January 2021 Edition

Residential Design Manual for FORMPRO® Wall System

Think FASTER | Think STRONGER | Think INSULATED

FORMCRAFT Design Manual
Leading Sustainable Construction

Design Manual Editions

Current:

January 2021 Edition

Superceded:

September 2015 Edition - Vertical System

August 2015 Edition - Vertical System

August 2014 Edition - Vertical System

June 2014 Edition

March 2014 Edition

2013 Edition

Release N - Issued 1/3/2013

Release M - Issued1/6/2011

Older Editions

Please check www.formcraft.com.au regularly to ensure that you are using the most up-to-date edition.

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INTRODUCTION

INTRODUCTION

The FormPro® wall system is a permanent formwork system for insitu reinforced concrete structures that are fast, insulated and economical. The wide range of FormPro® wall models meet fire, acoustic, thermal and structural code requirements.

Along with the vast utility of structural concrete walls and insulation for energy efficient homes, the FormPro® wall system is fast to construct and easy to install for hands-on owner builders. FormPro walls® are great for many applications including external walls, load bearing walls, fire rated zero-lot boundary walls, retaining walls, pool walls, theatre walls, cyclone-rated strong room walls and many others.

The permanent wall panels arrive to site flat-packed and are connected together with a plastic connection system. The connectors can vary in width depending on the structural requirements for the project. The panels are stood in place, both vertical and horizontal reinforcement is placed as required and the wall is completed by filling the panels with concrete. Once complete, the walls act as reinforced concrete walls that comply with AS 3600 Concrete structures.

The FormPro® wall system can utilise the following panel options on one or both sides of the forms:

1. 60mm Expanded Polystyrene (EPS) panels (product code "E")
2. 6mm Rebated Fibre Cement (FC) panels (product code "F")

FormPro® EE **FormPro® EF / FE** **FormPro® FF**

FormPro® Wall Model / Panel Combinations

These permanent and interchangeable formwork panels enable construction of walls with a range of R values, sound transmission coefficients, fire ratings, finishes and concrete thicknesses for different structural applications.

This manual has been prepared to assist in the detailing of the FormPro® walling system. It provides a basis from which to work, but does not replace the services of professional consultants on specific projects.

Formcraft provides technical support throughout the design and construction process to ensure quality project outcomes.

Advantages

FormPro® is a sustainable wall system that is fast to construct, provides cyclonic resistance, delivers high energy efficiency and creates a quiet, comfortable interior environment.

Speed/Cost Savings

Formcraft's advanced concrete forming technology also delivers proven savings in labour costs through its rapid construction technique. The pre-finished panels offer substantial savings in terms of scaffolding and also negate the need for additional finishing trades. Additional cost savings are derived from earlier occupancy and low maintenance environments.

The lightweight and flat packed design enables convenient on-site assembly and the panels are less expensive to transport, making them ideal for use in remote locations.

Strength

Nothing rivals steel-reinforced concrete for strength and stability. Reinforced concrete walls are known to withstand much stronger weather conditions than other construction systems. Use of the FormPro® wall system results in a solid, stable and durable structure.

Sustainable/Green Building

FormPro® walls allow architects and designers to create buildings that use fewer natural resources and provide ongoing energy savings for the project. FormPro® walls:

- Provide substantial reductions in heating and cooling costs because of the effective R-value (thermal resistance level) of up to R3.6
- Allow any waste produced to be 100% recyclable
- Are manufactured using no HCFCs or CFCs during the manufacturing process
- Create structures that last longer and require less maintenance.

When the FormPro® wall system is incorporated into a project, its energy efficiency and material properties can help a project qualify for superior performance under the new Section J requirements of the BCA.

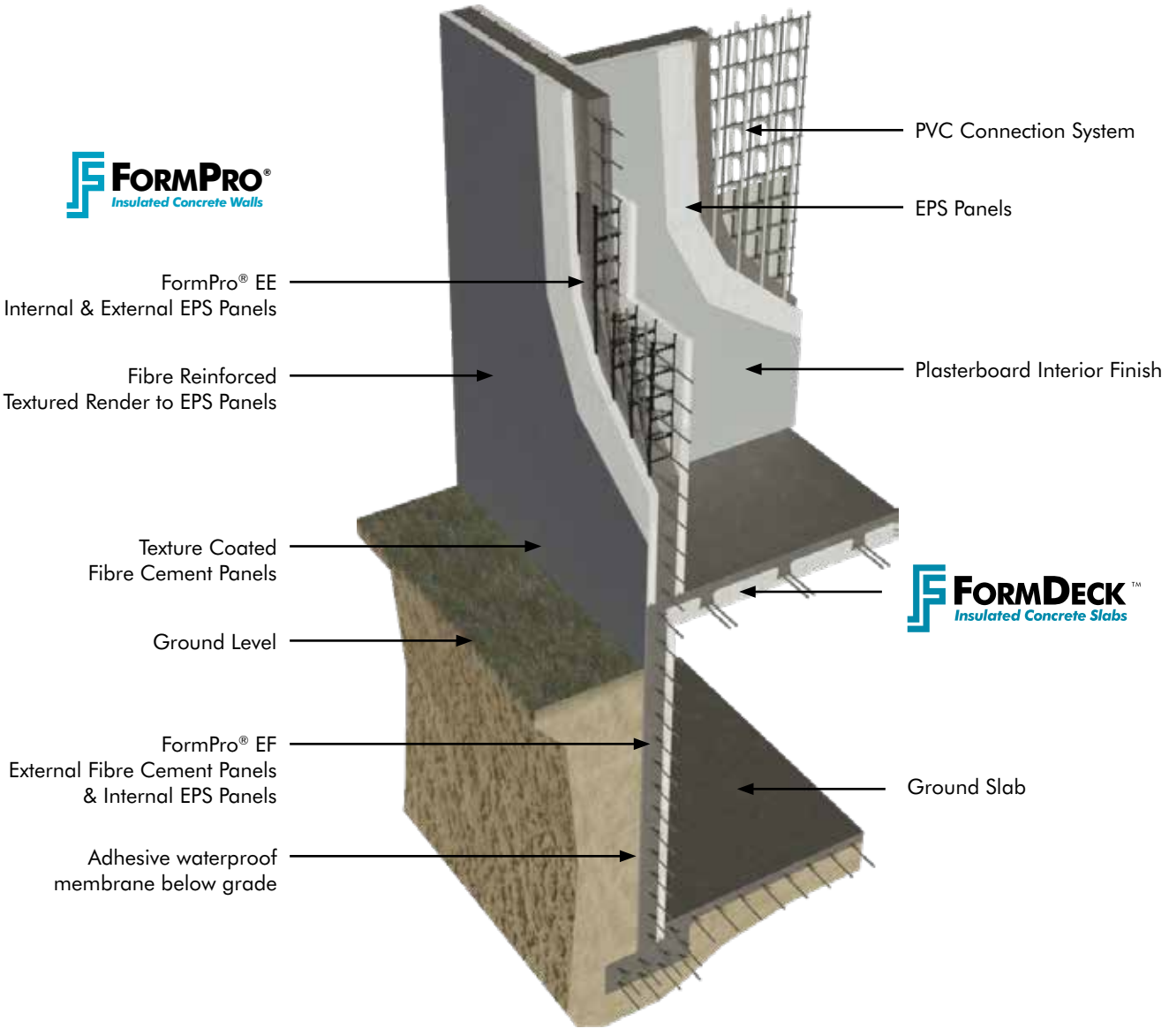
FORMPRO® CHARACTERISTICS

The FormPro® panels are designed to function as the formwork for concrete walls. The formwork stays in place on the exterior and interior face of the wall assembly, and also serves as the substrate for exterior and interior finishing systems. When concrete is poured into the cavity between the formwork, a solid, flat, cast-in-place and steel-reinforced concrete wall is formed.

The concrete cavity thickness can be easily varied by using panel connectors of different widths to provide for different structural requirements.

FormPro® walls are used in commercial and residential construction for external and internal, load bearing, above grade and below grade walls. Specific applications include basement and under-croft walls, insulated exterior walls, inter-tenancy walls, sheer walls, stem walls and lift shaft and stairwell applications.

Product literature, technical information, CAD/BIM details, specifications and product samples are available upon request.



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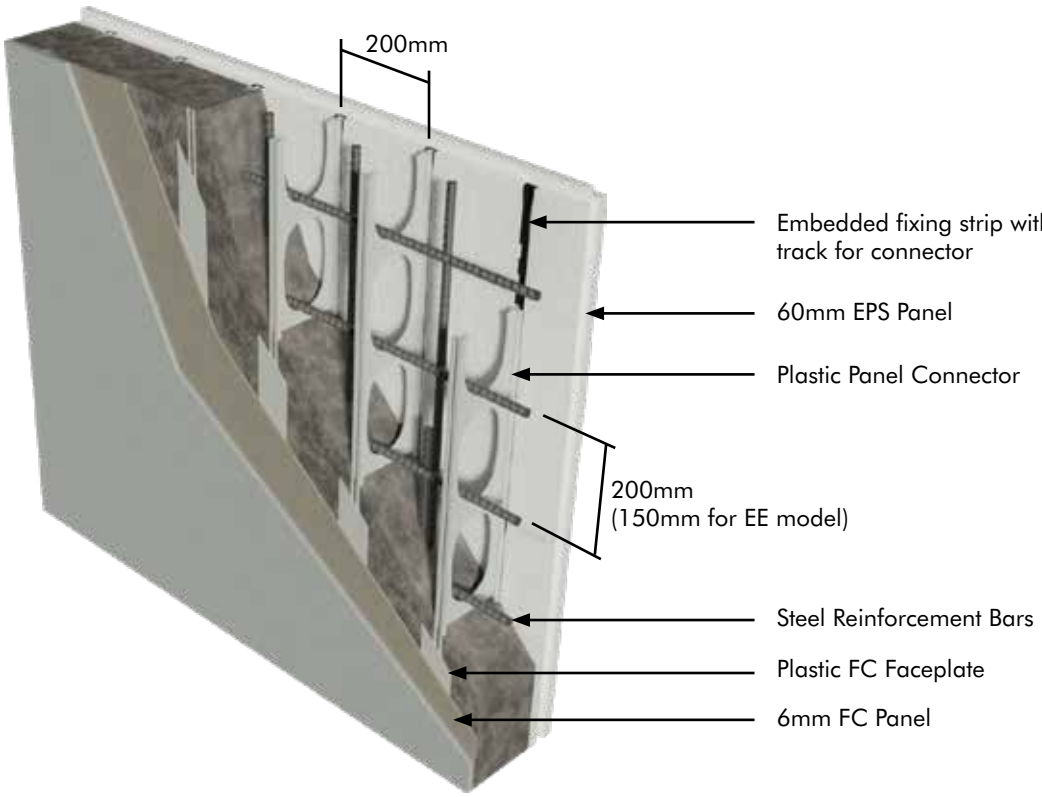
FORMPRO® CHARACTERISTICS

All FormPro® panels are delivered flat packed to site ready to assemble. The type and size of panels and connection system is determined by structural requirements, thermal, fire and sound rating requirements and the aesthetic preference of the designer or end client.

FormPro® is a modular form that comprises 2 opposing panels. The EPS (expanded polystyrene) panels are designed with tongue and groove joints for ease of assembly. Each panel can be either 60mm EPS or 6mm Fibre Cement. These panels are interchangeable and are held together by plastic connectors spaced at 200mm horizontal centres.

