

Issued on: 1/8/2009  
Release: I

## **Design Guide and Specifications**

### **Introduction**

Insulating concrete formwork (ICF) construction has accounted for an ever-increasing share of the overall construction market as architects and designers have found that ICFs meet their design and technical challenges easily and economically, while providing value-added structures to their customers.

The following is an overview of the Formcraft construction system. Formcraft is acknowledged as the most technologically advanced ICF in Australia, because of its innovative design and technical features that set it apart from other ICFs. Since its introduction in 2003, it has become the ICF of choice for commercial projects ranging from restaurants to multi-story hotels, as well as a wide range of residential projects. Formcraft provides training and technical support throughout the design and construction process to ensure that each project goes up smoothly and quickly.

### **Formcraft Advantages**

Formcraft is a sustainable green product that saves energy, is fast to construct, provides cyclonic resistance and creates a quiet, comfortable interior environment.

### **Sustainable/Green Building**

Formcraft ICFs allow architects and designers to create buildings that use fewer natural resources and are more sustainable. Formcraft ICFs:

- Reduce waste at the construction site, and any waste produced is 100% recyclable
- Use fewer natural resources, such as gas, electricity and wood
- Are manufactured clean, producing no HCFCs or CFCs during the manufacturing process, and they contain no formaldehyde
- Reduce operating costs for heating and cooling.
- Create structures that last longer and with less maintenance

When the Formcraft Wall System is incorporated into a project, the energy efficiency and material properties of Formcraft can help a project qualify for points toward a 5 star energy rating. The staff at Formcraft will be glad to assist you with questions and issues related to conformance with the 5 star energy rating requirements.

## **Fast**

Formcraft's advanced concrete forming technology also delivers proven savings in labour costs as it is a rapid construction technique. Additional cost savings are derived from earlier occupancy and maintenance-free environments. The simplicity of this construction method means that a highly skilled workforce is not required. 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. The Formcraft ICF wall system results in a solid, stable and durable structure.

## **Energy Efficiency**

Because of their effective R-value of 3.5+, Formcraft structures can save as much as 40 % to 60% on heating and cooling costs compared to the heating and cooling costs for conventionally built structures.

## **Quiet and Comfortable**

Formcraft ICFs create a clean, virtually airtight, interior environment. The monolithic concrete walls, surrounded by two insulating layers of expanded Polystyrene (EPS), serve as a barrier to drafts, pollens and other pollutants. With an excellent sound reduction rating, a Formcraft wall is one of the "quietest" wall systems available, reducing loud exterior noise to the level of a whisper inside.

## **Formcraft Characteristics and Uses**

Formcraft ICF is designed to function as the formwork for concrete walls. The formwork stays in place as insulation on the exterior and interior face of the wall assembly, and also serves as attachment for exterior and interior finish systems. It forms a solid flat steel-reinforced cast-in-place concrete wall of 100mm, 150mm, or 200mm thicknesses that is the structural component of the wall assembly.

Formcraft is used in commercial and residential construction for exterior and interior, load bearing, above grade and below grade walls. Specific applications include basement and undercoft walls, storm shelters, inter tenancy walls, slab on grade walls and single story to multi-story walls.

The concrete cavity varies to account for different structural requirements.

- 220mm model which is used for single and double storey structures
- 270mm model which is used for below grade and medium rise construction
- 320mm model which is used for below grade, medium rise construction and party walls.

Formcraft is a modular form that is installed in stretcher bond fashion. It has two faces or panels of EPS material 60mm thick that are held together by plastic ties spaced 200mm on centre. Product literature, technical information, CAD details, specifications and product samples are available upon request.

## Formcraft Raw Materials and Manufacturing

Formcraft is shape moulded to a nominal 28kg/sqm density using Type 2 flame retardant EPS to form two panels of insulation. A pentane gas inside the closed cell EPS resin bead is used to pre-expand the EPS resin beads. After the pre-expanded beads are injected into the mould cavity, steam and heat are applied to shape mould the product. Virtually all of the pentane gases are disburshed by the time the forms are shipped.

Plastic furring strips moulded from recycled polypropylene plastic, are inserted into the mould during the shape moulding process. Complete MSDS sheets about the raw materials in Formcraft are available on request.

