Technical Conference

14 November 2007, York Racecourse

Hidden Heat Loss Mechanisms

Dr Jez Wingfield

Senior Research Fellow

Centre for the Built Environment

Leeds Metropolitan University

STAMFORD BROOK

Stamford Brook Energy Standard - EPS08

leeds metropolitan university

A Trial of Dwelling Energy Performance Standards for 2008:

Prototype standards for energy and ventilation performance

Robert Lowe & Malcolm Bell

Centre for the Built Environment
Leeds Metropolitan University

November 2001

LEEDS METROPOLITAN UNIVERSITY

Element/ Parameter	EPS08 Requirement (*U*-values include thermal bridging)
Walls	*U*-value: 0.25 W/m²K
Roof	*U*-value: 0.16 W/m²K
Floor	*U*-value: 0.22 W/m²K
Windows, Doors & Rooflights	*U*-value: 1.3 W/m²K Max Area: 25% of GFA
Air Permeability	5 m³/h.m² @ 50Pa
Carbon Intensity of Heating System	70 kg CO_2/GJ Useful Heat – This equates to a gas condensing boiler efficiency of ≥85%

Stamford Brook - Initial Fabric Design Parameters

leeds metropolitan university

Floor *U*-value (W/m^2K)	0.17
Wall *U*-value (W/m^2K)	0.23
Roof *U*-value (W/m^2K)	0.14
Window/Door *U*-value (W/m^2K)	1.3
Linear Thermal Bridging y-value (W/m^2K)	0.03
SEDBUK Boiler Efficiency (%)	91.3
Air Permeability ($m^3/h.m^2$ @ 50Pa)	5.0
Glazing Ratio	0.20

Stamford Brook – 80m^2 Semi

Carbon Emissions: Realised vs. Design

leeds metropolitan university

Predicted Performance (80 m^2 semi)

Dwelling Carbon Emission Rate = **19.9 $kgCO_2/m^2$**

EPS08 Equivalent TER = **20.6 $kgCO_2/m^2$**

ADL1a 2006 TER = **23.2 $kgCO_2/m^2$**

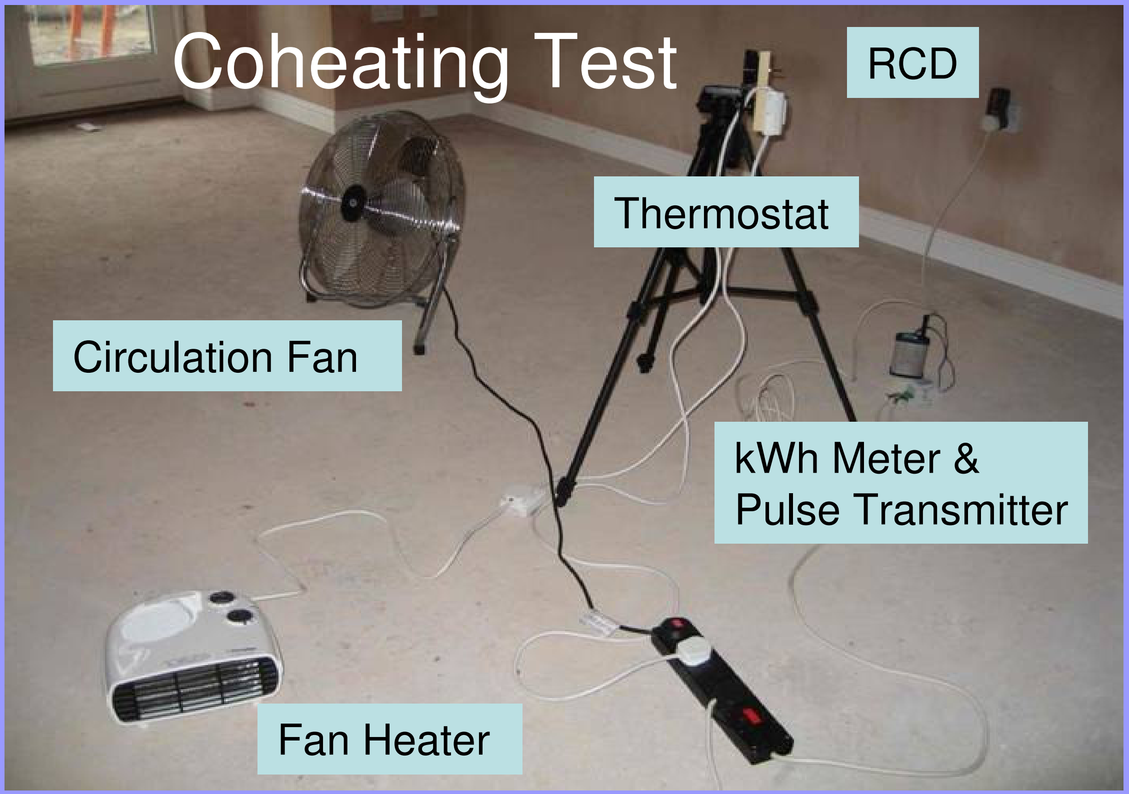
Realised Performance (80 m^2 semi)

Actual Dwelling Carbon Emission Rate =

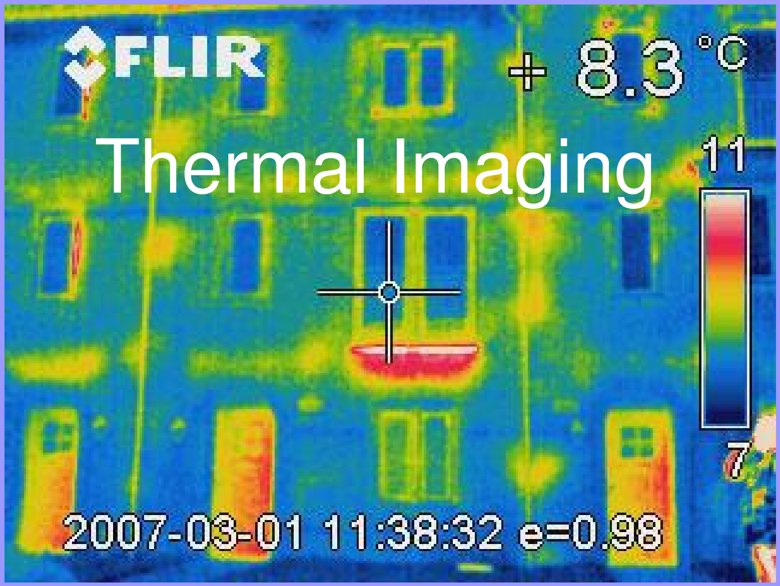
~24 $kgCO_2/m^2$

Realised = Predicted + 20% WHY ?