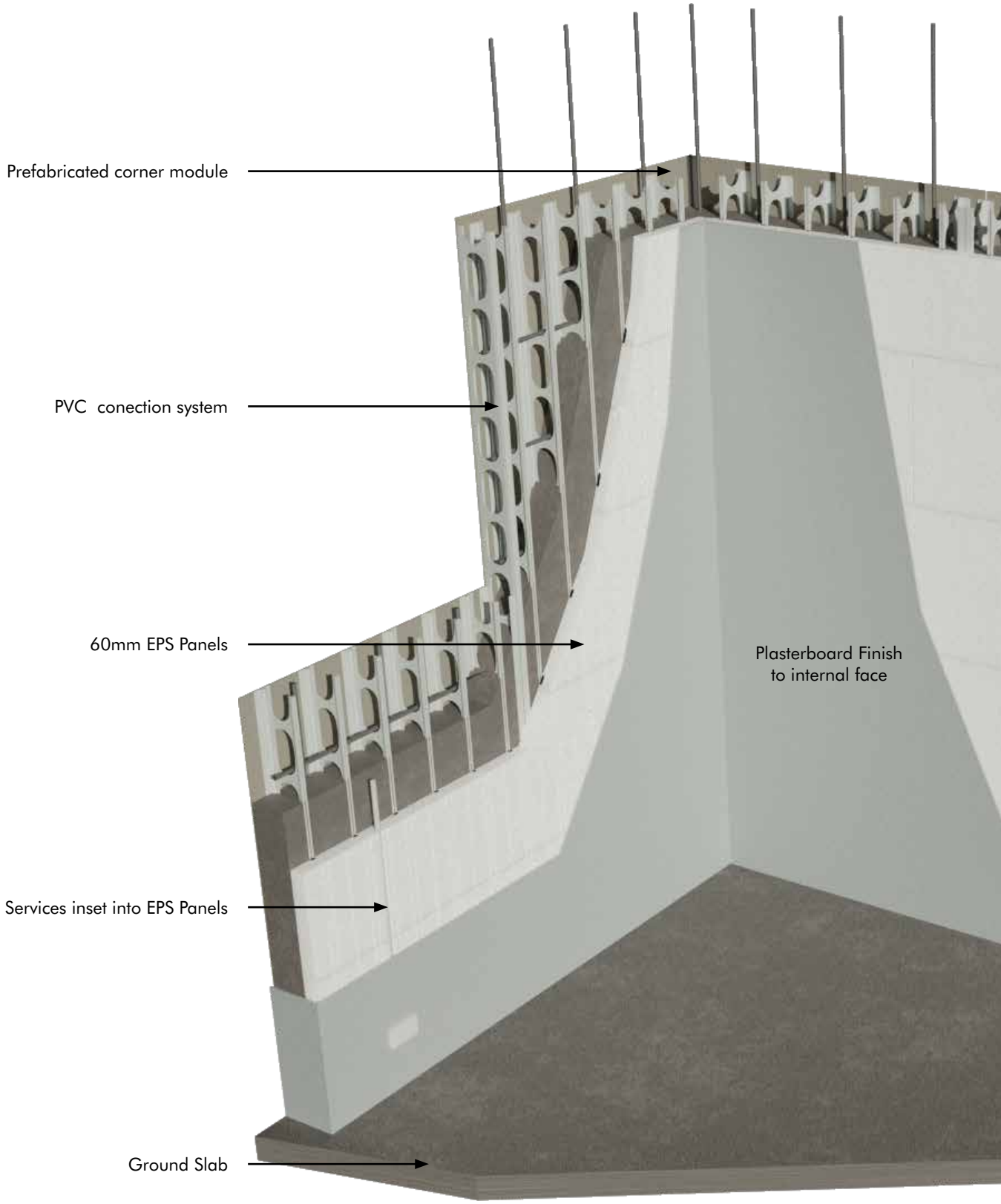
The flat panels are easily assembled into forms by inserting banks of connectors between panels. The connectors also provide loose fit horizontal rebar chairs at different positions to allow for multiple rebar positions to achieve the most efficient structural design. Vertical rebar spacing should be designed in increments of 200mm on centre. Horizontal rebar should be designed in increments of 150mm (FormPro® EE) or 200mm (FormPro® EF/FF) on centre to coincide with the height of the chairs.

FormPro ET Wall Module



FORMPRO® TYPICAL LAYOUT

Illustrative Features of the FormPro® FE Wall System



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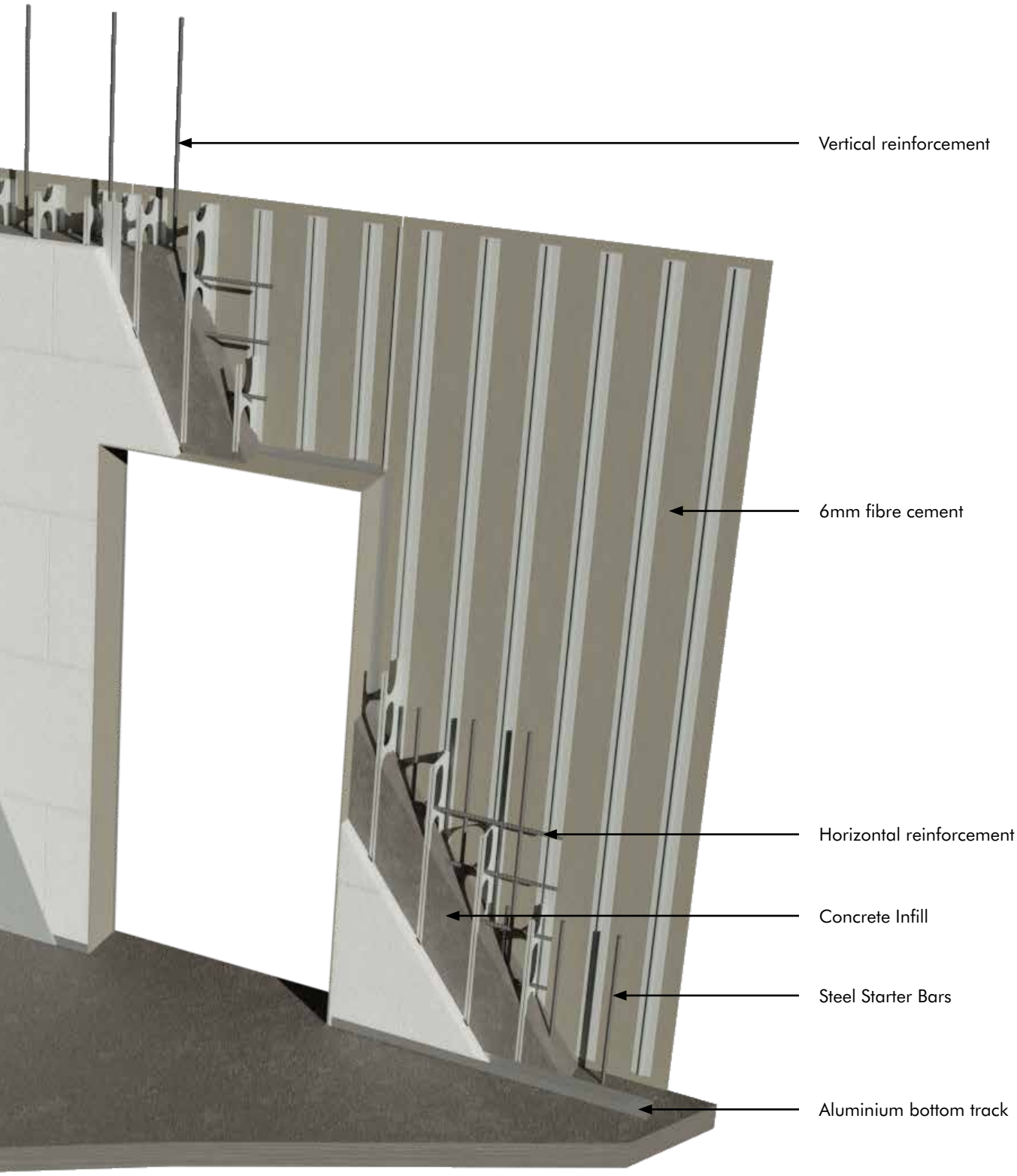
FORMPRO® TYPICAL LAYOUT

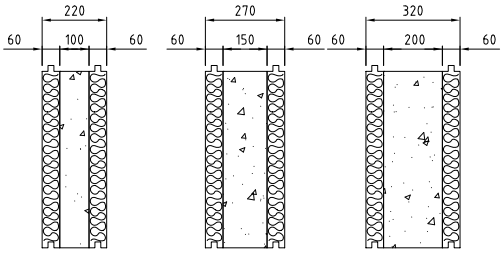


NOTES

APPLICATIONS

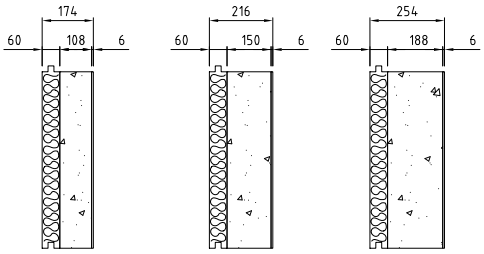
FORMPRO® WALL SELECTION GUIDE

FORMPRO® EE



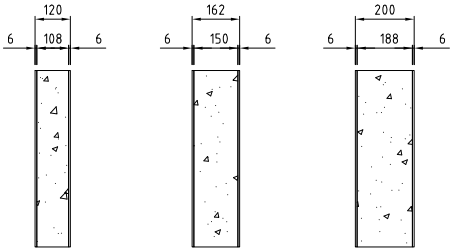
EE220 EE270 EE320

FORMPRO® EF



EF174 EF216 EF254

FORMPRO® FF



FF120 FF162 FF200

MODEL NO.	WALL THICKNESS	CONC. THICKNESS	FORMWORK MATERIAL	FIRE	THERMAL	ACOUSTICS
				FRL	R-Value	$R_w + C_{tr}$
EE220	220mm	100mm	60mm EPS/60mm EPS	90/90/90	3.5m².K/W	56
EE270	270mm	150mm	60mm EPS/60mm EPS	180/180/180	3.5m².K/W	59
EE320	320mm	200mm	60mm EPS/60mm EPS	240/240/240	3.6m².K/W	62
EF174	174mm	108mm	60mm EPS/6mm FC	90/90/90	1.86m².K/W	50
EF216	216mm	150mm	60mm EPS/6mm FC	180/180/180	1.86m².K/W	54
EF254	254mm	188mm	60mm EPS/6mm FC	240/240/240	1.87m².K/W	57
FF120	120mm	108mm	6mm FC/6mm FC	120/120/120	0.25m².K/W	46
FF162	162mm	150mm	6mm FC/6mm FC	180/180/180	0.25m².K/W	50
FF200	200mm	188mm	6mm FC/6mm FC	240/240/240	0.25m².K/W	54

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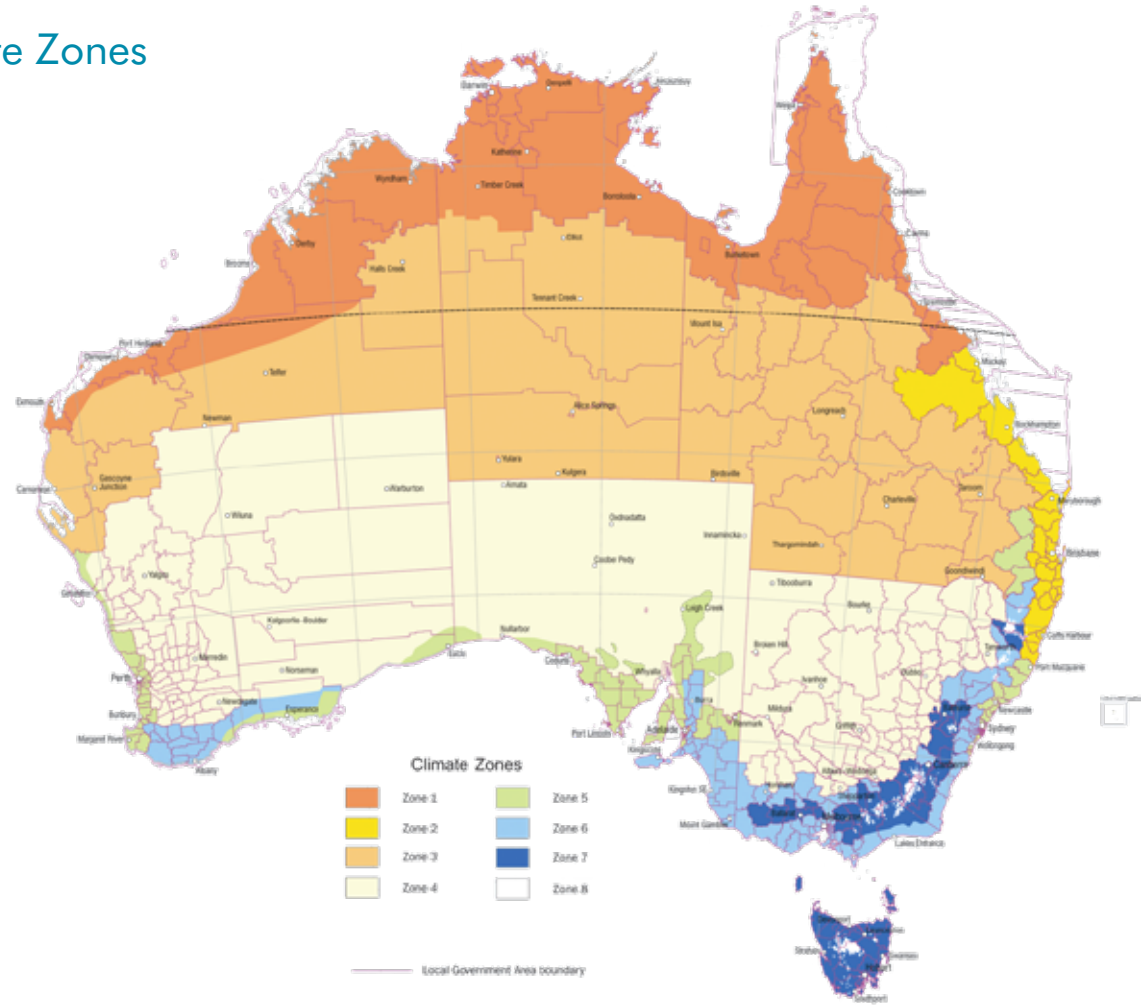
Climate Zones



1 High humid summer, warm winter
2 Warm humid summer, mild winter
3 Hot dry summer, warm winter
4 Hot dry summer, cool winter
5 Warm temperate
6 Mild temperate
7 Cool temperate
8 Alpine

