An Investigation Through

AIMS

The aim of this study undertake research, simulation, and testing, on four internal wall insulation systems, as applied to the external brick wall of the case study. This will prove whether the IWI systems are appropriate for the specific case study, on the basis of their thermal and hygrothermal performance. Following this investigation, a clear and user-friendly methodology will be produced when carrying out hygrothermal analysis on similar retrofit solutions.

OBJECTIVES

- Carry out a study into the Victorian house type in Ireland, and an investigation into the case study.
- Compare four IWI systems that are suitable for solid wall application.
- Conduct thermal performance testing on the existing wall and each of the retrofit wall types.
- Carry out a water absorption test on the brick facade.
- Investigate the hygrothermal performance of the Victorian brick wall, and each of the IWI systems
- Produce a methodology for selecting an appropriate IWI system for the thermal upgrade of a historic building using hygrothermal analysis

METHODOLOGY

Desktop Research

- Conduct a study into the case study and its typology; obtain drawings, location and material information; and establish a façade, floors and roof construction and materials.
- Conduct a research into similar studies on internal wall insulation, Victorian buildings and hygrothermal risk.
- Review standards and guidance documents outlining the practice of retrofitting and the management of moisture in buildings

Research Analysis

Select four retrofit systems and materials for the external wall with a range of compositions, thermal conductivity and vapor diffusion following research and analysis of commonly used and new systems.

Simulation

Conduct testing and simulation into each wall type

- Thermal performance: U-Value calculations
- Hygrothermal performance: WUFI

-Phase 1: at compliant U-Value thickness

-Phase 2: at thickness that achieves below 80% RH

- Hygrothermal performance: Build DeskU

Analysis

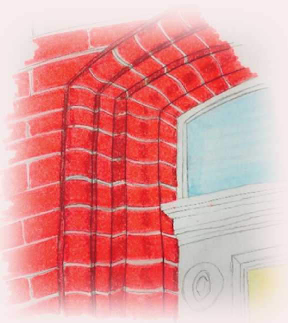
- Possibility of a TGD Part L compliant wall build-up with below 80% relative humidity
- Insulation thickness required to achieve below 80% relative humidity

Victorian Architecture

Brick and rendered facades with progression from handmade, varying sized bricks to identical machine-made bricks.

Walls were solid brick or stone walls which result in low thermal performance and areas of heatloss at floor and roof junctions as well as through any areas where the brick and mortar has warn down.

Traditional materials such as brick, stone and timber are open-pore, permeable materials which allow moisture to transport through them and the structure.



Floors and roofs were made using timber systems with typical timbers being sized at 125mmx35mm.

Doors were solid timber and often and glazing within them as well as in fanlights above. Windows were single glazed.

Fireplaces were commonly found in all habitable rooms and terraced houses often shared chimneys. This is now an area of heatloss in the buildings.

Heat, water vapourandliquid can cause moisture which can cause deterioration and decay to the materials and structure.

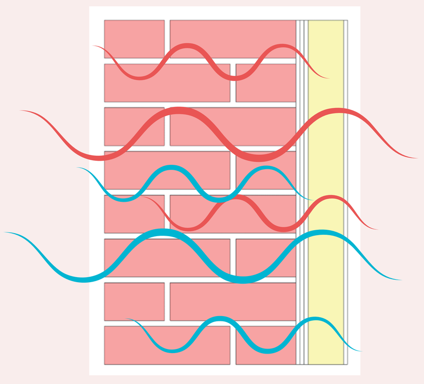
Hygrothermal Performance

The heat and moisture transport that happens within and through building elements.

Influenced by material characteristics and external conditions.

Heat Transfer Forms:
- Thermalconduction
- Thermal convection
- Thermalradiation

Moisture Movement Forms:
- Gas:Vapourdiffusion
  Vapour convection
- Liquid : Capillary transport
  Surfacediffusion



The combination of relative humidity and temperature contribute to the accumulation of moisture and condensation.

The RH bench mark for mould growth is 80% but can be influenced by material properties

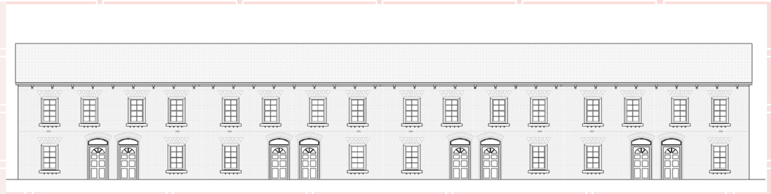
Retrofitting

According to the 2011 census, historic building built before 1919 accounts for 11% of the housing stock in Ireland. This includes both the Georgian, Victorian and Edwardian eras.

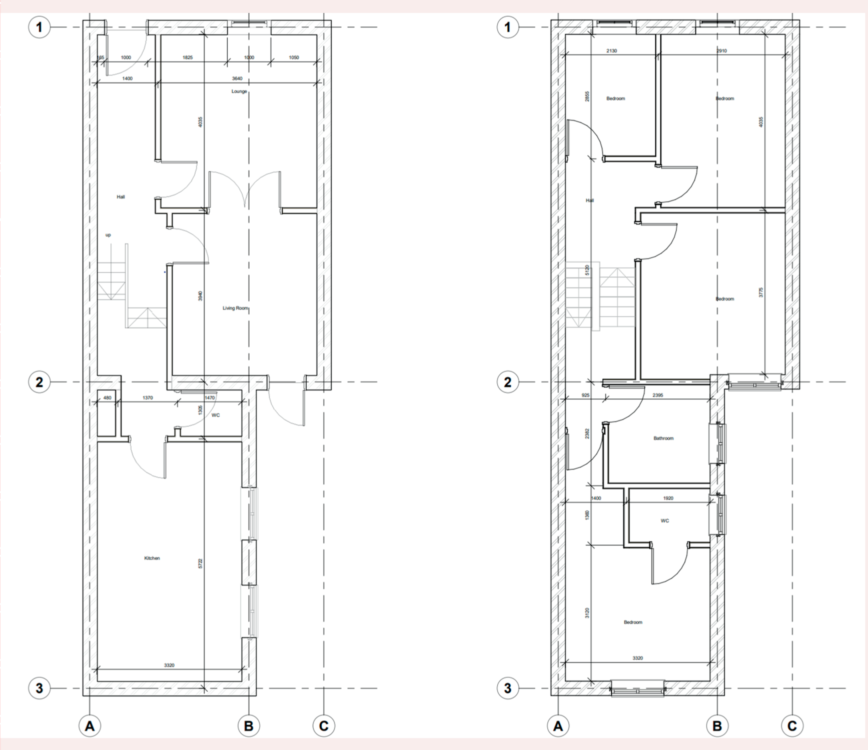
In the current climate where the importance of reuse and repurposing buildings and materials the practice of retrofitting these historic structures is becoming more popular.

Technical Guidance Document Part L outlines the current guidelines for the retrofit of an existing building to achieve standards. All windows and doors are to be improved to a U-Value of no more than 1.4W/m2k. External solid walls are to achieve a U-Value of no higher than 0.35W/m2k.

In the case of buildings with a brick or protected façade, the only option for thermally upgrading the external walls will be internal Wall Insulation.

