GBC Green Building Calculator
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JP10 Thermal Insulation

Thermal Insulation Master class

BrianSpecMan 4th July 2023

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This Presentation on GBE:

- Find this file on GBE websites at:
  - https://GreenBuildingEcyclopaedia.uk/?p=40839
- Go there for:
  - the latest update
  - versions presented to different audiences
  - the whole presentation, all of the hidden slides
  - other file formats:
    - Handout, Show, PDF, (PPTX in shop)
  - Links to related: GBE & GBC CPD & other content
    - CPD, Lectures, Checklists, Jargon Busters, Issue papers, Q&A, Links, etc.

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Thermal Insulation Functions

In use Carbon and Energy Reduction

Thermal comfort Moisture management

General Competency Issues

- Comply with Code of Practice or Workmanship British Standards or WOBS
- Products manufactured to BS standards and BSI Kitemarked ideally (or ENs and Kitemark)
- BBA Certified systems if no Kitemark
- Manufacturer recommendations should never be ignored
- BBA certificates should be checked for limitations too, stay within them
- Check currency of test evidence
  - (ideally post Grenfell)

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Regulated Issues

- Stuff we should understand
- k values of materials and products
- r values of materials of known thickness
- Surface resistivity at faces and in voids
- U values of whole elements
- R values if European/International
- Do you do your own calculations?
  - If not, do you check them for competency?
  - I have found manufacturers fudging values
- GBC V2 Includes U value calculators for all elements
- GRC V1 will too when issued

Unregulated Issues

- **Stuff green manufacturers understand**
  - but we tend not to know nor exploit
  - More research is done but not readily accessible
- **Hydrophobic insulation**
  - Vapour closed construction
- **Hygroscopic insulation**
  - Vapour open construction
  - Breathing walls & roofs

Unregulated Issues (BRAD O)

- BRAD O does not understand opaque building envelop permits solar radient heat inwards
- Solar Radiation Heat gain
- K value
- Density
- Specific Heat Capacity
  - Thermal Mass
    - storing heat in its thermal mass, if it has any
  - Decrement delay or Thermal lag
    - heat passage over time through insulation to interior

Meeting Targets: means Avoiding Substitutions

- Specify the reasons you chose it
- Make those reasons the criteria for substitution equivalency
- Don't say 'or similar' say 'or equivalent' and check equivalency
  - In annotation (don't undermine the specification)
  - Nor in the specification it encourages substitution
- Police your specification
  - Choosing Contractors, Suppliers, Installers
  - At price gathering and at tender stage
  - On site: Delivery tickets, packaging, products
  - As installed
  - At stage payments "Here be dragons"
  - (signing off stage payments approves surreptitious substitution)

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Violet v Green Contractors

- Violet contractors know what they know
- Have supply chains in order
- Buy the day they need it from merchants
- They don't like change: Business as usual
- Get them to do the TGR's Futureproof online training courses for sustainable retrofit subcontractors
- https://www.futureproof.uk.net/
- futureproof@cse.org.uk
- So they know why and how to change and want to change
- And not bother to bring spurious substitutions
- And get satisfaction they are part of the solution

Cost savings now, cost later

- Working with your client and the contractor
- Understand that initial cost savings will probably increase :
  - in-use cost
  - in use Energy and Carbon
  - Embodied Energy and Carbon
- Use Green Building Calculator to see all of the costs and impacts before you decide
- Making changes in GBC will instantaneously provide you with the consequences of any change of specification or targets

Completed by GBC	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Completed by GBC
To be completed by GBC user		Auto-filled	Choose		Auto-filled	Auto-filled	Auto-filled	Auto-filled	Auto-filled	Auto-filled	Auto-filled	Review	Auto-filled	Auto-filled	Auto-filled	Review	Auto-filled	Interact	Interact	Review	Interact	Review	To be completed by GBC user	Completed by GBC

U Values To Watts To CO_2

Elements

Scenarios

Scenario: Proposed 2

© STBA 2021 developed by GBC and STBA

DR Check

Actual

Senarios:

		Applicable	Scenarios	Elements	Calculated U value	Areas	External		Internal	Difference	Individual	Total	Area	Total Areas	Areas	Heat loss	Ratio:	Previous	Proposed 1	Improvement	Proposed 2	Improvement		
							Temperature				Heat loss							Pasted values					Auto-filled / Choose	Yes
Yes	Floor	Applicable	Scenarios	Elements	Calculated U value	Actual Areas	External		Internal	Difference	Individual	Total	Area	Total Areas	Areas	Heat loss	Ratio:	Set cell D4 to '**Previous**' then copy cells T26 to T99, paste > values	Set cell D4 to '**Proposed 1**' then review cells V26 to V99 in next column to right	Having set D4 in two columns to left, review differences below	Set cell D4 to '**Proposed 2**' then review cells V26 to V99 in next column to right	Having set D4 in two columns to left, review differences below	Check / Interact	Yes
					W/m2.K	m2	degree C		degree C	degree C	W	W	m2	m2	%	%	1 in x							Yes
		No	Proposed 2	Ground Bearing Solid Floor (GBSF)	0.461	0	0	-	17	17	0		0										Auto-filled	Yes
		Yes	Proposed 2	Suspended Ground Floor (SGF)	0.223	40	0	-	17	17	152		40										Auto-filled	Yes
						40						152	Floor	40	36%	32.9%	0.92	151.86	151.86	0.00	151.86	0.00	Review	Yes
							Temperature				Heat loss													
	Compartmentation	Applicable	Scenarios	Elements	Calculated U value	Areas	Party		Internal	Difference	Individual	Total	Area	Total Areas	Areas	Heat loss	Ratio:							
					W/m2.K	m2	degree C		degree C	degree C	W	W	m2	m2	%	%	1 in x							
						Assumed																	Check	Yes
No	Compartment Floor	No	Proposed 2	Party Floor (PF)	0.244	0	17	-	17	0	0	0	0		0%	0%	0.00	0.00	0.00	0.00	0.00	0.00	Auto-filled	Yes
Yes	Compartment Wall			Party Wall (PF):		Assumed																	Check	Yes
		No	Proposed 2	Solid Masonry Party Wall (SMPW)	0.000	0.00	17	-	17	0	0		0		0%								Auto-filled	Yes
		No	Proposed 2	Cavity Masonry Party Wall (CMPW)	5.882	0.00	17	-	17	0	0		0		0%	0.0%	0.00	0.00	0.00	0.00	0.00	0.00	Auto-filled	Yes
		Yes	Proposed 2	Timber Frame Party Wall (TFPW)	0.075	15.79	17	-	17	0	0	0	15.79		14%	0.0%	0.00	0.00	0.00	0.00	0.00	0.00	Auto-filled	Yes
						15.79						0	Compartmentation	15.79	14%	0.0%	0.00	0.00	0.00	0.00	0.00	0.00	Review	Yes
						Actual	Temperature				Heat loss												Check	Yes
Yes	Wall	Applicable	Scenarios	Elements	Calculated U value	Areas	External		Internal	Difference	Individual	Total	Area	Total Areas	Areas	Heat loss	Ratio:							
				External Walls:	W/m2.K	m2	degree C		degree C	degree C	W	W	m2	m2	%	%	1 in x							
		Yes	Proposed 2	Solid Masonry External Walls (SMEW)	0.176	50.00	0	-	17	17	149		50										Auto-filled	Yes
		No	Proposed 2	Cavity Masonry External Walls (CMEW)	5.882	0.00	0	-	17	17	0		0											Yes
						50.00						149	Wall	50	45%	32.3%	0.72	149.18	149.18	0.00	149.18	0.00	Review	Yes
						Assumed	Temperature				Heat loss												Check	Yes
No	Roof	Applicable	Scenarios	Elements	Calculated U value	Areas	External		Internal	Difference	Individual	Total	Area	Total Areas	Areas	Heat loss	Ratio:							
					W/m2.K	m2	degree C		degree C	degree C	W	W	m2	m2	%	%	1 in x							
		No	Proposed 2	Flat Roof (FR)	0.107	0	0	-	17	17	0		0										Auto-filled	Yes
		No	Proposed 2	Pitched Roof (PR)	#VALUE!	0	0	-	17	17	0		0										Auto-filled	Yes
						0						0	Roof	0	0%	0.0%	0.00	0.00	0.00	0.00	0.00	0.00	Review	Yes
							Temperature				Heat loss													
	Window/Door/Rooflight	Applicable	Scenarios	Elements	Calculated U value	Areas	External		Internal	Difference	Individual	Total	Area	Total Areas	Areas	Heat loss	Ratio:							
					W/m2.K	m2	degree C		degree C	degree C	W	W	m2	m2	%	%	1 in x							
						Assumed																	Check	Yes
Yes	Windows	Yes	Proposed 2	Windows (W)	1.600	4.11	0	-	17	17	112	112	4.11	Window	3.7%	24.2%	6.58	111.79	111.79	0.00	111.79	0.00	Review	Yes
						Assumed																	Check	Yes
Yes	Doors	Yes	Proposed 2	Glazed Pedestrian Doors (GPD)	1.600	1.80	0	-	17	17	49	49	1.8	Door	1.6%	10.6%	6.58	48.96	48.96	0.00	48.96	0.00	Review	Yes
						5.91						161	Combined	5.9	5.3%	34.8%	6.58	160.75	160.75	0.00	160.75	0.00	Review	Yes
												462	Total Envelop	111.7	100%	100.0%	1.00	461.79	461.79	0.00	461.79	0.00	Review	Yes
												301	Opaque Envelop	106	95%	65.2%	0.69	301.04	301.04	0.00	301.04	0.00	Review	Yes
																		Pasted values	Normal				Choose	Yes

Scenarios

				No	No	Yes	Yes	Yes	No	No	Yes	Yes			Previous	Proposed 1	Improvement	Proposed 2	Improvement	Check	Yes
	Total Conduction Heat Loss	Areas		Basement	Party floor	Party wall	Floor	Wall	Roof	Ceiling	Windows	Doors		Insulation: ignore undeveloped yet	Set cell D4 to '**Previous**' then copy cells T104 to T151, paste > values	Set D4 to '**Proposed 1**' then review cells U104 to U151 in next column to right	Having set D4 in two columns to left, review differences below	Set D4 to '**Proposed 2**' then review cells W104 to W151 in next column to right	Having set D4 in two columns to left, review differences below	Interact	Yes
Total	Total Envelope Area of Conducted Heat Loss (TEACHL)	111.7	m2	0	0	0	40	50	0	0			90	90	£111.70	£111.70	£0.00	£111.70	£0.00	Review	Yes
Window/Door/Rooflight	Total Transparent Area of Conducted Heat Loss (TTACHL)	5.9	m2								4.11	1.8	5.91		£5.91	£5.91	£0.00	£5.91	£0.00	Review	Yes
Walls Roof Floor	Total Opaque Area of Conducted Heat Loss (TOACHL)	105.8	m2												£105.79	£105.79	£0.00	£105.79	£0.00	Review	Yes
Window/Door/Rooflight	Transparent area as % of whole	5.59%	%	0%	0%	0%	36%	45%	0%	0%	3.7%	1.6%	86%		£0.06	£0.06	£0.00	£0.06	£0.00	Review	Yes
Walls Roof Floor	Transparent area's heat loss as % of whole heat loss	34.81%	%								24.2%	10.6%			£0.35	£0.35	£0.00	£0.35	£0.00	Review	Yes
	In-Use Energy		%	0.0%	0.0%	0.0%	32.9%	32.3%	0.0%	0.0%	24.2%	10.6%		0	Previous	Proposed 1	Improvement	Proposed 2	Improvement	Check	Yes
	Floor area	36.270	m2	Basement	Party floor	Party wall	Floor	Wall	Roof	Ceiling	Windows	Doors		Insulation: ignore undeveloped yet	36.270	36.270	0.000	36.270	0.000	Review	Yes
	Watts	461.790	W	0.00	0.00	0.00	151.86	149.18	0.00	0.00	111.79	48.96		0.00	461.790	461.790	0.000	461.790	0.000	Review	Yes
	KiloWatts	0.462	kW	0.00	0.00	0.00	0.15	0.15	0.00	0.00	0.11	0.05		0.00	0.462	0.462	0.000	0.462	0.000	Review	Yes
	KiloWatts/floor area	0.013	kW/m2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.013	0.013	0.000	0.013	0.000	Review	Yes
Energy Intensity	KiloWattHours/floor area	0.204	kWh/m2	0.00	0.00	0.00	0.07	0.07	0.00	0.00	0.05	0.02		0.00	0.204	0.204	0.000	0.204	0.000	Review	Yes
	KiloWattHours/Day	7.389	kWh/Day	0.00	0.00	0.00	2.43	2.39	0.00	0.00	1.79	0.78		0.00	7.389	7.389	0.000	7.389	0.000	Review	Yes
	KiloWattHours/Floor area/Day	0.204	kWh/m2/Day	0.00	0.00	0.00	0.07	0.07	0.00	0.00	0.05	0.02		0.00	0.204	0.204	0.000	0.204	0.000	Review	Yes
	KiloWattHours/Floor area/Year	30.896	kWh/m2/Year	0.00	0.00	0.00	10.16	9.98	0.00	0.00	7.48	3.28		0.00	30.896	30.896	0.000	30.896	0.000	Review	Yes
	KiloWattHours/Floor area/Whole life	865.097	kWh/m2/Life	0.00	0.00	0.00	284.49	279.46	0.00	0.00	209.43	91.72		0.00	865.097	865.097	0.000	865.097	0.000	Review	Yes
	In-Use Carbon Dioxide	CO_2	CarbonDioxide												Previous	Proposed 1	Improvement	Proposed 2	Improvement		Yes
	Fuel Choice	Mains Electricity	Drop Down List	Basement	Party floor	Party wall	Floor	Wall	Roof	Ceiling	Windows	Doors		Insulation: ignore undeveloped yet	Mains Electricity	Mains Electricity		Mains Electricity		Choose	Yes
	kg CO_2/kWh	0.186	kg CO_2/kWh	0.00	0.00	0.00	0.06	0.06	0.00	0.00	0.05	0.02		0.00	0.19	0.19	0.00	0.19	0.00	Review	Yes
	kg CO2	1.374	kg CO_2	0.00	0.00	0.00	0.45	0.44	0.00	0.00	0.33	0.15		0.00	1.37	1.37	0.00	1.37	0.00	Review	Yes
	kg CO2/year	3,334.93	kg CO_2/Year	0.00	0.00	0.00	1,096.70	1,077.32	0.00	0.00	807.33	353.58		0.00	3,334.93	3,334.93	0.00	3,334.93	0.00	Review	Yes
	kg CO2/whole life	93,378.145	kg CO_2/Life	0.00	0.00	0.00	30,707.64	30,164.95	0.00	0.00	22,605.38	9,900.17		0.00	93,378.14	93,378.14	0.00	93,378.14	0.00	Review	Yes
Embodied Carbon intensity	kg CO2/m2	153.508	kg CO_2/m²	0.00	0.00	0.00	50.48	49.59	0.00	0.00	37.16	16.28		0.00	153.51	153.51	0.00	153.51	0.00	Review	Yes

	In-Use Hours to Whole Life	No.	Unit/Unit	up to max	% of max	Start date	End date	Previous	Proposed 1	Improvement	Proposed 2	Improvement		Yes
	Hours of operation per day (Spaces heated)	16	h/d	24	66.67%			16	16		16		Yes	Yes
	Days Per week (Spaces heated)	7	d/wk	7	100.00%			7	7		7		Yes	Yes
	Weeks per month (Spaces heated)	4.33	w/m	4.33				4.33	4.33	0.00	4.33	-4.33	Review	Yes
	Months per year (Spaces heated)	5	m/y	12	41.67%			5	5		5		Yes	Yes
	Weeks per year (Spaces heated)	21.67	w/y	52	41.67%			21.67	21.67	0.0	21.67	-21.7	Review	Yes
	Days per year	151.67	d/y	365	41.55%			151.67	151.67	0.0	151.67	-151.7	Review	Yes
	Hours per year (Spaces heated)	2,427	h/y	8,760	27.70%			2,427	2,427	0	2,427	-2,427	Review	Yes
	Number of years design life expectancy	28	y/l			2022	2050	28	28	0.0	28	-28.0	Review	Yes
	Hours per building life	67,947	h/l	245,280	27.70%			67,947	67,947	0	67,947	-67,947	Review	Yes

	In-Use Running Costs			Basement	Party floor	Party wall	Floor	Wall	Roof	Ceiling	Windows	Doors	Insulation: ignore undeveloped yet	Previous	Proposed 1	Improvement	Proposed 2	Improvement		
					%%%	%%%	%%%	%%%	%%%	%%%	%%%	%%%	%%%							Yes
	Fuel Choice	Mains Electricity																		Yes
	£ in-use costs/unit of fuel/hour	£0.16	£/kWh	£0.00	£0.00	£0.00	£0.05	£0.05	£0.00	£0.00	£0.04	£0.02	£0.00	£0.16	£0.16	£0.00	£0.16	£0.00	Review	Yes
£ in-use costs/day	£ Unit cost of fuel x building consumption x hours/day	£1.19	£/d	£0.00	£0.00	£0.00	£0.39	£0.38	£0.00	£0.00	£0.29	£0.13	£0.00	£1.19	£1.19	£0.00	£1.19	£0.00	Review	Yes
	£ in-use costs/year	£180.42	£/y	£0.00	£0.00	£0.00	£59.33	£58.28	£0.00	£0.00	£43.68	£19.13	£0.00	£180.42	£180.42	£0.00	£180.42	£0.00	Review	Yes
	£ in-use costs/whole life	£5,051.71	£/l	£0.00	£0.00	£0.00	£1,661.27	£1,631.91	£0.00	£0.00	£1,222.94	£535.59	£0.00	£5,051.71	£5,051.71	£0.00	£5,051.71	£0.00	Review	Yes
					%%%	%%%	%%%	%%%	%%%	%%%	%%%	%%%	%%%							

	Embodied Energy to Sequestered Carbon			Basement	Party floor	Party wall	Floor	Wall	Roof	Ceiling	Windows	Doors	Insulation: ignore undeveloped yet	Previous	Proposed 1	Improvement	Proposed 2	Improvement		Yes
	Embodied Energy	1,818.78	MJ		749.61	224.35	363.14	476.16	0.00		2.77	2.74	0.00	1818.78	1818.78	0.00	1818.78	0.00	Review	Yes
Embodied Carbon Dioxide	Embodied Carbon Dioxide	2,719.71	kg CO2		1,044.82	483.51	424.18	751.01	0.00		0.00	2,719.71	0.00	2719.71	2719.71	0.00	2719.71	0.00	Review	Yes
	Sequestered Carbon Dioxide	51,908.58	kg CO2		24,663.60	6,088.62	11,854.88	8,800.00	0.00		246.60	254.88	0.00	51,908.58	51,908.58	0.00	51,908.58	0.00	Review	Yes
Total Carbon Dioxide	Total Carbon Dioxide	-49,188.88	kg CO2		-23,618.78	-5,605.11	-11,430.70	-8,048.99	0.00		-246.60	-238.70	0.00	-49,188.88	-49,188.88	0.00	-49,188.88	0.00	Review	Yes

Hidden rows awaiting development

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Pay back & carbon back periods

- Renewable energy systems are an add on cost
- Push-back comes in the form of 'what is the pay-back period' usually associated with energy costs
- More importantly are carbon-back periods
- If your client is switched on to carbon saving
- Provide them with that information too
- Green Building Calculator aims to provide this data in future
  - Focus on Insulation payback periods
  - Focus on high specification window payback periods
  - Focus on the cost of adding and running air conditioning
  - Focus on PV to EV on the drive not having to pay for fuel again
- Challenge payback period of £1000 tap or door handle

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Adding real value

- Estate agent's perceived 'adding value': if your selling it
  - Location Location Location in relation to schools
  - Increasing floor area,
  - Posh kitchens and posh bathrooms
  - Kerb appeal
  - Neutral colour, clutter-free interiors
- **Home owners perceived adding value:**
  - Being able to boast about how cheaply you extended/altered your house is not adding value
  - With increasing fuel and living costs, long term low running costs need to be perceived as adding value?
  - A to G ratings enable engagement
  - Boasting your 6 Bed house costs £50/year to heat and cool not £2000/year at the school gate has to be seen as adding value?