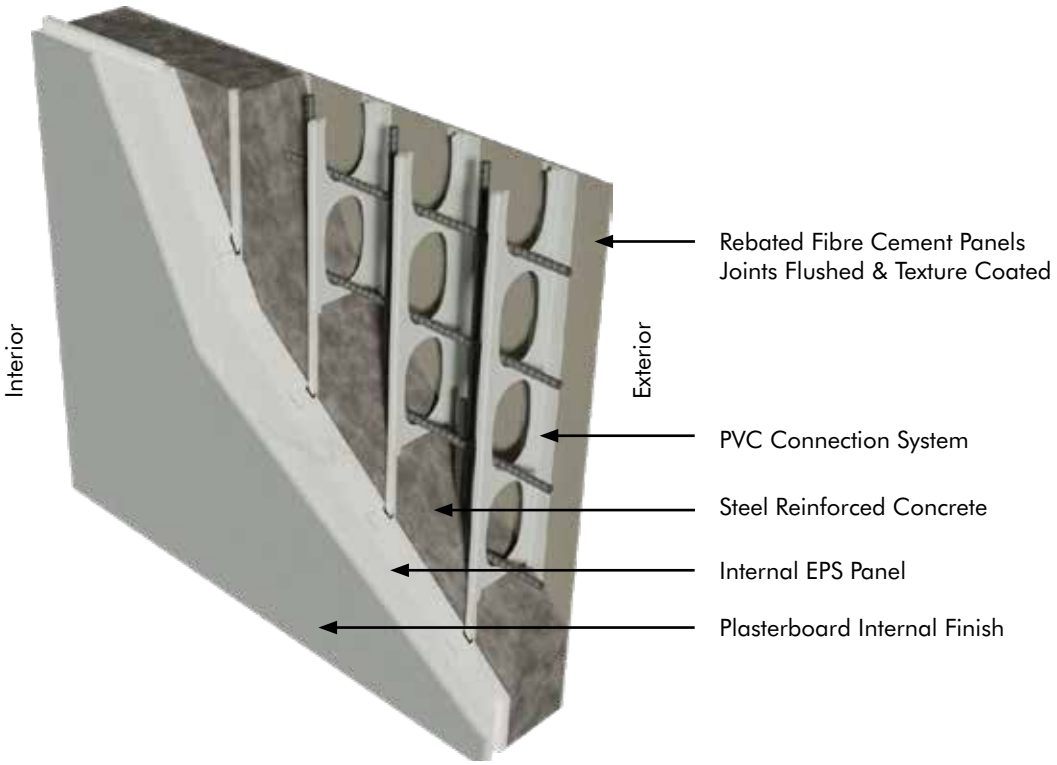
Building Classes

Class 1	Single or Small Dwellings.
Class 2	Residential Building containing 2 or more sole occupancies.
Class 3	Residential Building for longterm/transient stays excluding classes 1 & 2 eg, Motel, Boarding House.
Class 4	Dwelling within a building included in classes 5,6,7,8 & 9.
Class 5	Commercial Building excluding classes 6,7,8 & 9.
Class 6	Retail Building for the sale of goods or supply of services.
Class 7a	Carpark.
Class 7b	Building for Storage/Display of goods for wholesale.
Class 8	Laboratory/Building for production or assembly of goods.
Class 9	Building of a Public Nature eg Healthcare, Assembly or Aged-care etc.

External Walls

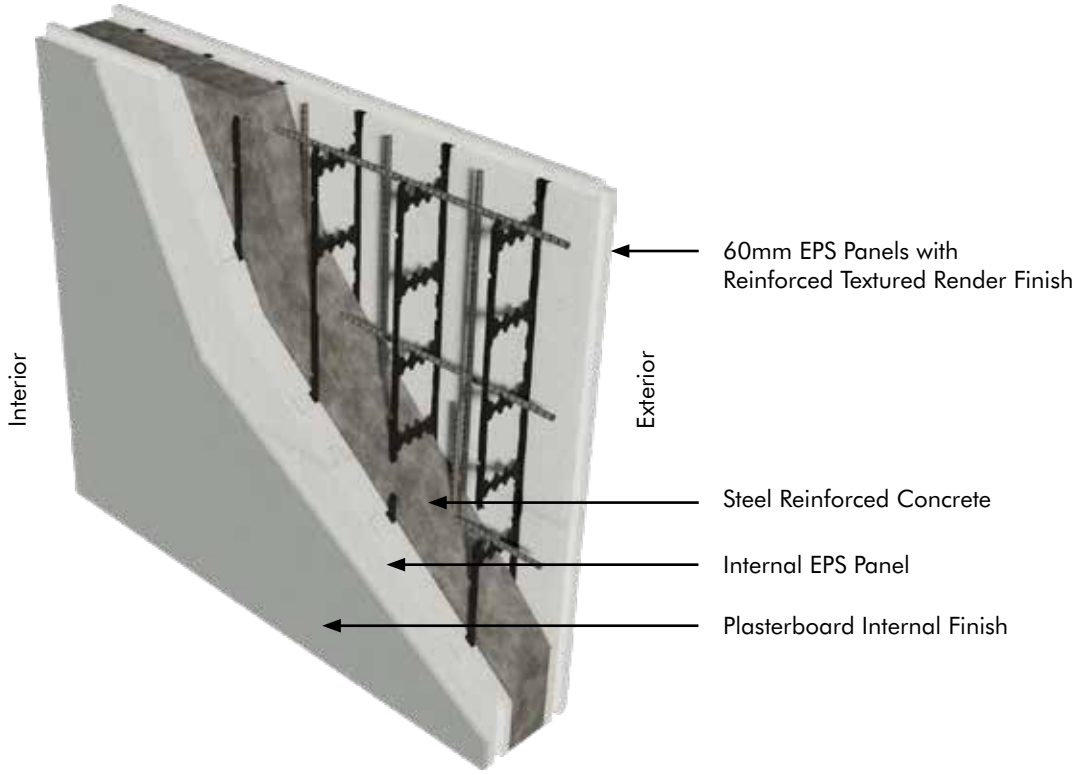
BCA REQUIREMENTS

CLASS OF BUILDING	REQUIRED FRL	BUILDING'S CLIMATE ZONE	REQUIRED R-VALUE	RECOMMENDED PRODUCT TO MEET REQUIREMENTS
1	N/A	1, 2, 3 &5 4 & 6 7 & 8	1.4 1.7 2.3	EE220 EE220 EE220
2	90/90/90	1, 2, 3 &5 4 & 6 7 & 8	1.4 1.7 2.3	EF174 EF174 EE220
5,7a &9	120/120/120	1, 2, 3 &5 4 & 6 7 & 8	1.4 1.7 2.3	EF216 EF216 EE270
6	180/180/180	1, 2, 3 &5 4 & 6 7 & 8	1.4 1.7 2.3	EF216 EF216 EE270
7b & 8	240/240/240	1, 2, 3 &5 4 & 6 7 & 8	1.4 1.7 2.3	EF254 EF254 EE320



EF174 Wall Model
(Typically used for zero lot boundary or bushfire prone areas)

External Walls (continued)



EE220 Wall Model
(Provides maximum insulation for energy efficient homes)

FORMPRO® WALL ALTERNATIVES

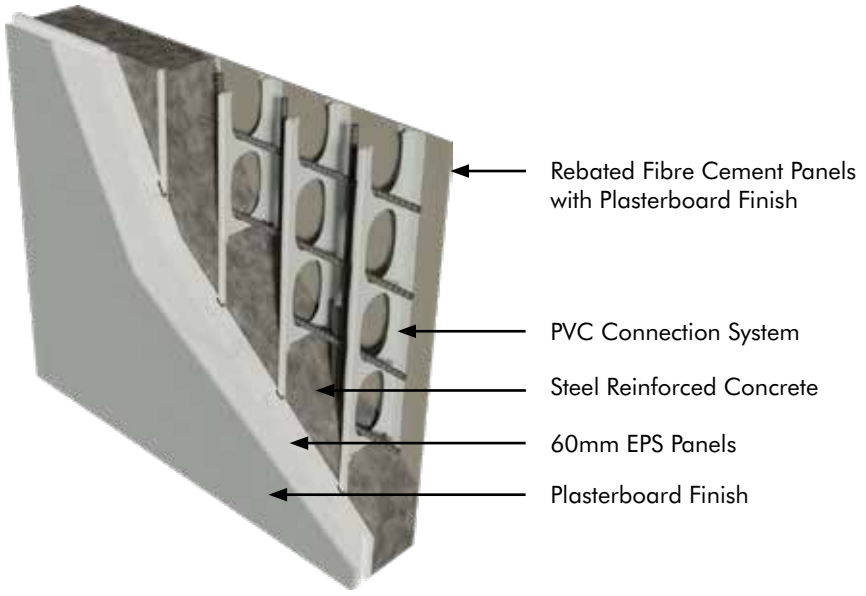
PRODUCT NUMBER	CONCRETE THICKNESS	WALL THICKNESS	FIRE	THERMAL	ACOUSTIC
			FRL	R-Value	$R_w + C_{tr}$
EE220	100mm	220mm	90/90/90	3.5m².K/W	56
EE270	150mm	270mm	180/180/180	3.5m².K/W	59
EE320	200mm	320mm	240/240/240	3.6m².K/W	62
EF174	108mm	174mm	90/90/90	1.86m².K/W	50
EF216	150mm	216mm	120/120/120	1.86m².K/W	54
EF254	188mm	254mm	240/240/240	1.87m².K/W	57

Inter-Tenancy Walls

Description: Walls separating sole occupancy units.

BCA REQUIREMENTS

WALL USE	REQUIRED FRL	REQUIRED $R_w + C_{tr}$	REQUIRED $D_{n,T,w} + C_{tr}$	RECOMMENDED PRODUCT
Habitable to Habitable	90/90/90	50	N/A	EF216
Habitable to Wet Area	90/90/90	50	45	EF216
Wet Area to Wet Area	90/90/90	50	45	EF216



EF216 Wall Model

FORMPRO® WALL ALTERNATIVES

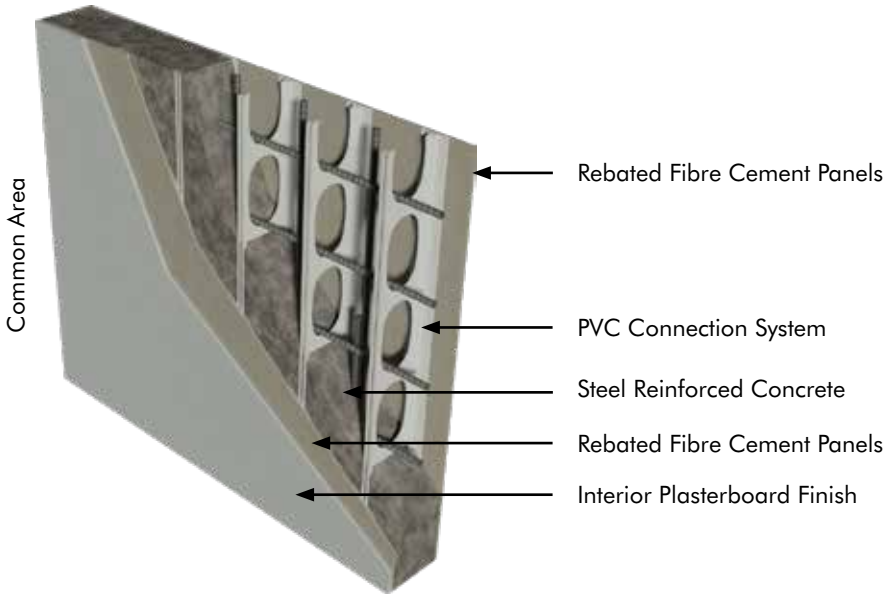
PRODUCT NUMBER	CONCRETE THICKNESS	WALL THICKNESS	FIRE FRL	THERMAL R-Value	ACOUSTIC $R_w + C_{tr}$
EE220	100mm	220mm	90/90/90	3.5m².K/W	56
EE270	150mm	270mm	180/180/180	3.6m².K/W	59
EE320	200mm	320mm	240/240/240	3.6m².K/W	62
EF174	108mm	174mm	90/90/90	1.86m².K/W	50
EF216	150mm	216mm	120/120/120	1.86m².K/W	54
EF254	188mm	254mm	240/240/240	1.87m².K/W	57

Lift, Stairwell & Service Shafts

Description: Walls separating shafts from common areas or sole occupancy units.

