This is the first of two guidance documents on the use of Polarwall. The first guide sets out specific points that should be noted by designers and contractors to aid them when using the product.

The second document sets out a compendium of other products that can be used with Polarwall.

It is recommended that both documents are read in conjunction with each other, along with other design information provided by Polarwall.

### Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Polarwall product components</td>
<td>2</td>
</tr>
<tr>
<td>Ties &amp; clips</td>
<td>2</td>
</tr>
<tr>
<td>Corner profiles &amp; rails</td>
<td>3</td>
</tr>
<tr>
<td>Ladders &amp; basic structure</td>
<td>4</td>
</tr>
<tr>
<td>Insulation levels</td>
<td>5</td>
</tr>
<tr>
<td>Modularity</td>
<td>5</td>
</tr>
<tr>
<td>Bracing supports</td>
<td>5</td>
</tr>
<tr>
<td>Engineering design</td>
<td>6</td>
</tr>
<tr>
<td>Design efficiency</td>
<td>7–8</td>
</tr>
<tr>
<td>Acoustic design</td>
<td>9</td>
</tr>
<tr>
<td>Airtightness</td>
<td>10</td>
</tr>
<tr>
<td>Energy and SAP calculations</td>
<td>10</td>
</tr>
<tr>
<td>Concrete placement</td>
<td>11</td>
</tr>
<tr>
<td>General guidance</td>
<td>11</td>
</tr>
<tr>
<td>Fire</td>
<td>11</td>
</tr>
<tr>
<td>Heat appliances</td>
<td>11</td>
</tr>
<tr>
<td>Electric cables</td>
<td>11</td>
</tr>
<tr>
<td>Service chasing</td>
<td>12</td>
</tr>
<tr>
<td>Internal finish</td>
<td>12</td>
</tr>
<tr>
<td>Heavy hangings</td>
<td>12</td>
</tr>
<tr>
<td>Damp proof courses</td>
<td>12</td>
</tr>
<tr>
<td>Angled walls</td>
<td>12</td>
</tr>
<tr>
<td>Radius walls</td>
<td>12</td>
</tr>
<tr>
<td>Window &amp; door construction</td>
<td>13</td>
</tr>
<tr>
<td>Thermal bridging for openings</td>
<td>13</td>
</tr>
<tr>
<td>Material storage</td>
<td>13</td>
</tr>
<tr>
<td>Health &amp; Safety</td>
<td>13</td>
</tr>
<tr>
<td>Basement construction</td>
<td>14</td>
</tr>
<tr>
<td>Reinforcement type</td>
<td>14</td>
</tr>
<tr>
<td>Starter bars</td>
<td>14</td>
</tr>
<tr>
<td>Mesh positioning</td>
<td>15</td>
</tr>
<tr>
<td>Further guidance</td>
<td>15</td>
</tr>
<tr>
<td>Drawing details</td>
<td>16</td>
</tr>
</tbody>
</table>
introduction

This first Polarwall technical guide provides a basic understanding of how the Polarwall product works.

It also includes important information on how the product range meets the various code requirements of the current building regulations and offers practical guidance on enhancing elements such as acoustics, airtightness and energy performance levels.

NB:
There are a number of hyperlinks in this document that link directly to the Polarwall standard design details. These will work if you are connected to the internet. If no internet access is available please click on the design detail section on the information disk.
product components

The Polarwall product can be split into 2 different product groups. Plastics which form a framework and insulation that creates the wall shutter.

There are a small number of plastic parts, which are connected together to form the framework.

**Ties or clips:** there are 4 different lengths of tie that will dictate how thick the concrete core is.

- 155mm tie normally used for above ground walls
- 206mm tie normally used for party walls to aid soundproofing
- 251mm tie is used for basement or retaining walls
- 302mm tie is also used for basement and retaining walls
Corner profiles: there are 3 corner profiles to ensure all corners of the structure remain true and square.

- **External H corner profile** used at every intermediate course height
- **Internal H corner profile** used at every intermediate course height – it is denoted by an arrow head along the side of the profile
- **U corner profiles** are used on the base and the top of the wall

Rails: there are 2 rail profiles to which ties/ clips are attached to

- **H-Rails** lock the insulation below and above its central spine
- **U-Rails** lock the insulation above its base spine
product components contd...

