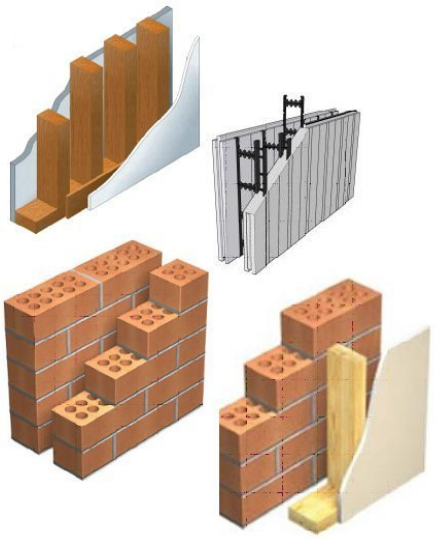
Comparison of the thermal efficiency of an ICF, Double Brick, Brick Veneer & Framed House



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ABSTRACT

This report compares the thermal efficiency of an ICF construction compared to a Brick Cavity, Brick Veneer & Framed House construction. A Home Energy Rating was conducted on a single and double storey house modeled with four types of exterior wall; ICF, Brick Cavity, Brick Veneer & Framed construction. The Home Energy Rating was carried out in accordance with *ABCB Protocol for House Energy Rating Software*. The house was modeled in 11 Cities, representing a range of Australian Climates including; Perth, Adelaide, Brisbane, Canberra, Darwin, Hobart, Melbourne, Sydney, Cairns, Carnarvon and Albany.

House 1 consisted of a 1 Storey (289.4m2), 4 bedroom, 2 Bathroom dwelling with Double Garage. House 2 consisted of a 2 Storey (201.2m2), 3 Bedroom, 2 Bathroom Dwelling with Double Carport

The results show that in a majority of given climates ICF Construction achieve a higher thermal performance and lower energy requirements for heating & cooling than the Brick Cavity, Brick Veneer & Framed Houses. The most significant reduction is in the lower heating requirements needed to keep the house comfortable in winter.

Content

Introduction

This report compares the thermal efficiency of an Insulated Concrete Form (ICF) construction compared to a Brick Cavity, Brick Veneer & Framed House. It demonstrates the results of an assessment on the thermal efficiency attributes of ICF Construction compared to heavy weight brick cavity walls, brick veneer and lightweight framed construction. The comparison has been conducted on 2 house types; type 1 single storey and type 2 double storey house. Each house type has the same layout but is modeled with different exterior, interior and floor systems.

Climate

The thermal performance of a building depends largely on the climate of which the building is located, for this reason the houses have been modeled in a number of different climates. Eleven cities that represent the range of climates within Australia were chosen: Perth, Adelaide, Brisbane, Canberra, Darwin, Hobart, Melbourne, Sydney, Cairns, Carnarvon and Albany.

The location and the associated Home Energy Rating Climate Zone are as follows:

Table 1 Home Energy Rating Climate Zone

LOCATION	HERS CLIMATE ZONE	DESCRIPTION
Perth	13	Warm Temperate
Adelaide	16	Warm Temperate
Brisbane	10	Warm Humid Summer, Mild Winter
Canberra	24	Cool Temperate
Darwin	1	High Humid Summer, Warm Winter
Hobart	26	Cool Temperate
Melbourne	21	Mild Temperate
Sydney	17	Warm Temperate
Cairns	32	High Humid Summer, Warm Winter
Carnarvon	33	Hot Dry Summer, warm winter
Albany	58	Mild Temperate

Building Envelope

The Building Envelope construction (roof space, exterior walls, windows & slab-on ground floors) are illustrated in Table 2 for the 11 Cities where the houses are modeled.

