DINCEL
STRUCTURAL WALLING

DINCEL STRUCTURAL WALLING

PART 2 – ENERGY EFFICIENCY FOR BUILDING OPERATIONAL USE

PART 2

ENERGY EFFICIENCY FOR BUILDING OPERATIONAL USE

The energy efficiency of buildings due to heating and cooling is directly related to the façade wall construction. The heat flow at the façade walls required by the Building Code of Australia (BCA) is complied by having the required R-value which is normally satisfied by having additional insulation material. **The recent application of the BCA allows reduction in the required insulation provided that the wall system adopted has density of not less than 220kg/m2. This provision allows some degree of thermal mass being accounted for.**

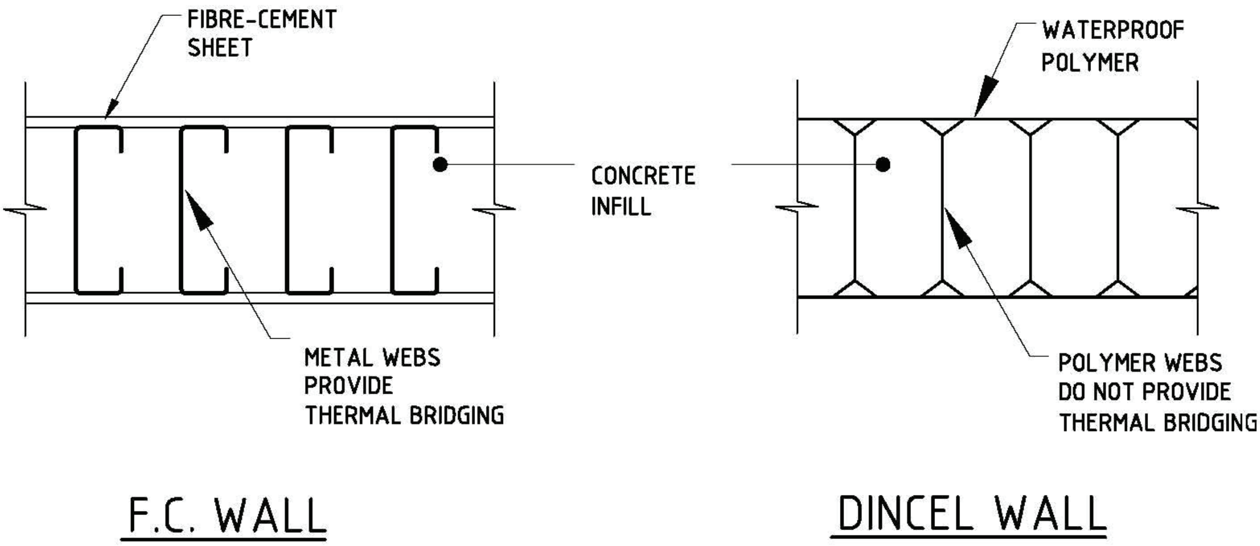
Dincel-Walls comply with this current BCA requirement by either incorporating aerated concrete or additional insulation with normal density concrete. The recommendations to climatical conditions and R-values are provided at the end of this document.

TERMINOLOGY

The factors affecting energy performance of a wall system are thermal bridging, air tightness of the enclosures and thermal mass. The combined effect of these factors is generally not considered when comparing the thermal performance of a building system. Normally a simple R-value is quoted. The research by CSIRO [3] demonstrates that the use of R-Values alone in assessing the thermal performance of a building can be misleading.

Thermal bridging: Dincel Construction System with its permanent impervious polymer skin significantly reduces the impact of thermal bridging in building envelopes.

(Thermal bridges are the regions of relatively high heat flow conductance in a building envelope and can seriously interfere with the performance of buildings. The negative influence of the thermal bridge exists when the thermal bridge decreases the internal surface temperature which causes internal condensation and formation of mould. Certain building materials are highly conductive of heat and they are the parts of the building construction which create the risk of internal condensation).