**Ladders:** These are pairs of rails clipped together using the ties and form the basic plastic framework. Clip centres and product dimensions can be viewed at PWD/002

![U-rail ladder](image)

![H-rail ladder](image)

**Basic structure:** Corners, ladders and polystyrene combine to form the basic hollow wall into which concrete is then poured. An annotated view can be seen at PWD/001

![First course of formwork showing polystyrene and plastic connections](image)
**Insulation:** Extruded polystyrene (XPS) is used. The quoted thermal conductivity of XPS is $0.029\text{W/m}^2\text{K}$. There are 4 different products that offer increasing levels of insulation to the building. These are seen as:

<table>
<thead>
<tr>
<th>Product</th>
<th>Inner Insulation width</th>
<th>Outer Insulation width</th>
<th>Total Polarwall width*</th>
<th>Wall U - Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>50mm</td>
<td>50mm</td>
<td>255mm</td>
<td>0.27W/m$^2$K</td>
</tr>
<tr>
<td>X25</td>
<td>50mm</td>
<td>75mm</td>
<td>280mm</td>
<td>0.22W/m$^2$K</td>
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<tr>
<td>X50</td>
<td>50mm</td>
<td>100mm</td>
<td>305mm</td>
<td>0.18W/m$^2$K</td>
</tr>
<tr>
<td>X100</td>
<td>50mm</td>
<td>150mm</td>
<td>355mm</td>
<td>0.14W/m$^2$K</td>
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</tbody>
</table>

* Excludes internal and external finish – used with the Polarwall 155mm tie.

The thicker insulation is cut along its length to allow it to be easily inserted into the the U and H Rails. See [PWD/016a](#).

**Modularity:** Other ICF products rely on a male to female connection, rather like Lego bricks. These are generally spaced in 50mm increments. Whilst this seems simple enough it will create difficulties as not all wall dimensions are designed to fit with a 50mm module. This is particularly relevant if a block needs to be cut horizontally to fit with a certain build height, as the male to female connection is then removed.

Polarwall’s components have no modular repeats. Any dimension can be catered, in both a horizontal and vertical plane, by simply cutting the product to suit the required measurement.

**Polarwall bracing supports:** These are used to provide an alignment guide when building the walls and to provide stability when the concrete is poured.

There are 2 types of brace, a *corner brace* and a *wall brace*. As the name suggests, a *corner brace* is placed externally to a right angled corner of the formwork, whilst the wall brace is placed on inside face of the formwork at no more than 1800mm centres.

The braces are mechanically fixed into the formwork and will remain in place until the concrete has been poured and is allowed to cure sufficiently for the wall to be free standing. Braces are removed and used again on the next floor or unit.
All structures using the Polarwall system must be designed by a qualified structural engineer. Polarwall has forged links with a number of engineering practices who will take on the design.

**Guides and standards:** The following standards should be followed:
- BS8110-2: Structural use of concrete
- Eurocode 2
- BS5628 Part 1 (Masonry)

A latest design guide for ICF has been produced which in many cases demonstrates why reinforcement is not used in ICF walls.

Click on the picture to be linked to the website where this can be purchased

**Concrete:** The following should be ordered from a QSRMC of BSI kite-marked supplier.
- Minimum RC25 strength for unreinforced walls.
- Minimum RC35 strength for reinforced walls.
- Slump class to be S2 with a target slump of 70-80mm
- Maximum aggregate size of 10mm
- Water cement ratio of 0.7%

**Exposure rating:** Because the concrete is allowed to cure within the insulation and therefore a protective environment, the exposure rating can be classed as ‘mild’. The minimum cover to reinforcement used is 15mm.

**Reinforcement:** The majority of walls constructed above ground will have no reinforcing steel within the concrete other than for lintel provision (see lintel below). These should be designed as plain concrete walls.

Where the wall is built below ground or it is required to be retaining then reinforcement may be used. It is best to specify mesh rather than individual bars as this will quicken construction times.

It is also possible for the steel to be replaced using fibre reinforcement.
engineering design contd…

**Lintel:** Lintel provision is created by placing either individual bars or a cage above the opening. When the concrete is poured into the wall the steel reinforcement is cast in place to provide loading support for the opening span.

**Vibration:** For most walls, external hand tamping will suffice to ensure adequate compaction of the concrete.

For reinforced walls or above openings where lintels are present, mechanical vibration may be required. As a general guide, the compaction of concrete will be $10 \times$ that of the diameter of the poker. If using a poker therefore, limit the size to 25mm. Avoid over vibration as this will cause segregation of the concrete.

**design efficiency**

**Wall heights:** The system has no modular repeats and consequently it can be built to any plan.

Though it is a relatively simple matter to cut the top course of the Polarwall to a given dimension, keeping wall heights to **multiples of 300mm** will save on labour costs, and will reduce material waste.