Table 2 Specifications of Typical Building (House Type 1 & 2)

Construction	Internal Wall	Suspended Floor (House Type 2)	Wall insulation	Ceiling Insulation	Windows	
					U	SHGC
Brick Cavity	Single Leaf Brick	Suspended Slab	None	R3	6.5	.75
Brick Veneer	Framed Wall	Timber Framed	R1.5	R3	6.5	.75
Framed	Framed Wall	Timber Framed	R1.5	R3	6.5	.75
ICF	Single Leaf Brick	FormDeck	None	R3	6.5	.75

Windows. Windows are based on a single clear glass with an aluminum frame. The window to floor area of house type 1 (single Storey) is 13.7% with the window to floor area of house type 2 (double Storey) is 20.8%. The u value is the measure of heat conduced through the window from the outside to the air inside, the SHGC is the amount of radiant solar heat admitted by the window and the R-Value is a measure of thermal resistance.

External Walls. The external walls of the Brick Veneer and Framed Construction included R1.5 Bulk insulation. The exterior walls of the ICF House consisted of FormCraft Wall System consisting of reinforced render system, 60mm Polystyrene, 100mm Concrete, 60mm Polystyrene, and 13mm Plasterboards. The R-Value of the FormCraft Wall is 3.5 based on Thermal Resistance Calculation provided by *Gabriel's Environmental Design*. The Brick Cavity Wall consisted of 2 Leafs of brick with a Total R value of 0.52 based on BERS Home Energy Rating Software

Roof & Ceilings. The roof consists of a Metal Deck with R3 insulation to a flat plasterboard ceiling.

Floors. The ground floor construction consists of a slab on ground with a combination of carpet and tiles. Second story floors are as per Table 2 and consist of carpet and tile floor coverings

House Energy Rating Software

House Energy Rating use thermal simulation computer programs to determine the thermal performance of a house, analysing all the elements of the building to determine how much cooling & heating energy is needed to maintain a comfortable internal temperature expressed as a measurement of MJ/m2/annum.

The BERS (Building Energy Rating Scheme) computer program is a tool used to simulate and analyse the thermal performance of Australian houses in climates ranging from Alpine to tropical.

BERS has been used to simulate the hourly energy requirements over a one year period. The energy requirements for cooling and heating are presented in Table 3. Although energy simulation is not an accurate predictor of actual energy use, it is a suitable tool for comparing and evaluating different constructions.

Heating and cooling loads will vary with orientation of the building; each house has been modeled with north facing the front elevation of each plan.

Table 3 Type 1 (1 Storey) Energy Requirements

PROJECT DETAILS		ADJUSTED ENERGY REQUIREMENT (MJ/m2)			
Area	Construction	Heating Load	Cooling Load	Total Load	Star Rating
Perth	Brick Cavity	71.0	11.4	82.5	5
	Brick Veneer	46.3	24.3	70.6	5.5
	Framed	48.6	27.8	76.3	5.5
	FormCraft	43.2	11.2	51.8	6.5
FormCraft achieved an energy saving of 37.2% over Brick Cavity, 26.6% over Brick Veneer & 32.1% over Light Framed					
Adelaide	Brick Cavity	115.7	18.5	134.3	4.5
	Brick Veneer	81.1	22.7	103.7	5.5
	Framed	79.3	28.6	107.7	5.5
	FormCraft	71.0	19.0	90.0	6
FormCraft achieved an energy saving of 33% over Brick Cavity, 13.2% over Brick Veneer & 16.5% over Light Framed					
Brisbane	Brick Cavity	21.5	36.6	58.2	4.5
	Brick Veneer	16.0	36.1	52.2	5
	Framed	15.1	45.3	60.4	4.5
	FormCraft	12.6	48.5	61.1	4.5
FormCraft achieved an energy loss of 5.1% over Brick Cavity, 17.1%% over Brick Veneer & 1.2% over Light Framed					
Canberra	Brick Cavity	314.9	1.8	316.8	3.5
	Brick Veneer	233.6	5.7	239.2	4.5
	Framed	227.0	9.9	236.8	4.5
	FormCraft	217.1	5.8	223.0	4.5
FormCraft achieved an energy saving of 29.6% over Brick Cavity, 6.8% over Brick Veneer & 5.8% over Light Framed					
Darwin	Brick Cavity	0.0	367.9	367.9	5.5
	Brick Veneer	0.0	332.1	332.1	6
	Framed	0.0	350.5	350.5	6
	FormCraft	0.0	338.2	338.2	6
FormCraft achieved an energy saving of 8.1% over Brick Cavity, an energy loss of 1.8% over Brick Veneer & a energy saving of 3.5% over Light Framed					
Hobart	Brick Cavity	331.8	0.0	332.1	3
	Brick Veneer	244.1	0.7	244.8	4
	Framed	245.2	1.4	246.4	4
	FormCraft	239.4	0.7	240.1	4
FormCraft achieved an energy saving of 27.7% over Brick Cavity, 3.1% over Brick Veneer & 2.6% over Light Framed					
Melbourne	Brick Cavity	209.2	5.1	214.3	3.5
	Brick Veneer	150.5	9.5	159.9	4.5
	Framed	149.0	13.3	162.3	4.5
	FormCraft	147.8	6.9	154.9	4.5