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Localised cooling of surfaces commonly occurs as a result of "thermal bridges", elements of the building structure that are highly conductive of heat (e.g. steel studs in exterior facade walls as shown in the above diagram, conventional concrete walls without Dincel's permanent polymer protection, un-insulated window lintels, and the edges of concrete floor slabs). Dust particles sometimes mark the locations of thermal bridges, because dust tends to adhere to cold spots. *If **thermal bridging** exists, the internal face of a façade wall must be protected by a cavity construction material or additional insulation material.*

Thermal energy flow [1, 2, 3]: Dincel Construction System with its 200mm thick concrete core forms a thermal mass envelope which acts to prevent large changes in indoor temperature as the outdoor temperatures rise or fall.

*(**Thermal mass** refers to a material's ability to store up thermal energy due to its mass. Thermal mass absorbs solar energy during the day and keeps the house from overheating and at night releases heat. Ultimately generating a warmer home at night in winter and a cooler home during the day in summer. Thermal mass can moderate the temperature of occupied spaces, minimise the need for mechanical cooling and reduce winter heating requirements. Thermal mass in the form of concrete, masonry or water has significant storage capacity for heating and cooling. The greater the area of thermal mass, the greater its ability to store heat and maintain a uniform temperature).*

During summer it absorbs heat, keeping the home comfortable, correct use of thermal mass (i.e. passive solar design and thermal mass together) can delay heat flow through the building envelope by as much as 10 to 12 hours [1] producing a warmer home at night in winter and a cooler home during the day in summer. However poor use of thermal mass can cause comfort liability, for this reason thermal mass should always be used together with a good passive solar design.[2]

Air leakage: Crack and joint free Dincel-Wall with its permanent impervious polymer skin works as an effective air barrier systems significantly reducing the impact of thermal bridging in building envelopes. **Droughts can account for up to 25% of heat loss.**

*(**Air leakage** or uncontrolled air flow, can have a damaging effect on the performance of a building. The energy use associated with penetration may account for more heat loss than is occurring by conduction through the insulation. Infiltration of cold air in space adjacent to the exterior walls may result in a loss of temperature and humidity control the build-up of moisture in the building envelope can reduce the service life of materials in the envelope).*

Condensation: Dincel Construction System acts as a vapour barrier for both internal and external faces of the exterior façade wall. Vapour barriers need to be placed on the warm side of the wall to prevent condensation.

*(**Condensation:** The amount of water vapour that air can hold is a function of temperature. When moist air comes into contact with either colder air or a colder surface, the air is unable to retain the same amount of moisture and the water is released to form condensation in the air on the surface. This process of condensation can reduce the service life of materials in the building envelope and causes long-term deterioration. One way to control condensation is to exchange the high moisture content air with air having lower moisture content. This is commonly called **ventilation**. Another method of controlling condensation is through the use of **vapour barriers**).*

Vapour Barriier

The table below shows the list of common building materials and their relative vapour resistance. The higher the value the more impervious the material is to the passage of water vapour. (Refer www.specifypga.com/index/articles)

MATERIAL	RELATIVE VAPOUR RESISTANCE
Mineral Wool	Negligible
Brickwork	1
Plaster	2
Timber	2
Plasterboard	2
Gloss Paint Film	20,000
Polymer Sheet*	45,000
Aluminium Foil	1,600,000

*Polymer sheet normally consists of polyethylene or vinyl sheets approximately 0.15mm thick.

Dincel-Wall provides a vapour barrier of minimum 2mm thick at each face and offers significantly higher imperviousness than the polymer sheet's value of the above table.

Insulation acts as a barrier to the heat flow of building façade walls for Winter and Summer climatic conditions.

The insulation can be in the forms of additional materials such as foams, batts, etc. or in the form of aerated concrete. The materials with high air content become very porous in nature. The porous materials can accumulate moisture and can cause significant air leakage. The aerated concrete encapsulated within Dincel-Forms will be non-porous and have adequate air content to offer the effective insulation properties because of the presence of permanent polymer skins on both faces of Dincel-Wall as vapour and air barriers.

The selection of additional insulation materials carries importance. A number of commercially available insulation products must be protected against contact with condensation and fire. For these reasons, the recommendation of Dincel Construction System is to use extruded polystyrene foams having a closed cell structure and they are covered by materials such as plasterboard and fibre-cement sheets.

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WHY USE IINSULATIION?