Fabric Performance Tests



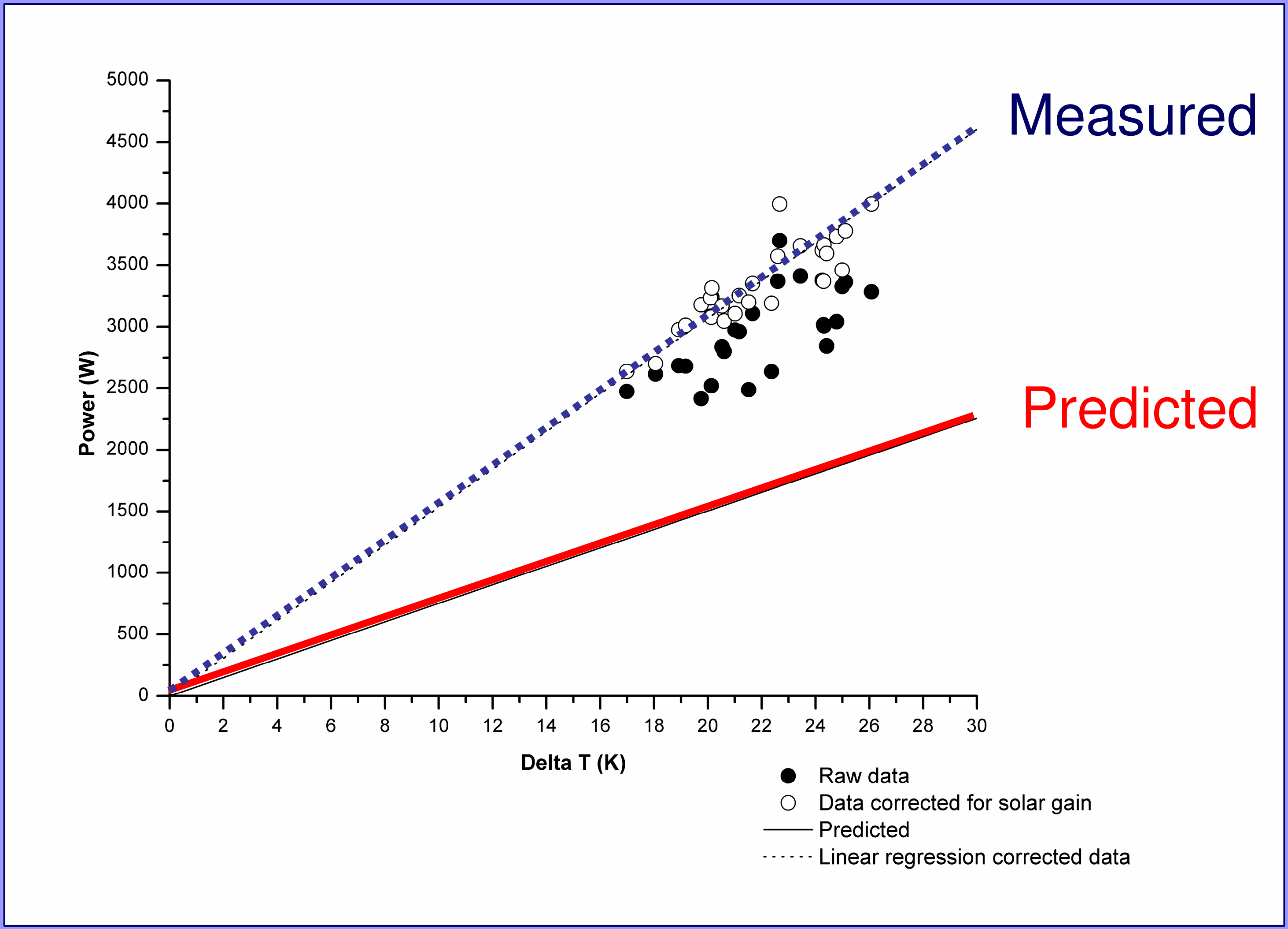
Fabric Performance Tests



Notional vs. Real heat loss

leeds metropolitan university

Coheating test 2 – winter 2005/06



Notional vs. Real heat loss

leeds metropolitan university

Coheating tests 1 & 2 – winter 2005/06

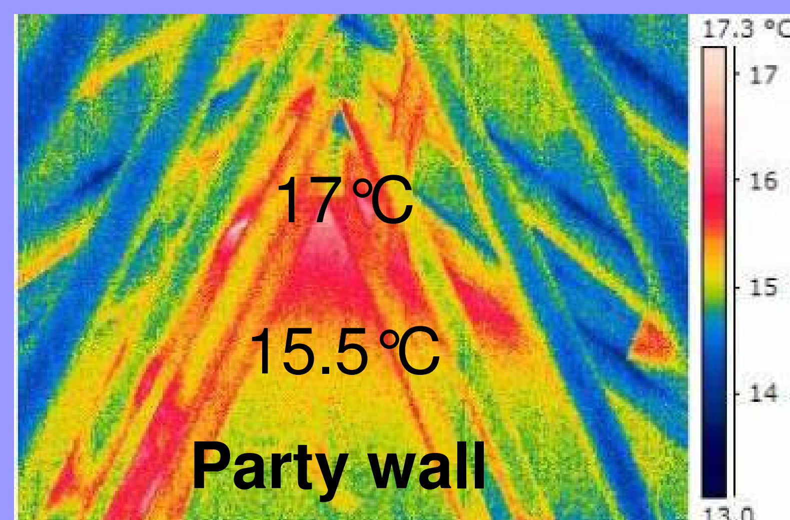
Type	Predicted Fabric Heat Loss (W/K)	Predicted Ventilation Heat Loss (W/K)	Predicted Total Heat Loss (W/K)	Measured Heat Loss (W/K)	Measured Heat Loss - Adjusted for Solar Gain (W/K)
Semi	50.6	13.2	63.8	105.4	111.7
Mid Terrace	54.9	20.3	75.2	136.3	153.4

Semi: **+75%**

Mid Terrace: **+104%**

Thermal bypass mechanisms

Party Wall



Technical Conference

14 November 2007, York Racecourse

Towards 2016: Implications for low and zero carbon housing

Malcolm Bell

Centre for the Built Environment

Leeds Metropolitan University

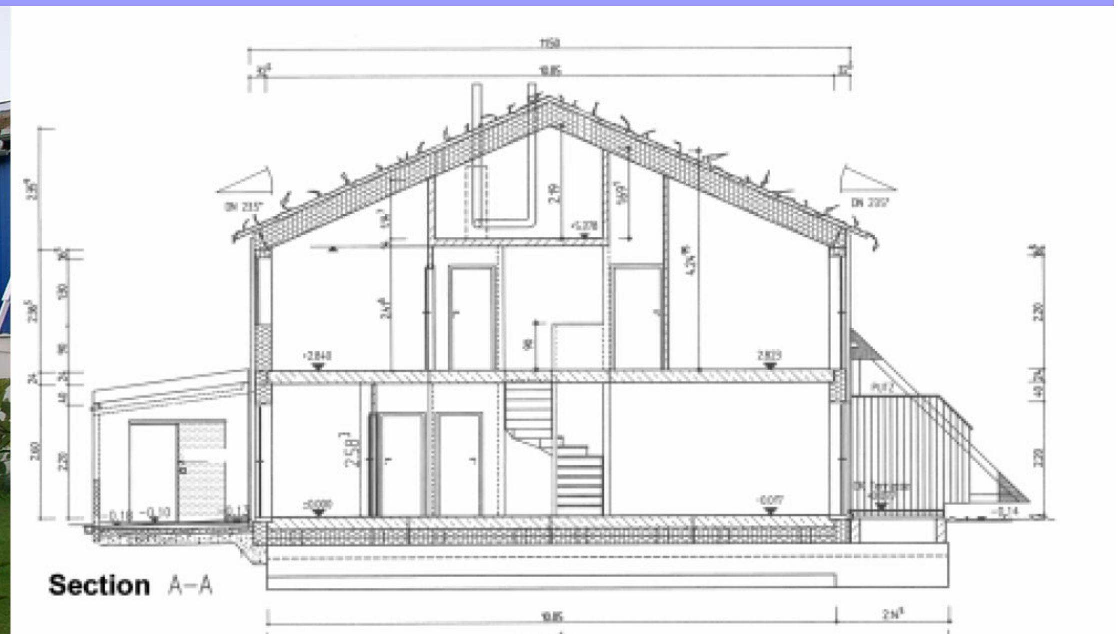
STAMFORD BROOK

The road to 2016?

- **Passive House standards**
  - Fabric U-Value: ~0.1 W/m^2K, Window U-Value: 0.8 W/m^2K
  - Airtightness: < 1 mh^{-1} @ 50Pa
  - MVHR
  - Solar Hot Water
  - Measured Space Heating: <15 kWh/m2.a = <1200 kWh per annum for $80m^2$ semidetached house

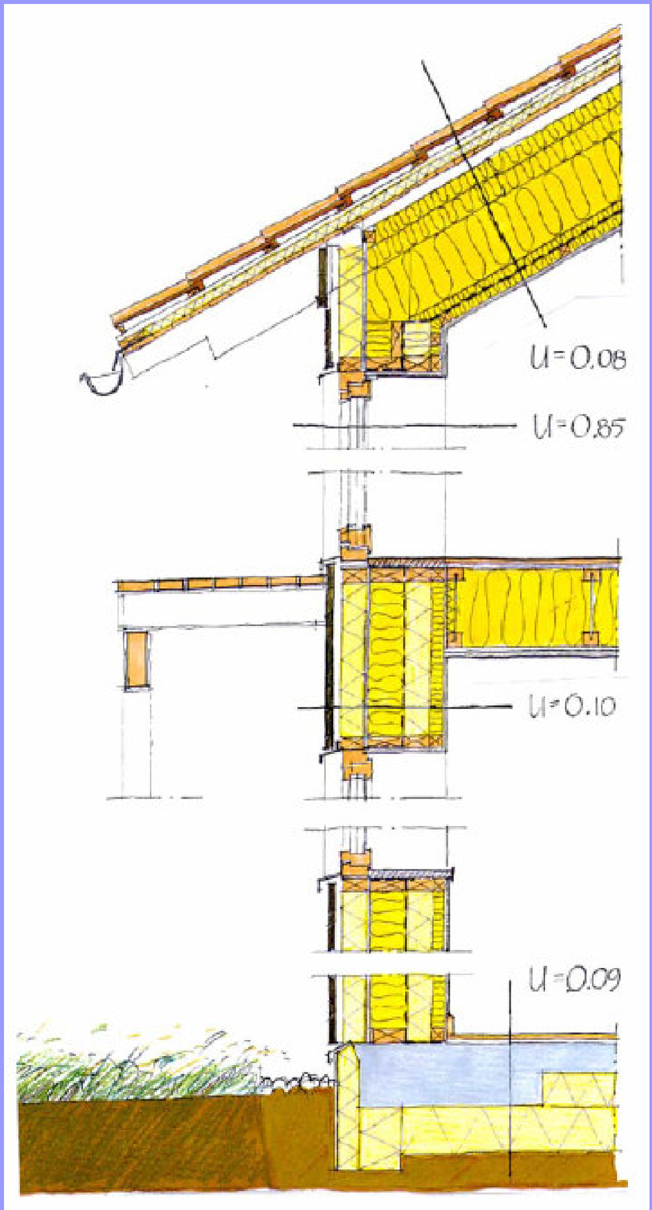
- **Carbon free energy generation**
  - Code 5 ~ 1500 - 2200 kWh (about 17 - $25m^2$ of good PV)
  - Code 6 ~ 3000 – 4000 kWh (PV + wind?)