FormCraft achieved an energy saving of 27.7% over Brick Cavity, 3.1% over Brick Veneer & 4.6% over Light Framed					
Sydney	Brick Cavity	41.4	19.3	60.7	4
	Brick Veneer	29.1	16.4	45.5	5
	Framed	25.1	21.4	46.5	5
	FormCraft	21.9	22.8	44.7	5
FormCraft achieved an energy saving of 26.3% over Brick Cavity, 1.7% over Brick Veneer & 3.8% over Light Framed					
Carnarvon	Brick Cavity	2.6	72.7	75.3	4
	Brick Veneer	3.5	54.0	57.4	5.5
	Framed	3.3	74.3	77.7	4
	FormCraft	0.7	69.9	70.7	4.5
FormCraft achieved an energy saving of 26.3% over Brick Cavity, an energy loss of 23.1% over Brick Veneer & a energy saving of 3.8% over Light Framed					
Albany	Brick Cavity	178.7	1.8	180.5	3
	Brick Veneer	130.3	3.4	133.7	4
	Framed	131.9	5.6	137.4	4
	FormCraft	125.4	3.0	128.5	4
FormCraft achieved an energy saving of 28.8% over Brick Cavity, 3.9% over Brick Veneer & 6.5% over Light Framed					

Table 4 Type 2 (2 Storey) Energy Requirements

PROJECT DETAILS		ADJUSTED ENERGY REQUIREMENT (MJ/m2)			
Area	Construction	Heating Load	Cooling Load	Total Load	Star Rating
Perth	Brick Cavity	63.7	49.8	113.4	4
	Brick Veneer	48.4	86.2	134.6	3.5
	Framed	56	97.2	153.2	3
	Formcraft	29.6	61.3	51.8	4.5
FormCraft achieved an energy saving of 54.3% over Brick Cavity, 61.5% over Brick Veneer & 66.1% over Light Framed					
Adelaide	Brick Cavity	121.7	63.6	185.3	3.5
	Brick Veneer	81.1	79.5	160.7	4
	Framed	92.4	90.4	182.9	3.5
	FormCraft	62.5	63.7	126.2	4.5
FormCraft achieved an energy saving of 31.9% over Brick Cavity, 21.5% over Brick Veneer & 31% over Light Framed					
Brisbane	Brick Cavity	18.7	45.7	64.4	4
	Brick Veneer	19	61.3	80.3	3.5
	Framed	34.2	82.1	116.2	2.5
	FormCraft	9.6	55.3	64.8	4

