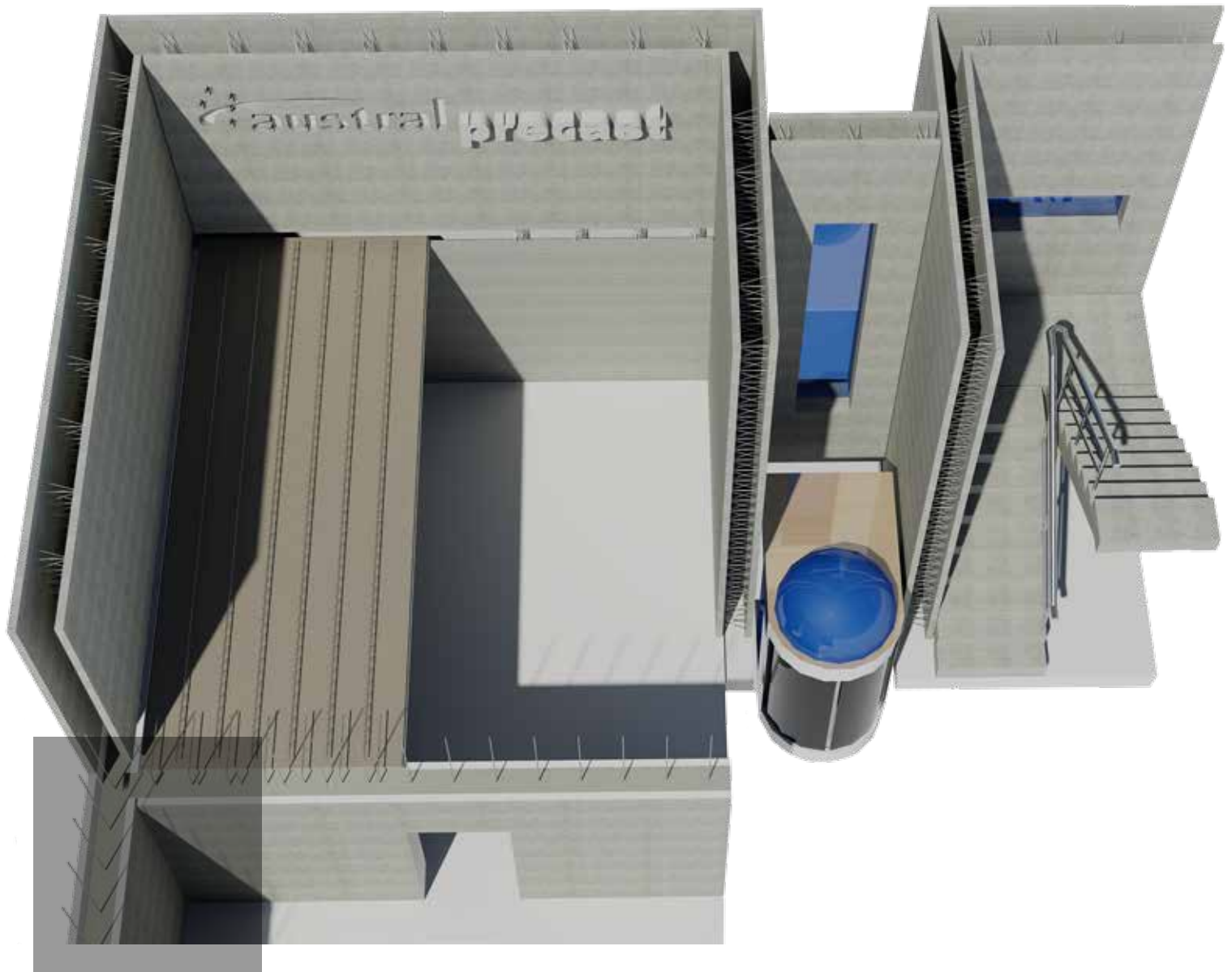


Double Wall

Austral Precast



precast.
build faster,
build smarter,
build better.

Technical Guide

The Guide to be used by Qualified Structural Engineers, Architects, Builders and Associated Industries

The information contained in this document is provided as a general guide only and does not replace the need for the specification to be reviewed and checked by a qualified person in the field of concrete, energy, building construction, sound, design, services and/or fire. This design of the Austral Precast Double Wall must be carried out by qualified and experienced structural engineers, who consider both the performance of the

walls and their role in the structural behaviour of the building as a whole. Austral Precast does not accept any responsibility for incorrect, inappropriate or incomplete use of this information.

This material has been prepared in the context of relevant Australian Standards, the National Construction Code (NCC) and the Building Code of Australia (BCA). Users should make themselves aware of any recent changes to these documents referred to and to local variations or requirements.

Double Wall

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Double Wall General Design Guide and Installation Information



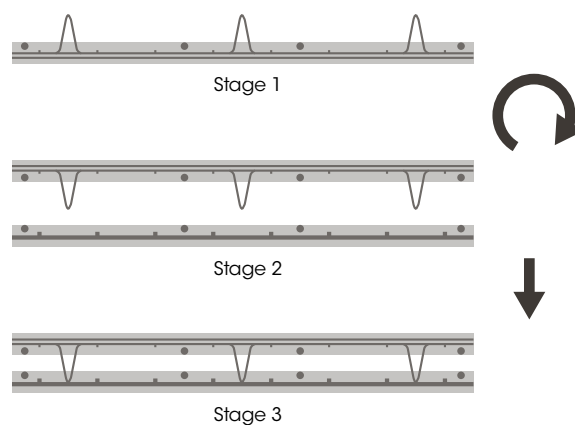
Double Wall

1.1 Overview

Austral Precast Double Wall consists of a pair of precast reinforced concrete shells connected by a lattice girder (trusses) fabricated from reinforcement bar, forming a cavity.

The first shell is cast as a slab on a vibrating table with mesh and connecting trusses cast in. Once this shell has sufficient strength, it is inverted and lowered into the second panel. The whole system is then vibrated to compact the concrete around the connecting trusses.

Steel reinforcement, edge forms and built-in components may be factory assembled and transported to site as part of the system. On site, edge forms and reinforcement connections are completed and the hollow cavity is filled with premixed concrete to create a solid concrete structure, tying the Double Wall panels to adjacent walls and floors.



Double Wall

1.2 Applications

The engineered Double Wall construction achieves incredible time and cost saving as the entire structure, walls, floors and shafts are casted simultaneously. Manufacturing and installation efficiency are key engineering of the Double Wall.

The Austral Precast Double Wall is custom-designed. The overall wall thickness, reinforcement contents, manufacturing and installation process will vary by project. (Refer to Double Wall technical guide)

There is a wide variety of applications for Double Wall.

- High-rise, residential, commercial and industrial building structure as
 - Basement retaining wall
 - High rise core wall
 - Cantilever retaining wall
 - Structural elements
- Concrete liquid-retaining structure
- Fire and sound barrier due to the Double Wall excellent performance in the areas of fire safety and noise reduction

1.3 Features and Benefits

- An efficient permanent structural framework:
 - Hybrid solution replacing conventional cast in situ operation.
 - Minimum excavation is required especially when employed as retaining wall.
 - Safer construction option as construction activities is performed within and inside the boundary.
- Suitable for construction where watertightness is essential:
 - Withstand water hydraulic pressure up to 0.2MPa (20m water head).
 - Water tightness is maintained by the property of the Double Wall and installation techniques.
 - Meets relevant Australian Standard including as AS 3735 – 2001 Concrete structures for retaining liquids.
- Employed in association with precast flooring achieving:
 - Monolithic structure, eliminating structural framework and step toward precast modularisation.
 - Manufacturing efficiency results from fast production, less material to handle and affordable construction.
 - Installation efficiency due to relatively large and light panels, the enhanced jointing method and the unneeded of grouting, welding and formwork.

Double Wall

2. Austral Precast Double Wall Configuration

Austral Precast Double Wall panel is constructed with 70mm thick shells. The overall wall thickness can vary between 200mm to 400mm depending on the structure and applied loads. The 70mm thick shells are adequate to withstand lateral hydrostatic pressure resulting from placing of concrete and will be identical for each panel.

The Austral Precast Double Wall is custom-designed. The overall wall thickness, reinforcement contents, manufacturing and installation process will vary by project. Refer to Double Wall Applications and their Design Guide section in this guide.

Please consult with the Austral Precast technical team and the structural engineer for projects specific Double Wall configuration.