Kronsberg Passive House



- Kronsberg Passive Houses, Hannover:
  - Built 1998, Measured 1999-2001
  - Fabric U-Value: ~0.1 W/m^2K, Window U-Value: 0.8 W/m^2K
  - Airtightness: Mean 0.29 h^{-1} @ 50Pa (32 dwellings)

Passive House Standards



External wall:
U value: 0.10 W/m^{2}K
Framed construction with 43 cm insulation.

Roof:
U value: 0.08 W/m^{2}K
Masonite beams with 48 cm insulation.

Floor:
U value: 0.09 W/m^{2}K
Concrete slab laid on 25 cm insulation.

Windows:
U value: 0.85 W/m^{2}K
Three pane windows with two metallic coats and krypton fill.
Energy transmittance 43%.
Light transmittance 63%.

External door:
U value: 0.80 W/m^{2}k

Airtightness 1 m/h

Timber frame scheme Göteborg, 20 dwellings (120 m^2) built 2001.

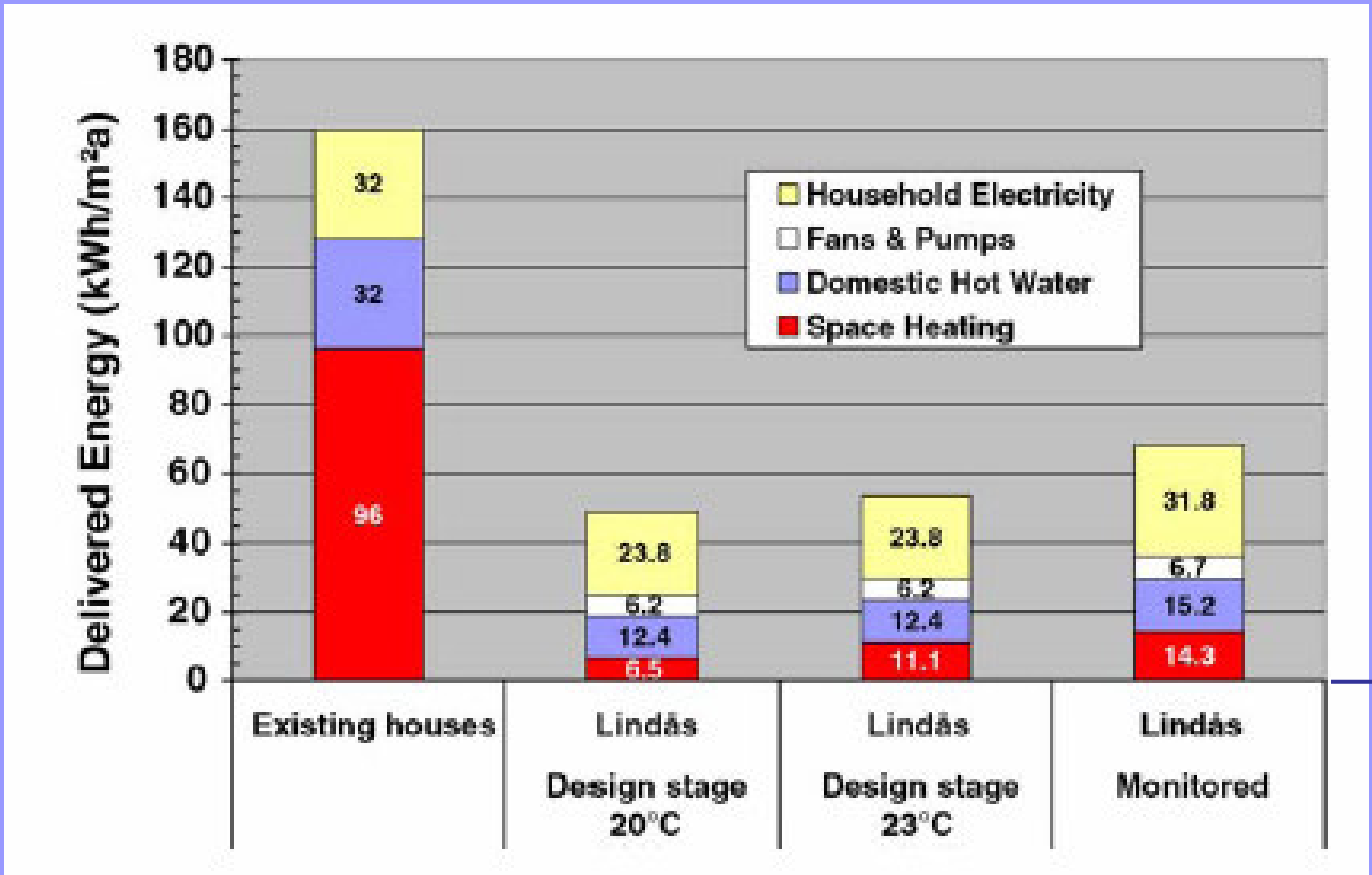
Source: Wall (2006), Photo: Hans Eek

MVHR – 80% with duct heaters

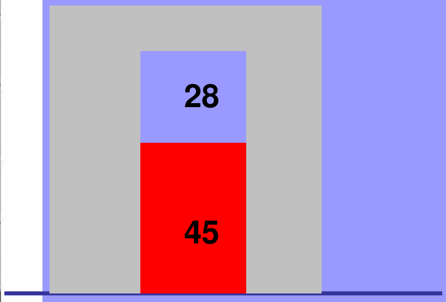
5m^2 Solar water + resistance top-up

Passive House Standards

Timber frame scheme Göteborg, Sweden, 120 m^2



Source: Wall (2006), Photo: Hans Eek



Stamford Brook monitored

Source: Wall (2006), Energy and Buildings. 38, pp 627-634

What can Stamford Brook tell us about the journey to 2016?

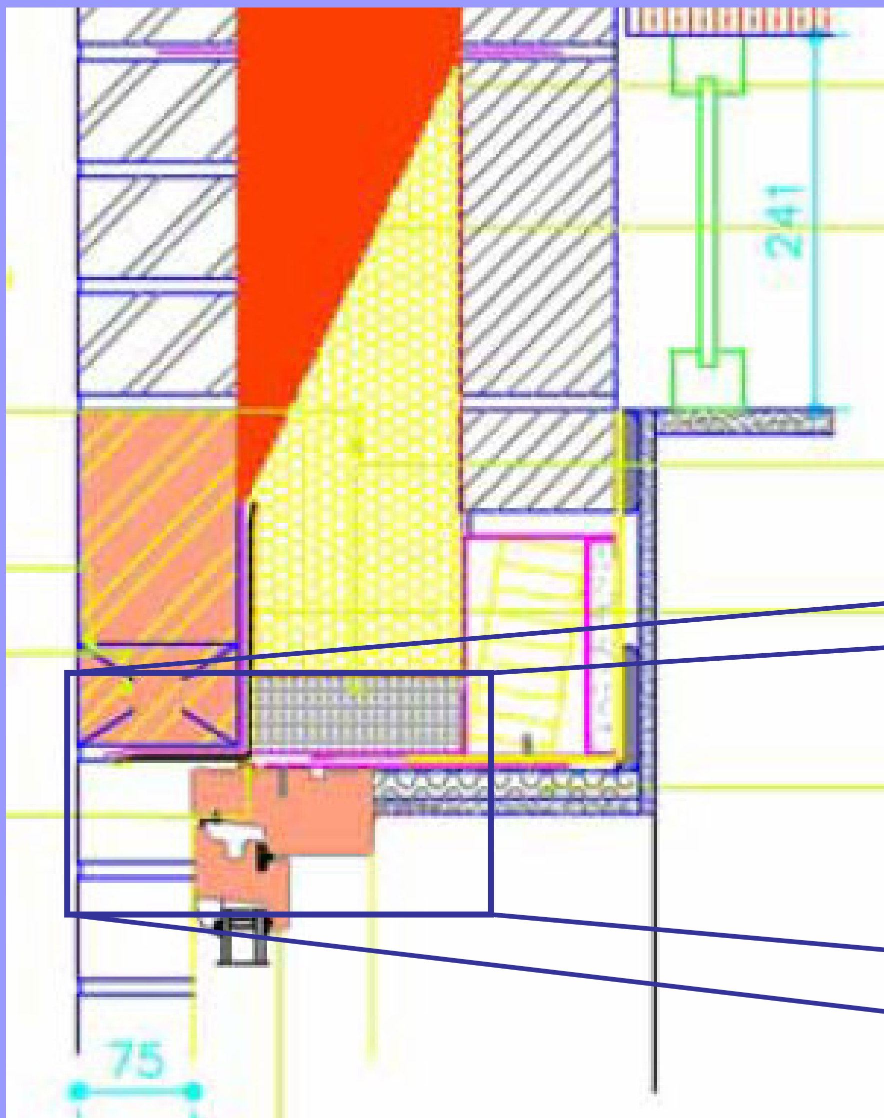
- Design
- Construction
- The supply chain
- Use – customer advice and guidance
- Regulation
- Education and training
- House building as a production process
- House building as a systems problem

