracket	4	ULS earthquake stability 1 ex- ey-	5 seconds	3.66	0.91	0.97	0.89
Wall 23	2.50	Ground connection - hold down - bracket	5	ULS Wind 6	5 seconds	15.28	3.06	0.97	2.96
Wall 24	1.30	Ground connection - hold down - bracket	2	ULS earthquake stability 1 ex+ ey-	5 seconds	1.57	0.79	0.97	0.76
Wall 25	2.49	Ground connection - hold down - bracket	4	ULS Wind 6	5 seconds	16.99	4.25	0.97	4.12

Angle bracket *bearing capacity*

The design value of the shear bearing capacity of the angle bracket can be estimated from the characteristic value by means of the following expression

$$R_{a,d} = \phi \cdot \mathrm{k}_1 \cdot \mathrm{k}_{13} \cdot \mathrm{k}_{14} \cdot \mathrm{R}_{\mathrm{a,k,dens}}$$

where

$\mathrm{R}_{\mathrm{a,k,dens}}$ is the characteristic value of the nailing resistance. It already considers the effect of multiple nails in the joint and the effect of the restraint against the rotation of the fastener head. This value is reduced by the k_{dens} factor when the density of the material used is less than 350 kg/m3. k_{dens} can be evaluated using the formula $\mathrm{R}_{\mathrm{c,k,dens}} = \mathrm{R}_{\mathrm{c,k}} \cdot \left(\frac{\rho_{\mathrm{k}}}{350}\right)^2$.

ϕ is the capacity factor for nails and screws

k_1 is the modification factor for duration of load for joints

k_{13} is equal to 1 for fasteners in side grain

k_{14} is equal to 1 for fasteners in single shear

Anchor *bearing capacity*

The design value of the shear strength of the anchor is evaluated as

$$R_{p,d} = \phi \cdot \mathrm{R}_{\mathrm{p,k}}$$

where

$R_{p,k}$ is the characteristic value of the shear strength of the anchor

ϕ is the capacity factor provided by manufacturers

The checks are summarized in the following tables according to each failure mode.

Name: Name of the connection in which the angle bracket is used

Comb.: The most severe combination of load

$V_{a,d}$: Shear force acting on the angle bracket

$V_{p,d}$: Shear force acting on the most stressed anchor

$$V_{a,d} \leq R_{a,d}$$

$$V_{p,d} \leq R_{p,d}$$

Wall name	Connection name	Comb.	$V_{a,d}$ [kN]	$R_{a,k,dens}$ [kN]	k_1	ϕ	$R_{a,d}$ [kN]	Check – angle brackets	$V_{p,d}$ [kN]	$R_{p,k}$ [kN]	ϕ	$R_{p,d}$ [kN]	Check - anchor
Wall 10	Ground connection - hold down - bracket	ULS earthquake stability 4 ex- ey+	0.87	18.09	1.14	0.85	17.53	5%	0.84	21	0.8	16.8	5%
Wall 11	Ground connection - hold down - bracket	ULS earthquake stability 4 ex- ey+	0.87	18.09	1.14	0.85	17.53	5%	0.84	21	0.8	16.8	5%
Wall 12	Ground connection - hold down - bracket	ULS earthquake stability 4 ex- ey+	0.87	18.09	1.14	0.85	17.53	5%	0.84	21	0.8	16.8	5%
Wall 13	Ground connection - hold down - bracket	ULS earthquake stability 4 ex- ey+	0.87	18.09	1.14	0.85	17.53	5%	0.84	21	0.8	16.8	5%
Wall 14	Ground connection - hold down - bracket	ULS Wind 6	4.50	18.09	1.14	0.85	17.53	26%	4.37	21	0.8	16.8	26%
Wall 15	Ground connection - hold down - bracket	ULS earthquake stability 1 ex- ey-	0.91	18.09	1.14	0.85	17.53	5%	0.89	21	0.8	16.8	5%
Wall 16	Ground connection - hold down - bracket	ULS earthquake stability 1 ex- ey-	0.91	18.09	1.14	0.85	17.53	5%	0.89	21	0.8	16.8	5%
Wall 18	Ground connection - hold down - bracket	ULS Wind 6	3.69	18.09	1.14	0.85	17.53	21%	3.58	21	0.8	16.8	21%
Wall 21	Ground connection - hold down - bracket	ULS earthquake stability 1 ex- ey-	0.90	18.09	1.14	0.85	17.53	5%	0.87	21	0.8	16.8	5%
Wall 22	Ground connection - hold down - bracket	ULS earthquake stability 1 ex- ey-	0.91	18.09	1.14	0.85	17.53	5%	0.89	21	0.8	16.8	5%
Wall 23	Ground connection - hold down - bracket	ULS Wind 6	3.06	18.09	1.14	0.85	17.53	17%	2.96	21	0.8	16.8	18%
Wall 24	Ground connection - hold down - bracket	ULS earthquake stability 1 ex+ ey-	0.79	18.09	1.14	0.85	17.53	4%	0.76	21	0.8	16.8	5%
Wall 25	Ground connection - hold down - bracket	ULS Wind 6	4.25	18.09	1.14	0.85	17.53	24%	4.12	21	0.8	16.8	25%