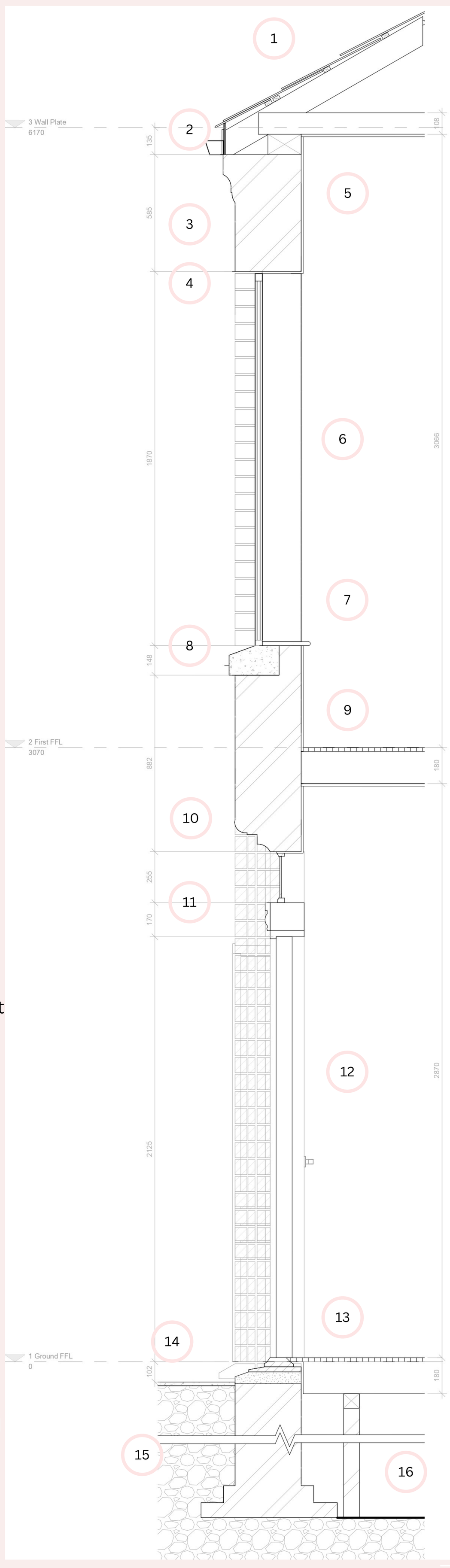


Case Study



Existing Ground and First Floor Plan

Existng Front Elevation



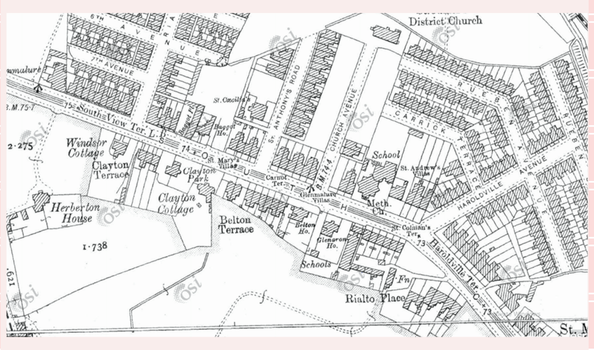
1. Roof tiles
2. Birds mouth eaves detail
3. Brick specials at eaves detail
4. Flat brick lintel above windows
5. Suspended timber floor at attic level
6. Current double glazed window
7. Timber window board
8. Stone sill
9. Suspended timber floor
10. Brick specials at fanlight head
11. Single glazed fanlight
12. Solid timber door
13. Suspended timber floor
14. Stone threshold to ground level
15. Brick foundation
16. Brick sleeper wall

Existing Facade Section

- -End of terrace house in the Belton Terrace, named after Belton House
- 8 houses in the terrace

- Formally known as 8 Belton Terrace, South Circular Road

- Estimated build between 1880 and 1890



The façade is uninsulated and the current windows are double glazed.

The external door is solid timber with a glazed fan window.

This study will focus on the front external wall section for the purpose of research, analysis and testing.

The external wall is 337mm thick with 330mm of traditional red brick and an internal plaster finish.

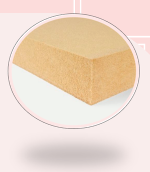
The brick is laid in a solider coarse, one and a half bricks in section.

The floors at the front of the house ag ground, first and attic level are a suspended floor system, the first floor is vented through the facade

There is a solid glazed fanlight above the door with a curved brick lintel above and flat brick lintels above the windows

Case Study Insulation Types

GUTEX THERMOROOM



Composition: Untreated black forest spruce and fir

Form: Insulation board

KOOLTHERM K18

Composition: Rubber and synthetic rubber are common thermoset materials that makes up the insulation

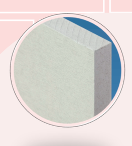
Form: Insulation board

CALSITHERM CLIMATE BOARD

Composition: Calcium silicate

Form: Insulation board

DIATHONITE EVOLUTION



Composition: Lime, clay and diatomaceous

Form: Wet application

GUTEX THERMOROOM

THICKNESS: 20MM, 40MM 50MM, 60MM, 80MM, 100MM

VAPOUR DIFFUSION FACTOR: 3 MU

THERMAL CONDUCTIVITY: 0.039 W/MK

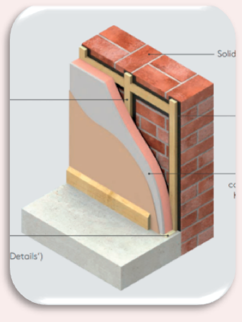
INSTALLATION:
1. Existing wall levelled with lime-based plaster
2. Adhesive applied to insulation boards
3. Boards tiled in place
4. Finished with lime plaster

KOOLTHERM I8

THICKNESS: 42.5MM, 52.5MM, 62.5MM

VAPOUR DIFFUSION FACTOR: HIGH RESISTANCE

THERMAL CONDUCTIVITY:
0.022 W/mK (25-44mm)
0.021 W/mK (45- 80mm)



INSTALLATION:
1. Timber battens fixed to existing wall with DPC
2. Boards mechanically fixed to studs
3. Finished with two layers of skim plaster

CALSITHERM CLIMATE BOARD

THICKNESS: 30MM, 50MM

VAPOUR DIFFUSION FACTOR: 3 MU

THERMAL CONDUCTIVITY: 0.059 W/MK

INSTALLATION:
1. Remove finish on existing wall
2. Apply lime-based plaster to level the wall
3. Adhesive applied to insulation board
4. Finished with lime plaster

DIATHONITE EVOLUTION

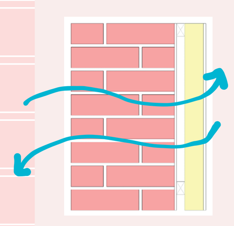
THICKNESS: 50-75MM

VAPOUR DIFFUSION FACTOR: 4 MU

THERMAL CONDUCTIVITY: 0.045 W/MK

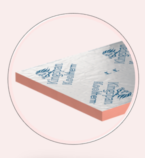
INSTALLATION:
1. Fine layer of mist applied to the existing wall
2. 15-25mm layers applied
3. Each layer allowed dry for 24 hrs
4. Reinforcing mesh used for thicknesses over 60mm
5. Finished with lime plaster

