TECHNICAL REPORT AND DESIGN GUIDANCE FOR THE USE OF POROTHERM BLOCKS IN THE UK

Special Publication 148

October 2019

ABOUT LUCIDEON

Lucideon is an internationally renowned centre for consultancy and testing in the materials world. Lucideon's involvement in masonry materials dates back to its formation in the 1920's. Initially from a manufacturing perspective and since the 1960's it has been central to the generation and interpretation of data to support the development of British Standards and Codes of Practice and more recently their European counterparts. Through large testing programmes at their extensive laboratories in Stoke-on-Trent, information has been produced covering large areas of design e.g. lateral loading of masonry walls, reinforced and pre-stressed masonry, durability, compressive strength of walls, shear strength. In many cases, the sequence has been the development of test data, all of which has been published, and the development of design approaches which have been published as authoritative guides for practicing designers. These have then formed the basis for Code of Practice guidance. Lucideon occupies a central role at the British Standards Institution (BSI) and the European Committee of Standardisation (CEN), providing Chairmen, leaders of delegations and conveners and is well placed to help in the development of guidance for Porotherm. Lucideon also provides project specific information for schemes, which because of their unique nature need bespoke assistance. Good examples are Glyndebourne Opera House, Portcullis House, Kelvingrove Museum and Art Gallery and La Poste, Marseilles.

Lucideon is UKAS accredited to the recognised international standard ISO/IEC 17025:2005 as both a testing laboratory (No. 0013) and a calibration laboratory (No. 0420). It is a Notified Laboratory to the European Commission and a member of AIRTO, the Association of Independent Research & Testing Organisations.

ABOUT THIS REPORT AND GUIDE

Porotherm* masonry has a long history of successful use in mainland Europe and was launched into the UK market in 2008. Although the units themselves comply with the relevant product standard BS EN 771-1 and carry the CE mark, guidance on their use is limited. In March 2010 the British Standard Code of Practice, BS 5628, was withdrawn and has been superseded by EN 1996, Eurocode 6. BS 5628 did not provide guidance on the use of Porotherm masonry. In order to meet the requirements of the Building Regulations the first edition of this Technical Report and Guide SP147 demonstrated that Porotherm masonry can be designed so as to incorporate an equivalent level of safety to design to BS 5628. Although BS 5628 was withdrawn in 2010, designs to it will continue to be produced and the relevant guidance, although no longer in this guide, is available from Wienerberger. This edition includes the means of demonstrating compliance with the Building Regulations using Eurocode 6, the National Annexes to it and the Published Document, PD 6697 which includes guidance that was previously in BS 5628 and which complements that in Eurocode 6. Although Porotherm masonry is within the scope of Eurocode 6 the detail is limited, as to cover in detail all of the various national traditions throughout Europe would have been a vast task. Consequently, there is a need for the supplementary guidance referred to above and the additional design data given here. This edition includes some new test data on products which have now been tested and their suitability for use in Porotherm masonry confirmed. As compliance with the Building Regulations is by design independent certification is not relevant. Some of the components may be certified by e.g. BBA or BRE. This Technical Report and Guide has been drafted in a similar way to a Code of Practice and much of the terminology should be familiar. Where values are given for use in the design the supporting test data is summarised in the many annexes**. The complete Lucideon reports are available from Wienerberger.***

*	Porotherm is a Wienerberger Group brand.

**	This guide has been reviewed and updated in June 2019 to incorporate additional data.

***	The PTH 300 Series of Porotherm blocks is progressively being replaced with the PLS 500 Series of blocks during 2019, with the change anticipated to be completed by the end of 2019.

TECHNICAL REPORT AND DESIGN GUIDANCE FOR THE USE OF POROTHERM BLOCKS IN THE UK

GENERAL

The guidance given in this Report is intended for use with Eurocode 6 (BS EN 1996-1-1). The tables below summarises the key properties of Porotherm Masonry to be used with the provisions of EC6.

PTH 300 Series and 365 (T12)

Block Type	**Porotherm Blocks**							
	Porotherm 100		**Porotherm 140**		**Porotherm 190**		**Porotherm 365**	
Dimensions ℓ x w x h (mm)	300 x 100 x 224		300 x 140 x 224		300 x 190 x 224		248 x 365 x 249	
Typical Mean Compressive Strength (N/mm²)	10		10		10		10	
Characteristic Compressive Strength of Masonry (N/mm²)	6.50		5.00		4.50		3.00	
Flexural Strength (N/mm²)*	Parallel	Normal	Parallel	Normal	Parallel	Normal	Parallel	Normal
	0.80	0.30	0.55	0.20	0.40	0.15	0.15	0.10
Shear Strength*	f_{vko}	A	f_{vko}	A	f_{vko}	A	f_{vko}	A
	0.20	0.20	0.15	0.20	0.15	0.20	0.15	0.20
Manufacturing Control	Class 1		Class 1		Class 1		Class 1	
Masonry Classification Group	2		2		2		3	

*With Zero Plus mortar

PLS 500 Series

Block Type	**Porotherm Blocks**					
	Porotherm 100		**Porotherm 140**		**Porotherm 190**	
Dimensions ℓ x w x h (mm)	500 x 100 x 224		500 x 140 x 224		500 x 190 x 224	
Typical Mean Compressive Strength (N/mm²)	10		10		10	
Characteristic Compressive Strength of Masonry (N/mm²)	6.50		5.00		4.5	
Flexural Strength (N/mm²)*	Parallel	Normal	Parallel	Normal	Parallel	Normal
	0.80	0.4	0.55	0.3	0.4	0.2
Shear Strength*	f_{vko}	A	f_{vko}	A	f_{vko}	A
	0.20	0.2	0.15	0.20	0.15	0.20
Manufacturing Control	Class 1		Class 1		Class 1	
Masonry Classification Group	2		2		2	

*With Zero Plus mortar

1 INTRODUCTION

Porotherm blocks are perforated clay blocks manufactured by Wienerberger intended for use in masonry, which is above dpc and protected against water penetration. Protection may be provided to external masonry by suitable render, cladding or external wall insulation (EWI), or by its location as an inner leaf in cavity walling or as an internal partition. The blocks are supplied in thicknesses ranging from 100 mm to 365 mm and are placed on a bed of ZeroPlus Bed Joint Mortar. The bed surfaces of the blocks are ground flat and parallel such that the target thickness of the bed joint is 1 mm. The cross-joints are formed by interlocking features in the header ends of the unit and contain no mortar.

Porotherm blocks have a long history of use in mainland Europe and comply with the European Standard BS EN 771-1. However, as clay blocks have not been used extensively in the UK for many years masonry made from them was not covered by UK Codes of Practice. The aim of this Technical Report and Guide is to provide that guidance so that Porotherm masonry may be designed in the UK with confidence that it meets regulatory requirements. Zero Plus is specially formulated exclusively for Porotherm by Nicholls and Clarke, Stoke-on-Trent. It is intended for use as the thin bed mortar for the Porotherm clay block walling system when the air temperature is not less than zero degrees C.

The UK Code of Practice BS 5628 was withdrawn in March 2010 and superseded by Eurocode 6, together with its National Annexes and the Published Document produced by BSI. The guidance given here is based upon the Eurocode, the National Annex to it and the Published Document which provides complementary recommendations.

SCOPE

This Technical Report and Guide cover the use of Porotherm Blocks with ZeroPlus Bed Joint Mortar for protected masonry.

REFERENCES

BS 476 Fire tests on building materials and structures:
Part 20: Method for determination of the fire resistance of elements of construction (general principles)

BS 4315 Methods of test for resistance to air and water penetration:
Part 2: Permeable walling constructions (water penetration)

BS 5628 Code of Practice for use of masonry:
Part 1: Structural use of unreinforced masonry
Part 3: Materials and components, design and workmanship

BS 8104 Code of Practice for assessing exposure of walls to wind driven rain.

BS 8215 Code of Practice for the design and Installation of damp proof courses in masonry construction.

BS EN 771 Specification for masonry units:
Part 1: Clay masonry units

BS EN 772 Methods of test or masonry units:
Part 1: Determination of compressive strength

BS EN 845 Specification for ancillary components for masonry:
Part 1: Ties, tension straps, hangers and brackets
Part 2: Lintels

BS EN 846 Methods of test for ancillary components for masonry:
- Part 4: Determination of load capacity and load deflection characterisation of straps
- Part 5: Determination of tensile and compressive load capacity and load displacement characteristics of wall ties (couplet test)
- Part 8: Determination of load capacity and load deflection characteristic of joist hangers
- Part 9: Determination of flexural resistance and shear resistance of Lintels

BS EN 998 Specification for Mortar for Masonry:
- Part 1: Rendering and plastering mortar
- Part 2: Masonry mortar

BS EN 1015 Methods of test for mortar for masonry:
- Part 11: Determination of flexural and compressive strength of hardened mortar

BS EN 1052 Methods of test for masonry:
- Part 1: Determination of compressive strength
- Part 2: Determination of flexural strength
- Part 3: Determination of initial shear strength
- Part 4: Determination of shear strength including damp proof course

BS EN 1365 Methods for determination of:
- Part 1: The fire resistance tests for loadbearing elements. Walls

BS EN 1996 Eurocode 6 design of masonry structures:
- Part 1.1: General Rules for reinforced and unreinforced masonry structures
- Part 1.2: General rules for structural fire design
- Part 2: Design considerations, selection of materials and execution of Masonry

BS EN 13914 Design, preparation and application of external rendering and internal plastering:
- Part 1: External Rendering

PD 6697 Recommendations for the design of masonry structures to BS EN 1996-1-1 and BS EN 1996-2.

BS 8000 Workmanship on Building Sites:
- Part 3: Code of Practice for Masonry

BS 8200 Code of Practice for Design of non-load bearing external vertical enclosures of buildings.

Building Research Establishment
Dynamic Stiffness of Wall Ties used in Masonry Cavity walls: Measurement Procedure.
Information Paper IP 3/01, 2001.

Communities and Local Government, The Building Regulations 2000 (as amended) and the Approved Documents

BS EN IS0 140 Acoustics - Measurement of sound insulation in buildings and of building elements:
- Part 3: Laboratory measurement of airborne sound insulation of building elements
- Part 4: Field measurement of airborne sound insulation between rooms

Ceram Special Publication 148
Supplementary Guidance Note No 1, December 2011

SYMBOLS

A	slope of the line relating shear strength with pre-compression
B	slope of the line relating shear strength including a d.p.c. with pre-compression
f_k	characteristic compressive strength of masonry (N/mm^2)
f_{xk}, f_{xk1}, f_{xk2}	characteristic flexural strength of masonry (N/mm^2)
f_{xd}	design flexural strength of masonry (N/mm^2)
f_v, f_{vk}	characteristic shear strength of masonry (N/mm^2)
f_{vko}	characteristic initial shear strength of masonry (N/mm^2)
g_A	design vertical load per unit area of wall section (N/mm^2)
L	length of panel (m)
M_{RD}	design value of moment of resistance (N-m)
U	heat flow per unit area per degree temperature difference (W/m^2k)
W_{ED}	design lateral load per unit area (N/m^2)
W_k	Characteristic wind load (N/m^2)
α_2	bending moment coefficient
γ_m	partial safety factor for material
γ_{mv}	partial safety factor for the shear strength of material
γ_f	partial safety factor for loads
Z	section modulus (m^3)
σ_D	design compressive stress (N/mm^2)
μ	orthogonal ratio.

2 MATERIALS AND COMPONENTS

2.1 General

The materials and components used in Porotherm masonry should all meet the requirements of the relevant British Standard.

2.2 Masonry Units

Porotherm masonry units meet the requirements of BS EN 771-1: 2003. The units meet the requirements for LD units and are vertically perforated with a tongue and groove system on their header ends. LD units are those with a gross dry density less than or equal to 1000 kg/m^3 for use in protected masonry. Typical properties of the core range of Porotherm blocks are given in Table 1 and 2.

Table 1: Properties of the Core Range of PTH 300 Series and 365 (T12)

Block Type	Dimensions l x w x h (mm)	Typical Mean Compressive Strength N/mm^2
Porotherm 100	300 x100 x 224	10
Porotherm 140	300 x 140 x 224	10
Porotherm 190	300 x 190 x 224	10
Porotherm 365 (T12)	248 x 365 x 249	10

Table 2: Properties of the Core Range of PLS 500 Series

Block Type	Dimensions l x w x h (mm)	Typical Mean Compressive Strength N/mm^2
Porotherm 100	500 x100 x 224	10
Porotherm 140	500 x 140 x 224	10
Porotherm 190	500 x 190 x 224	10

Porotherm blocks all carry the CE mark and the information that is required to be declared together with the mark is given in Annex A.

2.3 Masonry Mortar

Porotherm masonry is constructed using ZeroPlus Bed Joint Mortar (a thin layer mortar), which is supplied with the blocks and complies with BS EN 998-2.

For lateral loads calculations ZeroPlus Bed Joint Mortar is considered to be equivalent to an M12 mortar in accordance with the UK National Annex to BS EN 1996-1-1.

2.4 Rendering Mortar

2.4.1 Rendering Mortar for Porotherm Masonry

The system to be used consists of:

a) a base coat of lightweight render in accordance with BS EN 998-1.The strength classification is CS11 and the capillary water absorption is Class W2

b) a ready to use acrylic based liquid primer
c) a finishing coat silicon resin based decorative render.

or a system tested and recommended and supplied under warranty as being suitable for use with Porotherm masonry.

The System Chosen for Testing consisted of:

a) MP69
b) DG27
c) SiliconPutz

and was supplied by Baumit GmbH.

2.5 Damp Proof Courses

In most locations DPCs within Porotherm masonry are embedded in a sand: cement mortar e.g. at the base of a wall or at cavity trays above lintels and a DPC appropriate to the situation should be used.

Where a damp proof course to be used in Porotherm masonry and is subjected to shear stress a Co-Polymer Thermoplastic should be used. The system chosen for testing was Zedex CPT High performance DPC which meets the requirements of BBA Certificate 94/039. Zedex damp proof systems are manufactured by Visqueen.

2.6 Wall Ties

The wall ties to be used in Porotherm masonry comply with the requirements of BS EN 845-1 and are classified as Type 3 or Type 4 to PD 6697.

2.7 Tension Straps

Tension Straps shall comply with the requirements of BS EN 845-1.