Shear connections with punched metal plate

The design resistance R_d of a punched metal plate is determined as the minimum value among the resistances relating to the following failure modes:

- Shear failure of the metal plate
- Shear failure of the group of fasteners of the connection

Shear forces

The shear force acting on the single metal plate is calculated by dividing the total shear force V_2 by the number of metal plates in the wall (taking into account the possible presence of angle brackets on both sides of the structural element).

$$V_a = \frac{V_2}{n_{anc}}$$

where

V_2 is the design shear force on the considered wall

n_{anc} is the number of shear connections present in the wall

Wall name	Length [m]	Connection name	N of connections	Comb.	Dur.	V_2 [kN]	Va [kN]
Wall 35	2.45	Upper levels - tensile plate - shear plate	4	ULS earthquake stability 4 ex- ey+	5 seconds	2.66	0.66
Wall 36	2.45	Upper levels - tensile plate - shear plate	4	ULS earthquake stability 4 ex- ey+	5 seconds	2.66	0.66
Wall 37	2.45	Upper levels - tensile plate - shear plate	4	ULS earthquake stability 4 ex- ey+	5 seconds	2.66	0.66
Wall 38	2.45	Upper levels - tensile plate - shear plate	4	ULS earthquake stability 4 ex- ey+	5 seconds	2.66	0.66
Wall 39	2.50	Upper levels - tensile plate - shear plate	5	ULS Wind 6	5 seconds	13.51	2.70
Wall 40	2.45	Upper levels - tensile plate - shear plate	4	ULS earthquake stability 1 ex- ey-	5 seconds	2.79	0.70
Wall 41	2.45	Upper levels - tensile plate - shear plate	4	ULS earthquake stability 1 ex- ey-	5 seconds	2.79	0.70
Wall 43	2.50	Upper levels - tensile plate - shear plate	5	ULS Wind 6	5 seconds	11.08	2.22
Wall 46	1.87	Upper levels - tensile plate - shear plate	3	ULS earthquake stability 1 ex- ey-	5 seconds	2.07	0.69
Wall 47	2.45	Upper levels - tensile plate - shear plate	4	ULS earthquake stability 1 ex- ey-	5 seconds	2.79	0.70
Wall 48	2.50	Upper levels - tensile plate - shear plate	5	ULS Wind 6	5 seconds	9.17	1.83
Wall 49	1.30	Upper levels - tensile plate - shear plate	2	ULS earthquake stability 1 ex+ ey-	5 seconds	1.22	0.61
Wall 50	2.49	Upper levels - tensile plate - shear plate	4	ULS Wind 6	5 seconds	10.18	2.55
Wall 60	2.45	Upper levels - tensile plate - shear plate	4	ULS earthquake stability 1 ex+ ey+	5 seconds	1.33	0.33
Wall 61	2.45	Upper levels - tensile plate - shear plate	4	ULS earthquake stability 1 ex+ ey+	5 seconds	1.33	0.33
Wall 62	2.45	Upper levels - tensile plate - shear plate	4	ULS earthquake stability 1 ex+ ey+	5 seconds	1.33	0.33
Wall 63	2.45	Upper levels - tensile plate - shear plate	4	ULS earthquake stability 1 ex+ ey+	5 seconds	1.33	0.33
Wall 64	2.50	Upper levels - tensile plate - shear plate	5	ULS Wind 6	5 seconds	4.50	0.90
Wall 65	2.45	Upper levels - tensile plate - shear plate	4	ULS earthquake stability 1 ex+ ey-	5 seconds	1.41	0.35
Wall 66	2.45	Upper levels - tensile plate - shear plate	4	ULS earthquake stability 1 ex+ ey-	5 seconds	1.41	0.35
Wall 68	2.50	Upper levels - tensile plate - shear plate	5	ULS Wind 6	5 seconds	3.69	0.74
Wall 71	1.87	Upper levels - tensile plate - shear plate	3	ULS earthquake stability 1 ex+ ey-	5 seconds	1.05	0.35
Wall 72	2.45	Upper levels - tensile plate - shear plate	4	ULS earthquake stability 1 ex+ ey-	5 seconds	1.41	0.35
Wall 73	2.50	Upper levels - tensile plate - shear plate	5	ULS Wind 6	5 seconds	3.06	0.61
Wall 74	1.30	Upper levels - tensile plate	2	ULS earthquake stability 1	5 seconds	0.62	0.31

