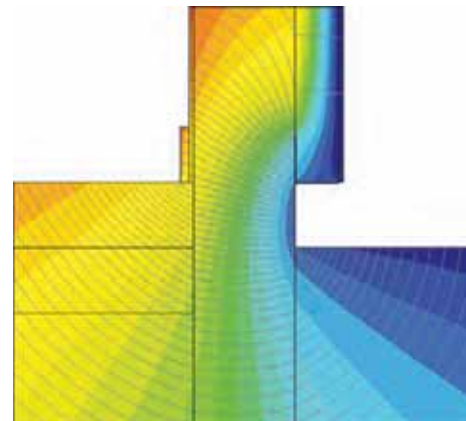



Reducing thermal bridging at junctions when designing and installing solid wall insulation

Caroline Weeks, Tim Ward and Colin King





Reducing thermal bridging at junctions when designing and installing solid wall insulation

Caroline Weeks, Tim Ward and Colin King

The research and writing for this publication has been funded by BRE Trust, the largest UK charity dedicated specifically to research and education in the built environment. BRE Trust uses the profits made by its trading companies to fund new research and education programmes that advance knowledge, innovation and communication for public benefit.

BRE Trust is a company limited by guarantee, registered in England and Wales (no. 3282856) and registered as a charity in England (no. 1092193) and in Scotland (no. SC039320).

Registered office: Bucknalls Lane, Garston, Watford, Herts WD25 9XX
Tel: +44 (0) 1923 664743
Email: secretary@bretrust.co.uk
www.bretrust.org.uk

IHS (NYSE: IHS) is the leading source of information, insight and analytics in critical areas that shape today's business landscape. Businesses and governments in more than 165 countries around the globe rely on the comprehensive content, expert independent analysis and flexible delivery methods of IHS to make high-impact decisions and develop strategies with speed and confidence. IHS is the exclusive publisher of BRE Trust publications.

IHS Global Ltd is a private limited company registered in England and Wales (no. 00788737).

Registered office: Willoughby Road, Bracknell, Berkshire RG12 8FB.
www.ihs.com

BRE Trust publications are available from:
www.brebookshop.com

or
IHS BRE Press
Willoughby Road
Bracknell
Berkshire RG12 8FB
Tel: +44 (0) 1344 328038
Fax: +44 (0) 1344 328005
Email: brepress@ihs.com

© IHS 2013. No part of this publication may be reproduced or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, or be stored in any retrieval system of any nature, without prior written permission of IHS. Requests to copy any part of this publication should be made to:

The Publisher
IHS BRE Press
Garston
Watford
Herts WD25 9XX
Tel: +44 (0) 1923 664761
Email: brepress@ihs.com

Printed using FSC or PEFC material from sustainable forests.

FB 61

First published 2013

ISBN 978-1-84806-350-1

Any views expressed in this publication are not necessarily those of BRE Trust or IHS. BRE Trust and IHS have made every effort to ensure that the information and guidance in this publication were accurate when published, but can take no responsibility for the subsequent use of this information, nor for any errors or omissions it may contain. To the extent permitted by law, BRE Trust and IHS shall not be liable for any loss, damage or expense incurred by reliance on the information or any statement contained herein.

Cover photographs:

Typical external wall insulation being applied (left)
Thermal bridging modelling image of an external wall/ground floor junction (top right)
Thermal image of a dwelling (bottom right);
courtesy of Joanne Hopper

Contents

Executive summary	iv
<hr/>	
1 Introduction	1
<hr/>	
2 Background	2
2.1 Risks associated with thermal bridging	3
2.2 Solid wall constructions modelled	3
2.3 Key junction details modelled	4
<hr/>	
3 Detailing of external wall insulation	5
3.1 Window jamb	5
3.2 Window head	6
3.3 Window sill	7
3.4 Eaves	8
3.5 External wall/ground floor junction	9
3.6 Party wall/external wall junction	10
3.7 Quality control on site	11
3.8 Conclusions for external wall insulation	11
<hr/>	
4 Detailing of internal wall insulation	13
4.1 Interstitial condensation risk	13
4.2 Window jamb	13
4.3 Window head	14
4.4 Window sill	16
4.5 Intermediate floor/external wall junction (within the same dwelling)	17
4.6 Intermediate floor/external wall junction (in apartments)	18
4.7 Party wall/external wall junction	19
4.8 Quality control on site	20
4.9 Conclusions for internal wall insulation	20
<hr/>	
5 Comparing the overall thermal performance of external and internal insulation	21
5.1 Conclusions for external versus internal wall insulation of solid walls	21
<hr/>	
6 References	24