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History Lesson

Just my opinion

GBC will confirm or not

Energy loss through

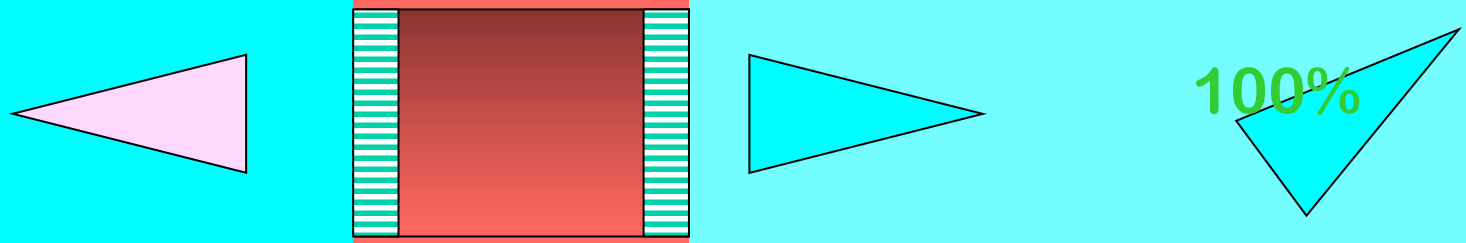
Hot air up chimney

100%

Pre 1919 - 1962 Building Regs

Energy loss through cold air infiltration

Energy loss through hot air ex-filtration



100%

Outside

Wall & Airbrick

Inside

Thermal mass absorbs radiant heat from sun and fireplace

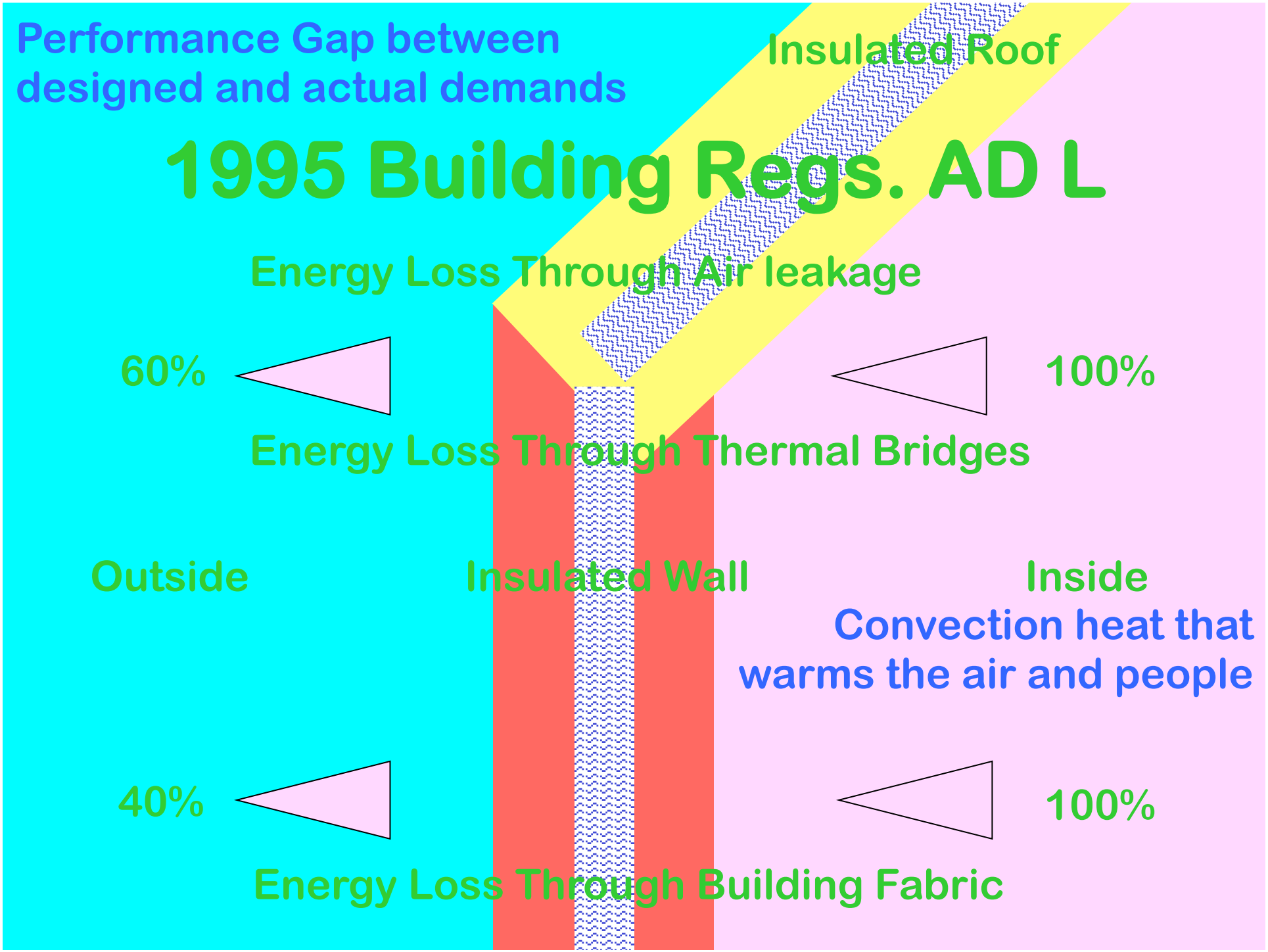
Radiant heat that warms objects and people

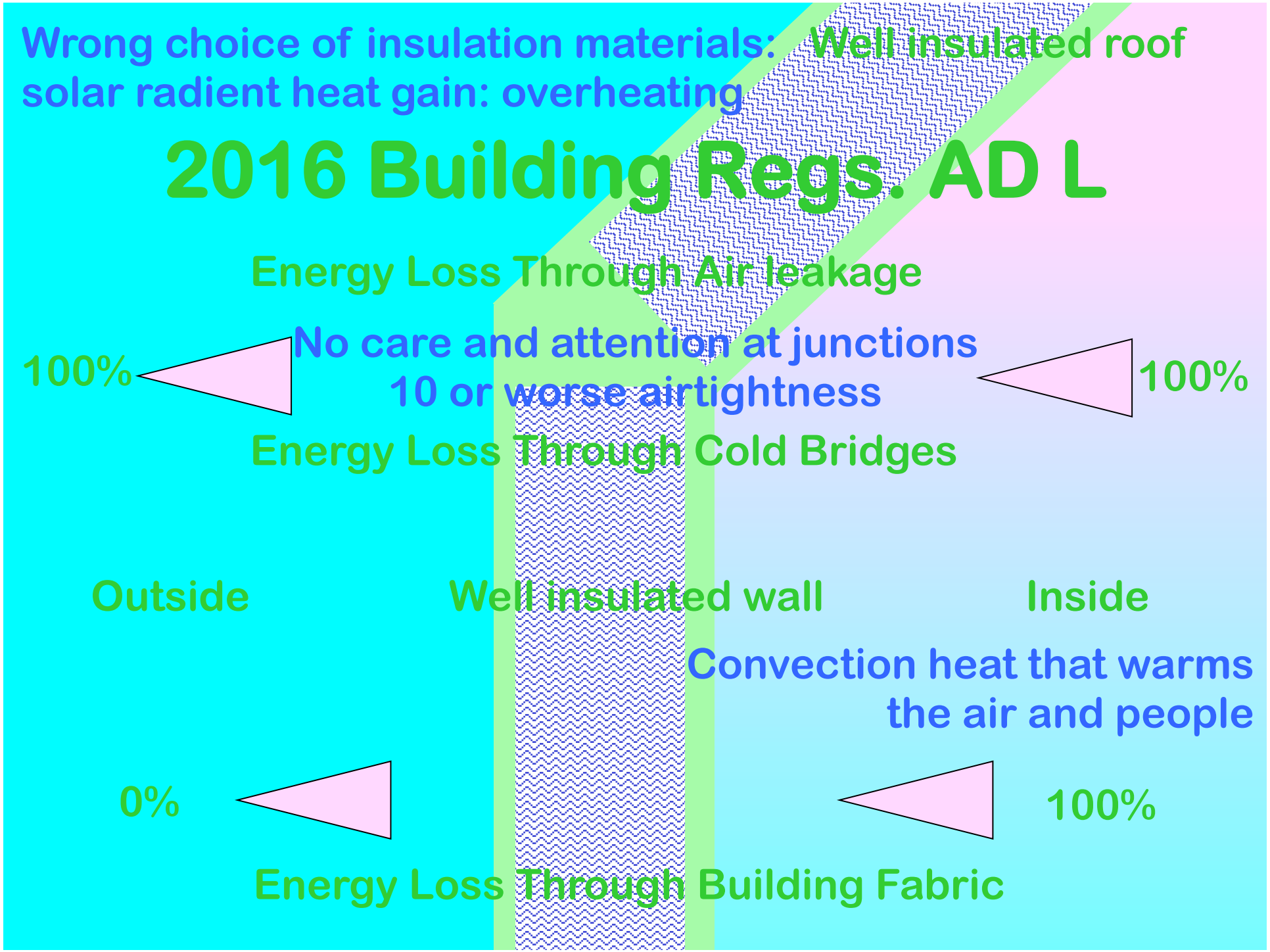
Energy loss through cold bridges

0%

100%

Energy loss through building fabric


Performance Gap between
designed and actual demands
Insulated Roof
1995 Building Regs. AD L
Energy Loss Through Air leakage
60%
100%
Energy Loss Through Thermal Bridges
Outside
Insulated Wall
Inside
Convection heat that
warms the air and people
40%
100%
Energy Loss Through Building Fabric


Wrong choice of insulation materials:
solar radient heat gain: overheating
Well insulated roof
2016 Building Regs. AD L
Energy Loss Through Air leakage
No care and attention at junctions
10 or worse airtightness
100%
100%
Energy Loss Through Cold Bridges
Outside
Well insulated wall
Inside
Convection heat that warms
the air and people
0%
100%
Energy Loss Through Building Fabric


Care and attention at junctions
0.6 or better airtightness
Well insulated roof
2023 Passivhaus & Biobased
Controlled Solar heat gains
add heat energy via windows
White goods and other
equipment add heat energy
Low Energy Loss Through Air leakage
0%
100%
Low Energy Loss Through Cold Bridges
Humans and pets add
100 watts heat energy
Outside
Well insulated wall
Inside
Mechanical Ventilation with 90% heat
recovery and summer bypass
0%
100%
Low Energy Loss Through Building Fabric

CO_2 and Energy demand targets

- **Set out to meet or exceed:**
  - Kyoto, Paris, EU or UK CO_2 targets,
  - or ACAN, LETI, RIBA campaigns (but silos still apply)
- **Do not limit projects to complying with Building Regulations Approved Documents L1A, L1B, L2A, L2B they are not yet aiming to meet any targets**
  - Weak Regulations since 1965 could be blamed for Climate Change
  - but coal, oil and gas are the real culprits
- **EcoHomes & Code for Sustainable Homes**
  - Challenged Building Regulations
  - CfSH strived for Zero Carbon buildings by 2016,
  - Industry responded and invested for one up man ship
    - Lots of bad application and lessons learned
  - but were optional,
  - challenged by profit hungry developers and now no longer available
  - Some T&CP still ask for them

Reduce Your Targets

- Reduce heating, cooling, ventilation and air-conditioning demands towards zero
- Insulation costs less than heating and cooling plant so insulate
- Windows: U value of 1.0 W/m2.K or better targets 0.75 W/m2.K
- Walls: U value of 0.1 W/m2.K or better
- Airtightness: Building Regulations Approved Document L
- less than 1, (0.6 PH) not 10 required by BRADL
- An existing unusable library survey
  - Howling wind through windows
  - Papers fluttering across table
  - Airtightness tested at 8
  - Then reduced to 2 in an hour with smoke wands and tapes

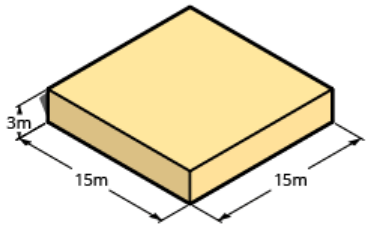
Form Factor

GBC Green Building Calculator

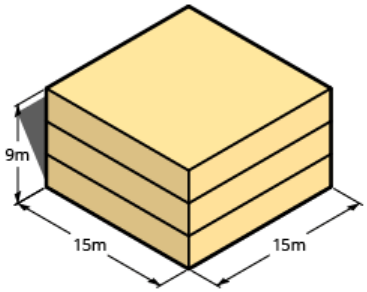
GBE

GRC Green Retrofit Calculator

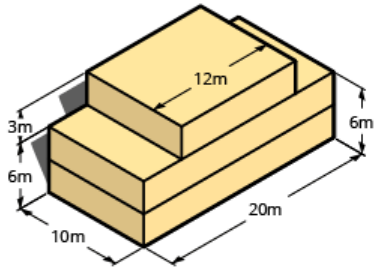
Heat Loss Form Factor and Surface to Volume Examples



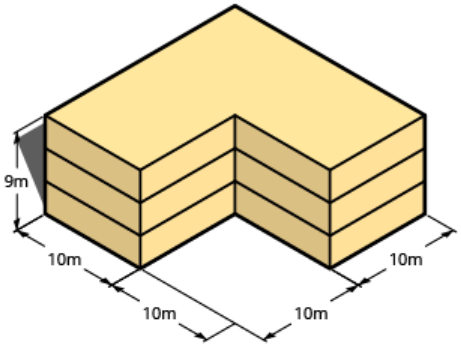
Heated Floor Area (A_{hf})*:	168.75 m²
Envelope Area (A_e):	630 m²
Volume (V):	675 m³
Heat Loss Form Factor(A_e/A_{hf}):	**3.73**
Surface to Volume Ratio(A_e/V):	**0.93 1/m**



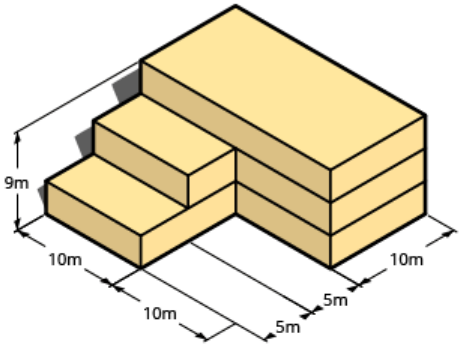
Heated Floor Area (A_{hf})*:	506.25 m²
Envelope Area (A_e):	990 m²
Volume (V):	2,025 m³
Heat Loss Form Factor(A_e/A_{hf}):	**1.96**
Surface to Volume Ratio(A_e/V):	**0.49 1/m**



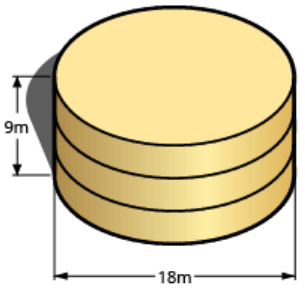
Heated Floor Area (A_{hf})*:	390 m²
Envelope Area (A_e):	892 m²
Volume (V):	1,560 m³
Heat Loss Form Factor(A_e/A_{hf}):	**2.29**
Surface to Volume Ratio(A_e/V):	**0.57 1/m**



Heated Floor Area (A_{hf})*:	675 m²
Envelope Area (A_e):	1,320 m²
Volume (V):	2,700 m³
Heat Loss Form Factor(A_e/A_{hf}):	**1.96**
Surface to Volume Ratio(A_e/V):	**0.49 1/m**



Heated Floor Area (A_{hf})*:	562.5 m²
Envelope Area (A_e):	1,230 m²
Volume (V):	2,250 m³
Heat Loss Form Factor(A_e/A_{hf}):	**2.19**
Surface to Volume Ratio(A_e/V):	**0.55 1/m**



Heated Floor Area (A_{hf})*:	562.5 m²
Envelope Area (A_e):	1,004.65 m²
Volume (V):	2,250 m³
Heat Loss Form Factor(A_e/A_{hf}):	**1.79**
Surface to Volume Ratio(A_e/V):	**0.45 1/m**

*A_{hf} = 75% Gross Floor Area

Form Factor dictates heat loss

- Ratio between external envelop and floor areas
- Spherical is optimum but impractical and costly
- Compact square plans, cubical volumes best
- L, C, O, I, H, T, X shaped plans worse
- Bungalows worse than Apartments
- Villas worse than Terraces
- Bay, Oriel, Dormer, Porch, Extensions, Conservatory, recessed covered walkways: all worse Form Factor
- Towers with multiple occupancy: okay
- Towers with single occupancy: not so good
- Form Factor included in GBC V2

Yes	Yes	Auto-filled	Multiple	Multiple	Multiple	Multiple	Multiple	Multiple	Auto-filled	Auto-filled	Auto-filled			To be completed by GBC user
	User name:	**BrianSpecMan did this**												Auto-filled
	Project name:	**Over type with Project name**												Auto-filled
	Project address:	**Over type with Project address**												Auto-filled
	Building Facility Fuction/Use:	**Over type with Building User Activity or Purpose**												Auto-filled
	Project Brief Employer Requirements or Architect's Proposal													
	Form Factor		No.	No.	m	m	m2	m	m3					
	Building(s)	**Room Functions**	Number of buildings	Number of floors	Length(s)	Width(s)	Floor Area Ceiling Area Roof Area	Room heights	Volumes					
	© GBE Green Building Calculator 2011-2021		1 to 1000	1 to 50	1 to 1000	1 to 1000	1 to 1 million	2.4 to 10	1 to 10 million					
	Whole Building	All rooms	1	4	10	6	240	2.5	600	m3	Volume			Auto-filled
	Terrace(s)	**One or many**	Number of terraces	Number of units in terrace	Depth front to back in terrace	Party wall to party wall	Position of single unit in terrace	Number of party walls	Number of end walls					
	© GBE Green Building Calculator 2011-2021		1 to 1000	1 to 100	1 to 25	1 to 10	N/A, End or Mid							
			3	51	10	6	End	1	1	No.				Auto-filled
			Number of buildings	Number of floors	Length(s)	Width(s)	Floor Area Ceiling Area Roof Area	Room heights						
	External wall		1	4	80	48	1280	2.5						Auto-filled
	Ground floor footprint		1		10	6	60							Auto-filled
	Ground or upper Floor suspended over external air		1	1	10	6	60							Multiple
			Number of buildings	Number of roofs	Length(s)	Width(s)	Roof Area	Roof height	Roof Volume					
Yes	Roof area, Roof shape and Attic volume	22 Flat Roof (FR)	1	1	10	6	60	0.25	0	m3				Multiple
Yes		23 Shallow Roof (SR)	1	1	10	6	60	0.5	15	m3				Multiple
Yes		24 Pitched Roof (PR)	1	1	10	6	60	3	90	m3				Multiple
Yes		25 Barrel Vault Roof (BVR)	1	1	10	6	60	3	283	m3				Multiple
Yes		26 Domed Roof (DR)	1	1	10	6	60	3	113	m3				Multiple
Yes		27 Hipped/Pyramid Roof (HPR)	1	1	10	6	60	3	45	m3				Multiple
Yes		28 Mono-Pitched Roof (MPR)	1	1	10	6	60	3	90	m3				Multiple
Yes		29 Mansard Roof (MR)	1	1	10	6	60	0.25	14	m3				Multiple
Yes		33 Other Geometry Roof (OGR)	1	1	10	6	60	3	121	m3				Multiple
			No.	Number of floors	Depth	Width	Floor/Roof Area	Height	Volume		Heat Loss Surface Area			
	Terraced House Rear Extension		1	1	5	3.5	17.5	2.5	43.75	m3	51	m2		Multiple
	Weather Porch		1	1	2	2	4	3	12	m3	25	m2		Multiple
	Conservatory/Sun Space		1	1	3	5.5	16.5	5	82.5	m3	73.5	m2		Multiple
	Bay window		1	1	1	3	3	2.5	7.5	m3	16.5	m2		Multiple
	Oriel Window (upper floor bay window)		1	1	1	3	3	2.5	7.5	m3	16.5	m2		Multiple
	28-30 Dormer roof/window		1	1	4	5.5	22	2	44	m3	37.5	m2		Multiple
	Heat Loss Surface Area	SA	1				1766	m2	797.25	m3	220	m2		Auto-filled
	Treated Floor Area	TFA	1	4	10	6	240	m2						Auto-filled

Form Factor (FF) range	0	1	2	3	4	5	6	7	8	9	10		
Form Factor (FF) =	SA/TFA					8.28	Used by Zero Carbon Hub's Designer's Manual						Auto-filled
	Typology/Shape ology					FF		Target U values	Y/N	Unit			
Target Form Factor FF	Apartment Block or uniform terrace					<2	1	0.2 to 0.15	N	W/m2.K	4		Auto-filled
	Semi-detached or compact detached houses					2 to 3	2	0.15 to 0.12	N	W/m2.K	3		Auto-filled
	Less compact detached houses or compact detached bungalows					3 to 4	3	0.12 to 0.10	N	W/m2.K	2		Auto-filled
	Complex shaped detached bungalows					>4	4	<0.1	Y	W/m2.K	1		Auto-filled

	Passivhaus Heat Loss Factor (HLF)	0.7	1.1	1.5	2	2.4	2.8	3	3.3	3.7	4	4.5	No.
0.038	Stone wool insulation (mm)	70	110	150	200	240	280	300	330	370	400	450	mm
K value	Equals U values of:	0.54	0.35	0.25	0.19	0.16	0.14	0.13	0.12	0.10	0.10	0.08	U
0.04	Lightweight Expanded Sewage Aggregate	116	158	211	253	295	316	347	347	389	421	474	mm
		Rule of thumb: Halve the heat loss area, halve the insulation thickness											

Surface to Volume Ratio	0.6	1	1.5	2	2.5	3.5	5		
Surface to Volume Ratio	SA/V	This row feels unreliable at the moment, needs more research				2.49	Used by AECB, CarbonLite and PassivhausUK columns in worksheet 'U values Etc'.		