BCA REQUIREMENTS

WALL USE	REQUIRED FRL	REQUIRED $R_w + C_{tr}$	REQUIRED $D_{n,T,w} + C_{tr}$	RECOMMENDED PRODUCT
Lift Shaft	90/90/90	N/A	N/A	FF162
Stairwell Shaft	90/90/90	N/A	N/A	FF162
Service Shaft	90/90/90	25/40	N/A	FF162



FF162 Wall Model

FORMPRO® WALL ALTERNATIVES

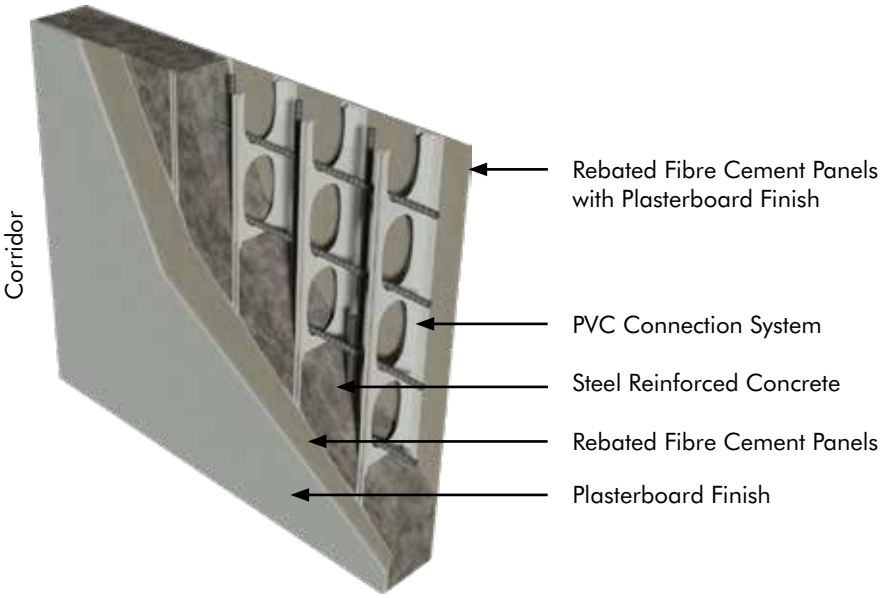
PRODUCT NUMBER	CONCRETE THICKNESS	WALL THICKNESS	FIRE	THERMAL	ACOUSTIC
			FRL	R-Value	$R_w + C_{tr}$
EF174	108mm	174mm	90/90/90	1.86m².K/W	50
EF216	150mm	216mm	120/120/120	1.86m².K/W	54
EF254	188mm	254mm	240/240/240	1.87m².K/W	57
FF120	108mm	120mm	120/120/120	0.25m².K/W	46
FF162	150mm	162mm	180/180/180	0.25m².K/W	50
FF200	188mm	200mm	240/240/240	0.25m².K/W	54

Corridor Walls

Description: Walls separating sole occupancy units from common areas and stair shafts.

BCA REQUIREMENTS

WALL USE	REQUIRED FRL	REQUIRED $R_w + C_{tr}$	REQUIRED $D_{n,T,w} + C_{tr}$	RECOMMENDED PRODUCT
Common Area Separation	90/90/90	N/A	N/A	FF120
Stair Shaft Separation	90/90/90	N/A	N/A	FF120



FF162 Wall Model

FORMPRO® WALL ALTERNATIVES

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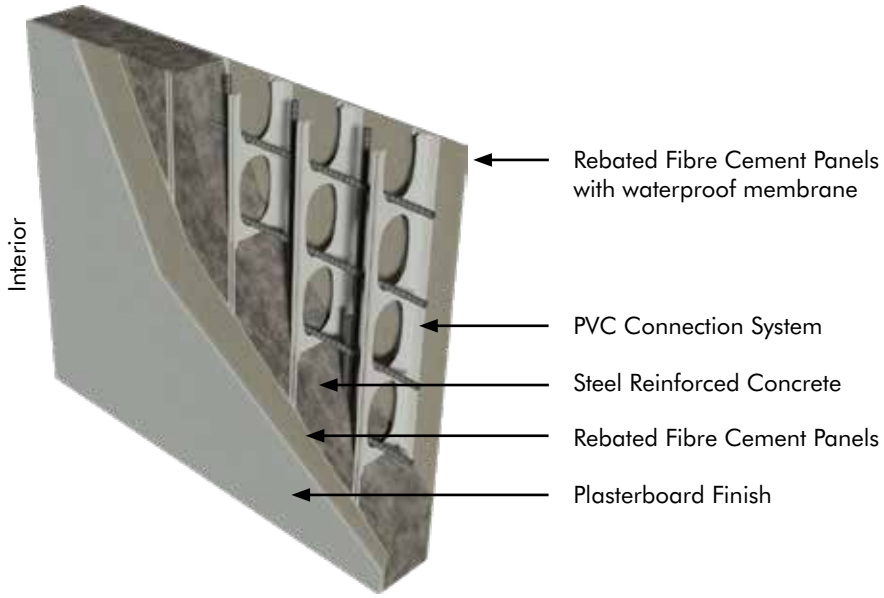
EF216	150mm	216mm	120/120/120	1.86m².K/W	54
EF254	188mm	254mm	240/240/240	1.87m².K/W	57

Retaining & Basement Walls

Description: Walls to retain earth or similar. eg Basements, etc.

BCA REQUIREMENTS

WALL USE	REQUIRED FRL	REQUIRED $R_w + C_{tr}$	REQUIRED $D_{n,T,w} + C_{tr}$	RECOMMENDED PRODUCT
Retaining Wall	Varied according to application	N/A	N/A	FF162



FF162 Wall Model

FORMPRO® WALL ALTERNATIVES

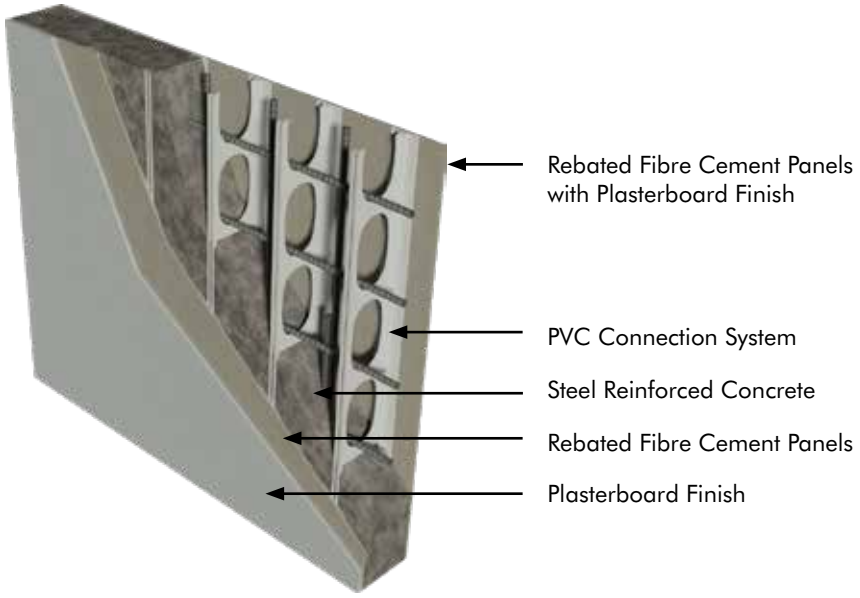
PRODUCT NUMBER	CONCRETE THICKNESS	WALL THICKNESS	FIRE FRL	THERMAL R-Value	ACOUSTIC $R_w + C_{tr}$
EF216	150mm	216mm	180/180/180	1.86m².K/W	55
FF162	150mm	162mm	180/180/180	0.25m².K/W	50
FF200	188mm	200mm	240/240/240	0.25m².K/W	54

Blade Walls

Description: Independant wall typically of achitectural or structural significance.

BCA REQUIREMENTS

WALL USE	REQUIRED FRL	REQUIRED $R_w + C_{tr}$	REQUIRED $D_{n,T,w} + C_{tr}$	RECOMMENDED PRODUCT
Blade Wall	Varied according to application	N/A	N/A	FF162



FF162 Wall Model

FORMPRO® WALL ALTERNATIVES

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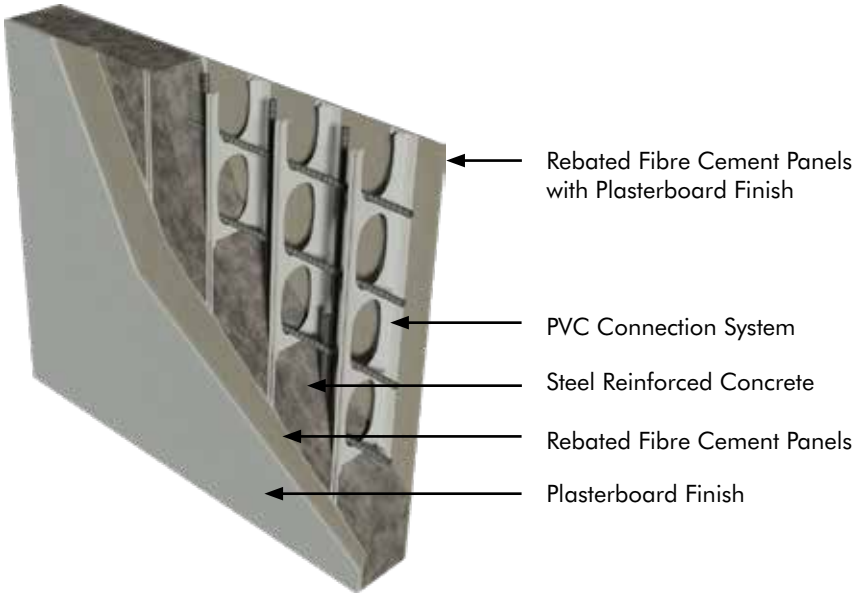
FF162	150mm	162mm	180/180/180	0.25m².K/W	50
FF200	188mm	200mm	240/240/240	0.25m².K/W	54

Internal Walls

Description: Structural walls within sole occupancy units.

BCA REQUIREMENTS

WALL USE	REQUIRED FRL	REQUIRED $R_w + C_{tr}$	REQUIRED $D_{n,T,w} + C_{tr}$	RECOMMENDED PRODUCT
Internal Wall	90/-/-	N/A	N/A	FF162



FF162 Wall Model

FORMPRO® WALL ALTERNATIVES

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			FRL	R-Value	$R_w + C_{tr}$
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EF216	150mm	216mm	180/180/180	1.86m².K/W	57
FF120	108mm	120mm	120/120/120	0.25m².K/W	46
FF162	150mm	162mm	180/180/180	0.25m².K/W	50
FF200	188mm	200mm	240/240/240	0.25m².K/W	54

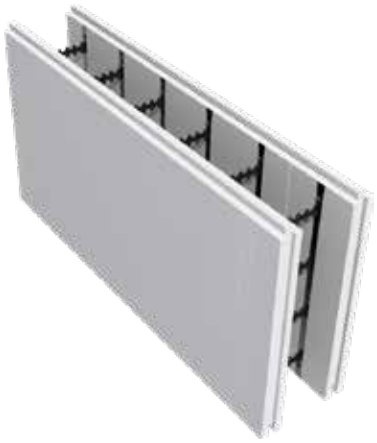
NOTES

ARCHITECTURAL

FORMPRO® PANEL TYPES & FINISHES

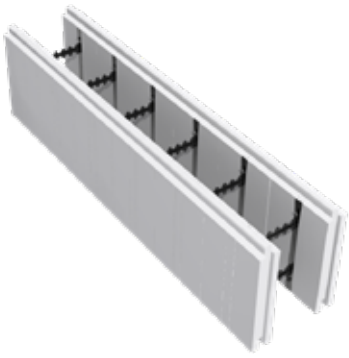
FormPro® EPS panels

Typical EPS panels 60mm thick, 600mm tall and 1200mm wide. EPS panels also come as half panels (300mm tall) and corner panels. Furring strips are embedded within the EPS panels 10mm below the surface to assist with the fixing of bracing and finishes. The position of each furring strip is marked on the exterior of each panel (double vertical groove). The long corner panel contains a vertical 30mm square hole that can receive a plastic insert to aid corner alignment.



EE Full Panel Block

EE Corner Panel Block



EE Half Panel Block

FormPro® Thin Panels

FormPro® thin panels are 6mm thick and are 1200mm wide with heights manufactured as required for a given project. Face-plates are adhered inside the 6mm panels at 200mm horizontal centres and joined via a polypropylene connector. Corner joins are supported by a propriety corner brace during pouring. The FormPro® EF/FF systems also uses an additional inter-panel connector to connect adjacent panels, prevent concrete leakage and create space to install services.

Exterior Finishes

Typical exterior finishes are:

1. A sample of cladding systems able to be fixed to FormPro® walls.
2. Rebated FC (Fibre Cement) panels with flushed joints and textured render
3. Exterior EPS panels with acrylic textured render system.

1. Cladding fixed to FormPro® wall system

2. Rebated FC flushed and beaded ready for rendering

3. EPS panels with acrylic textured render system

Rebated detail

Fibre cement panels can be supplied with a standard 30mm x 2mm rebate on the four edges of the panel. Joints are flushed and set before a textured render is applied to achieve a continuous surface finish.

Interior Finishes

The most common and cost effective interior finishing material used is plasterboard. Plasterboard can be applied directly to FormPro® walls using conventional drywall screws that are fixed into the furring strips, or with drywall screws and EPS compatible adhesives.

It is recommended that plasterboard is applied to internal FormPro® fibre cement walls to give a high level of internal finish.

