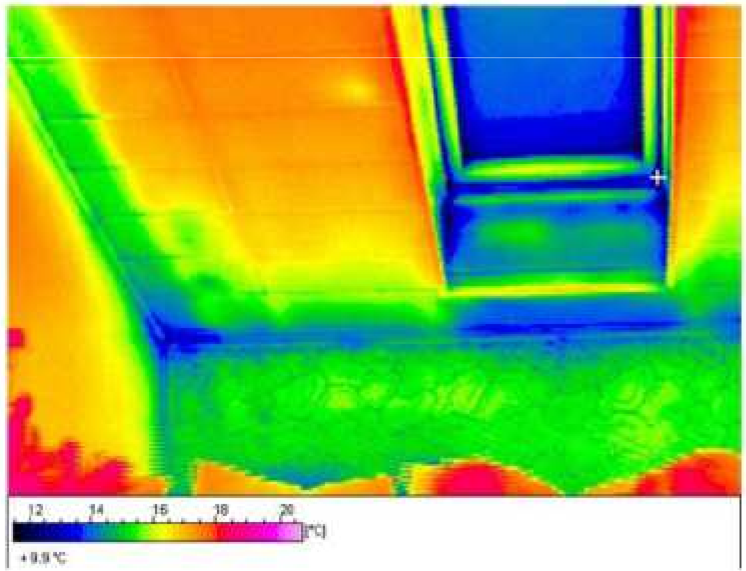
Acceptable Construction Details, Thermal Bridging and Air Permeability

Sean Armstrong,
Technical Adviser,
Building Standards,
DEHLG



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Outline

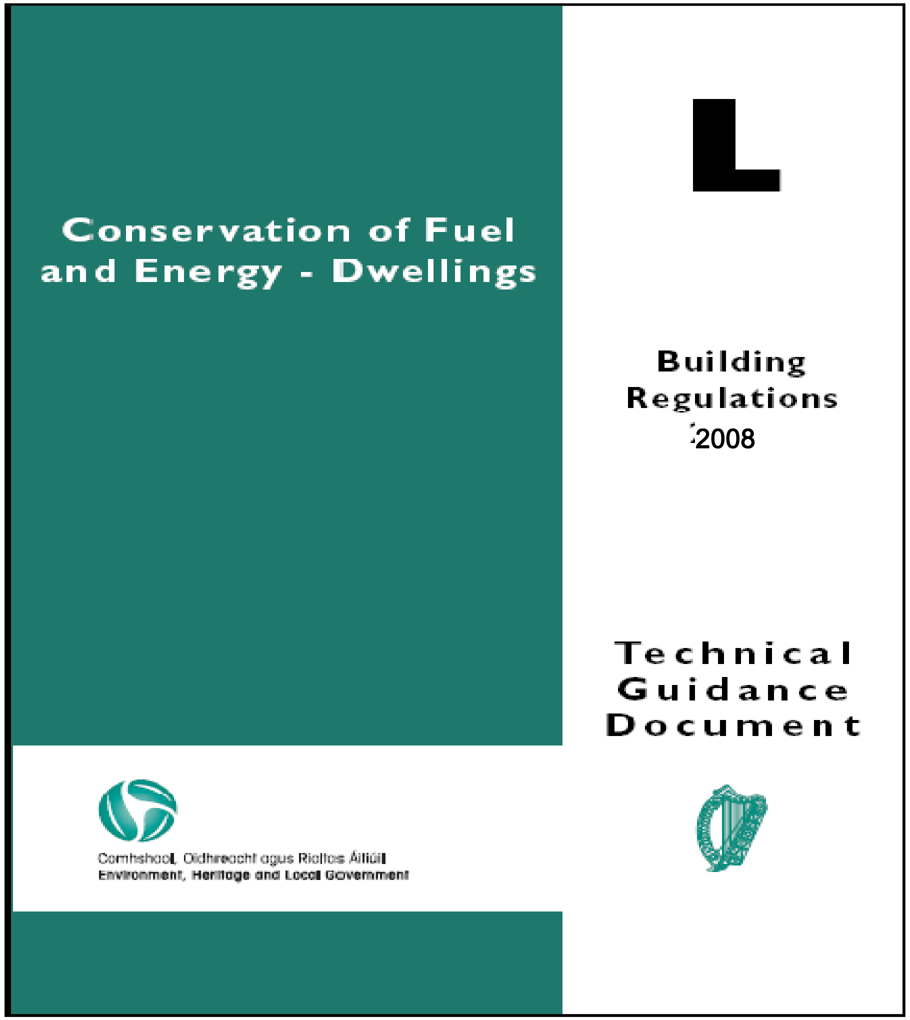
- Overview of TGD L
- Overview of Guidance wrt Airtightness and Thermal Bridging
- Overview of Acceptable Construction Details

Building Standards - Strategy

Strategy 2008-2010

Promote high quality, safe and sustainable design and construction, notably, through ongoing review of the Building Regulations and prioritisation of energy efficiency and eco-design.

Part L


Conservation of Fuel and Energy - Dwellings

L

Building Regulations 2008

Technical Guidance Document

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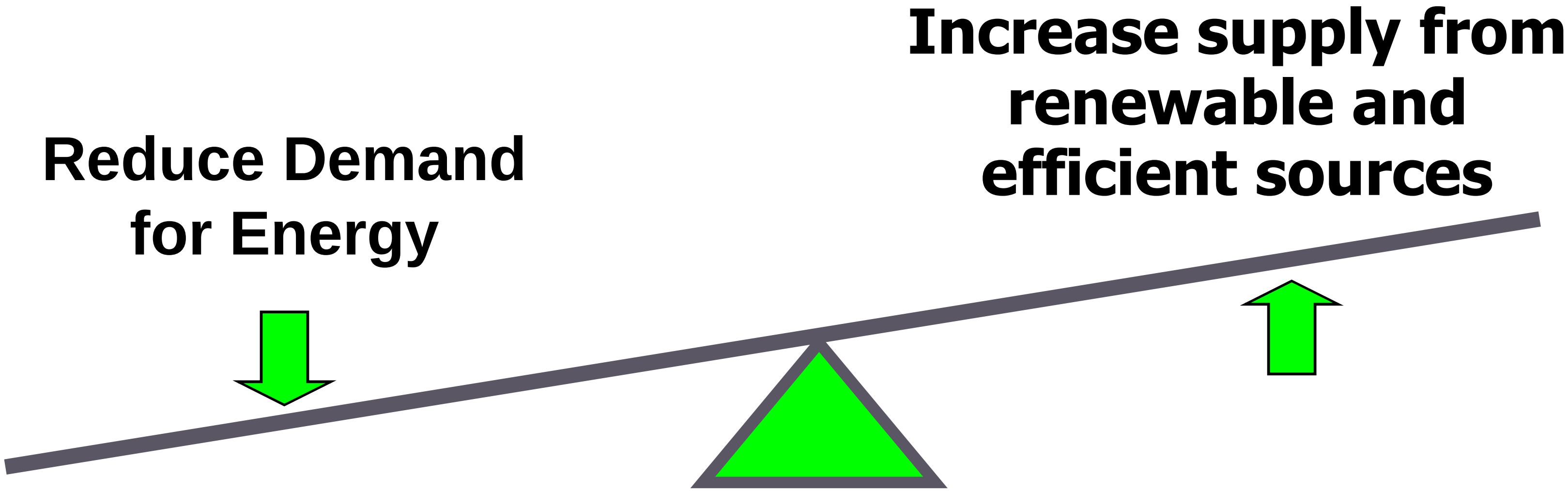
What principle underpins Part L?