Project Size: If areas vary between floors and/or if rooms need different temperatures go to 'ScheduleAccommodation: Floors and Rooms'

Auto-filled Auto-filled Auto-filled Auto-filled Auto-filled Auto-filled Auto-filled Hide Hide Review

Form Factor suggests Targets

- With a Form Factor Calculator
- You can determine U value Targets
- That are more important than BRADL
- A large form factor will always use more energy to heat or cool
- So U value should be correspondingly more onerous
- or it will be expensive to occupy

GBC
Green Building Calculator

GBE

GRC
Green Retrofit Calculator

Changes of Direction/Plain

- Junctions between elements
- Corners between walls
- Angles between planes
- Are all costly:
  - Are all more labour intensive
  - All generate offcut waste
    - (in factory, on site or both)
  - Are often thermal bridges that loose heat
  - Are often air leaky where heat is also lost

Orientation

GBC Green Building Calculator https://GreenBuildingCalculator.uk

GBE https://GreenBuildingEncyclopaedia.uk

GRC Green Retrofit Calculator https://GreenBuildingCalculator.uk

Orientation of what?

- Building orientation: can influence building performance
  - Plan shape and orientation
    - Area of external opaque surfaces facing sun,
    - Pitched roofs in particular (potential overheating),
  - Volumetric shape (form factor)
- Windows, Glazing: solar heat gain
  - South: needs shading in summer, solar access in winter
  - East & West: Morning and evening heat gains at low angles
  - North: heat free daylight, but heat loss too
- Roofs: facing the sun at different times of day
  - For Renewable energy systems
  - Use PV on more roof orientations to match energy supply to energy demand over longer period of day,
  - Do not maximise battery capacity for mid day only gains
  - Not just south facing and not just at 30 degree pitch
  - Vertical in winter (Bill Dunster at FutureBuild 2023)
  - Potential to overheat attic and top floors

Really want this?

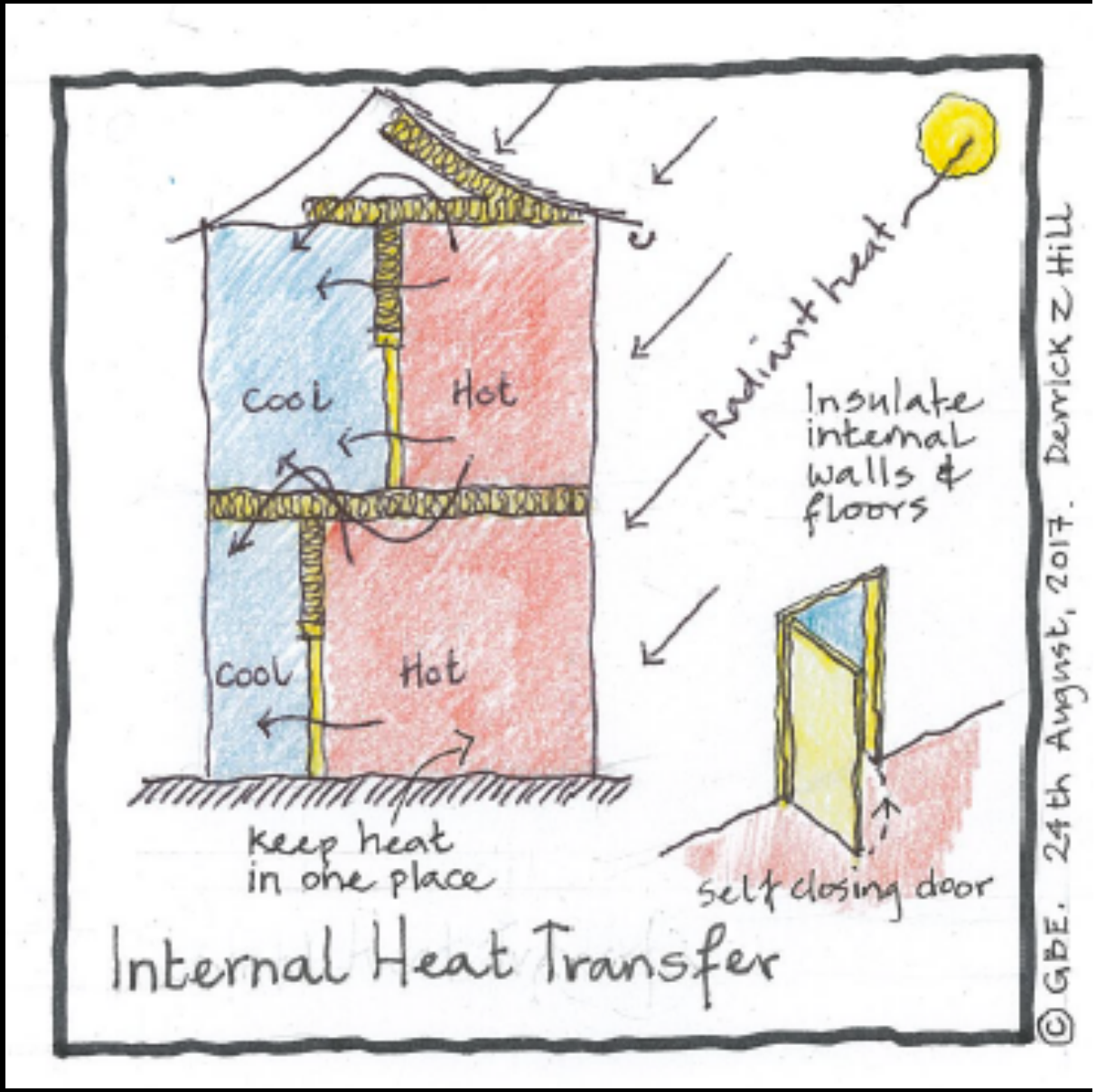
- Form Factor: So high
- South facing?: No shading
- 6 bathrooms: Who's cleaning them?
- £100,000: to pay for:
  - summer air conditioning
  - winter heating bills
  - House maid

Orientation

- Solar heat gains can be beneficial in winter if exploited well
- Solar heat gains can be detrimental in summer due to overheating
- Opaque building fabric needs thermal mass OR
- Insulation material choice will exacerbate or solve overheating

Internal Heat Transfer

- Keep heat in its place of arrival
- Maintain safe refuge on the cooler side
- Insulate internal floors and partitions
- Self closing doors
- Promoted by BedZED
- Rotate around rooms of the house to stay cool



GBC Green Building Calculator
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Thermal Bridges
Geometry dictates
& Material choices

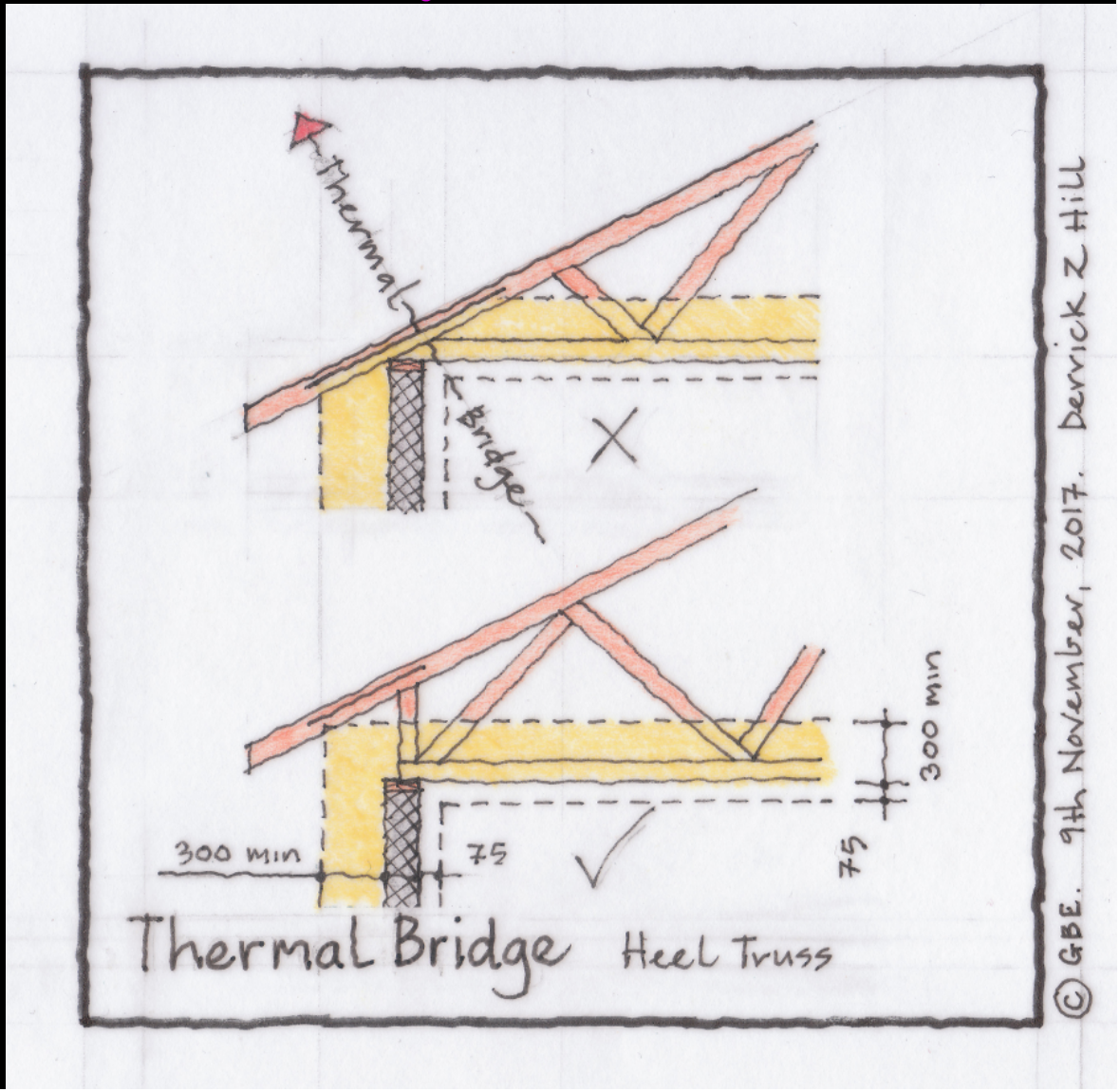
Thermal bridges will ruin any choice of insulation material performance

Thermal bridges will let conducted heat out, conducted coolth in and solar radiant heat in

Eaves details are most vulnerable

300 mm of insulation reduced to 50 mm is asking for trouble

Risking interstitial condensation, surface condensation, mould, structural failure, asthma, toxic mould and death



Thermal Breaks

High Density Expanded Polystyrene

- Strong enough for nails and screws
- For securing windows, doors, etc.
- Embedded in walls
- Moisture tolerant
- Thermal insulation but poorer k value

Thermal Bypass & Wind Washing

- Wind washing at eaves
- Essential eaves ventilation to prevent condensation
- Cold air from eaves ventilation can blow the warmth out of the ceiling insulation
- Install a wind baffle to maintain ventilation route past the insulation edge

Thickness

Carbon and Energy Reduction

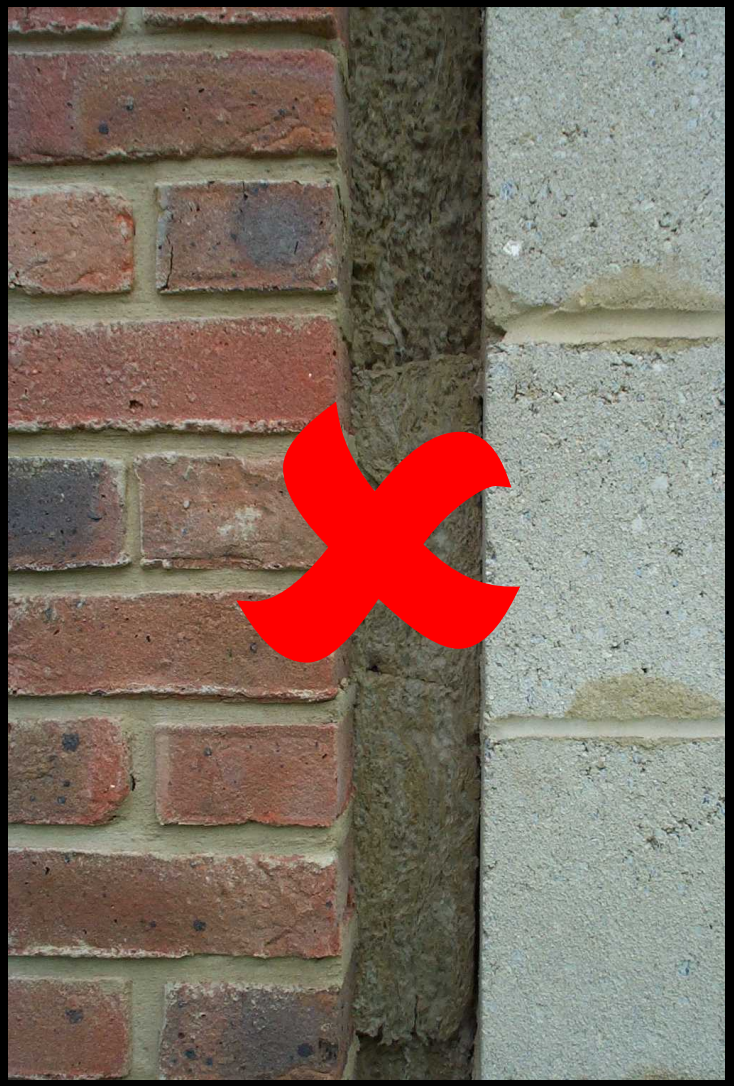
Insulation thicknesses required to achieve a U-value of 0.2W/m²k

235mm	Cellulose fibre
220mm	Glass wool fibre
210mm	Rock wool fibre
190mm	Extruded polystyrene foam
185mm	Polyurethane foam with CO_2
180mm	Expanded polystyrene
150mm	Polyurethane foam with pentane
135mm	Phenolic foam
130mm	Polyisocyanurate foam
120mm	Phenolic foam with foil face
95mm	Polyisocyanurate foam with foil face
75mm	Aerogel blanket
25mm	Vacuum insulation

50 mm. cavity
is history

300 – 600 mm.
is optimum

Ties and
tie spacing
may change



BedZED Beddington Sutton Architect: Bill Dunster

Zero Fossil Fuel Energy Development

High thermal mass cavity walls, roofs and floors

Low U values
300 mm.
Rock Mineral Fibre
Long 2 part cavity ties

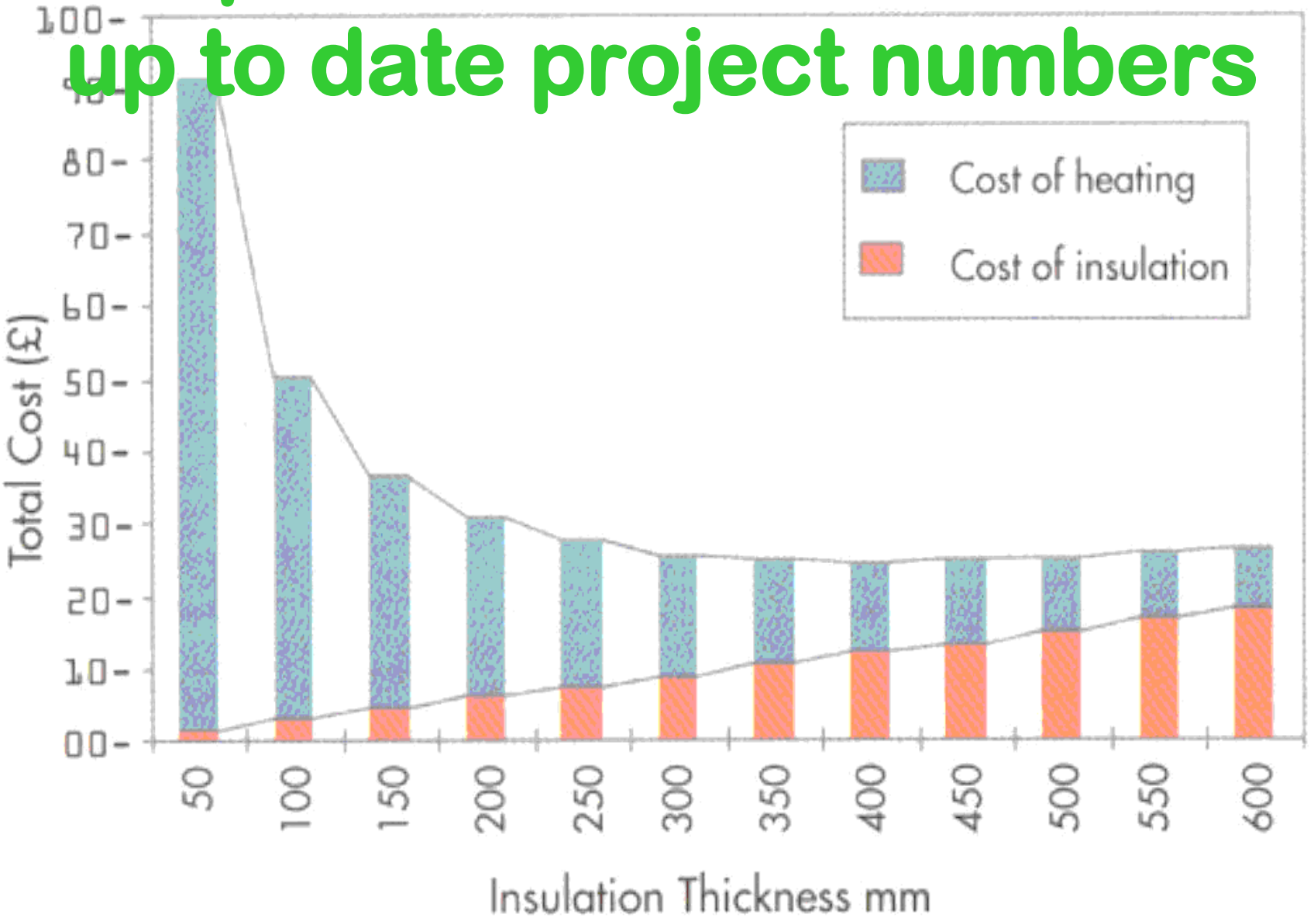
BedZED Beddington Sutton Architect: Bill Dunster

Long ties and deep reveals
For 300 mm. insulation

Insulation, Insulation, Insulation

- Spend money on insulation, its cheap
- Save money on heating and cooling plant, it's expensive, reduce plant room sizes
- Save money on heating and cooling bills
- it will get more expensive over time
- Peak oil has been passed
- Prices have been rising
- Government will not intervene