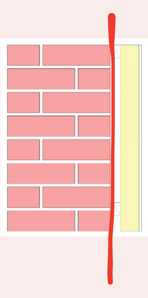
GUTEX THERMOROOM



- Breathaboe material and allows for the passage of moisture
- Absorbs heat in summer and slowly releases
- Breathable material

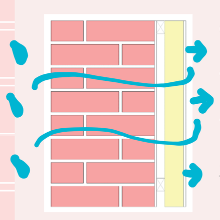
KINGSPAN K18





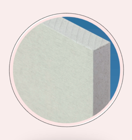
- System contains VCL with high vapour resistance which prevents passage of moisture

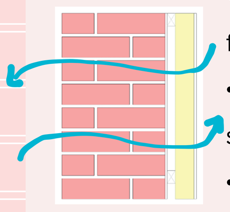
CALSITHERM CLIMATE BOARD



- Draws moisture away and distributes to internal
- High PH and molecular structure
- Composition inhibits mould growth

DIATHONITE EVOLUTION

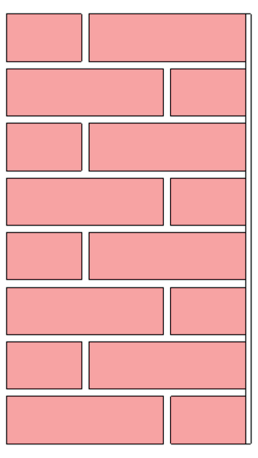




- Breathaboe material and allows for the passage of moisture
- Absorbs heat in summer and slowly releases
- Breathable material

Case Study Into the Energy Retrofit of a Solid Wall Dwelling Us

Existing Wall



WALL BUILD-UP

330mm Historic Red Brick
10mm Gypsum Plaster and Paint Finish

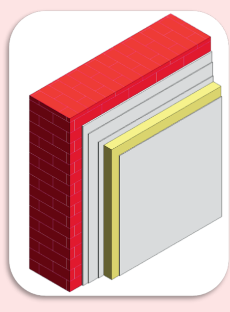
THERMAL PERFORMANCE

tThe existing wall tested achieved a 1.62 W/m2K U-Value

HYGROTHERMAL PERFORMANCE

When tested over a 10 year span, the maximum RH recorded was below 70%

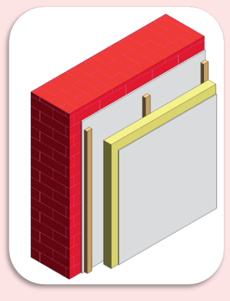
GUTEX THERMOROOM



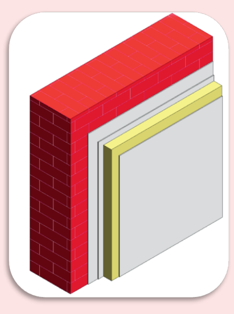
330mm existing historic red brick
10mm existing wall finish
5mm levelling lime based plaster
5mm adhesive
Gutex Thermoroom Board
5mm lime based plaster

KOOLTHERM KI8

330mm existing historic red brick
5mm levelling lime based plaster
5mm adhesive
Calsitherm Climate Board
5mm lime based plaster



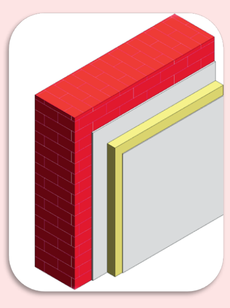
CALSITHERM CLIMATE BOARD



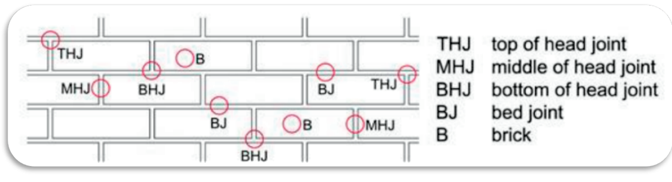
330mm existing historic red brick
10mm existingwallfinish
40x25mm timber studs fixed to wall
Kooltherm K18 Board
5mm plaster skim finish

DIATHONITE EVOLUTION

330mm existing historic red brick
10mm existing wall finish
Diathonite Evolution
5mm lime based plaster



Water Absorbtion Test



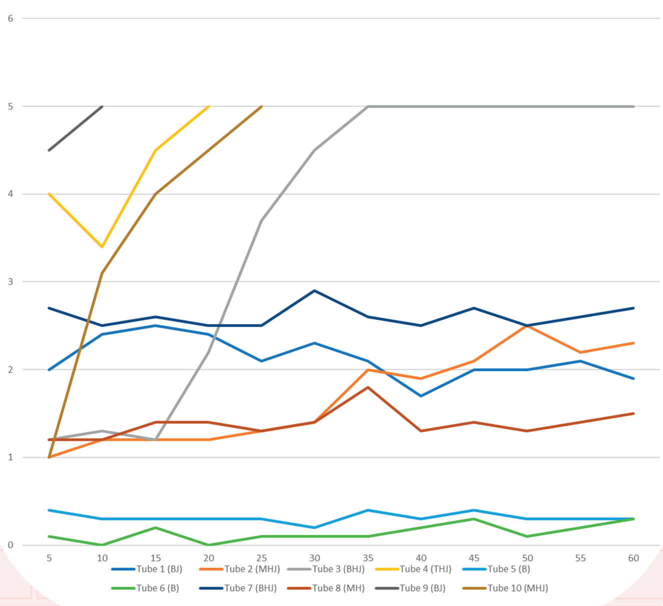
•The water level in each tube was recorded and refilled to 0 level every 5 minutes.

•The bricks were arranged in the recommended locations

• Because of the uneven surface of the brick façade, some of the tubes began to leak and one fell off the wall

•The lowest recorded absorption was from tubes 9 and 10 which sat on the brick face

•. This concludes that the mortar has a much higher absorption rate than the brick.



Case I: Testing for TGD Part L Compliant U-Value

Layer	d (mm)	λ layer	λ bridge	Fraction	R layer	R bridge	Description
					0.130		Rsi
1	5	0.540			0.009		Lime Plaster
2	100	0.039			2.564		Gutex Thermoroom
3	5	0.155			0.032		Gutex Adhesive
4	5	0.540			0.009		Lime Plaster
5	10	0.570			0.018		Gypsum Plaster
6	330	0.770			0.429		Brick
					0.040		Rse
	455 mm (total wall thickness)				3.231		

Total resistance: Upper limit: 3.231 Lower limit: 3.231 Ratio: 1.000 Average: 3.231 m²K/W

U-value 0.310
U-value (rounded) 0.31 W/m²K

Layer	d (mm)	λ layer	λ bridge	Fraction	R layer	R bridge	Description
					0.130		Rsi
1	5	0.570			0.009		Gypsum Plaster
2	55	0.021			2.619		Kooltherm K18
3	10	0.570			0.018		Gypsum Plaster
4	330	0.770			0.429		Brick
					0.040		Rse
	400 mm (total wall thickness)				3.244		

Total resistance: Upper limit: 3.244 Lower limit: 3.244 Ratio: 1.000 Average: 3.244 m²K/W