2.1 Double Wall Reinforcement Configuration

The reinforcement of Austral Precast Double Wall consists of:

- Connection lattice girder
- Shell reinforcement: steel mesh and steel bar reinforcement (if specified)
- Wall cavity reinforcement: starter bars at joints and additional cavity reinforcement (if specified)

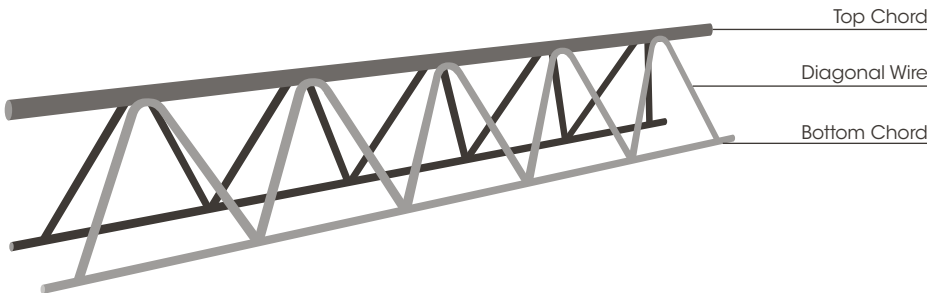
2.1.1 Connection: Steel Lattice Girder Properties and Range of Double Wall Thickness

A specialised lattice girder (truss) shall be used to connect the Double Wall shells; the lattice girder height has to suit the overall double wall thicknesses and specified reinforcement cover.

The trusses are proportioned to provide:

- Robustness (dimensional stability) during erection
- Resistance to hydrostatic forces during concrete infill placement. The magnitude of the hydrostatic pressure should be determined by the structural designer and will vary depending on concrete mix design and rate of concrete placement and
- Provide the required cavity width.

Truss Type		Nominal Chord and Diagonal Wire Diameter			Height (h) mm	Mass (kg/m)	Double Wall overall thickness
Australian Code Steel Truss	Lattice Girder EU 10080 Code	Top Chord	Bottom Chord	Diagonal Wire			
T150/10	6/10/6 – 150	10	6	6	150	1.91	200mm
T190/10	6/10/6 – 190	10	6	6	190	2.06	250mm
T250/10	6/10/6 – 250	10	6	6	250	2.31	300mm
TG300/10	6/10/8 – 300	10	8	8	300	4.00	350mm
TG320/10	6/10/8 – 320	10	8	8	320	4.15	400mm



Trusses are typically fabricated from a "L" Grade 6mm bottom chords and wire lattice. For the purposes of wall construction, a "L" Grade 10mm top chord should be sufficient. The top chords and bottom chords will be tied to the embedded panel reinforcing, hence the truss heights will vary with the overall width of the wall.

Sample calculations indicate that for a 4m high pour and maximum hydrostatic pressure, a truss spacing of 600mm would be required. Axial forces in the truss lattice chords do not vary appreciably with wall width.

2.1.2 Double Wall Shell Reinforcement

Reinforcing for the Double Wall shells will typically be mesh, but may be supplemented with additional reinforcement depending on the application.

Calculations indicate that SL82 mesh is sufficient for a truss spacing of 600mm and a hydrostatic pressure equivalent to 4m high.

2.1.3 Wall Cavity Reinforcement

Placement of principal reinforcement for wall panels can be carried out in the factory prior to connecting panels.

Secondary reinforcement, such as starter bars, can either be placed in the factory or on site depending on the wall configuration.

Double Wall

3. Design Guide

3.1 Design Standards and Criteria

As a concrete structure, the design of Austral Precast Double Wall will be carried out in accordance with the following Australian design standards:

- AS/NZS 1170.0:2002 Structural Design Actions Part 0: General Principles
- AS/NZS 1170.1:2002 Structural Design Actions Part 1: Permanent, imposed and other actions
- AS 3600:2009 Concrete Structures
- AS 3850:2003 Tilt-up concrete construction

For the purpose of this document, the following design criteria has been applied for the design of Austral Precast Double Wall panels.

- Reinforced Concrete

Concrete Strength f'_c (Panels):	40 MPa
Concrete Strength f'_c (Infill):	40 MPa
Concrete Density γ_c :	24 kN/m ³
Cover to outer concrete faces:	25 mm
Reinforcing Grade:	L (mesh), N (bar)
- Geotechnical

Soil Backfill Density γ_s :	18 kN/m ³
Soil Backfill Friction Angle ϕ_s :	30°
Water Table:	RL 0.0m (fully drained)

3.2 Design Principle

The transfer of the shear forces from the Austral Precast Double Wall to the structure below is via a combination of concrete in the cavity, concrete in the shells and reinforcement in the cavity (if specified).

Additional reinforcement starters are incorporated at the top and bottom of the walls. The shells are cast with rough internal surfaces and are joined by truss

reinforcement (lattice girder). This maximises the bond between the site-cast cavity concrete and the factory-cast shell concrete, and thus ensures monolithic action.

The lower edges of the precast concrete shells must bond with site-cast concrete of the floor slab below to enable the shells to contribute to shear capacity.

The following section demonstrates typical design information of Double wall for three main applications.

3.3 Double Wall Applications and their Design Guide

The Austral Precast Double Wall, when filled with concrete and reinforced, will behave like a fully cast in situ reinforced concrete wall.

There is a wide variety of applications for this product. The following are examples of three main applications of the Double Wall and their design guide:

- Cantilever retaining wall
- Basement retaining wall, and
- High rise core wall

Double Wall

3. Design Guide

3.3.1 Cantilever Retaining Wall

Double Wall is used for earth or liquid retaining (cantilever retaining wall), ranging in size from small residential applications to major civil structures. The Double Wall is also applicable to other earth-retained structures associated with highways, railways and other civil constructions.

Cantilever retaining walls are usually more heavily reinforced than high rise core walls. It is anticipated that additional reinforcing will need to be placed within the wall cavity (between wall shells).

Span tables below have been prepared for a variety of wall heights, thicknesses and surcharge.

WALL SELECTION CHART- Cantilever retaining wall						
SURCHARGES (kPa)	WALL HEIGHT H (m)					
	2	2.5	3	3.5	4	4.5
10	200A	200B	200C			
		250A	250B	250C	250D	
			300A	300B	300C	300D

15	200A	200B	200C			
		250A	250B	250C		
			300B	300B	300D	
				350B	350C	350D
					400B	400C

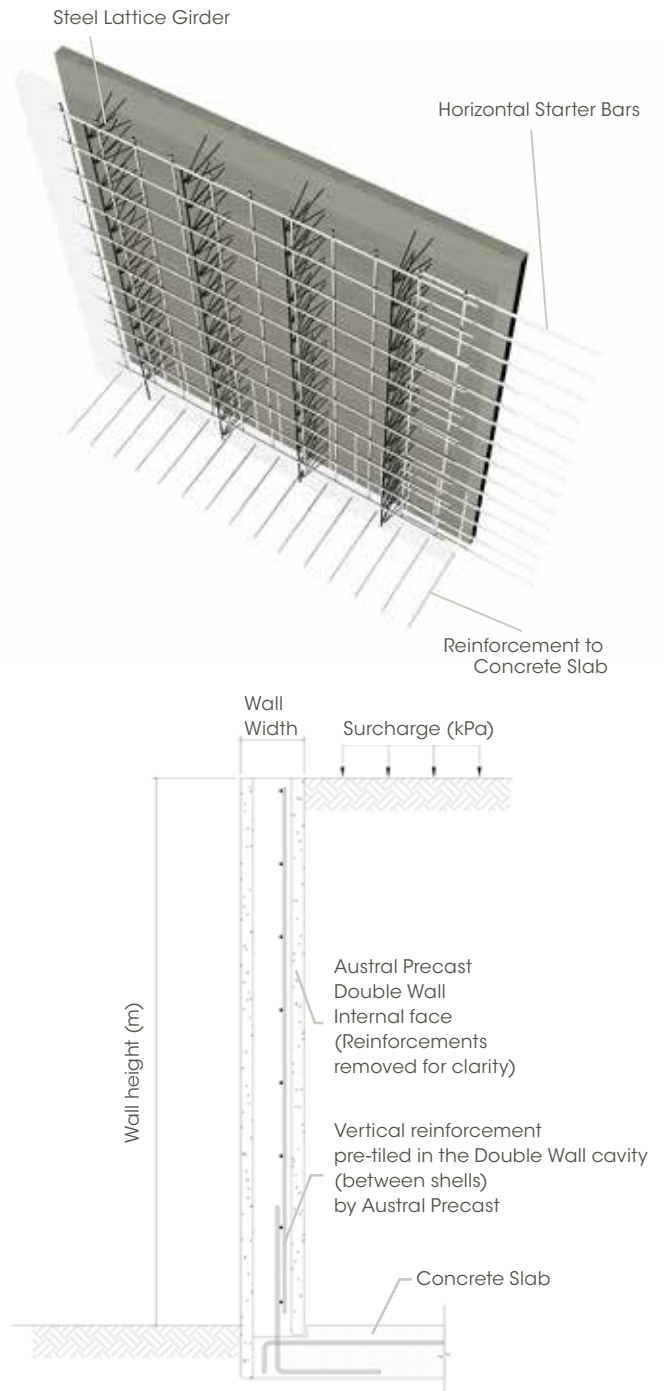
20	200A	200B				
			250C			
		300A	300B	300C	300D	
			350A	350B	350C	350D

Vertical reinforcement

A. N16-200
B. N20-200
C. N24-200
D. N28-200

Note

The table has been prepared based on the assumption of 70mm cover to main vertical reinforcement. The structural engineer may choose to adopt a smaller cover, ie cast the vertical bars within the shell. Refer to the Joint section (Section 3.4) for further details.