Principle still true could do with up to date project numbers

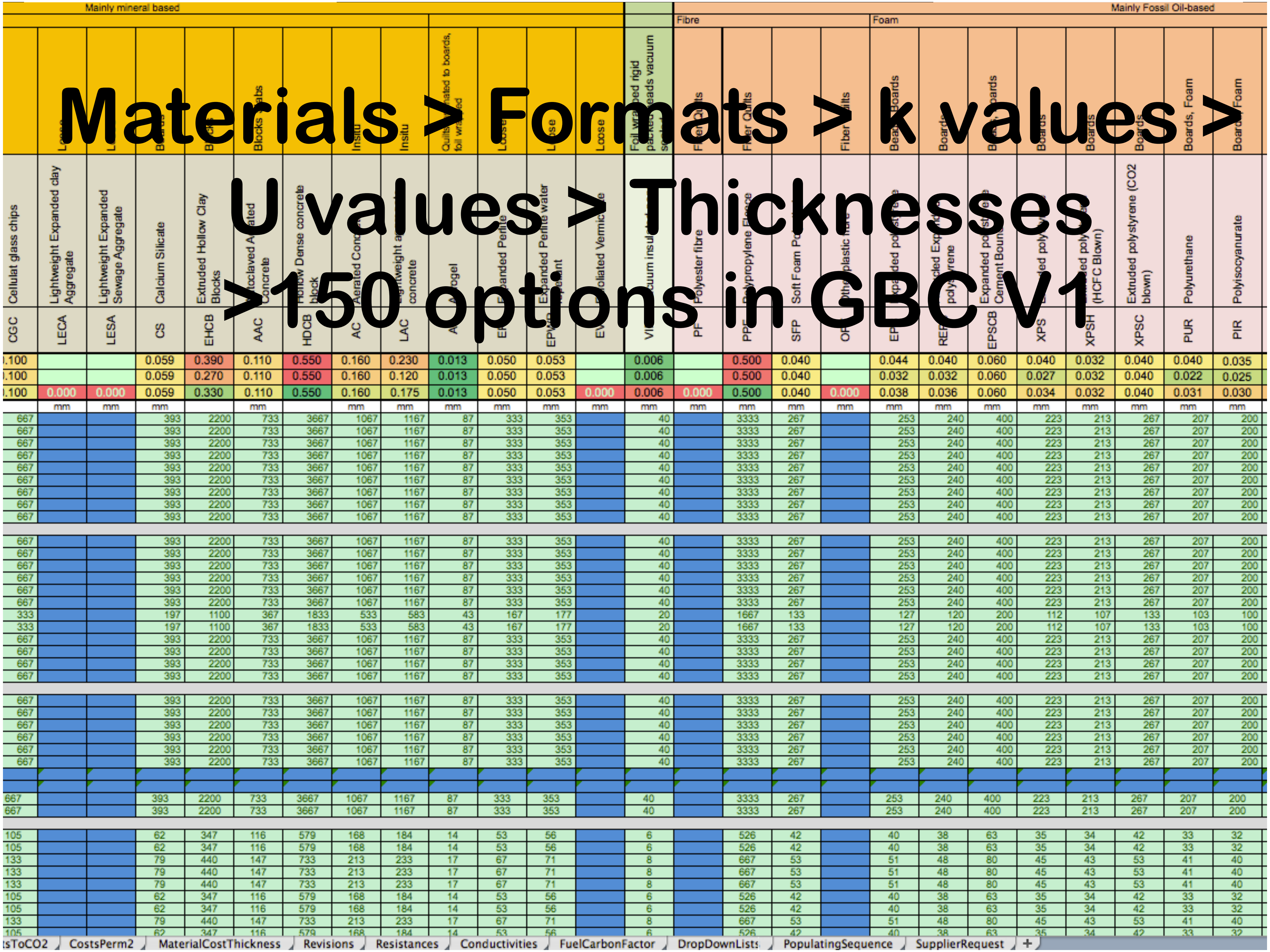


Materials > Formats > k values > U values > Thicknesses >150 options in GBC V1

Chosen column:	AB	Group		Mainly mineral based															
		Form		Fibre					Foam										
		Format																Insitu	Insitu
		Material		Glass M… Wool	Stone M… Wool	Blast Fu… ag wool	Asbestos fibre… es its used in easte… pe)	Ceramic… no longer available in UK/EU market)	Cellular glass	Cellular g… Recycled Glass balls	Cellulat… ass chip	Lightwei… Aggrega…	Lightweight Expanded Sewage aggrega…	Calcium Silicate	Extrude… llow Clay Blocks	Autoclaved Aer… Concrete	Hollow Dense concrete block	Aerated Concrete	Lightweight aggregate concrete
		Initials		GMW	SMW	BFSW	AF	CF	CG	CGB	CGC	LECA	LESA	CS	EHCB	AAC	HDCB	AC	LAC
	k values	Worst	W/m.K	0.045	0.045	0.040	Don't	Don't	0.060	0.060	0.100			0.059	0.390	0.110	0.550	0.160	0.230
	k values	Best	W/m.K	0.031	0.031	0.031	Use	Use	0.037	0.039	0.100			0.059	0.270	0.110	0.550	0.160	0.120
	k values	Average	W/m.K	0.038	0.038	0.036	It	It	0.049	0.050	0.100	0.000	0.000	0.059	0.330	0.110	0.550	0.160	0.175
Floor	© GBE Calculator 2018	U values	W/m2.K	mm	mm	mm	mm		mm	mm		mm	mm	mm		mm		mm	mm
Yes	Basement Floor	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Yes	Swimming Pool Basin	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Yes	Upper floors (including ground floor over basement)	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Yes	Ground floor over ground	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Yes	Ground floor over ventilated void	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Yes	Floor with underfloor heating	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Yes	External floor over air	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Yes	Compartment Floor	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Yes	Party Floor	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Walls		0.00																	
Yes	Basement Perimeter Wall	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Yes	Basement internal Wall/Partitions	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Yes	External wall	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
No	External wall Insulated Cavity	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
No	External wall Solid wall insulated (Int or Ext)	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Yes	Internal partition/wall	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Yes	Compartment Wall	0.30	W/m2.K	127	127	118			162	165	333			197	1100	367	1833	533	583
Yes	Party Wall	0.30	W/m2.K	127	127	118			162	165	333			197	1100	367	1833	533	583
No	Solid Wall	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
No	Unfilled cavity unsealed edges	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
No	Unfilled cavity sealed edges thermal breaks	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
No	Filled cavity sealed edges thermal breaks	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Roof	Roofs (includes opaque parts of dormers)	0.00																	
Yes	Flat roof	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Yes	Shallow roof	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Yes	Pitched roof (insulation at rafter)	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Yes	Loft ceiling (insulation at ceiling)	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Yes	Barrel Vault roof	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Yes	Domed Roof	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Yes	Eaves overhang	Unregulated	W/m2.K																
Yes	Verge overhang	Unregulated	W/m2.K																
Yes	Basement roof at site level	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Yes	Basement roof at subterranean level	0.15	W/m2.K	253	253	237			323	330	667			393	2200	733	3667	1067	1167
Glazing	Glazing (Maximum % of total area)	0.00	%																
Yes	Windows (whole window value)	0.95	W/m2.K	40	40	37			51	52	105			62	347	116	579	168	184
Yes	Glazed Pedestrian Doors	0.95	W/m2.K	40	40	37			51	52	105			62	347	116	579	168	184
Yes	Vehichle access and similar large doors	0.75	W/m2.K	51	51	47			65	66	133			79	440	147	733	213	233
Yes	High usage entrance doors	0.75	W/m2.K	51	51	47			65	66	133			79	440	147	733	213	233
Yes	Opaque Door	0.75	W/m2.K	51	51	47			65	66	133			79	440	147	733	213	233
Yes	Rooflights	0.95	W/m2.K	40	40	37			51	52	105			62	347	116	579	168	184
Yes	Roof windows	0.95	W/m2.K	40	40	37			51	52	105			62	347	116	579	168	184
Yes	Roof ventilation including smoke vents	0.75	W/m2.K	51	51	47			65	66	133			79	440	147	733	213	233
Yes	Glazed roof	0.95	W/m2.K	40	40	37			51	52	105			62	347	116	579	168	184

Instructions | ScheduleAccommodation | BuildingAreas | U values Etc | Insulation | Legend | Elements | UToWattsToCO2 | CostsPerm2 | MaterialCostThickness | Revisions | Resistances

Materials > Formats > k values > U values > Thicknesses >150 options in GBC V1



Thick walls, roofs and floors

We have a preoccupation with thin walls 300 mm. or less
Which drives the demand for energy intensive man-made petrochemical fossil derived CFC HCFC HFC HFA foamed plastic
O_3 Ozone Depletion
Greenhouse Gas Potential
300-400 mm. optimum insulation thickness (details)
Avoid problems

Construction Resources Showrooms Southwark London

Construction Resources

Showroom Tour 1:1 Section models

Thermal & Acoustic Insulation
Different eras and climate zones
Another CPD seminar

Wildlife Action

Inhabitation

- Rats, mice, birds, bats enter buildings for warmth, dryness, gnawing food, breeding and sleeping
- Rodents teeth grow continuously, they gnaw materials to keep them short, anything will be tried including timber structure, cables, insulation and membranes
- Insulation is good bedding material

Wildlife Action

- Extruded and expanded polystyrene and even high-density mineral fibre are very seriously attacked by "wildlife".
- That's another mechanism by which you can lose most of the r-value of your insulation.
- None of them appear suitable for use in ground contact as was being recommended just a decade or two ago in Sweden, USA and elsewhere.

Hygroscopic v Hydrophobic

Moisture and its effect on performance

Hydrophobic Insulation in masonry

- Glass and rock mineral wool thermal and acoustic insulation
- If used in wet construction e.g. masonry cavity wall the moisture content of the wall is expected to be 3% MC
- Rainwater can pour down the inside face of the external leaf
- Hydrophobic materials in these conditions will absorb moisture in the surface
- The water will occupy the air spaces and prevent the insulation from acting as insulation
- Its performance drops off unless it can lose the water
- High resin content can offer some resistance to water uptake
- Fibre orientation or disorientation can discourage capillary attraction into the depth of the insulation
- Allegedly the insulation keeps the moisture close to the exposed surface and little of the insulation' s thickness loses performance

Hydrophobic Insulation in timber frame

- Glass and rock mineral wool thermal and acoustic insulation
- If used in dry construction e.g. timber frame wall the moisture content of the wall is expected to be low
- However compromised vapour barriers (VB) are only a Vapour check (VC) and some moisture will enter the construction
- Hydrophobic materials in these conditions will adsorb moist air and water
- The moisture will occupy the air spaces and prevent the insulation from acting as insulation
- Its performance drops off unless it can loose the moisture
- High resin content and non absorbent materials offer resistance to moisture uptake into the fibre so it remains in the airspaces.
- 1:5 ratio is critical to the moisture passing through driven by warm air
- If the insulation holds the water it can hold the water against timber sections
- Timber sections kept wet will rot

Hygroscopic Insulation

- Any natural plant based material: hemp, straw, flax, coconut husk, cellulose, sheep's wool, grass, etc.
- Air trapped in material is what makes insulation work
- Water does not work in the same way
- Moisture laden air or interstitial condensation occupies the space that air would
- Stops hydrophobic insulation from insulating
- Hygroscopic insulation absorbs the moisture into the fibre leaving the air spaces to insulate
- Releases the moisture when conditions are right and it leaves the construction and building

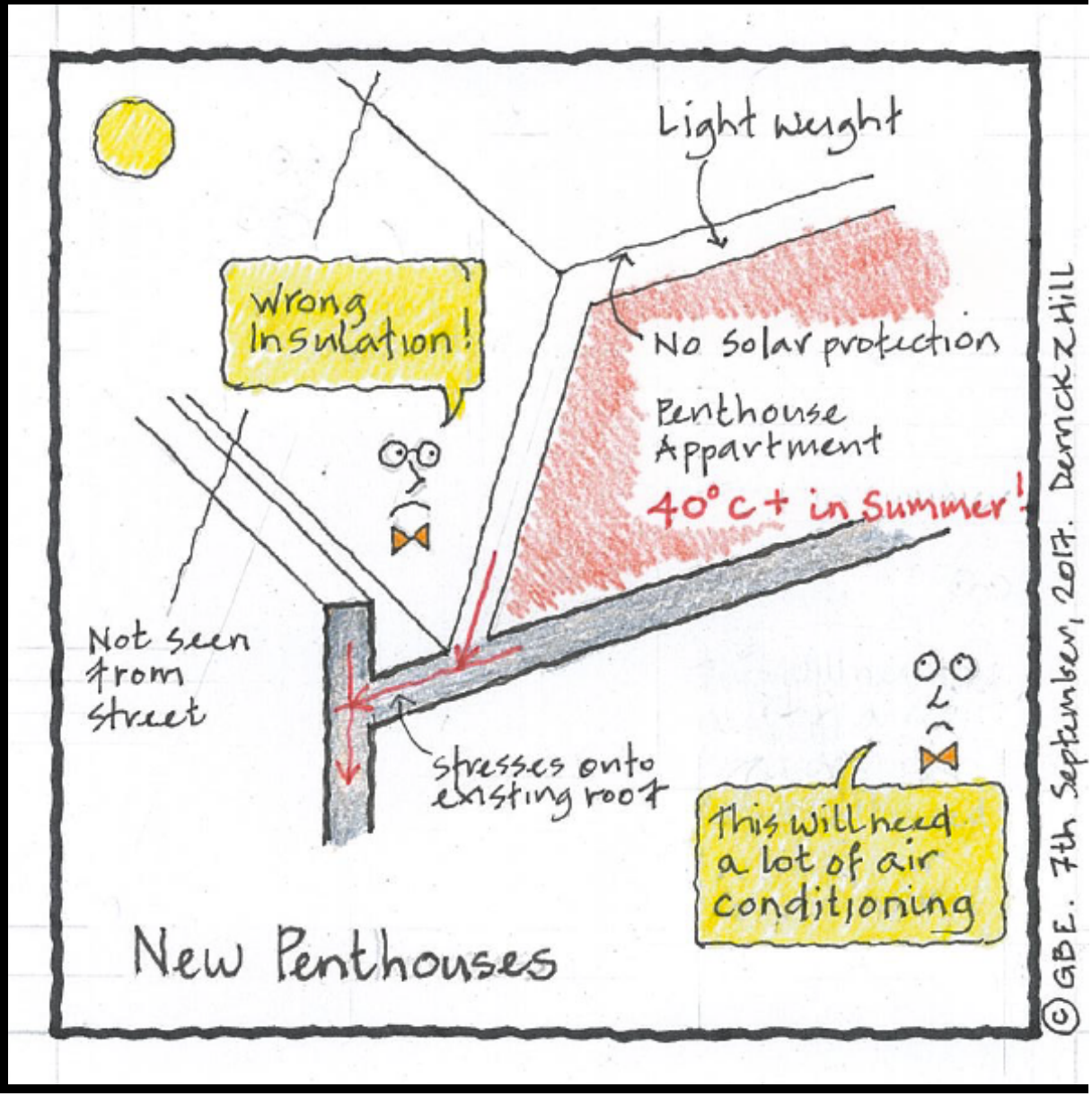
Hygroscopic Thermal Insulation

Newspaper
Flax
Hemp
Sheep's wool
Cellulose

Decrement Delay Thermal Lag

Roof Top Extensions

- Planners insist on top floor additions set-back
- Structure needs lightweight construction
- Comes with with wrong insulation
- Will overheat
- Needs air-con



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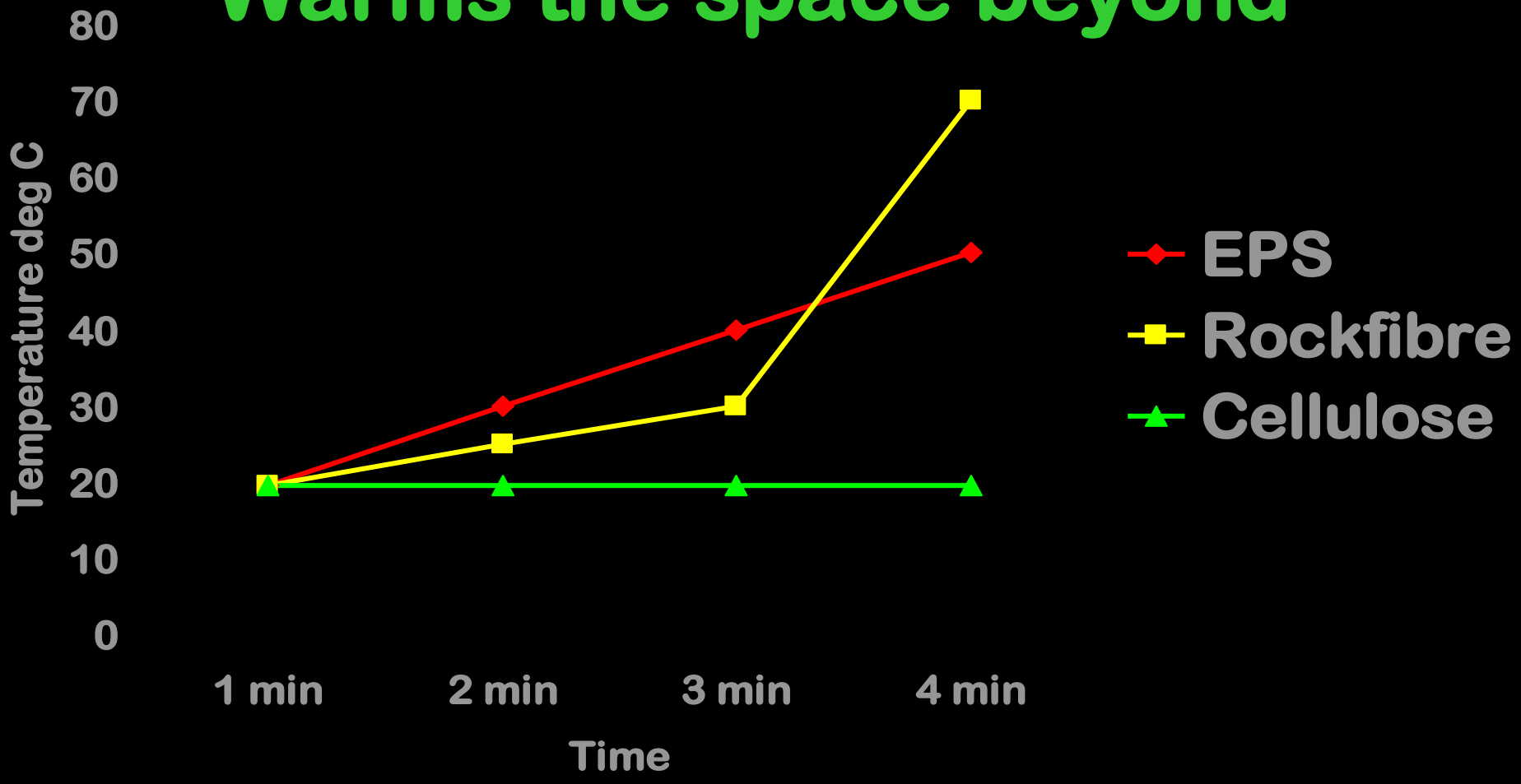
Radiant heat through 50 mm. of thermal insulation types over time Warms the space beyond