## Formcraft Types and Sizes Available

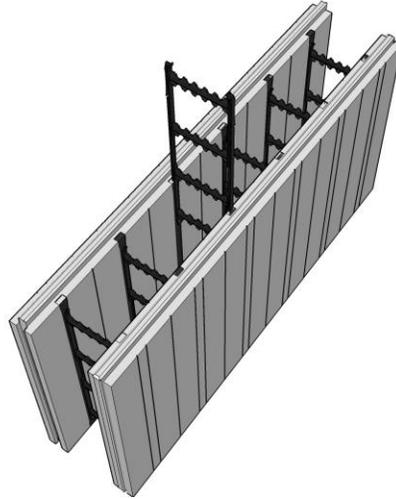
All Formcraft forms arrive to site flat packs and are easily assembled on site. The type and size of product is determined by structural requirements, fire and sound rating requirements and designer or owner preference.

## Formcraft Specifications

Full Block	Length	Return	Height	Wall width	Concrete width	Concrete usage	Surface area
220 model	1200mm	N/A	600mm	220mm	100mm	0.072m <sup>3</sup>	0.72m <sup>2</sup>
270 model	1200mm	N/A	600mm	270mm	150mm	0.108m <sup>3</sup>	0.72m <sup>2</sup>
320 model	1200mm	N/A	600mm	320mm	200mm	0.144m <sup>3</sup>	0.72m <sup>2</sup>
Half Block	Length	Return	Height	Wall width	Concrete Width	Concrete usage	Surface area
220 model	1200mm	N/A	300mm	220mm	100mm	0.036m <sup>3</sup>	0.36m <sup>2</sup>
270 model	1200mm	N/A	300mm	270mm	150mm	0.054m <sup>3</sup>	0.36m <sup>2</sup>
320 model	1200mm	N/A	300mm	320mm	200mm	0.072m <sup>3</sup>	0.36m <sup>2</sup>
Corner Block	Outside length	Return	Height	Wall width	Concrete Width	Concrete usage	Surface area
220 model	1000mm	400mm	600mm	220mm	100mm	0.0708m <sup>3</sup>	0.84m <sup>2</sup>
270 model	1000mm	400mm	600mm	270mm	150mm	0.1017m <sup>3</sup>	0.84m <sup>2</sup>
320 model	1000mm	400mm	600mm	320mm	200mm	0.1296m <sup>3</sup>	0.84m <sup>2</sup>

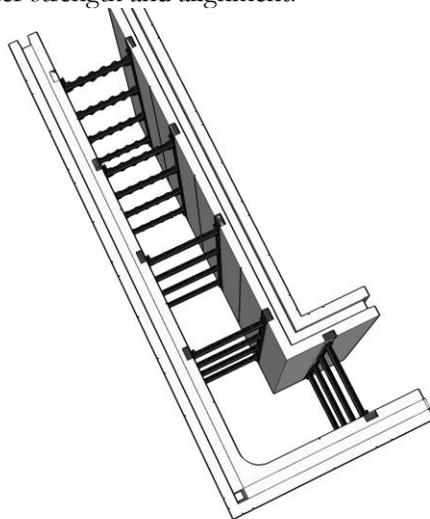
## Formcraft Design Features

The full, half and corner forms are designed with male joints at the top of the form and female joint at the bottom. They also have the added benefit of tongue and groove joints on the vertical sides of the forms. This makes for an extremely strong configuration that is easy to stack, brace and pour.



The flat panels are easily assembled into blocks on site by pushing in 6 banks of connectors to the opposing panels. The connectors are spaced vertically 150mm on centre and horizontally 200mm on centre and provide superior form strength during concrete placement. The connectors also provide loose fit horizontal rebar chairs at several locations within the form. The loose fit eliminates the strain of bent rebar on the wall while allowing for rebar overlap without tying.

The 30mm wide furring strips are moulded inside the Formcraft forms and are embedded 10mm below the EPS surface and run internally the full height of the block to reduce block compression during the concrete pour. The position of the furring strips are marked on the exterior of the form making it easy to correctly attach exterior and interior finishes. Because the furring strips are embedded, traditional and acrylic finishes can be easily applied directly to the forms. The corner forms contain a vertical 30mm square corner tubular insert to receive the exterior and interior finishes and aid corner strength and alignment.