FormCraft achieved an energy loss of 0.6% over Brick Cavity, an energy saving of 19.3% over Brick Veneer & 44.2% over Light Framed					
Canberra	Brick Cavity	346.6	15.2	361.7	3
	Brick Veneer	207.5	40.5	247.9	3.5
	Framed	239.1	54.6	293.7	3.5
	FormCraft	173.2	29.7	203	5
FormCraft achieved an energy saving of 43.8% over Brick Cavity, 18.1% over Brick Veneer 30.8% over Light Framed					
Darwin	Brick Cavity	0	464.7	464.7	3.5
	Brick Veneer	0	487.6	487.6	4
	Framed	0	460.7	460.7	4
	FormCraft	0	412.9	412.9	4.5
FormCraft achieved an energy saving of 11.2% over Brick Cavity, 7.9% over Brick Veneer & 10.4% over Light Framed					
Hobart	Brick Cavity	375.3	1.8	377.1	2.5
	Brick Veneer	232.7	4.9	237.5	4.5
	Framed	225.2	5.4	230.6	4.5
	FormCraft	214.7	3.3	218	4.5
FormCraft achieved an energy saving of 42.2% over Brick Cavity, 0.23% over Brick Veneer & 5.5% over Light Framed					
Melbourne	Brick Cavity	247.8	23.6	271.5	3
	Brick Veneer	140.9	35.4	176.3	4
	Framed	146.3	39.3	185.6	4
	FormCraft	134.6	25.7	160.3	4.5
FormCraft achieved an energy saving of 40.9% over Brick Cavity , 9% over Brick Veneer & 13.6% over Light Framed					
Sydney	Brick Cavity	31.6	44.8	76.4	3.5
	Brick Veneer	27.2	59.6	86.8	3
	Framed	31.6	64.4	95.9	3
	FormCraft	13.4	52.5	66.1	4
FormCraft achieved an energy saving of 13.5% over Brick Cavity, 23.9% over Brick Veneer & 31% over Light Framed					
Carnarvon	Brick Cavity	2.9	91.6	94.4	3
	Brick Veneer	8.2	117.1	125.3	2
	Framed	10.7	124.5	135.1	2
	FormCraft	1.9	96.6	98.5	3
FormCraft achieved an energy loss of 4.34% over Brick Cavity, a energy saving of 21.4% over Brick Veneer & 27% over Light Framed					
Albany	Brick Cavity	175.2	7.6	182.8	3
	Brick Veneer	114.4	18.6	133.0	4
	Framed	125	21.2	146.2	4
	FormCraft	92.2	12.7	104.9	5

FormCraft achieved an energy saving of 42.6% over Brick Cavity, 21.2% over Brick Veneer & a energy saving of 28.3% over Light Framed

In the majority of climate zones, the ICF House achieved lower household Energy Requirements compared to the Brick Cavity, Brick Veneer & Framed House with the lower household energy use ranging from 0.2 to 66%.

The areas where the FormCraft did not achieve lower energy requirements was in comparison to a single storey light framed (-1.22%) & heavyweight (-5%) house in Brisbane, a single storey brick veneer house in Brisbane (-17.1%), Darwin (-1.8%) and Carnarvon (-23.1%). A 2 Storey heavyweight house in Brisbane (-0.57%) and Carnarvon (-4.4%) also performed better then the FormCraft.

Another Important difference between the two houses is that heating requirements were less in ICF Construction then all other construction methods in all climate zones. This is a result of a combination of a well insulated envelope provided by R3.5 Insulation and thermal mass of the ICF Construction moderating temperature swings.

The areas where ICF did not perform as well as other construction were due to areas where key design responses consist of lightweight (low mass) construction. The heavyweight construction and high R value of the external walls act to trap heat in the building which causes thermal discomfort. This can be overcome by careful design, well shaded and good cross flow ventilated buildings.

Energy Efficiency Provisions of the BCA

The Energy Provisions of the Building Codes of Australia set the standard for houses in Australia in respect to Thermal Efficiency. The energy efficiency provisions of the BCA are applicable to new and fully refurbished dwellings.

External Wall

It is a requirement under the deemed to satisfy energy efficiency provisions of the BCA Part 3.12.1.4 (a) that an External Wall has a minimum Total R Value as specified under the table below, with various alternative options available for compliance. Masonry (Brick Cavity) Construction will comply with External wall requirements based on the additional requirements listed in Table 5. It can be seen the ICF has the benefit over Brick Cavity Walls in a number of different climate zone where additional requirements are needed for Masonry Construction, which include insulation and shading.