U-value 0.308
U-value (rounded) 0.31 W/m²K

Layer	d (mm)	λ layer	λ bridge	Fraction	R layer	R bridge	Description
					0.130		Rsi
1	5	0.540			0.009		Lime Plaster
2	150	0.059			2.542		Calsitherm Climate Board
3	5	0.155			0.032		Calsitherm Adhesive
4	5	0.540			0.009		Lime Plaster
5	330	0.770			0.429		Brick
					0.040		Rse
	495 mm (total wall thickness)				3.192		

Total resistance: Upper limit: 3.192 Lower limit: 3.192 Ratio: 1.000 Average: 3.192 m²K/W

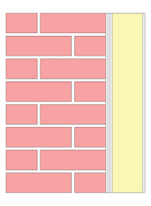
U-value 0.313
U-value (rounded) 0.31 W/m²K

Layer	d (mm)	λ layer	λ bridge	Fraction	R layer	R bridge	Description
					0.130		Rsi
1	5	0.540			0.009		Lime Plaster
2	120	0.045			2.667		Diathonite Evolution
3	5	0.570			0.009		Gypsum Plaster
4	330	0.770			0.429		Brick
					0.040		Rse
	460 mm (total wall thickness)				3.283		

Total resistance: Upper limit: 3.283 Lower limit: 3.283 Ratio: 1.000 Average: 3.283 m²K/W

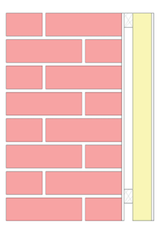
U-value 0.305
U-value (rounded) 0.30 W/m²K

GUTEX THERMOROOM



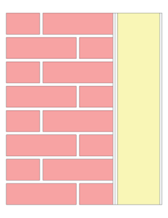
100mm Insulation

KOOLTHERM KI8



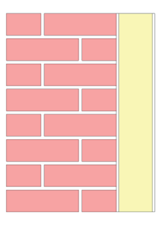
55mm Insulation

CALSITHERM CLIMATE BOARD



150mm Insulation

DIATHONITE EVOLUTION



120mm Insulation

Table 5	**Maximum elemental U-value (W/m²K)[1, 2,6] for Material Alterations or Material Change of Use**	
Column 1 Fabric Elements	**Column 2 Area-weighted Average Elemental U-value (Um)**	**Column 3 Average Elemental U-value – individual element or section of element**
Roofs Pitched roof - Insulation at ceiling - Insulation on slope Flat roof	 0.16 0.25 0.25	0.35
Walls Cavity walls[4] Other walls	 0.55 0.35	0.6
Ground floors[3]	0.45[5]	
Other exposed floors[3]	0.25	0.6
External doors, windows and rooflights and curtain walling	1.40	3.0

Notes:
1. *The U-value includes the effect of unheated voids or other spaces.*
2. *For material alterations, the U-values relate to the new works.*
3. *For insulation of ground floors and exposed floors incorporating underfloor heating, see paragraph 2.1.2.2.*
4. *This only applies in the case of a wall suitable for the installation of cavity insulation. Where this is not the case it should be treated as for "other walls".*
5. *This U-value only applies where floors are being replaced.*
6. *For buildings of architectural or historical interests or permeable traditional construction, refer to paragaragh 0.6.*

Technical Guidance Document Part L (2022) p. 36

The retrofit wall systems were tested at various thicknesses until each system achieved between a 0.30 W/m2K and 0.31 W/m2K U-Value.

This would produce the thickness of each insulation that is required to produce a wall system that complies with the guidance set out in TGD Part L (2022).

Although the thermal performances of these wall systems is optimum, their hygrothermal performance should be simulated to ensure the system does not allow for the possibility of mould growth.

Insulation Type	Gutex System	Kooltherm System	Calsitherm System	Diathonite System
U-Value Achieved	0.31 W/m2K	0.30 W/m2K	0.30 W/m2K	0.30 W/m2K
Thickness Required	100mm	55mm	150mm	130mm

Case I: Testing for TGD Part L Compliant U-Value

WUFI

WUFI is a numerical simulator for the Hygrothermal performance of a building fabric.

In literature the threshold for the possibility of mould growth is 80% Relative Humidity.

In this study the performance of the wall types has been simulated over a 10-year period.

Due to system applications, the RH can be higher at start of the simulation but will level out after some time.

All of the IWI systems achieved above 80% in the RH simulation.

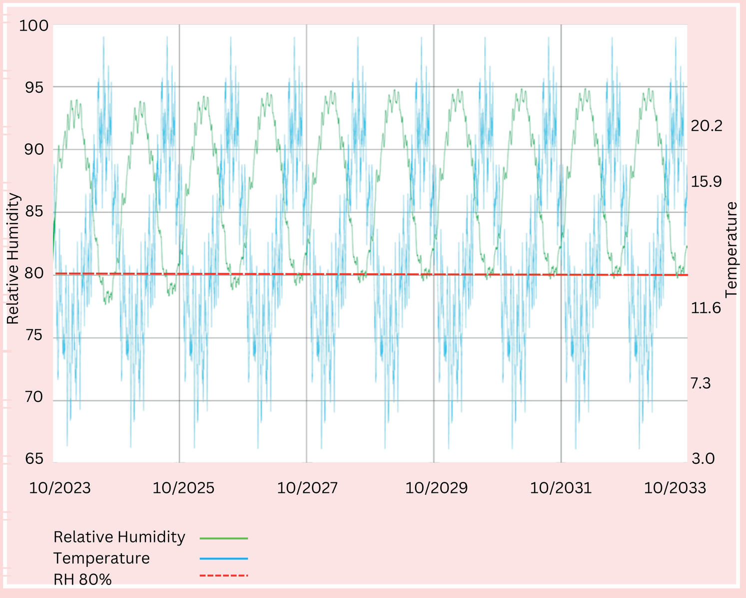
Insulation Type	Gutex System	Kooltherm System	Calsitherm System	Diathonite System
Maximum RH	95%	92%	93%	86%
Thickness	100mm	55mm	150mm	130mm

BuildDesk U

BuildDesk U is a glasier simulator for the Hygrothermal performance of a building fabric. It has been used for the purpose of comparison in this study. The results differ from those produced by WUFI.

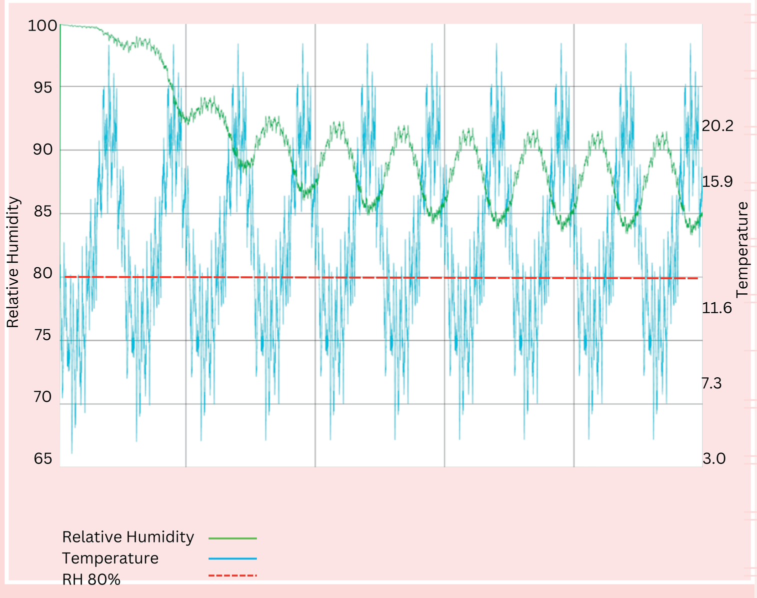
None of the wall types tested for over 80% RH and the simulation results that there was "No condensation is predicted at any interface in any month". These results do not account for the possibility of condensation and mould growth produced in the results by WUFI.