Construction Resources Showrooms Southwark London

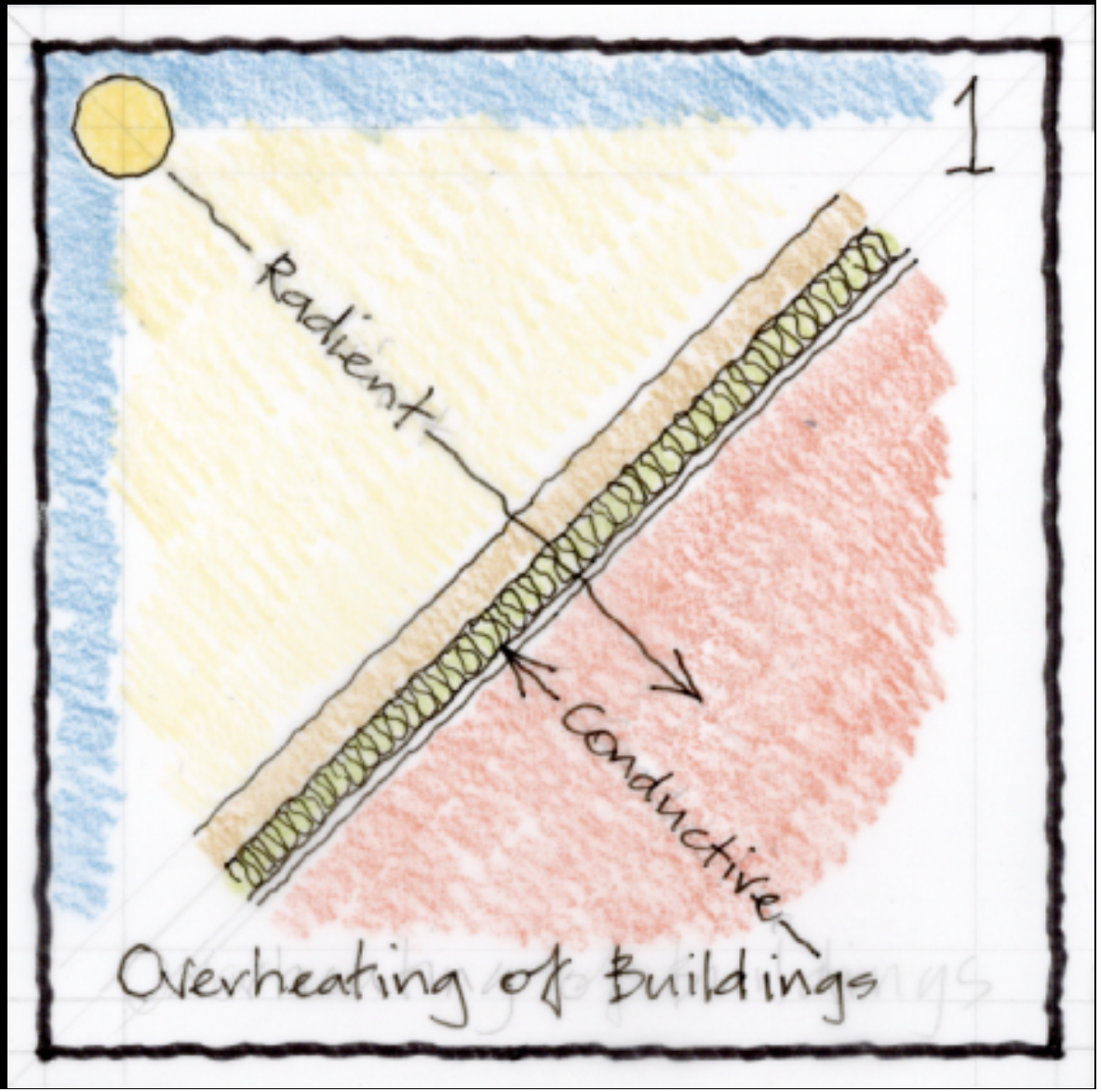
GBC Green Building Calculator https://GreenBuildingCalculator.uk

GBE https://GreenBuildingEncyclopaedia.uk

GRC Green Retrofit Calculator https://GreenBuildingCalculator.uk

Radiant verses Conductive heat flows

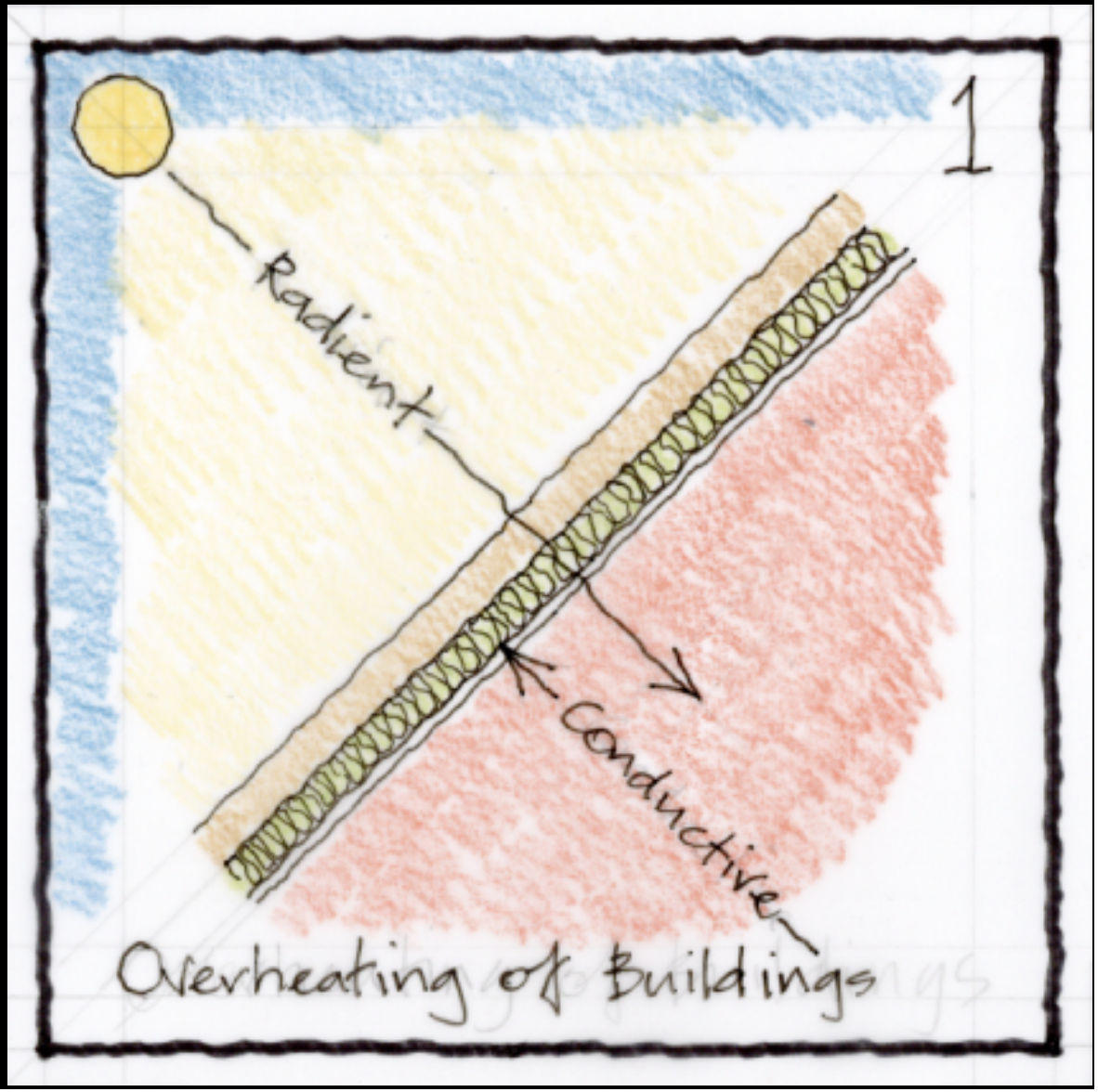
Insulation needs to resist both or overheating occurs



Radiant v Conductive

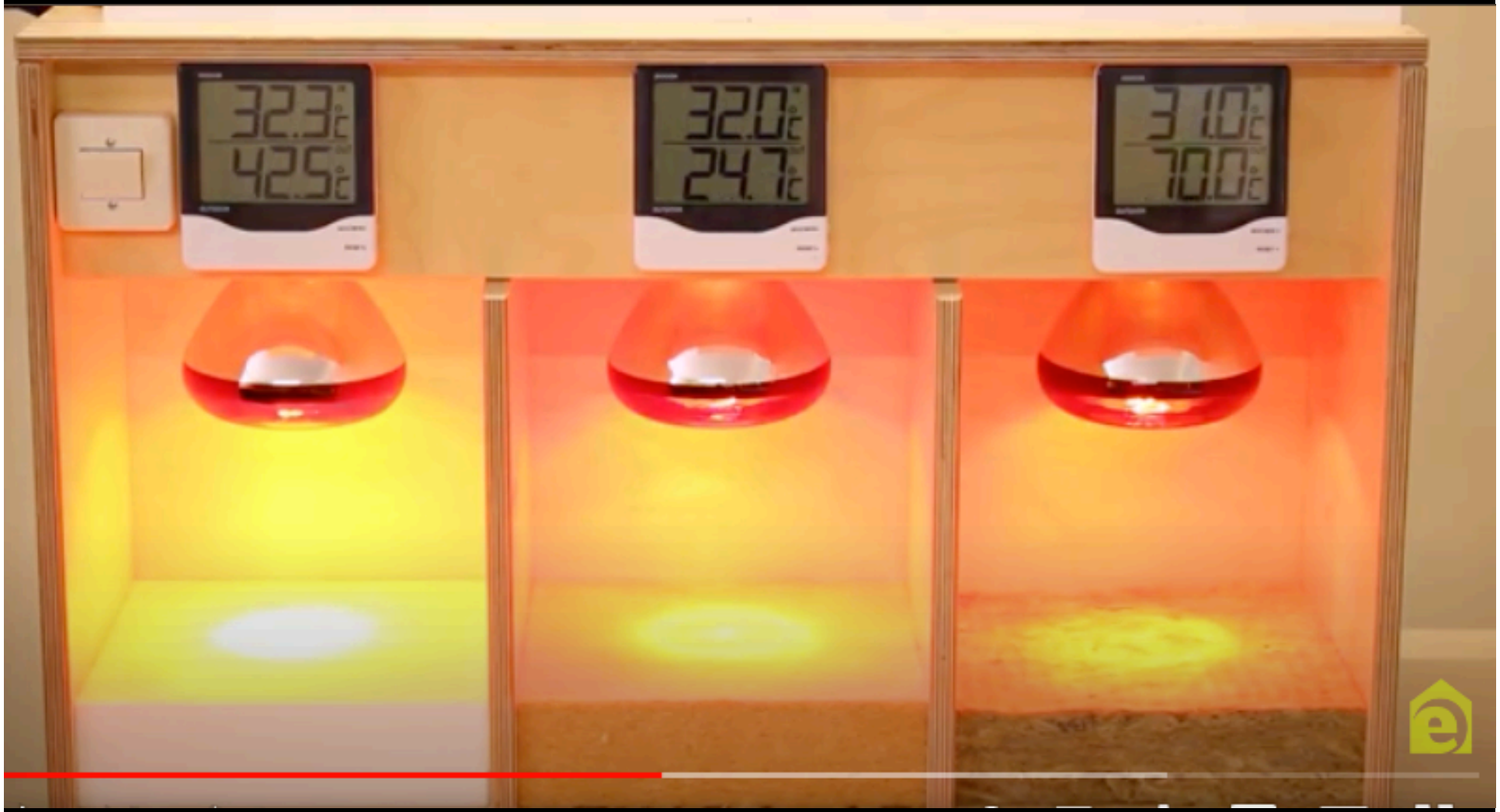
Thermal Insulation:

Once radiant heat gets in it warms the space and the warmth cannot get out through conductivity insulation



Radiant v Conductive

- UK Government funded insulation programmes
- Refurbishment and retrofit
- Cavity insulation
- Attic insulation
- Cheap materials: glass and stone wool or polystyrene: all conductive insulation
- Will overheat top floors


32.3
42.5
32.0
24.7
31.0
70.0

- The insulation heats up with solar radiant heat
- The insulation delays the passage of solar radiant heat through thickness of insulation
- British Library Euston saw asphalt roofing laid on Foamglas on concrete, heat bounced back and kept asphalt warm, not setting and running down slope, pushed back by installer until cool enough to set
- Uninsulated concrete would soak up the heat and the asphalt set quickly

Building Integrated Renewables

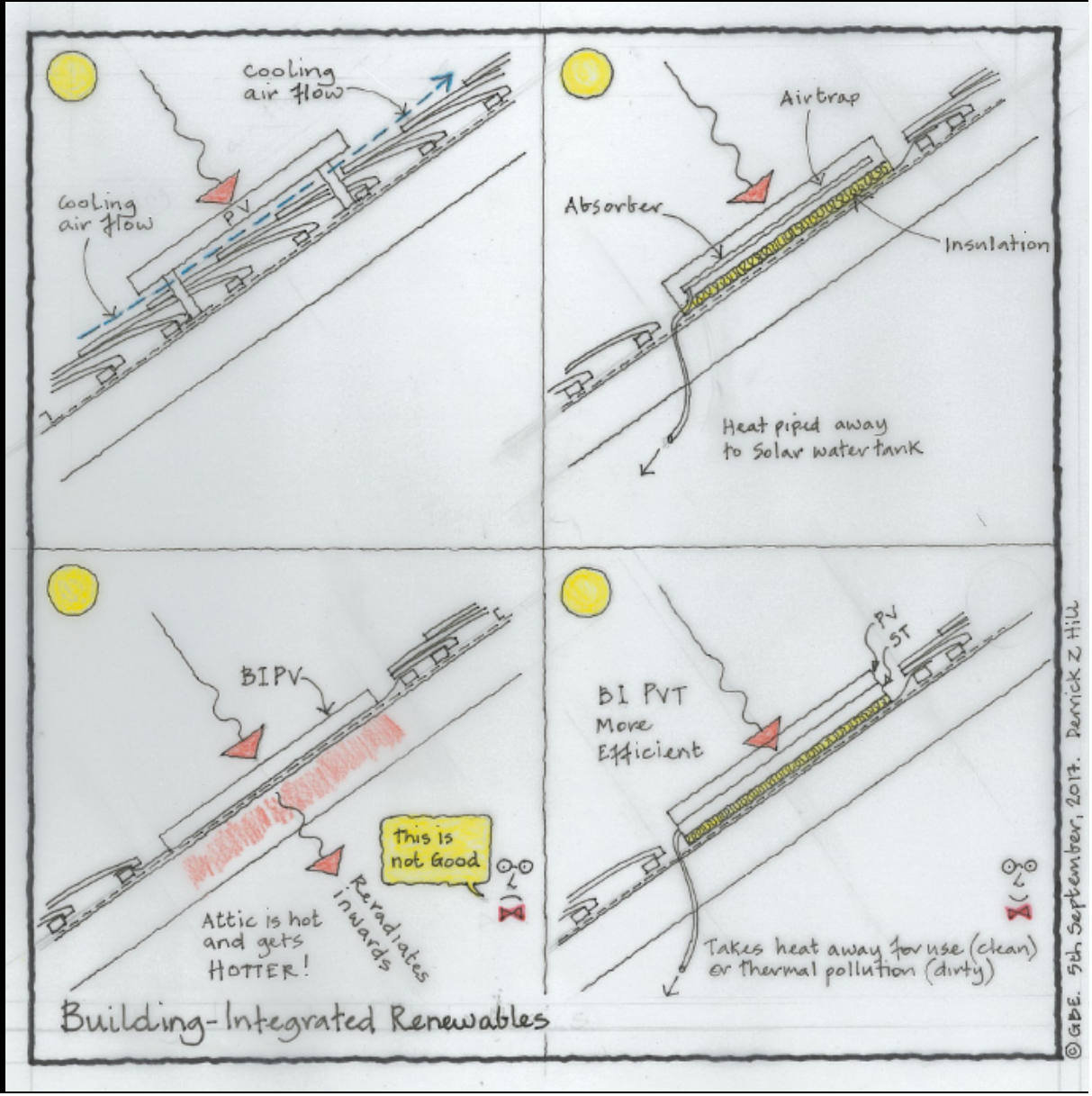
Building Integrated Renewables

Is it really a good idea?

I don't think so

Non-BIR ventilate below and PVs perform better

BIR PV radiate below into a hot attic



Decrement Delay Equation GBE Green Building Calculator Will be added GBC V3?

Decrement delay FU : to give a decrement delay (d) of X hours (defined by the user) for 1 m² surface

Property 2: Decrement delay (d), Approach a: Specific Heat Value = Wh/kg.K								
Needed data			DL	Design Life of Building	50	Years	Default	Choose this method not the next one
Needed data			CLE	Component Life Expectancy/Replacement period	50	Years	Default or PDS	
Needed data				Material				
Needed data		1	e	thickness of material layer	0.3		PDS	
Needed data		2	ρ	Rhô (volumic mass) [density]	700		PDS	
Default data		3	S	surface area of wall considered	1		Default	
Needed data		4	λ	thermal conductivity	1		PDS	Be careful with units
Needed data (option 1)		6	c	Specific heat value	0.58	Wh/kg.K	PDS	See Converter if units are: J.kg/K
Defined by User		7	d	Decrement delay (Hours)	12		LookUpTable	Could this be LUT/DDL with options?
Formulas	d=1,38*e*√1/a		d	Decrement delay (Hours)				
Formulas	a=λ/p*C		a	diffusivity				
Formulas	e=d/1.38*v(p*C/λ)		e	thickness of material layer				
Formulas	Q=e*S*ρ		Q	Quantity				
Calculation	Q=(d/1.38*v(p*C/λ))*S*p*(DL/CLE)		Q	Quantity			Calculated	

Input from:	Product Data Sheets		Result
Specific Heat Value from	J/kg.K	to	Wh/kg.K
2100			0.583333333

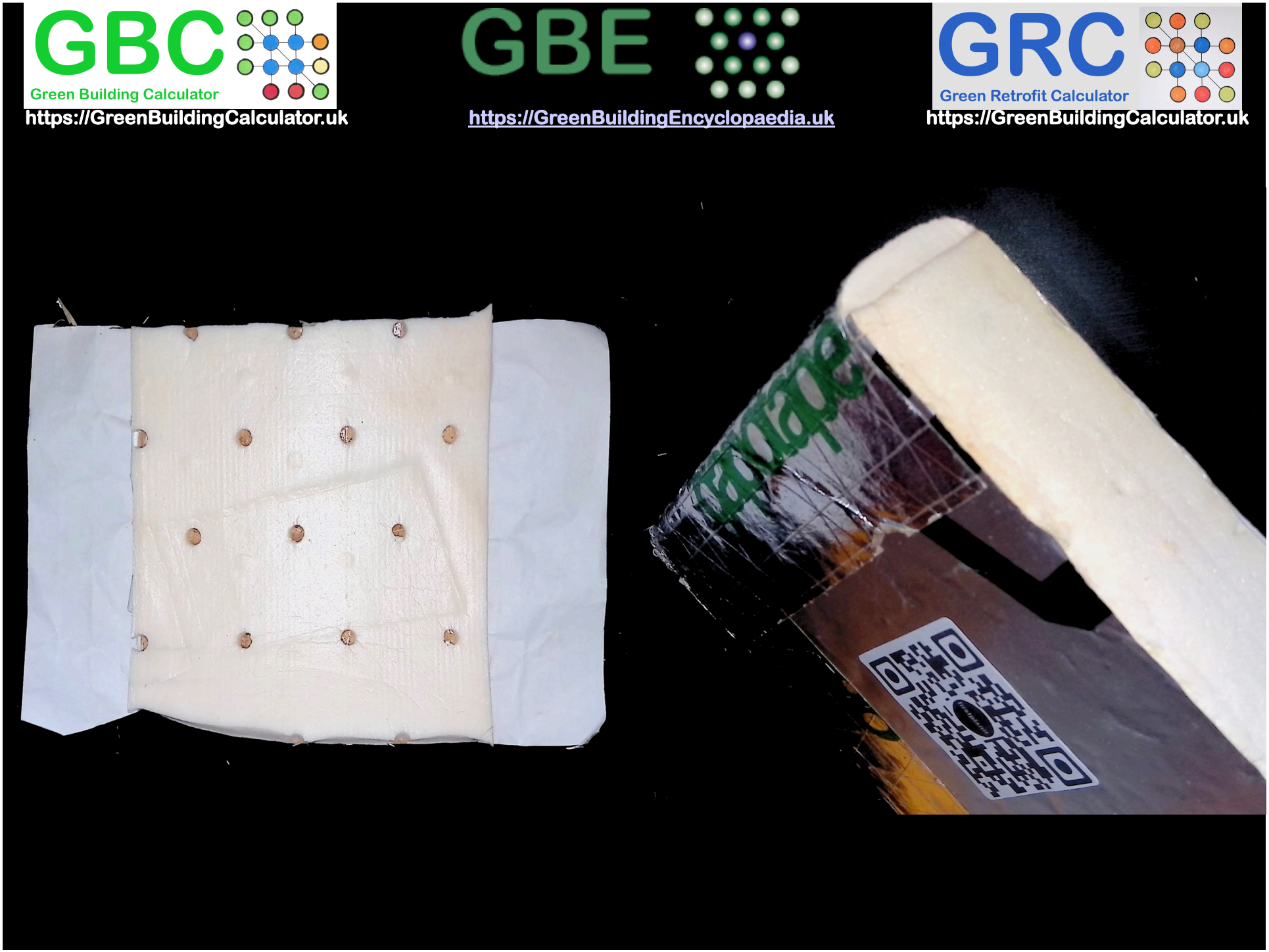
Acoustic Insulation

P10 Insulation

Sheep's Wool Acoustic Isolation

- Used within floor finish build up
- Isolate hard top surfaces from sub-construction
- Footfall should not transfer noises to sub-floor