Interior EPS Panels with screw fixed plasterboard

This can be achieve by one of three methods;

1. Discontinuous stud wall – used when impact sound abatement is required for inter-tenancy walls.
2. Plasterboard on battens – is used when there is a high level of service reticulation required in that section of walling.
3. Direct stick plasterboard – is used internally to achieve a high level of finish.

Level of Finish

The quality of the finish on walls depends on the straightness of walls, and the quality of the finishing system and the amount of glancing light projected on the wall surface. It is essential for designers and builders to determine the level of finish required before construction commences, otherwise it may not be possible to attain the desired finish level without extensive corrective measures. Generally FormPro® walls achieve Level 4 finish (as determined by AS2589.1) which is +/- 4mm tolerance across an 1800mm plane.

Glancing light
Glancing light is where the light from an artificial or natural source is nearly parallel to the surface. This condition exaggerates vertical joints and other imperfections making them more obvious. It is recommended designers give consideration to the level of finish required and eliminate potential problems due to glancing light.

External coating for Rebated Fibre Cement panels
It is recommended for external walls that an external textured render system be applied. It is important that the procedure from the chosen manufacturer must be followed. Good preparation of the panels by the surface applicator is critical to achieving quality finishes.

The procedure is as follows;

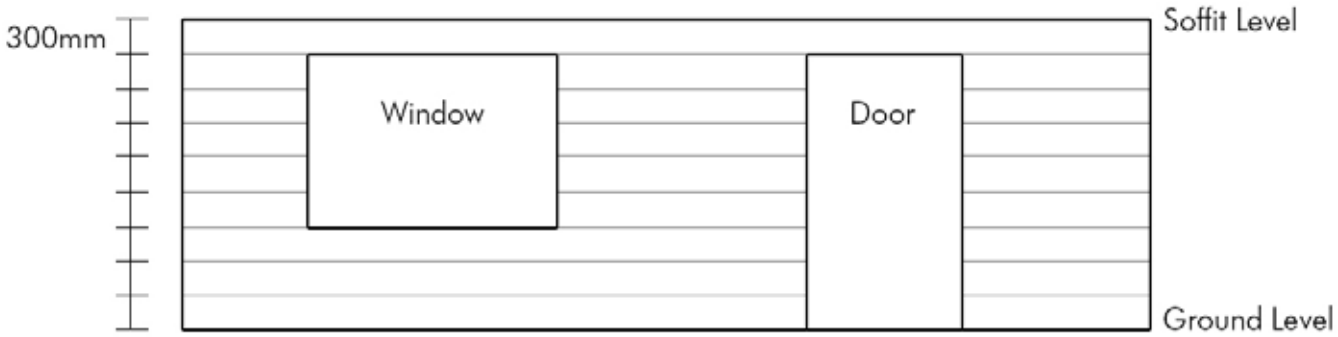
1. Screw holes or any other high points in the wall should be sanded or grinded back to provide a flat surface.
2. Panel joints should be primed and taped with a fibre glass mesh.
3. Jointing compound is applied by trowel to the panel joints.
4. Complete panel surface should be rendered with one or more coats to a thickness of 4-10mm to provide a flat surface.
5. The top coat should be a minimum be 2–3 mm thick trowel-on system and be designed to perform as a water resistant membrane.

Suppliers
The main suppliers of texture coating materials are;

Rockcote	Ph. 1800 267 737
Wattyl	Ph. 13 21 01
Dulux	Ph. 13 23 77
Taubmans	Ph. 13 16 86

EPS Courses & Dimensioning

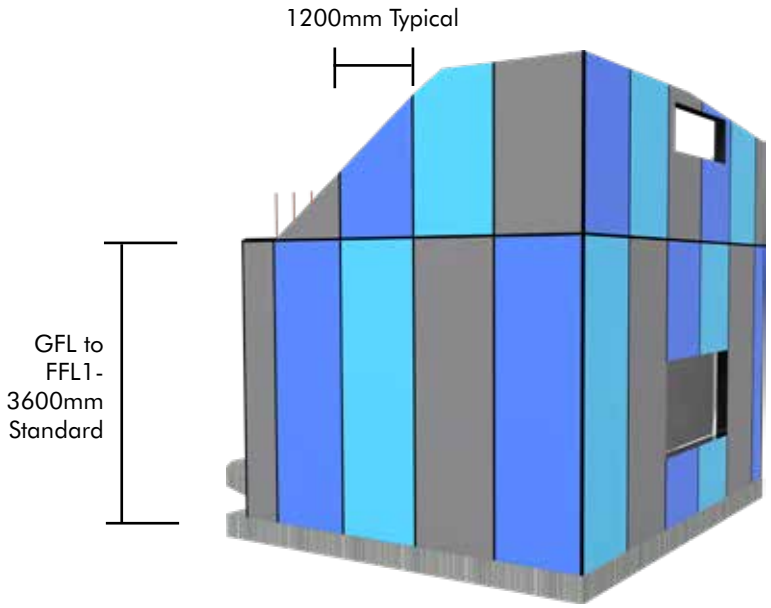
The most critical aspect of designing with FormPro® is that all vertical coursing heights for window sills, top of doors, top of windows and wall plate heights should be designed in 300mm increments. This coincides with minimum module heights of the EPS half block and connectors. An example is shown in the diagram below:



Typical coursing heights

Fibre Cement Panel Courses & Dimensioning

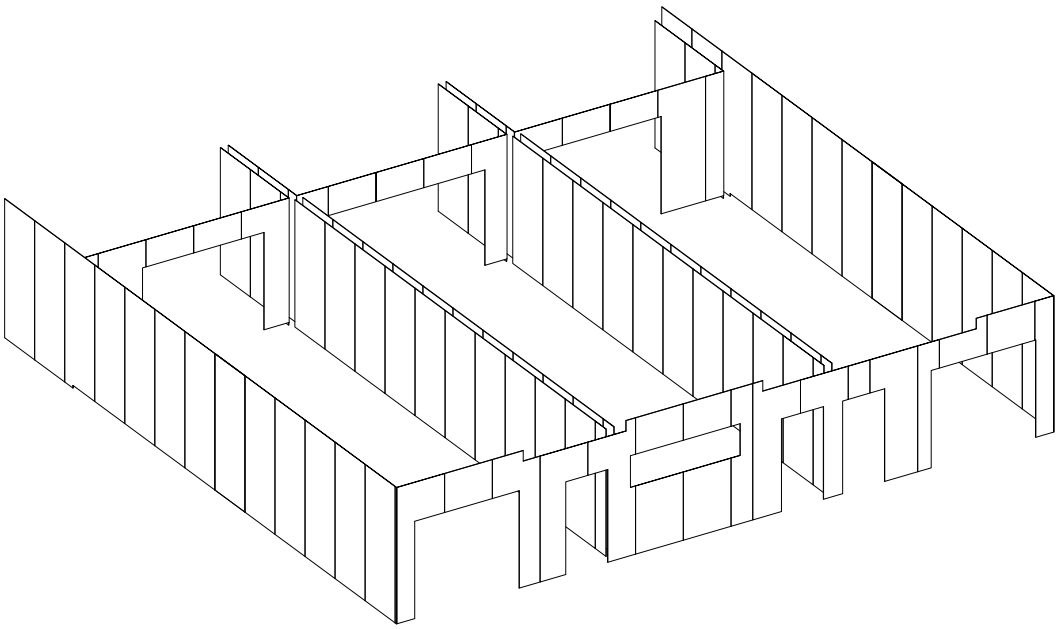
It is also important that the dimension from top of floor slab to the soffit level above is also in a 200mm vertical increment minimising waste and construction time.



Typical coursing heights for Thin panels

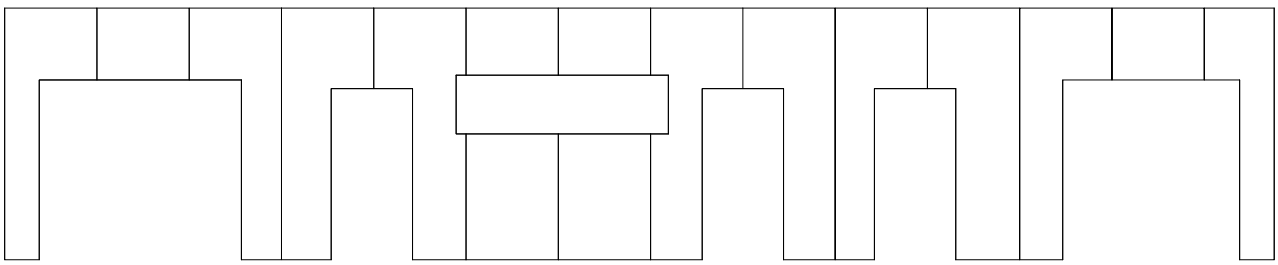
Panelisation for the FormPro® EF/FF System

A major feature of the FormPro® EF & FF systems is Formcraft's ability to pre-cut panels to dramatically reduce installation times. Each panel is shop drawn and labelled for easy onsite identification to assist chronological installation.



Panelised Floor of Example Development

A panelised wall schedule of the project is produced for client sign off before the panels are manufactured.



Wall surface extracted and panels ready for production

Doors and Windows

Formcraft recommends placing the tops of doors and the heads and sills of windows at the top of course heights (i.e. in 300mm vertical increments), to save both labour and materials by eliminating the necessity of cutting the forms horizontally.

Door and window frames may be placed as close to a corner as needed as long as the wall is structurally adequate. A 400mm offset works best with the EPS corner panels. It is necessary to allow enough wall space for proper functioning of the door or window. The spacing between two or more doors or windows is determined by the need for the structural design to allow for adequate steel reinforcement placement.

Windows are detailed at the rear, here; | EE(p61) EF(p81) FE(p99) FF(p117)

Windows and door frames can be installed into the formed openings according to the design typically by fixing an L angle into the concrete to line the opening. The door and window frames are then riveted in place to the angle from the inside of the building. Formcraft recommends double glazed windows and doors to maintain optimal energy efficiency.

With hinged doors, the orientation of the hinge must be considered due to the thickness of the wall in comparison to the door. Exterior hinged doors that are hung to the FormPro® wall should be installed so that the hinge is flush with the inside wall.

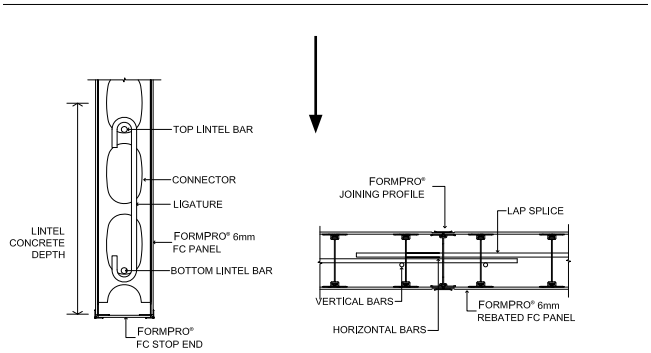
Various fire door options are detailed here; EE(p60) ET(p80) TE(p98) TT(p116)

Electrical, Mechanical and Plumbing

Since the FormPro® wall ultimately becomes a solid concrete wall, the electrical, mechanical and plumbing penetrations through the wall must be carefully pre-planned. Penetrations are easily accommodated before the concrete is placed by installing conduits through the wall. Examples of items that would need penetrations include exterior lighting, vents, and the main utility box.

If EPS panels are used internally, electrical boxes, conduits and plumbing pipes are installed after the concrete is placed by using an electric hot knife to chase channels into the 60mm thick EPS panels. If thin panels are used, electrical boxes, conduits and pipes should either be placed in the concrete cavity prior to the pour or inserted through the conection profile in the case of the Vertical System.

Services can be reticulated in the internal EPS panel.



Services can be inserted through Vertical system connection profile.

Sizing Air Conditioning Systems

A major benefit of using the FormPro® EE/EF system is it's inbuilt insulation and low air infiltration which creates a very efficient exterior building envelope. These capabilities translate into lower heat transfer and the ability to downsize air-conditioning requirements lowering procurement and maintenance costs. The high R-value, thermal mass and very low air infiltration must all be considered in sizing the mechanical Air Conditioning system.