Within the full and corner forms, the plastic ties have 4 tie rods that allow the forms to be cut in half horizontally to form half corner blocks or additional half blocks if required. The minimal tie design also provides a very open cavity to allow for good concrete flow.

The connectors provide multiple rebar positioning to allow for the most efficient structural design. The concrete wall may be designed with one or two mats of horizontal or vertical rebar. Vertical rebar should be designed in increments of 200mm on centre Horizontal rebar should be designed in increments of 150mm on centre.

## Formcraft AS & BCA Conformance

Formcraft has 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

## Formcraft Performance Values

### Tests Conducted on EPS Material

Test Description	Value
R-Value (Thermal Resistance)	R 3.5
Water Absorption	0.18%
Water Vapor Permeance	94.0ng/Pa-s-m <sup>2</sup>
Compressive Strength	165kPa
Flexural Strength	365kPa
Dimensional Stability – Thermal & Humid Aging	0.5%
Density	27.5kg/m <sup>3</sup>
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
Smoke Density Rating	19.1%

### 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

Form type	FRR rating
220 model	90/90/90
270 model	180/180/180
320 model	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

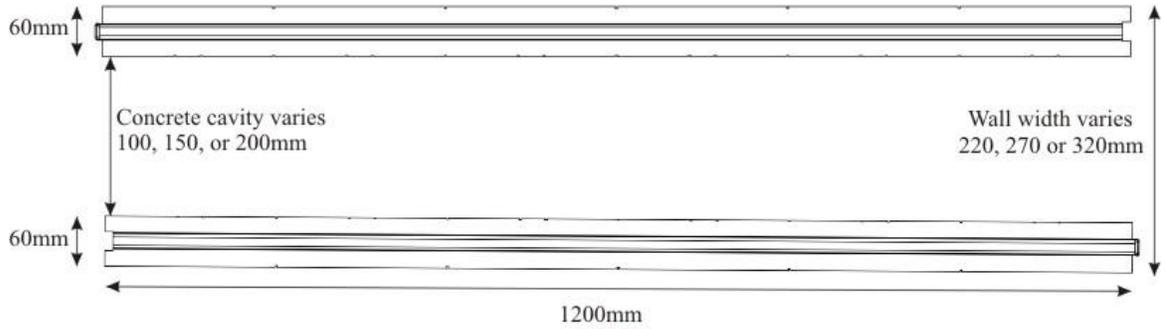
Form type	$R_w + C_{tr}$
220 model	46
270 model	59
320 model	62

### Determination of the Wall Impact Sound Rating

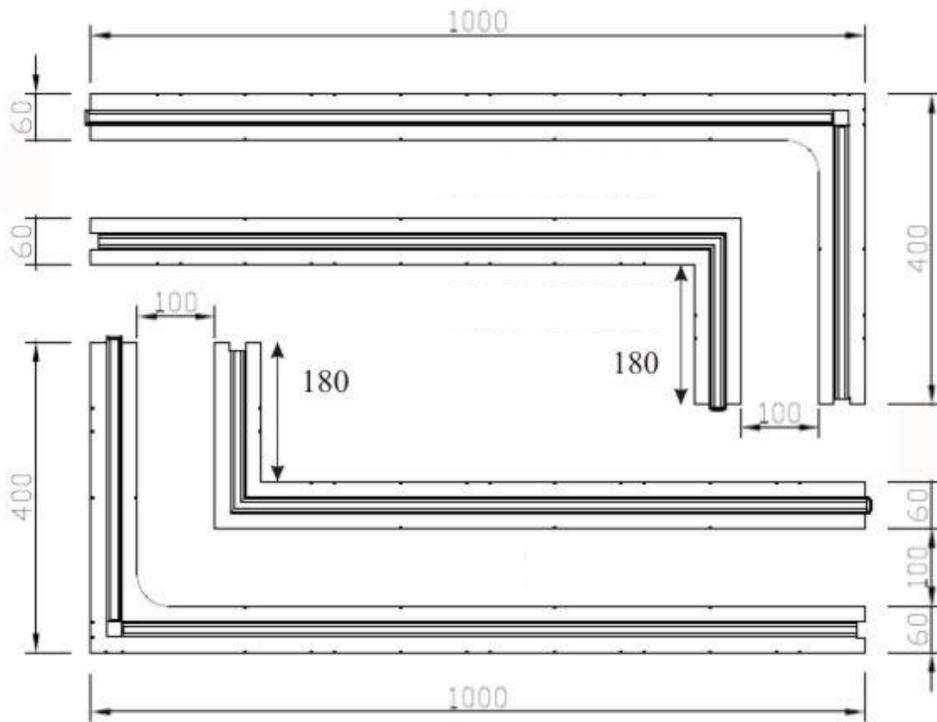
#### VIPAC Technical report W-09-0084-TNT-840103-0