2.8 Lintels

Lintels to be used in Porotherm masonry comply with the requirements of BS EN 845-2. Lintel bearing blocks comply with BS EN 771-1. Keystone Lintels Ltd, Catnic and Birtley Building Products Ltd all supplied lintels used in the test programme.

2.9 Fixings

Fixings for use with Porotherm masonry are provided by Spit or by Fischer.

The fixings supplied by Spit are classified as either Light Duty, Light/Medium, Medium/Heavy or Heavy Duty. Spit provide design data for the range of fixings suitable for use with Porotherm masonry either in tension or combined tension and shear. The data is supported by testing carried out in accordance with the Construction Fixing Association Guidelines at Lucideon and Wienerberger.

The fixings supplied by Fischer are classified as either Light Duty, Facade Fixing, Light-Medium or Heavy Duty. Fisher provide design data for the range of fixings suitable for use in tension in Porotherm Masonry. The data is supported by testing carried out by Fischer in accordance with the Construction Fixing Association Guidelines and reviewed by Lucideon.

Test data on Spit and Fischer fixings is given in Appendix F.

2.10 Joist Hangers

Joist Hangers shall comply with the requirements of BS EN 845-1.

The Joist Hangers used in the test were supplied by Simpson Strong-Tie.

2.11 Parge Coat

The parge coat should be mortar complying with BS EN 998-1, traditional wet plaster or a roll on parge coat.

The roll on coat used in the test programme was Ecoparge supplied by La Roc Building Solutions Ltd.

2.12 EWI Systems

EWI systems which are supplied under warranty as being suitable for use with Porotherm masonry may be used.

3 STRUCTURAL USE OF MASONRY

3.1 General

The structural design of Porotherm masonry may follow the guidance in BS 5628-1 or in BS EN 1996-1-1 (EC6). The recommendations in this guide are based upon BS EN 1996-1-1. The characteristic values of the properties of Porotherm masonry have been derived by testing in accordance with BS EN 1052. The test results and recommended values are given in the following clauses.

3.2 Characteristic Compressive Strength of Porotherm Masonry, f_k

The characteristic compressive strengths for use in design are given in Clause 3.6 of BS EN 1996-1-1. The values for Porotherm masonry are given in Table 3 for the PTH 300 series and Table 5 for the PLS 500 Series.

A programme of testing was carried out to determine whether curing the ZeroPlus Bed Joint Mortar at low temperatures had an impact upon the Characteristic Compressive Strength, the results of this testing can be found in Table 4 and Appendix B.

Table 3: Characteristic Compressive Strength of Porotherm Masonry for PTH 300 Series, and 365 (T12) $f_{k,,}$ when Cured at Ambient Temperature

Block Type	Dimensions l x w x h (mm)	Characteristic Compressive Strength (N/mm^2)
Porotherm 100	300 x 100 x 224	6.5
Porotherm 140	300 x 140 x 224	5.0
Porotherm 190	300 x 190 x 224	4.5
365 (T12)	248 x 365 x 249	3.0

Table 4: Comparative Characteristic Compressive Strength of Porotherm Masonry for PTH 300 Series, $f_{k,,}$ when Cured Different Temperatures

Block Type	Dimensions l x w x h (mm)	Characteristic Compressive Strength (N/mm^2) When Cured at Ambient Temperature	Characteristic Compressive Strength (N/mm^2) When Cured at 0˚C
Porotherm 100	300 x 100 x 224	7.7	7.4

Table 5: Characteristic Compressive Strength of Porotherm Masonry for PLS 500 Series, f_k

Block Type	Dimensions l x w x h (mm)	Characteristic Compressive Strength (N/mm^2)
Porotherm 100	500 x 100 x 224	6.5
Porotherm 140	500 x 140 x 224	5.0
Porotherm 190	500 x 190 x 224	4.5

The characteristic values given in Table 3 and 5 are based upon the formula given in BS EN 1996-1-1, rounded for convenience taking into account the experimentally derived values. Experimental data is available for all of the masonry types and indicates that the approach taken is conservative.

The characteristic values given in Table 4 are experimentally derived values. The Comparative results given in this table relate to the performance of the mortar and as such are relevant to all block widths.

The experimental results are given in full in Annex B.

3.3 Flexural Strength of Porotherm Masonry, f_{xk1}, f_{xk2}

The flexural strengths of masonry for use in design are given in Clause 3.6.3 of BS EN 1996-1-1. The values recommended by Wienerberger for Porotherm masonry are given in Table 6 and 8.

It should be noted that tests in accordance with BS EN 1052-2 have been carried out on the PTH 300 Series 100 mm and 365 mm thick masonry such that the plaster parge coat was on the tension face and also with it on the compression face. As the designer will need to design against both positive and negative wind loads, the values are based upon the lower of the two results and engineering judgement.

Although these results are mean values they may be used when designing to BS EN 1996-1-1. Subsequent tests on PTH 300 Series 100 mm and 140 mm masonry with and without a thin parge coat on the tension face confirmed the recommended values for the 100 mm and 140 mm masonry.

The values for the PTH 300 Series 190 mm masonry have been determined from a further programme which did not include a parge coat.

The values for the PLS 500 Series were determined from a further programme which did not include a parge coat. Tests for Flexural Strength Parallel to the bed joint and shear strength were omitted as the performance was deemed to be unaffected by the increase in block length for these tests.

A programme of testing was carried out to determine whether curing the ZeroPlus Bed Joint Mortar at low temperatures had an impact upon the Characteristic Compressive Strength, the results of this testing can be found in Table 7.

The characteristic values given in Table 7 are experimentally derived values. The Comparative results given in this table relate to the performance of the mortar and as such are relevant to all block widths.

The complete set of experimental results is given in Annex C. Typical failures are shown in Annex H.

Table 6: Mean Flexural Strength of Porotherm Masonry for PTH 300 Series and 365 (T12)

Block Thickness	**Mean Flexural Strength (N/mm^2)**	
(mm)	Parallel, $\mathbf{f_{xk1}}$	Normal, $\mathbf{f_{xk2}}$
365	0.15	0.1
190	0.4	0.15
140	0.55	0.2
100	0.8	0.3

Table 7: Comparative Mean Flexural Strength of Porotherm Masonry for PTH 300 Series when Cured at Different Temperatures

Block Thickness	**Mean Flexural Strength (N/mm^2)**		**Mean Flexural Strength When Cured at 0˚C (N/mm^2)**	
(mm)	Parallel, $\mathbf{f_{xk1}}$	Normal, $\mathbf{f_{xk2}}$	Parallel, $\mathbf{f_{xk1}}$	Normal, $\mathbf{f_{xk2}}$
100	0.8	0.3	1.01	0.4

Table 8: Mean Flexural Strength of Porotherm Masonry for PLS 500 Series

Block Thickness	**Mean Flexural Strength (N/mm^2)**	
(mm)	Parallel, $\mathbf{f_{xk1}}$	Normal, $\mathbf{f_{xk2}}$
190	0.40	0.2
140	0.55	0.3
100	0.80	0.4

3.4 Characteristic Shear Strength of Porotherm Masonry, f_{vk}

The characteristic shear strength of Porotherm masonry is given by:

$$f_{vk} = f_{vko} + A.\sigma_D$$

Where f_{vko} is the characteristic initial shear strength in N/mm^2 and σ_D is the design compressive stress.

For Porotherm masonry f_{vko} and A may be taken as 0.15 N/mm^2 and 0.2 for 365 mm units. For 100 mm units 0.20 N/mm^2 and 0.2 may be used.

The National Annex to BS EN 1996-1-1 limits f_{vk} to 0.045 f_b. In the case of the 100 mm units this is 0.63 N/mm^2 which should be applied. No limit is given for the 365 mm units as it is slightly higher than can be achieved using the shear strength formula with the upper limit to the design compressive strength.

Examples of experimental results in accordance with BS EN 1052-3 are given as Annex D.

Further checks are in hand to see whether linear interpolation for f_{vko} and A is permissible for other block widths. In the meantime it is suggested that the lower values of both f_{vko} and A i.e. 0.15 N/mm^2 and 0.2 be used for block widths between 100 mm and 365 mm. If these values are used no upper limit to f_{vk} needs to be applied.

3.5 Characteristic Shear Strength of Porotherm Masonry Containing a Damp Proof Course, f_{vk}

The characteristic shear strength of Porotherm masonry containing a DPC is given by:

$$f_{vk} = f_{vko} + B.\sigma_D$$

Where f_{vko} is the characteristic initial shear strength in N/mm^2 and σ_D is the design compressive stress.

For Porotherm masonry made from 365 mm unit's f_{vko} may be taken as 0.05 N/mm^2 and B as 0.1. For 100 mm units f_{vko} may be taken as 0.05 N/mm^2 and B as 0.

No upper limit needs to be applied to f_{vk}.

The Complete set of experimental results in accordance with BS EN 1052-4 is given as Annex D.

4 PERFORMANCE OF ANCILLARY COMPONENTS

4.1 Lintels

Inner leaf lintels were tested in accordance with BS EN 846-9. The load capacity is based upon the maximum load sustained in the flexural strength test i.e. the flexural resistance. However, if the shear resistance does not exceed half of the flexural resistance this controls the load capacity which can be declared. Typical failures in the tests, all of which were carried out using Porotherm blocks as lintel bearings, are shown in Annex H.

Safe Working Loads have been calculated based upon a global safety factor of 1.6 in accordance with the National Annex to BS EN 845-2. At the Safe Working Load the average deflections are required to be less than span/325 which is the guidance figure given in the National Annex to BS EN 845-2.

Porotherm masonry made with 365 (T12) blocks requires the use of two lintels side by side. This configuration was tested in accordance with BS EN 846-9 with a spreader plate across both lintels i.e. they were tested as a single lintel. The Safe Working Loads have been calculated as before, based upon the load capacity. Where the monolithic block is to receive a direct application of render an alternative is available with the external box being replaced by an angle to receive a suitably cut block hence providing a consistent substrate to render.

The experimental results are summarised in Appendix E.

The Safe Working Loads which should be used for design, together with other design information, are given in the Porotherm specific publications produced by Keystone, Catnic and Birtley, go to www.keystonelintels.com, www.catnic.com or www.birtley-building.co.uk.

4.2 Fixings

Tests were carried out on Spit products in accordance with ETAG 001 at either the Lucideon laboratories or a Wienerberger factory facility.

The results were used to determine design data using a factor of 4 for chemical anchors and a factor of 7 for anchors where creep could be significant e.g. nylon anchors.

A summary of Lucideon experimental data, together with some recommended levels, are given in Appendix F.

Further design data about the fixings can be found at www.itwcp.co.uk.

In the testing programme to support the recommendations in 2.9 the Fischer products used complied with the following requirements:

a) Light Duty: Manufacturer's declarations
b) Facade Fixing: General Approval Z-21.2-1204 (Deutsches Inst. for Bautechnik)
c) Light-Medium Duty: European Technical Approval ETA-07/0121
d) Heavy Duty: General Approval Z-21.3-1824 (Deutsches Inst. for Bautechnik).

A summary of the experimental data, which was determined by Fischer and reviewed by Lucideon is in Appendix F. For further design data go to www.fischer.co.uk.

4.3 Joist Bearings

Joists may be built in or be supported on joist hangers. Where hangers are to be used blocks will need to be cut or notched to accept them, alternatively traditional mortar joists may be specified at this point. Where hangers are to be used the manufacturer should be consulted as to their suitability for use with Porotherm masonry.

In order to check that with narrow, commonly used joists the bearing was satisfactory when they were built in 38 mm and 50 mm wide joists 225 mm deep were tested in a 100 mm deep end cap in a 100 mm thick Porotherm masonry wall. The test followed the principles for testing joist hangers to BS EN 846-8. In all cases the joist failed in bending before any damage to the Porotherm blockwork occurred.

The mean failure loads for the 38 mm joists were 21.81 kN and for the 50 mm joists were 22 kN. A general value of the Safe Working Load for these joist sizes may be taken as 8 kN, which is comparable to that for steel hangers onto dense aggregate blockwork. For larger joist sizes specialist advice should be sought. Typical joist failure is shown in Annex H.

4.3.1 Joist Hangers

Joist hangers are supplied by Simpson Strong-Tie as suitable for a range of joist sizes and Porotherm masonry. Hangers suitable for testing joists 225 mm deep and 75mm, 100 mm and 300 mm wide were tested with timber joists in accordance with BS EN 846-8. The results are given in Table 9.

Table 9: Joist Hanger Test Results

Identifier	Mean Failure Load kN
HJHH 225/75	39.11
JHM 225/100	22.97
HJHM 225/30	45.49[1]

Note 1: The deflection controls the value which may be declared to no more than 38.04 kN.

The JHM range is supplied in 2 mm pre-galvanised mild steel for a joist width in the range of 40-100 mm and height 114-400 mm. The HJHM range is supplied in 3 mm pre-galvanised mild steel for a joist width in the range of 40-300 mm and height 140-400 mm.

The test data confirms for the joist hangers tested that a declared capacity for JHM range of 16 kN and for the HJHM range of 38 kN are reasonable. The Safe Working Loads for the two ranges are given as 8 kN and 19 kN respectively.

4.4 Tension Straps

4.4.1 Horizontal Restraint Straps

Heavy Duty 27.5 mm x 4.6 mm tension straps, 1200 mm long were tested in a horizontal attitude, and this represents the strap as used to restrain the inner leaf of a cavity wall by connecting it to a floor joist. The strap passed through a 100 mm Porotherm leaf and was connected to a timber joist using 5 No. 3.35 mm x 35 mm square twist sheradised nails. The block above the bed joint was notched to accommodate the strap thickness. The straps were tested in accordance with BS EN 846-4. The result showed that the mean result for the masonry embedded end was 11.2 kN and for the timber end was 11.3 kN. Consequently, with the recommended fixings into the timber the straps when used with Porotherm masonry comfortably exceed the value of 8kN required by the National Annex to BS EN 845-1. The full experimental results are given in Annex G. Expamet (Birtley Building Products) supplied the straps used in the experimental programme. A typical failure is shown in Annex H.