GUTEX THERMOROOM



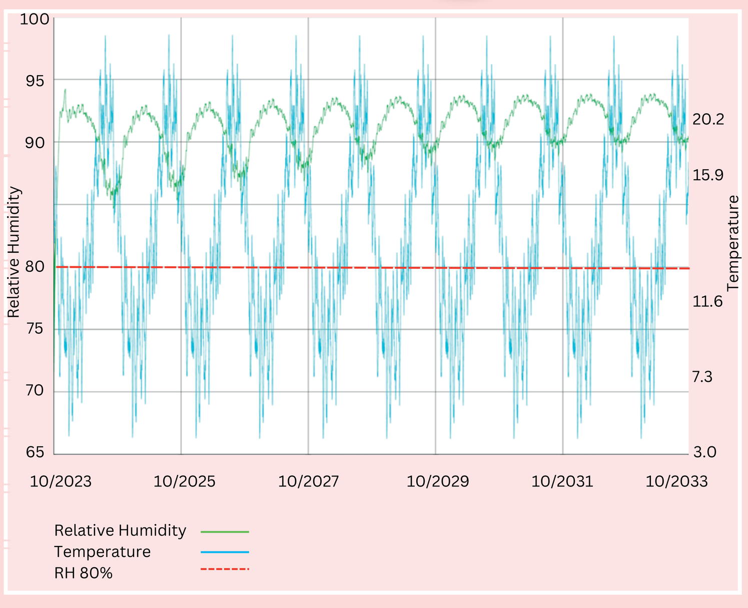
The Gutex averaged a high RH with a maximum of 95%. This means the production of moisture and condensation when the system is applied to the existing wall, and the possibility of mould growth between the IWI system and the solid wall.

KOOLTHERM KI8



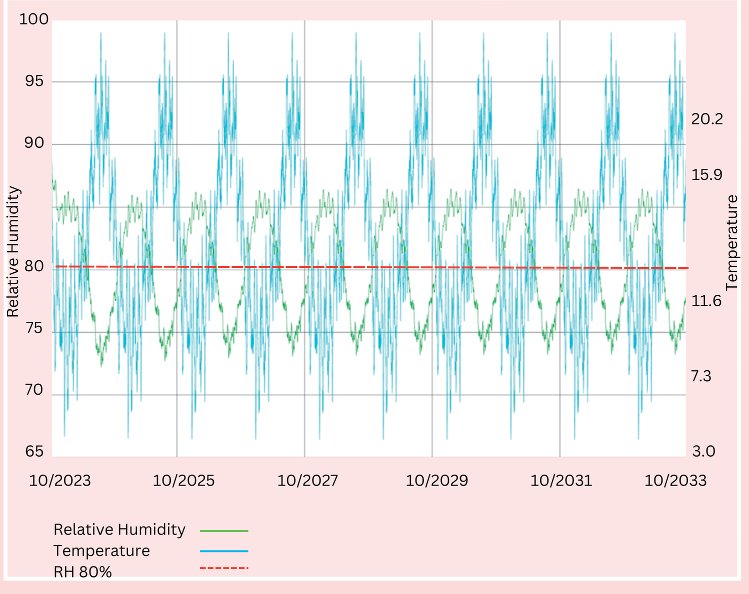
The high moisture resistance of this Kooltherm system is evident in it's hygrothermal performance. Following the drying-out period of the new system, the wall achieved a maximum of 92% RH. This system may allow for mould growth.

CALSITHERM CLIMATE BOARD



The RH performance of the Calsitherm system grew steadily from it's application. With a maximum of a 93% RH the figure is above the 80% threshold for mould growth.

DIATHONITE EVOLUTION



The Diathonite achieved a lower RH in comparison to the other IWI systems tested. The maximum RH recorded was 86%. Due to being above 80% RH, this system may produce mould growth.

Component: **Case 1 Gutex**

Interstitial condensation - main results
Calculation according BS EN ISO 13788

No condensation is predicted at any interface in any month.

		Jan	Feb	Mar	Apr
Internal temperature [°C]	Ti	20.0	20.0	20.0	20.0
Internal rel. humidity [%]	phi_i	70.4	70.1	68.5	67.3
External temperature [°C]	Te	4.4	4.4	5.7	7.1
External rel. humidity [%]	phi_e	86.0	85.0	82.0	80.0

May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
67.4	68.7	71.1	72.1	70.2	70.3	70.3	70.9
9.7	12.6	14.4	14.1	12.1	9.3	6.4	5.3
80.0	80.0	81.0	83.0	83.0	86.0	87.0	88.0

Component: **Case 1 Kooltherm**

Interstitial condensation - main results
Calculation according BS EN ISO 13788

No condensation is predicted at any interface in any month.

		Jan	Feb	Mar	Apr
Internal temperature [°C]	Ti	20.0	20.0	20.0	20.0
Internal rel. humidity [%]	phi_i	58.7	58.4	58.1	58.4
External temperature [°C]	Te	4.4	4.4	5.7	7.1
External rel. humidity [%]	phi_e	86.0	85.0	82.0	80.0

May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
61.1	65.4	69.6	70.4	66.4	63.6	60.7	60.1
9.7	12.6	14.4	14.1	12.1	9.3	6.4	5.3
80.0	80.0	81.0	83.0	83.0	86.0	87.0	88.0

Component: **Case 1 Kooltherm**

Interstitial condensation - main results
Calculation according BS EN ISO 13788

No condensation is predicted at any interface in any month.

		Jan	Feb	Mar	Apr
Internal temperature [°C]	Ti	20.0	20.0	20.0	20.0
Internal rel. humidity [%]	phi_i	58.7	58.4	58.1	58.4
External temperature [°C]	Te	4.4	4.4	5.7	7.1
External rel. humidity [%]	phi_e	86.0	85.0	82.0	80.0

May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
61.1	65.4	69.6	70.4	66.4	63.6	60.7	60.1
9.7	12.6	14.4	14.1	12.1	9.3	6.4	5.3
80.0	80.0	81.0	83.0	83.0	86.0	87.0	88.0

Component: **Case 1 Diathonite**

Interstitial condensation - main results
Calculation according BS EN ISO 13788

No condensation is predicted at any interface in any month.