3.3.2 Basement Retaining Wall

Basement retaining walls are required to resist lower movements than cantilever walls of the same height and surcharge loading.

Span tables below have been prepared for a variety of wall heights, thicknesses and surcharge.

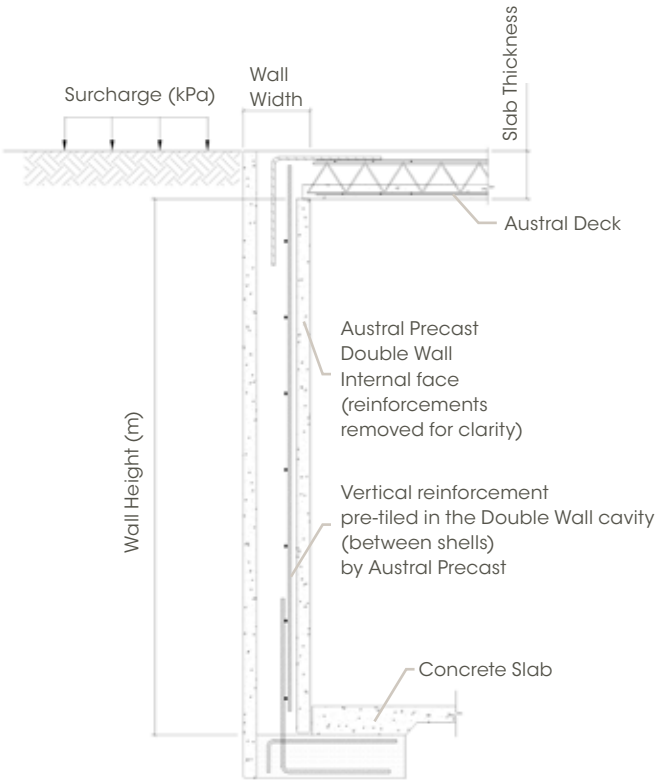
WALL SELECTION CHART- Basement retaining wall						
SURCHARGES (kPa)	WALL HEIGHT H (m)					
	2	2.5	3	3.5	4	4.5
10	200A	200A	200A	200A	200B	200C
					250A	250B
15	200A	200B	200A	200A	200B	200C
					250A	250B
20	200A	200A	200A	200B	200C	
				250C	250B	250B
					300A	300B
						350A

Vertical reinforcement

A. N16-200
B. N20-200
C. N24-200
D. N28-200

Note

The table has been prepared based on the assumption of 70mm cover to main vertical reinforcement. The structural engineer may choose to adopt a smaller cover, ie cast the vertical bars within the shell. Refer to the Joint section (Section 3.4) for further details.



3.3.3 High Rise Core Wall

High rise core walls typically vary in thickness over the height of the building. Wall thicknesses typically vary between 200mm and 300mm.

Walls are generally not heavily reinforced, so it is anticipated that all reinforcing can be placed in the panels during casting.

Span tables have been prepared for walls 3.5m high (clear span) for wall thicknesses 200, 250 and 300mm.

Walls are required to principally resist the horizontal shear and vertical compression loads.

Horizontal shear requires the panels to be connected at vertical joints by dowels. The span tables for core walls indicate the requirements for horizontal dowels for a variety of loading cases.

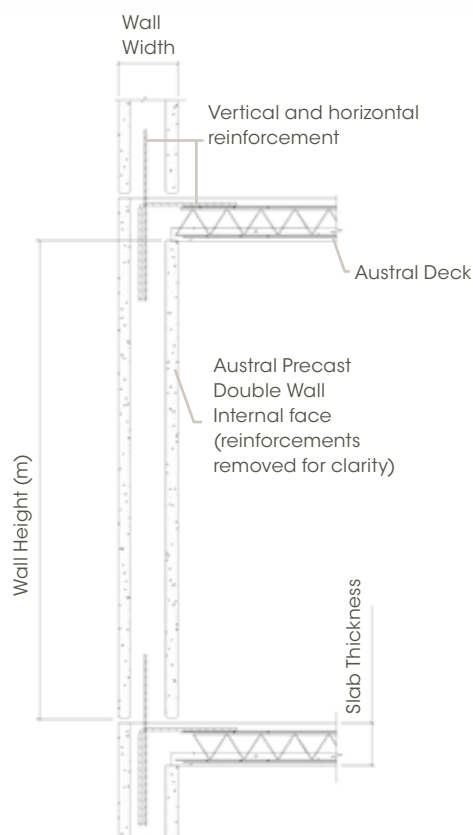
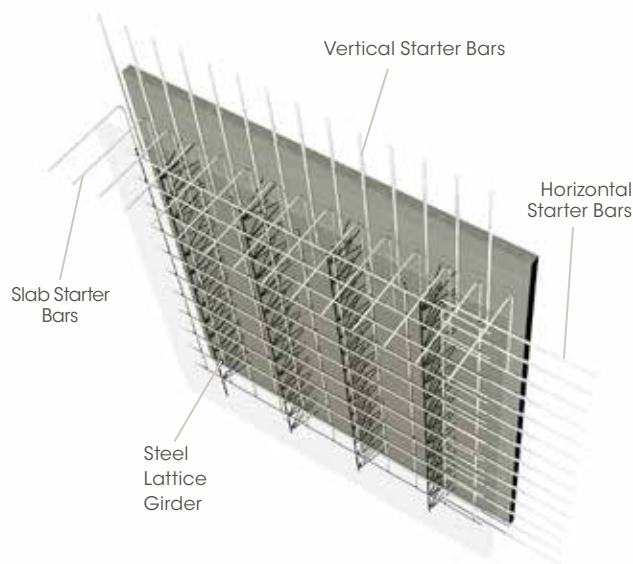
WALL SELECTION CHART – High rise core wall							
AXIAL COMPRESSION LOAD (kN/m)	IN PLANE SHEAR (kN/m)						
	50	75	100	125	150	175	200
2000	200a	200c					
3000	250b	250b	250b	250d			
3750	300c	300c	300c	300c	300c	300d	300e

Horizontal Reinforcement for Vertical Joint (Dowel)	
a	N12-350
b	N12-250
c	N12-200
d	N12-150
e	N16-200

Shell Reinforcement	
WALL	REQ
200	SL72
250	SL82
300	SL82

Note

Designs for high rise core walls are based on zero tension in the vertical direction. Additional vertical reinforcing may be required to resist tension. Refer to the Joint section (Section 3.4) for further details.



3.4 Vertical and Horizontal Joints

3.4.1 Vertical Joints

Vertical joints occur between the Double Wall panels where the length of the wall cannot be easily accommodated by a single precast panel width due to either manufacturing, installation or transportation limitations.

A vertical control joint must also be considered in the wall to cater for vertical movement of the foundation.

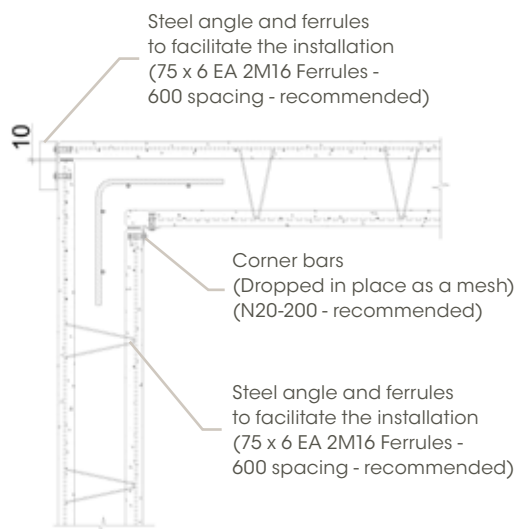
Staggering the joint is recommended to assist in weatherproofing the wall.

Horizontal reinforcing across vertical joints is usually employed to transfer shear in the plane of the wall. The span table for the High Rise Core Wall (page 10) also outline the recommended reinforcement across vertical joints.

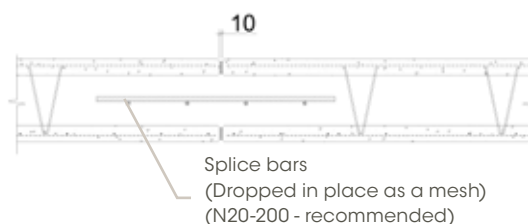
Reinforcement continuity is typically provided using a prefabricated single or double layer of reinforcement, which is lowered into place between the lattice girders bonding the two precast concrete shells.

The reinforcement can also be placed in the factory as part of the manufacturing process.

Double Wall: Vertical Joint - Corner Arrangement



Double Wall: Vertical Joint - Continuous Wall



3.4.2 Horizontal Joints (Core Walls)

Horizontal joints occur at both the top and bottom of the wall at the junctions with the slab (typically only occur in core walls).

The connections and supporting structure must have sufficient combined capacity to transmit the horizontal in-plane and out-of-plane loads from the wall to the supports. The connections should be detailed to ensure that the walls do not collapse outwards during a fire.