Form type	$L_{n,w}$
220 model	48
270 model	51
320 model	54

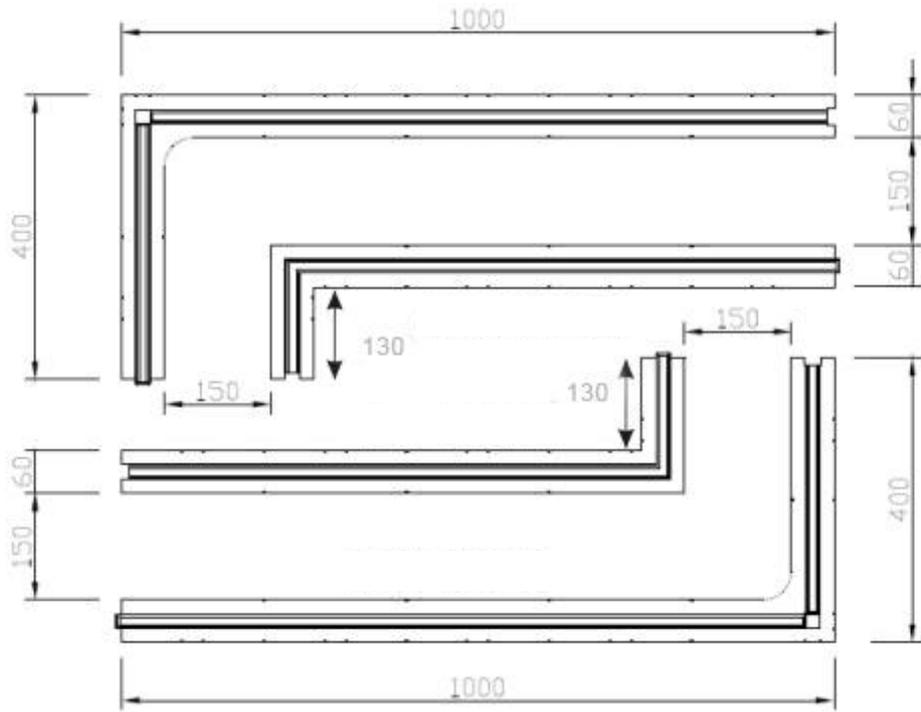
### Plan view of module sizes



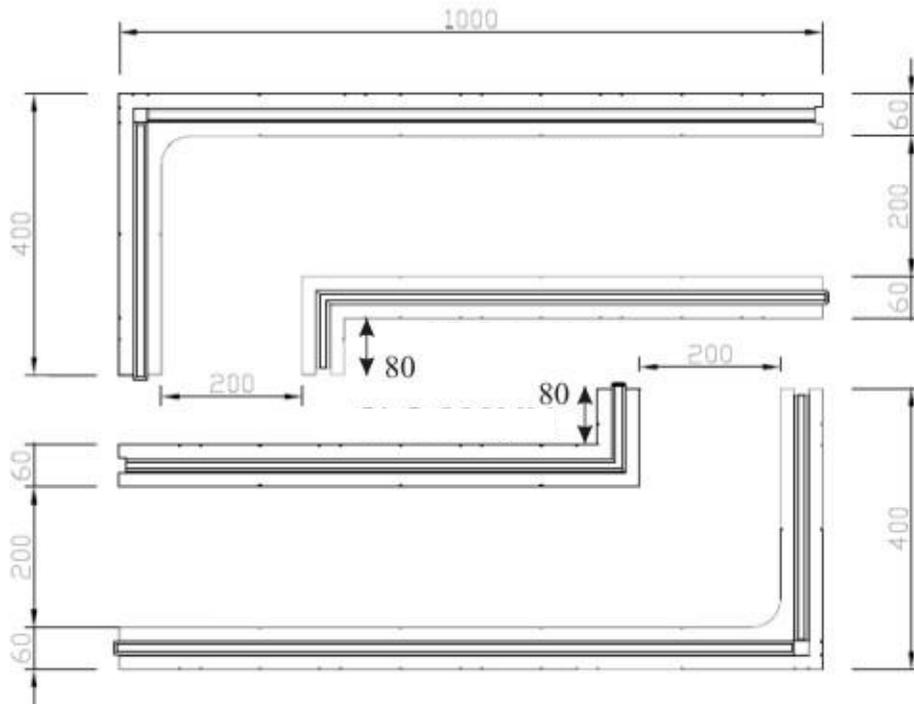
Full and Half blocks



220 Model Corner Block



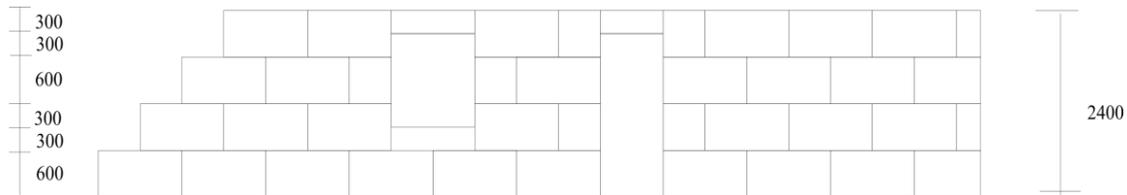
**270 Model Corner Block**



**320 Model Corner Block**

## Formcraft Vertical Courses and Dimensioning

The most critical aspect of design with Formcraft is that 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 half block and to limit the amount of cutting. An example is shown in the diagram below:

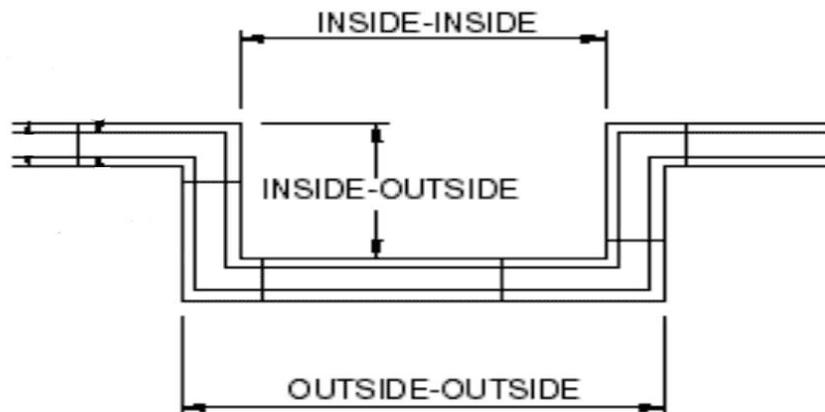


It is also important that the dimension from top of slab to the top of slab on the floor above is also in a 300mm vertical increment. This is because the outside panel forms the slab edge of the suspended slab and the slab thickness is cut from the interior panel. This provides a continuous substrate for render and continuous insulation for the exterior of the structure.

## Formcraft Horizontal Wall Layout and Dimensioning

The biggest difference between ICF construction and conventional construction is that the ICF wall assemblies are typically thicker. Wall widths should be modified to either:- 220mm, 270mm or 320mm depending on what model is structurally required.

It is preferential that wall layouts are generally dimensioned in a 200mm horizontal increments from outside corner to outside corner. If used, these will reduce construction costs due to reducing labour and minimizing onsite waste. Window and door placement should also be set to the 200mm horizontal increment where possible.