Insulation materials that is generally available for the construction market is a heat flow barrier, not a vapour or air barrier.

The purpose of this heat barrier is:

Summer Condiitiions

The purpose of the heat flow barrier is to prevent the heat from the direct summer sun to reach the building's interior which may create a need for cooling, i.e. energy use. The reality is that windows always transmit much more heat than the wall. The effectiveness of insulation on the walls will therefore diminish with the extent of windows. The most effective way therefore is to have sun shading from direct sun, especially in the western walls and possibly in the northern walls together with walls having thermal mass, vapour barrier on the warm side of the façade wall (i.e. external face).

Wiinter Condiitiions

The purpose of the heat flow barrier (i.e. insulation) is to prevent the heat flow of the heated building's interior space escaping through the façade walls. The warmer air will move towards colder air thus imperviousness of the façade wall is very important for energy efficiency.

Studies show that 25% of heating energy is lost due to air leakage at the building's fabric. Effective utilisation of thermal mass, vapour barriers and insulation, together with passive heating and cooling represents significant potential energy savings in building use.

Air leakage can be attributed to having porous nature façade walls (e.g. brick walls are porous due to its nature of material, joints and cracks), not having air barriers and/or vapour barriers, the leaking wall-window junctions and inappropriate window frame construction and the size of the windows. There is no doubt that majority of leaks occur within and around the window's construction. Dincel-Wall clearly addresses the air leakage problem due to its impervious Dincel-Polymer vapour/air barriers on both faces of Dincel-Wall.

In Australia, it appears that all the emphasis is given for walls having an adequate heat flow barrier capacity. As stated above all the insulation efforts for the walls are easily wasted and have no purpose if the windows do not provide the same heat flow reduction of the walls. This can only be provided to a degree by windows having double glazing for winter conditions and shading to the same window in summer conditions.

The energy efficiency due to heating/cooling in façade walls can be controlled by having only thermal mass, appropriate size and type of glazing, shading and vapour barriers to both wall faces in all climate conditions, except where the outside ambient temperature falls below approximately 5°C. This condition will require insulated walls.

It is important to consider the heat flow of façade walls for the purpose of energy efficiency. The necessity or contribution of additional insulation can be questioned if the façade walls are subjected to air leakage, have big and single glazed windows and located in ambient conditions experiencing cold winters.

The key issue is the air leakage – brick walls have thermal mass but air will easily leak through the brick/mortar material combination or mandatory brick joints or unavoidable wall cracks. The same is applicable to single skin concrete/block walls.

The building authority's requirement is for the façade walls to have air barriers and vapour barriers on the warm face of the façade. This will necessitate the vapour barriers to be on both internal and external faces of the façade walls. The many wall systems with single skin walls conforming to this requirement consist of internally placed sarking as a vapour barrier, and they rely on the externally applied paint/rendering system in which the manufacturing warranty is only for a maximum of 10 years. This cannot be relied upon unless ongoing mandatory maintenance programs are enforced by building authorities. More importantly, commercially available paints/renders are porous and cannot be used as a replacement for conventional vapour barriers even if they have an on-going maintenance program.

The importance of air/vapour barriers are not only necessary for energy efficiency, but more importantly the condensation will lead to unhealthy building air and damaged building materials and shorten the building's life significantly. The shortening of the building's life, i.e. durability/longevity is the most important aspect of embodied energy used during building construction (refer Part 1, Embodied Energy).

Therefore Dincel-Walls incorporating its thermal mass and polymer vapour/air barriers on both faces avoids condensation and air leakage. The presence of in-built permanent vapour barriers, joint and crack free uniqueness of Dincel-Wall separates Dincel-Walls from other alternatives.

The reader may refer to the following link to assess the contribution of insulated conventional walls for energy efficiency.

http://www.energysave.energyaustralia.com.au/energy_calculators

The above link is for the state of New South Wales, Australia. The comparison will only be relevant to similar climates to the state of New South Wales which has temperate climate along the coastal areas. The colder climates and alpine regions will require significantly more energy for heating purposes than what the above calculator indicates. Therefore, the beneficial impact of additional insulation in cold, especially in Alpine climates, cannot be ignored.