4.4.2 Vertical Restraint Straps

Standard 27.5 mm x 2.4 mm tension straps were used and were fixed using four Fischer Nylon UX plugs (UX10 x 60R) with 60 mm No. 12 (6 mm) screws. The straps were tested in accordance with BS EN 846-4. The results were a mean value of 8.2 kN for the masonry end and a mean value of 7.3 kN for the timber header end. These values comfortably exceed the 4 kN commonly quoted for these straps. BS EN 845-1 requires that the tensile capacity of straps with their recommended fixings be declared. These values may be used to design connections to resist the wind uplift on roofs. The full results are given in Annex G. Expamet supplied the straps used in the experimental programme.

4.5 Wall Ties

Stainless steel asymmetric ties designed for use in cavity walls were tested in accordance with BS EN 846-5. The ties were designed for use with a Porotherm masonry inner leaf and a brick outer leaf. The ties were designed to span 100 mm, 125 mm and 150 mm cavities respectively the declared load capacities are given in Table 10. For ease of specification and classification in relation to use BS 6697 includes limiting values of tensile and compressive strength and Table 10 includes the classification by type.

Table 10: Wall Tie Strengths – Ancon

Cavity Width (mm)	Mean Strength of Porotherm End		Tie Type
	Tension (N)	Compression (N)	
100	1320	877	4 (3)*
125	1513	982	4 (3)*
150	1611	522	4

***Amendments with CE declarations and harmonising of standards have caused these to be re-classified as Type 4 per Ancon advice.

Although the tie is asymmetric in each case the brick end of the tie had been tested under separate programmes and the tie classification is valid.

The ties tested in the above experimental programme were supplied by Ancon Building Products. At the 100 mm and 125 mm cavity width, a degree of connection of the leaves consistent with a Type 2 tie may be achieved with reduced tie spacing. At 150 mm, performance consistent with a Type 3 classification may be achieved by the same means.

In addition a symmetrical tie intended for use in a party wall consisting of two leaves of Porotherm masonry was tested over a 75 mm cavity. This tie met the structural requirements for a Type 4 masonry tie. The mean dynamic stiffness of the tie was 1.38 MN/m^3, which means that at the standard spacing of 2.5 ties/m^2 the sum of the dynamic stiffness's is 3.5 MN/m^3. This meets the requirements for Part E of the Building Regulations for a Type A tie (the upper limit is 4.8 MN/m^3). A similar tie tested over a 100 mm cavity also met these requirements.

Ancon Building Products should be consulted over specific applications.

Ties designed for use in Porotherm masonry were also supplied by Bever Ties. The declared load capacities are given in Table 11.

Table 11: Wall Tie Strengths – Bever

Identifier	Cavity Width (mm)	Lowest Mean Strength of Tie End	
		Tension (N)	Compression (N)
Cavity	150	571	1030
Plug	165	585	540
Duo	150	571	580

*Provided not less than 3 ties per m^2 are used these ties will all give the same degree of connection between the leaves of cavity walls as Type 4 ties to PD 6697.

A Duo 3 – part stainless steel wall tie at 75 mm working cavity achieved a measured dynamic stiffness of 1.37 MN/m providing a performance of 4.1 MN/m^3 at a tie density of 3 ties/m^2. This meets the requirements of Part E of the Building Regulations for a Type A tie in separating walls.

5 PARTIAL SAFETY FACTORS FOR MATERIAL STRENGTH, γ_m, γ_{mv}

5.1 General

The principle followed in BS EN 1996-1-1 is that the value of γ_m to be used in design is related to the material selection and control over the execution on site.

5.2 Quality Control

5.2.1 Materials

Porotherm blocks are declared as being Category I masonry units in accordance with Annex A. The mortar is a factory made mortar and complies with BS EN 998-2.

5.2.2 Execution Control

Class 1 of execution control may be assumed if:

The work is carried out following the recommendations in BS EN 1996-2, including appropriate supervision and inspection.

The specification, supervision and control are compatible with the use of the partial factors in BS EN 1996-1-1.

The requirements in Section 7 and the Wienerberger requirements are met.

Class 2 of execution control may be assumed if:

The work is carried out following the recommendations of BS EN 1996-2 including appropriate supervision.

The requirements of Section 7 and the Wienerberger requirements are met.

5.3 Value of γ_m and γ_{mv} for Normal and Accidental Loads

The values of γ_m to be used in design are given in Table 12. These are based upon BS EN 1996-1-1 together with the considerations in Clause 5.2.

Table 12: Partial Factors for Material Strength

	Category of Execution Control	
	1	2
Compression and Flexure γ_m	2.3	2.7

When considering the possible effects of misuse or accident it would be usual to half these values.

The value for the partial safety factor for masonry in shear γ_{mv} is recommended to be 2.5 as in BS EN 1996-1-1 and that as with compression and flexure in cases of misuse or accident this value may be halved.

The value for the partial safety factor to be applied to the strength of wall ties conforming to BS EN 845-1 should be 3.5. When considering the effects of misuse or accident, this may be halved.

5.4 Design Comparisons

Some comparisons between the design strength of aggregate concrete blockwork to BS EN 1996-1-1 and Porotherm masonry to this guide are given in Annex M.

6 DESIGN DATA: OTHER IMPORTANT CONSIDERATIONS

6.1 Design to Resist Lateral Loading

Using the conventions in BS EN 1996-1-1 the bending moment in the wall is calculated as:

$M_{Ed1} = \alpha_1 W_{Ed} \ell^2$ when the plane of failure is parallel to the bed joint.

or

$M_{Ed2} = \alpha_2 W_{Ed} \ell^2$ when the plane of failure is perpendicular to the bed joints.

where $\alpha_1 = \mu\alpha_2$

The resistance is given by:

$$M_{RD} = f_{xd} Z$$

Where $f_{xd} = f_{xk1} / \gamma_m$ or f_{xk2} / γ_m as appropriate.

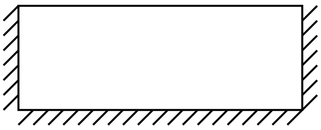
The second moment of area Z is $bd^2/6$ where b is the breadth of the section and d is the wall thickness i.e. as if the section was solid. Clearly Porotherm blocks are perforated and the actual second moment of area differs. The reasoning is that the values given in Table 6 (PTH 300 Series) are based upon tests where the f_{xk1} or f_{xk2} values have been derived from the failure moments using one of the formulae above with γ_m taken as unity and Z as for the solid section. Consequently, the characteristic flexural strength values in Table 6 are those to be used for design with the solid section Z value.

Annex E to BS EN 1996-1-1 gives values for the bending moment coefficients for some wall configurations and a range of orthogonal ratios (μ). The value of μ for Porotherm masonry taken from Table 6 for PTH 300 Series 100, 140 and 190 mm thicknesses is 2.7 and is beyond this range. Some values are given below for the bending moment coefficients to be used with Porotherm masonry of these thicknesses.

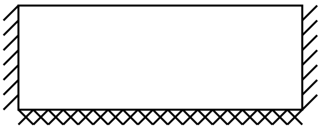
Bending Moment Coefficients α_2											
h/l	**0.25**	**0.3**	**0.5**	**0.75**	**1**	**1.25**	**1.50**	**2**	**2.5**	**3.0**	**3.3**
Case 1 (free at the top with simple supports at the sides and base)	0.017	0.020	0.031	0.042	0.051	0.060	0.067	0.078	0.086	0.091	0.094
Case 2 (free at the top with simple supports at the sides and continuous support at the base)	0.007	0.009	0.017	0.028	0.037	0.045	0.052	0.064	0.073	0.080	0.083
Case 3 (free at the top with simple support at 1 side and continuous support at the other and continuous support at base)	0.008	0.008	0.015	0.023	0.030	0.036	0.041	0.049	0.055	0.059	0.061
Case 4 (free at 1 side with simple support at the other side and at the top and bottom)	0.003	0.004	0.010	0.020	0.032	0.047	0.062	0.093	0.124	0.159	0.180
Case 5 (free at 1 side with simple support at the other side and at the top and continuous support at the base)	0.002	0.003	0.007	0.014	0.024	0.034	0.046	0.071	0.097	0.123	0.140
Case 6 (free at 1 side with simple support at the other side and continuous support at top and bottom)	0.001	0.002	0.005	0.011	0.018	0.026	0.036	0.056	0.078	0.102	0.113
Case 7 (free at 1 side with continuous support at the other and at the top and bottom)	0.001	0.002	0.005	0.010	0.016	0.023	0.031	0.046	0.061	0.076	0.085
Case 8 (simple support on all 4 sides)	0.002	0.003	0.008	0.014	0.023	0.031	0.038	0.050	0.059	0.067	0.071
Case 9 (continuous support at the base, simple support at the sides and at the top)	0.002	0.002	0.006	0.012	0.018	0.024	0.031	0.042	0.051	0.059	0.063
Case 10 (continuous support at the top and bottom and simple supports at the sides)	0.001	0.002	0.005	0.009	0.014	0020	0.025	0.035	0.045	0.052	0.056
Case 11 (simple support at 1 side and continuous support at the other side and at the top and bottom)	0.001	0.003	0.004	0.008	0.013	0.017	0.022	0.030	0.036	0.041	0.044
Case 12 (continuous support on all 4 sides)	0.001	0.002	0.004	0.008	0.012	0.015	0.019	0.025	0.030	0.033	0.035

The values in the above table are of α_2 with μ taken to be 2.7. The formula for design is $M_{Ed2} = \alpha_2 W_{Ed} \ell^2$.

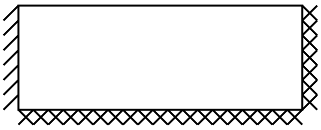
Case 1 is a wall free at the top with simple supports at the sides and base.



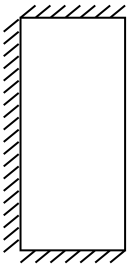
Case 2 is a wall free at the top with simple supports at the sides and continuous support at the base.



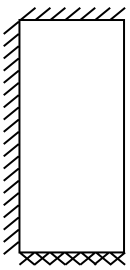
Case 3 is a wall free at the top with simple support at one side and continuous support at the other and continuous support at base.



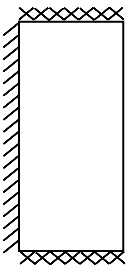
Case 4 is a wall free at one side with simple support at the other side and at the top and bottom.



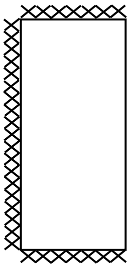
Case 5 is a wall free at one side with simple support at the other side and at the top and continuous support at the base.



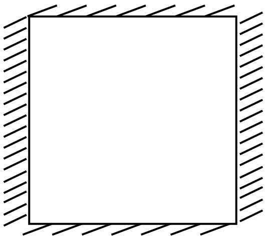
Case 6 is a wall free at one side with simple support at the other side and continuous support at top and bottom.



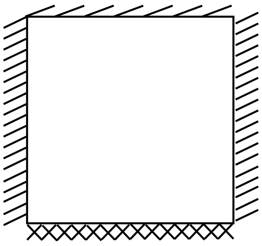
Case 7 is a wall free at one side with continuous support at the other and at the top and bottom.



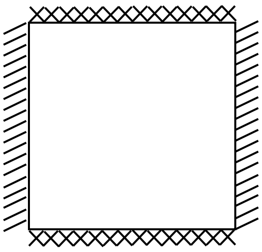
Case 8 is a wall with simple support on all four sides.



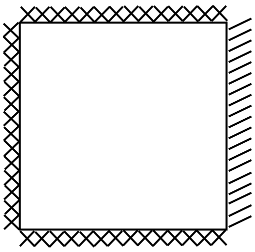
Case 9 is a wall with continuous support at the base, simple support at the sides and at the top.



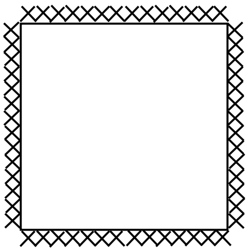
Case 10 is a wall with continuous support at the top and bottom and simple supports at the sides.



Case 11 is a wall with simple support at one side and continuous support at the other side and at the top and bottom.



Case 12 is a wall with continuous support on all four sides.



Note: BS EN 1996-1-1 restricts the application of the bending moment coefficients to single leaf walls of 250 mm thick or less.

When external walls are penetrated by window openings it is usual to subdivide the wall into notional sub panels and to justify each to resist lateral load separately. Where low height sub panels exist above or below window openings these must be justified to resist the wind load on them and that transferred to them from the window. This maybe relatively straightforward as the vertical spanning capacity of Porotherm masonry is relatively high.

Nevertheless attention must be paid to the provision of effective mechanical restraints e.g. at the wall head. Where horizontal spanning is being relied upon the justification may be more difficult and care must be given in providing adequate vertical restraints e.g. at columns or wind posts.

6.2 Exclusion of Water

Porotherm masonry units meet the requirements for LD units to BS EN 771-1 and hence are intended for use in masonry protected against water penetration. Protected masonry includes internal masonry and that in the internal leaves of external cavity walls. In the external leaves of cavity walls or in monolithic (single leaf) external walls the masonry must be protected by cladding or render.

When Porotherm masonry is used in the inner leaves of cavity walls the guidance on exclusion of water is no different to that for other types of cavity walling. The inner leaf is not relied upon to resist the passage of water and hence the relevant guidance is that in PD 6697 which applies to the outer leaf and any materials bridging the cavity. Care needs to be taken over the construction of the outer leaf, mortar joint finish etc. and particularly over the positioning of damp proof course materials, materials, cavity trays and weepholes and any insulation in the cavity. Detailed guidance is given in PD 6697. Used in properly constructed inner leaves of cavity walls with normal detailing Porotherm provides adequate protection.

Where Porotherm masonry, rendered in accordance with BS EN 13914-1, is used in the external leaf of a cavity wall the guidance in PD 6697 is relevant. Damp proof courses and cavity trays should be installed following the provisions of PD 6697, BS 8215 and manufacturer's instructions. In the case of cavity trays it is preferable to include weepholes as although not strictly required by PD 6697 water may at some stage enter the cavity through defects and should have a clear route to escape. Weepholes would normally be placed at approximately 900 mm centres with a minimum of two per cavity tray, common practice is to include a proprietary device which tapers from the cavity to the outer face to reduce the visual impact. It is recommended that partial fill insulants and a clear cavity be provided in these situations.

Rendered monolithic (single leaf) Porotherm masonry walls may be used as the external walls of buildings. Providing the rendering is in accordance with BS EN 13914-1 and manufacturer's instructions walls made from blocks 365 mm thick will be suitable in conditions of severe exposure (as defined in PD 6697 using the local spell index from BS 8104).