### Rules

1. Outside corner to outside corner dimensions must be in 200mm horizontal increments
2. Outside to Inside dimension = Outside to Outside dimension minus Wall thickness
3. Inside to Inside dimension = Outside to Outside dimension minus (Wall thickness x 2)
4. Window and door placement should also be set to the 200mm horizontal increment
5. Try to use the 400mm external offset when positioning openings close to corners

## Other Points to Consider

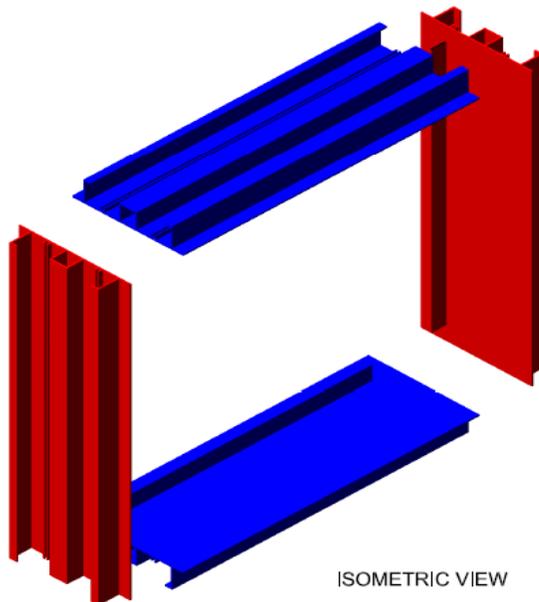
1. The 90° corner forms are provided in a left-hand and right-hand configuration. This ensures that there is a half bond (600mm) offset between the joints in subsequent courses.
2. Designs that utilize 90° corners are the most efficient since Formcraft features 90° corner blocks. Corners of any other angle also can be constructed by mitering full blocks on site and using a hinged ply section to achieve the angle.
3. Curved walls are difficult to construct with the straight modules.

## Doors and Windows

Formcraft recommends placing the tops of doors and the tops and sills of windows at the top of course heights (ie 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 well with the corner blocks. 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.

Formcraft manufactures an aluminium sub frame solution that provides for an easy means of fixing doors and windows and also provides a mechanical waterproofing flange around the perimeter of the opening.



Almost any aluminium window or sliding door frame can be inserted into the opening and riveted to the flange from the inside. On the interior, drywall is typically wrapped onto the sill, jambs and head.

With hinged doors, the hinge side of the door must be considered due to the thicker wall. Exterior hinged doors that are hung to the Formcraft wall should be installed so that the hinge is flush with the inside wall. This allows the door to open fully without hitting the doorjamb. Doors should be specified with jamb extensions to reflect the thicker wall plus the exterior and interior cladding.

## **Electrical, Mechanical and Plumbing**

Since the Formcraft 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 sleeves through the wall. Examples of items that would need penetrations include exterior lighting, dryer vents, water faucets, service entrances and the main utility box.

Electrical boxes and wiring are installed after the concrete is placed by using an electric hot knife to chase channels into 60mm thick EPS foam. Run horizontal wires between the horizontal seams of the blocks whenever possible to avoid cutting into the plastic ties.

Where possible plumbing should be pre-planned so that the plumbing lines are run on interior walls. If it is necessary to run any plumbing lines into the Formcraft wall, they easily can be chased into the EPS by creating chases with an electrical hot knife.

## **Exterior Finishes**

Any typical exterior finish, such as any type of cladding, textured acrylic render and brick or stone veneer may be used with Formcraft walls.

Formcraft recommends the use of the Rockcote Reinforced Render (RRR) system. The performance of RRR has been proven in varied conditions and delivers a coloured textured render finish, indistinguishable from masonry. The company offer a 10 year guarantee and more details can be obtained from <http://www.rockcote.com.au/>

Cladding such as colour bond, mini orb or Hardi-board can be fastened to the plastic ties using coarse thread corrosion-resistant screws.

Textured acrylic finish is applied directly to the forms.. Brick and stone veneer are typically fixed to the Formcraft walls with tile adhesive and also mechanically fastened to the plastic furring strips using corrugated steel ties