What are the main provisions of the Regulations for new dwellings?

a) Primary energy consumption and associated CO_2 emissions

Energy consumption and emissions should be 40% better than 2005 Reference House.

Ie. MPEPC=.6, MPCPC=.69

b) Renewable energy sources

10kWH/M2/Annum Thermal, 4kwh/m2/annum Electrical or a combination or CHP

c) Building fabric

Fabric Insulation, Thermal Bridging, Air Infiltration

d) Space and water heating

Oil or gas fired boilers should have a seasonal efficiency should be not less than **86%** as specified in HARP ➔Condensing boiler

MVHR as per GPG 268

e) Owner information

Operation and maintenance of the:

- Building
- Fixed Services

3) Building Fabric

a) Fabric insulation
   a) Elemental U Values
   b) Area weighted average elemental u-value of doors, windows, rooflights reduced to 2.0

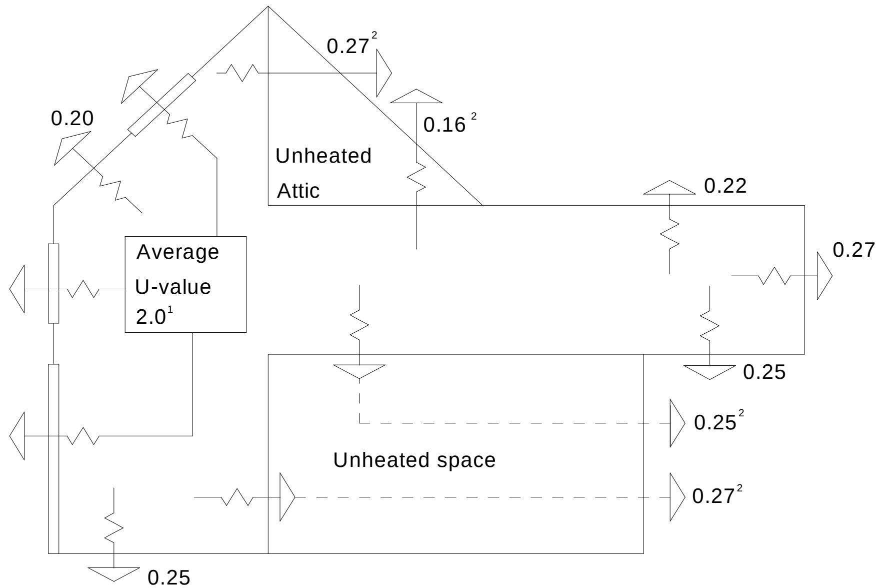
b) Air infiltration
   a) On site testing
   b) Use of Acceptable Construction Details

c) Thermal bridging
   a) Use of Acceptable Construction Details
   b) Y value

a) Building Fabric –U values

Fabric insulation

- Area weighted average elemental u-values
- Area weighted average elemental u-value of doors, windows, rooflights reduced to 2.0 (opening area 25% of floor area)



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b)Building Fabric - Thermal Bridging

- Demonstrate by calculation that the all thermal bridges meet a table of acceptable values in TGD L, Table D1
- Use acceptable details that have been assessed and limit thermal bridges to acceptable values as per Table D1 in TGD L
- Use alternative details that limit risk of mould growth and condensation using a calculation method for the temperature factor in TGD L

APPROPRIATE ON SITE INSPECTION & QUALITY CONTROL

Value of Y = 0.08

Alternatively, Value of Y = 0.15

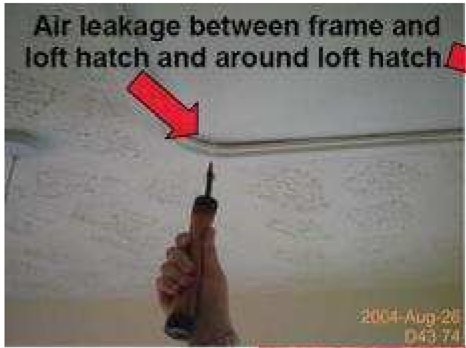
c) Building Fabric –Air Permeability

1.3.4.1 To avoid excessive heat losses, reasonable care should be taken to limit the air permeability of the envelope of each dwelling. In this context, envelope is the total area of all floors, walls (including windows and doors), and ceilings bordering the dwelling, including elements adjoining other heated or unheated spaces.

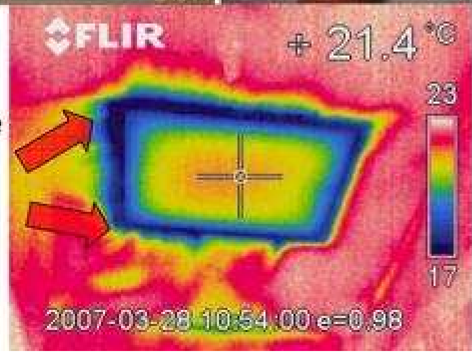
1.3.4.3 Achievement of reasonable levels of air permeability can be facilitated by adopting the standard details referred to in Paragraph 1.3.3.2 (Acceptable Construction Details) above, together with an appropriate performance specification and the on-site inspection regime and related quality control procedures, referred to in that paragraph.