Porotherm forms an acceptable background for many EWI systems where resistance to rain penetration is provided by the EWI components and design.

A Porotherm masonry wall was built from 365 mm thick blocks into a Frame 1.8 m square. The wall was rendered on the outer face and parged on the inner. The wall was subjected to a rain penetration test following the principles of BS 4135 Part 2.

The test regime was:

Day 1: Continuous spray over a 6-hour period at zero applied air pressure
Day 2: Continuous spray over a 6-hour period at 250 Pa. applied air pressure
Day 3: Continuous spray over a 6-hour period at 500 Pa. applied air pressure

This is a severe test and the spray rate at 0.5 ℓ/min/m^2 was equivalent to 53 mm rain/hour or 322 mm rain/spell which is three times the amount of rain regarded as very severe exposure in BS 8104, the Code of Practice for assessing exposure of walls to wind driven rain.

No water was observed to reach the inner face of the panel. In order to check whether water was passing through the render and accumulating within the wall approximately 200 mm of the wall thickness including the parge coat was removed from the wall and it was retested. The testing replicated the BS 4315 test regime but with two hours application at each air pressure. No water could be detected within the blockwork.

Subsequently a second wall panel of similar construction to the first but containing a central window opening was built and tested using the same testing regime i.e. that to BS 4315 Part 2. There was no intrusion of water either through the wall construction or around the window detail. The window detail is shown in Annex M.

215 mm rendered aircrete construction is considered in PD 6697 to be suitable for severe exposure. This form of construction with a traditional three coat render system was tested using the same testing regime as that for the 365 mm Porotherm masonry wall. No leakage was detected and hence the Porotherm wall should also be suitable for conditions of severe exposure.

6.3 Durability

Traditionally in the UK durability of clay masonry had been taken to include resistance to freeze thaw action and also to the attack on cement in mortar by sulfates derived from the clay units or other external sources. Porotherm masonry units are supplied as LD units to BS EN 771-1 and hence there are no requirements for freeze thaw resistance and no limits to the levels of soluble sulfate in the blocks. Deterioration of clay units due to freeze thaw action may occur when they are in an exposed situation such that they become saturated and are subjected to repeated freezing and thawing. Sulfate attack is associated with the movement of water through the clay units such that sulfates are dissolved and transported to be in contact with the cement in the hardened mortar. Sulfates attack the tricalcium aluminate in the cement to form calcium sulfoaluminate (etteringite) which leads to cracking of the mortar. The causes of both forms of disruption are related to the ingress of water and the Porotherm system relies upon the protection offered by the external render or cladding and the damp proof detailing to ensure that the blockwork is adequately protected against water.

Another aspect of durability is the ability of a render coating to withstand severe weather conditions. In order demonstrate this two panels of rendered 365 mm Porotherm masonry were subjected to a hygrothermal test. The test is based upon that in MOAT 22 developed by the BBA for external insulation systems. The test consists of exposure to 70°C for 3 hours followed by spraying with water at a temperature between 13°C and 20°C for 3 hours, which is repeated 140 times followed by 20 cycles of 8 hours at 30°C followed by 16 hours at -20°C. Both panels survived the test with no indication of cracking, discolouration or debonding of the render. This is clearly a very severe test and the Porotherm masonry passed with no sign of distress.

6.4 Fire Resistance

The Reaction to fire of clay masonry units shall be declared if they are to be used in elements which are subjected to fire regulation.

The following requirements of the Building Regulations can therefore be easily satisfied:

1. Means of escape.
2. Internal fire spread (surfaces): surfaces within the building should be such as to inhibit the spread of flame.
3. Internal fire spread (structure): the structure shall be designed so as to inhibit the spread of fire and retain its stability for a reasonable period.
4. External fire spread: the external surfaces of the building shall offer adequate resistance to the spread of fire from one building to another.

Porotherm blocks are classified as non-combustible in accordance with the Building Regulations, and Class A1, non-combustible, in accordance with BS EN 771-1.

Information contained in the Building Regulations and in the National Annex to BS EN 1996-1-2 confirms that Porotherm may be used to achieve fire resistance grades as given in the following table. Data has been adjusted to suit declared block sizes.

Wall Type	**Fire Resistance (hr) – Block Thickness (mm) Achieving Integrity (E) Loadbearing Capacity (R) & Insulation (I)**							
	EN 1996-1-2 UK Annex Table NA 1.2				**UK & European Test Data**			
	1 hr	**2 hr**	**3 hr**	**4 hr**	**1 hr**	**2 hr**	**3 hr**	**4 hr**
Loadbearing single leaf un-plastered wall	110	190	240	240	100	190	190/240	190 (E&R)
Loadbearing single leaf plastered wall	110	190	190	240	100	190	190/240	190 (E&R)
Data interpolation between Group IS & Group 2 units with $\alpha \leq 0.6$								

Nevertheless a wall constructed of Porotherm 100 blocks and finished both faces with a plaster finish, 10-15 mm thick was tested to determine its fire resistance in accordance with BS EN 1365-1:1999 at Exova Warrington fire under reference WF Report No. 186546. The wall was subjected to vertical load of 96 kN (stress of 0.32 N/mm^2) and after 78 minutes the maximum temperature at the cold face exceeded the test criterion. The test was terminated after 132 minutes. A brief extract of the test report is included as Annex J with the permission of Exova Warringtonfire.

6.5 Thermal Performance

The thermal transmittance which is the heat flow through the wall construction per square metre for a one degree difference in temperature (U value) depends on the wall construction. The value is calculated using the design thermal resistance of the wall including any finishes and the cavity, if one exists. Wienerberger provide a U value indicator on their website.

6.6 Sound Control

6.6.1 Party Walls

Part E of the Building Regulations is simple in that it requires that separating (party) walls and internal walls provide reasonable resistance to the transmission of sound between and within residential accommodation.

The quantative requirement above for the party walls is considered to be met if the airborne sound insulation including associated flanking transmission has an insulation value of 45dB or greater. Approved Document E gives examples of five specific forms of construction ranging from solid masonry walls to timber frame constructions together with associated wall and floor junctions which should achieve the performance standard. The key characteristic which describes the walls is surface density i.e. mass per metre square of surface area and although Porotherm Masonry is similar to some of these constructions they are not directly relevant. Consequently, in order to satisfy the requirement Pre Completion Testing of houses made from Porotherm Masonry has been required.

Preliminary laboratory testing was carried out at AIRO in accordance with BS EN ISO 140-3:1995. The walls were constructed of two 100 mm leaves of Porotherm masonry with a rolled parge coat, an insulated cavity and plasterboard on dabs. The rating exceeded the requirements of the Building Regulations, Approved Document L[5]. The report is included in Appendix N. In order to validate the laboratory tests site testing has been carried out. From a total of 42 tests at four developments which were carried out by four accredited test houses the average result was a sound insulation value 56.2dB to be compared with the 45dB requirement. The range in results was 50–66dB. Clearly the performance in the field demonstrates that separating (party) wall constructions in Porotherm have consistently achieved the degree of isolation envisaged in the Regulation. Porotherm party walls construction with a 100 mm fully filled cavity was accepted by Robust Details Limited as ENM-25 in August 2013. Porotherm party wall construction with a 75 mm cavity is expected to be accepted as a robust detail in early 2014.

6.6.2 Partition Walls

For internal walls within dwellings the Regulation is considered to be met if laboratory values achieve a weighted sound reduction value, Rw, of 40dB and on site testing is not required. Over the years a number of mass laws have been defined which relate the sound reduction index to the surface density of homogeneous materials. Homogeneous materials are defined as those having small perforations i.e. not greater than 15% of the volume of the block and so would not apply necessarily to Porotherm blocks. EN 12354-1 shows some of the mass laws which have been generated and adopted in various European countries. The data is quite scattered (+4dB to -8dB) and that is considered to be for reasons that are product, measurement method or test facility dependent. Nevertheless the mass laws have been used to generate Rw values for different surface densities across a range of materials. In particular one generated in Austria is considered to apply to perforated units with densities greater that 800 kg/m^3 but not to those with thermally engineered cross sections. This excludes 365 mm thick blocks but these are not of major interest from the acoustic perspective.

EN 12354-1 gives a lot of detail about the effect of providing finishes to both the internal wall in question and those which can provide flanking transmission. There are no standardised measurement techniques to allow for flanking and the effect on direct transmission of finishes can be to increase or decrease sound insulation dependent on its resonant frequency. The standard gives modifications to the Rw factor based upon additional layers on flanking walls or on resonant frequencies of finishes to direct transmission. This is complex and does not translate easily into useful data that manufacturers can pass on to users.

Figure 1 shows the standardised mass laws for Great Britain and Austria referred to above.

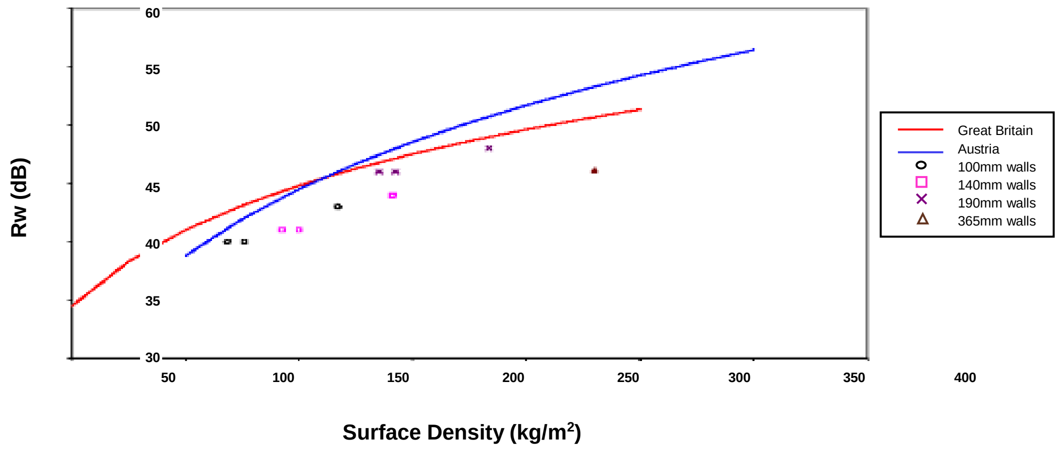


Figure 1: Sound Reduction vs Surface Density

In view of the complexities referred to above Wienerberger have taken a conservative view of the declarations it has made for its products.

The Wienerberger guidance is tabulated below and the values are shown in Figure 1.

Sound Insulation Values (Rw) dB

Block Thickness (mm)	Finish		
	13 mm Dense Plaster	13 mm Lightweight Plaster	12.5 mm Plasterboard
100	43	40	40
140	44	41	41
190	48	46	46
365	46	-	-

Note: Finishes to both sides are assumed to be.
Dense plaster 13 mm at 27 kg/m^2
Lightweight Plaster 11 mm base, 2 mm skim 11.8 kg/m^2
Ecoparge plus 12.5 mm plasterboard on dabs 15.4 kg/m^2

6.7 Movement

The general advice from Wienerberger is that vertical movement joints to deal with thermal and moisture related movements are not generally required unless continuous lengths of masonry exceed 20 m or where structural joints in the building need to be carried through the Porotherm masonry. However, the normal considerations for short returns and highly fenestrated elevations apply. Where Porotherm masonry is being used to infill within framed structures, careful consideration needs to be given to restraint ties to vertical columns and deflection joints at the head of panels. In all cases, a structural engineer should consider and allow provisions for movement.

6.8 Air Leakage

Porotherm masonry should always be used with a parge coat or wet plaster on the inside. This is extremely important in ensuring that buildings perform well thermally. The Building Regulation requirement is that for buildings over 500 m^2 in floor area when subjected to a pressure test at a pressure of 50 Pa. The leakage should not be greater than 10 m^3/h/m^2. Testing has demonstrated that lightweight aggregate blockwork or Porotherm with no coating leaks at a considerable rate and that plasterboard on dabs alone does not provide an acceptable performance. However, with a brush on or trowel applied parge coat it was possible to achieve results less than 1.2 $m^3/h/m^2$. The full results of the test programme are given in Annex K.

6.9 Impact Testing

Impact testing has been carried out in accordance with the Dutch Technical Guideline BRL[1] 1008:2003 Annex 4 and supervised by KIWA[2]. The general principle of the testing is the same as incorporated in BS 8200 which consists of impacting the wall surface with a hard body impactor (steel ball) and soft body impactor (filled bag). The intention is to show that walls have reasonable resistance to impact by hard objects such as balls and soft bodies such as might be caused by impact from people. The details of the tests differ in that in the UK the hard body impact is by dropping the ball onto a horizontal surface whereas the Dutch approach is by swinging the ball in a pendulum arc although the weight of the ball is the same. In the UK a heavier bag is used than in the Netherlands but the impact energy is the same or greater. The results of the tests which in both cases supplied the same impact energy as specified in BS 8200 i.e. 10 N-m (hard body) and 120 N-m (soft body) were that no damage was sustained under any of the relevant criteria. The wall tested was 100 mm thick, 2.75 m high and 1.5 m wide, restrained only at the top and bottom. The results suggest that despite some differences in approach the wall retained the performance of the exterior wall surface. For the levels of impact energy quoted above the wall would be suitable in "*zones up to 1.5 m above pedestrian or floor level in areas readily accessible to the public and others with little incentive to exercise care. Chances of accident occurring and misuse.*"

[1] BRL is the Dutch equivalent of a BBA Certificate
[2] KIWA N.V. Certification and Inspection, Rijswijk, Netherlands.

7 WORKMANSHIP

7.1 The general requirements for workmanship for masonry given in BS 8000-3 and PD 6697 apply to Porotherm masonry. These requirements together with those in the Wienerberger Installation Manual should be considered as the minimum requirements for building successful Porotherm masonry.

7.2 Preparation of Mortar

ZeroPlus Bed Joint Mortar is a factory made bagged mix which is mixed with water. Only enough bed joint mix should be produced for immediate use. The mix is prepared in a clean bucket using an agitator or a paddle mixer. The mixture is mixed until it has a smooth lump free consistency, it is then left for five minutes and then remixed and is ready to use. If the mortar is to be applied using a roller, the recommended method, 3.1 ℓ of clean water is required for a full bag (12.5 kg) mix. If using the monolithic block roller 2.8 ℓ is required.