Continuity reinforcement is provided at horizontal joints with splice bars lapped with the embedded reinforcement. Splice bars should be positioned so as to avoid touching the inside face of the precast

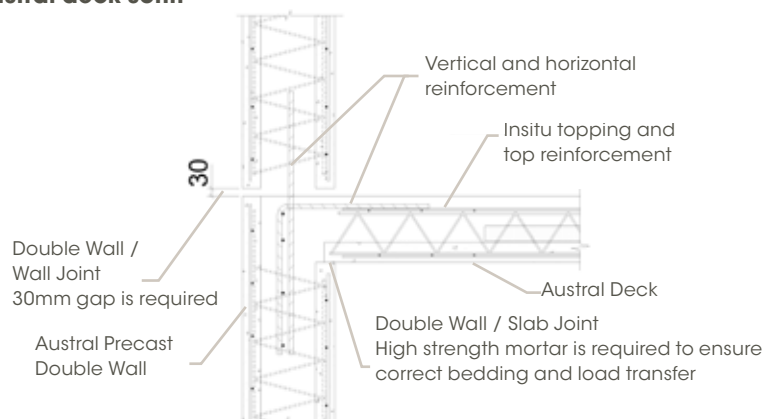
shells with tolerances to allow the lowering of top units during installation.

At Double Wall panel connections, a gap is recommended sufficient to allow concrete to easily penetrate and provide continuous bedding. A gap of 30mm will allow penetration of concrete across the joint.

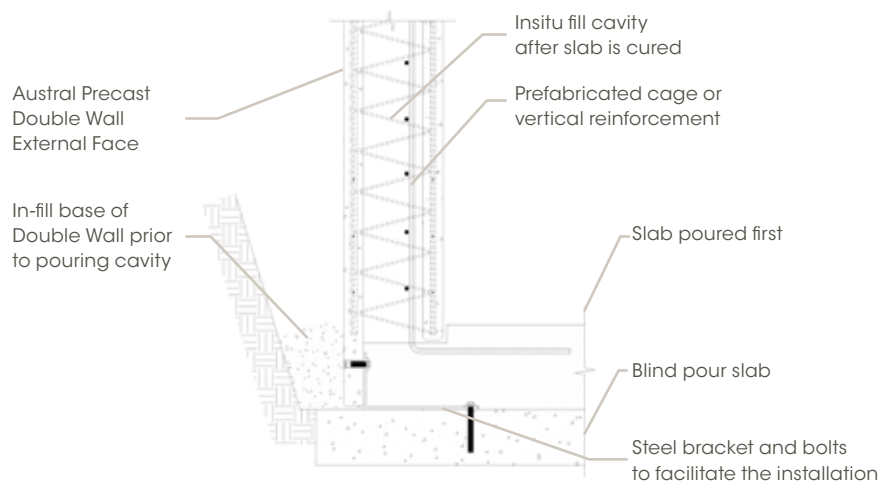
For Double Wall to in situ slab joints, no gap is required as the slab concrete will provide effective load transmittal.

For Double Wall to precast slab soffit joints, a high strength mortar is required to ensure correct bedding and load transfer. Alternatively, a gap may be provided as described above.

Horizontal Joint - Double Wall to Double Wall and Austral deck soffit



Horizontal Joint - Double Wall to in situ slab



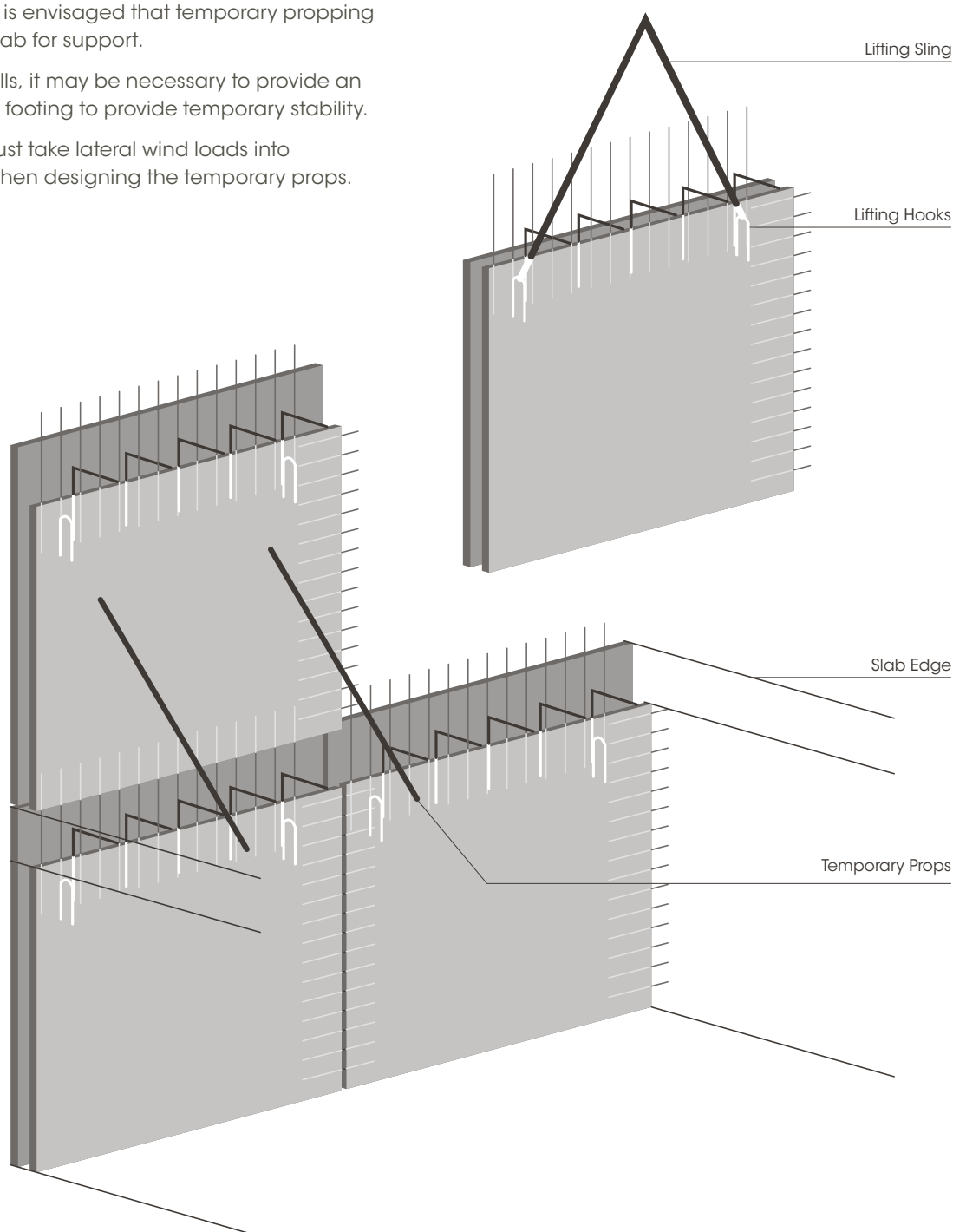
3.5 Temporary Propping

Propping is required to provide temporary stability of wall sections while infill concrete is being placed.

For core walls, it is envisaged that temporary propping would use the slab for support.

For retaining walls, it may be necessary to provide an anchor block or footing to provide temporary stability.

The designer must take lateral wind loads into consideration when designing the temporary props.



3.6 Design Calculation – Example in Accordance with AS360

3.6.1 Input Parameters

$H_w =$	3500mm	Height of Wall
$L_w =$	1000mm	Length of Wall
$t_w =$	300mm	Total wall thickness
$t_{\text{precast}} =$	70mm	Precast Panel Thickness
$t_{\text{wc}} =$	160mm	Continuous Concrete Thickness
$f'_c =$	40 MPa	
$f_{sy} =$	500MPa	

3.6.2 Effective Height

Effective Height	$H_{we} = k H_w$...11.4	$H_w = 3500\text{mm}$	As above
	$= 3500\text{mm}$		$k = 1.0$	No rotation Restraint ...11.4 (a)

3.6.3 Simplified Design for Compression

Axial Strength	$N_u = (t_w - 1.2e - 2e_a)0.6f'_c$...11.5.1	$t_w = 300\text{mm}$	As above
	$\Phi N_u = 3859 \text{ kN/m}$		$f'_c = 40 \text{ MPa}$	As above
			$\Phi = 0.6$	
			$e_a = H_{we}^2/2500t_w$...11.5.1
			$= 16\text{mm}$	
			$e = 0.05 t_w$	Minimum ...11.5.2
Vertical Bars	Bars SL82 x 2 No			
	$A_{st} = 454\text{mm}^2$	(0.15%)		
	$P_w = 0.15\%$	Ratio of Horizontal Reo to cross sectional area per vertical m		($H_w/L_w > 1$)
Minimum Reinforcement =	0.15%	...11.7.1		
	$= 450\text{mm}^2$			
	$A_{st} \text{ Total} = 454\text{mm}^2$	$> 450\text{mm}^2$	OK	99.12%
	Min Spacing of Reo = N/A	$= 3 d_b$	OK	
	Max Spacing of Reo = N/A	$= \text{Min}(2.5t_w, 350)$	OK	