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THE CONTRIIBUTIION OF DIINCEL CONSTRUCTIION SYSTEM TO A BUIILDIING’S OPERATIIONAL ENERGY SAVIINGS

Energy efficiency, sick building syndrome, condensation, mould and mildew are issues that are very much related to each other. The reader should read this document together with **(Download – Indoor Air Quality, Condensation, Mould and Mildew)**. The solutions have to be based on climatic conditions.

One of the main solutions to the subject topic is what type, how and where to use insulation. Much literature recommends the use of insulation on the external face of the building fabric. This is especially true in the case of single skin solid walls.

Because of the abovementioned economical and construction reasons, Dincel Construction System is based on the following features:

1. The externally insulated Dincel-Wall (or lightweight aerated concrete filled Dincel-Wall) together with natural/mechanical ventilation, its permanent vapour barriers, waterproof nature and no thermal bridging (no metal studs or exposed slab edges) will provide the best possible solution.
2. Internal and external polymer skins of Dincel-Form work as vapour barriers which are absolutely necessary for condensation and energy efficiency. **Studies show that air leakage at the building periphery can contribute up to 25% heating energy loss.**
3. he condensation and heat loss are directly related to thermal bridging which is a result of having building facade walls that consist of metal studs. The metal studs being highly conductive, transfer the heat or cold on either side of the wall.
4. It has been confirmed by CSIRO[3] that thermal mass adds significant energy saving for both cooling and heating. Thermal mass effectiveness increases with the thickness of a solid wall. For example, a 100mm thick concrete wall will not give the same performance as a 200mm thick wall. In fact, the thermal mass capacity of a 100mm thick concrete wall without additional insulation can be ignored in the majority of cases.

RECOMMENDATIIONS FOR ENERGY EFFIICIIENT FAÇADE WALL CONSTRUCTIION

Any façade wall specification must consider external finishes – Insulation and Condensation together. Refer **(Download – Finishes)**. The following considers the use of insulation from an energy efficiency point of view only.

The climatic conditions and wall positions mentioned in the following comments are for the Southern Hemisphere – Australia. The readers from the Northern Hemisphere should read the wall references in the opposite direction, e.g. North should be reading as South.

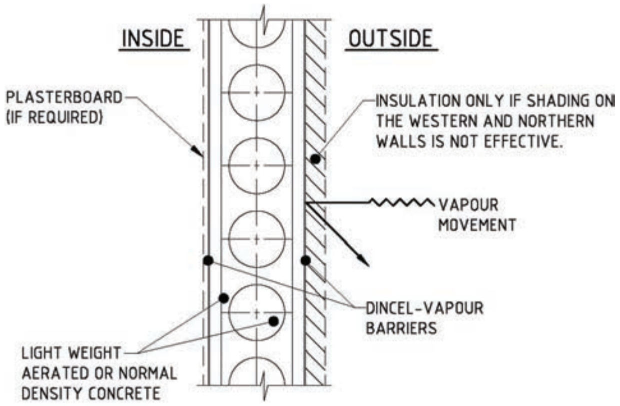
HOT HUMIID CLIIMATES

The climatic conditions covered under this topic include the following:

- Tropical humid (high humidity summer, warm winter).
- Sub-tropical (warm humid summer, mild winter).
- Hot arid summer (warm winter and hot arid summer).

The cooling energy required is essentially independent of the R-Value of the wall system. Specifying a minimum R-Value for the walls for climates that require cooling, thus has little impact on the energy efficiency of the building[3].

In hot humid climates excessive cooling should be avoided. The reduced internal temperature may fall below the dew point and as a result interstitial condensation occurs. Thermal bridging must be avoided and vapour barriers must be provided on the exterior (warm) side of the wall (Dincel-Wall provides vapour barriers on both faces simultaneously). The provisions to avoid excessive cooling generated by air conditioning systems includes cross ventilation and passive solar design (i.e. shading to the Northern and Western walls) used together with thermal mass available from the 200mm thick concrete Dincel-Wall which will provide thermal lag of a minimum of six (6) hours. Alternatively, if the above provisions are not adequate, externally applied insulation, especially on the Northern and Western walls should be considered to prevent the over heating of the concrete wall.