		- shear plate		ex+ ey-			
Wall 75	2.49	Upper levels - tensile plate - shear plate	4	ULS Wind 6	5 seconds	3.39	0.85

Metal plate *shear capacity*

The design value of the shear strength of single metal plate is calculated according to the following expression by assuming an uniform distribution of the stress:

$$V^* = \phi \cdot V_u = \phi \cdot 0.6 \cdot f_y \cdot A_v$$

where

ϕ is the capacity factor for steel in shear

A_v is the net shear area

f_y is the nominal value of the yield strength of the steel

Nailing *capacity*

The design capacity of Type 1 joints with nails and screws is given by the following equation:

$$R_{c,d} = \phi \cdot k_1 \cdot k_{13} \cdot k_{14} \cdot k_{16} \cdot k_{17} \cdot n \cdot R_{c,k}$$

where

ϕ is the capacity factor for nails and screws

k_1 is the modification factor for the duration of load for joints

k_{13} is equal to 1 for fasteners in side grain

k_{14} is equal to 1 for fasteners in single shear

k_{16} is assumed equal to 1 since its contribution is already considered in the $R_{c,k}$ value

k_{17} is the modification factor for multiple nailed and screwed joints

n is the total number of fasteners in the joint resisting the design action

$R_{c,k}$ is the characteristic capacity of a single fastener estimated according to the Johansen theory of timber connections with dowel-type fasteners for steel-to-timber connections in single shear.

Wall name	Connection name	Number of rows	Number of fasteners in a row	Combination	Rc,k [N]	k_1	k_{13}	k_{14}	k_{16}	k_{17}	n	ϕ	$R_{c,d}$ [kN]
Wall 35	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 4 ex-ey+	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 36	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 4 ex-ey+	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 37	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 4 ex-ey+	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 38	Upper levels - tensile	10	3	ULS earthquake	1840.55	1.14	1	1	1	0.90	30	0.85	48.15

	plate - shear plate			stability 4 ex- ey+									
Wall 39	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 40	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex- ey-	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 41	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex- ey-	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 43	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 46	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex- ey-	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 47	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex- ey-	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 48	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 49	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex+ ey-	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 50	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 60	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex+ ey+	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 61	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex+ ey+	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 62	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex+ ey+	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 63	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex+ ey+	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 64	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 65	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex+ ey-	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 66	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex+ ey-	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 68	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 71	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex+ ey-	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 72	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex+ ey-	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 73	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 74	Upper levels - tensile plate - shear plate	10	3	ULS earthquake stability 1 ex+ ey-	1840.55	1.14	1	1	1	0.90	30	0.85	48.15
Wall 75	Upper levels - tensile plate - shear plate	10	3	ULS Wind 6	1840.55	1.14	1	1	1	0.90	30	0.85	48.15

The checks are summarized in the following table which shows the characteristic and design values of resistance associated with the different failure modes of the components.