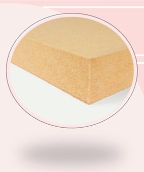
		Jan	Feb	Mar	Apr
Internal temperature [°C]	Ti	20.0	20.0	20.0	20.0
Internal rel. humidity [%]	phi_i	70.4	70.1	68.5	67.3
External temperature [°C]	Te	4.4	4.4	5.7	7.1
External rel. humidity [%]	phi_e	86.0	85.0	82.0	80.0

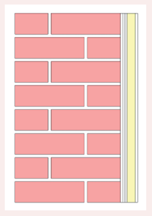
May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
67.4	68.7	71.1	72.1	70.2	70.3	70.3	70.9
9.7	12.6	14.4	14.1	12.1	9.3	6.4	5.3
80.0	80.0	81.0	83.0	83.0	86.0	87.0	88.0

ING HYGROTHERMAL ANALYSIS

Case 2: Testing to Achieve below 80% Relative Humidity

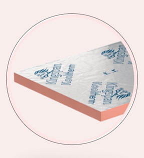
GUTEX THERMOROOM

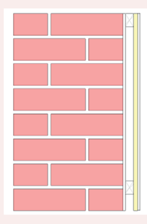




25mm Insulation

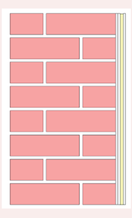
KOOLTHERM K18





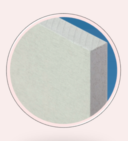
12.5mm Insulation

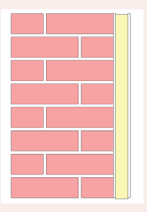
CALSITHERM CLIMATE BOARD



10mm Insulation

DIATHONITE EVOLUTION





40mm Insulation

Layer	d (mm)	λ layer	λ bridge	Fraction	R layer	R bridge	Description
					0.130		Rsi
1	5	0.540			0.009		Lime Plaster
2	25	0.039			0.641		Gutex Thermoroom
3	5	0.115			0.043		Gypsum Adhesive
4	5	0.540			0.009		Lime Plaster
5	10	0.570			0.018		Gypsum Plaster
6	330	0.770			0.429		Brick
					0.040		Rse
	380 mm (total wall thickness)				1.319		

Total resistance: Upper limit: 1.319 Lower limit: 1.319 Ratio: 1.000 Average: 1.319 m²K/W

U-value 0.758
U-value (rounded) 0.76 W/m²K

Layer	d (mm)	λ layer	λ bridge	Fraction	R layer	R bridge	Description
					0.130		Rsi
1	5	0.570			0.009		Skim Finish
2	12.5	0.022			0.568		Kooltherm K18
3	25	R-value			0.180		Cavity unventilated
4	10	0.570			0.018		Gypsum Plaster
5	330	0.770			0.429		Brick
					0.040		Rse
	383 mm (total wall thickness)				1.373		

Total resistance: Upper limit: 1.373 Lower limit: 1.373 Ratio: 1.000 Average: 1.373 m²K/W

U-value 0.728
U-value (rounded) 0.73 W/m²K

Layer	d (mm)	λ layer	λ bridge	Fraction	R layer	R bridge	Description
					0.130		Rsi
1	5	0.540			0.009		Lime Plaster
2	10	0.059			0.169		Calsitherm Climate Board
3	5	0.155			0.032		Calsitherm Adhesive
4	5	0.540			0.009		Lime Plaster
5	330	0.770			0.429		Brick
					0.040		Rse
	355 mm (total wall thickness)				0.819		

Total resistance: Upper limit: 0.819 Lower limit: 0.819 Ratio: 1.000 Average: 0.819 m²K/W

U-value 1.221
U-value (rounded) 1.22 W/m²K

yer	d (mm)	λ layer	λ bridge	Fraction	R layer	R bridge	Description
					0.130		Rsi
1	5	0.540			0.009		Lime Plaster
2	40	0.045			0.889		Diathonite Evolution
3	5	0.570			0.009		Gypsum Plaster
4	330	0.770			0.429		Brick
					0.040		Rse
	380 mm (total wall thickness)				1.505		

otal resistance: Upper limit: 1.505 Lower limit: 1.505 Ratio: 1.000 Average: 1.505 m²K/\

-value 0.664
-value (rounded) 0.66 W/m²K

0.6 APPLICATION TO BUILDINGS OF ARCHITECTURAL OR HISTORICAL INTEREST

0.6.1 Part L and the European Union (Energy Performance of Buildings) Regulations 2019 do not apply to works (including extensions) to an existing building which is a "protected structure" or a "proposed protected structure" within the meaning of the Planning and Development Act 2000 (No. 30 of 2000). Nevertheless, the application of this Part and of the European Union (Energy Performance of Buildings) Regulations 2019 may pose particular difficulties for habitable buildings which, although not protected structures or proposed protected structures, may be of architectural or historical interest including buildings of traditional construction with permeable fabric that both absorbs and readily allows the evaporation of moisture.

The aim should be to improve the energy efficiency as far as is reasonably practicable. The work should not prejudice the character of the building or increase the risk of long term deterioration of the building fabric.

Technical Guidance Document Part L (2022) p. 13

This case study is not "protected structure" or a "proposed protected structure" which would mean that it is exempt from the current Technical Guidance Document part L (2022).

The document also states that the energy retrofit of an existing building should not increase the risk of deterioration to the fabric.

Because the wall types that tested at compliant U-Values with TGD L, all produced RH results that could cause mould growth, the systems were tested at thicknesses to achieve below 80% RH.

Insulation Type	Gutex System	Kooltherm System	Calsitherm System	Diathonite System
U-Value Achieved	0.76 W/m2K	0.73 W/m2K	1.22 W/m2K	0.66 W/m2K
Thickness Required	25mm	12.5mm	10mm	40mm

Case 2: Testing to Achieve below 80% Relative Humidity

WUFI

WUFI is a numerical simulator for the Hygrothermal performance of a building fabric.

The systems were tested to achieve below 80% RH. This would eliminate the risk of mould growth between the existing wall and the proposed IWI systems.

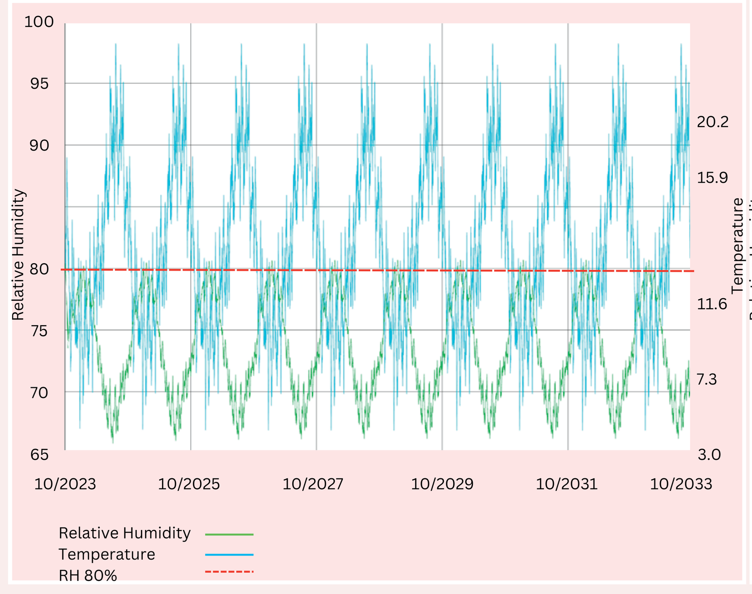
Insulation Type	Gutex System	Kooltherm System	Calsitherm System	Diathonite System
Below 80% RH	YES	YES	YES	YES
Thickness	25mm	12.5mm	10mm	40mm

BuildDesk U

BuildDesk U is a glasier simulator for the Hygrothermal performance of a building fabric. It has been used for the purpose of comparison in this study. The results differ from those produced by WUFI.