HOT HUMID CLIMATE WALLS

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COOLER (WIINTER) CLIIMATES

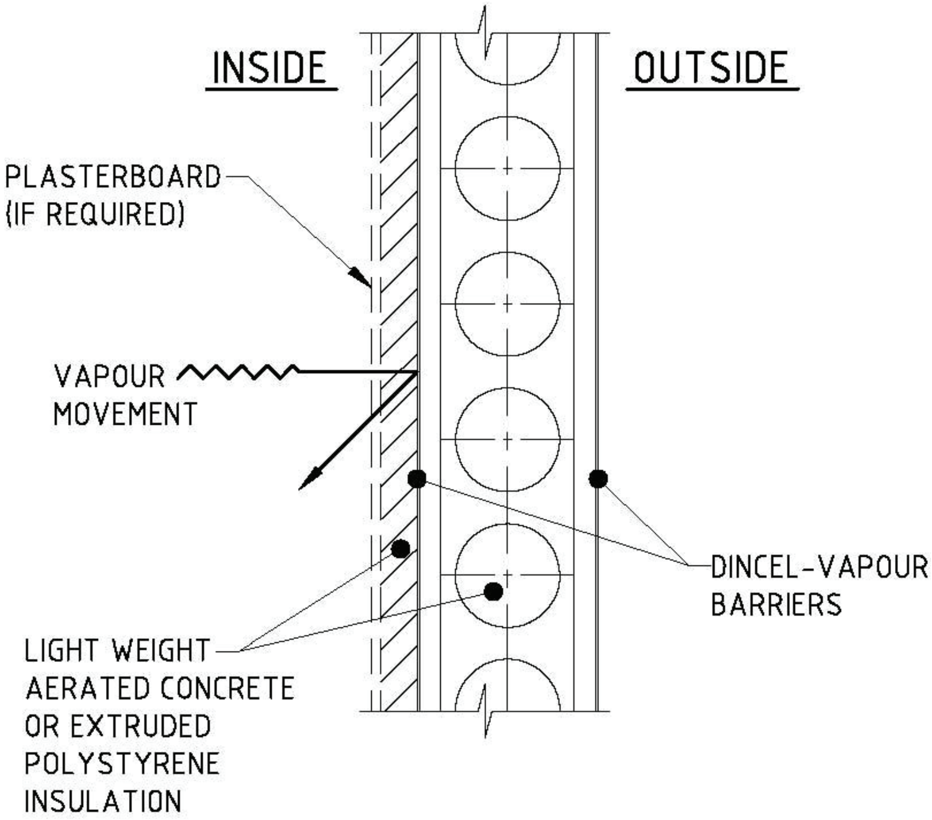
The climatic conditions covered under this topic include the following:

• Alpine areas.

• Cool temperate climates.

In cooler (Winter) climates where heating is a predominant requirement, once the walls are insulated, the heating energy differences between the wall types are relatively small and the location of insulation (inside face, outside face, central or both faces) has little impact. [3,6]

Dincel-Form filled with lightweight aerated concrete or foam boards of 30mm to 50mm thick at the inside face of Dincel-Wall can be used as an effective insulation. Under heating conditions the use of insulation will improve energy efficiency by reducing heat loss and requiring less heating. The vapour barriers to the interior surface (warm surface due to internal heating) of a single skin concrete façade wall, elimination of thermal bridging (i.e. metal studs of a single skin wall transfer external cold to interior surface), and natural/mechanical ventilation are also essential factors for the elimination of condensation.



COLD CLIMATE WALLS

NOTE: The above detail is recommended for a cladding type of external finish. Place insulation at the external face if render finishes are selected. In the case of insulation being external, minimum 16mm gap between internal plasterboard and Dincel-Wall, and 10mm gap between external Dincel face and the foam board is achieved.