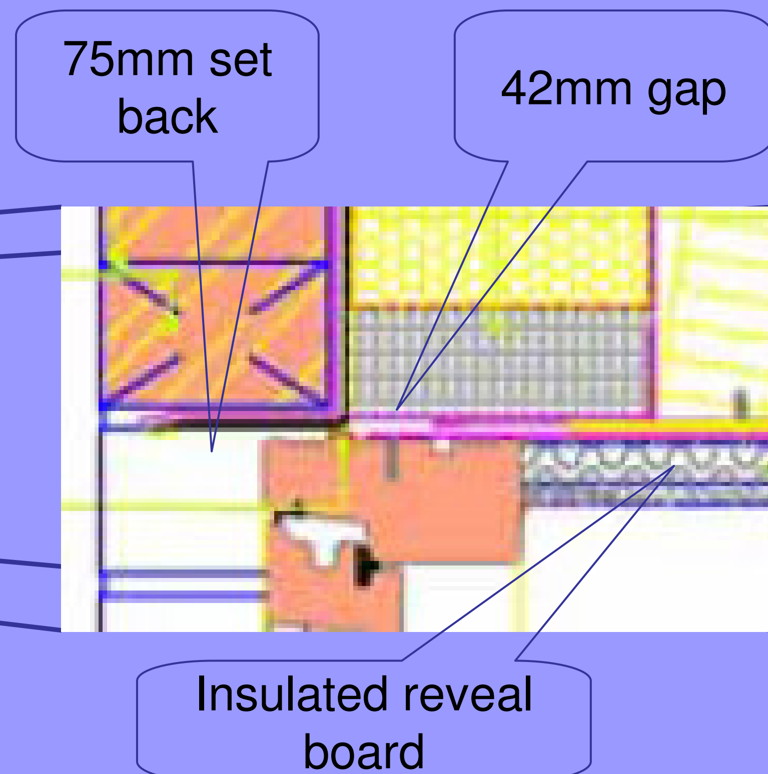
The truth about building houses

Tales from the building trade

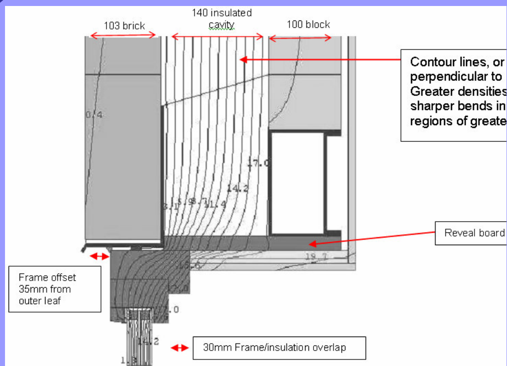
Window head design & construction

Window head detail - *Ψ value = 0.068 W/mK*



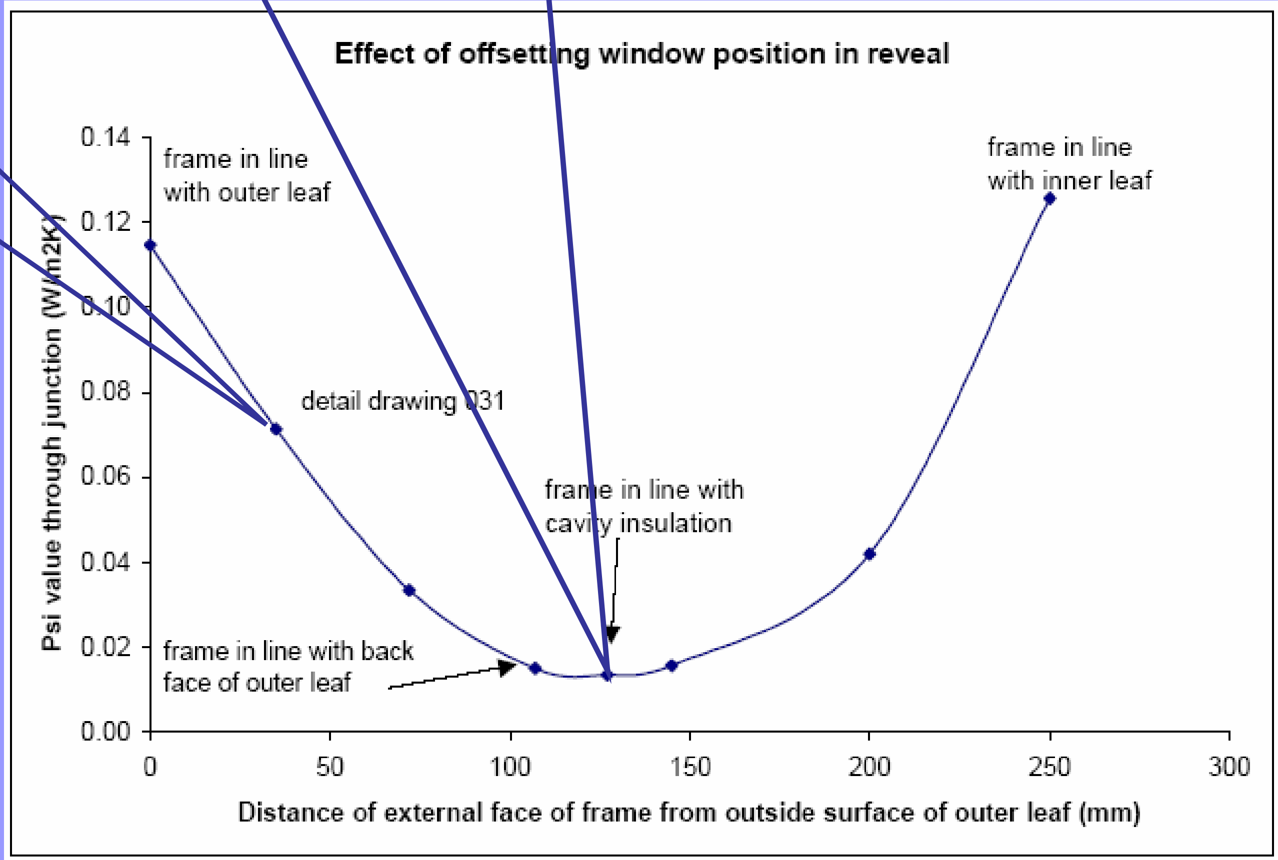


Optimum arrangement

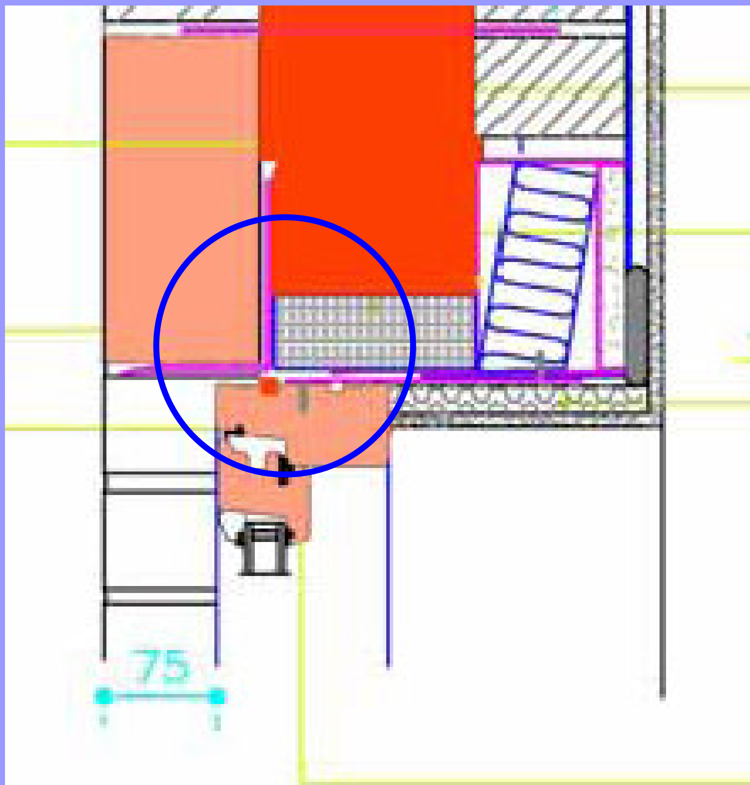


Optimum ***Ψ value = 0.016 W/m.K***

Plain twin lintels, no toe, frame in line with insulation