Table 5 BCA External Wall Requirements

Climate Zone	Total R-Value	Masonry Requirement
1	1.9	1. Incorporate reflective insulation 2. Construct on a flooring system that is in direct contact with the ground (e.g. slab on ground) 3. Shade external wall at a min angle of 15 degrees
2(below 300m altitude)	1.9	1. Construct on a flooring system that is in direct contact with the ground (e.g. slab on ground)
2(at or above 300m altitude)	1.9	1. Construct on a flooring system that is in direct contact with the ground (e.g. slab on ground)
3	1.9	1. Achieve a Total R value of 1.4 2. Construct on a flooring system that is in direct contact with the ground (e.g. slab on ground)
4	2.2	1. Construct on a flooring system that is in direct contact with the ground (e.g. slab on ground)
5	1.9	1. Construct on a flooring system that is in direct contact with the ground (e.g. slab on ground)
6	2.2	1. Incorporate insulation with an R-Value of not less than 0.5 2. Construct on a flooring system that is in direct contact with the ground (e.g. slab on ground)
7	2.4	1. Incorporate insulation with an R-Value of not less than 1
8	3.3	2. Incorporate insulation with an R-Value of not less than 1.5

Conclusions

This report presents the results of an assessment of the Thermal Performance of an ICF Construction compared to Brick Cavity Wall and Light Framed Construction. A Home Energy Rating (HER) was conducted on two types of houses (Single & Double Storey) with three types of exterior walls: an ICF Wall, A Brick Cavity Wall and a Stud Framed Wall. The House Energy Rating was conducted in accordance with *ABCB Protocol for House Energy Rating Software.*

The Results Show that in the majority of Locations for both Single and double storey houses the ICF house achieves lower heating and cooling requirements with the exception of a single storey light framed (-1.22%) & heavyweight (-5%) house in Brisbane, a single storey brick veneer house in Brisbane (-17.1%), Darwin (-1.8%) and Carnarvon (-23.1%). A 2 Storey heavyweight house in Brisbane (-0.57%) and Carnarvon (-4.4%) also performed better then the FormCraft.

The areas where ICF did not perform as well as other construction were due to areas where key design responses consist of lightweight (low mass) construction. The heavyweight construction and high R value of the external walls act to trap heat in the building which causes thermal discomfort. This can be overcome by careful design, well shaded and good cross flow ventilated buildings.

The ICF house performs better than the Brick Cavity House due to the additional R Value of the Wall and better then the Light framed house due to the combination of the additional R Value and the thermal mass of the concrete, the thermal mass having the ability to absorb heat energy creating stable internal temperatures. Where the ICF may not perform as well is in, high humid summer and hot, warm winters (e.g. Darwin, Brisbane) where key design responses include employing lightweight (low mass) construction.

ICF has additional advantages in regards to the requirements for compliance with the Energy Efficiency Provisions of the BCA. It is demonstrated that ICF has the benefit over Brick Cavity

Walls where additional requirements are needed for Masonry Construction, which include insulation and shading.

APENDIX 1 – House 1 Specification

Project Brick Cavity Run 1

Summary

Conditioned Area	221.9 m²
Unconditioned Area	67.6 m²
Total Floor Area	289.4 m²
Total Glazed Area	39.5 m²
Total External Solid door Area	14.2 m²
Glass to Floor Area	13.7 %
Gross External Wall Area	207.0 m²
Net External Wall Area	153.3 m²

Window

Area 39.5 m² GGG-05-001a Generics Uval 6.46 SHGC 0.76
Glass Single Glazed Clear
Frame Aluminium

External Wall

Net Wall Area 28.7 m² Single Skin Brick No Insulation (garage)
Net Wall Area 124.6 m² Cavity Brick No Insulation

Internal Wall

Net Wall Area 219.8 m² Single Skin Brick No Insulation

External Floor

Floor Area 34.5 m² Concrete Slab on Ground No Insulation Bare (garage)
Floor Area 126.0 m² Concrete Slab on Ground No Insulation Carpet and Underlay
Floor Area 128.9 m² Concrete Slab on Ground No Insulation Ceramic Tiles

External Ceiling

Ceiling Area 289.4 m² Plasterboard Bulk Insulation R 3.0 0° slope Highly ventilated roofspace cavity above ceiling

Roof

Floor Area 289.4 m² Corrugated Iron No Insulation 22° slope Hip roof

Project Brick Veneer Run 1

Summary

Conditioned Area	221.9 m²
Unconditioned Area	67.6 m²
Total Floor Area	289.4 m²
Total Glazed Area	39.5 m²
Total External Solid door Area	14.2 m²
Glass to Floor Area	13.7 %
Gross External Wall Area	207.0 m²
Net External Wall Area	153.3 m²