3.6.4 Simplified Design for Compression

Axial Strength	$\Phi N_u = 3859 \text{ kN/m}$	$> 0 \text{ kN}$	OK	0.00%
----------------	--------------------------------	------------------	----	-------

3.6.5 Critical Section for Shear

Height =	0.5 H_w form base	$H_w = 3500\text{mm}$	As Above
	$= 1750\text{mm}$		

3.6.6 Shear Excluding Reinforcement

Minimum of:

$$V_{uc} = \left[0.66\sqrt{f'_c} - 0.21 \frac{H_w}{L_w} \sqrt{f'_c} \right] 0.8L_w t_w \quad \dots 11.6.3(1)$$

$f'_c = 40 \text{ MPa}$ As above
 $H_w = 3500 \text{ mm}$ As Above
 $L_w = 1000 \text{ mm}$ As Above
 $t_w = 160 \text{ mm}$ As Above

$$= 0 \text{ kN/m}$$

$$V_{uc} = \left[0.05\sqrt{f'_c} + \frac{0.1\sqrt{f'_c}}{\left(\frac{H_w}{L_w} - 1 \right)} \right] 0.8L_w t_w \quad \dots 11.6.3(2)$$

$$= 73 \text{ kN/m}$$

But not less than;

$$V_{uc} = 0.17\sqrt{f'_c} (0.8L_w t_w) = 138 \text{ kN/m} \quad \dots 11.6.3(2)$$

Shear Excluding Reinforcement

$$V_{uc} = 138 \text{ kN/m}$$

3.6.7 Shear Contribution by Reinforcement

Horizontal Bars Bars **N16** @ **200** Centres

$$A_{st} = 1000 \text{ mm}^2 \quad (0.33\%)$$

$$P_w = 0.33\% \quad \text{Ratio of Horizontal Reo to cross sectional area per vertical m} \quad (H_w/L_w > 1)$$

Minimum Reinforcement

$$= 0.15\% \quad \dots 11.7.1$$

$$= 450 \text{ mm}^2$$

$$A_{st} \text{ Total} = 1000 \text{ mm}^2 > 450 \text{ mm}^2 \quad \text{OK} \quad 45.00\%$$

$$\text{Min Spacing of Reo} = 48 \text{ mm} = 3d_b \quad \text{OK}$$

$$\text{Max Spacing of Reo} = 350 \text{ mm} = \text{Min}(2.5t_w, 350) \quad \text{OK}$$

Shear Contribution by Reinforcement

$$= 211 \text{ kN/m} \quad \dots 11.6.4$$

$f_{sy} =$ As Above
 $L_w = 1000 \text{ mm}$ As Above
 $t_w = 160 \text{ mm}$ As Above

3.6.8 Strength In Shear

$$V_u = 138 + 211$$

$$= 349 \text{ kN/m}$$

$f'_c = 40 \text{ MPa}$ As Above
 $L_w = 1000 \text{ mm}$ As Above
 $t_w = 160 \text{ mm}$ As Above
 $\Phi = 0.6$

$$= 1024 \text{ kN/m}$$

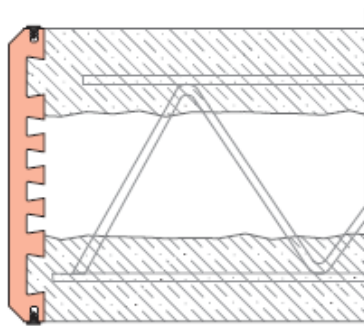
In Plane Shear Strenght

$$\Phi V_u = 209 \text{ kN} > 0 \text{ kN} \quad \text{OK} \quad 0.00\%$$

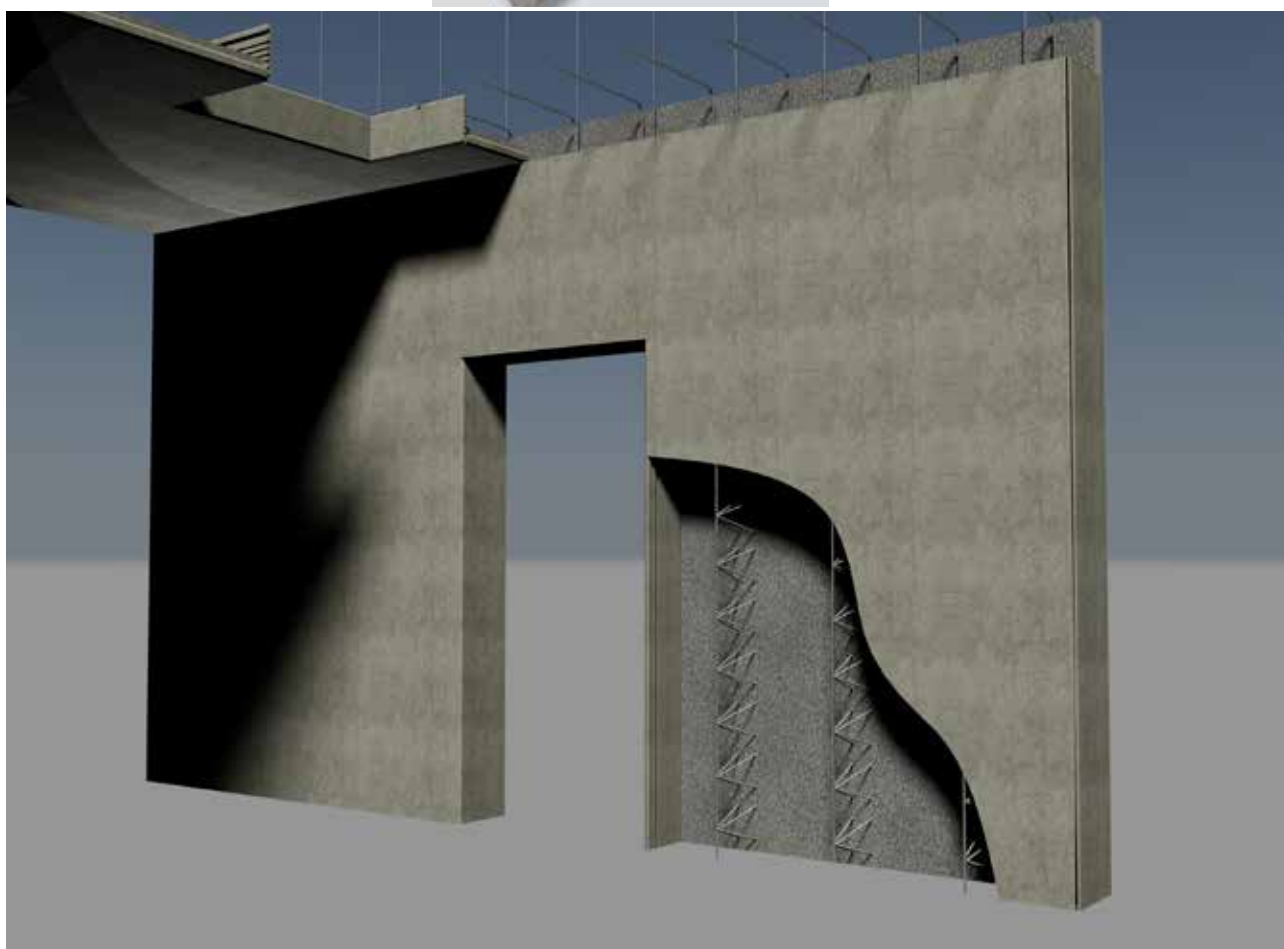
3.6.7 Edging and opening formwork

A permanent edging formwork made of extruded fibre-reinforced concrete specifically designed to be used with Double Wall to form the openings for doors and windows, ease the construction of concrete walls and to eliminate the need for any on site formwork. The smooth surface permanent edging formwork has:

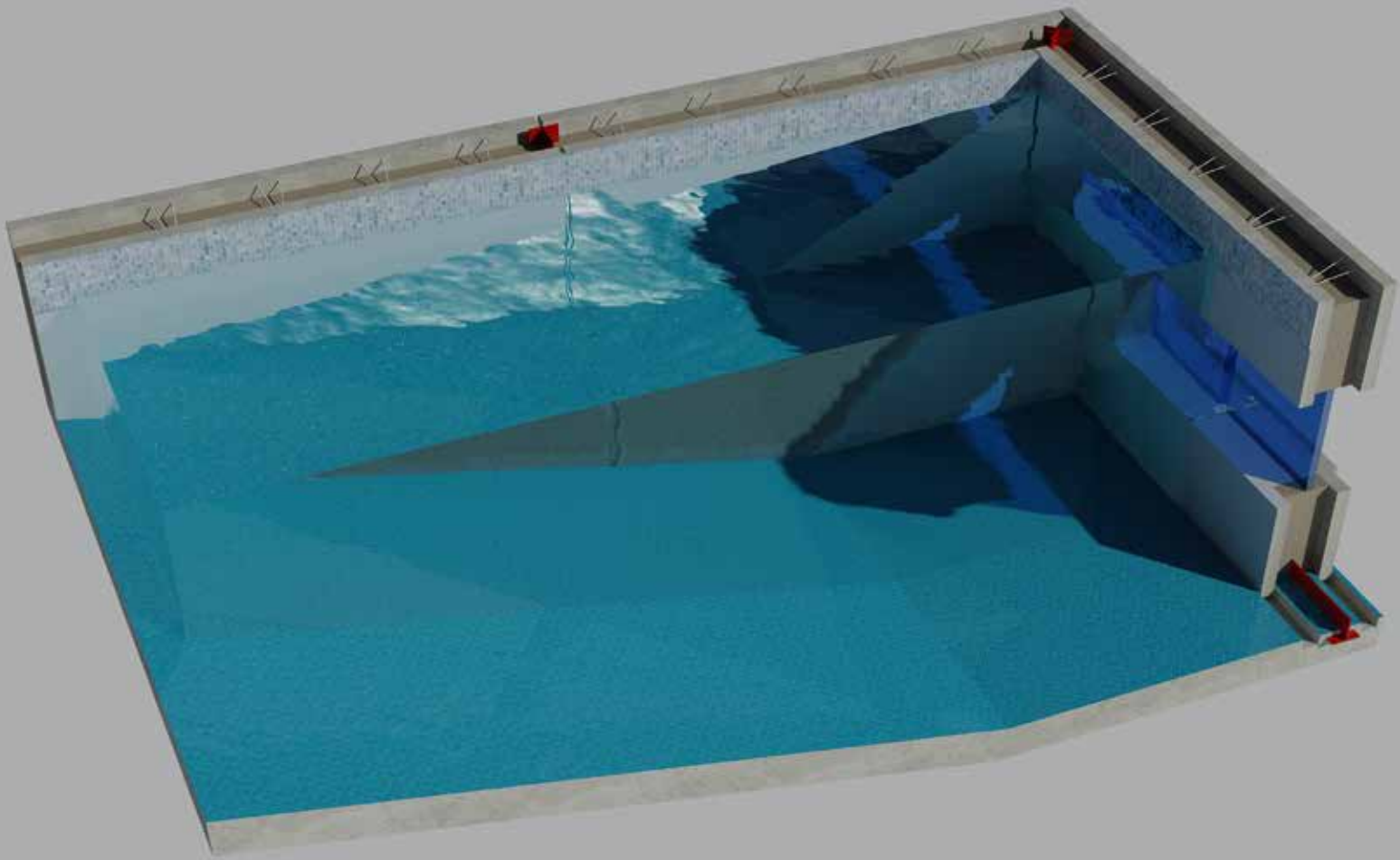
- Perfect bond with the Double Wall and in situ-concrete
- Fire resistant meeting the fire resistance period (FRP) for structural adequacy, integrity and insulation as specified in The National Construction Code – Building Code of Australia (NCC-BCA).
- High compressive strength
- Durability as the concrete structure



¹ The information including photos of permanent Edging Formwork is the property of Max Frank GmbH & Co.KG



Double Wall Water Tightness and Water Proofing



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This material has been prepared in the context of relevant Australian Standards, the National Construction Code (NCC) and the Building Code of Australia (BCA). Users should make themselves aware of any recent changes to these documents referred to therein and to local variations or requirements.

Double Wall Resistance to Water Penetration.

Austral Precast Double Wall can be designed and used in engineering construction where watertightness of the construction site is essential.

The resistance to water penetration of the Double Wall is maintained by the property of the Double Wall and installation techniques. Using construction water stops and a proper on-site drainage system are essential to maintain water tightness of the structure.

The Austral Precast Double Wall can be designed in accordance with relevant Australian Standard to achieve the required water tightness for various construction sites.

Assessment reports of Austral Precast Double Wall for resistance to water penetration can be obtained by contacting Austral Precast technical team.

The water tightness of the Double Wall can be tested, measured and assessed in accordance with the following Australian and international standards and test methods:

ASTM E96/E96M: Standard Test Methods for Water Vapour Transmission of Materials

This test method covers the determination of water vapour transmission (WVT) of materials through which the passage of water vapour may be of importance.

ASTM Test Method for Water Penetration and Leakage Through Masonry

This test method is designed to measure the water that penetrates into and through the masonry specimen and is collected at controlled laboratory environment.

This test method provides information that aids in evaluating the effect of four principal variables: materials, coatings, wall design and workmanship.

The test method can be used to measure water penetration through Austral Precast Double Wall having various thicknesses and compare its result with masonry walls.

AS/NZS 4347.1:1995, Method 1: Determination of Water Permeability

This Standard sets out the method of determining the water permeability of damp-proof courses and flashings.

A specimen held in a flange is subjected, on one surface, to a head of water under specified conditions and later examined to see whether any moisture has passed through to the other surface.

Water permeability of Austral Precast Double Wall is assessed in accordance with AS/NZS 4347. 1. The assessment can be done with or without applying water resistance components to the Double Wall.

AS 3735—2001 Concrete Structures for Retaining Liquids

This Standard specifies the requirements for concrete structures and members that include reinforcing steel or tendons, or both, used for retaining liquids at ambient temperature.

The Austral Precast Double Wall can be assessed for watertightness using test procedure and assessment criteria in accordance with AS 3735-2001.

Double Wall

Requirements to Water-Proofing and Drainage.

Weather-Proofing

Buildings must be constructed such that they are weather proof.

- The building must be detailed such that the wall panels do not crack, due to shrinkage, footing movement or other sources of building movement;
- The walls should be protected by a damp-proof course from moisture and salts that otherwise would rise through the wall by capillary action; and
- Any moisture that penetrates the building fabric, through the walls, roof, openings and the like should be collected, concentrated and removed using flashings.

Using water stop. Illustrations on the following pages of metal water stop¹ specifically designed to provide construction joint crack control and to seal joints (construction and butt joints) of concrete with high resistance to water penetration exposed to the following:

- Ground moisture and water without hydrostatic pressure.
- Seepage water which temporarily accumulated and water hydraulic pressure up to 0.2 MPa (20m water head).

Foundation Movements

Moisture movements in clay or similar soils result in expansion and contraction, causing the building to either "hog" or "sag". Trees roots suck the moisture out of the soil causing it to shrink.

Poor or badly maintained drainage systems allow a build up of moisture in the soil causing it to expand. Wall panels move sympathetically with deflected concrete footings, and the inclusion of articulation

joints will control the position and width of cracks.

In a wall exposed to the weather, articulation joints must incorporate flexible sealants, which should be regularly inspected and maintained. The steel reinforcement in Austral Precast Double Wall provides resistance to cacking in the most extreme cases of foundation movement.

Buildings should be regularly maintained, to ensure that:

- Trees have not grown too close to the footings;
- The plumbing system does not leak; and
- The stormwater drainage system effectively removes rainwater.

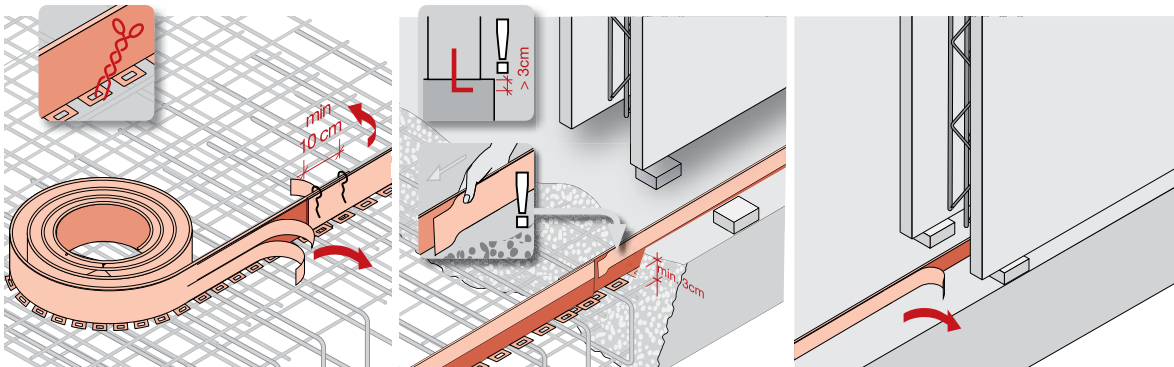
Drainage

Building must be correctly detailed to account for weatherproofing requirements, foundation movement, shrinkage and the efficient removal of rain water. Gutters and rainwater downpipes must be regularly inspected and kept clean, free of corrosion, and connected to a functioning stormwater system. Flashing must be secured and joints sealed with flexible sealant (e.g. silicone or similar), which should be renewed over time as they deteriorate.