As constructed



As Designed = 42mm gap
Ψ value = 0.068 W/mK

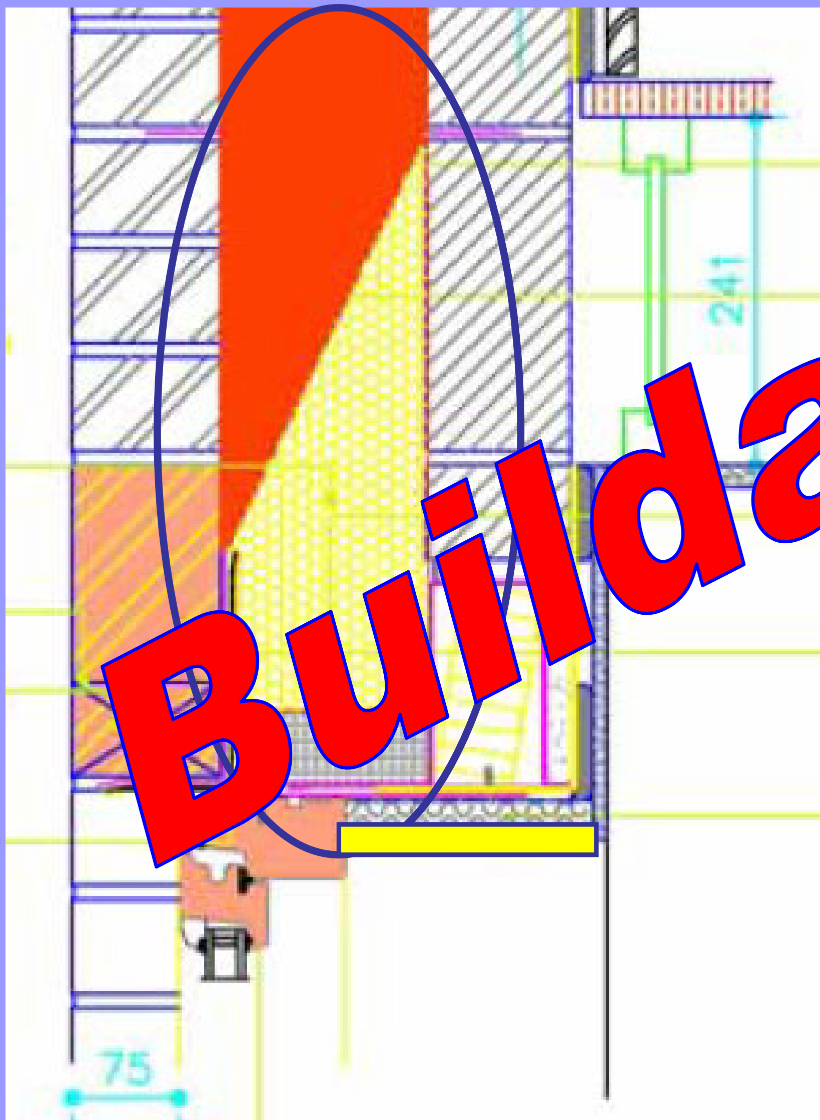
Typical As Built - 20mm gap + air gaps – no insulated board **Ψ value = 0.203 W/mK**

+199%

+1,168% on optimum (0.016 to 0.203)

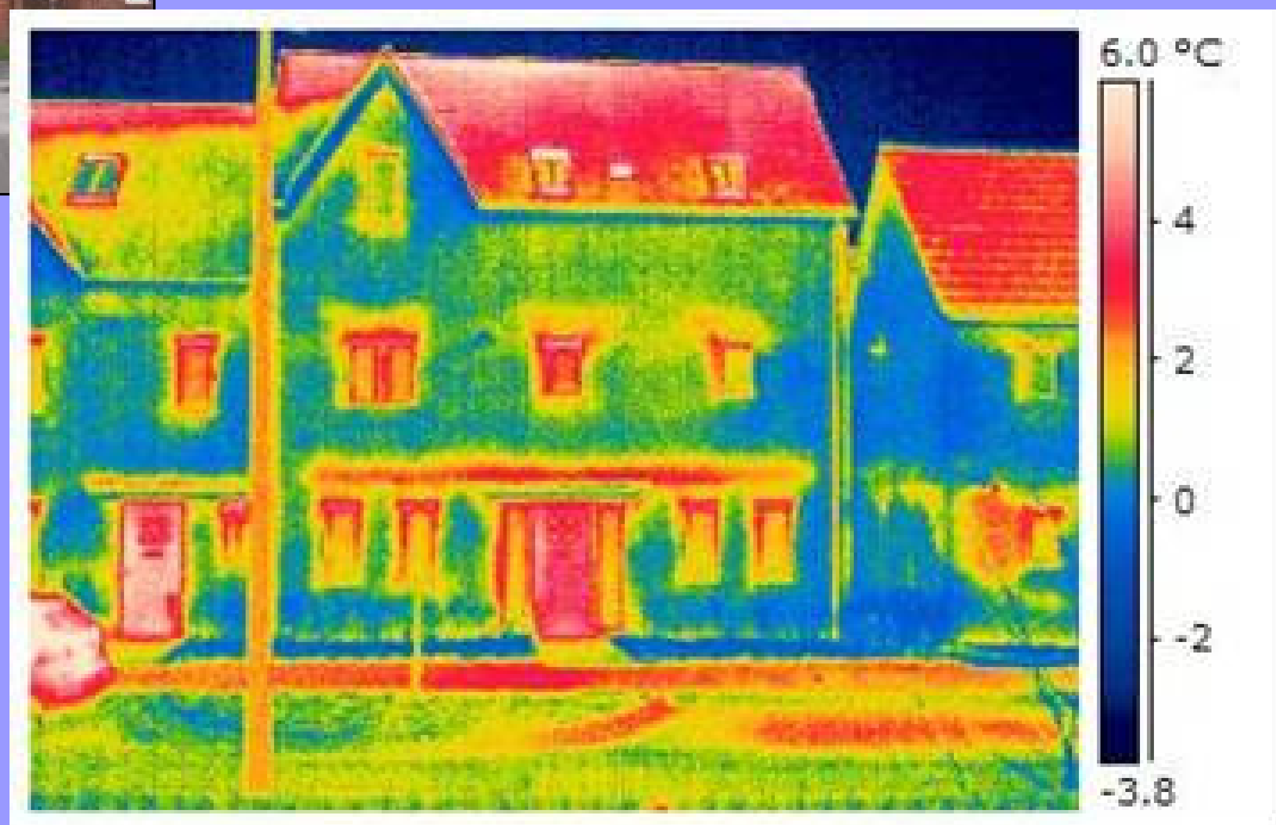
As constructed?

leeds metropolitan university

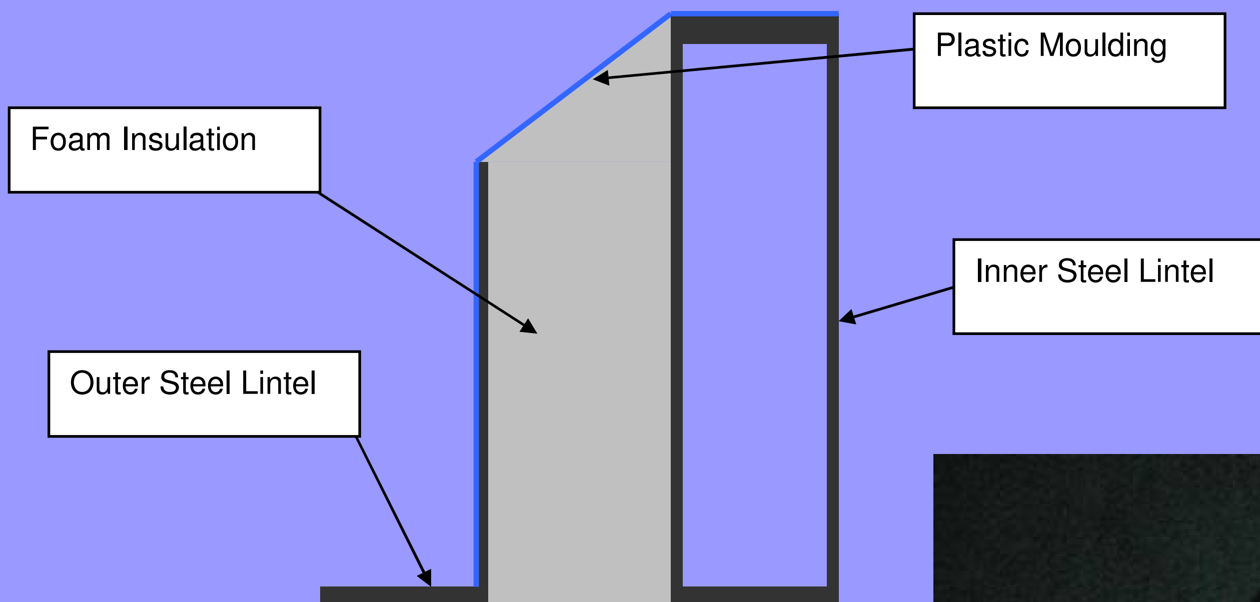


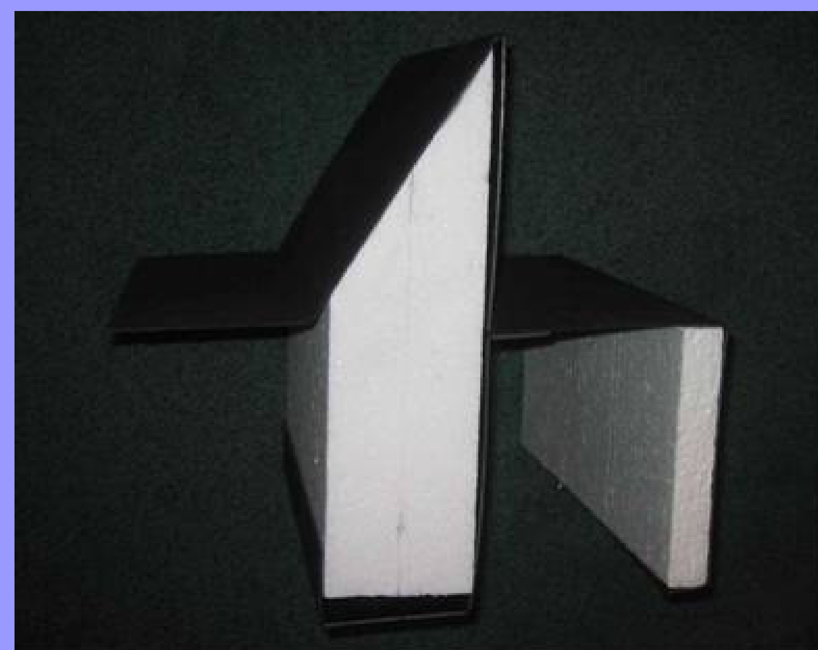
Buildability!