1.3.4.4 Air pressure testing should be carried out on a proportion of dwellings on all development sites. See Sub-section 1.5.4 for details of the test procedure, extent of testing, use of test results in DEAP calculations and appropriate measures to be undertaken where the limit set is not achieved. When tested in accordance with the procedure referred to in Sub-section 1.5.4, a performance level of

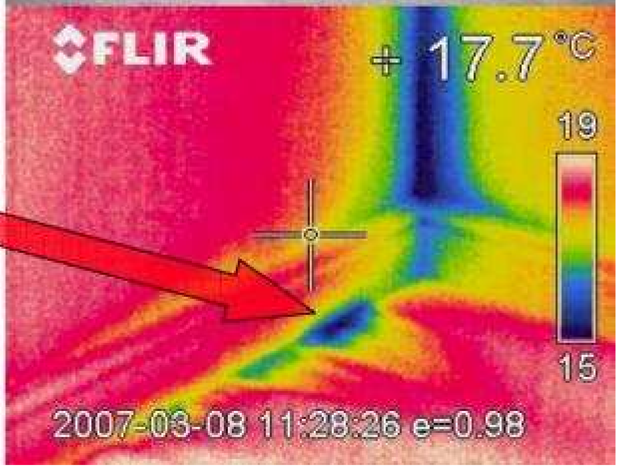
Air Leakage



Thermal image showing infiltration around loft hatch.



Thermal image showing infiltration through intermediate floor/wall junction.



Source: Leeds Metropolitan University
Low Carbon Housing Learning Zone

Guidelines to improve air tightness

- **Design Stage**
  - Keep it simple! Simple designs are more likely to get built right.
  - Decide which layer of the construction provides the air barrier. Stick with this. Use the pen-on-section test to check continuity and to identify key details
  - Pay careful attention to the design of junctions between elements to ensure continuity of the air barrier.
  - Minimise penetrations of the thermal envelope, whether by services or structure or construction.
- **Construction Stage**
  - Ensure that details of all design changes involving elements of the external envelope are distributed throughout the design, procurement and construction teams
  - It is important that the project programme reflects the required sequence for effective formation of the air barrier and insulation installation
  - *Communication and Education* – Personnel involved in procurement and constructing the building fabric should understand the need for insulation continuity and airtightness.
  - *Quality Control* -Quality Assurance (QA) should be extended to check for insulation continuity and airtightness

Thermal Bridging

Thermal Bridge: Part of the structure of lower thermal resistance that bridges adjacent parts of higher thermal resistance and which can result in localised cold surfaces on which condensation, mould growth and/or pattern staining can occur.

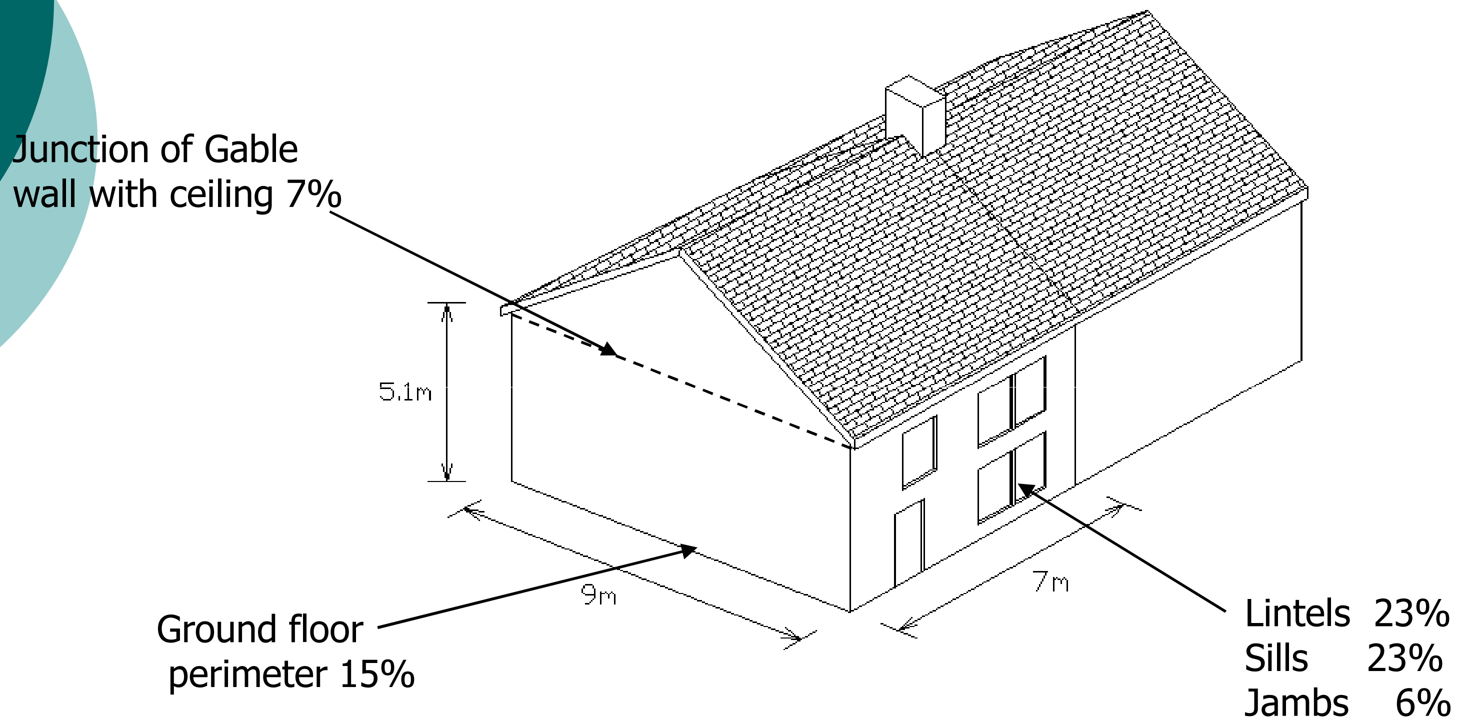
Thermal bridges fall into two categories:

(a) Repeating thermal bridges (such as timber joists, mortar joints, and mullions in curtain walling). The additional heat flow due to the presence of this type of thermal bridge is included in the determination of the U-value of the particular building element which contains these bridges.

(b) Non-repeating thermal bridges (such as junctions of floor and roof with the external wall, and details around window and door openings) where the additional heat flow due to the presence of this type of thermal bridge is determined separately

Acceptable Construction Details address Thermal Bridge Type B

Main thermal bridges using traditional cavity construction details



Sect. 1.3.3 TGD L Thermal Bridging

1.3.3.2 The following represents alternative approaches to making reasonable provision with regard to limitation of thermal bridging:

(a) Demonstrate by calculation in accordance with the methodology outlined in Appendix D that all key thermal bridges meet the performance levels set out in Table D1 of Appendix D.

(b) Adopt details that are similar to, or demonstrated as equivalent to, generic details that have been assessed as limiting thermal bridging to an equivalent level to that set out in Table D1 of Appendix D. A set of such details for typical constructions will be developed in consultation with relevant construction industry organisations and will be made available in a document "Limiting Thermal Bridging and Air Infiltration – Acceptable Construction Details".