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TEMPERATE CLIIMATES

The climatic conditions covered under this topic include the following:

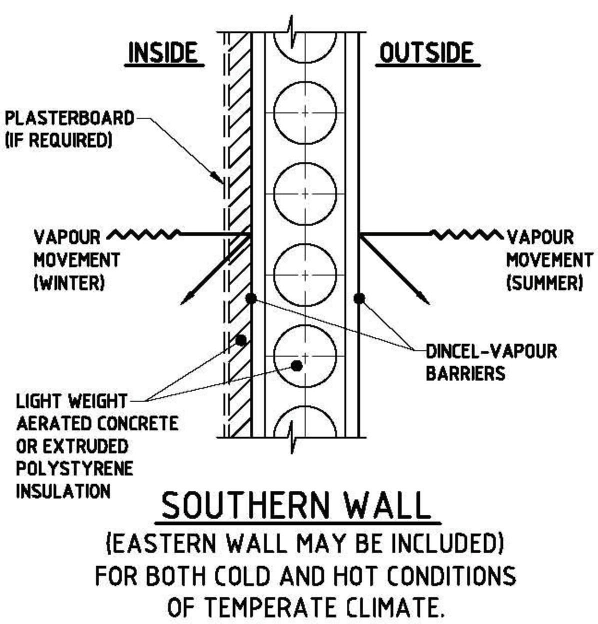
• Warm temperate (hot summer, cool to chilly but generally sunny winters).

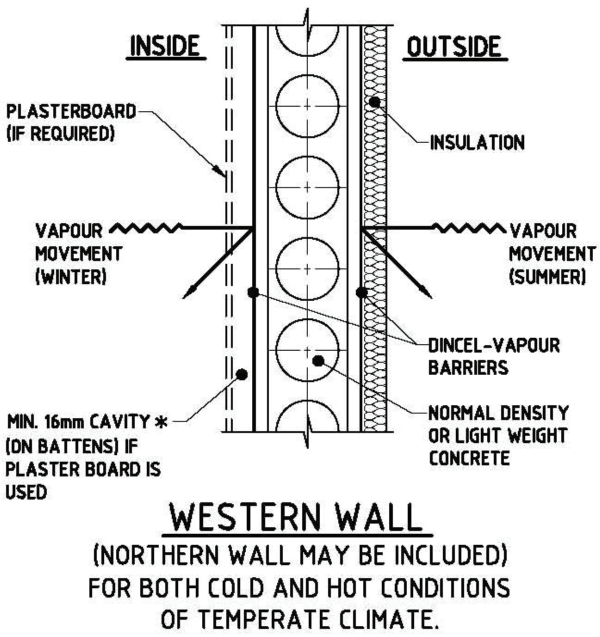
• Mild temperate (summers average about 27°c, winters need heating).

• Cool temperate (winter heating is a major issue, overheating in summer should not be ignored).

Building walls of temperate climates may experience hot summers and cold winters. Vapour barriers and avoidance of thermal bridging at both faces of a single skin façade wall is required. The presence of Dincel-Wall automatically complies with these requirements.

If the same wall of temperate climate experiences both hot and cold, the use of internally placed insulation may create comfort liability in summer conditions, especially on the Western walls, and to some degree in the Northern walls as well. However, the reader must remember that insulation, especially for winter conditions, is required for energy efficiency, i.e. reducing heating energy used in winter conditions.





Both options should incorporate mechanical ventilation for bathrooms, laundries and kitchen exhausts, natural ventilation for the remaining areas. Western walls should incorporate shading on the walls and light coloured external paint finishes to reflect the sunlight for hot summer conditions.

*** Important Note**

A minimum gap of 16mm cavity is recommended for winter conditions where internal temperature at or below 15°c and internal humidity is high (bathroom, laundries, kitchens without mechanical ventilation). The internal moisture will tend to move outside (cold temperature) of Dincel-Wall. The moisture that penetrates through the internal plasterboard will be captured by Dincel-Polymer-vapour barriers. If the plasterboard is directly attached to Dincel-Wall, the possible moisture captured by Dincel-vapour barriers may be absorbed by plasterboard.

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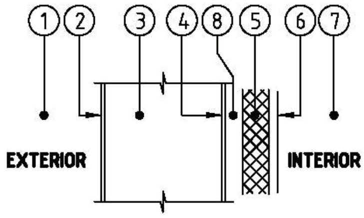
ENERGY EFFICIENCY/THERMAL INSULATION WITH 200MM DINCEL-WALL

The calculation of thermal resistance (R value).