Airtightness Accessories



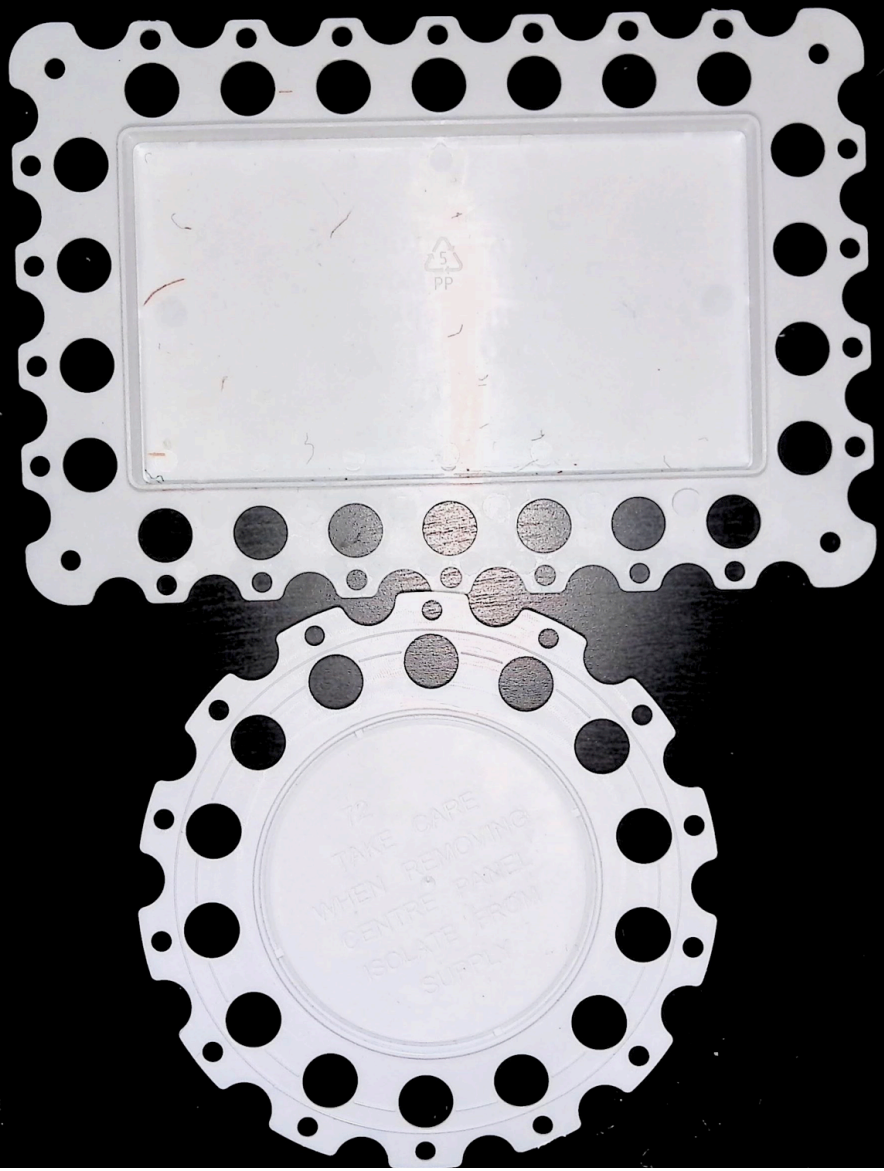
GBC Green Building Calculator https://GreenBuildingCalculator.uk

GBE https://GreenBuildingEncyclopaedia.uk

GRC Green Retrofit Calculator https://GreenBuildingCalculator.uk

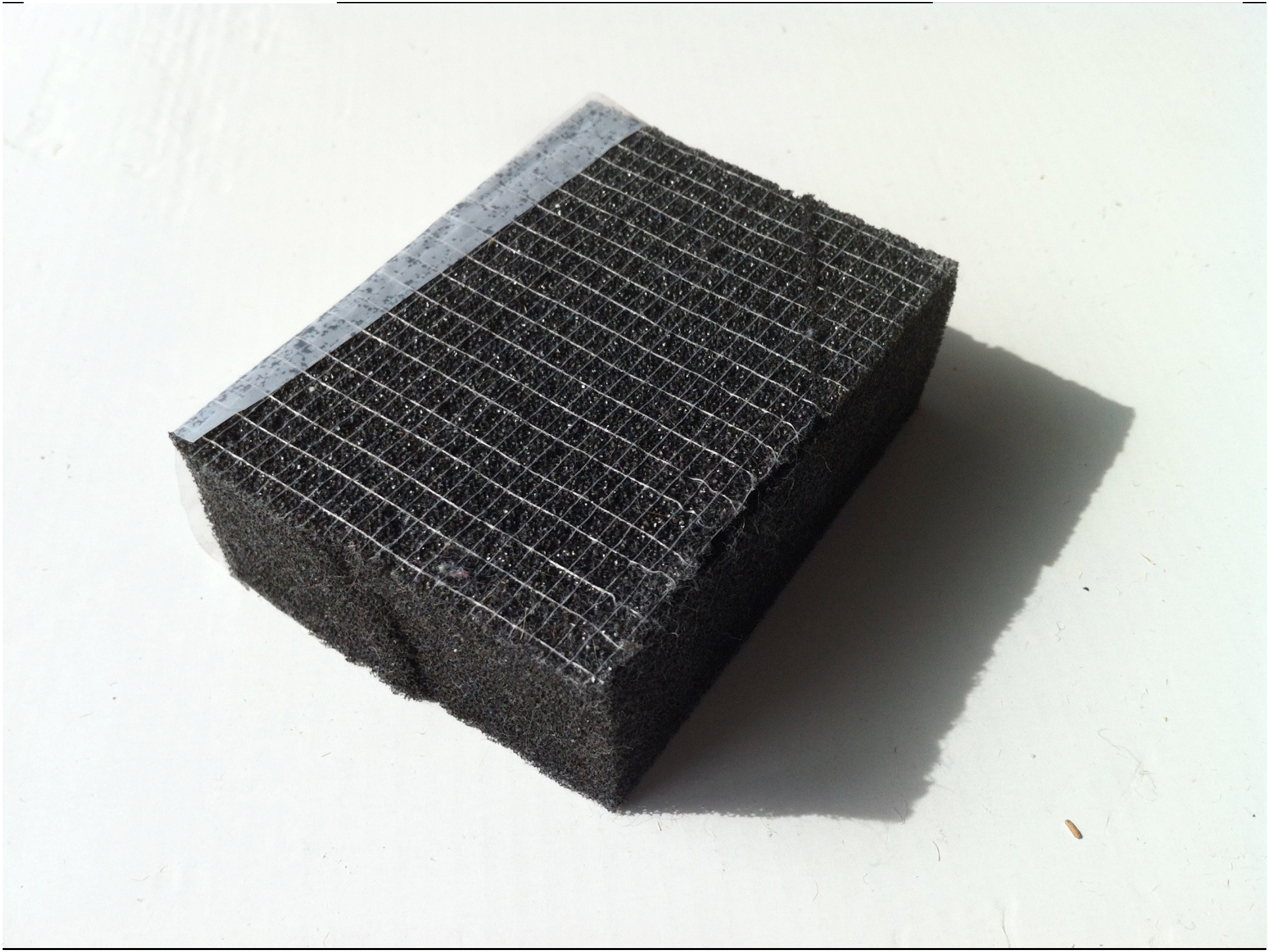
Building Regulations AD L update

- Inaccurate fit rigid insulation (expanded plastic/foil face)
  - Heat loss in winter
  - Heat gain in summer
  - Coolth loss in summer
  - Cold gain in winter
  - Higher than necessary energy demand
    - And carbon from that fuel
  - Interstitial condensation risk
    - Mould risk
    - Rot and Structural failure risk
- The only practical competent solution: GapOTape
  - Self adhesive compressible insulation
  - Bonded to edge of rigid insulation boards
  - Squeeze into framing zone
  - Airtight but forces all moisture through timber framing



Building Regulations AD L Airtightness

- Inaccurate fit/seal electrical boxes and membranes
- Heat loss in winter
  - Heat gain in summer
  - Coolth loss in summer
  - Cold gain in winter
  - Higher than necessary energy demand
    - And carbon from that fuel
  - Interstitial condensation risk
    - Mould risk
    - Rot and Structural failure risk
- A practical competent solution: Bead Master
  - Ready made square, rectangular or circular beading
  - Makes airtight seal with plaster applied
  - Sharp knife & pop out centre panel



Window perimeter insulation

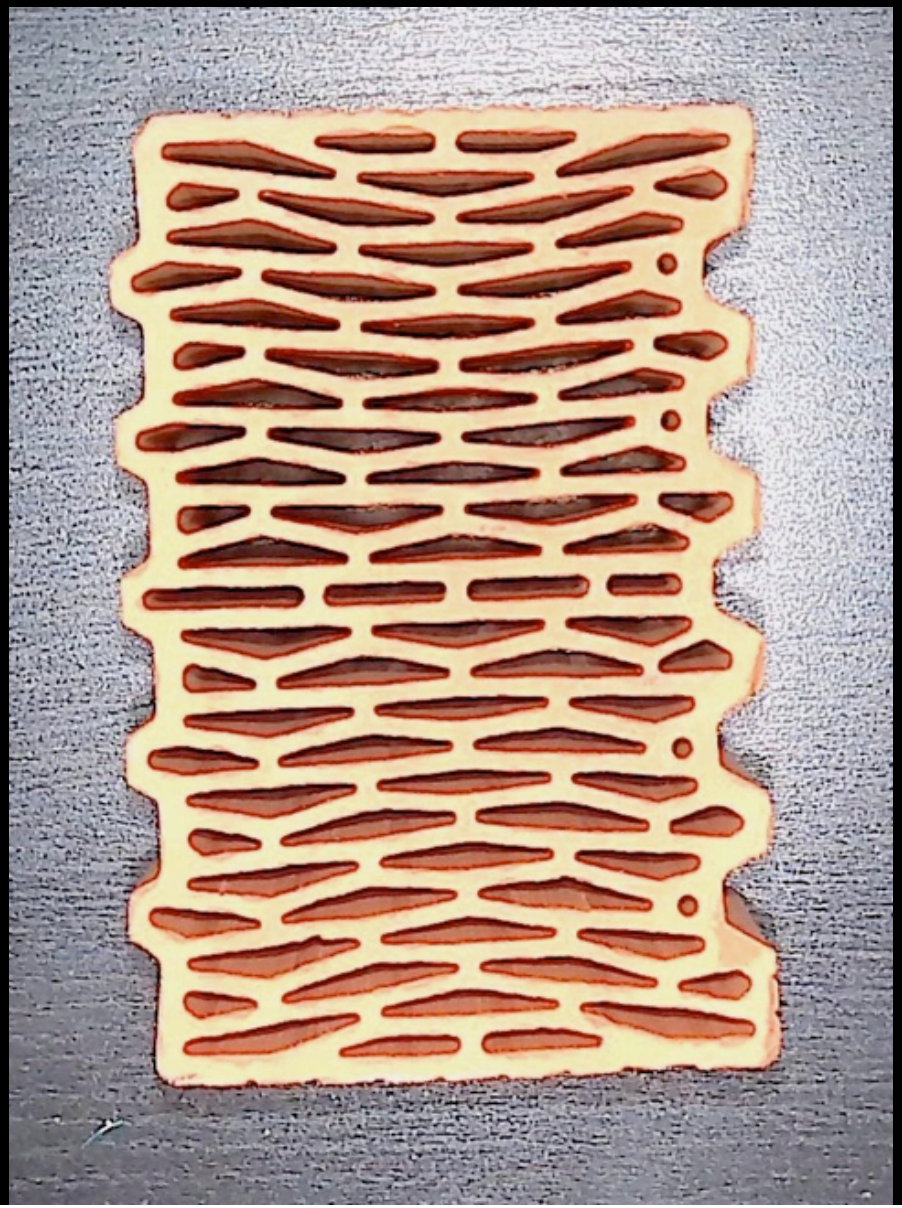
- Self-adhesive Compressed foam strip
- Fix to perimeter of windows
  - Install windows within 3 hours
  - Foam strip will expand to fill the gap
  - The closer the opening to the windows size
  - The more compressed the strip remains
  - Weather and wind tightness, acoustics and thermal performance possible

Thermal Insulation Materials

Mineral Insulations

Fired clay

Extruded Block:
cellular and long pathways



Extruded Fired Clay Block

- Like bricks only much more
- Clay with sawdust that burns off
  - Many small air bubbles throughout clay
- Extruded with many air pockets
  - Small section to minimise eddy currents
- Solid parts create a long pathway from one side of block to the other
- Better k value than filed clay brick
- Better actual performance

Aerogel with Mineral Fibre

Aerogel

- Silica in solution, water removed
  - Leaving silica matrix and
  - Microscopic air bubbles
  - Added fibres to reinforce quilt
  - k values better than the best plastic insulation
  - Micro porous
  - Good fire performance (some tested)

Aerogel in Paint

Aerogel in Paint

- Government Magic wand!
  - Insulating paint
- 1 mm of Aerogel not a good U value
- It's a small improvement in thermal comfort
  - But mostly to the touch only

Glass Mineral Fibre

Glass Wool

- Middle of the road k value
- No decrement delay at normal density so exacerbates summer overheating
- Combustible?
- Hydrophobic: No moisture management
- Only use in vapour closed thermal construction
- Used for acoustics a lot

Stone Mineral Fibre

Stone Mineral Fibre

- Its Cheap and large market share
- Created from abundant natural resource (stone)
- Also uses Pumice (volcanic rock, renewable but not abundant)
- Saves in-use winter energy (so do all insulation materials)
- No Decrement delay at thermal insulation densities so exacerbates summer overheating
- Offers no solar radiation heat gain protection in summer
- Uses more embodied energy to make it
- Recyclable (after many years of use but also degrades with brittleness so not reusable)
- Hydrophobic (repels water so water is held in air spaces so cannot insulate, can hold water against timbers)
  -
- Fire resistant densities:
  - Non-combustible
  - Used in fire resistant assemblies
  - Almost unique in rainscreen cladding thermal insulation (post-Grenfell)

Cellular Glass (CG)

Foamed into slabs and boards or nuggets for aggregates

Cellular Glass boards

- The use of Foamglas on British Library Euston (BLE) was extensive
- Non-combustible in a Section 20 building
  - High rise, large m2, public assembly
- Applications: next slide

It was used in: (BLE)

- **Basement perimeter wall internal gutters with asphalt**
  - Foamglas slabs T2 or T4 (thermal) (no paper surface)
- **External Cavity walls partial fill**
  - Foamglas wallboard T2 or T4 (thermal) (papered surface)
- **Forecourt waterproofing with asphalt or high performance felt**
  - Foamglas S3 (structural) and Foamglas slabs T4 (thermal)
- **Flat roofs asphalt**
  - Foamglas slabs T4 thermal (no paper surface) in hot bitumen flood coat
- **Floor insulation under screeds**
  - Foamglas slab S3 (no paper surface)
- **Exposed floor soffit insulation**
  - Foamglas T4 Aluboard (aluminium foil faced)
- **and many other details**
- **But not outside of the basement wall or basement suspended lowest floor.**

Application

- In all cases the intention was for:
- Bonded to inner leaf and fully filled joints in (paper or foil surfaced) boards to walls and soffits: 2 part adhesive
- (not papered surfaced) slabs in bitumen flood coat to asphalt roofs, gutters and waterproofing to ensure joints filled and tops are squeegeed with excess bitumen, followed by protective/ waterproof membranes.
- In all cases the insulation was protected from moisture ingress and frost damage, even though the insulation itself is water and vapour proof.

Precautionary principle (BLE)

- Despite Foamglas being a waterproof and vapour proof material
- BLE did not rely on this and always protected it from water
- treated it as a 2nd or 3rd line of defence in construction on a building with up to 500 year design life for basements and 250 years for superstructure 120 years for external envelop. (BLE)

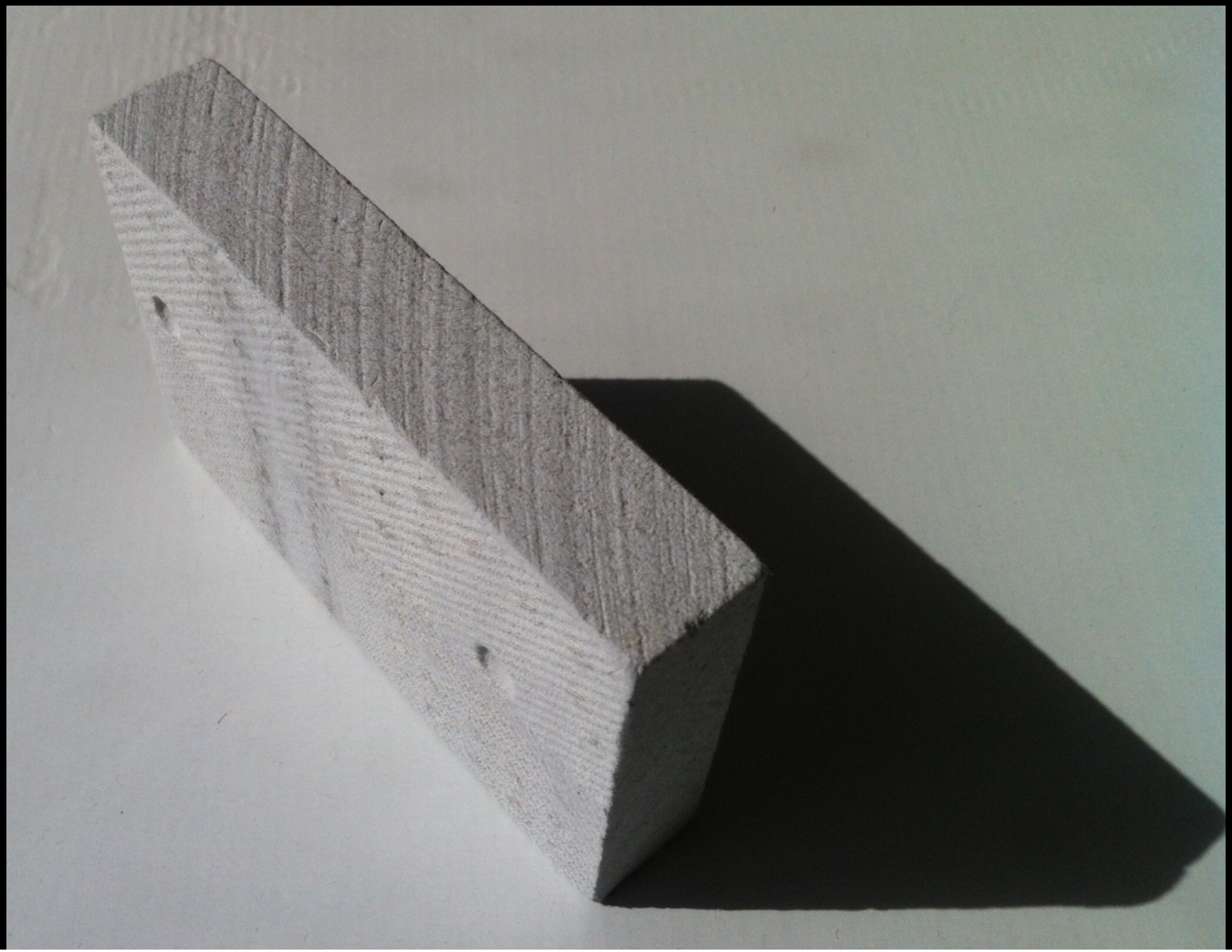
Expanded mineral insulation

Expanded perlite insulation

Expanded Perlite

- Expanded or Exfoliated?
- Mineral
- Thermal and Fire performance

Calcium Silicate Expanded mineral insulation



Calcium Silicate

- Invented for historic building fabric external masonry walls
- Aerated mineral matrix board
- IWI Internal wall insulation
- Bonded direct to internal surface
- Moisture permeable
- Controls prevents condensation mould

Autoclaved Aerated concrete

Autoclaved Aerated Concrete AAC
Aerated Concrete AC

- Steam cured concrete: energy intensive
- Binder: OPC Cement matric
  - High Energy High Carbon
- Aggregate: Sand or fine aggregate
- Aluminium oxide: Saponification bubbles
- Format: AAC block or wall slabs
- Format: AC insitu concrete
- AAC: Internal wall or partition, wall panel
- AC: self insulating ground floor slab

Animal

Sheep's Wool

And goat hair

Hygroscopic Insulation: Sheep's Wool

BBA BRITISH BOARD OF AGREMENT
TECHNICAL APPROVALS FOR CONSTRUCTION

Designated by Government to issue European Technical Approvals

Second Nature (UK) Ltd
Soulands Gate
Soulby
Dacre
Penrith
Cumbria CA11 0JF
Tel: 01768 486285 Fax: 01768 486825
e-mail: info@secondnatureuk.com
website: www.secondnatureuk.com

Agrément Certificate No 02/3950

THERMAFLEECE
Isolation thermale
Wärmedämmung

Product

- *THIS CERTIFICATE RELATES TO THERMAFLEECE, THERMAL INSULATION BATTS FOR USE IN DWELLINGS AND BUILDINGS WITH SIMILAR TEMPERATURE AND HUMIDITY CONDITIONS.*
- *The batts are for use in:*

loft applications between joists in ventilated and unventilated lofts under pitched roofs and between rafters for tiled or slated pitched roofs designed and constructed in accordance with the relevant clauses of BS 5534-1 : 1997, and

timber-frame wall applications between studding with a weather-resistant cladding, and a ventilated and drained cavity.