The proof of the pudding!



Driving the supply chain

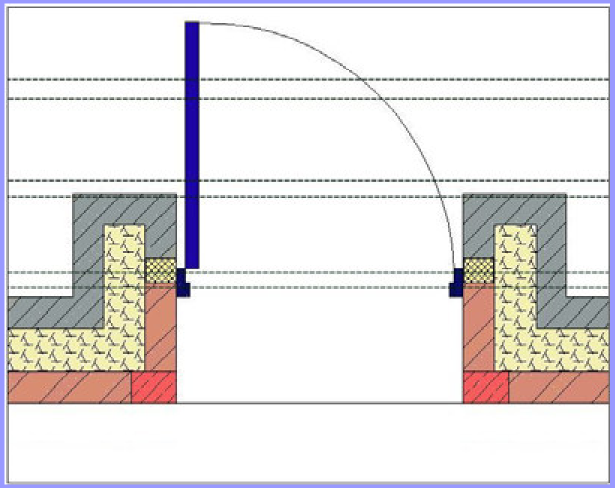


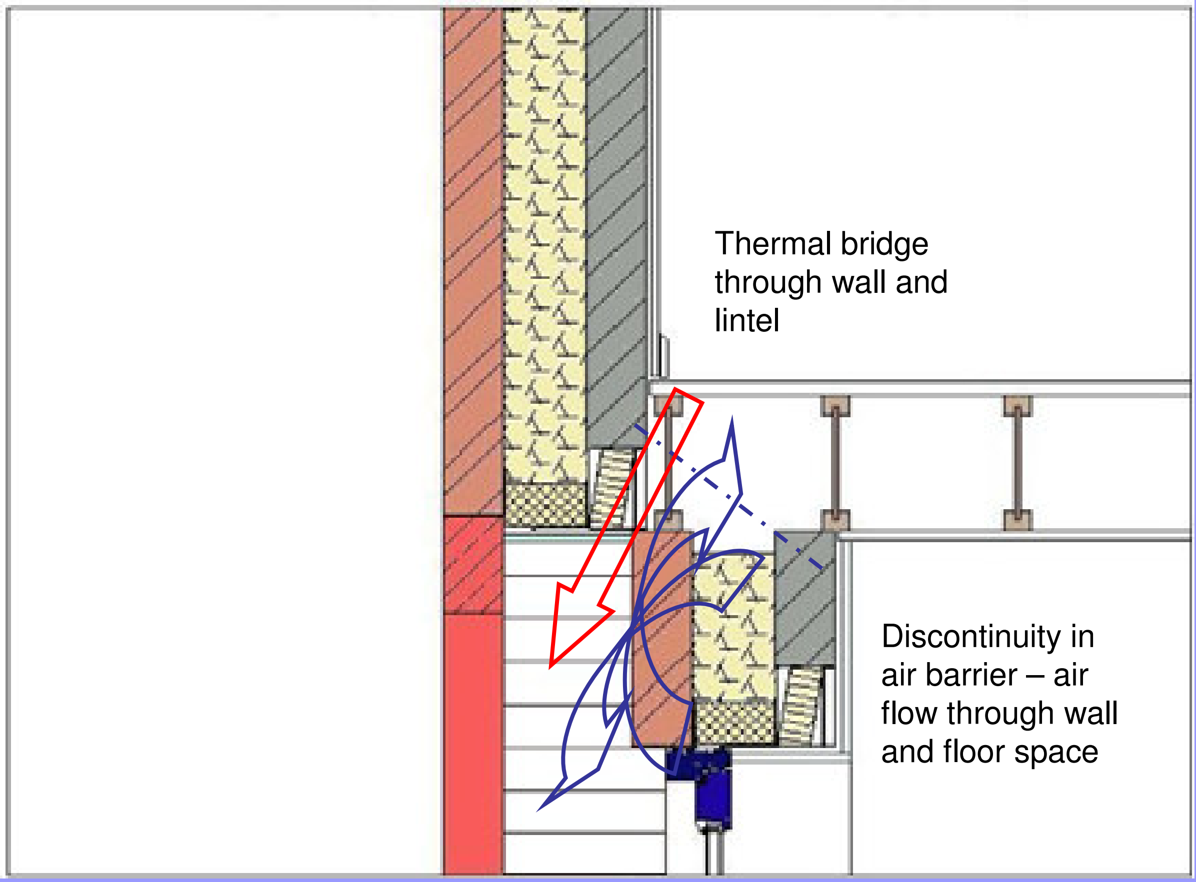


Underlying systems issues

Recessed front door design and construction

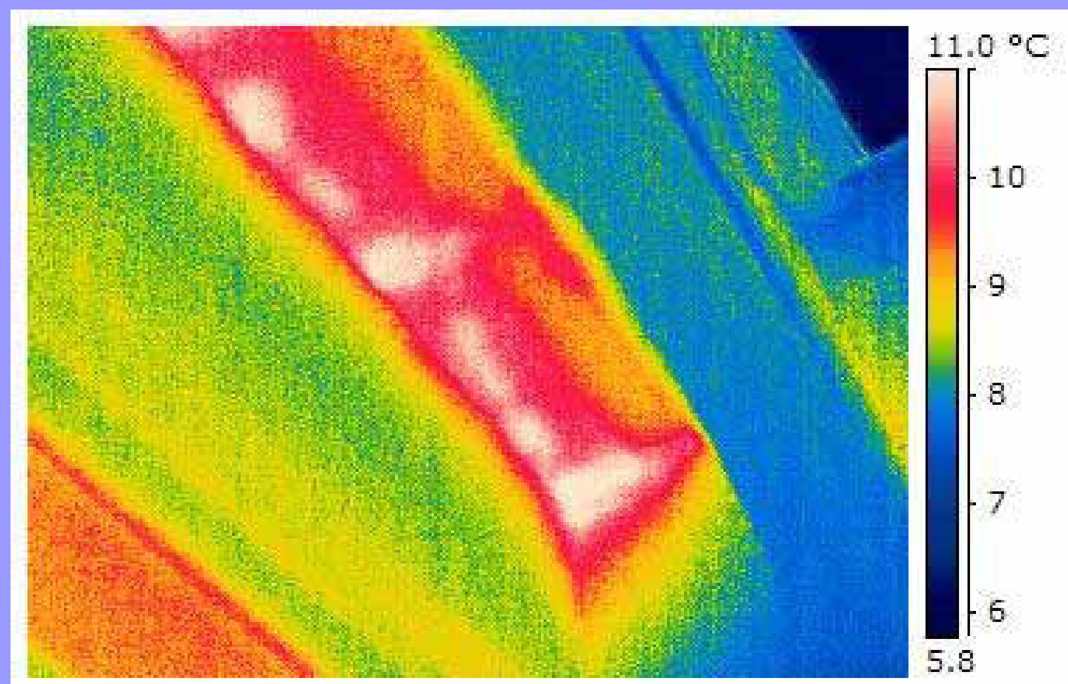
Underlying systems issues





Underlying systems issues

Recessed front door design and construction

