2.5 Example calculations

To illustrate the calculation method, an example calculation for each construction type is shown below. In each case the thermal conductivity of insulation is 0.035 W/m K. The layer resistances come from the table above.

Required U-value = 0.27 W/m² K
Required resistance = 3.70 m² K/W

	Resistances excluding insulation [m² K/W]			
Layers	**W1**	**W2/W3**	**W4**	**W5**
External surface resistance	0.040	0.040	0.040	0.040
Render	0.020	0.020	0.020	0.020
Outer leaf	0.087	0.087	0.087	
Air cavity	0.180	0.180		
(Cavity insulation)				
Inner leaf	0.087	0.087	0.087	
Hollow concrete block				0.210
Air space between masonry and internal insulation		0.130		0.130
(Internal insulation)				
Gypsum plastering	0.023		0.023	
Gypsum plasterboard		0.052		0.052
Internal surface resistance	0.130	0.130	0.130	0.130
Total resistance excluding insulation [m² K/W]	0.567	0.726	0.387	0.582
Resistance deficit [m² K/W]	3.137	2.978	3.317	3.122
Conductivity of insulation [W/m K]	0.035	0.035	0.035	0.035
Required insulation thickness [mm]	110	104	116	109

2.6 Comments on calculation

In the U-value calculations reported here, good quality construction is assumed, with no air circulation possible on the warm side of the insulation, and no significant gaps penetrating the insulation layer. Corrections for air gaps given in EN 6946 are thus not applied.

Also, the corrections for wall ties are assumed to be less than 3% of the U-value, and hence are neglected. In general, this will be valid with stainless steel wall ties (typical conductivity 17 W/m K) of non-excessive cross-sectional area, but not with galvanised steel ones (typical conductivity 50 W/m K).

Regarding the outer leaf construction of cavity walls, three options were considered as follows

(a) 102 mm clay brick, λ = 0.77 W/m K (no render)
(b) 100 mm concrete (medium density: 1800 kg/m³, λ = 1.15 W/m K) with 20 mm external render (cement sand, λ = 1.00 W/m K)
(c) Same as (b) above except slightly higher density concrete used (medium density: 2000 kg/m³, λ = 1.35 W/m K)

Of these, option (b) (concrete of density 1800 kg/m³) has a thermal resistance intermediate between the others, so this “middle-of-the-road” option was used in the analyses. (Since most of the thermal resistance will come from the insulation layer(s), the choice of outer leaf will make little difference to the resulting U-value).

Consultancy Study

for

Irish Concrete Federation

Wall Constructions

Installation Requirements

for

Compliance With

Technical Guidance

Document Part L

Report

Energy Research Group
University College Dublin
April 2002

Contents

This publication is a summary of the study completed in April 2002, by the Energy Research Group (UCD). Copies of the complete study are available on request.

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Executive Summary

This report highlights the findings of a study by the Energy Research Group UCD, which was commissioned by the Irish Concrete Federation.

The Energy Research Group UCD was requested to examine various common forms of concrete block wall and concrete floor construction used in Irish housing with a view to establishing construction details which would meet the proposed new thermal insulation standards proposed by the Government.

It has been shown that utilising insulating materials currently available, all forms of concrete construction can be detailed to fully comply with the proposed thermal insulation standards.

The Report outlines proposed materials and details and provides general guidelines and advice on good construction practice suitable for compliance with the requirements of the proposed building regulations.

1. Introduction

This study was undertaken by the Energy Research Group UCD at the request of the Irish Concrete Federation between June and December 2001.

The main aim of the study was to assess the solutions proposed by the Federation for concrete block wall and concrete floor construction, to achieve the performance standards indicated by the Dept of the Environment and Local Government (DOELG) for the proposed revisions to Technical Guidance Document L (TGD L) 2002 of the Building Regulations. The study addressed the following:

- Required insulation thicknesses
- Minimisation of thermal bridging
- Technical guidance on detailing
- Appropriate insulation materials, proper location and placement of insulation, and completeness of insulation cover.

The current and proposed maximum U-values for exposed elements are as follows

	Current	**Proposed**
Roof	0.25	0.16
Walls	0.45	0.27
Floors	0.45	0.25

The complete study is in two parts. The first part indicates the construction types and insulation thickness required to achieve the performance standards indicated in the proposed revisions to Technical Guidance (TGD L) 2002. The second part addresses installation guidelines for each of the construction types studied.

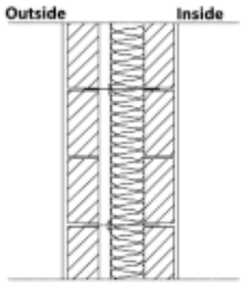
2. Wall Constructions

The insulation thicknesses required to achieve a U-value of 0.27 W/m² K were calculated using the method specified in IS EN 6946.

2.1 Constructions

Five wall constructions were considered as follows (with layers listed from outside to inside).

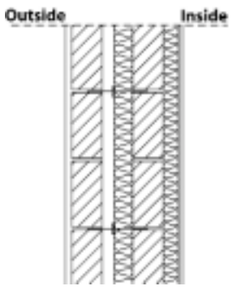
W1 Up to 150 mm cavity, partial-fill cavity insulation only



Render
Outer leaf
Air space in cavity wall
Cavity insulation
Inner leaf
Plaster

The maximum cavity width is 150 mm (in accordance with IS 325), hence with a 40 mm air space, the maximum insulation thickness is 110 mm.