Regulations — Detail Sheet 1

1 The Building Regulations 2000 (as amended) (England and Wales)

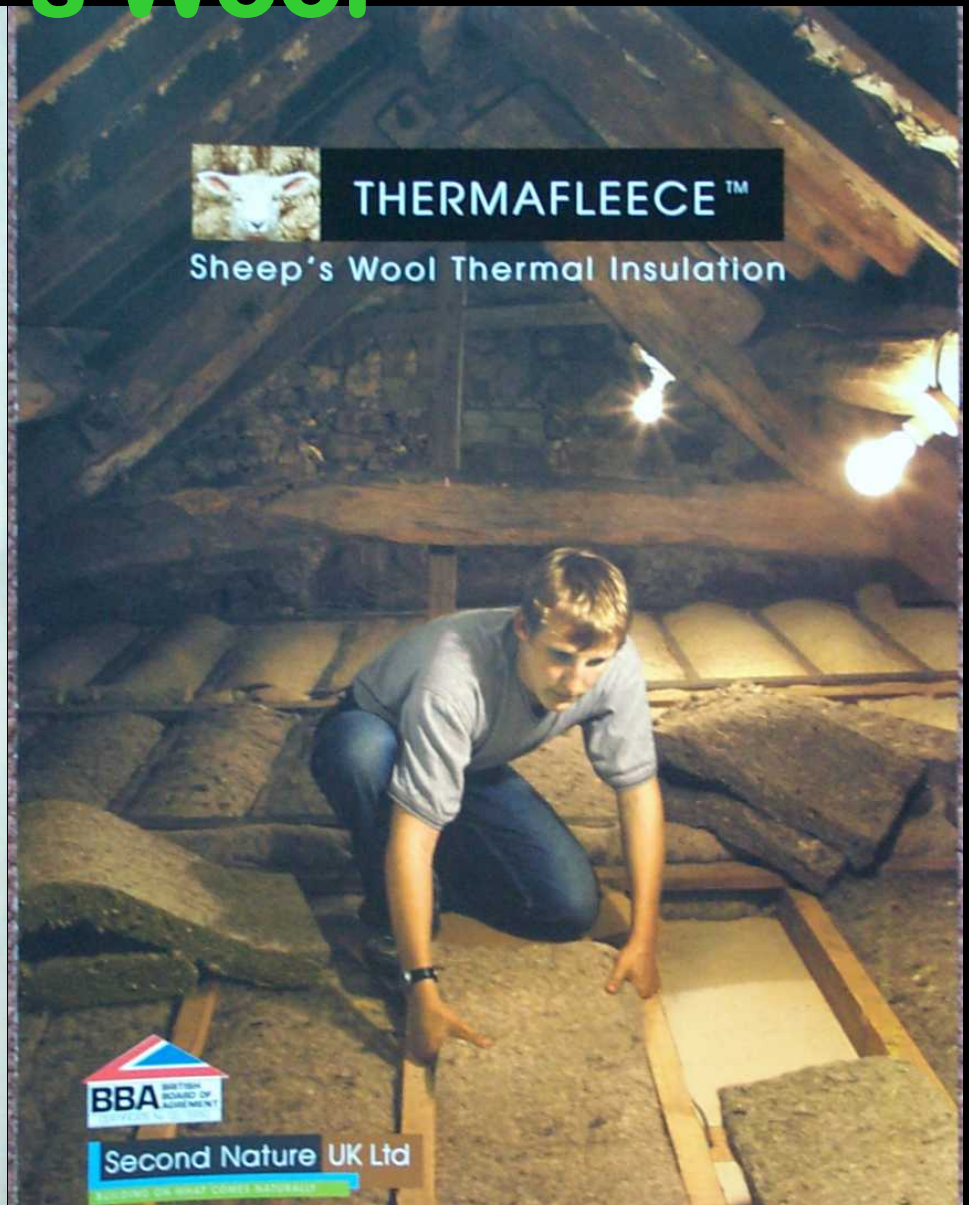
The Secretary of State has agreed with the British Board of Agrément the aspects of performance to be used by the BBA in assessing the compliance of insulation with the Building Regulations. In the opinion of the BBA, Thermafleece, if used in accordance with the provisions of this Certificate, will meet or contribute to meeting the relevant requirements.

General

Requirement: B3 — Internal fire spread (structure)
Comment: Lofts, roofs and walls incorporating the product can meet this Requirement. See the *Behaviour in relation to fire* section of the relevant Detail Sheet.

Requirement: L1 — Conservation of fuel and power in dwellings
Requirement: L2 — Conservation of fuel and power in buildings other than dwellings
Comment: The product can meet or contribute to meeting this Requirement. See the *Thermal insulation* section of the relevant Detail Sheet.

Requirement: Regulation 7 — Materials and workmanship
Comment: The product is acceptable. See the *Durability* section of the



Sheep's wool

- When on the sheep's back they are kept warm in winter and cool in summer
- Hygroscopicity absorbs moisture into fibre and the insulating action is maintained
- But also in summer moisture loss has cooling effect and in winter moisture gain has warming effect

Sheep's wool: Cool in Summer

- When outside temperature increases and begins to heat sheep's wool, it releases moisture;
- has a cooling effect on the fibre which reduces the flow of heat to the inside of the building
- Can reduce peak temperature by up to 7°C compared to alternative insulation

Sheep's wool: Warm in Winter

- In the winter the absorption of moisture by sheep's wool insulation
- can increase peak temperature by up to 4°C
- when compared to buildings in which alternative forms of insulation are installed.

Bird feather

Eider down

Bird feathers

- Used in bedding quilts
- Crate still air pockets
- Quilts need drycleaning but cost more to clean than buy new
- Big waste stream to divert from landfill
- Interreg Project investigated converting into construction thermal insulation

Plant fibre

Hygroscopic Thermal Insulation

Newspaper
Flax
Hemp
Sheep’s wool
Cellulose

Coconut Husk Fibre

Plant fibre - Essence

- Dried fibres minus essence
- Loose, Batts, Quilts, Boards
- MOR k value similar to Mineral Wool
- +Specific Heat Capacity: High
- +Density provides Decrement Delay
- Good winter and summer performance

Plant Fibre

- Cork Bark
- Hemp shiv
- Flax stalks
- Straw stalks
- Straw board
  - (Strammit: Not compatible with UK Climate)
- Grass cuttings
- Cotton (but water & chemical intensive)
- Denim (ditto)
- Many more

Cork

Loose, Boards, Tiles,

Added to plaster

Cork: Tree Bark

- Portugal, Seasonal production, harvested for limited number of years
- Tree based: Bark and binder
  - Carbon Sequestration
- Binder: can be combustible, flammable initially
  - But the cork will char like timber and become fire resistant
- Many formats:
  - Loose: Chips
  - Rigid: board, sheet,
  - Flexible: floor tile
- Decrement: Radient Thermal Insulation
- Hygroscopicity: Moisture Management
- Chipped: Added ingredient in renders

Cork: Floor tile

- Portugal, Seasonal production, harvested for limited number of years
- Tree based: Bark and binder
  - Carbon Sequestration
- Flexible: floor tile: Thermal comfort on feet
  - 2-3 mm thickness: good k value, poor U value
- Decrement: Radient Thermal Insulation
  - If laid on concrete it can be warmed through cork tile
- May get a surface sealer preventing Hygroscopicity
  - Hygroscopicity: Moisture Management?

Strawboard

- 50 mm thick panels
- Compacted straw
- Paper surface all round
- Good k value for winter
- Good Decrement factor for summer
- Goof fire performance (doors, partitions)
- Good Acoustics (Partitions roofs walls)
- Not good in UK climate: any grains can grow and board expands
- Disappeared from UK market 1970's
- R&D at Brunell University trying to solve it
- Very effective in other dryer climates

Wood fibres

Woof Fibre Batts or Slabs

-
-
  - Framed Walls, Roofs, Floors
  - Solid Masonry: IWI with clay and EWI with lime render
-
-
  - (Specific Heat Capacity, Density and k value)
- k value worse than rock,
  - Increased thickness needed
-
  - glass/rock mineral fibre
  - expanded polystyrene plastics insulation

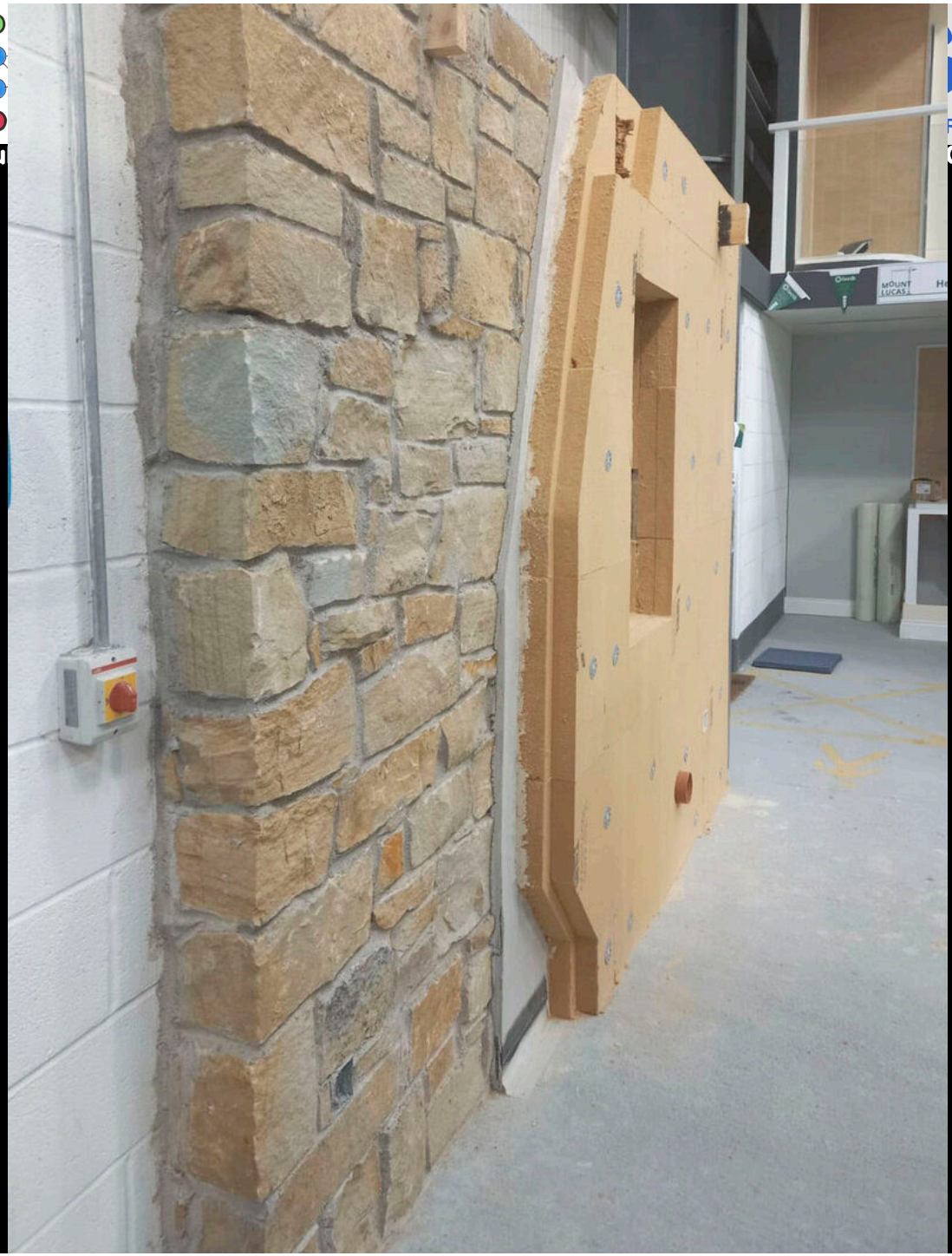
Dense wood fibre rigid board

- **Wet or dry manufacturing process**
  - Lectin released and used to bind fibres
- **k value little worse than stone wool**
  - Greater thickness needed for winter
- **High decrement delay: good for summer**
- **Hygroscopic:**
  - good for moisture management,
  - use in vapour open construction
- **Rigid: can span between framing**
- **Versatile applications:**
  - Roofs Walls Floors
  - Inside or outside framing

Wood Fibre Systems

Dense wood fibre (DWF) systems

- Original inventers or DWF
- Continuously inventing whole systems
- Versatile applications:
  - Roofs Walls Floors
  - Inside or outside framing
  - IWI & EWI
- Purpose made ‘Systems’ including accessories and finishes



Dense wood fiber systems

- Stone walls lumpy profiles
- Rigid boards would create cavities
  - Where moisture cannot jump cavities
  - Moisture stops at cavity
  - Will reactivate any spores in the cavities
  - Mould can grow undetectable
- Vapour permeable adhesive bonded to stone wall, no more cavities
- Moisture transport across wall restored
- Vapour open system

Wood Fibre Rigid & Soft Insulation

- Stone walls lumpy profiles
- Rigid boards would create cavities
  - Where moisture cannot jump cavities
  - Moisture stops at cavity
  - Will reactivate any spores in the cavities
  - Mould can grow undetectable
- Compressible insulation on back face mould to lumpy profiles of stone wall, no more cavities
- Moisture transport across wall restored
- Vapour open system

Cellulose Fibre

Recycled Newspaper
Recycled Magazines

Cellulose Fibre Flake

- Recycled newspaper/magazine
- Cellulose fibre flake insulation in:
  - Framed Walls, Roofs, Floors
- High acoustic density & high thermal mass whilst k value similar to rock
- Phenomenal summer performance compared to:
  - glass/rock mineral fibre
  - expanded polystyrene plastics insulation

Recycled Cloth Insulation

Recycled denim

Recycled Denim

- Matisse from France
- Available in UK
- Denim clothes shredded
- Batts
- Hygroscopic: Moisture management use on vapour open construction
- Some thermal mass
- Used in framing zone of lightweight timber frame (LTF)

GBC Green Building Calculator

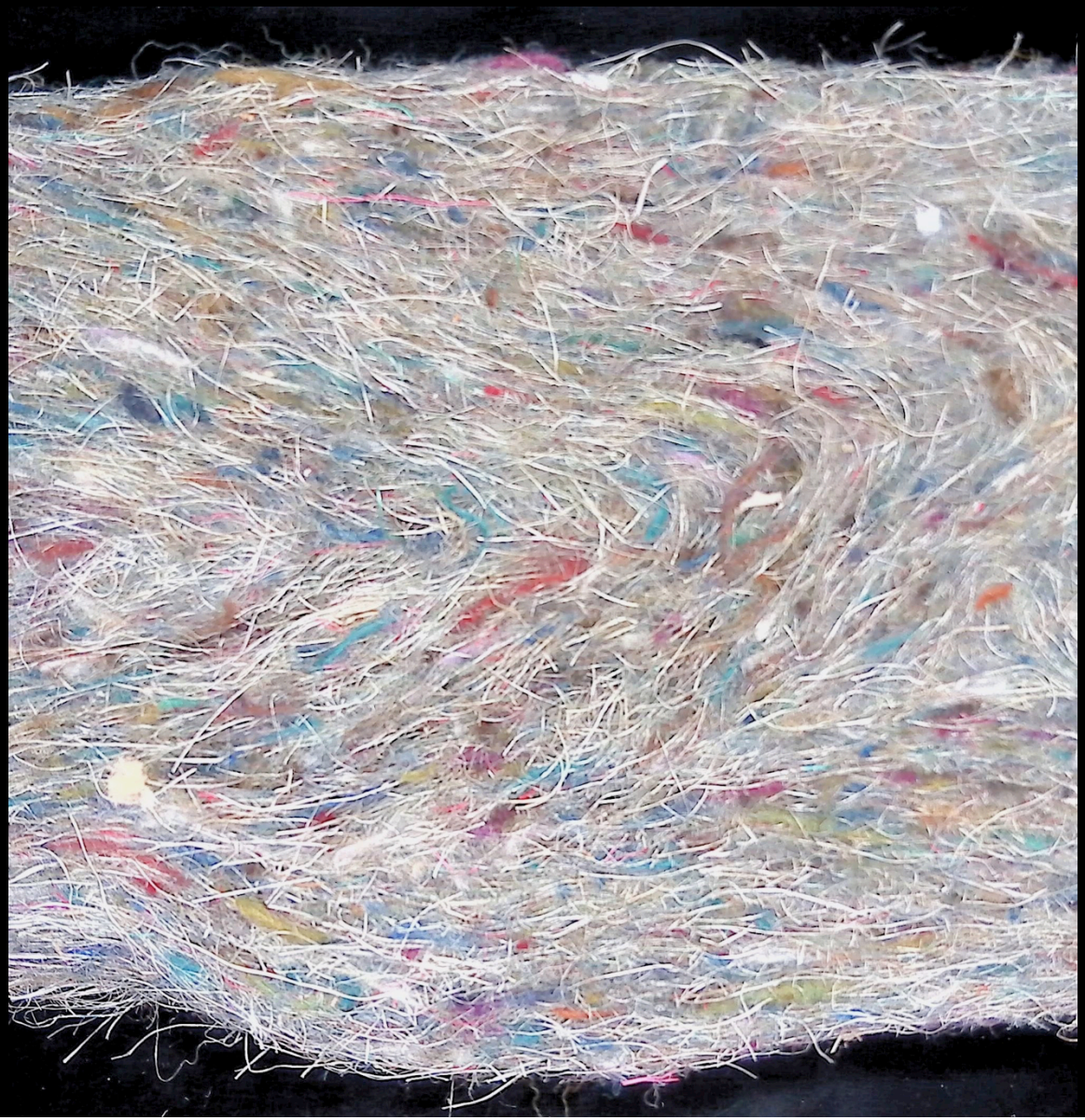
https://GreenBuildingCalculator.uk

GBE

https://GreenBuildingEncyclopaedia.uk

GRC Green Retrofit Calculator

https://GreenBuildingCalculator.uk



Recycled Tweed

- Made in Scotland
- Tweed clothes shredded
- Batts
- Hygroscopic: Moisture management use on vapour open construction
- Some thermal mass
- Used in framing zone of lightweight timber frame (LTF)

Plastic Insulation

GBC Green Building Calculator https://GreenBuildingCalculator.uk

GBE https://GreenBuildingEncyclopaedia.uk

GRC Green Retrofit Calculator https://GreenBuildingCalculator.uk

Plastics

- Potentially less materials
- Potentially better winter performance
- Potentially worse summer performance
- Specification, detailing and Installation workmanship undermines performance
- Gappy insulation is very ineffective
- BRADL has been updated to force use of GapOTape or equivalent