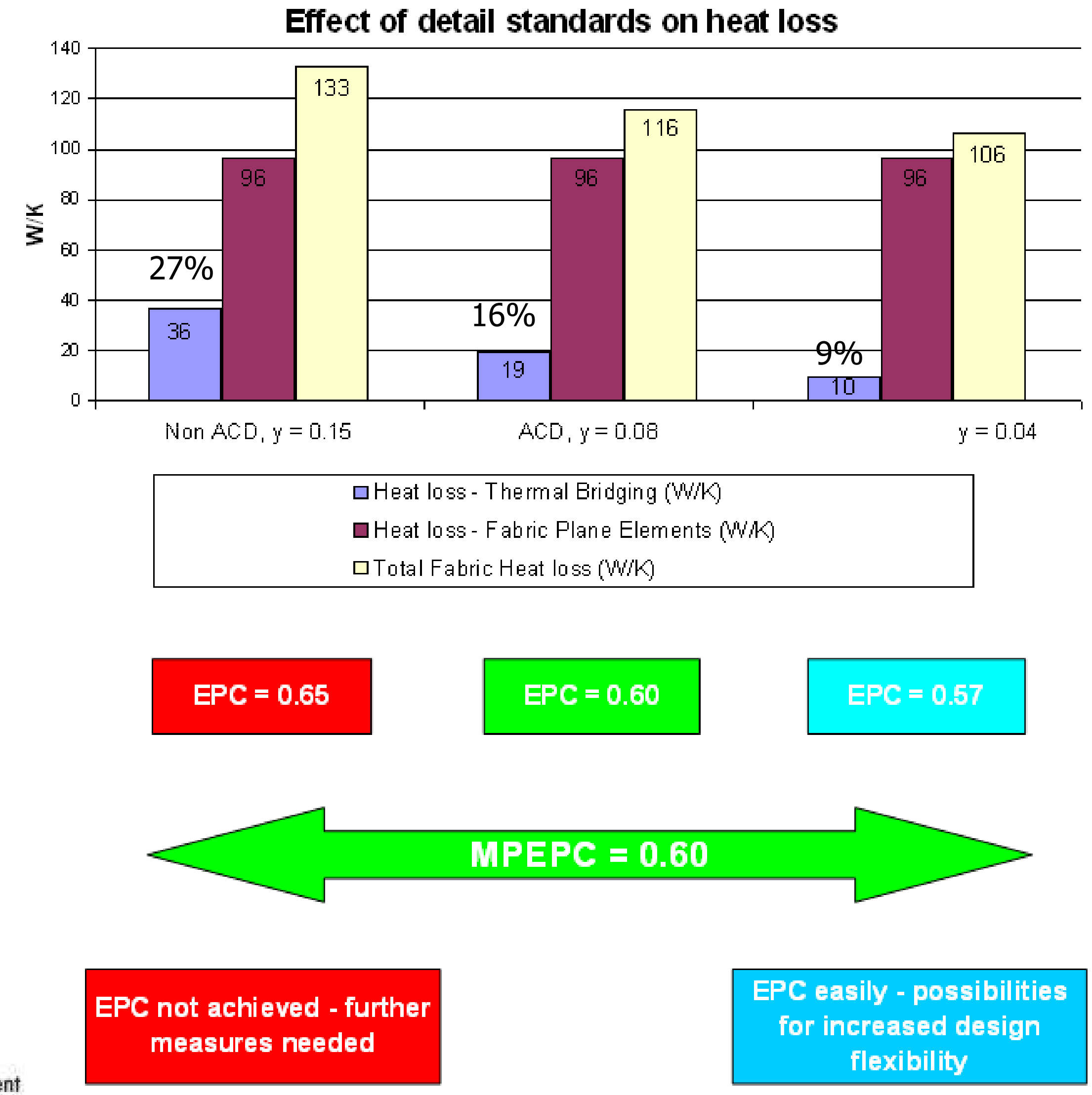
(c) Use alternative details which limit the risk of mould growth and surface condensation to an acceptable level as set out in Paragraph D.2 of Appendix D.

Deap Calculations

1.3.3.3 DEAP allows for thermal bridges by including an allowance for additional heat loss due to thermal bridging, expressed as a multiplier (y) applied to the total exposed surface area.

- Where provision for thermal bridging is made in accordance with options (a) or (b) of Paragraph 1.3.3.2, this multiplier should be taken as 0.08.
- Where option (c) of Paragraph 1.3.3.2 is used, it will be necessary to allow for each thermal bridge separately in the calculation.
- Alternatively a multiplier of 0.15 may be used.

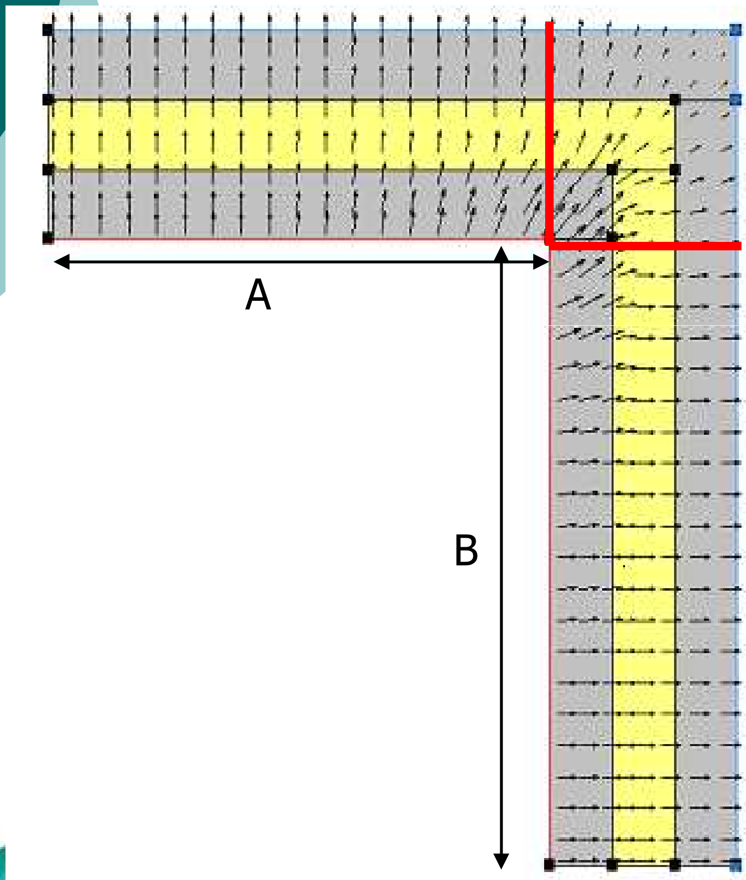
Significance of Thermal Bridging in DEAP



Methodology outlined in Appendix D

- The procedure to establish linear thermal transmittance (ψ) is outlined in BRE IP 1/06.
- Modelling Software should perform to IS EN ISO 10211 Parts 1 and 2. Several packages are available that meet this requirement. –Therm (free), HEAT, Physibel
- The guidance in BRE Report BR 497 *Conventions for calculating linear thermal transmittance and temperature factors* on inputting parameters should be used for modelling. This allows different users of the same software package and users of different software packages can obtain correct and consistent results.