**Opening positions:** Keeping the dimension from the top of the previous floor level to the bottom of the window sill, at multiples of 300mm will again reduce material waste and increase build speed.

**Sub-structure wall:** Polarwall formwork is ideal for creating a rising wall from a footing to dpc level. This also ensures consistency of load bearing structure and continuity of insulation at the ground floor/wall junction.

**Corbel or brick ledge:** If a brick skin is required where a basement has been created, a brick corbel (or brick ledge) can be created as a “tip out” to support the brick skin. This can be up to 600mm wide. See detailed illustration.

**Window and door openings:** Designing standard window dimensions will ensure that the ply and timber profiles used to brace the opening can be re-used thus reducing timber use and costs on site.
design efficiency contd…

**Floor spans:** The high structural strength of the concrete wall will allow for greater loadings to be applied. This can allow wide span floors to be included in the design, which in turn gives the option to remove internal load bearing walls and create an open-plan scheme.

**Wall plate detail:** If required the top course of the wall may be finished with a pair of H-rails rather than the usual U-rails to help encase the wall plate in insulation. See PWD/008 and PWD/015.

**Attic living:** A small dwarf wall (600-900mm) can be constructed onto the first floor. Steel reinforcement cast into the top of the first floor walls and spanning into the dwarf wall can provide the appropriate structural support to cater for the lateral forces exerted by the roof structure.

**Multi-storey construction:** It is ideal to tie both floor and wall structures together thus aiding structural integrity. Using a concrete poured floor such as a structural metal deck, the top of each wall can be tied into the floor using appropriate right angled steels.

**Tying a traditional masonry skin:** The most cost effective method of tying a brick wall to the Polarwall is probably the insertion of stainless steel “helical” ties. These can be inserted during the curing process or after the concrete has cured, and as the build progresses. Ties are driven into the concrete using a special adaptor to an SDS drill. See PWD/013. Alternatively a brick slip can be used.

**Application of render:** Thin coat acrylic or silicone materials are recommended over traditional sand and cement. If applied the render must be used in conjunction with Polarwall’s X25, X50 or X100 products. There are a number of products on the market, so please contact Polarwall to obtain the necessary specifications.
acoustic design

The acoustic resistance of the wall is provided through the mass of the concrete. See PWD/027

**Pre-completion tests (PCT):** The evidence used to demonstrate Polarwall’s soundproofing is taken through PCT’s. Tests show that the 206mm core with 50mm of insulation to both sides of the core will achieve a figure of 47 dB $D_{n_{T,w}} + C_{tr}$. This relates to the calculation method for the approved Document E: 2003 for England & Wales. Copies of sample tests are available on request.

**Desk based assessments:** These were undertaken by Sound Research Laboratories Ltd based on a wall with densities of 2000kg/m$^3$. Copies of the assessment are available on request. The figures below represent the estimated sound reduction for each wall thickness.

<table>
<thead>
<tr>
<th>Tie length</th>
<th>$D_{n_{T,w}} + C_{tr}$ predicted figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>155mm</td>
<td>45</td>
</tr>
<tr>
<td>206mm</td>
<td>47</td>
</tr>
<tr>
<td>251mm</td>
<td>48</td>
</tr>
<tr>
<td>302mm</td>
<td>50</td>
</tr>
</tbody>
</table>

**Increasing acoustic performance:** To improve the effectiveness of a party or compartment wall by 5 to 6dB the following construction detail is suggested:

“line one side of the party wall with an independent lining of 48mm metal stud with 50mm Isowool APR suspended between frames with 12.5mm plasterboard. The independent lining frame should be offset from the wall by at least 15mm”

This can be used where higher ‘Code for Sustainable Homes’ levels are required.

**Robust Details:** These are a series of construction details that have been tested to provide a consistent barrier to the passage of sound as directed by the approved Doc E of the 2003 current Building Regulations.

Polarwall is one part of this construction design, as flanking details, (floors and ceilings), also affect acoustic effectiveness. These flanking details vary from project to project. Trying to provide a series of robust details for a wide variety of options is therefore difficult and impractical to achieve.
airtightness

The concrete structure of Polarwall is limited to one construction joint per storey level, thus it able to offer an inherently airtight building fabric.

Tests using plasterboard mechanically fixed to the Polarwall average a figure of $2.1m^3/hr/m^2 @ 50Pa$.

Fixing Internal lining: Test advice has been received stating that mechanical fixing of internal plasterboard to the Polarwall, improves the performance levels of the test over a ‘dot & dab’ applied lining.