Executive summary

With the advent of the Green Deal, Energy Company Obligation (ECO) and other financial incentives to improve the UK's existing building stock, there has never been a more relevant time to push the construction industry towards better performance. Current practice during refurbishment does little or nothing to minimise the effects of thermal bridging or inconsistency in thermal envelope performance. This guide sets out clear principles and methods that should be considered and adopted during the design and installation of solid wall insulation in order to reduce thermal bridging effects, maximise carbon dioxide (CO₂) emission reductions and minimise the risk of condensation.

The effect of installing external and internal wall insulation in typical solid wall homes has been modelled for junctions with windows, eaves, floors and party walls. Potential problems are considered, taking examples from recent refurbishment projects in which BRE has been involved. This BRE Trust Report will be a useful resource for public and private clients looking to improve the performance of their properties and for architects/designers, specifiers and installers.

1 Introduction

Improving the energy efficiency of the existing building stock is one of the biggest challenges facing the UK. In particular, traditional solid wall houses are more difficult and more costly to improve than more modern, cavity wall constructions. Initiatives such as the Green Deal should serve to finally encourage such refurbishment. However, current industry practice does little or nothing to minimise the effects of thermal bridging or inconsistency in thermal envelope performance when installing insulation in solid wall dwellings. Making the effort to minimise thermal bridges is considered likely to add more time and expense to what is already regarded as a costly improvement measure.

This BRE Trust Report seeks to highlight the importance of appropriate detailing for both externally and internally applied solid wall insulation and demonstrates its effect on heat flow and potential condensation risk at key junctions.

3 Detailing of external wall insulation

3.1 Window jamb

For the window jamb junction in the 'uninsulated' base case, it is assumed that the window frame is situated in the centre of the wall cross-section, with external render and internal plaster returned to the window frame (Figure 2a). In the case where the wall is externally insulated, it is assumed that the insulation will run flush to the edge of the jamb and the render finish will again be returned to the window (Figure 2c).

To improve this junction, it is recommended that a fillet of insulation is applied within the window reveal prior to rendering (Figure 2d). In this 'improved' case, a 20 mm thickness of insulation with a thermal conductivity of 0.02 W/mK (such as phenolic foam) is assumed, since typically there will be a 30–40 mm space between the existing wall and any opening casement windows that may be present. In reality, the thickness of the applied insulation has to be tailored to the available space within the reveal, and a lack of such space is often quoted as the reason why improved detailing cannot be practically achieved.

Such restrictions are lessened if new windows are installed at the same time as the external insulation is applied. In such circumstances it is then possible to design appropriate window frame arrangements to allow the desired insulation detail to be included. There may also be scope to insulate across the entire cross-section of the wall at the reveal, but this is not explored in this study. This issue regarding replacement windows applies also to the window head and window sill junctions that follow.

The application of the external insulation to the wall significantly reduces the U-value of the wall, hence reducing the overall heat loss. However, the concentration of different-coloured bands around the location of the window frame in Figure 2c indicates the rapid temperature drop across this particular location. The ψ -value of Figure 2c is significantly higher than the base-case ψ -value in Figure 2b, the reason being that although the heat loss through the wall itself has been reduced, there is more lateral heat loss flowing towards the junction.

It is interesting to note that, despite this concentration of heat flow at the junction, the temperature factor at the coldest internal point of the junction (where the plaster meets the window frame) has in fact improved from the base case and does not drop below the critical value of 0.75.

Figure 2d includes additional insulation returned into the reveal. Here the ψ -value has returned (ie reduced) to a more acceptable value and the temperature factor has risen again, hence further reducing the risk of condensation or mould growth at the junction.