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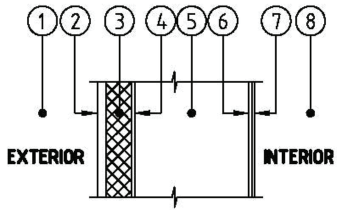
	OPTION 1	OPTION 2
1. Exterior air film	0.04	0.04
2. Exterior polymer skin	0.0174	0.0174
3. 200mm thick concrete wall (min. 2300kg/m3 density) for Option 1	0.138	NIL
700kg/m3 density concrete for Option 2	NIL	1.7
4. Interior polymer skin	0.0174	0.0174
5. 75mm thick extruded polystyrene sheet *	2.595	NIL
6. 10mm thick interior plasterboard	0.06	0.06
7. Indoor air film (still air)	0.12	0.12
Total	R = 2.989m2 k/W	R = 1.95m2k/W

8. Minimum 25mm air gap between 4 & 5 or 6 if used additional R=0.16m2 k/W can be added to the values shown above to achieve a higher rating, i.e. 28mm furring channels for internal plasterboard fixing achieves R = 1.95 + 0.16 = 2.11m2 k/W for Option 2.

HIGH THERMAL MASS CONSTRUCTION (HOT HUMID CLIMATE)



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1. Exterior air film	0.04	0.04
2. Optional 6mm thick fibre-cement board or cement render	0.06	0.06
3. 75mm thick extruded polystyrene sheet *	2.595	NIL
4. Exterior polymer skin	0.0174	0.0174
5. 200mm thick concrete wall (min 2300kg/m3 density)	0.138	NIL
700kg/m3 density lightweigh	NIL	1.7
6. Interior polymer skin	0.0174	0.0174
7. 10mm thick interior plasterboard	0.06	0.06
8. Indoor air film (still air)	0.12	0.12
Total	R = 3.05m2 k/W	R = 2.01m2 k/W

9. Minimum 25mm air gap between 6 & 7 if used additional R=0.16m2 k/W can be added to the values shown above to achieve a higher rating. R = 2.01 + 0.16 = 2.17m2 k/W for Option 2.

* XPS with thermal conductivity 0.0289 W/m.k (Total R value can be changed to suit varying XPS thicknesses and air gaps)

NOTE: The above information needs to be read together with **(Download – Finishes)** and **(Download - Indoor Air Quality, Condensation, Mould, Mildew)**.

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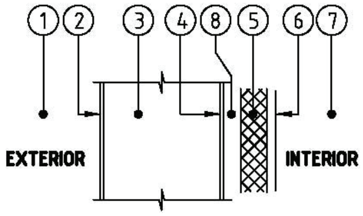
ENERGY EFFICIENCY/THERMAL INSULATION WITH 155MM DINCEL-WALL

The calculation of thermal resistance (R value).

	OPTION 1	OPTION 2
1. Exterior air film	0.04	0.04
2. Exterior polymer skin	0.0174	0.0174
3. 155mm thick concrete wall (min. 2300kg/m3 density) for Option 1	0.108	NIL
700kg/m3 density concrete for Option 2	NIL	1.14
4. Interior polymer skin	0.0174	0.0174
5. 75mm thick extruded polystyrene sheet *	2.595	NIL
6. 10mm thick interior plasterboard	0.06	0.06
7. Indoor air film (still air)	0.12	0.12
Total	R = 2.95m2 k/W	R = 1.39m2k/W



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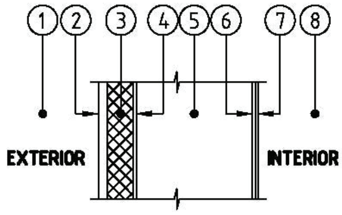
8. Minimum 25mm air gap between 4 & 5 or 6 if used additional R=0.16m2 k/W can be added to the values shown above to achieve a higher rating. R = 1.39 + 0.16 = 1.55m2/kW for Option 2.