Window

Area 39.5 m² GGG-05-001a Generics Uval 6.46 SHGC 0.76
Glass Single Glazed Clear
Frame Aluminium

External Wall

Net Wall Area 153.3 m² Brick Veneer Bulk Insulation R 1.5

Internal Wall

Net Wall Area 219.8 m² Cavity Panel 75mm gap No Insulation

External Floor

Floor Area 34.5 m² Concrete Slab on Ground No Insulation Bare
Floor Area 126.0 m² Concrete Slab on Ground No Insulation Carpet and Underlay
Floor Area 128.9 m² Concrete Slab on Ground No Insulation Ceramic Tiles

External Ceiling

Ceiling Area 289.4 m² Plasterboard Bulk Insulation R 3.0 0° slope Highly ventilated roofspace cavity above ceiling

Roof

Floor Area 289.4 m² Corrugated Iron No Insulation 22° slope Hip roof

Project Framed Construction Run 1

Summary

Conditioned Area	221.9 m²
Unconditioned Area	67.6 m²
Total Floor Area	289.4 m²
Total Glazed Area	39.5 m²
Total External Solid door Area	14.2 m²
Glass to Floor Area	13.7 %
Gross External Wall Area	207.0 m²
Net External Wall Area	153.3 m²

Window

Area 39.5 m² GGG-05-001a Generics Uval 6.46 SHGC 0.76
Glass Single Glazed Clear
Frame Aluminium

External Wall

Net Wall Area 153.3 m² Cavity Panel 70mm gap Bulk Insulation R 1.5

Internal Wall

Net Wall Area 219.8 m² Cavity Panel 75mm gap No Insulation

External Floor

Floor Area 34.5 m² Concrete Slab on Ground No Insulation Bare
Floor Area 126.0 m² Concrete Slab on Ground No Insulation Carpet and Underlay
Floor Area 128.9 m² Concrete Slab on Ground No Insulation Ceramic Tiles

External Ceiling

Ceiling Area 289.4 m² Plasterboard Bulk Insulation R 3.0 0° slope Highly ventilated roofspace cavity above ceiling

Roof

Floor Area 289.4 m² Corrugated Iron No Insulation 22° slope Hip roof

Project FormCraft Run 1

Summary

Conditioned Area	221.9 m²
Unconditioned Area	67.6 m²
Total Floor Area	289.4 m²
Total Glazed Area	39.5 m²
Total External Solid door Area	14.2 m²
Glass to Floor Area	13.7 %
Gross External Wall Area	207.0 m²
Net External Wall Area	153.3 m²

Window

Area 39.5 m² GGG-05-001a Generics Uval 6.46 SHGC 0.76
Glass Single Glazed Clear
Frame Aluminium

External Wall

Net Wall Area 153.3 m² Tilt Concrete Bulk Insulation R 3.4

Internal Wall

Net Wall Area 219.8 m² Single Skin Brick No Insulation

External Floor

Floor Area 34.5 m² Concrete Slab on Ground No Insulation Bare
Floor Area 126.0 m² Concrete Slab on Ground No Insulation Carpet and Underlay
Floor Area 128.9 m² Concrete Slab on Ground No Insulation Ceramic Tiles

External Ceiling

Ceiling Area 289.4 m² Plasterboard Bulk Insulation R 3.0 0° slope Highly ventilated roofspace cavity above ceiling

Roof

Floor Area 289.4 m² Corrugated Iron No Insulation 22° slope Hip roof

APENDIX 2 – House 2 Specification

Project Brick Cavity Run 1

Summary

Conditioned Area	141.2 m²
Unconditioned Area	60.0 m²
Total Floor Area	201.2 m²
Total Glazed Area	41.8 m²
Total External Solid door Area	12.0 m²
Glass to Floor Area	20.8 %
Gross External Wall Area	242.2 m²
Net External Wall Area	188.4 m²