Thermal Bridge and Linear Thermal Transmittance Ψ



D.3 Linear Thermal Transmittance and

Additional Heat Loss

The linear thermal transmittance (Ψ) describes the

heat loss associated with a thermal bridge. This is a

property of a thermal bridge and is the rate of heat

flow per degree per unit length of bridge that is not

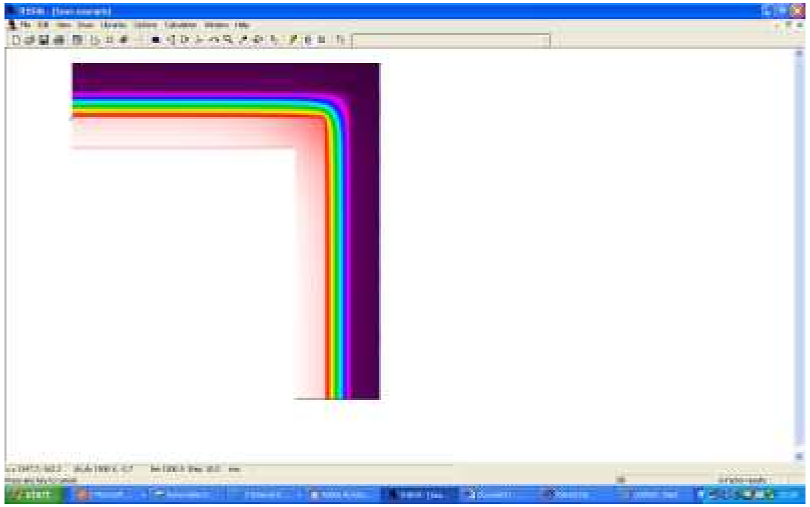
accounted for in the U-values of the plane building

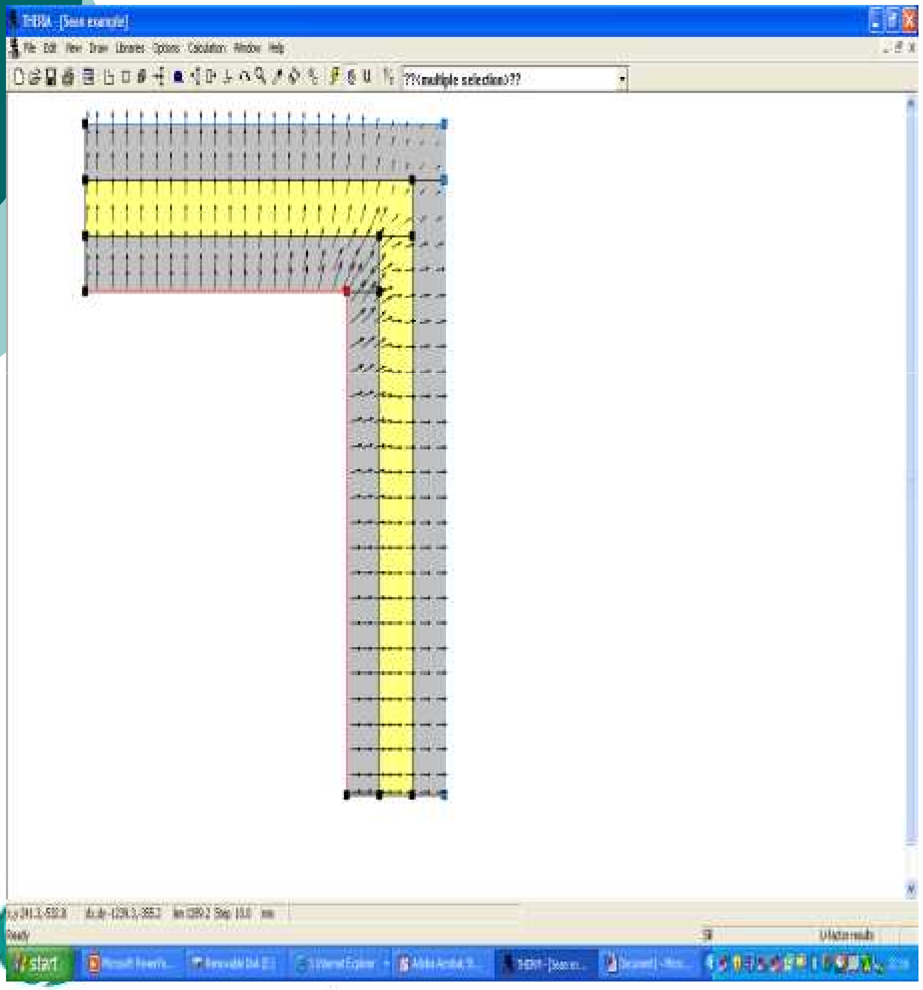
elements containing the thermal bridge. The linear

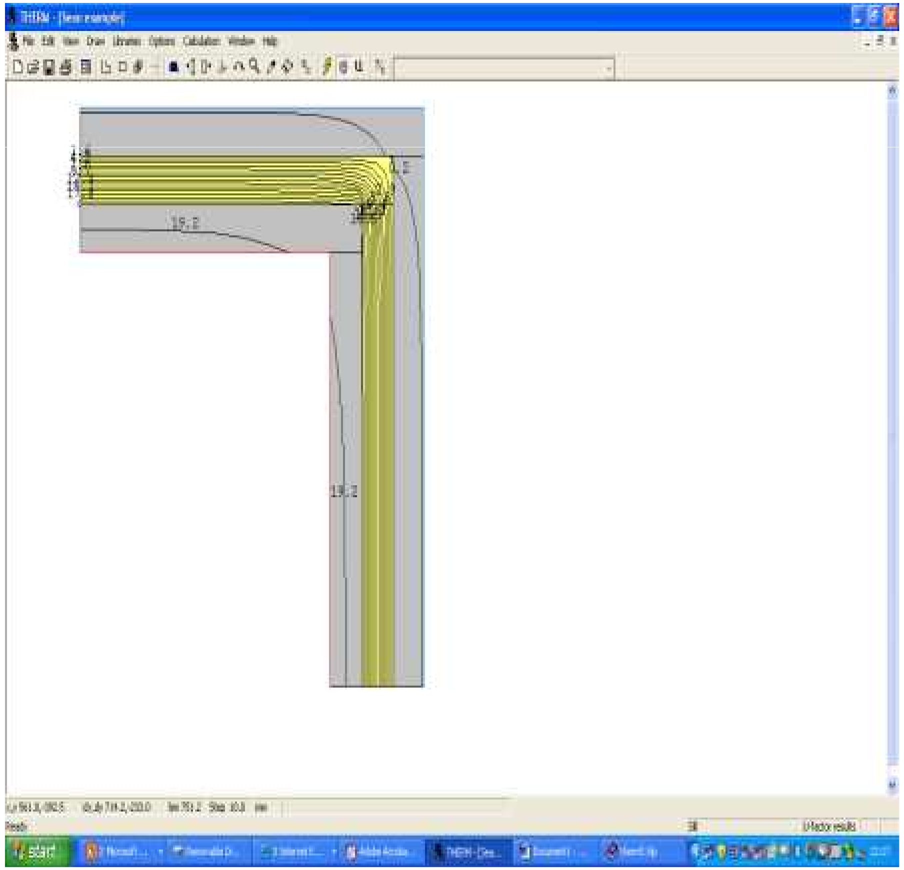
transmission heat loss coefficient associated with