Construction joints: Where floors span into the wall, such as a beam and block floor, the edge of the floor is subsequently sealed into the wall when the concrete is poured on the next storey. This seals gaps for possible air escape to the outside face of the structure.

Service connections: Where a protrusion through the wall occurs, such as service ducting, then appropriate sealants can be used between the ducting sleeve and building fabric on both internal and external faces.

Window and door fixing: It is suggested sealing both the inner and outer face of the frame to the polystyrene reveal, with a suitable low modulus silicone sealant.

energy rating & SAP calculations

The approved calculation method relies on many different parameters, Polarwall is just one of these, however as it is a major component of the build it can positively influence the chance of a achieving a higher % pass rating.

When calculating the SAP assessment, designers must make allowance for the enhancements Polarwall offers in the following areas:

• High insulation levels, ranging from 0.27 to 0.14W/m²K
• Airtightness of the superstructure, levels of $<3m^3/hr/m^2 @ 50Pa$
• Excellent thermal bridging (Y-values) of $<0.04$
concrete placement

Placement: A Polarwall structure is filled with concrete in storey height lifts. The concrete is placed in layers of approximately 900mm (3 courses), therefore three to four layers are usually made around the structure to fill each storey level.

After the first layer is placed and the operative has returned to the starting point, the concrete should be attaining its ‘first set’. It is usually advisable to leave between 20-40 minutes between each successive layer so as to keep a minimum head of hydrostatic pressure inside the formwork.

The maximum height of pour at any one time should be no more than 3.0m. This is generally adequate to fill a standard residential storey height.

To increase the directional flow of the concrete and reduce the force of concrete placed into the formwork, a maximum 100mm diameter nozzle should be used. Ideally this will be 75mm.

Equipment: The best way to place concrete inside Polarwall is via a concrete pump. This increases the speed and ease of placement.

general guidance

Fire: Polystyrene is a combustible material and it is recommended that plasterboard be mechanically fixed to the horizontal H & U rails, rather than an adhesive based dot & dab to provide the appropriate protection. All Polystyrene used in Polarwall is tested to BSEN 13164 and classed, as Euroclass E. Copies of a fire test carried out by BRE are available on request.

Heat appliances: the polystyrene of the formwork must be separated from any heat producing appliances, such as flues and chimneys. This can be done by stripping away the polystyrene and inserting in its place a non combustible insulation such as mineral wool.

Electric cables: care should be taken to ensure that the polystyrene does not come into contact with any electrical cables, as the plasticizer in the cable sheathing will migrate to the polystyrene. Therefore all cabling should be enclosed within a conduit channel.
**general guidance contd...**

**Service chasing:** Chases are created with a router fitted with a flat-bottomed cutter head. Ply or timber templates can be fixed to the wall and used to ensure the chasing follows a straight path. A template can also be used to chase out polystyrene for electric fuse and switch boxes.

**Internal finish:** Plasterboard is mechanically fixed to the Polarwall using the H-Rail as a fixing batten. Normally 300mm vertical and horizontal fixing centres are used.

Where boards butt together and where other joints are present, these must be tapered and sealed, prior to skimming.

If a more robust or waterproofed lining is required, a cement fibre board can also be used in a similar manner.

**Heavy hangings:** Smaller sections of polystyrene board can be replaced with treated timber and cast back into the concrete. An alternative method is to use 50 x 50mm treated timber cut to 300 mm lengths and inserted in between the polystyrene boards at the correct positions. Attach anchor bolts to cast back into the concrete.

**Damp proof courses:** PWD/014, 020 and 026 illustrate the inclusion of a damp proof course using different ground floor options. The easiest method is to use a water resisting concrete placed into the formwork to a minimum height of 150mm above ground level as approved by the BRE in Polarwall’s technical certificate.

**Angled walls:** Any angle can be created using Polarwall by simply cutting the required dimensions on site.

**Radius walls:** Building with the rails and boards running vertically rather than horizontally allows a radius wall to be formed. The internal board is cut to the required size for the necessary radius. The radius wall requires strapping to be run horizontally around the external face of the formwork to keep the wall stable and aligned during the concrete pour.
**Window and door construction:** openings are formed in the formwork as the build progresses. To ensure the opening dimensions are not distorted by the pressure of the concrete, temporary shutters are used to prop the jambs and head of the window. This is inserted onto the sill level when the formwork reaches the desired height. The wall is then built around the shutter. The sill is left open to allow concrete placement beneath the window. The window shutter should be constructed 50mm higher than required to provide room for a polystyrene board to be placed on the sill level.