Waterproofing and Termite Protection

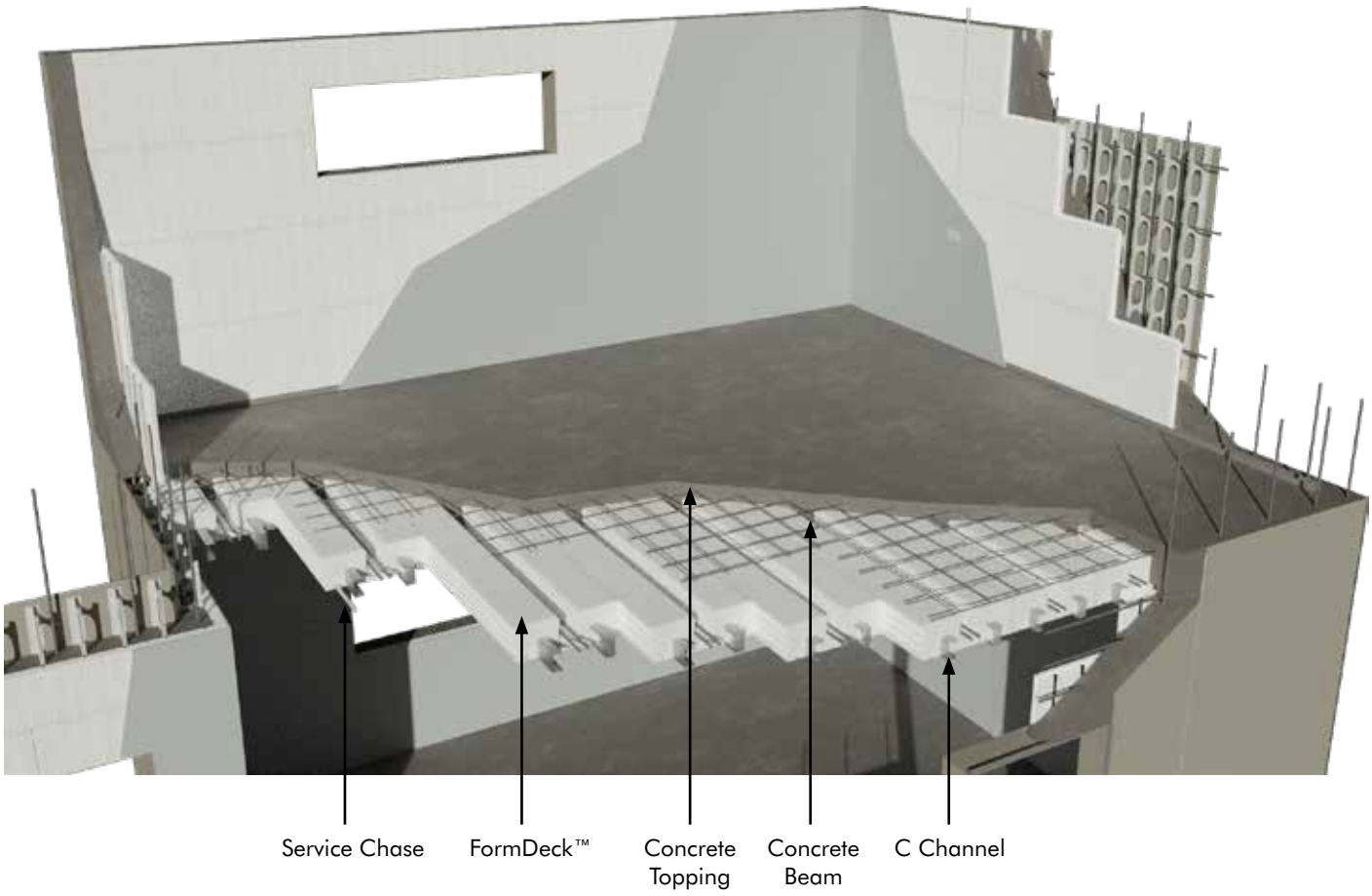
We recommend the use of adhesive waterproofing blankets for best results. In areas vulnerable to termite infestation, Formcraft recommends the use of a peel and stick waterproofing membrane below grade. This product has been approved for termite protection and waterproofing.

Formcraft recommends that irrigated termite management systems be used in conjunction with its construction system. Recharging the system with appropriate chemicals is relatively easy. Formcraft's construction system complies with AS 3660.1 by implementing an exposed slab edge of at least 100mm on monolithic concrete slabs.

FormDeck™ Floor Systems

Formcraft manufactures the FormDeck™ insulated suspended slab system to integrate with the FormPro® wall system. FormDeck™ is a lightweight permanent formwork system used to create insulated suspended slab construction. The EPS profile forms structural concrete T beams integrated with a thinner flat concrete slab. This reduces concrete usage and weight significantly without compromising strength. FormDeck™ works particularly well when one directional spans can be utilised.

The EPS remains mechanically locked to the underside of the concrete slab when erected. FormDeck™ is capable of providing forms with continuous metal furring strips and plaster board can be attached directly to the C furring strips. The FormDeck™ forms also contain two service chases to place utilities such as electrical conduits. The FormDeck™ system is cut to custom made lengths for each order. Please see FormDeck™ Design Guide for further information.



FormDeck™ Suspended Slab Integrated with FormPro® Walls

Other Floor Systems

FormPro® walls are versatile and are fully capable of being integrated with a variety of other floor systems including the following;

Please follow the below links to see technical details of the following floor systems integrated with FormPro®.

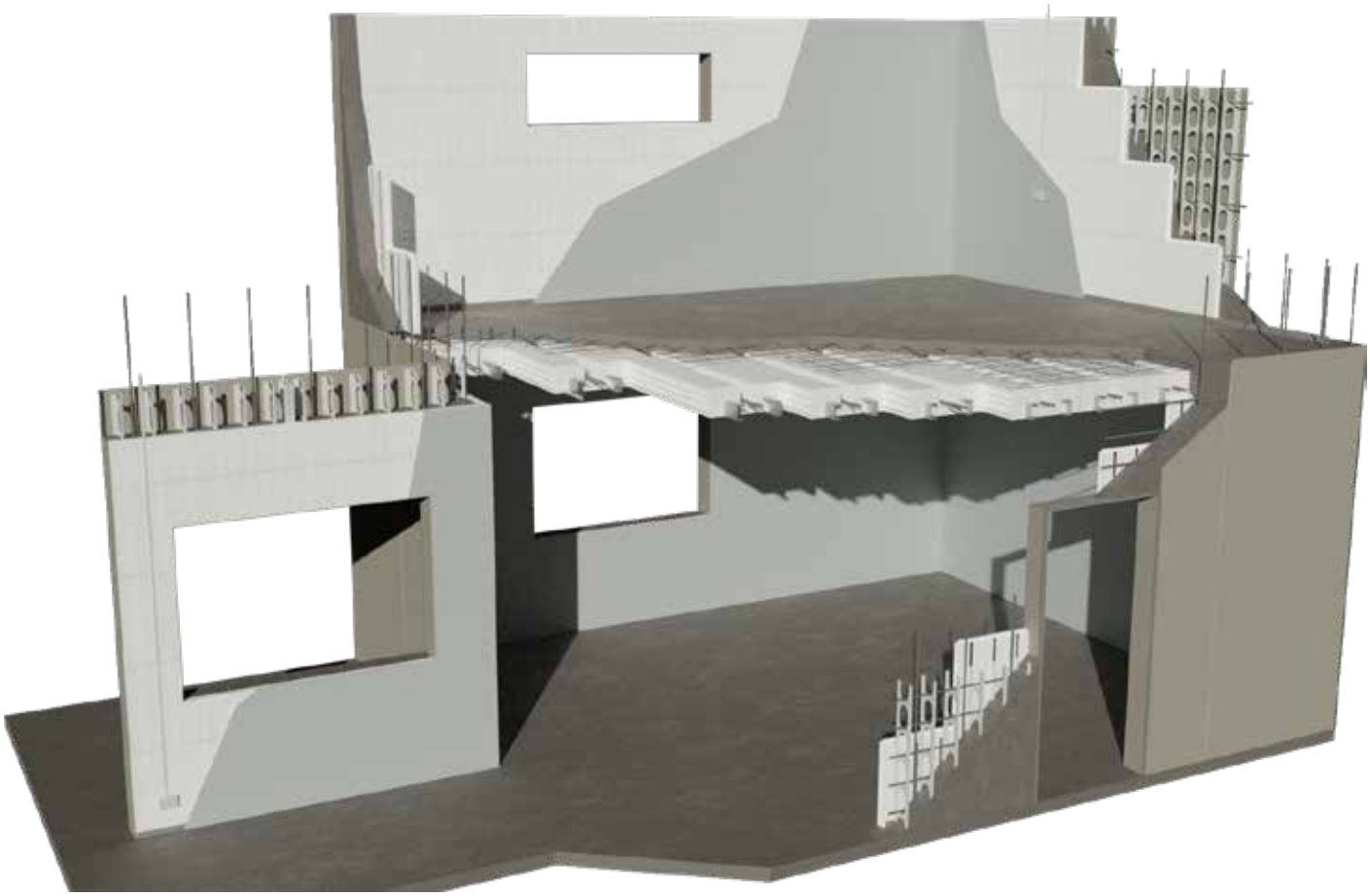
• Conventional Slab	|	EE(p63)	EF(p83)	FE(p101)	FF(p119)
• Bondek Slab	|	EE(p68)	EF(p88)	FE(p106	FF(p124)
• Post Tension Slab	|	EE(p69)	EF(p89)	FE(p107)	FF(p125)
• Light Frame Floor	|	EE(p65)	EF(p85)	FE(p103)	FF(p121)

If you would like to enquire whether your preferred floor system can be integrated with our FormPro® system, our sales and technical consultant can provide assistance.

BIM Software

Formcraft realises the importance of software in the design of buildings and so can provide product details and models in the following formats;

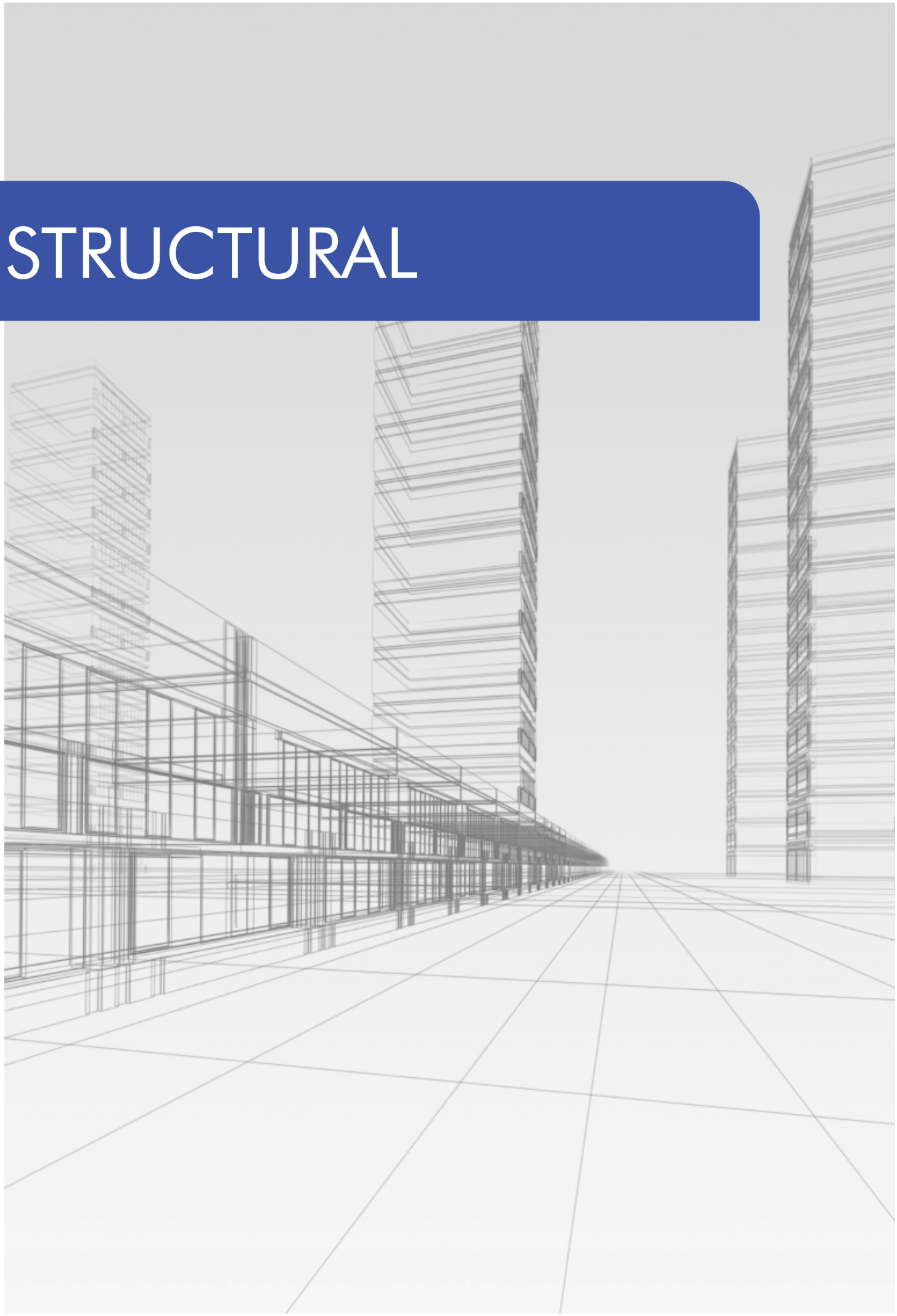
- AutoCAD
- DWG
- Revit
- PDF



3D BIM Model using FormPro® Products

NOTES

STRUCTURAL



Vertical Load Capacity

The vertical load design capacit y (ϕN_u) for the various wall thicknesses, wall heights and support conditions are shown in the following Charts.