Window

Area 41.8 m² GGG-05-001a Generics Uval 6.46 SHGC 0.76
Glass Single Glazed Clear
Frame Aluminium

External Wall

Net Wall Area 25.3 m² Single Skin Brick No Insulation (garage)
Net Wall Area 163.1 m² Cavity Brick No Insulation

Internal Wall

Net Wall Area 155.2 m² Single Skin Brick No Insulation

External Floor

Floor Area 36.2 m² Concrete Slab on Ground No Insulation Bare (garage)
Floor Area 43.5 m² Concrete Slab on Ground No Insulation Carpet and Underlay
Floor Area 32.0 m² Concrete Slab on Ground No Insulation Ceramic Tiles

External Ceiling

Ceiling Area 50.2 m² Plasterboard Bulk Insulation R 3.0 0° slope Unventilated roofspace cavity above ceiling
Ceiling Area 66.3 m² Plasterboard Bulk Insulation R 3.0 22° slope Unventilated roofspace cavity above ceiling

Roof

Floor Area 15.7 m² Corrugated Iron No Insulation 0° slope Hip roof
Floor Area 89.4 m² Corrugated Iron No Insulation 22° slope Hip roof

Project Brick Veneer Run 1

Summary

Conditioned Area	141.2 m²
Unconditioned Area	60.0 m²
Total Floor Area	201.2 m²
Total Glazed Area	41.8 m²
Total External Solid door Area	12.0 m²
Glass to Floor Area	20.8 %
Gross External Wall Area	242.2 m²
Net External Wall Area	188.2 m²

Window

Area 41.8 m² GGG-05-001a Generics Uval 6.46 SHGC 0.76
Glass Single Glazed Clear
Frame Aluminium

External Wall

Net Wall Area 188.4 m² Brick Veneer Bulk Insulation R 1.5

Internal Wall

Net Wall Area 155.2 m² Cavity Panel 75mm gap No Insulation

External Floor

Floor Area 36.2 m² Concrete Slab on Ground No Insulation Bare
Floor Area 43.5 m² Concrete Slab on Ground No Insulation Carpet and Underlay
Floor Area 32.0 m² Concrete Slab on Ground No Insulation Ceramic Tiles

External Ceiling

Ceiling Area 50.2 m² Plasterboard Bulk Insulation R 3.0 0° slope Unventilated roofspace cavity above ceiling
Ceiling Area 66.3 m² Plasterboard Bulk Insulation R 3.0 22° slope Unventilated roofspace cavity above ceiling

Roof

Floor Area 15.7 m² Corrugated Iron No Insulation 0° slope Hip roof
Floor Area 89.4 m² Corrugated Iron No Insulation 22° slope Hip roof

Project Framed Construction Run 1

Summary

Conditioned Area	141.2 m²
Unconditioned Area	60.0 m²
Total Floor Area	201.2 m²
Total Glazed Area	41.8 m²
Total External Solid door Area	12.0 m²
Glass to Floor Area	20.8 %
Gross External Wall Area	242.2 m²
Net External Wall Area	188.4 m²

Window

Area 41.8 m² GGG-05-001a Generics Uval 6.46 SHGC 0.76
Glass Single Glazed Clear
Frame Aluminium

External Wall

Net Wall Area 188.4 m² Cavity Panel 70mm gap Bulk Insulation R 1.5

Internal Wall

Net Wall Area 155.2 m² Cavity Panel 75mm gap No Insulation

External Floor

Floor Area 36.2 m² Concrete Slab on Ground No Insulation Bare
Floor Area 43.5 m² Concrete Slab on Ground No Insulation Carpet and Underlay
Floor Area 32.0 m² Concrete Slab on Ground No Insulation Ceramic Tiles

External Ceiling

Ceiling Area 50.2 m² Plasterboard Bulk Insulation R 3.0 0° slope Unventilated roofspace cavity above ceiling
Ceiling Area 66.3 m² Plasterboard Bulk Insulation R 3.0 22° slope Unventilated roofspace cavity above ceiling

Roof

Floor Area 15.7 m² Corrugated Iron No Insulation 0° slope Hip roof
Floor Area 89.4 m² Corrugated Iron No Insulation 22° slope Hip roof