7.3 Laying Blocks

The initial course is laid on a bed of conventional mortar. This bed may need to be thicker than subsequent ones in order to allow for any imperfections in the floor slab or foundation from which the wall is being built. This course is extremely important as any imperfections will be amplified as the wall is raised, as there is very little room for adjustment of the subsequent thinner joints. The first course is laid carefully to line and level which may be by traditional means, i.e. spirit level and stringline or more sophisticated laser levelling arrangement.

Prior to applying the bed joint mix the bed surface of the units is brushed with a damp brush. Mortar may be applied using a roller, which is the recommended method.

Lintels are placed onto a conventional mortar bed on the pre-cut shoulder units and the bed joint above is usually placed in conventional mortar to allow for any levelling tolerances.

7.4 Applying the Render System

The render manufacturer’s instructions should be followed.

ANNEX A: CE MARKING INFORMATION

Each of the block types used in Porotherm masonry carries the CE mark. This means that the blocks meet the legal requirements in all of the countries of the EEA. There is also a presumption that if the blocks are used to construct buildings then they will meet all of the relevant requirements of the Construction Products Regulation e.g. mechanical stability. The properties of the Porotherm blocks that are declared in support of the CE mark, in accordance with BS EN 771-1:2011, are summarised in the tables below.

Table A1: PTH 300 Series and 365 (T12)

Property	Porotherm 100	Porotherm 140	Porotherm 190	Porotherm 365 (T12)
Length (mm)	300	300	300	248
Width (mm)	100	138	188	365
Height (mm)	224	224	224	249
Tolerance Class, l,w,h (mm)	T1+7.0,4.0,1.0	T1+7.0,5.0,1.0	T1+7.0,5.0,1.0	Tm 10,10,1
Range Class, range, l.w.h (mm)	R1+10,6,1	R1+10,7,1	R, 10, 8,1	Rm 12,12,1
Gross Dry Density (Kg/m^3)	950	850	850	630
Density Category	D1	D1	D1	Dm
Density Percentage (%)	10	10	10	3
Group (to EN 1996-1-1)	2	2	2	3
Volume of Formed Voids (%)	NPD	NPD	NPD	58
Compressive Strength. Mean, Normalised (N/mm^2)	10-,14	10-,13	10-,12	10,12.5
Strength Category	I	I	I	I
Bond Strength (N/mm^2)*	NPD	NPD	NPD	NPD
Thermal Conductivity	λ_D = 0.29	λ_D = 0.26	λ_D = 0.26	λ_D = 0.12
Water Absorption (%)	≤ 18	≤ 18	≤18	NPD
Initial Rate of Water Absorption (Kg/m^2-min)	≤ 2	≤ 2	≤ 2	NPD
Reaction to Fire	A1	A1	A1	A1
Flatness of Bed Faces	≤ 2	≤ 2	≤ 2	≤ 1
Plane Parallelism (mm)	≤ 2	≤ 2	≤ 2	≤ 1

*Not given on product level. Flexural strength values are given for the blocks in combination with Zero Plus bed joint mortar in Table 6 (f_{xk1}).

Table A2: PLS 500 Series

Property	Porotherm 100	Porotherm 140	Porotherm 190
Length (mm)	500	500	500
Width (mm)	100	138	188
Height (mm)	224	224	224
Tolerance Class, l,w,h (mm)	T1+7.0,4.0,1.0	T1+7.0,5.0,1.0	T1+7.0,5.0,1.0
Range Class, range, l.w.h (mm)	R1+10,6,1	R1+10,7,1	R1+10,8,1
Gross Dry Density (Kg/m^3)	N/A	N/A	N/A
Density Category	D1	D1	D1
Density Percentage (%)	10	10	10
Group (to EN 1996-1-1)	2	2	2
Volume of Formed Voids (%)	NPD	NPD	NPD
Compressive Strength. Mean, Normalised (N/mm^2)	10-,14	10-,13	10-,12
Strength Category	I	I	I
Bond Strength (N/mm^2)*	NPD	NPD	NPD
Thermal Conductivity	λ_D = 0.29	λ_D = 0.26	λ_D = 0.26
Water Absorption (%)	≤ 18	≤ 18	≤ 18
Initial Rate of Water Absorption (Kg/m^2-min)	≤ 2	≤ 2	≤ 2
Reaction to Fire	A1	A1	A1
Flatness of Bed Faces	≤ 2	≤ 2	≤ 2
Plane Parallelism (mm)	≤ 2	≤ 2	≤ 2

ANNEX B: MASONRY COMPRESSIVE STRENGTHS

The tables give the data used to support the values given as characteristic values in Table 2. The tests were in accordance with BS EN 1052-1, BS EN 772-1 and BS EN 1015-11 as appropriate.

Where there are no values in the tables for Mortar compressive strength values from Table B1 are to be assumed.

Table B1: ZeroPlus Mortar Compressive Strength Values

Specimen Identification	Compressive Strength (N/mm^2) - Ambient Cured	Compressive Strength (N/mm^2) – Cured at 0˚C
Zero Plus Mortar	12.2	11.9

Table B2: PTH 300 Series Porotherm 100

Mean Unit Strength (N/mm^2)	14.6
Normalised Unit Strength (N/mm^2)	20.2
Masonry Strength (N/mm^2)	
Specimen	
1	11.7
2	9.9
3	10.7
4	9.7
5	7.7
6	10.8
Mean Value (N/mm^2)	10.1
Characteristic Compressive Strength (N/mm^2)	7.7

Table B3: PTH 300 Series Porotherm 140

Mean Unit Strength (N/mm^2)	13.2
Normalised Unit Strength (N/mm^2)	17.1
Masonry Strength (N/mm^2)	
Specimen	
1	7.9
2	6.6
3	8.4
4	5.6
5	7.6
6	6.2
Mean Value (N/mm^2)	7.1
Characteristic Compressive Strength (N/mm^2)	5.6

Table B4: PTH 300 Series Porotherm 190

Mean Unit Strength (N/mm²)	12.1
Normalised Unit Strength (N/mm²)	14.6
Masonry Strength (N/mm²)	
Specimen	
1 2 3 4 5 6	5.1 5.4 5.4 5.4 5.2 5.8
Mean Value (N/mm²)	5.4
Characteristic Compressive Strength (N/mm²)	4.5

Table B5: 365 (T12)

Mean Unit Strength (N/mm²)	10.5
Normalised Unit Strength (N/mm²)	12.1
Masonry Strength (N/mm²)	
Specimen	
1 2 3 4 5 6	3.6 3.9 4.6 5.0 5.5 4.9
Mean Value (N/mm²)	4.6
Characteristic Compressive Strength (N/mm²)	3.6

Table B6: PLS 500 Series Porotherm 100

Mean Mortar Strength (N/mm²)	Flexure 2.22	Compression 13.7
Mean Unit Strength (N/mm²)	10.8	
Normalised Unit Strength (N/mm²)	15.0	
Masonry Strength (N/mm²)		
Specimen		
1 2 3 4	7.8 9.1 10.1 8.9	
Mean Value (N/mm²)	9.0	
Characteristic Compressive Strength (N/mm²)	7.5	

Table B7: PLS 500 Series Porotherm 140

Mean Mortar Strength (N/mm²)	Flexure 2.67	Compression 13.7
Mean Unit Strength (N/mm²)	10.6	
Normalised Unit Strength (N/mm²)	13.8	
Masonry Strength (N/mm²)		
Specimen		
1 2 3 4 5	7.2 8.3 8.6 8.9 5.3	
Mean Value (N/mm²)	7.64	
Characteristic Compressive Strength (N/mm²)	5.64	

Table B8: PLS 500 Series Porotherm 190

Mean Mortar Strength (N/mm²)	Flexure 4.79	Compression 12.8
Mean Unit Strength (N/mm²)	10.50	
Normalised Unit Strength (N/mm²)	12.63	
Masonry Strength (N/mm²)		
Specimen		
1 2 3 4 5	7.22 8.68 7.81 7.50 8.66	
Mean Value (N/mm²)	7.97	
Characteristic Compressive Strength (N/mm²)	7.22	

Table B9: PTH 300 Series Porotherm 100 with Zero Plus Mortar Cured at 0˚C (± 2˚C)

Mean Mortar Strength (N/mm²)	Flexure 2.11	Compression 11.9
Mean Unit Strength (N/mm²)	14.2	
Normalised Unit Strength (N/mm²)	19.7	
Masonry Strength (N/mm²)		
Specimen		
1 2 3 4 5	9.3 9.4 7.2 8.5 8.0	
Mean Value (N/mm²)	8.5	
Characteristic Compressive Strength (N/mm²)	7.4	

ANNEX C: MASONRY FLEXURAL STRENGTH

The tests were carried out at Lucideon according to BS EN 1052-2.

Table C1: 365 (T12) Tested with Plaster Parge Coat in Tension

Flexural Strength (N/mm^2)			
Parallel		**Normal**	
Specimen		Specimen	
1	0.24	1	0.11
2	0.28	2	0.10
3	0.23	3	0.13
4	0.14	4	0.12
5	0.21	5	0.12
Mean Value (N/mm^2)	0.22	**Mean Value (N/mm^2)**	0.12

Table C2: PTH 300 Series Porotherm 100 Tested with Plaster Parge Coat in Tension

Flexural Strength (N/mm^2)			
Parallel		**Normal**	
Specimen		Specimen	
1	1.44	1	0.46
2	1.39	2	0.62
3	1.54	3	0.54
4	1.46	4	0.48
5	0.96	5	0.50
Mean Value (N/mm^2)	1.36	**Mean Value (N/mm^2)**	0.52

Table C3: 365 (T12) Tested with Plaster Parge Coat in Compression

Flexural Strength (N/mm^2)			
Parallel		**Normal**	
Specimen		Specimen	
1	0.16	1	0.12
2	0.21	2	0.10
3	0.19	3	0.12
4	0.12	4	0.11
5	0.10	5	0.12
Mean Value (N/mm^2)	0.15	**Mean Value (N/mm^2)**	0.12

Table C4: PTH 300 Series Porotherm 100 Tested with Plaster Parge Coat in Compression

Flexural Strength (N/mm^2)			
Parallel		**Normal**	
Specimen		Specimen	
1	0.80	1	0.51
2	0.78	2	0.44
3	1.00	3	0.39
4	0.90	4	0.34
5	0.88	5	0.41
Mean Value (N/mm^2)	0.87	**Mean Value (N/mm^2)**	0.42

Table C5: PTH 300 series Phase 2 Tests Porotherm 100

Flexural Strength (N/mm^2)			
Parallel		**Normal**	
Specimen		Specimen	
1	0.98	1	0.44
2	0.98	2	0.39
3	0.91	3	0.34
4	0.92	4	0.24
5	1.03	5	-
6	1.05	6	0.33
Mean Value (N/mm^2)	0.98	**Mean Value (N/mm^2)**	0.35

Table C6: PTH 300 Series Phase 2 Tests Porotherm 100 + Brush Applied Parge Coat

Flexural Strength (N/mm^2)			
Parallel		**Normal**	
Specimen		Specimen	
1	0.97	1	0.34
2	1.16	2	0.37
3	1.38	3	0.37
4	1.01	4	0.28
5	1.17	5	0.39
6	1.18	6	0.29
Mean Value (N/mm^2)	1.14	**Mean Value (N/mm^2)**	0.34

Table C7: PTH 300 Series Phase 2 Tests Porotherm 140

Flexural Strength (N/mm^2)			
Parallel		**Normal**	
Specimen		Specimen	
1	0.60	1	0.20
2	0.75	2	0.25
3	0.70	3	0.22
4	0.61	4	0.20
5	0.69	5	0.19
6	0.55	6	0.21
Mean Value (N/mm^2)	0.65	**Mean Value (N/mm^2)**	0.21

Table C8: PTH 300 Series Phase 2 Tests Porotherm 140 + Brush Applied Parge Coat

Flexural Strength (N/mm^2)	
Parallel	
Specimen	
1	0.77
2	0.95
3	1.05
4	1.24
5	1.04
6	0.96
Mean Value (N/mm^2)	1.00

Table C9: PTH 300 Series Phase 3 Tests Porotherm 190, No Parge Coat

Flexural Strength (N/mm²)			
Parallel		**Normal**	
Specimen		Specimen	
1	0.50	1	0.07
2	0.79	2	0.25
3	0.39	3	0.17
4	0.60	4	0.09
5	0.47	5	0.07
Mean Value (N/mm²)	0.55	**Mean Value (N/mm²)**	0.13

Table C10: PLS 500 Series Porotherm 100 Tested with No Parge Coat

Flexural Strength (N/mm²)	
Normal	
Specimen	
1	0.51
2	0.40
3	0.37
4	0.40
5	0.49
Mean Value (N/mm²)	**0.43**

Table C11: PLS 500 Series Porotherm 140 Tested with No Parge Coat

Flexural Strength (N/mm²)	
Normal	
Specimen	
1	0.65
2	0.29
3	0.27
4	0.32
5	0.21
Mean Value (N/mm²)	**0.35**

Table C12: PLS 500 Series Porotherm 190 Tested with No Parge Coat

Flexural Strength (N/mm²)	
Normal	
Specimen	
1	0.25
2	0.23
3	0.24
4	0.24
5	0.18
Mean Value (N/mm²)	**0.23**

Table C13: PTH 300 Series Porotherm 100 Tested with No Parge Coat and Cured at 0˚C (± 2˚C)

Flexural Strength (N/mm^2)			
Parallel		**Normal**	
Specimen		Specimen	
1	0.99	1	0.30
2	1.07	2	0.43
3	0.83	3	0.42
4	1.12	4	0.43
5	1.05	5	0.43
Mean Value (N/mm^2)	1.01	**Mean Value (N/mm^2)**	0.40