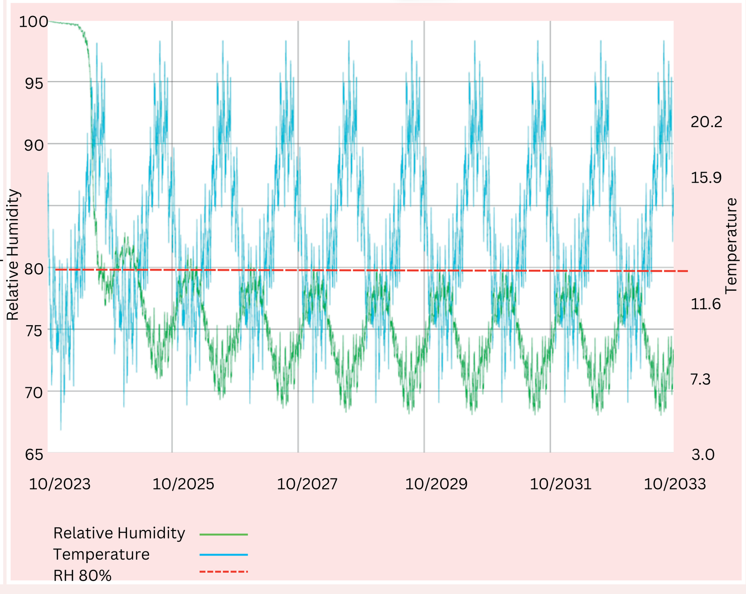
Similar to Case 1, the results don't show for any possibility of interstitial condensation. In this case it aligns with results produced by WUFI which show relative humidity reaching 80% at the maximum. The BuildDesk U results don't exceed 80%.

GUTEX THERMOROOM



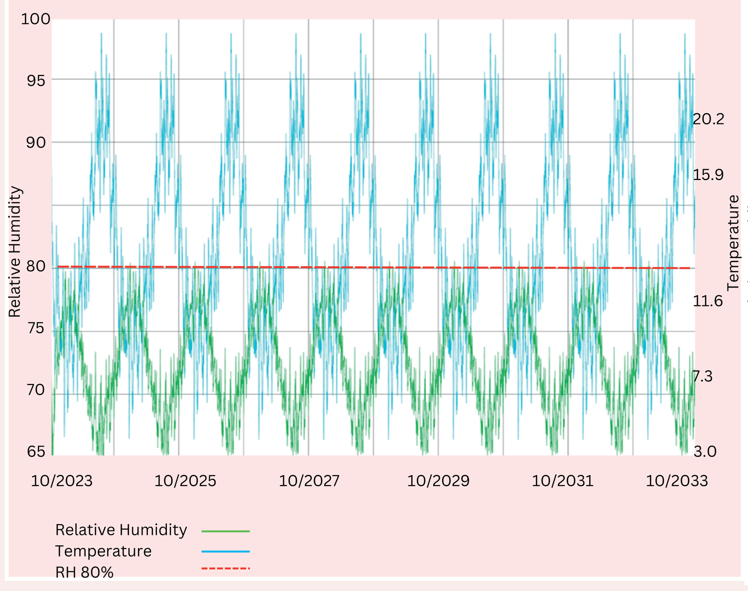
The Gutex system simulated a maximum of 80% RH when tested with 25mm insulation as part of the retrofit system. The insulation is produced at 20mm,40mm,50mm,60mm,80mm, and 100mm thicknesses.

KOOLTHERM K18



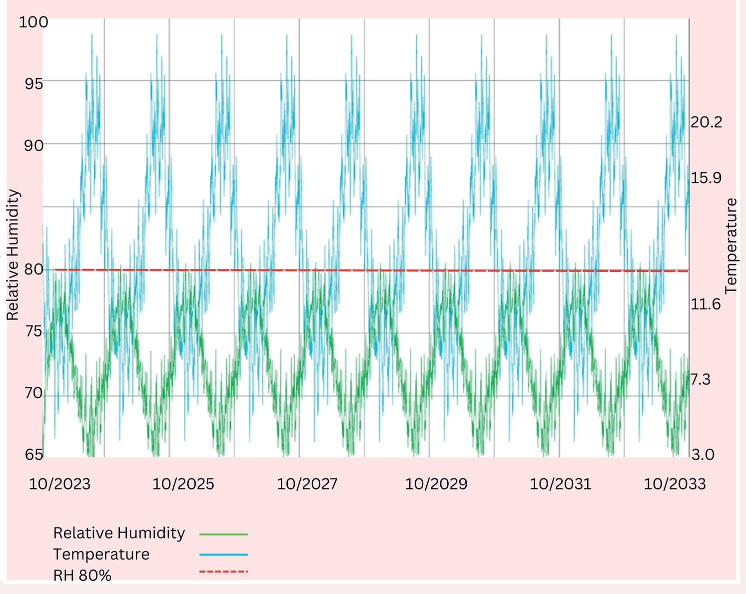
After the drying-out period of the Kooltherm system, the system simulated below 80% RH when tested with 12.5mm. This board is manufactured at 42.5 and 52.5mm thicknesses.

CALSITHERM CLIMATE BOARD



The Calsitherm board, when tested at 10mm simulated a 80% maximum RH. This product is available at 30mm and 50mm thicknesses.

DIATHONITE EVOLUTION



The Diathonite system simulated below 80% RH when it was tested with a 45mm thickness. This product is a typically applied with thicknesses between 40- 60mm.

Component: **Case 2 Gutex**

Interstitial condensation - main results
Calculation according BS EN ISO 13788

No condensation is predicted at any interface in any month.

		Jan	Feb	Mar	Apr
Internal temperature [°C]	Ti	20.0	20.0	20.0	20.0
Internal rel. humidity [%]	phi_i	70.4	70.1	68.5	67.3
External temperature [°C]	Te	4.4	4.4	5.7	7.1
External rel. humidity [%]	phi_e	86.0	85.0	82.0	80.0

May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
67.4	68.7	71.1	72.1	70.2	70.3	70.3	70.9
9.7	12.6	14.4	14.1	12.1	9.3	6.4	5.3
80.0	80.0	81.0	83.0	83.0	86.0	87.0	88.0

Component: **Case 2 Kooltherm**

Interstitial condensation - main results
Calculation according BS EN ISO 13788

No condensation is predicted at any interface in any month.

		Jan	Feb	Mar	Apr
Internal temperature [°C]	Ti	20.0	20.0	20.0	20.0
Internal rel. humidity [%]	phi_i	58.7	58.4	58.1	58.4
External temperature [°C]	Te	4.4	4.4	5.7	7.1
External rel. humidity [%]	phi_e	86.0	85.0	82.0	80.0

May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
61.1	65.4	69.6	70.4	66.4	63.6	60.7	60.1
9.7	12.6	14.4	14.1	12.1	9.3	6.4	5.3
80.0	80.0	81.0	83.0	83.0	86.0	87.0	88.0

Component: **Case 2 Calsitherm**

Interstitial condensation - main results
Calculation according BS EN ISO 13788

No condensation is predicted at any interface in any month.