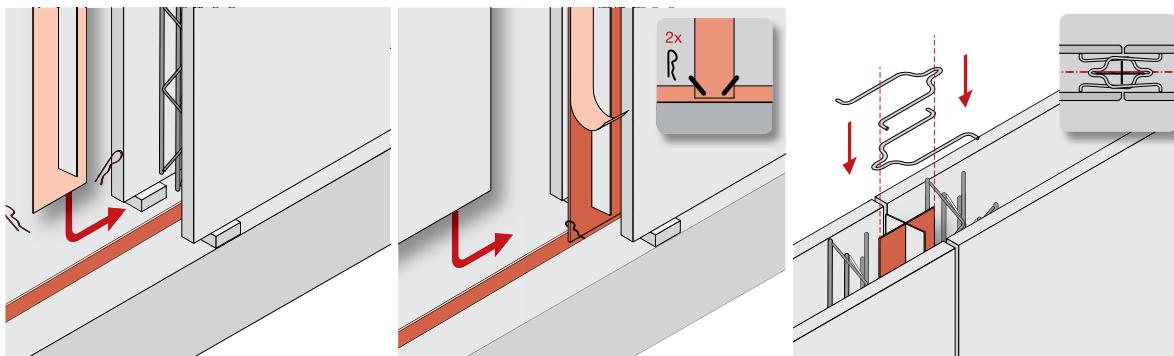
¹ The information including photos of water stop is the property of Max Frank GmbH & Co.KG



Horizontal Water Stop / Double Wall to Concrete Slab Joint



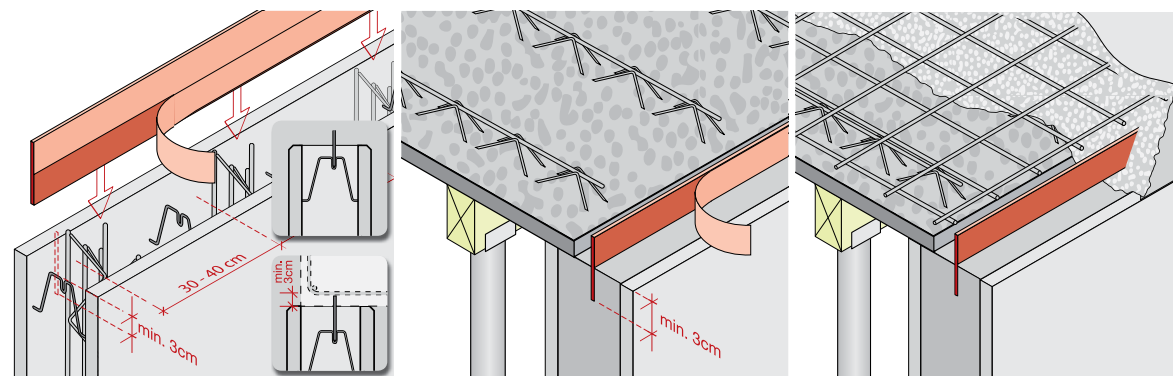
Vertical Water Stop / Double Wall to Double Wall Joint



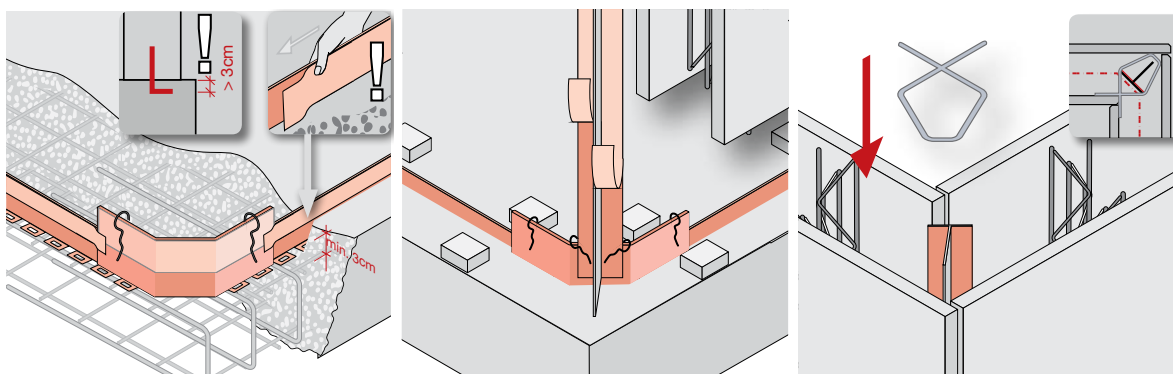
¹ The information including photos of water stop is the property of Max Frank GmbH & Co.KG



Horizontal Water Stop /Double Wall to Austral Deck Joint



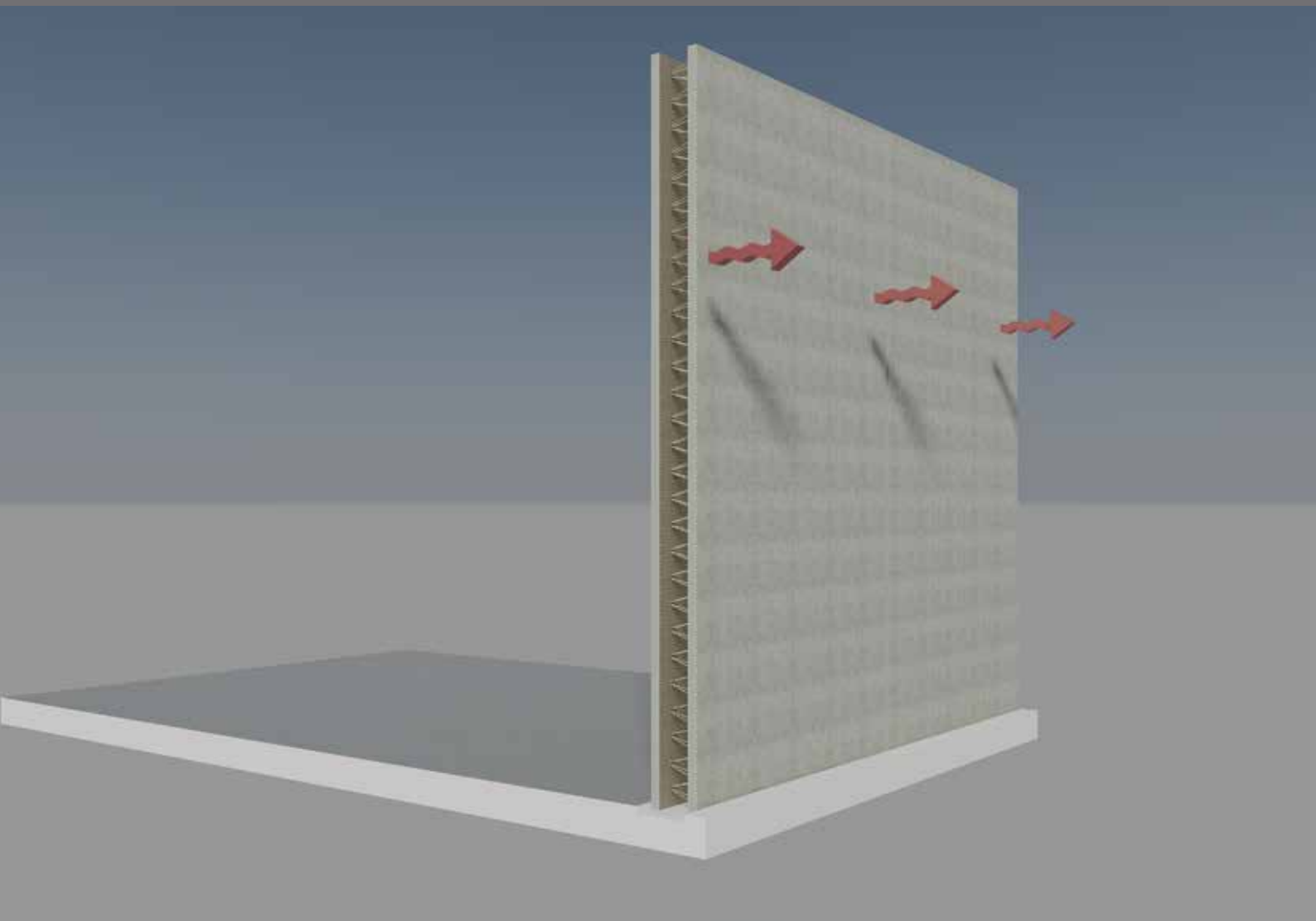
Corner Stop - Double Wall Vertical Corner Joint



¹ The information including photos of water stop is the property of Max Frank GmbH & Co.KG



Double Wall Fire, Thermal and Acoustics



The information contained in this document is provided as a general guide only and does not replace the need for the specification to be reviewed and checked by a qualified person in the field of concrete, energy, building construction, sound, design, services and/or fire.

This material has been prepared in the context of relevant Australian Standards, the National Construction Code (NCC) and the Building Code of Australia (BCA). Users should make themselves aware of any recent changes to these documents referred to therein and to local variations or requirements.

Double Wall Fire Performance.

Fire Resistance Periods for Insulation

Austral Precast Double Wall are solid with effective thicknesses in the range from 200 mm to 400 mm. The Fire Resistance Period (FRP)⁽¹⁾ for Insulation is not less than 240 minutes, in accordance with Australian Standard, Concrete Structures, AS 3600, Section 5 Design for fire resistance, Table 5.7.1.