non-repeating thermal bridges is calculated as:

Example of mode







Option A

(a) Demonstrate by calculation in accordance with the methodology outlined in Appendix D (BRE IP 1/06, Software to ISO 10211, Inputs to BR497) that all key thermal bridges meet the performance levels set out in Table D1 of Appendix D.

Table D1	**Target linear thermal transmittance (ψ) for different types of junctions.**
Junction detail in external wall	**Linear Thermal Transmittance (Ψ) (W/mK)**
Steel lintel with perforated steel base plate	0.50
Sill	0.04
Other lintels (including other steel lintels)	0.30
Jamb	0.05
Ground floor	0.16
Intermediate floor within a dwelling	0.07
Intermediate floor between dwellings [1]	0.14
Balcony within a dwelling [2]	0.00
Balcony between dwellings [1, 2]	0.04
Eaves (insulation at ceiling level)	0.06
Eaves (insulation at rafter level)	0.04
Gable (insulation at ceiling level)	0.24
Gable (insulation at rafter level)	0.04
Corner (normal)	0.09
Corner (inverted)	-0.09
Party wall between dwellings [1]	0.06

Note 1: For these junctions, half the value of ψ is applied to each dwelling

Note 2: Refers to an externally supported balcony (the balcony slab is not a continuation of the floor slab)

Option C

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Use alternative details which limit the risk of mould growth and surface condensation to an acceptable level as set out in Paragraph D.2 of Appendix D

D.2 Mould Growth and Surface Condensation

The temperature factor (f_{Rsi}) is defined as follows:

f_{Rsi} = (Tsi – Te) / (Ti – Te) where:

Tsi = minimum internal surface temperature,

Te = external temperature, and

Ti = internal temperature.

For dwellings, the value of f_{Rsi} should be greater than or equal to 0.75 so as to avoid the risk of mould growth and surface condensation.

For three dimensional corners of ground floors this value maybe reduced to 0.70, for all points within 10 mm of the point of lowest f_{Rsi}

Where option (c) of Paragraph 1.3.3.2 is used, it will be necessary to allow for each thermal bridge separately in the calculation of a value for y.

Option B

- Adopt details that are similar to, or demonstrated as equivalent to, generic details that have been assessed as limiting thermal bridging to an equivalent level to that set out in Table D1 of Appendix D. A set of such details for typical constructions will be developed in consultation with relevant construction industry organisations and will be made available in a document “Limiting Thermal Bridging and Air Infiltration – Acceptable Construction Details”.

Acceptable Construction Details Format

- Details have been developed by DEHLG, HomeBond and SEI.
- They were developed in Consultation with an Industry Working Group made up of representatives from different Sectors of the Construction Industry.
- The guide is presented in 2 sections.
  - Section 1 discusses the general theory of insulation continuity and airtightness in construction.
  - Section 2, in seven separate parts, provides indicative detail drawings of thermal insulation and airtightness provisions for specific construction interfaces.

Acceptable Construction Details –Section 1

- Explains how to achieve minimise thermal bridges at design stage and construction stage
- Provides an Index to drawings
- Explains how thermal bridging multiplier (y) can be used in DEAP
- Provides pictures and guidelines of best practice with regards to achieving airtightness in Buildings
- Provides examples of how to calculate value for y for TGD L example
- Provides an appendix 2 of Psi (ψ) values for commonly used details
  which can be used when value for y is obtained by calculation.

Acceptable Construction Details – Section 2

- Consists of drawings for each construction type. 21-25 Drawings for each construction type and 4 common drawings
  - Type 1 Cavity wall insulation
  - Type 2 External insulation
  - Type 3 Internal insulation
  - Type 4 Timber Frame
  - Type 5 Steel Frame
  - Type 6 Hollow Block Internal Insulation
  - Type G General Details(common to all constructions)
- 21-25 Drawings for each construction type and 4 common drawings

Details -Introduction Page

Example Detail-Gable Wall

(1) WALLS:- INSULATION IN CAVITY | **Ventilated Roof - Attic Floor Level** | *DETAIL 1.15, JULY 2008*

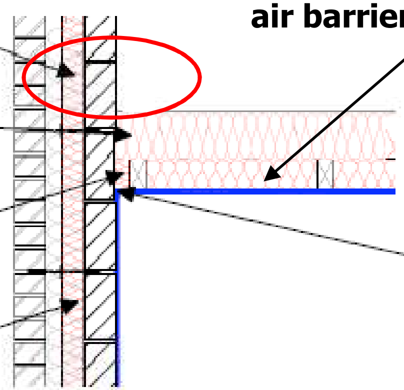
Blue line on Drawing indicates air barrier

THERMAL PERFORMANCE

CHECKLIST (TICK ALL)

- ☐ Continue wall insulation a minimum of 250 mm over top of attic insulation
- ☐ Ensure full depth of insulation between and over joists extends to inner edge of wall
- ☐ Pack compressible insulation between last truss or joist, and gable wall
- ☐ Ensure partial fill insulation is secured firmly against inner leaf of cavity wall

Complying with checklist qualifies builder to claim Ψ value in Table 3 of IP 1/06 and Table K1 of DEAP 2006



AIR BARRIER - CONTINUITY

CHECKLIST (TICK ALL)

- ☐ Seal all penetrations through air barrier using a flexible sealant
- ☐ Fix ceiling first, and seal all gaps between ceiling and masonry wall with either plaster, adhesive or flexible sealant