		Jan	Feb	Mar	Apr
Internal temperature [°C]	Ti	20.0	20.0	20.0	20.0
Internal rel. humidity [%]	phi_i	58.7	58.4	58.1	58.4
External temperature [°C]	Te	4.4	4.4	5.7	7.1
External rel. humidity [%]	phi_e	86.0	85.0	82.0	80.0

May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
61.1	65.4	69.6	70.4	66.4	63.6	60.7	60.1
9.7	12.6	14.4	14.1	12.1	9.3	6.4	5.3
80.0	80.0	81.0	83.0	83.0	86.0	87.0	88.0

Component: **Case 2 Diathonite**

Interstitial condensation - main results
Calculation according BS EN ISO 13788

No condensation is predicted at any interface in any month.

		Jan	Feb	Mar	Apr
Internal temperature [°C]	Ti	20.0	20.0	20.0	20.0
Internal rel. humidity [%]	phi_i	70.4	70.1	68.5	67.3
External temperature [°C]	Te	4.4	4.4	5.7	7.1
External rel. humidity [%]	phi_e	86.0	85.0	82.0	80.0

May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
67.4	68.7	71.1	72.1	70.2	70.3	70.3	70.9
9.7	12.6	14.4	14.1	12.1	9.3	6.4	5.3
80.0	80.0	81.0	83.0	83.0	86.0	87.0	88.0

Resuts Analysis

Hygrothermal Simulation Methods

The results produced by both the glasier and numerical simulators were not similar. The glasier results often produced results with RH below 80% when the numerical simulator calculated the performances over 80%. When undertaking hygrothermal analysis during th energy retrofit of a historic solid wall building, the numerical simulator should be used to ensure accurate information on the possibility of mould growth

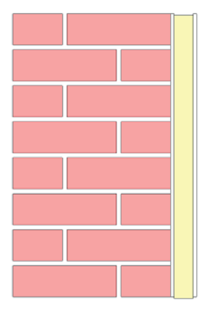
CASE 1

Case 1 tested the selected IWI systems at thicknesses to achieve a U-Value lower than the 0.035 W/m2K outlined for existing buildings in TGD part L (2022). When the wall build-ups that achieved a compliant U-Value were tested for the hygrothermal performance, the all produced RH% results that could possibly produce would growth between the retrofit system and the existing wall

CASE 2

Case 2 tested the IWI systems when applied to the exising wall to simulate RH% below 80% to restrict the possibility of mould growth. The U-Values achieved from this case were below part L guidlines. The lowest U-Value was 0.66W/m2K and achieved by the Diathonite system when tested at 40mm. This system would be the optimum system for this case study. The wall thickness would increase from 330mm to 385mm.

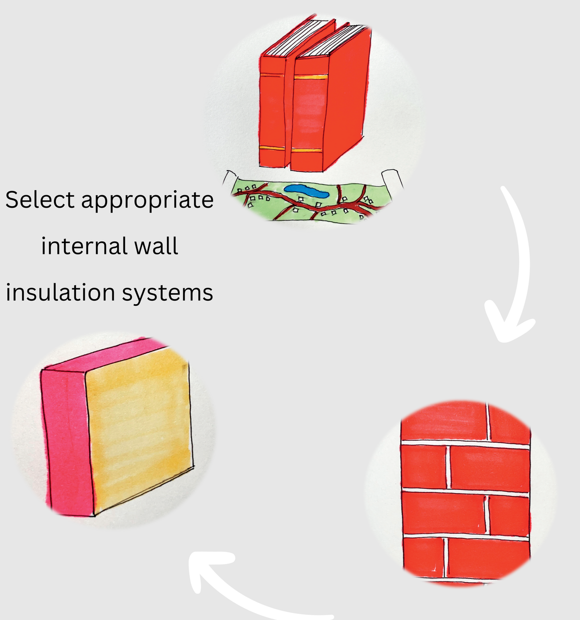
DIATHONITE EVOLUTION



330mm existing historic red brick
10mm existing wall finish
40mm Diathonite Evolution
5mm lime based plaster

STEP 1

Analysing your Building



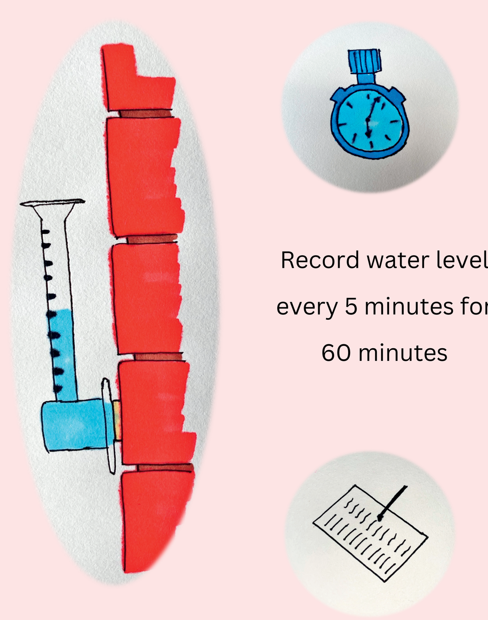
Research the building's history

Select appropriate internal wall insulation systems

Survey the building

STEP 2

Water Absorption Test of Your Wall



Record water level every 5 minutes for 60 minutes

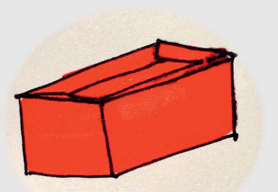
Apply Karsten tubes to the wall

Document results

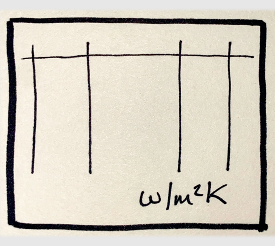
STEP 3

Thermal Performance Analysis of Retrofit Wall Options

Use the thermal resistance of each material



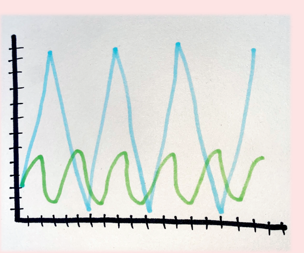
Use a U-Value calculator to produce the U-Value of each wall



STEP 4

Hyrgrothermal Performance Simulation of Retrofit Wall Options

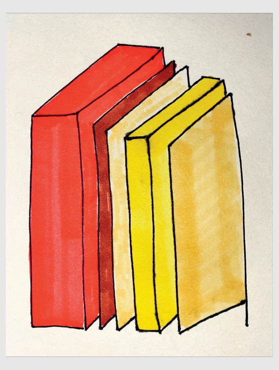
Input selected internal wall insulation systems on existing wall



Simulate the temperature and relative humidy using WUFI

STEP 5

Selecting Your Energy Retrofit Wall System



Select your IWI system

Your system should:

- Achieve below 80% RH
- Achieve a satisfactory U-Value
- Be a thickness that would not impact the existing floor space

C19371726
Rebecca Atkinson