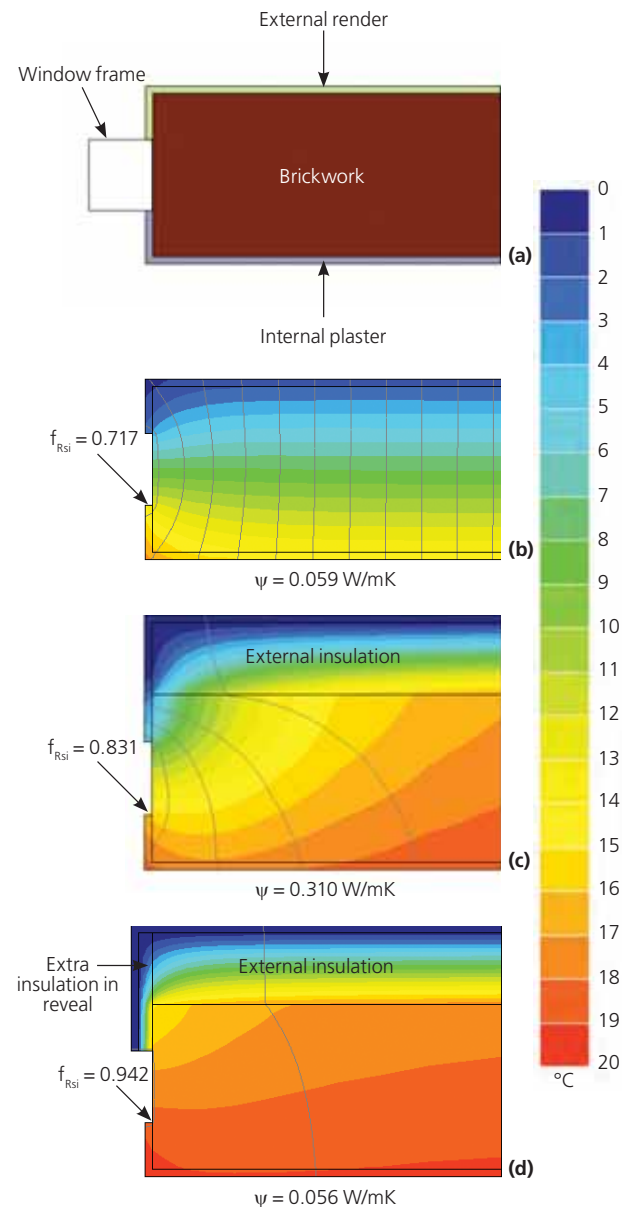


Figure 2: Junction detail for window jamb
a: 'Uninsulated' detail
b: 'Uninsulated' modelling results
c: 'Typical' external insulation
d: 'Improved' external insulation

Other reports from BRE Trust

- Modern methods of house construction: a surveyor's guide. **FB 11**
- Crime opportunity profiling of streets (COPS): a quick crime analysis – rapid implementation approach. **FB 12**
- Subsidence damage to domestic buildings: a guide to good technical practice. **FB 13**
- Sustainable refurbishment of Victorian housing: guidance, assessment method and case studies. **FB 14**
- Putting a price on sustainable schools. **FB 15**
- Knock it down or do it up? **FB 16**
- Micro-wind turbines in urban environments: an assessment. **FB 17**
- Siting micro-wind turbines on house roofs. **FB 18**
- Automatic fire sprinkler systems: a guide to good practice. **FB 19**
- Complying with the Code for Sustainable Homes: lessons learnt on the BRE Innovation Park. **FB 20**
- The move to low-carbon design: are designers taking the needs of building users into account? **FB 21**
- Building-mounted micro-wind turbines on high-rise and commercial buildings. **FB 22**
- The real cost of poor housing. **FB 23**
- A guide to the Simplified Building Energy Model (SBEM): what it does and how it works. **FB 24**
- Vacant dwellings in England: the challenges and costs of bringing them back into use. **FB 25**
- Energy efficiency in new and existing buildings: comparative costs and CO₂ savings. **FB 26**
- Health and productivity benefits of sustainable schools: a review. **FB 27**
- Integrating BREEAM throughout the design process: a guide to achieving higher BREEAM and Code for Sustainable Homes ratings through incorporation with the RIBA Outline Plan of Work and other procurement routes. **FB 28**
- Design fires for use in fire safety engineering. **FB 29**
- Ventilation for healthy buildings: reducing the impact of urban pollution. **FB 30**
- Financing UK carbon reduction projects. **FB 31**
- The cost of poor housing in Wales. **FB 32**
- Dynamic comfort criteria for structures: a review of UK standards, codes and advisory documents. **FB 33**
- Water mist fire protection in offices: experimental testing and development of a test protocol. **FB 34**
- Airtightness in commercial and public buildings. 3rd edn. **FB 35**
- Biomass energy. **FB 36**
- Environmental impact of insulation. **FB 37**
- Environmental impact of vertical cladding. **FB 38**
- Environmental impact of floor finishes: incorporating The Green Guide ratings for floor finishes. **FB 39**
- LED lighting. **FB 40**
- Radon in the workplace. 2nd edn. **FB 41**
- U-value conventions in practice. **FB 42**
- Lessons learned from community-based microgeneration projects: the impact of renewable energy capital grant schemes. **FB 43**
- Energy management in the built environment: a review of best practice. **FB 44**
- The cost of poor housing in Northern Ireland. **FB 45**
- Ninety years of housing, 1921–2011. **FB 46**
- BREEAM and the Code for Sustainable Homes on the London 2012 Olympic Park. **FB 47**
- Saving money, resources and carbon through SMARTWaste. **FB 48**
- Concrete usage in the London 2012 Olympic Park and the Olympic and Paralympic Village and its embodied carbon content. **FB 49**
- A guide to the use of urban timber. **FB 50**
- Low flow water fittings: will people accept them? **FB 51**
- Evacuating vulnerable and dependent people from buildings in an emergency. **FB 52**
- Refurbishing stairs in dwellings to reduce the risk of falls and injuries. **FB 53**
- Dealing with difficult demolition wastes: a guide. **FB 54**
- Security glazing: is it all that it's cracked up to be? **FB 55**
- The essential guide to retail lighting. **FB 56**
- Environmental impact of metals. **FB 57**
- Environmental impact of brick, stone and concrete. **FB 58**
- Design of low-temperature domestic heating systems. **FB 59**
- Performance of photovoltaic systems on non-domestic buildings. **FB 60**