Complying with checklist will help achieve design air permeability

GENERAL NOTES

Thermal performance of junction can be improved significantly by using blockwork with a thermal conductivity of ≤.20 W/mK in direction of heat flow in external wall at attic floor level or alternatively by running insulation of R-value 1.5 m^2K/W vertically up internal face of gable wall to a height of 450 mm above ceiling level

Keep cavities clean of mortar snots and other debris during construction

Use of over joist insulation is considered best practice, as it eliminates the cold bridge caused by the joist

Cavity must be closed along the verge

Read this detail in conjunction with details 1-09: Eaves - Ventilated Attic, or 1-10: Eaves - Unventilated Attic, as appropriate

Where different block materials are being used consideration should be given to avoid cracking in plaster at the junction between the block materials

AIR BARRIER - OPTIONS

OPTION (TICK ONE)

- ☐ Masonry inner leaf with wet-finish plaster, or
- ☐ Masonry inner leaf with scratch coat, and finished with plasterboard, or
- ☐ Inner leaf with plasterboard on dabs, with continuous ribbon of adhesive tape around all openings, along top and bottom of wall, and at internal and external corners, or
- ☐ Airtightness membrane and tapes

ACCEPTABLE CONSTRUCTION DETAIL | **Ventilated Roof - Attic Floor Level**

Example Detail-Foundation

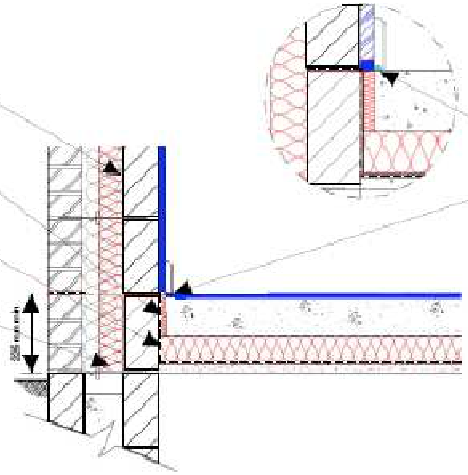
(1) WALLS:- INSULATION IN CAVITY | **Ground Floor - Insulation below slab** | DETAIL 1.02a, JULY 2008

THERMAL PERFORMANCE

CHECKLIST
(TICK ALL)

- [ ] Ensure partial fill insulation is secured firmly against inner leaf of cavity wall
- [ ] Install perimeter insulation with a min. R-value of .75 m² K/W
- [ ] Floor insulation to tightly abut blockwork wall
- [ ] Ensure wall insulation is installed at least 225 mm below top of floor

Complying with checklist qualifies builder to claim ψ-value in Table 3 of IP 1/06 and Table K1 of DEAP 2006



AIR BARRIER - CONTINUITY

CHECKLIST
(TICK ALL)

- [ ] Seal between wall and floor air barrier with a flexible sealant OR seal gap between skirting board and floor with a flexible sealant
- [ ] Seal all penetrations through air barrier using a flexible sealant

Complying with checklist will help achieve design air permeability

GENERAL NOTES

The wall insulation installed below the wall DPC must be fit for purpose with regards to water absorption

Keep cavities clean of mortar snots and other debris during construction

Detail applicable:- Ground-bearing floor; raft foundation; in-situ suspended ground floor slab; pre-cast suspended ground floor; concrete and screed. Insulation below slab

AIR BARRIER - OPTIONS

OPTION
(TICK ONE)

- [ ] Masonry inner leaf with wet-finish plaster, or
- [ ] Masonry inner leaf with scratch coat, and finished with plasterboard, or
- [ ] Inner leaf with plasterboard on dabs, with continuous ribbon of adhesive tape around all openings, along top and bottom of wall, and at internal and external corners, or
- [ ] Airtightness membrane and tapes

ACCEPTABLE CONSTRUCTION DETAIL | **Ground Floor - Insulation below slab**

Example Acceptable Construction Detail
Lintel

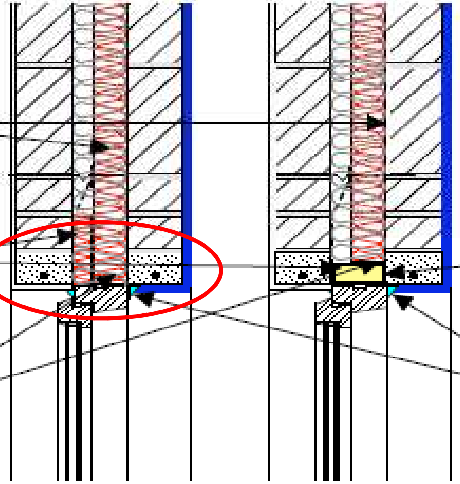
(I) WALLS:- INSULATION IN CAVITY | **Ope - Prestressed concrete lintels** | DETAIL 1.23, JULY 2008

THERMAL PERFORMANCE

CHECKLIST (TICK ALL)

- ☐ Ensure partial fill insulation is secured firmly against inner leaf of cavity wall
- ☐ Install proprietary cavity closer or block of insulation with path of minimum thermal resistance through the closer of not less than 0.45 m² K/W (manufacturers certified data)
- ☐ Ensure all gaps around and between lintels are tightly packed with insulation

Complying with checklist qualifies builder to claim ψ value in Table 3 of IP 1/06 and Table K1 of DEAP 2006



AIR BARRIER - CONTINUITY

CHECKLIST (TICK ALL)

- ☐ Seal all penetrations through air barrier using a flexible sealant
- ☐ If forming the air barrier to the walls with a blockwork inner leaf or a scratch coat on blocks, install a flexible sealant between the cavity closer and blockwork wall
- ☐ Apply flexible sealant to all interfaces between internal air barrier and window / door frame members

Complying with checklist will help achieve design air permeability

GENERAL NOTES

Keep cavities clean of mortar snots and other debris during construction

AIR BARRIER - OPTIONS

OPTION (TICK ONE)

- ☐ Masonry inner leaf with wet-finish plaster, or
- ☐ Masonry inner leaf with scratch coat, and finished with plasterboard, or
- ☐ Inner leaf with plasterboard on dabs, with continuous ribbon of adhesive tape around all openings, along top and bottom of wall, and at internal and external corners, or
- ☐ Airtightness membrane and tapes