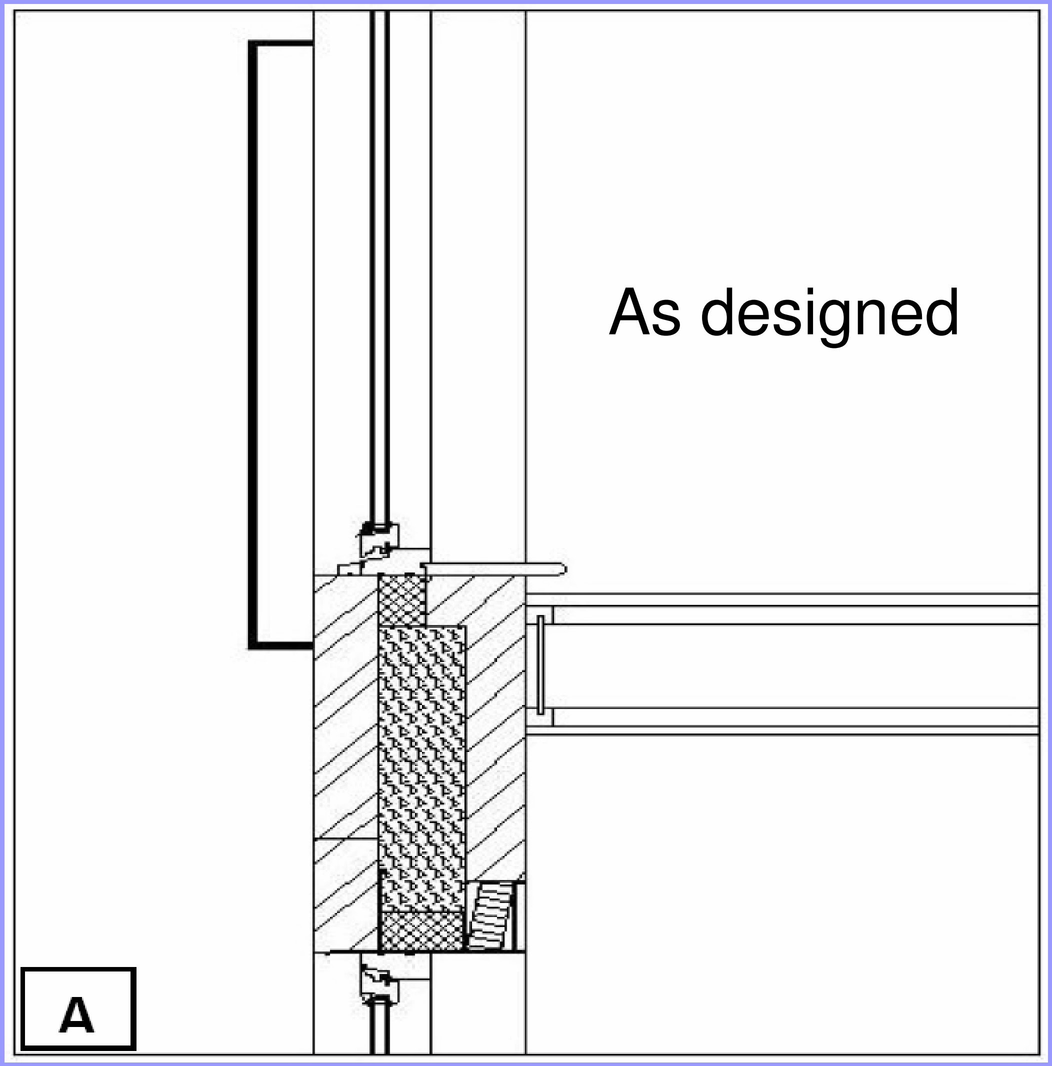


Underlying systems issues

Juliet balcony

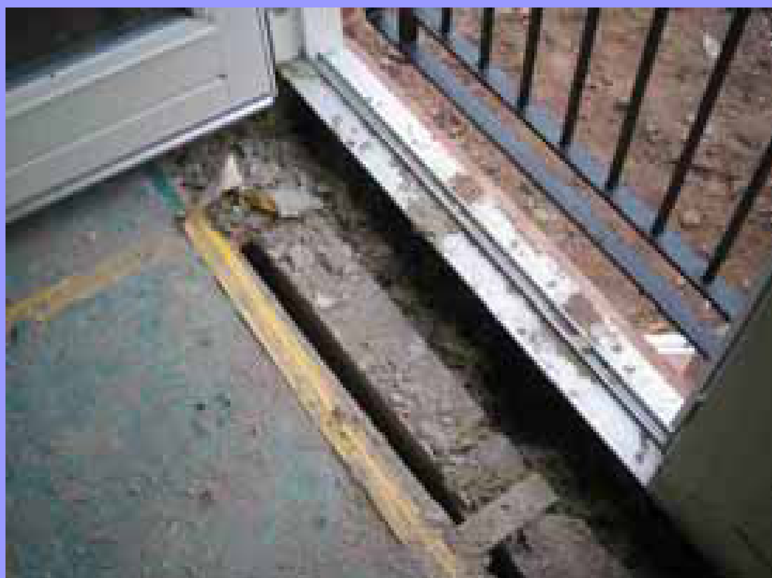
Underlying systems issues

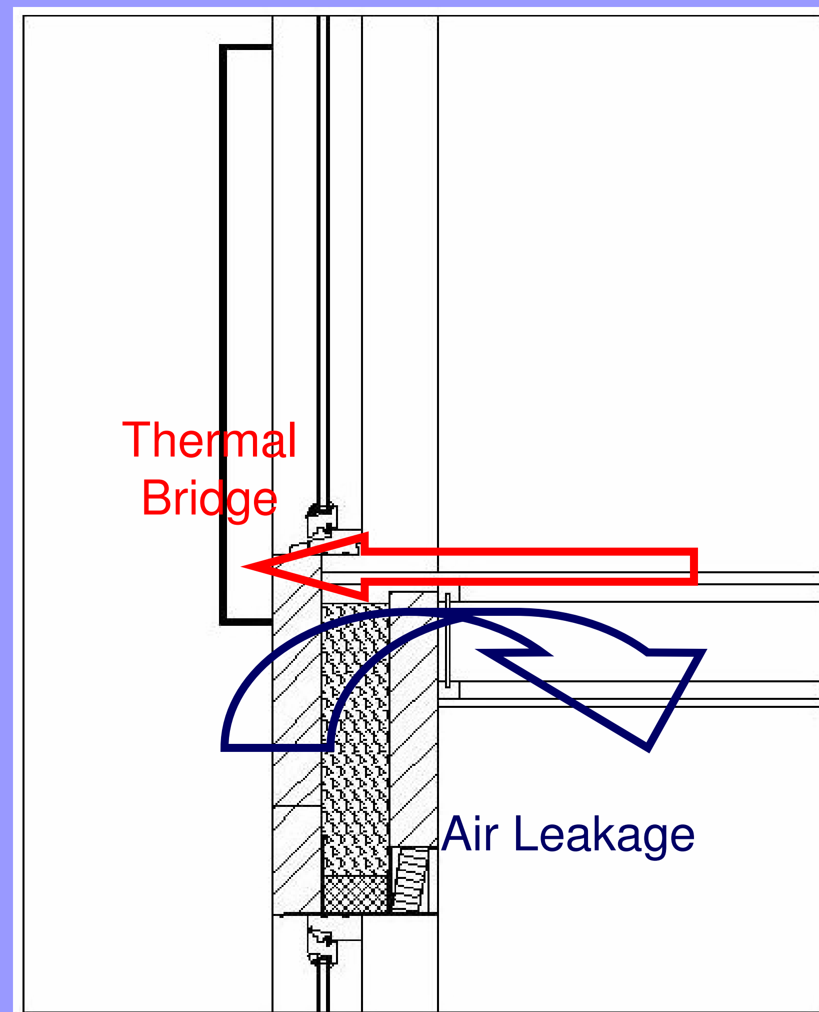
Juliet balcony – as designed



Underlying systems issues

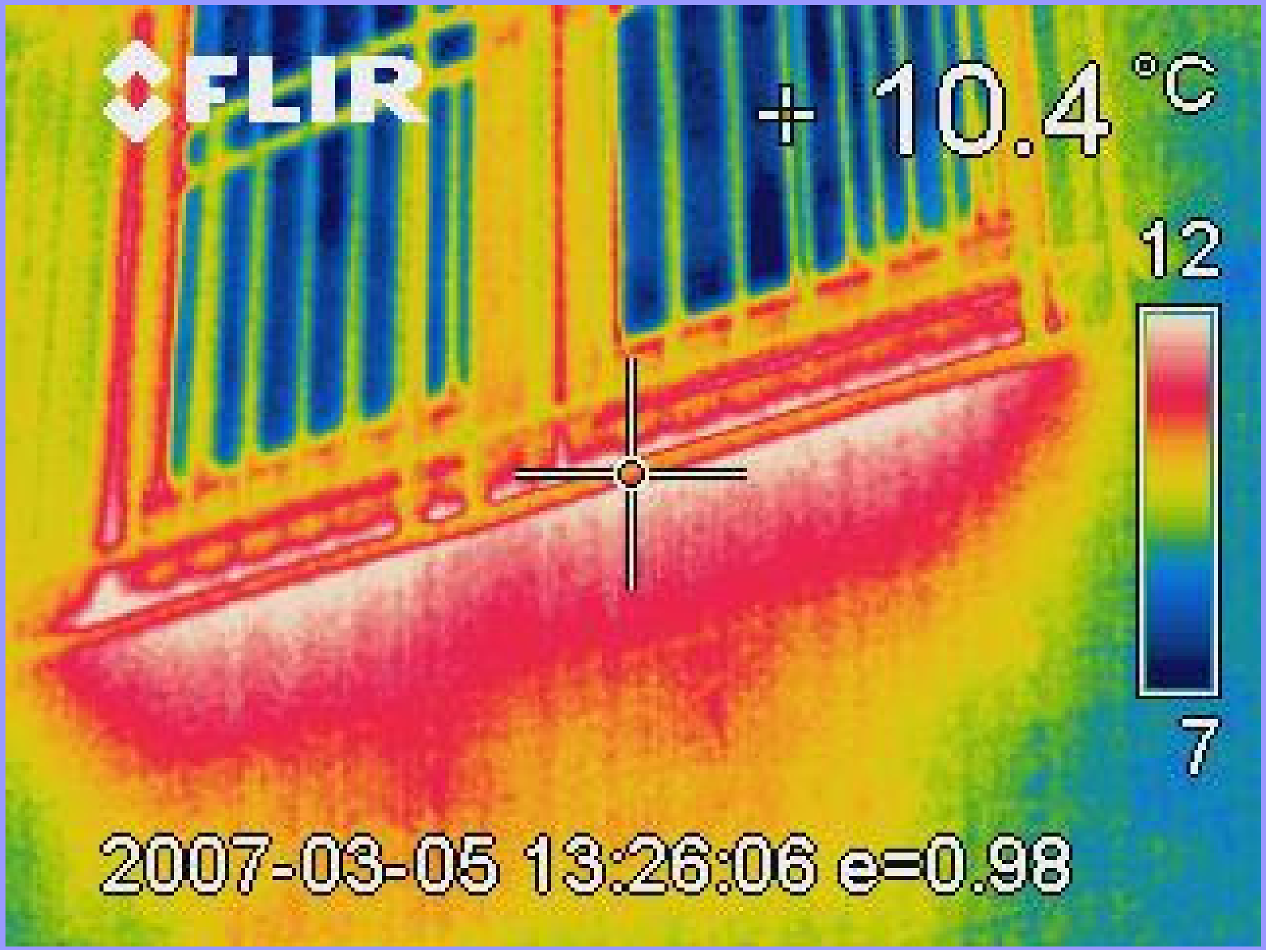
Juliet balcony – as constructed





Underlying systems issues

Juliet balcony



The Hard Questions!