Wall name	Connection name	Combination	$V_{a,Ed}$ [kN]	$R_{c,d}$ [kN]	Fasteners check	V_u [kN]	ϕ	V* [kN]	Metal plate check
Wall 35	Upper levels - tensile plate - shear plate	ULS earthquake stability 4 ex- ey+	0.66	48.15	1%	45	0.9	40.5	2%
Wall 36	Upper levels - tensile plate - shear plate	ULS earthquake stability 4 ex- ey+	0.66	48.15	1%	45	0.9	40.5	2%
Wall 37	Upper levels - tensile plate - shear plate	ULS earthquake stability 4 ex- ey+	0.66	48.15	1%	45	0.9	40.5	2%
Wall 38	Upper levels - tensile plate - shear plate	ULS earthquake stability 4 ex- ey+	0.66	48.15	1%	45	0.9	40.5	2%
Wall 39	Upper levels - tensile plate - shear plate	ULS Wind 6	2.70	48.15	6%	45	0.9	40.5	7%
Wall 40	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex- ey-	0.70	48.15	1%	45	0.9	40.5	2%
Wall 41	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex- ey-	0.70	48.15	1%	45	0.9	40.5	2%
Wall 43	Upper levels - tensile plate - shear plate	ULS Wind 6	2.22	48.15	5%	45	0.9	40.5	5%
Wall 46	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex- ey-	0.69	48.15	1%	45	0.9	40.5	2%
Wall 47	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex- ey-	0.70	48.15	1%	45	0.9	40.5	2%
Wall 48	Upper levels - tensile plate - shear plate	ULS Wind 6	1.83	48.15	4%	45	0.9	40.5	5%
Wall 49	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex+ ey-	0.61	48.15	1%	45	0.9	40.5	2%
Wall 50	Upper levels - tensile plate - shear plate	ULS Wind 6	2.55	48.15	5%	45	0.9	40.5	6%
Wall 60	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex+ ey+	0.33	48.15	1%	45	0.9	40.5	1%
Wall 61	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex+ ey+	0.33	48.15	1%	45	0.9	40.5	1%
Wall 62	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex+ ey+	0.33	48.15	1%	45	0.9	40.5	1%
Wall 63	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex+ ey+	0.33	48.15	1%	45	0.9	40.5	1%
Wall 64	Upper levels - tensile plate - shear plate	ULS Wind 6	0.90	48.15	2%	45	0.9	40.5	2%
Wall 65	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex+ ey-	0.35	48.15	1%	45	0.9	40.5	1%
Wall 66	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex+ ey-	0.35	48.15	1%	45	0.9	40.5	1%
Wall 68	Upper levels - tensile plate - shear plate	ULS Wind 6	0.74	48.15	2%	45	0.9	40.5	2%
Wall 71	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex+ ey-	0.35	48.15	1%	45	0.9	40.5	1%
Wall 72	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex+ ey-	0.35	48.15	1%	45	0.9	40.5	1%
Wall 73	Upper levels - tensile plate - shear plate	ULS Wind 6	0.61	48.15	1%	45	0.9	40.5	2%
Wall 74	Upper levels - tensile plate - shear plate	ULS earthquake stability 1 ex+ ey-	0.31	48.15	1%	45	0.9	40.5	1%
Wall 75	Upper levels - tensile plate - shear plate	ULS Wind 6	0.85	48.15	2%	45	0.9	40.5	2%

Inter-storey drift checks

The inter-storey drifts at the ultimate limit state calculated from the relevant seismic forces are limited in accordance to the following equation:

$$d_i < d_{\mathrm{i,lim}} = 0.015\ \mathrm{h}$$

where

d_i is the inelastic inter-storey drift obtained by multiplying the value determined by an elastic analysis by μ/S_p

h is the storey height

The table below shows the drift checks for each wall.

Wall name: Wall ID

h: Storey height

Comb.: The most severe combination of load

d_i: Evaluated inter-storey drift

$d_{i,lim}$: Inter-storey drift limit

The table provides the Drift checks in the case of Dynamic Linear Analysis.