ANNEX D

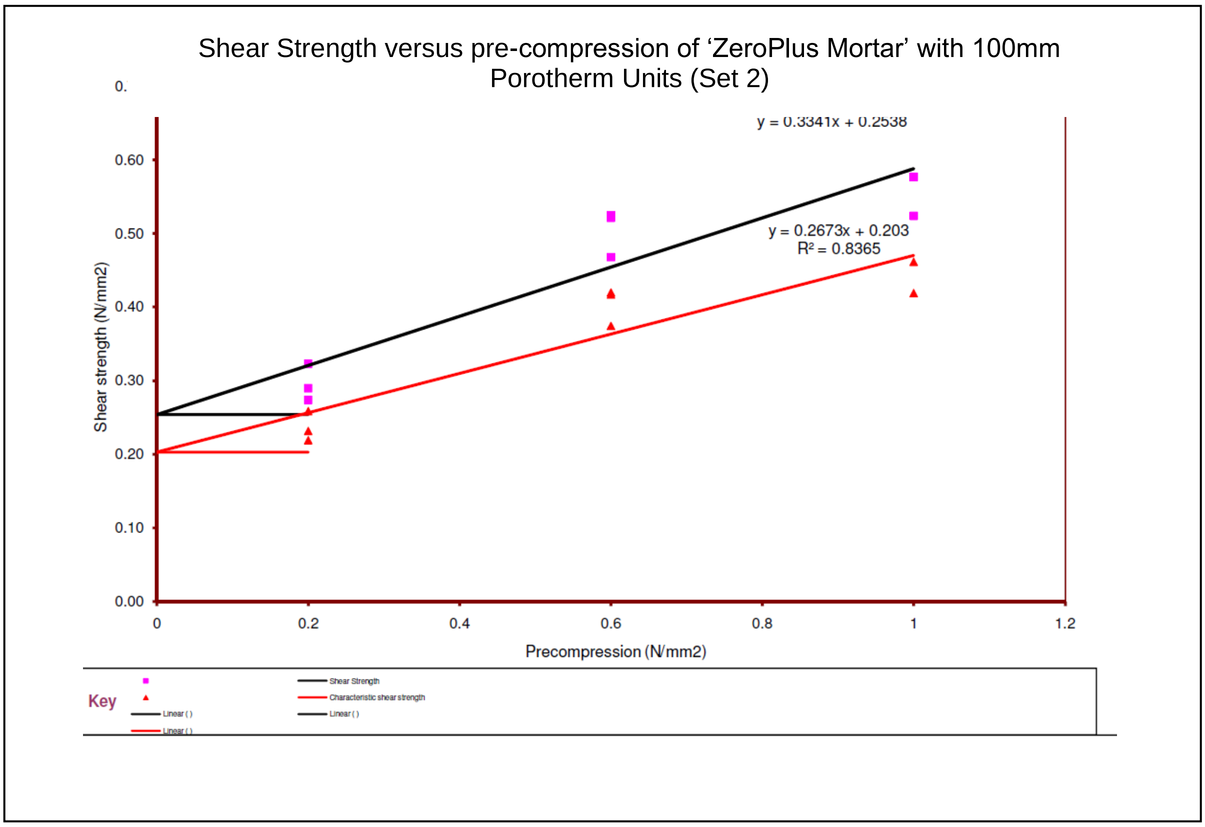


Figure D1

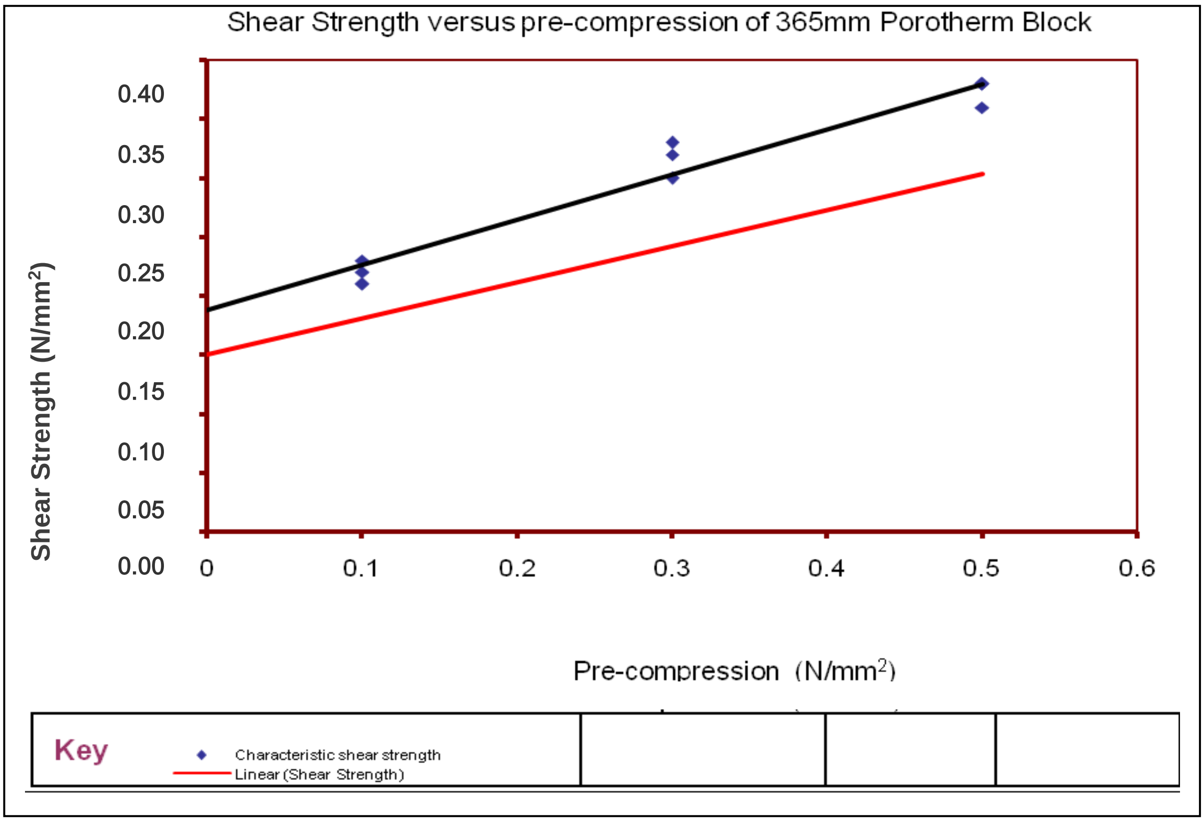


Figure D2

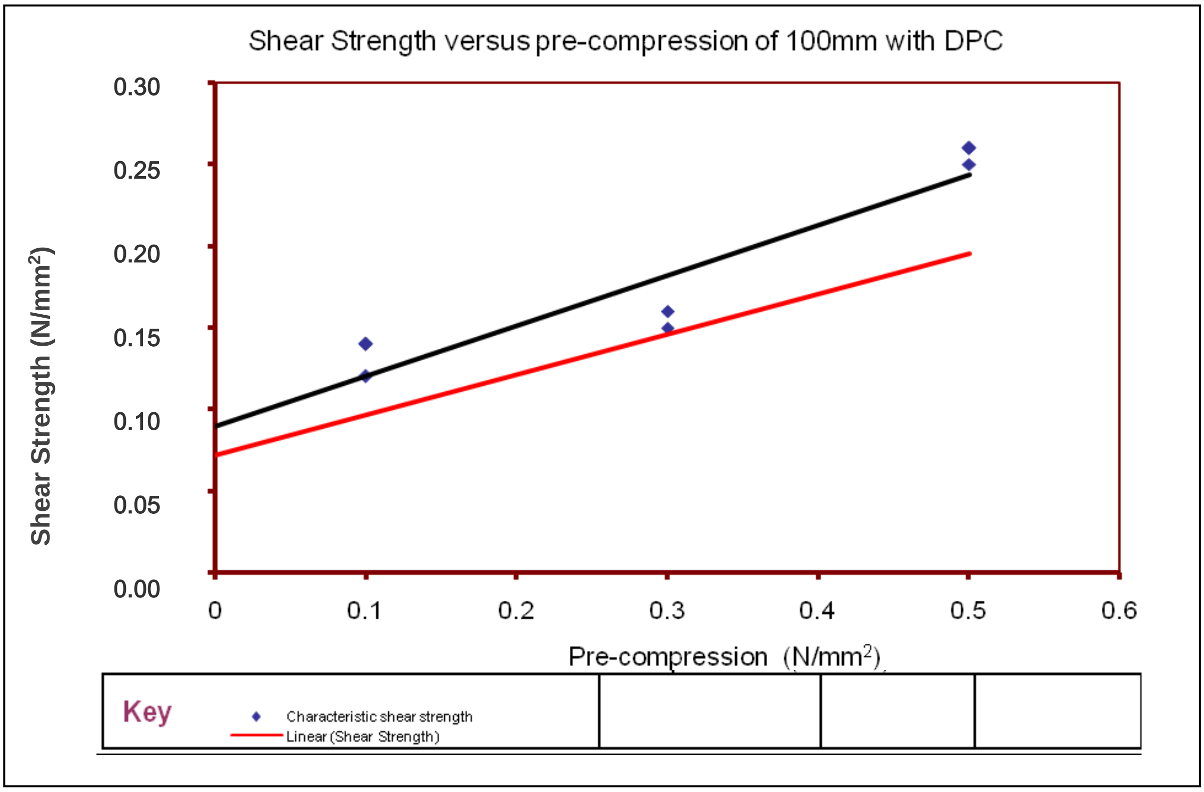


Figure D3

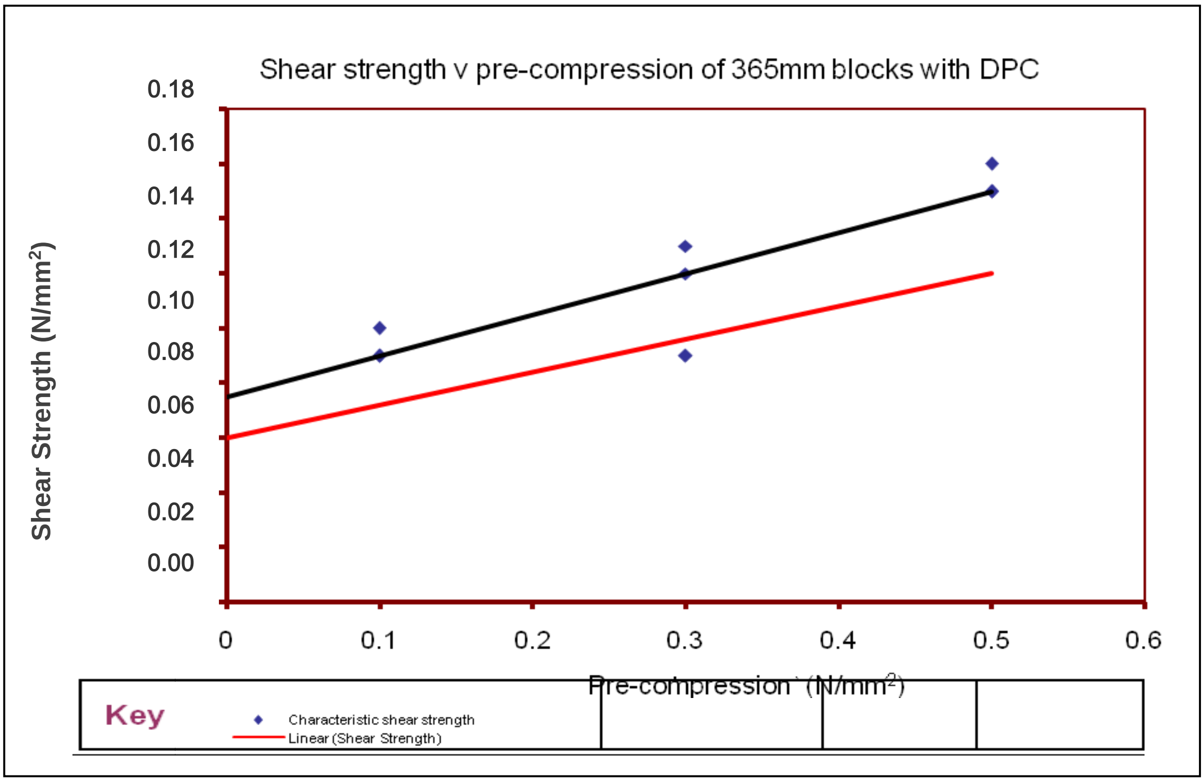


Figure D4

ANNEX E

The experimental results derived at Lucideon for the Keystone Lintels tested with Porotherm blocks are in Table E1 below. The Safe Working Loads are those derived directly from the experimental results, the figures in brackets are those given by Keystone for the design of these lintels.

Table E1: Experimental Results - Keystone Lintels

Block Thickness 100 mm		
Clear Span (mm)	**Load Capacity (kN)**	**Safe Working Load (kN)**
1000	57.1	35.7 (16)
2300	38.6	24.1 (22)

Block Thickness 140 mm		
Clear Span (mm)	**Load Capacity (kN)**	**Safe Working Load (kN)**
880	43.0	26.9 (18)
2250	49.1	30.7 (30)

Block Thickness 190 mm		
Clear Span (mm)	**Load Capacity (kN)**	**Safe Working Load (kN)**
1080	56.4	35.2 (18)
2190	61.4	38.4 (30)

Block Thickness 365 mm		
Clear Span (mm)	**Load Capacity (kN)**	**Safe Working Load (kN)**
1050	70.6	44.1 (18)
2250	99.7	62.3 (30)

The experimental results derived at Lucideon for the Catnic Lintels tested with Porotherm blocks are given in Table E2 below. The Safe Working Loads are these derived directly from the experimental results, the figures in brackets are those given by Catnic for the design of these lintels.

Table E2: Experimental Results - Catnic Lintels

Block Thickness 100 mm		
Clear Span (mm)	**Load Capacity (kN)**	**Safe Working Load (kN)**
880	68.9	43.0 (29)
2230	69.8	43.7 (29)

Block Thickness 140 mm		
Clear Span (mm)	**Load Capacity (kN)**	**Safe Working Load (kN)**
880	59.6	37.2 (29)
2230	104.6	65.4 (54)

The experimental results derived at Lucideon for the Birtley Building Products Lintels tested with Porotherm blocks are given in Table E3 below. The Safe Working Loads are derived directly from the experimental results. The figures in brackets are those given by Birtley Building Products for the design of these lintels.