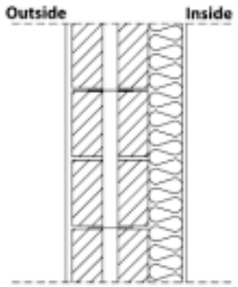
W2 100 mm cavity, both partial-fill cavity and internal insulation



Render
Outer leaf
Air space in cavity wall
Cavity insulation
Inner leaf
Air space between masonry and internal insulation
Internal insulation
Vapour barrier
Plasterboard

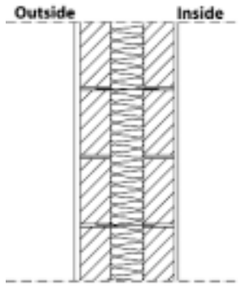
With a 40 mm cavity, the maximum insulation thickness in the cavity is 60 mm, with the balance of insulation fixed internally. In the calculations reported below, the same thermal conductivity is assumed for both cavity and internal insulation.

W3 50 mm cavity, internal insulation only



Render
Outer leaf
Air space in cavity wall
Inner leaf
Air space between masonry and internal insulation
Internal insulation
Vapour barrier
Plasterboard

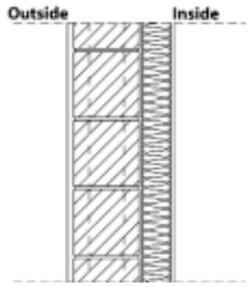
W4 Full-fill cavity insulation



Render
Outer leaf
Cavity insulation
Inner leaf
Plaster

The maximum cavity width is 150 mm.

W5 Hollow-block, internal insulation



Render
Hollow block
Air space between masonry and internal insulation
Internal insulation
Vapour barrier
Plasterboard

The internal insulation, where present, is fixed to the masonry wall either on plaster dabs or over battens or metal furring. This gives rise to a small air space between insulation and wall.

2.2 Wall components

The thicknesses and thermal conductivities of the components making up these wall constructions are as follows:

	Thickness [mm]	Conductivity [W/m K]	Resistance [m² K/W]
External surface resistance	-	-	0.040
External rendering (cement sand)	20	1.00	0.020
Outer leaf of medium density concrete block (1800 kg/m³)	100	1.15	0.087
Air space in cavity wall	40	-	0.180
Inner leaf of medium density concrete block (1800 kg/m³)	100	1.15	0.087
Hollow concrete block	215	-	0.210
Air space between masonry and internal insulation (due to plaster dabs, battens or metal furring)	7	-	0.130
Gypsum plastering (dense, 1300 kg/m³)	13	0.57	0.023
Gypsum plasterboard (900 kg/m³)	13	0.25	0.052
Internal surface resistance		-	0.130

Notes:

1. All the above thermal conductivity values are taken from IS EN 12524.

2. In specifying the thermal resistance of the air space between the masonry and internal insulation above, good construction practice to avoid air movement or circulation through this air space is assumed. To achieve this, the perimeters of the insulated area (ceiling, floor and wall junctions, and around window and door openings) should be sealed with continuous ribbons of bonding plaster or battens as appropriate (see TGD L 2002, page 15, diagram 4.1). A failure to do this may seriously compromise the effectiveness of the insulation.

2.3 Thermal conductivities of insulation materials

Typical values of thermal conductivity for some commonly-used insulation materials are given below. Note that certified thermal conductivity values for particular insulation products should be used in preference where available. These values may be used together with the table of insulation thicknesses below to obtain the required insulation thickness for a given insulation type.

Insulation material	Conductivity [W/m K]
Glass fibre/wool quilt	0.040
Expanded polystyrene (EPS) slab (SD)	0.037
Glass fibre/wool batt	0.035
Expanded polystyrene (EPS) slab (HD)	0.035
Extruded polystyrene	0.025
Phenolic foam	0.025
Polyurethane board	0.025

[Source: Draft TGD L, 2002]

Consultancy Study *for Irish Concrete Federation*

2.4 Required insulation thicknesses

Insulation thicknesses required for a U-value of 0.27 W/m² K are as follows:

Conductivity	Constructions			
[W/m K]	W1	W2/W3	W4	W5
0.020	63	60	66	62
0.021	66	63	70	66
0.022	69	66	73	69
0.023	72	68	76	72
0.024	75	71	80	75
0.025	78	74	83	78
0.026	82	77	86	81
0.027	85	80	90	84
0.028	88	83	93	87
0.029	91	86	96	91
0.030	94	89	100	94
0.031	97	92	103	97
0.032	100	95	106	100
0.033	104	98	109	103
0.034	107	101	113	106
0.035	110	104	116	109
0.036	X	107	119	112
0.037	X	110	123	116
0.038	X	113	126	119
0.039	X	116	129	122
0.040	X	119	133	125
0.041	X	122	136	128
0.042	X	125	139	131

Constructions:

W1 150 mm cavity, partial-fill cavity insulation only
W2 100 mm cavity, both partial-fill cavity and internal insulation
W3 50 mm cavity, internal insulation only
W4 Full-fill cavity insulation
W5 Hollow-block, internal insulation

Notes

For construction W1, the maximum insulation thickness allowed is 110 mm. Insulation of a thermal conductivity of 0.035 or less must be used to achieve the required U-value with this constraint.

As mentioned above, for construction W2 (insulation both in cavity and internal), the same thermal conductivity is assumed for both insulation layers.

Constructions W2 and W3 require the same total insulation thickness; the difference is that in W3, all the insulation is internal, whereas in W2, 60mm is in the cavity, with the balance inside.

For construction W2, if insulation of thermal conductivity 0.020 W/m K is used, the required U-value can be achieved with cavity insulation alone - no internal insulation is required. (It is assumed that there is still an air gap between the inner leaf and plasterboard).

For construction W4 (full-fill cavity), the constraint of a maximum cavity width of 150 mm is not a problem; the required U-value can be achieved with insulation of all thermal conductivity values considered.