Project Formcraft Run 1

Summary

Conditioned Area	141.2 m²
Unconditioned Area	60.0 m²
Total Floor Area	201.2 m²
Total Glazed Area	41.8 m²
Total External Solid door Area	12.0 m²
Glass to Floor Area	20.8 %
Gross External Wall Area	242.2 m²
Net External Wall Area	188.4 m²

Window

Area 41.8 m² GGG-05-001a Generics Uval 6.46 SHGC 0.76
Glass Single Glazed Clear
Frame Aluminium

External Wall

Net Wall Area 188.4 m² Tilt Concrete Bulk Insulation R 3.4

Internal Wall

Net Wall Area 155.2 m² Single Skin Brick No Insulation

External Floor

Floor Area 36.2 m² Concrete Slab on Ground No Insulation Bare
Floor Area 43.5 m² Concrete Slab on Ground No Insulation Carpet and Underlay
Floor Area 32.0 m² Concrete Slab on Ground No Insulation Ceramic Tiles

External Ceiling

Ceiling Area 50.2 m² Plasterboard Bulk Insulation R 3.0 0° slope Unventilated roofspace cavity above ceiling
Ceiling Area 66.3 m² Plasterboard Bulk Insulation R 3.0 22° slope Unventilated roofspace cavity above ceiling

Roof

Floor Area 15.7 m² Corrugated Iron No Insulation 0° slope Hip roof
Floor Area 89.4 m² Corrugated Iron No Insulation 22° slope Hip roof

APPENDIX 3 – Wall Construction

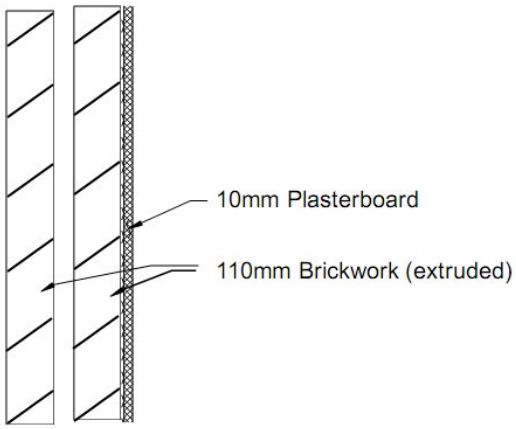

Figure 1. Brick Cavity Wall

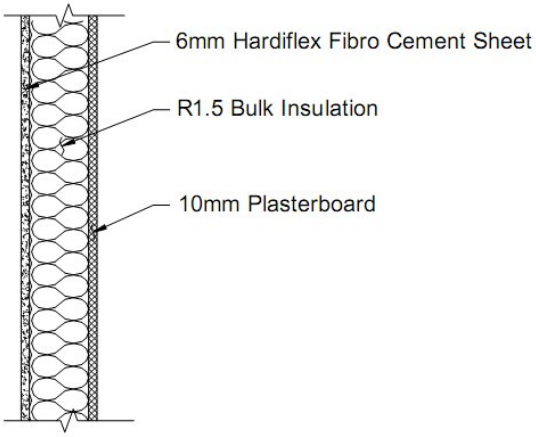

Figure 2 Fibro Cement wall with studwork & bulk insulation

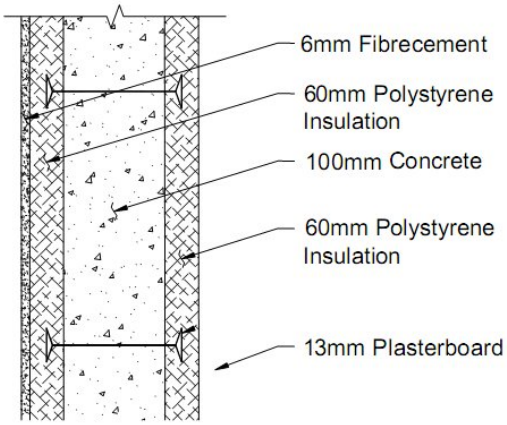

Figure 3 ICF Wall construction