Table E3: Experimental Results - Birtley Building Products Lintels

Block Thickness 100 mm		
Clear Span (mm)	**Load Capacity (kN)**	**Safe Working Load (kN)**
880	49.4	30.9 (25)
2230	37.5	23.4 (20)

Block Thickness 140 mm		
Clear Span (mm)	**Load Capacity (kN)**	**Safe Working Load (kN)**
880	62.2	38.9 (25)
2230	50.3	31.4 (25)

Block Thickness 190 mm		
Clear Span (mm)	**Load Capacity (kN)**	**Safe Working Load (kN)**
880	69.1	43.2
2230	94.6	59.1

Block Thickness 365 mm		
Clear Span (mm)	**Load Capacity (kN)**	**Safe Working Load (kN)**
880	77.3	48.3
2230	85.8	53.6

ANNEX F

SPIT have carried out tests of their anchors into Porotherm blocks 100 mm, 190 mm and 365 mm in thickness. The Spit tests were carried out at Lucideon and at Wienerberger. The SPIT experimental results and the manufacturers recommended loads are given in Tables F1 and F2.

Fischer Fixings have carried out tests of their fixing into Porotherm blocks 190 mm and 365 mm in thickness. The Fischer tests were carried out at Wienerberger, and Lucideon reviewed the results. The experimental results and the manufacturers recommended loads are given in Table F3.

All tests were carried out following the recommendations of the Constructions Fixings Association.

Table F1: Tensile Test Results on Spit Fixings

Fixing Details	Block Thickness (mm)	Number of Tests	Mean Failure Load (kN)	Manufacturers Recommended Tensile Load (kN)
Spit Idall Cmix Plus Resin M10 x 135 mm Stud	100	10	3.7	0.9
20 x 85 Plastic Sleeve Epomax Resin M10 x 135 mm Stud	100	10	8.6	2.2
Pro 6 Universal Nylon Anchor, 10 mm x 50mm	100	10	2.1	0.3
Hit M6 x 30 A4 Stainless	100	10	1.0	0.1
Pro 6 8 x 40 mm Nylon Anchor	190	5	1.45	0.21
Pro 6 8 x 40 mm Nylon Anchor	365	5	0.83	0.12
WTech 8 x 40 mm with 5 mm screw	190	3	1.63	0.23
WTech 8 x 40 mm with 5 mm screw	365	3	0.79	0.11
20 x 85 Plastic Sleeve Epomax Resin M12 x 160mm	190	5	12.88	3.22
20 x 85 Plastic Sleeve Epomax Resin M12 x 160 mm Stud	365	5	11.62	2.91
Spit Prolong 10/10-80 H 6 x 85 mm Hex Screw	190	5	2.51	0.36
Spit Prolong 10/10-80 H 6 x 85 mm Hex Screw	365	5	2.12	0.30
Spit Prolong 8/10-80 H 7 x 85 mm Hex Screw	190	5	2.04	0.29
Spit Prolong 8/10-80 H 7 x 85 mm Hex Screw	365	5	2.01	0.29
Spit Idall Cmix Plus Resin M10 x 135 mm Stud	190	5	3.01	0.29
Spit Idall Cmix Plus Resin M10 x 135 mm Stud	365	5	3.87	0.96

Table F2: Combined Shear and Tension Results on Spit Fixings

Fixing Details	Block Thickness (mm)	Number of Tests	Mean Failure Load (kN)	Manufacturers Recommended Tensile Load (kN)
Pro 6 8 x 40mm	190	5	2.1	0.2
20 x 85 Plastic Sleeve Epomax Resin M12 x 160mm	190	5	11.75	2.94
20 x 85 Plastic Sleeve Epomax Resin M12 x 160mm	365	5	10.94	2.74
Spit Prolong 10/10-80 H	190	5	4.93	0.70
Spit Prolong 10/10-80 H	365	5	4.4	0.63
Spit Prolong 8/10-80 F	190	5	2.36	0.34
Spit Prolong 8/10-80 F	365	5	2.34	0.33
Spit Idall Cmix M10	190	5	4.02	1.00
Spit Idall Cmix M10	365	5	4.14	1.03

Table F3: Tensile Test Results on Fischer Fixings

Porotherm 190			
Product Tested	**Average Ultimate Load (kN)**	**Average Recommended Load (kN)**	**Average Failure Mode**
UX 8 Plug	0.68	0.1	1st Tensile Slip
FUR 10	1.23	0.15	1st Tensile Slip
SXR 10	1.05	0.15	Substrate Failure
FISV 360 S + FIS H K	6.7	1.67	Block Failure
Porotherm 365			
Product Tested	**Average Ultimate Load (kN)**	**Average Recommended Load (kN)**	**Average Failure Mode**
UX 8 Plug	0.91	0.13	1st Tensile Slip
FUR 10	1.15	0.16	1st Tensile Slip
SXR 10	1.25	0.17	Substrate Failure
FISV 360 S + FIS H K	5.7	1.44	Block Failure

ANNEX G: TENSION STRAPS

Table G1: Tensile Load Capacity of Horizontal Straps (kN)

Test No.	Porotherm End	Timber End
1	10.59	11.80
2	11.10	12.30
3	10.90	12.33
4	11.07	9.24
5	12.15	10.84
Mean	**11.16**	**11.30**

Table G2: Tensile Load Capacity of Vertical Straps (kN)

Test No.	Porotherm End	Timber End
1	8.73	6.92
2	7.77	6.83
3	7.82	7.76
4	8.01	7.20
5	8.77	7.88
Mean	**8.22**	**7.32**

ANNEX H: FIGURES

Figure H1: Flexural Failure of 100 mm Porotherm Blockwork

Figure H2: Flexural Failure of 365 mm Porotherm Blockwork

Figure H3: Localised Failure of Lintel due to Shear Load

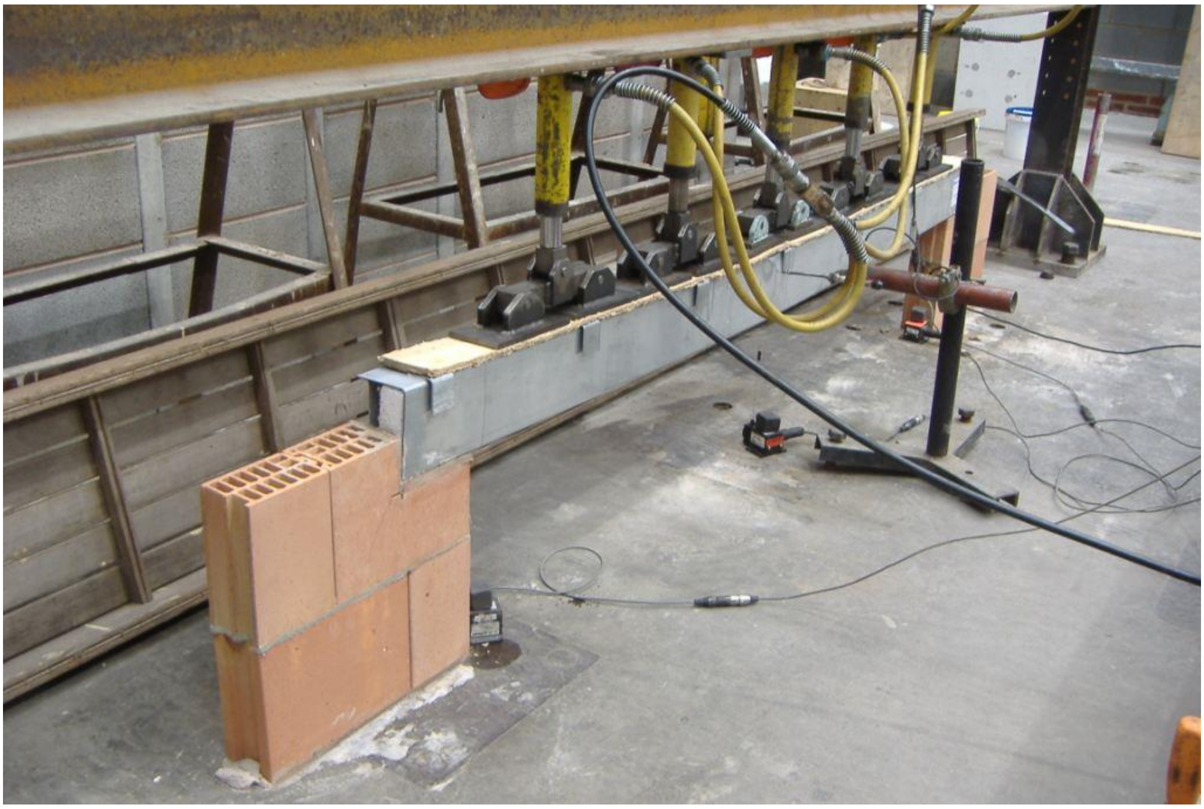


Figure H4: Flexural Test on 2.5 mm Long, 100 mm Wide Lintel

Figure H5: Localised Buckling of Lintel Web in Flexural Test

Figure H6: Joist Failure in Bearing Test

Figure H7: Failure of Horizontal Tensile Restraint Strap

ANNEX J

Exova Warringtonfire
Holmesfield Road
Warrington
WA1 2DS
United Kingdom

T : +44 (0) 1925 655 116
F : +44 (0) 1925 655 419
E : warrington@exova.com
W: www.exova.com

Testing. Advising. Assuring.

Title:

The fire resistance performance of a loadbearing wall assembly, tested in accordance with BS EN 1365-1: 1999.

WF Report No:

186546

Prepared for:

Wienerberger Ltd
Wienerberger House,
Brooks Drive,
Cheadle Royal Business Park,
Cheadle,
Manchester,
SK8 3SA.

Date:

2nd November 2009

Notified Body No:

0833

0249

Summary

Objective	To determine the fire resistance performance of a loadbearing wall assembly when tested in accordance with BS EN 1365-1: 1999.
Sponsor	**Wienerberger Ltd,** Wienerberger House, Brooks Drive, Cheadle Royal Business Park, Cheadle, Manchester, SK8 3SA.
Summary of the Tested Specimen	The wall assembly had actual overall dimensions of 2600 mm high by 3000 mm wide and was formed from 100 mm thick 'Porotherm PTH 100' extruded hollow clay precision blocks bonded with Porotherm Thin-bed mortar. A 10 to 15 mm plaster coat was applied to each face of the wall assembly. A load spreader consisting of a steel channel with a sand / cement mortar bed was provided at the base of the assembly. The test sponsor requested a total applied load of 96 kN. This load was applied to the specimen via a steel load spreader and hydraulic rams positioned underneath the assembly.
Test Results:	

Loadbearing Capacity	132 minutes*
Integrity	132 minutes*
Insulation	78 minutes
	* The test duration. The test was discontinued after a period of 132 minutes
Date of Test	15th October 2009

ANNEX K

Table K1: EcoParge Air Leakage Rates

Wall Type	Air Leakage Rate $m^3/h/m^2$				
	50Pa	100Pa	150Pa	200Pa	280Pa
Porotherm masonry & brush on parge coat	1.15	1.52	1.80	2.11	2.35
Porotherm masonry & trowel applied parge coat	0.94	1.19	1.49	1.76	2.08
Porotherm masonry & browning & plaster skim coat	0.02	0.34	0.44	0.55	0.69
Porotherm masonry & plasterboard on dabs & skim coat[1]	-	-	-	-	-

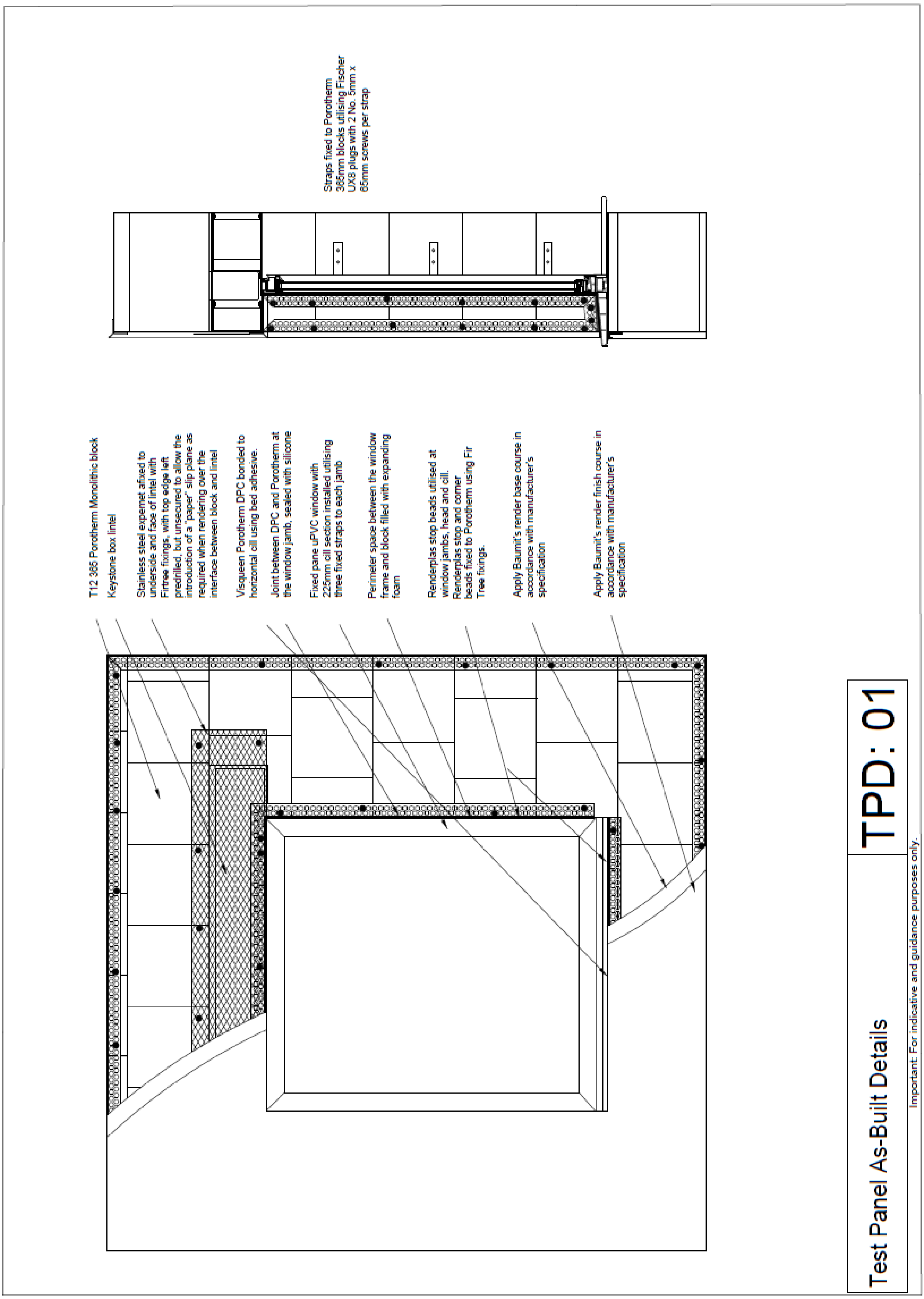
[1]Unable to achieve measurable pressure. This was also the case when lightweight aggregate concrete masonry was tested.