## **Interior Finishes**

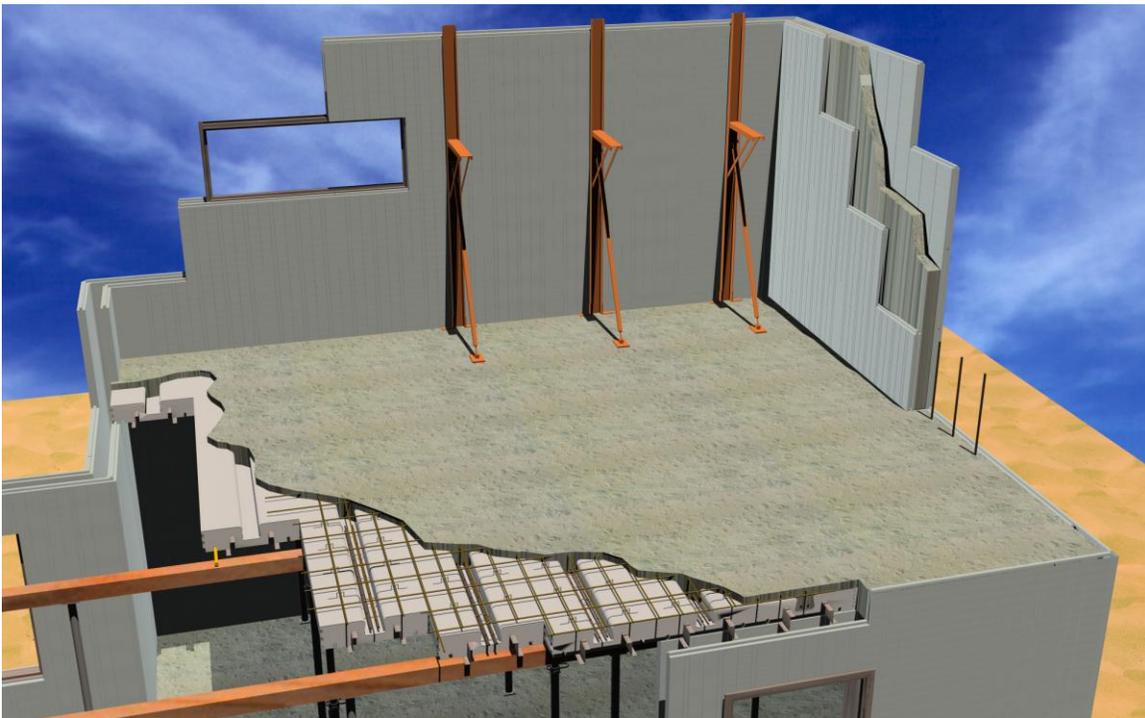
The most common and cost effective interior finishing material used is gypsum board, also known as Gyprock.. Gyprock board can be applied directly to the Formcraft walls using conventional drywall screws that are fixed into the furring strips, or with drywall screws and EPS compatible adhesives.

## Floor Systems

Formcraft manufactures the FormDeck® and insulated suspended slab system to integrate with the ICF wall system. FormDeck® is a lightweight form 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 while maintaining strength.

The polystyrene 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 Z channels. The FormDeck® forms also contain two service chases to place utilities such as electrical conduit. The FormDeck® system is cut to custom made lengths for each order.

Please see FormDeck® Design Guide for further information



## Sizing Air Conditioning Systems

Building a structure with Formcraft walls creates a very energy efficient exterior building envelope. The exterior walls have a high R-value, thermal mass and very low air infiltration that must all be considered in sizing the mechanical Air Conditioning system. It is very important to get the right size the system to maximize the energy efficiency and to properly remove indoor moisture.

## **Waterproofing and Termite Protection**

Formcraft walls require proper waterproofing below grade using material compatible with EPS. We recommend the use of adhesive waterproofing blankets for best results. In areas vulnerable to termite infestation, Formcraft recommends using Kordon waterproofing membrane below grade. This product has been approved as termite protection and waterproofing.

Termites are not attracted to the Polystyrene itself but have been known to travel through it to wooden structures attached to the building. Formcraft recommends that irrigated termite management systems be used in conjunction with its construction system. Recharging the system with appropriate chemicals at a time in the future is relatively easy. Formcraft's construction system complies with AS 3660.1 by having an exposed slab edge of at least 100mm on a monolithic concrete slab. This is deemed to satisfy the standard.

Above the tropic of Capricorn termites are more voracious and require a higher standard of treatment. A borate additive such as Perform Guard may be added to the polystyrene in the production process as a further safeguard.

## **Attachment**

When planning to hang heavy cabinets or fixtures from the Formcraft wall, Formcraft fixing plates should be installed before the concrete is placed.

Alternatively a 60mm thick timber backing plate could be fastened to the concrete wall after the concrete is placed using concrete fasteners and installed so that it is flush with the surface of the EPS foam face. A hot knife is used to remove the EPS foam and create the space for the backing and the items can be attached in the conventional way.