ACCEPTABLE CONSTRUCTION DETAIL | **Ope - Prestressed concrete lintels**

Deap calculations

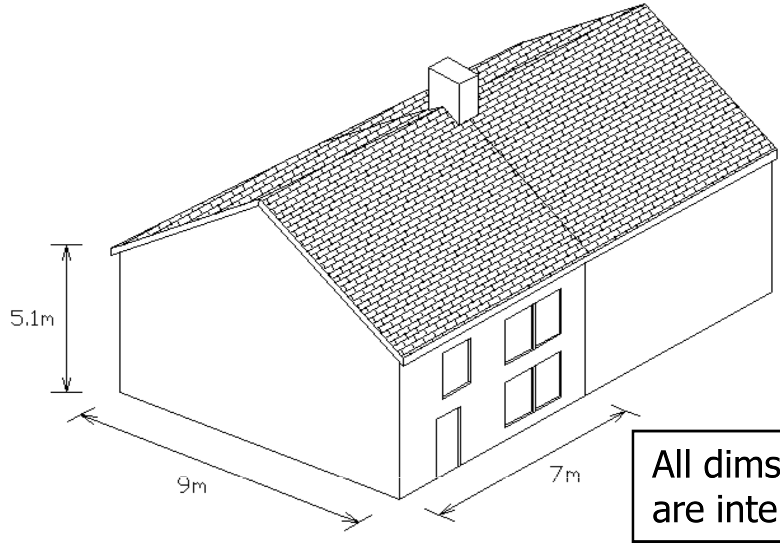
- Heat loss through thermal bridging is not accounted for in the u-value calculation for the plane building elements containing the thermal bridge and therefore must be evaluated separately. It is usually expressed in terms of a fraction known as y. In order to determine the value of y to be used in an energy rating calculation, an assessor has three choices:
    a) Use 0.15 where no calculations have been performed and where Acceptable Construction Details have not been used;
    b) Use 0.08 where the Acceptable Construction Details have been used in all details;
    c) **Or use a value for y which can be determined through calculation, this procedure must be followed where a value for y other than those outlined above is used by the assessor; sample calculations are provided later in this section**

Example Calculation

Roof: Pitched tiled roof, insulation laid on attic floor, part between joists and part over joists.

Walls: Cavity wall (dense concrete blocks) rendered externally, with partial fill insulation in the cavity and 50mm cavity retained.

Floor: Concrete slab-on-ground floor with insulation under slab

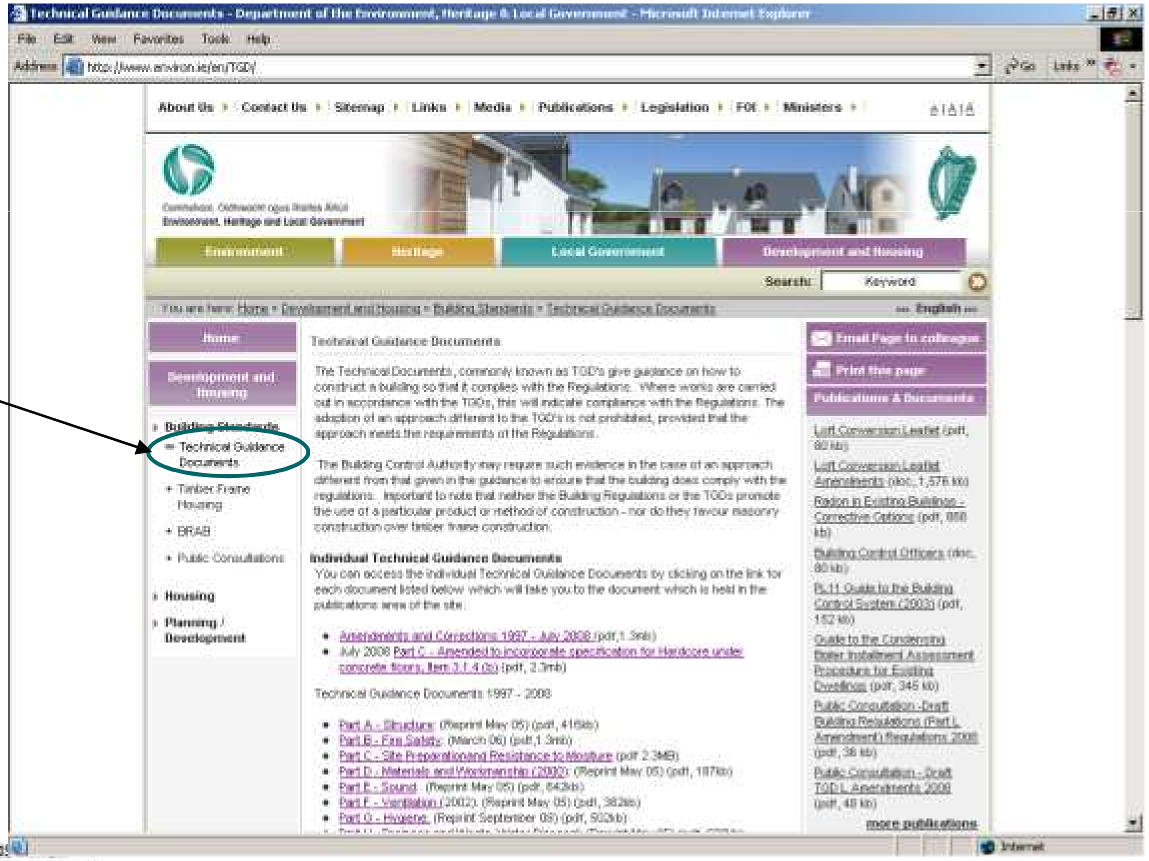


All dims. are internal

Example using Table D1 Psi values and Appendix 2, Diagram 1 Concrete lintel				
Junction detail	**L m**	**Psi**	**L x Psi**	**Psi value source**
ACD Concrete Lintel	25	0	0.00	Diagram 1, Appendix 2
ACD Sill	23.2	0.04	0.93	Table D1/IP1/06
ACD Jamb	43	0.05	2.15	Table D1/IP1/06
ACD Ground Floor	23	0.16	3.68	Table D1/IP1/06
ACD Intermediate Floor within a dwelling	23	0.07	1.61	Table D1/IP1/06
ACD Eaves	14	0.06	0.84	Table D1/IP1/06
ACD Gable (insulation at ceiling level)	9	0.24	2.16	Table D1/IP1/06
ACD Corner(normal)	10.2	0.09	0.92	Table D1/IP1/06
ACD Party wall between dwellings	10.2	0.03	0.31	Table D1/IP1/06
Appendix 2 Party wall with floor	9	0.11	0.99	Appendix 2
ACD Party wall with ceiling	9	0.22	1.98	Appendix 2
Appendix 2 Rising wall	9	0.22	1.98	Appendix 2
			17.54	
y factor (exposed surface area 243.3 m^2)			**0.07**	

Acceptable Construction Details

- Available on DEHLG website; http://**www.environ.ie**/en/TGD/



Draft document available on website