The design capacities have been calculated in accordance with AS 3600 Clause 11.4 SIMPLIFIED DESIGN METHOD FOR BRACED WALLS SUBJECT TO VERTICAL FORCES ONLY, as follows:

Design axial compressive strength = ϕN_u (kN/m)

where:

ϕ = 0.6

N_u = the ultimate strength (kN/m)
= $(tw - 1.2e - 2e_a)0.6\, f'_c\, 10^3$

t_w = Wall concrete thickness (m)
= overall thickness – 0.012

e = the eccentricity of the load (m)
= 0 for continuous floor slab
(adopt 0.05 t_w as minimum)
= 0.166 t_w for discontinuous floor slab

e_a = additional eccentricity (m)
= $H^2_{we}/(2500\, t_w)$

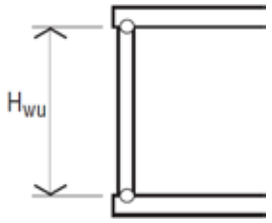
H_{we} = the effective height of wall (m)
= 0.75 H_{wu} where wall restrained against rotation top and bottom by floors
= 1.0 H_{wu} where wall not rotationally restrained top and bottom

H_{we}/t_w = 30 max. when $N^* > 0.03\, f'_c\, Ag$
= 50 max. when $N^* \leq 0.03\, f'_c\, Ag$

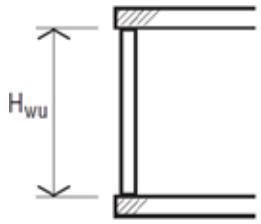
H_{wu} = Unsupported height of wall (m)

f'_c = Concrete compressive strength (MPa)

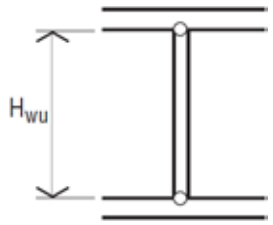
NOTE: Charts have been calculated for infill concrete strengths of 25 MPa and 32 MPa. Where other concrete strengths are used, the capacities will change proportionally.



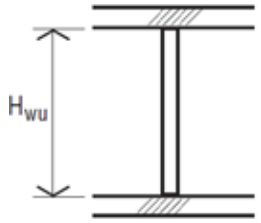
Floor Continuous
Wall Rotationally Restrained



Floor Continuous
Wall Rotationally Unrestrained



Floor Discontinuous
Wall Rotationally Restrained



Floor Discontinuous
Wall Rotationally Unrestrained

Lateral Load Capacity

The capacity of a wall subjected to a lateral load (wind or earthquake) is given in the chart on the following page.

It has been calculated on the basis of a simply-supported beam spanning vertically between floor supports, with central reinforcement @ 400 mm centres and concrete strength 25 MPa, refer chart on following page. Capacities are given for N12 and N16 vertical reinforcement. Higher capacities can be achieved by increasing the size of the vertical reinforcement.

The capacity is given by the formula:

Design Capacity, $w = 8\phi M_u / L^2$ (kPa)

where:

$M_u = f_{sy}\, d\, A_{st} \left[1 - \dfrac{0.6\, A_{st}\, f_{sy}\, 10^{-6}}{f'_c\, b\, d} \right] 10^{-3}$ (kN.m/m)

ϕ = 0.8

L = Design span for bending (m)
= Height between floors

b = Design width (m)
= 1.0

d = Depth to tensile reinf orcement (m)
= $t_w/2$

t_w = Wall concrete thickness (m)
= Overall wall thickness - 0.012

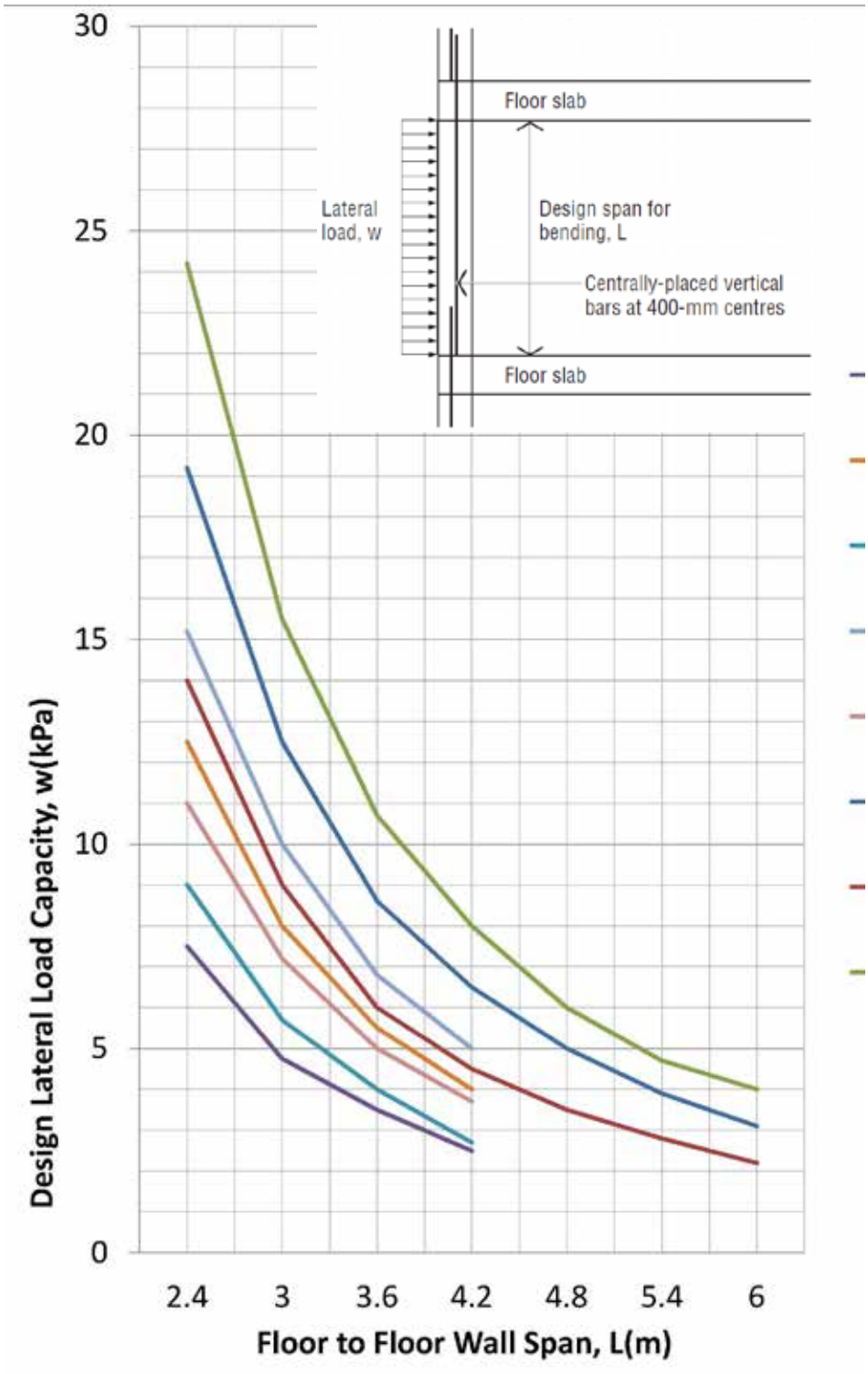
A_{st} = Area of vertical reinforcement (mm^2)

f'_c = Concrete compressive strength (MPa)

f_{sy} = Yield strength of reinforcement (MPa)

LATERAL LOAD CAPACITY

Design Lateral Load Capacity
Vertical Reinforcement



Racking Resitance

When a wall is subjected to racking forces, it can fail by either overturning of the wall or shear through the length of the wall. The wall capacity is therefore limited by the lesser value of overturning or shear.

Wall Overturning

The resistance to overturning of the wall is controlled by wall thickness and length, concrete strength and the amount and strength of tiedown reinforcement. In addition, weight of the wall as well as any other applied loads will help to resist overturning. The overturning is calculated in accordance with the assumptions contained in AS 3600 Clause 8.1.2.1 Combined bending and axial force. The following formula has been used:

$$V=\phi\left[\frac{(f_{sy}\,A_{st}\,10^{-3}+w\,L_w)d\left\{1-\frac{0.6(f_{sy}\,A_{st}\,10^{-3}+w\,L^w)}{t_w\,d\,f'_c\,10^3}\right\}-w\,L_w\left\{d-\frac{L_w}{2}\right\}}{H_w}\right]$$

where:

V	= Design overturning resistance	(kN)
ϕ	= Strength reduction factor for shear	
	= 0.7 (adopt shear value)	
f_{sy}	= Yield strength of reinforcement	(MPa)
f'_c	= Concrete compressive strength	(MPa)
A_{st}	= Area of tiedown reinf. in tension	(mm^2)
	= Reinf. area over half wall length	
w	= Total Vertical load on wall	(kN/m)
	= $w_s + w_{sw}$	
w_s	= Superimposed permanent load (PL)	(kN/m)
w_{sw}	= Self-weight of wall (SW)	(kN/m)
d	= Distance from the compression face (end of wall) to the centroid of tensile reinforcement	(m)
H_w	= Wall height	(m)
L_w	= Wall length	(m)
t_w	= Concrete thickness	(m)
	= Overall wall thickness – 0.012	

The overturning capacities shown in the Racking Resistance chart have been calculated for the EF174 walls with concrete strength 25 MPa and tiedown rods N12@ 400 mm centres. Two sets of design curves are given covering two load cases. One set of curves is for a UPL of 0 kN/m and the second set is for a UPL of 100 kN/m. Where a UPL is between these values, the overturning capacity can be obtained by interpolation. Increases in wall size or concrete strength will only give marginally higher strength.

Wall Shear

The shear strength through the wall is controlled by wall thickness and length, concrete strength and amount and strength of reinforcement. The shear capacity is calculated in accordance with AS 3600 Clause 11.5.3. Strength in shear, as follows:

$$\mathbf{V_u = \phi(V_{uc} + V_{us})}$$

When $H_w/L_w < 1.3$

$$V_{uc} = \left[0.66 \sqrt{f'_c} - 0.21 \frac{H_w}{L_w} \sqrt{f'_c} \right] 0.8\, L_w\, t_w\, 10^3$$

When $1.3 \le H_w/L_w < 1.83$

$$V_{uc} = \left[0.05 \sqrt{f'_c} + \frac{0.1 \sqrt{f'_c}}{\left[\frac{H_w}{L_w} - 1 \right]} \right] 0.8\, L_w\, t_w\, 10^3$$

When $H_w/L_w \ge 1.83$

$$V_{uc} = [0.17 \sqrt{f'_c}]0.8\, L_w\, t_w\, 10^3$$

$$V_{us} = \frac{A_s}{s} f_{sy}\, 0.8\, L_w\, 10^3$$

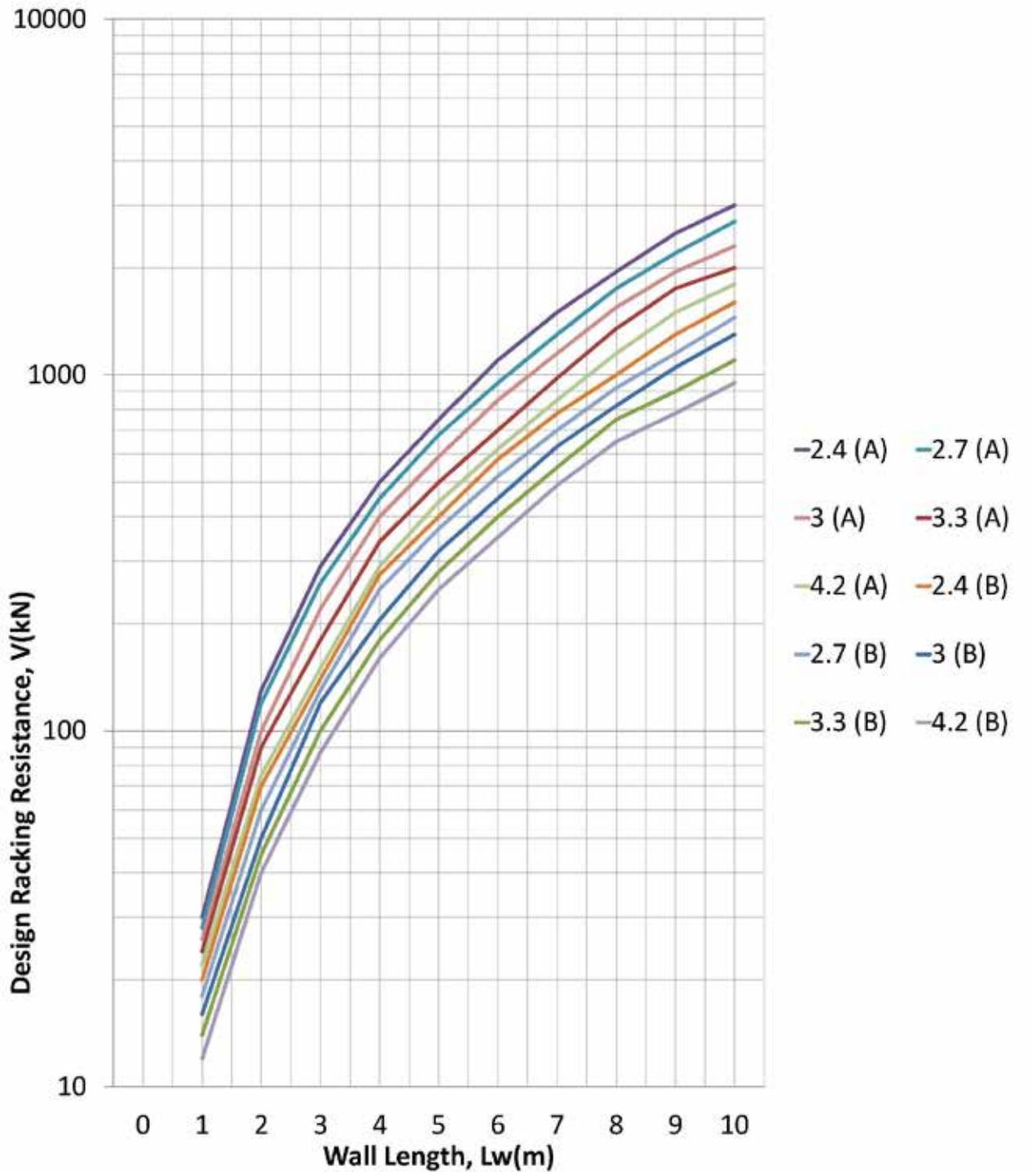
where:

V_u	= Design strength in shear	(kN)
V_{uc}	= Shear strength without reinf.	(kN)
V_{us}	= Contribution to shear strength by reinforcement	(kN)
ϕ	= Strength reduction factor for shear	
	= 0.7	
f'_c	= Concrete compressive strength	(MPa)
f_{sy}	= Yield strength of reinforcement	(MPa)
A_s	= Area of vertical and horizontal reinforcing bars	(mm^2)
s	= Spacing of vertical and horizontal reinforcing bars	(mm)
H_w	= Wall height	(m)
L_w	= Wall length	(m)
t_w	= Wall concrete thickness	(m)
	= Overall thickness – 0.012	

The shear capacity given in the following chart have been calculated for the EF174 wall with concrete strength 25 MPa and N12 bars @ 400 mm centres. Increases in wall size, concrete strength or einforcement will give proportionally higher shear strength.

Racking Resistance
The racking resistance given in the following chart is the lesser of the shear and overturning values. Except for long and heavily-loaded walls, the value of racking resistance is limited by overturning.

Wall Overturning use AS3600 clause 8.1.2.1 - Combined Bending and Axial Force
Wall Shear use AS3600 clause 11.5.3 - Strength in Shear



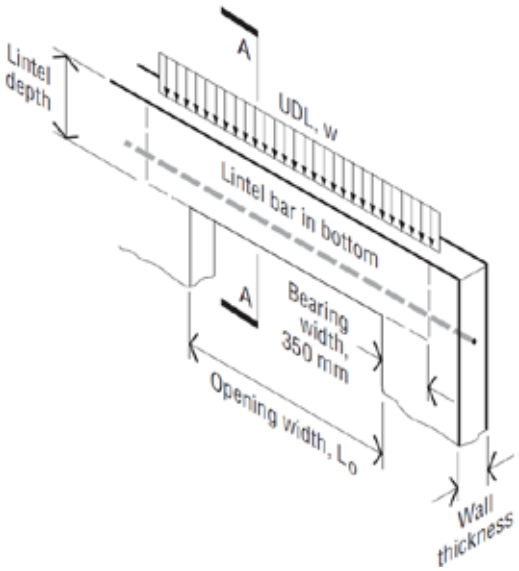
Lintel Capacity

The design lintel capacity is the lesser of the strength in flexure or in shear. Deflection must also be checked to ensure that serviceability limits are not exceeded.

The design capacities given have been calculated on the basis of simply supported beams using concrete strength of 25 MPa and the details shown in the image below.

Flexural Capacity
The capacity in flexure is calculated for a simply-supported beam using the following formula:

Design Capacity, $w = 8 \phi M_u / L^2$ (kN/m)



where:

$$M_u = f_{sy}\, d\, A_{st} \left[1 - \frac{0.6\, A_{st}\, f_{sy}\, 10^{-6}}{f'_c\, b\, d} \right] 10^{-3} \quad \text{(kN.m)}$$

ϕ = 0.8

L = Design span for flexure (m)
= L_o + 0.35

L_o = Opening width (m)

b = Thickness (m)
= Overall wall thickness – 0.012

d = Depth to tensile reinf orcement (m)

A_{st} = Area of tensile reinforcement (mm^2)

$$\geq 0.22\, b\, d \left[\frac{d + 50}{d} \right]^2 \frac{f'_{ct}}{f_{sy}}$$

f'_c = Concrete compressive strength (MPa)

f'_{ct} = Concrete flexural tensile strength
= $0.6\sqrt{f'_c}$ (MPa)

f_{sy} = Yield strength of reinforcement (MPa)

Assumptions

- Simply-supported beam
- Bearing width = 350mm
- Design span for flexure,
  L = Opening width + 0.35 (m)
- Design span for shear,
  L = Opening width - 2d (m)
- No vertical shear reinforcement

NOTES

NOTES

PERFORMANCE

PERFORMANCE & BCA COMPLIANCE

FormPro® walls have been evaluated for compliance with the following Australian Standards and BCA codes

Australian Standards

- AS.3600 Concrete structures
- AS.1366 EPS
- AS.3610 Formwork for concrete
- AS.3700 Masonry structures

BCA Requirements

- Volume 1 - Class 2 to 9 Buildings
- Volume 2 - Class 1 & Class 10 Buildings - Housing Provisions
- Part 1.1.1.2 Alpine Areas
- Part 3.1.3 Termite Risk Management
- Part 3.3.2 Reinforced Masonry
- Part 3.3.4 Weatherproofing of Masonry
- Part 3.6.2 Glazing Sizes & Installation
- Part 3.7 Fire Safety
- Part 3.8.1.5 Protection of walls in wet areas
- Part 3.8.6 Sound Insulation
- Part 3.10.1 Cyclonic Areas
- Part 3.10.1 High Wind Areas

FormPro® Model Performance

MODEL NO.	WALL THICKNESS	CONC. THICKNESS	FORMWORK MATERIAL	FIRE	THERMAL	ACOUSTICS	
				FRL	R-Value	$R_w + C_{tr}$	$D_{nT,w} + C_{tr}$
EE220	220mm	100mm	60mm EPS/60mm EPS	90/90/90	3.5m².K/W	46	45
EE270	270mm	150mm	60mm EPS/60mm EPS	180/180/180	3.6m².K/W	59	50
EE320	320mm	200mm	60mm EPS/60mm EPS	240/240/240	3.6m².K/W	62	55
EF174	174mm	108mm	60mm EPS/6mm FC	90/90/90	1.86m².K/W	47	42
EF216	216mm	150mm	60mm EPS/6mm FC	120/120/120	1.86m².K/W	51	45
EF216	216mm	150mm	60mm EPS/6mm FC	180/180/180	1.86m².K/W	55	47
EF254	254mm	188mm	60mm EPS/6mm FC	240/240/240	1.87m².K/W	60	52
TT98	98mm	86mm	6mm FC/6mm FC	60/60/60	0.25m².K/W	43	40
FF120	120mm	108mm	6mm FC/6mm FC	120/120/120	0.25m².K/W	48	44
FF162	162mm	150mm	6mm FC/6mm FC	180/180/180	0.25m².K/W	51	47
FF200	200mm	188mm	6mm FC/6mm FC	240/240/240	0.26m².K/W	55	49

Tests Conducted on FC Material as per AS2908

Test Description	Value
Water Absorption	16.22%
Flexural Strength	16Mp
Dimensional Stability – Thermal & Humid Aging	0.52%
Density	1613kg/m^3
Dimensions	+- 2mm
Flame Test to AS1530.2	Pass
Flame Test to AS1530.3	
- Structural Adequacy	219 minutes
- Integrity	219 minutes
- Insulation	149 minutes

Tests Conducted on EPS Material

Test Description	Value
Water Absorption	0.18%
Water Vapour Permeance	94.0ng/Pa-s-m^2
Compressive Strength	165kPa
Flexural Strength	365kPa
Dimensional Stability – Thermal & Humid Aging	0.5%
Density	27.5kg/m^3
Dimensions	+- 3mm
Limiting Oxygen Index	29.1%
Formaldehyde Emission	No formaldehyde detected
Fungi Resistance	No fungal growth detected
Flame Spread Rating	< 25
Smoke Developed Rating	< 450

Tests Conducted on Polypropylene Web

Test Description	Value
Flammability	Flame Front Distance = 100mm Avg. Linear Burn Rate = 17.9mm/min
Average Lateral Fastener Resistance	1.63kN
Average Withdrawal Fastener Resistance	0.75kN
Shear Strength	26.1MPa
Average Tensile Strength	3.75kN

Fire Resistance Rating - BRANZ Fire Test FAR3116

Wall type	FRR rating
EE220 model	90/90/90
EE270 model	180/180/180
EE320 model	240/240/240

Fire Assessment Report - BRANZ Fire Test FAR4359

Assessment report on FormPro® walls to AS: 3600:2001. Walls were found to be compliant.

Model	Wall Thickness	Concrete	External Material	FRL
EE220	220mm	100mm	0.144	90/90/90
EE270	270mm	150mm	0.216	180/180/180
EE320	320mm	200mm	0.288	240/240/240
EF174	174mm	108mm	0.078	90/90/90
EF216	216mm	150mm	0.096	120/120/120
EF216	216mm	150mm	0.113	180/180/180
EF254	254mm	188mm	0.147	240/240/240
FF120	120mm	108mm	0.086	120/120/120
FF162	162mm	150mm	0.104	180/180/180
FF200	200mm	188mm	0.120	240/240/240

BRANZ Fire Test FI 3672 to ISO 9705

BCA 2006 Specification C1.10a Clause 3 and Specification A2.4 Clause 4

Plasterboard lined Formcraft wall system

Result:
Group 1 classification – Does not reach flash over during Test

Determination of the Airborne Sound Insulation

VIPAC Technical report W-09-0084-TNT-840103-0

Wall Type	**$R_w + C_{tr}$**
EE220 model	56
EE270 model	59
EE320 model	62

Determination of the Wall Impact Sound Rating

VIPAC Technical report W-09-0084-TNT-840103-0

Wall Type	**$L_{n,w}$**
EE220 model	48
EE270 model	51
EE320 model	54

Field Sound Transmission Loss Performance

Wall Type	**$D_{nT,w} + C_{tr}$**
EF216	47

Thermal Performance Calculations (R-Value)

General assumptions:

- Thermal conductivity for Concrete at density 2850 Kg/m3 = 1.44 W/mK
- Thermal Conductivity for EPS at density of 26 Kg/m3 and 23°C = 0.0376 W/mK
- Thermal conductivity of Plasterboard = 0.173 W/mK
- 3.4m/s wind and surface emittance = 0.9

Non-Concrete R-value contribution - (thickness (m)/k)

Outside air		= 0.044
60mm EPS	= 0.060 / 0.0376	= 1.596
6mm Fibre Cement	= 0.006 / 0.173	= 0.034
10mm Plasterboard	= 0.010 / 0.173	= 0.057
Inside air		= 0.12
EE Wall Non-Concrete Contribution (Total)		= 3.413
EF Wall Non-Concrete Contribution (Total)		= 1.863
FF Wall Non-Concrete Contribution (Total)		= 0.260

Concrete R-value contribution - (thickness (m)/k)

EE220 (100mm conc.)	= 0.100 / 1.44	= 0.144
EE270 (150mm conc.)	= 0.150 / 1.44	= 0.216
EE320 (200mm conc.)	= 0.200 / 1.44	= 0.288
EF174 (108mm conc.)	= 0.108 / 1.44	= 0.078
EF216 (150mm conc.)	= 0.150 / 1.44	= 0.094
EF254 (188mm conc.)	= 0.188 / 1.44	= 0.147
FF120 (108mm conc.)	= 0.108 / 1.44	= 0.085
FF162 (150mm conc.)	= 0.150 / 1.44	= 0.104
FF200 (188mm conc.)	= 0.188 / 1.44	= 0.119

Thermal Performance Values

Product Line	Wall Model	Total Wall Thickness	Concrete Thickness	Concrete R–value	Total R-Value
FormPro®	EE220	220mm	100mm	0.144	3.557
FormPro®	EE270	270mm	150mm	0.216	3.629
FormPro®	EE320	320mm	200mm	0.288	3.701
FormPro®	EF174	174mm	108mm	0.078	1.941
FormPro®	EF216	216mm	150mm	0.113	1.976
FormPro®	EF254	254mm	188mm	0.147	2.010
FormPro®	FF120	120mm	108mm	0.086	0.342
FormPro®	FF162	162mm	150mm	0.104	0.360
FormPro®	FF200	200mm	188mm	0.120	0.376