- Do designers & constructors understand thermal performance?
- Do they design details to be thermally efficient?
- Do they make allowance for buildability?
- Do constructors avoid on-site design?
- Are design modifications and material substitutions minimised?
- Are changes thought through and approved?

The Hard Questions!

- Is design fully communicated and in detail?
- Do site teams look at design information?
- Is thermal performance measured routinely?
- Is measurement used to provide feedback on performance?
- Do we learn from our mistakes?
- Do we know if our regulation standards are being achieved on the ground?

The Hard Answers!

- NO - NOT OFTEN!
- At every turn there are systems problems
  - Regulatory issues
  - Industry culture and structure
  - Design and construction process
  - Education & training
  - There is little or no performance measurement
  - There is little or no feedback
  - There is little or no improvement

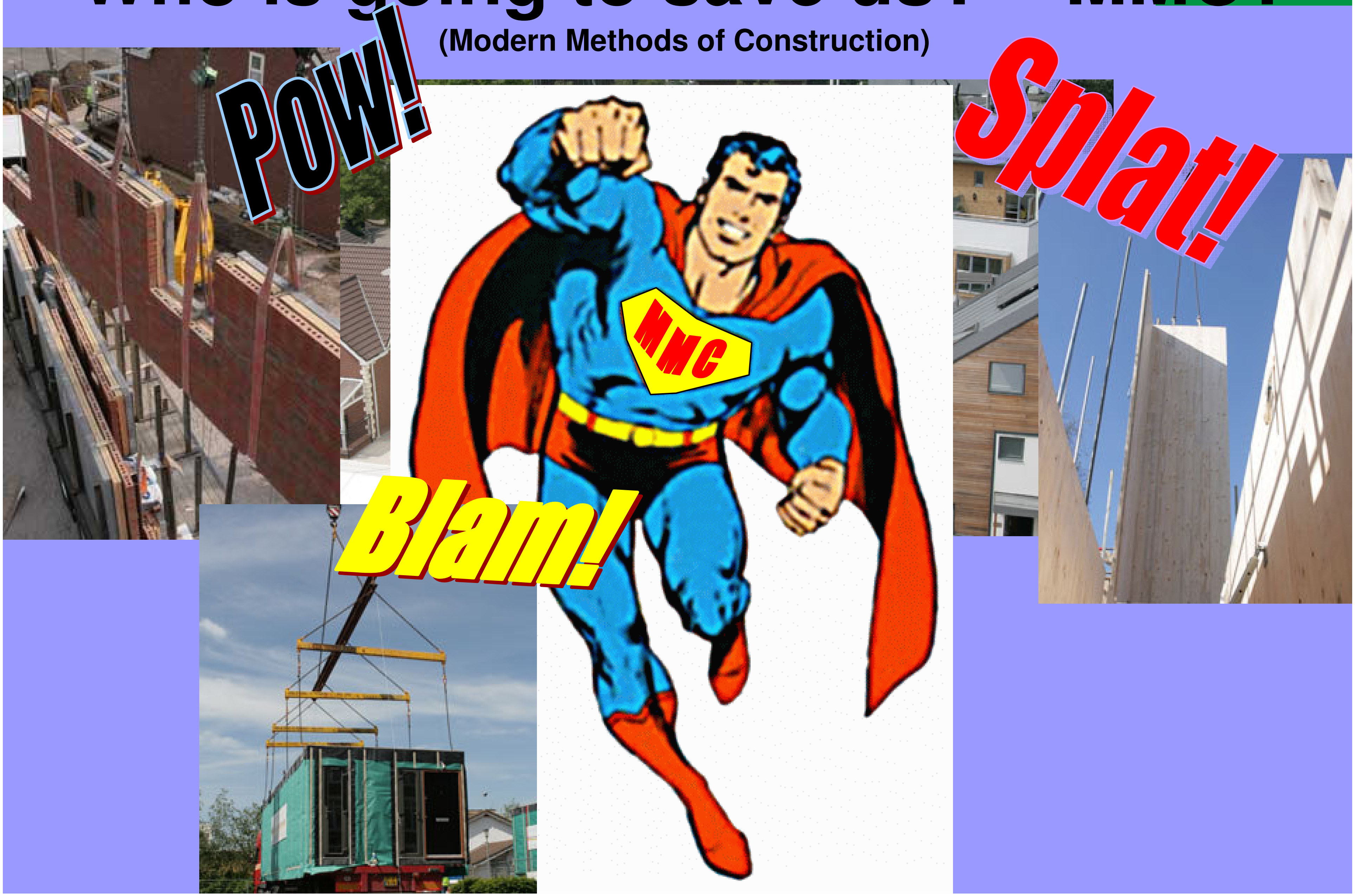
The Road to 2016?

leeds metropolitan university

- As very low carbon becomes mandatory small things will matter
- Thermal bridging is important and air gaps make a difference
- Small changes in efficiency will be noticed
- Zero is absolute!

Who is going to save us? – MMC?

(Modern Methods of Construction)



MMC can be just as bad

Anonymous example of hidden timber!

There is many a SIP!

MMC can be just as bad

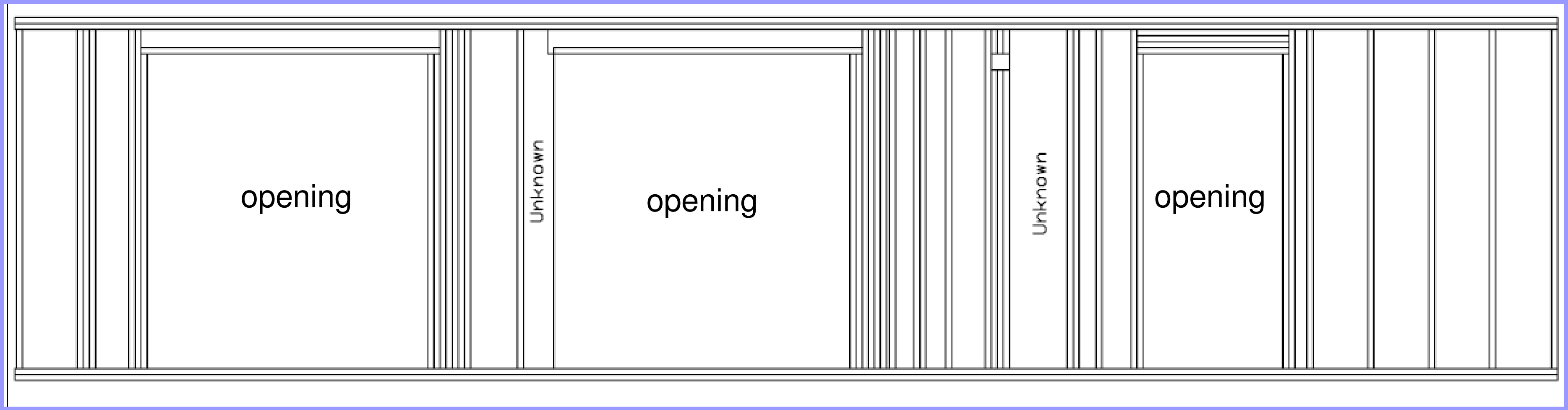
Anonymous example of hidden timber!

There is many a SIP!

MMC can be just as bad

Anonymous example of hidden timber!

There is many a SIP!



28% strand studs and head/sole plates

2% I beam webs

6% lintels

9% unknown

Total timber fraction 36% to 45% (opaque area)

Nominal U = 0.18 W/m^2K

Simple combined area estimate of Actual U = 0.26 or 0.29

The industry must change!

- It has been said before (Latham, Egan…)
- *Plus ça change, plus c'est la même chose* (the more it changes the more it remains the same)
- Old problems persist!
- It is time to retool, to retool cultures and processes as well as technology.

What will change look like?

- A detailed construction process – inception, design, construction and support in use.
- Performance will be guaranteed with consequences for underperformance.
- A quality control process based on measurement not assumption.
- A re-engineered processes will bring economies!
- Constant feedback will bring constant improvement.
- Re-engineered regulations, education, training

The world will not be the same!

We are entering a new paradigm.

As in science, so in construction:
It is time for the industry to Retool!