**Thermal bridging for openings:** Insulation is placed around both jambs and head of the window during construction. This prevents any thermal bridge once the concrete is poured.

**Storage:** all materials stored on site should be retained in its packaging for as long as possible. Polystyrene may slowly degrade in sunlight so it should be protected from direct light. Degradation by sunlight is evident when a fine dust appears on the boards. This should be brushed off prior to any render finishes being applied.

**Health & safety:** working with Polarwall Insulating Concrete Formwork is safer than traditional construction in terms of falling objects and damage caused by manual lifting of heavy objects due to the nature of its lightweight construction.

Special areas where extra care needs to be taken are as follows.

- During the pumping of the concrete all operatives should ensure a safe exit in the event of any break in the formwork
- During placement of concrete all operatives should wear protective clothing
- Eye protection must be worn when machine cutting the rails to avoid injury from splintering fragments which may occur.
- If hand sawing the rails care should be taken to ensure the saw blade does not spring back off the rails at the beginning of the cut.
- All hot wire cutting of the boards must take place in a well ventilated area.
- If cutting chases with a router it is recommended that dust masks and eye protection be worn.
As well as above ground, Polarwall is also used to construct the walls of below ground structures such as basement or retaining walls.

Polarwall should not be used as a means of waterproofing the structure and this should be undertaken by other product groups (see Technical Guidance note 002).

Generally, the 251mm or 302mm tie width will be used, this provides greater structural wall strength and allows more room for the concrete to consolidate around reinforcement.

PWD/009 illustrates the basement wall detail junction with the slab.

Engineering for basement or retaining wall construction should always be carried out by a qualified structural engineer. Site conditions are never the same, therefore the wall width and level of reinforcement should always be designed for the specific site.

Reinforcement type: In the majority of cases, mesh reinforcement such as A393 is preferred over individual re-bar. This allows a 'reinforced cage' to be built much quicker.

Starter bars: As PWD 009 details, starter bars cast into the slab protrude into the wall plane between 900-1200mm. The reinforced mesh is tied to these starter bars.

Care must be taken to ensure that the starter bars are cast within the central area of the formwork to be constructed.
Mesh positioning: the position of mesh tied to the starter bars must be aligned so that the horizontal grid lines do not clash with the Polarwall tie centres.

For example, if an A393 mesh is being used then vertical and horizontal grid centres are 200mm. Therefore the horizontal grid centres at 600, 1200, 1800mm and so on, will clash with the 2nd, 4th, 6th course of the Polarwall tie.

To avoid this, lift the mesh off the slab by around 50-75mm. This will ensure that both mesh grid and Polarwall tie will never meet.

Further guidance: Further reading, guidance and information can be sought from the following documents.

- BCA Approved Document – Basements for Dwellings (ISBN 07210 1508 5)
- NHBC Standards – Chapter 5.1
- BS 8002: 1994 Code of practice for Earth Retaining Structures
- BS 8004: 1986 Code of Practice for Foundations
- BS 8007: 1987 Code of Practice for design of concrete structures for retaining aqueous liquid
- BS 8102: 1990 Code of Practice for protection of structures against water from the ground
- BS 8110 Structural Use of Concrete
- BS 8301: 1985 Code of Practice for Building Drainage.
drawing details

The following details are provided in a PDF format. CAD format is available by contacting Polarwall.

PWD/001 – Typical section through the Polarwall
PWD/002 – U and H ladder annotated measurements
PWD/004 – Beam & block floor installation
PWD/006 – Timber joist floor installation
PWD/008 – Detail at wall plate
PWD/009 – Detail at basement wall - slab junction
PWD/010 – Alternative basement detail
PWD/011 – Formation of kicker on slab
PWD/012 – Lintel support for outer masonry skin
PWD/013 – Methods of tying a masonry skin to Polarwall
PWD/014 – Construction with ground bearing slab
PWD/016 – Illustration of the Polarwall X-range
PWD/018 – Detail of wall plate restraint strapping
PWD/019 – Typical detail of the Polarwall ‘R’ Wall
PWD/020 – Construction with suspended ground floor
PWD/021 – Typical wall – roof detail
PWD/022 – Typical parapet wall construction
PWD/023 – Typical sill detail
PWD/024 – Window and door fixing detail
PWD/025 – Typical fixing for slate/tile & siding
PWD/026 – Construction off block foundation
PWD/027 – Polarwall detail of external – internal party wall
Corbel or brick ledge construction