Polypropylene

- 'Non-itch' marketed as an improvement over glass or stone mineral wool
- Finite resource: Petrochemical, hydrocarbon, oil bi-product
- Fossil Carbon: Adds to Climate Change
- Plastics manufacturing generates:
  -
  -
- Hydrophobic, Moisture impermeable:
  - use in vapour closed construction
  -
- No Decrement Delay: can exacerbate overheating
- Applications:
  -
  -

Multi Foils


TRISO-SUPER 9®
Actis UK, 12 Market Place - Devizes
Wiltshire SN 10 1 H.T. - Grande Bretagne
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Radiation & Reflection

- Multi-foil insulation rolls exploit these characteristics
- Many layer of metalised plastic foils and expanded polyethylene sheets bound together by stitching
- Use of surface resistivity relies on cavities of air space
- Outwards
  - Reflects heat back in
  - Insulates between reflective foils
  - Does not conduct heat outwards
  - Does not radiate heat outwards
- Inwards
  - Reflects solar heat back out
  - Insulates between reflective foils
  - Does not conduct heat or coolth inwards
  - Does not radiate heat or coolth inwards

Controversy

- Manufacturer claims 19 mm. is equivalent to 250mm. of rock mineral fibre
- BSI's Hot box test method does not support this claim
- Whole house tests do allegedly
- AECB challenge: manufacturer trying to prove it
- Dropped the existing product and created a new one with one more layer loosing all the baggage
- Check their figures

Foamed Plastics

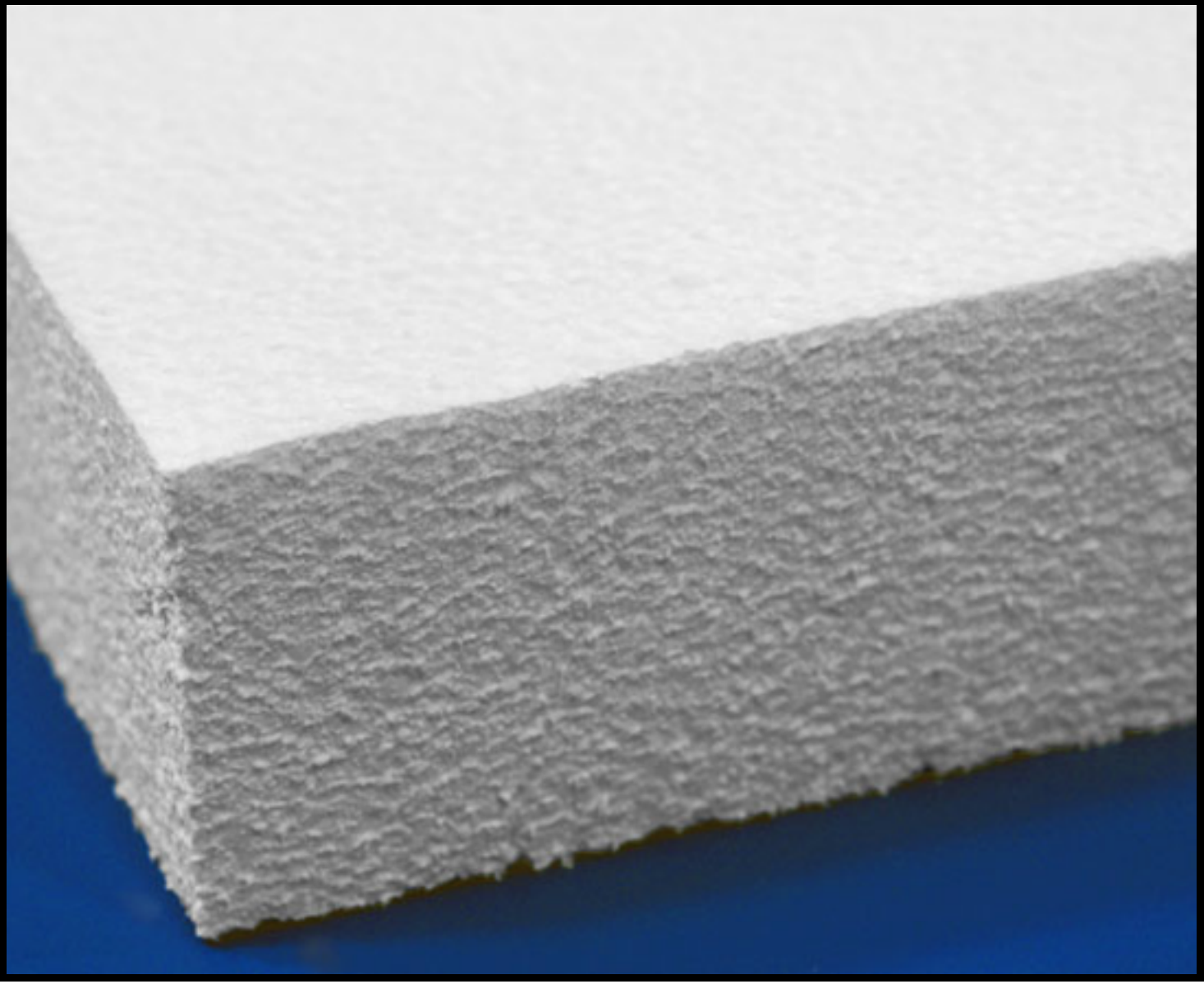
EPS Expanded Polystyrene,
XPS Extruded Polystyrene,
PIR, PUR Polyurethane,

Expanded Polystyrene (EPS)

- Finite resource: Petrochemical, hydrocarbon, oil bi-product
- Fossil Carbon: Adds to Climate Change
- Plastics manufacturing generates:
  - 4.5% of man made CO2
  - And lots of heat energy and its CO2
- Hydrophobic, Moisture impermeable:
  - use in vapour closed construction
  - Incompatible with historic building fabric
- No Decrement Delay: can exacerbate overheating
- Applications:
  - Below Ground floor thermal conductivity insulation
    - Protected by Damp Proof Membrane (DPM)
  - Inverted Flat roof construction? multi-layered to minimise cold bridging
    - Needs decrement delay somewhere in the roof element

Extruded Polystyrene failures

- Below Ground Insulation
- Wet and failed extruded polystyrene,
- 3 reported instances of this, 2 in Belgium and 1 in France and all on Earthships.
- Every building material suffers from failure if badly installed or installed outside manufacturers standard details.
- In all the cases, failure was due to poor waterproofing and freeze thaw degradation of the material.
- In the cases investigated, the contractors had failed to install either a waterproofing layer or where the board product was used, had cut corners by not using any sealant on the joints.



Recycled Expanded Polystyrene (REPS)

- Finite resource: Petrochemical, hydrocarbon, oil bi-product
- Fossil Carbon: Adds to Climate Change
- Plastics manufacturing generates:
  - 4.5% of man made CO2
  - And lots of heat energy and its CO2
- Recycled content, Or Graphite added
- Hydrophobic, Moisture impermeable:
  - use in vapour closed construction
  - Incompatible with historic building fabric
- No Decrement Delay: can exacerbate overheating
- Applications:
  - Below Ground floor thermal conductivity insulation
    - Protected by Damp Proof Membrane (DPM)
  - Inverted Flat roof construction?
    - multi-layered to minimise rainwater cold bridging
    - Needs decrement delay somewhere in the roof element

Rubber Insulation

Latex Foam

- Invented by mould growth consultants to remove risk of surface condensation in fuel poverty stricken houses
- IWI Internal wall insulation
- Provides the barest minimum of thickness and allows wall papering over
- Offers a degree of thermal comfort
- Thin, okay k value, poor u value
- Same materials as Spitting Image puppet heads

Mixed materials

Papercrete

Cement and Paper making fibre sludge GGBS OPC replacements ideally

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Papercrete

- Paper making waste sludge fibres
- Cementitious binder
  - OPC Ordinary Portland Cement
  - Could be GGBS Ground Granulated Blast Furnace Slag cement
  - Could be blended OPC & GGBS
- Very low density
- High thermal mass: Decrement Delay?
- OPC is water and vapour resistant
- Paper sludge fibres are vapour permeable
- How vapour permeable if the end result?
- Strength: ? Similar low strength Hemp-lime blocks
- Connected two companies to try to bring something to market

Cork Diamaceous Earth Render

Diatomeic Powders, Cork, Clay and Lime Plaster/Render

- IWI Internal Wall Insulation or EWI External Wall Insulation
- Premixed thermal plaster
  - Ocean floor minerals: Diatomeic Powders
  - Cork granules: 0-3 mm
  - Hydraulic Lime: NHL 3.5
  - Clay
- Vapour permeability: $\mu = 4$
  - Breathable: compatible with historic walls
- Capillary water absorption: 0.35 kg/m2.hr (Category W2)
- Fire: Euroclass A2
- Sound absorbing coating
- k value: 0.045 W/mk Winter Insulation
- Density: 360+/-20 kg/m3
- Decrement delay: Summer Insulation
- Inert and recyclable
- Indoor Air Quality: Low VOC emissions
- Manufacturer: Diasen
- Product Reference: Diathonite Evolution

Hemp-lime

Hemp-lime Hempcrete

- Hemp shiv fibres
- Rapidly renewable plant fibre
- Lime binder
- Very low density
- High thermal mass: Decrement Delay?
- Lime is water and vapour permeable
- Hemp shiv fibres are vapour permeable
- How vapour permeable if the end result?
- Strength: ? Similar low strength Hemp-lime blocks
- NGS Connected two companies to try to bring something new to market with a new non-cementitious binder

Hemp Lime Applications

- Insitu spray on to walls
- Insitu spray into cassette panels
- Insitu compact into diaphram wall cavity
- Insitu ground bearing floor
- Non-loadbearing blockwork
- Loadbearing blockwork ? Add cement?

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Tradical Hemp-lime Hempcrete

- Hemp shiv fibres
- Rapidly renewable plant fibre
- Lime binder: Slow set, softer bond, high energy, high carbon
- Cementitious binder added to drive the lime's hydration
  - OPC Ordinary Portland Cement, fast set, strong bond, very high energy, very high carbon
- Aluminium oxide: saponification reaction with cement generated bubbles
  - Bubbles add thermal insulation
- Phase Change characteristic
- Very low density
- High thermal mass: Decrement Delay
- Lime is water and vapour permeable
- OPC is water and vapour resistant
- Hemp shiv fibres are vapour permeable
- How vapour permeable if the end result?
- Strength: ? Similar low strength Hemp-lime blocks, very low strength
- Manufacturer: Lhoist
- Product Reference: Tradical

Lightweight Cob Clay-Straw

Interreg CobBauge Project

- Cob=English, Bauge=French
- Earth (Clay recipe) and straw
- 21st Century Cob (Regulations)
- Traditional Cob is Structure, Thermal mass and weather exclusion
- CobBauge combines: (see previous slide)
  - structural mix cob (yellow) with
  - light clay straw/hemp insulating mix cob (brown)

Mixed materials Multi-component systems

SIPs Structural Insulated Panels

Structural Insulated Panels SIP

- OSB Oriented Strand Board skins
  - Biobased but added chemistry binder
- PUR Polyurethane
  - Non-renewable fossil fuel bi-product
  - High carbon: adds to climate change
  - Toxic in fire
- Panel jointing adhesive: more chemistry
- Good k value for winter
- Poor decrement factor for summer
- High risk of overheating in summer

ISPs Insulated Structural Panels

Structural Timber cassette panels any insulation fill

Thermal Performance

With an impressive thermal conductivity value (k) of only 0.038 W/mK in walls and 0.035 W/mK in lofts, Warmcel's 'in use' performance is further enhanced by its ability to create a high level of airtightness to help seal a building against air infiltration and prevent thermal convection currents.

The proven methods of application ensure the insulation provides a complete seal to prevent heat loss, eliminating gaps, cracks or other cold bridges.

Fire Performance

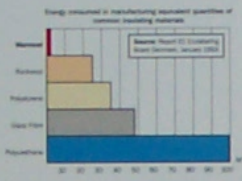
As the photograph demonstrates, Warmcel is extremely resistant to fire. Its remarkable performance is achieved through the addition of simple inorganic salts, enabling it to

EVT Breathing Technology wall panel, the fire resistance properties of Warmcel saw the panel exceed 71 minutes when exposed to temperatures of up to 1000°C.

Throughout the test the external face of the EVT Breathing Technology wall panel remained at a cool 17°C.

Environmental

Manufactured from 100% recycled waste newspaper, Warmcel has extremely low embodied energy, requiring far less energy to produce than any other mainstream insulation material.



Warmcel has zero ODP (Ozone Depletion Potential). It does not contain any added formaldehyde and is free from CFCs, volatile organic compounds (VOCs) or other toxic substances. And Warmcel is formulated to protect it against any potential hazards that may be encountered in use. It is resistant to biological and fungal attack, treated against insects and is unattractive to vermin. Warmcel is also harmless to other common building components such as copper pipes, electric cabling and metal nail-plate fasteners.

Warmcel® is the only insulation material with BBA approval for use in timber framed structures that is able to demonstrate a 20 year record of successful installations.

The EVT Standard

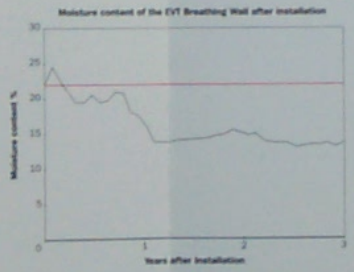
The EVT Standard describes a particular make-up of building structure, which performs in a very specific manner. The structure may be individual elements of the building, such as the walls, floor or roof, or the complete building envelope. The fundamental criteria determining if a structure meets the EVT Standard are defined by a combination of the design of the structure, the components used in its manufacture and its 'in use' performance.

EVT Structures

EVT Breathing Technology Structures comply with the EVT Standard. They combine high levels of insulation with the ability to 'breathe' in such a way as to ensure any natural moisture ingress always migrates safely and completely to the external atmosphere where it is harmlessly expelled.

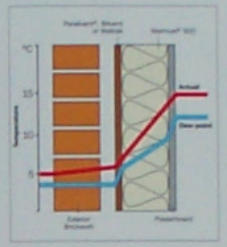
No Vapour Barrier

In conventional timber frame, the more vapour resistant plywood is on the outside of the wall rather than the inside. As a result of this imbalance, a plastic vapour barrier is required to prevent any moisture ingress. However, the effect of this is to all but eliminate vapour diffusion through the wall. EVT Breathing Technology Structures do not need a vapour barrier.



Perfect Balance

EVT Breathing Technology utilises components that provide the perfect balance of vapour resistivity and permeability to achieve true breathability. This balance is designed around Warmcel 500 Breathing Insulation, which has the ability to promote the migration of moisture through the structure and is the only insulation material that has been exhaustively tested to prove its effectiveness in EVT Breathing Technology Structures.



This unique combination ensures diffusion is maximised, in a controlled way, to make the structure as free to the passage of water vapour as possible, an effect known as Enhanced Vapour Transfer (EVT).

Extensive Testing

All components used in EVT Breathing Technology Structures have been carefully selected in conjunction with Warmcel 500, following extensive testing, to provide the correct vapour compatibility that allows water vapour to diffuse naturally through the structure without risk of interstitial condensation.

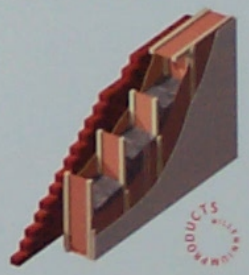
Only approved components will ensure the integrity of the EVT structure is maintained. Substitute components, untested in combination, may not perform to their design criteria.

TRADIS® – The Next Generation

TRADIS is a range of factory-produced structural wall panels, roof plates and floor cassettes that enables a complete house shell to be constructed in less than a day.

It also exemplifies the principles proposed by Sir John Egan's 'Rethinking Construction' report, which calls for more standardisation and off-site manufacture and addresses the DETR's sustainability objective of less wasteful, more energy efficient build processes and technology.

Based on the well-proven closed panel EVT Breathing Technology solution, TRADIS combines all the performance benefits offered by the closed panel system, with the erection benefits of a factory engineered product, including dimensional accuracy, consistency and quality controlled compatibility.



Design features of TRADIS also offer on-site advantages. For example, wall panels can be supplied with doorframes and fully glazed windows already in place, so that once erected, the building interior is immediately weather protected.

An in-built service zone on the interior side of each panel facilitates the rapid installation of following services, allowing finishing times to be dramatically reduced without disturbing the integrity of the panel.

And a roof constructed from TRADIS automatically produces a 'Room-in-the-Roof' feature, without further work or adaptation, producing extra valuable living space for the same size house footprint.

Components that meet the EVT Standard

Warmcel® 500

Warmcel 500 is the heart of the EVT Breathing Technology Solution. In addition to outstanding thermal performance, its excellent hygroscopic properties promote the migration of water vapour through the wall, floor or roof to the outside. Furthermore, this capability enables it to absorb surplus water vapour at times of high internal humidity and release it when conditions allow.

Masonite® Beams

EVT Breathing Technology walls, floors and roofs can be manufactured from standard timber, but, for maximum performance, it is recommended that Masonite Beams are used. They enable the Warmcel 500 to interlock with the wall studs, floor or roof joists, thereby maximising the integrity of the insulated section. Masonite Beams are themselves designed for minimal cold bridging, featuring only an 8mm thick web between two flanges of sustainable Swedish whitewood.

Panelvent®, Bitvent and Wallrak

For EVT Breathing Technology walls, only Panelvent, Bitvent or Wallrak external sheathing offer the correct vapour compatibility for guaranteed performance. The only sheathing products to have been extensively tested for EVT Breathing Technology applications, they provide high racking strength and exhibit excellent weather resistance.

Paneline

Paneline is the internal sheathing on TRADIS panels.

Roofrak

In an EVT Breathing Technology roof, Roofrak replaces traditional felt. Bitumen free and manufactured from sustainable materials, Roofrak provides the combined benefits of racking strength, added insulation and weather protection. This profiled, interlocking board accommodates mid-span joints to minimise waste, while ensuring the finished roof is also wind and watertight.

All of these components have been selected to create a healthy living environment and do not produce any harmful emissions.

Insulated Structural Panels ISP

- Plywood, chipboard or OSB skins
  - Biobased but added chemistry binder
- Any insulation ideally biobased
  - Rapidly renewable agricultural bi-product
  - High Sequestered carbon: reduce climate change
  - Hygroscopic: Moisture management
- Dry Panel jointing or taped joints
- Good k value for winter
- Good decrement factor for summer
- Low risk of overheating in summer

Vacuum Insulated Panel VIP

Vacuum Insulated panels VIP

- Aluminium Foil envelope
- Plastic spherical balls accurately packed with 12 points of contact between each
- Air sucked out of envelop
- Vacuum in interstices between spheres
- Best ever thermal insulation k value
- No decrement delay
  - Sun's heat passes through vacuum of space without hindrance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Lightweight Thermal Mass

- Dense wood fibre outer layers
- Cardboard honeycomb core
- Cardboard cells contain wax
- Phase change materials (PCM):
  - Phases: Solid, Liquid & Gas
  - Fluidity: ability to move between phases
  - Changing phases: gains or released heat energy
  - Wax stores or releases heat energy
- Adds thermal mass to partitions and freestanding screens
- 22:26 Austria: Suggestion
  - Reduce 700 mm extruded clay walls to 500 mm
  - Add back lightweight thermal mass IWI

Wood Fibre based Systems

- IWI: Wood fibre board with moisture permeable plaster skim
- EWI: Wood fibre board with moisture permeable lime render

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File Updates

Rev No.	Comments	Author	Date
A01	First created, up to revision 93	BRM	10/03/2007
A02	GS to GBE Logos, Rev Table added, major update for GBE CPD @ MMA	BRM	01/07/2023-03/07/2023
A03	Added more scanned sample images	BRM	04/07/2023
A04	After CPD added more text, slides, etc. Posted on GBE website	BRM	06/07/2023
A05		BRM	03/07/2023
A06		BRM	03/07/2023
A07		BRM	03/07/2023
A08		BRM	03/07/2023
A09		BRM	03/07/2023

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  - Environmentalist by Actions
  - Writer and Educator as a Calling
  - Number Cruncher by Necessity
- Greening up my act since 1999
- Founded National Green Specification 2001
- Launched www.greenspec.co.uk 2003
- Created: GBE at https://greenbuildingencyclopaedia.uk 2012 – 2022
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