HIGH THERMAL MASS CONSTRUCTION (HOT HUMID CLIMATE)

1. Exterior air film	0.04
2. Optional 6mm thick fibre-cement board or cement render	0.06
3. 75mm thick extruded polystyrene sheet *	2.595
4. Exterior polymer skin	0.0174
5. 200mm thick concrete wall (min 2300kg/m3 density)	0.108
6. Interior polymer skin	0.0174
7. 10mm thick interior plasterboard	0.06
8. Indoor air film (still air)	0.12
Total	R = 3.011m2 k/W



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9. Minimum 25mm air gap between 6 & 7 if used additional R=0.16m2 k/W can be added to the values shown above to achieve a higher rating.

* XPS with thermal conductivity 0.0289 W/m.k (Total R value can be changed to suit varying XPS thicknesses and air gaps)

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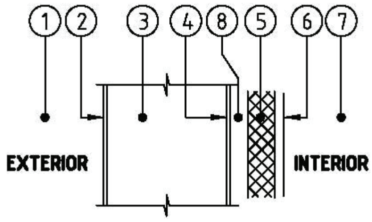
ENERGY EFFICIENCY/THERMAL INSULATION WITH 110MM DINCEL-WALL

The calculation of thermal resistance (R value).

	OPTION 1	OPTION 2
1. Exterior air film	0.04	0.04
2. Exterior polymer skin	0.0174	0.0174
3. 110mm thick concrete wall (min. 2300kg/m3 density) for Option 1	0.076	NIL
700kg/m3 density concrete for Option 2	NIL	0.79
4. Interior polymer skin	0.0174	0.0174
5. 75mm thick extruded polystyrene sheet *	2.595	NIL
6. 10mm thick interior plasterboard	0.06	0.06
7. Indoor air film (still air)	0.12	0.12
Total	R = 2.92m2 k/W	R = 1.01m2k/W



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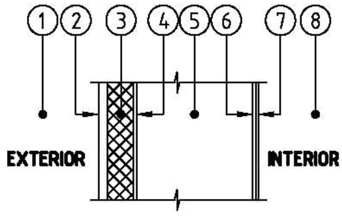
8. Minimum 25mm air gap between 4 & 5 or 6 if used additional R=0.16m2 k/W can be added to the values shown above to achieve a higher rating. R = 1.01 + 0.16 = 1.17m2/kW for Option 2, additional insulation is required to satisfy Section J of the BCA.

HIGH THERMAL MASS CONSTRUCTION (HOT HUMID CLIMATE)

1. Exterior air film	0.04
2. Optional 6mm thick fibre-cement board or cement render	0.06
3. 75mm thick extruded polystyrene sheet *	2.595
4. Exterior polymer skin	0.0174
5. 200mm thick concrete wall (min 2300kg/m3 density)	0.076
6. Interior polymer skin	0.0174
7. 10mm thick interior plasterboard	0.06
8. Indoor air film (still air)	0.12
Total	R = 2.979m2 k/W



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FAÇADE WALLS

9. Minimum 25mm air gap between 6 & 7 if used additional R=0.16m2 k/W can be added to the values shown above to achieve a higher rating.

* XPS with thermal conductivity 0.0289 W/m.k (Total R value can be changed to suit varying XPS thicknesses and air gaps)

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DINCEL STRUCTURAL WALLING

Additional external render finishes or a variety of claddings such as stone, brick, fibre cement sheeting, and aluminium panels are ignored in the calculation of the above R value.

Aerated Concrete / Dincel

DENSITY	SAND-CEMENT RATIO	R VALUE m^2k/w per 100mm THICKNESS	COMPRESSIVE STRENGTH	
			7 DAYS	28 DAYS
1600 kg/m3	3:1	0.28	10 Mpa	18 Mpa
1400 kg/m3	3:1	0.43	8 Mpa	12 Mpa
1100 kg/m3	3:1	0.43	3 Mpa	7 Mpa
1000 kg/m3	2:1	0.48	2.2 Mpa	5 Mpa
900 kg/m3	2:1	0.57	1.4 Mpa	3.2 Mpa
800 kg/m3	1:1	0.66	2.5 Mpa	4.5 Mpa
700 kg/m3	1:1	0.76	1.4 Mpa	3.5 Mpa
600 kg/m3	1:1	0.87	0.8 Mpa	2.0 Mpa

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