Wall	h [m]	Comb.	d_r [mm]	d_{lim} [mm]	Check
Wall 10	3.20	ULS earthquake drift 2 ex- ey+	6.03	48.00	13%
Wall 11	3.20	ULS earthquake drift 2 ex- ey+	6.03	48.00	13%
Wall 12	3.20	ULS earthquake drift 2 ex- ey+	6.03	48.00	13%
Wall 13	3.20	ULS earthquake drift 2 ex- ey+	6.03	48.00	13%
Wall 14	3.20	ULS earthquake drift 4 ex+ ey-	11.77	48.00	25%
Wall 15	3.20	ULS earthquake drift 1 ex- ey-	6.22	48.00	13%
Wall 16	3.20	ULS earthquake drift 1 ex- ey-	6.22	48.00	13%
Wall 18	3.20	ULS earthquake drift 4 ex+ ey-	6.59	48.00	14%
Wall 21	3.20	ULS earthquake drift 1 ex- ey-	6.22	48.00	13%
Wall 22	3.20	ULS earthquake drift 1 ex- ey-	6.22	48.00	13%
Wall 23	3.20	ULS earthquake drift 4 ex- ey-	10.32	48.00	21%
Wall 24	3.20	ULS earthquake drift 1 ex- ey-	5.76	48.00	12%
Wall 25	3.20	ULS earthquake drift 4 ex- ey-	7.93	48.00	17%
Wall 35	3.20	ULS earthquake drift 2 ex- ey+	4.51	48.00	9%
Wall 36	3.20	ULS earthquake drift 2 ex- ey+	4.51	48.00	9%
Wall 37	3.20	ULS earthquake drift 2 ex- ey+	4.51	48.00	9%
Wall 38	3.20	ULS earthquake drift 2 ex- ey+	4.51	48.00	9%
Wall 39	3.20	ULS earthquake drift 4 ex+ ey-	8.87	48.00	18%
Wall 40	3.20	ULS earthquake drift 1 ex- ey-	4.65	48.00	10%
Wall 41	3.20	ULS earthquake drift 1 ex- ey-	4.65	48.00	10%
Wall 43	3.20	ULS earthquake drift 4 ex+ ey-	4.94	48.00	10%
Wall 46	3.20	ULS earthquake drift 1 ex- ey-	4.65	48.00	10%
Wall 47	3.20	ULS earthquake drift 1 ex- ey-	4.65	48.00	10%
Wall 48	3.20	ULS earthquake drift 4 ex- ey-	7.69	48.00	16%
Wall 49	3.20	ULS earthquake drift 1 ex- ey-	4.30	48.00	9%
Wall 50	3.20	ULS earthquake drift 4 ex- ey-	5.92	48.00	12%
Wall 60	3.20	ULS earthquake drift 2 ex- ey+	2.25	48.00	5%
Wall 61	3.20	ULS earthquake drift 2 ex- ey+	2.25	48.00	5%
Wall 62	3.20	ULS earthquake drift 2 ex- ey+	2.25	48.00	5%
Wall 63	3.20	ULS earthquake drift 2 ex- ey+	2.25	48.00	5%
Wall 64	3.20	ULS earthquake drift 4 ex+ ey-	5.07	48.00	11%
Wall 65	3.20	ULS earthquake drift 1 ex- ey-	2.32	48.00	5%
Wall 66	3.20	ULS earthquake drift 1 ex- ey-	2.32	48.00	5%
Wall 68	3.20	ULS earthquake drift 4 ex+ ey-	2.63	48.00	5%
Wall 71	3.20	ULS earthquake drift 1 ex- ey-	2.32	48.00	5%
Wall 72	3.20	ULS earthquake drift 1 ex- ey-	2.32	48.00	5%
Wall 73	3.20	ULS earthquake drift 4	4.11	48.00	9%

		ex- ey-			
Wall 74	3.20	ULS earthquake drift 1 ex- ey-	2.15	48.00	4%
Wall 75	3.20	ULS earthquake drift 4 ex- ey-	3.13	48.00	7%