BRE Connect Online

Build on your foundation of **knowledge** and **expertise**

WHAT IS BRE CONNECT ONLINE?

BRE Connect Online gives you **access to the unrivalled expertise and insight of BRE** – the UK's leading centre of excellence on the built environment. BRE Connect Online is an **annual subscription service** from IHS BRE Press giving online access to **over 1700 BRE titles**

WHAT DO I GET?

ALL NEW AND PUBLISHED BRE TITLES

700 books, reports and guides – research, innovation, best practice and case studies, including:

- The Green Guide to Specification
- Designing quality buildings
- Foundations, basements and external works
- Roofs and roofing
- Site layout planning for daylight and sunlight

250 Digests – authoritative state-of-the-art reviews

600 Information Papers – BRE research and how to apply it in practice

150 Good Building and Repair Guides – illustrated practical guides to good building and repair work

AND MUCH MORE ...

WHAT'S NEW IN 2014?

MORE THAN 50 NEW TITLES, INCLUDING:

- Design of low-temperature domestic heating systems
- Delivering energy efficiency in commercial buildings
- Energy surveys and audits
- External fire spread performance of cladding systems on multi-storey buildings
- Performance of photovoltaic systems on non-domestic buildings
- Radon solutions in homes
- Security glazing
- The essential guide to retail lighting



bre

All this for an annual subscription of only **£399** + VAT
Call now on +44 (0) 1344 328038 to find out more or arrange a free trial

Reducing thermal bridging at junctions when designing and installing solid wall insulation

With the advent of the Green Deal, Energy Company Obligation (ECO) and other financial incentives to improve the UK's existing building stock, there has never been a more relevant time to push the construction industry towards better performance. Current practice during refurbishment does little or nothing to minimise the effects of thermal bridging or inconsistency in thermal envelope performance. This guide sets out clear principles and methods that should be considered and adopted during the design and installation of solid wall insulation in order to reduce thermal bridging effects, maximise carbon dioxide (CO₂) emission reductions and minimise the risk of condensation.

The effect of installing external and internal wall insulation in typical solid wall homes has been modelled for junctions with windows, eaves, floors and party walls. Potential problems are considered, taking examples from recent refurbishment projects in which BRE has been involved. This BRE Trust Report will be a useful resource for public and private clients looking to improve the performance of their properties and for architects/designers, specifiers and installers.

Related titles from IHS BRE Press

Conventions for calculating linear thermal transmittance and temperature factors

BR 497

Greener homes for Redbridge: sustainable refurbishment of 19 dwellings

IP 16/13

Sustainable refurbishment of the BRE Victorian Terrace

IP 12/11

Sustainable refurbishment of non-traditional housing and pre-1920s solid wall housing

IP 3/10



IHS BRE Press, Willoughby Road
Bracknell, Berkshire RG12 8FB
www.brebookshop.com

FB 61

ISBN 978-1-84806-350-1



9 781848 063501