Fire Resistance Periods for Structural Adequacy

The Austral Precast Double Wall Systems have Fire Resistance Period for Structural Adequacy shown in the table below.

The figure in the table below are generated in accordance with Australian Standard AS 3600, Section 5 Design for fire resistance, Table 5.7.2.

Any concrete wall must be designed to achieve a Fire Resistance Period for structural adequacy, integrity and insulation of not less than the required fire resistance level⁽²⁾ (FRL) as specified in The National Construction Code – Building Code of Australia, Specification 3. Type A Fire-Resisting Construction.

Note

Shell reinforcement (mesh) should not be considered as main reinforcement for the purpose of FRP for the structural adequacy. Moving this mesh away from the centreline of the shell will impede handling ability of the Double Wall. All main reinforcement will be placed inside the shell mesh, meaning that "as" will be > 50mm

Fire Resistance Period (FRP) for Structural Adequacy Austral Precast Double Wall							
Overall wall thickness mm	Shell thicknesses on side exposed to fire mm	Fire Resistance Period (FRP) for Structural Adequacy, mins					
		Axis distance ⁽³⁾	Loading	N*f / Nu = 0.35	Axis distance	Loading	N*f / Nu = 0.7
		a _s mm	Wall exposed on one side	Wall exposed on two sides	a _s mm	Wall exposed on one side	Wall exposed on two sides
220	70	40	180	180	35	120	120
260	70	55	240	240	55	180	120
320	70	55	240	240	60	240	180
370	70	55	240	240	60	240	240
390	70	55	240	240	60	240	240

Double Wall Thermal Performance.

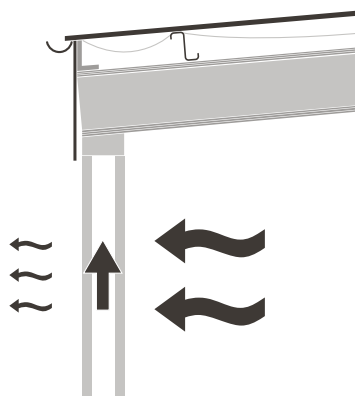
Thermal Mass and Comfort Zone

Austral Precast Double Wall has high thermal mass.

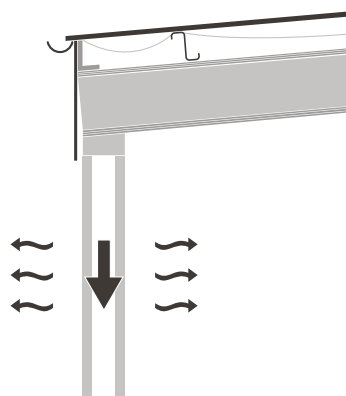
The high thermal mass in a building constructed with Austral Precast Double Wall will experience a heating and cooling cycle which contributes passively to achieve the comfort zone. The Double Wall will store the heat energy for an extended period, gradually releasing it over time. In winter, high thermal mass buildings will remain relatively warm, while in summer, they will remain relatively cool.

The high thermal mass will provide natural thermal comfort levelling out the temperature reducing the dependence on heating and cooling systems.

In winter, heat trying to pass through the Double Wall will become trapped in the wall and will slowly pass back into the room. In summer the reverse occurs. Heat trying to pass through the wall from the outside will become trapped in the wall and will slowly pass back out of the building.

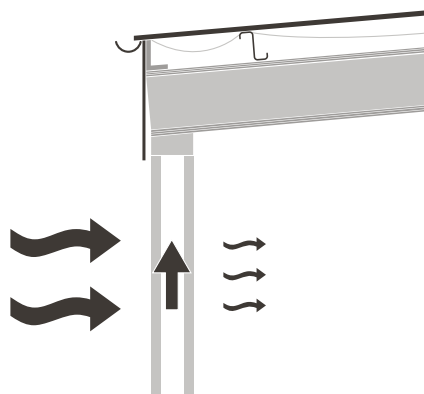


During the day
Heat trapped in the Double wall

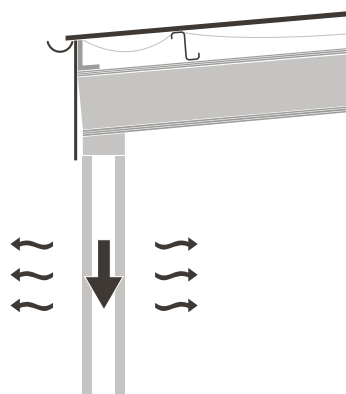


During the night
Heat passed back into the room

Winter



During the day
Passing heat will be trapped in the Double wall



During the night
Heat slowly passes back out of the building

Summer

Double Wall

Thermal Performance and Energy Efficiency.

Austral Precast Double Wall can be designed to achieve energy efficiency provisions as specified in The National Construction Code Volume Two – Building Code of Australia (BCA).

The thermal resistance coefficient “The R- Value” ⁽⁴⁾ of the Double Wall system is affected by the wall thickness (its mass) and the use of insulation materials and cladding.

The mass of the precast concrete Double Wall will be better thermal performance than its R Value alone would indicate.

The National Precast Concrete Association of Australia “NPCAA” has developed an R Value calculator that determines the “Mass enhanced R Value” of precast walls. A copy of the software tool can be downloaded via the NPCAA website.

<http://www.nationalprecast.com.au/r-value-calculator>

Thermal Properties, R- Value – Austral Precast Double Wall					
Thickness of Austral Precast Double Wall (mm)	200	240	300	360	400
	Thermal resistance, R- Value m².K/W				
Austral Precast Double Wall Without Lining or Additional Insulation					
External air film	0.04	0.04	0.04	0.04	0.04
Austral Precast Double Wall	0.14	0.17	0.21	0.25	0.28
Internal air film	0.12	0.12	0.12	0.12	0.12
Total	0.30	0.33	0.37	0.41	0.44
Austral Precast Double Wall With Plasterboard Lining and Additional Insulation					
External air film	0.04	0.04	0.04	0.04	0.04
Austral Precast Double Wall	0.14	0.17	0.21	0.25	0.28
50 mm Kooltherm phenolic board insulation	2.35	2.35	2.35	2.35	2.35
Internal plasterboard	0.06	0.06	0.06	0.06	0.06
Internal air film	0.12	0.12	0.12	0.12	0.12
Total	2.71	2.74	2.78	2.82	2.85
Austral Precast Double Wall With Plasterboard Lining and Additional Insulation					
External air film	0.04	0.04	0.04	0.04	0.04
Austral Precast Double Wall	0.14	0.17	0.21	0.25	0.28
80 mm Kooltherm phenolic board insulation	3.80	3.80	3.80	3.80	3.80
Internal plasterboard	0.06	0.06	0.06	0.06	0.06
Internal air film	0.12	0.12	0.12	0.12	0.12
Total	4.16	4.19	4.23	4.27	4.30

Double Wall Acoustic Performance.

Austral Precast Double Walls are solid with effective thicknesses in the range from 200 mm to 400 mm.

The weighted sound reduction Index (R_w) ⁽⁵⁾ of Austral Precast Double Wall and its sound insulation effectiveness is not less than $R_w + C_{tr}$ of 50 dBA complying with the minimum requirements of the National Construction Code (NCC) Sound Attenuation Provisions, Building Code of Australia (BCA).

NCC Volume One Specification F5.2 Table 2 states that walls 150 mm thick concrete panel achieves an $R_w + C_{tr}$ ⁽⁶⁾ not less than 50 dBA. Therefore all Austral Precast Double walls exceed the minimum NCC requirements.

Definitions and References

1. Fire resistance period (FRP)
Time, in minutes, for a member to reach the appropriate failure criterion (i.e., structural adequacy, integrity and/or insulation) if tested for fire in accordance with the appropriate Standard. Source Australian Standards, Concrete Structures, AS3600-2009, Clause 5.2.5
2. Fire resistance level (FRL)
Fire resistance periods for structural adequacy, integrity and insulation, expressed in that order.
NOTE: Fire resistance levels for structures, parts and elements of construction are specified by the relevant authority, e.g., in the Building Code of Australia (BCA). Source Australian Standards, Concrete Structures, AS3600-2009, Clause 5.2.4
3. The Australian Standard – Concrete structures, AS 3600 Clauses 1.6.3.6. and 5.2.2 defines Axis distance a_s as: "Axis distance – Distance from the centre-line axis of a longitudinal bar or tendon to the nearest surface exposed to fire".
4. The R-value of a substance is its direct measure of its resistance to transferring energy or heat; R Values are expressed using the metric units ($m^2.K/W$). The amount of degrees kelvin temperature difference required to transfer one watt of energy per one square metre of a substance.
5. The weighted sound reduction index (R_w)
A number used to rate the effectiveness of a soundproofing system or material. Increasing the R_w by one translates to a reduction of approximately 1db in noise level. The higher the R_w number, the better a sound resistance.
6. $R_w + C_{tr}$
Is the weighted sound reduction index with the addition of a low frequency sound correction factor C_{tr} . (a negative number). The material sound insulation effectiveness is displayed by the R_w/R_w+C_{tr} values together.

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