Table K2: PoroParge Air Leakage Rates

Wall Type	Pressure (Pa)	Panel Flow (ls^{-1})	Control Flow (ls^{-1})	Total Corrected Flow (ls^{-1})	Air Leakage Rate ($m^3/hr/m^2$)
Porotherm Masonry & Brush on Parge Coat	50	3.11	2.74	0.37	1.32
	100	3.15	2.62	0.52	1.89
	150	3.06	2.43	0.63	2.28
	200	3.05	2.33	0.72	2.58
	250	3.07	2.13	0.95	3.41

EcoParge and PoroParge are both Wienerberger approved parge coats. PoroParge has been shown to be a suitable alternative to EcoParge with comparable performance.

ANNEX L


Straps fixed to Porotherm 365mm blocks utilising Fischer UX8 plugs with 2 No. 5mm x 65mm screws per strap
T12 365 Porotherm Monolithic block
Keystone box lintel
Stainless steel expamet afixed to underside and face of lintel with Firtree fixings, with top edge left predrilled, but unsecured to allow the introduction of a "paper" slip plane as required when rendering over the interface between block and lintel
Visqueen Porotherm DPC bonded to horizontal cill using bed adhesive.
Joint between DPC and Porotherm at the window jamb, sealed with silicone
Fixed pane uPVC window with 225mm cill section installed utilising three fixed straps to each jamb
Perimeter space between the window frame and block filled with expanding foam
Renderplas stop beads utilised at window jambs, head and cill. Renderplas stop and corner beads fixed to Porotherm using Fir Tree fixings.
Apply Baumit's render base course in accordance with manufacturer's specification
Apply Baumit's render finish course in accordance with manufacturer's specification
Test Panel As-Built Details
TPD: 01
Important: For indicative and guidance purposes only.

ANNEX M

Lucideon Design Note

Porotherm Masonry: Compressive Strength

This note gives some comparisons of design strengths of aggregate concrete block masonry and Porotherm masonry. The table gives values for aggregate concrete blocks, with not more than 25% of formed voids, laid in the usual orientation or as a collar jointed wall and for solid blocks laid flat, all in a designation (iii) (M4) mortar. For use in design, the masonry strength is divided by the partial factor for materials (γ_M). For Category I units laid with a 'normal' category of construction control a value of 2.7 would be applied and this has been used for aggregate blockwork in this illustration. Porotherm masonry units are Category I units and in view of the comprehensive training, supervision and inspection it receives a partial factor for materials of 2.3 has been used. When Category II units are used with a 'normal' standard of construction a partial factor for materials of 3.0 should be used.

As a result at the 'working stress' (design strength) level the strength of Porotherm masonry is comparable with that of aggregate concrete masonry of the same or similar thickness.

Comparative Strengths of Aggregate Block and Porotherm Masonry

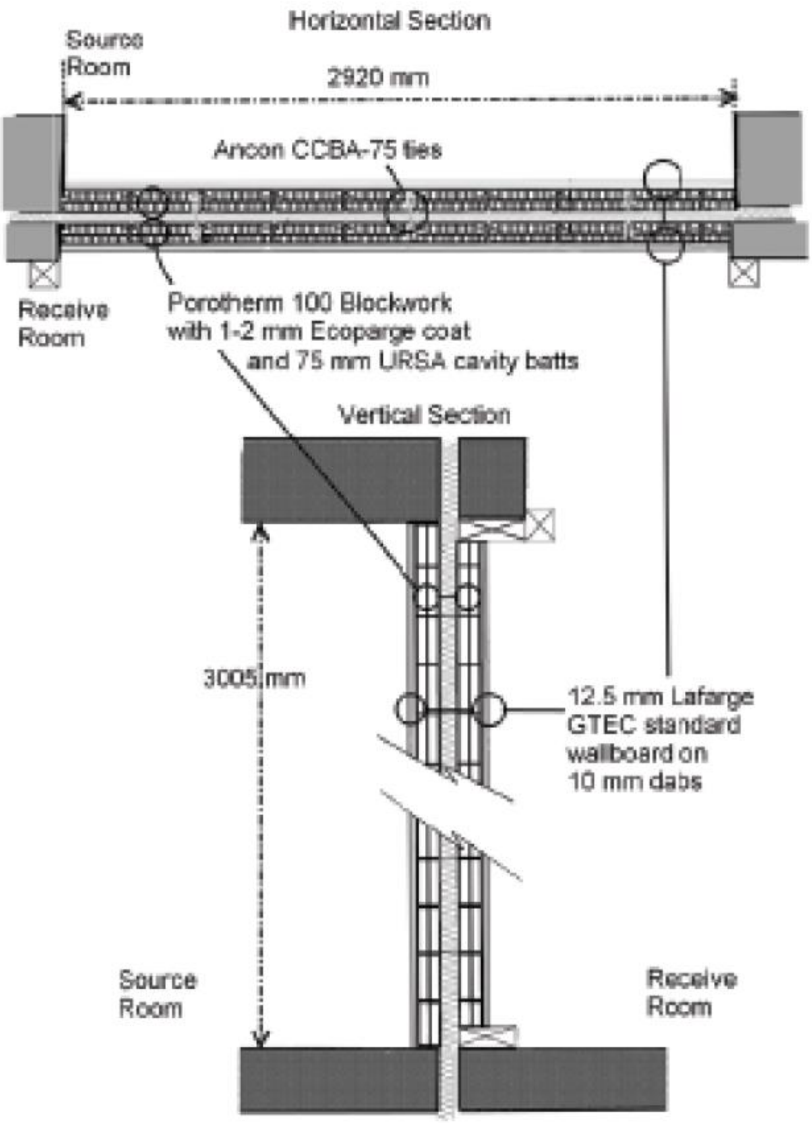
<table>
<tr><th colspan="4">Aggregate Block Masonry (void content <25%) in Designation (iii) M4 Mortar</th><th colspan="2">Porotherm</th></tr>
<tr><td rowspan="8">Block Size
l x w x h (mm)

440 x 100 x 215</td><td colspan="3">Unit Strength (N/mn^2)</td><td rowspan="8">Block Size
l x w x h (mm)

300 x 100 x 224</td><td>Unit Strength</td></tr>
<tr><td>3.6</td><td>7.3</td><td>10.4</td><td>10</td></tr>
<tr><td colspan="3">Characteristic Masonry Strength (N/mm^2)</td><td>Characteristic Masonry Strength (N/mm^2)</td></tr>
<tr><td>3.5</td><td>5.7</td><td>7.3</td><td>6.5</td></tr>
<tr><td colspan="3">Design Strength (N/mm^2)</td><td>Design Strength (N/mm^2)</td></tr>
<tr><td>1.3</td><td>2.1</td><td>2.7</td><td>2.8</td></tr>
<tr><td rowspan="8">440 x 140 x 215</td><td colspan="3">Unit Strength (N/mn^2)</td><td rowspan="8">300 x 140 x 224</td><td>Unit Strength</td></tr>
<tr><td>3.6</td><td>7.3</td><td>10.4</td><td>10</td></tr>
<tr><td colspan="3">Characteristic Masonry Strength (N/mm^2)</td><td>Characteristic Masonry Strength (N/mm^2)</td></tr>
<tr><td>3.3</td><td>5.5</td><td>6.8</td><td>5.0</td></tr>
<tr><td colspan="3">Design Strength (N/mm^2)</td><td>Design Strength (N/mm^2)</td></tr>
<tr><td>1.2</td><td>2.0</td><td>2.5</td><td>2.2</td></tr>
<tr><th colspan="4">Solid Aggregate Units Laid Flat in Designation (iii) M4 Mortar Blocks Tested Upright</th><th colspan="2">Porotherm</th></tr>
<tr><td rowspan="6">440 x 100 x 215</td><td colspan="3">Unit Strength (N/mn^2)</td><td rowspan="6">300 x 190 x 224</td><td>Unit Strength</td></tr>
<tr><td>3.6</td><td>7.3</td><td>10.4</td><td>10</td></tr>
<tr><td colspan="3">Characteristic Masonry Strength (N/mm^2)</td><td>Characteristic Masonry Strength (N/mm^2)</td></tr>
<tr><td>2.3</td><td>3.9</td><td>4.9</td><td>4.5</td></tr>
<tr><td colspan="3">Design Strength (N/mm^2)</td><td>Design Strength (N/mm^2)</td></tr>
<tr><td>0.9</td><td>1.4</td><td>1.8</td><td>2.0</td></tr>
<tr><th colspan="4">Aggregate Concrete Units (void content <25%) in Designation (iii) M4 Mortar Laid to Form a Collar Jointed Wall</th><th colspan="2">Porotherm</th></tr>
<tr><td rowspan="6">440 x (2 x 100) x 215</td><td colspan="3">Unit Strength (N/mn^2)</td><td rowspan="6">300 x 190 x 224</td><td>Unit Strength</td></tr>
<tr><td>3.6</td><td>7.3</td><td>10.4</td><td>10</td></tr>
<tr><td colspan="3">Characteristic Masonry Strength (N/mm^2)</td><td>Characteristic Masonry Strength (N/mm^2)</td></tr>
<tr><td>3.0</td><td>5.0</td><td>6.4</td><td>4.5</td></tr>
<tr><td colspan="3">Design Strength (N/mm^2)</td><td>Design Strength (N/mm^2)</td></tr>
<tr><td>1.1</td><td>1.8</td><td>2.4</td><td>2.0</td></tr>
</table>

AIRO Report No. L/3201 Dated: 27 June 201

Porotherm 100 cavity blockwork wall on isolated reveals with parge and dryline finishes

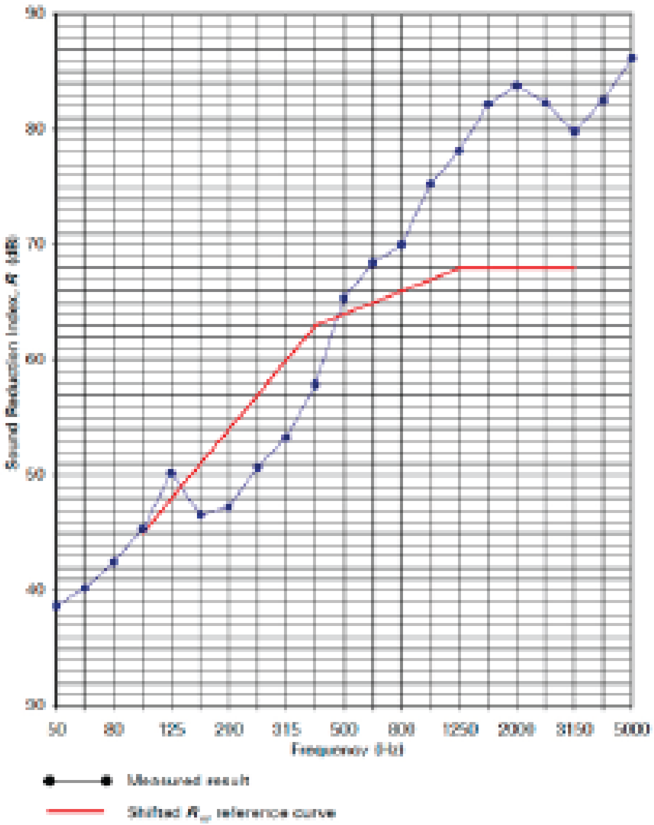


Sound Reduction Index according to BS EN ISO 140-3:1995

Test No.	L/3201	Date of Test: 24 June 2011
Client:	Wienerberger Ltd	
Specimen:	Porotherm 100 cavity blockwork wall on isolated reveals with parge & dryline finishes	
Installed by:	Wienerberger Ltd	
Specimen area:	8.37 m²	Mass per unit area: 210 kg/m²

Chamber Conditions	Volume	Air Temperature	Relative Humidity
Source Chamber	100 m³	20°C	74%
Receiving Chamber	200 m³	18°C	82%

Frequency (Hz)	R One-third Octave (dB)	R Octave (Db)
50	38.7	
63	40.2	40.2
80	42.5	
100	45.4	
125	50.2	47.0
160	46.6	
200	47.3	
250	50.7	49.7
315	53.3	
400	57.9	
500	65.4	61.6
630	68.4	
800	70.0	
1000	75.3	73.2
1250	78.1	
1600	82.2	
2000	83.8	82.7
2500	82.3	
3150	79.8	
4000	82.5	82.1
5000	86.2	
6300		
8000		
10000		



Rating according to BS EN ISO 717-1:1997

$R_w(C;C_{tr}) = 64\ (-2;-6)$

$C_{50-3150}$ = -2 dB	$C_{50-5000}$ = -1 dB	$C_{100-5000}$ = -1 dB
$C_{tr,50-3150}$ = -9 dB	$C_{tr,50-5000}$ = -9 dB	$C_{tr,100-5000}$ = -6 dB

Evaluation based on laboratory measurement results obtained by an engineering method

Approved by:

D L Watts

Eur Ing D L Watts BEng CEng FIOA
Principal Consultant

Report Author:

P Tarrant

P Tarrant MIOA
Senior Consultant

The guidance given in this document is aimed at showing ways in which appropriately qualified persons can produce structures using Porotherm blocks that have an equivalent level of safety to that when using British Standard Codes of Practice and will therefore meet the requirements of the Building Regulations. Lucideon accepts no responsibility for the safety of any building or construction, which makes use in whole or in part of this guidance or any liability howsoever arising from the use in whole or in part of this guidance.

Queens Road, Penkhull, Stoke-on-Trent,
Staffordshire, ST4 7LQ, United Kingdom

T +44 (0)1782 764428
E enquiries@lucideon.com
W www.lucideon.com/construction