Green Insulation – Solution for Redesigning and Retrofitting

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Biswajit Roy
U.P. Twiga Fiberglass Ltd.

From the day we arrive on the planet

And blinking, step into the sun

There's more to be seen than can ever be seen

More to do than can ever be done

Some say eat or be eaten

Some say live and let live

But all are agreed as they join the stampede

You should never take more than you give

In the Circle of Life

(Elton John/Tim Rice, Lion King, movie, 1994)

Agenda

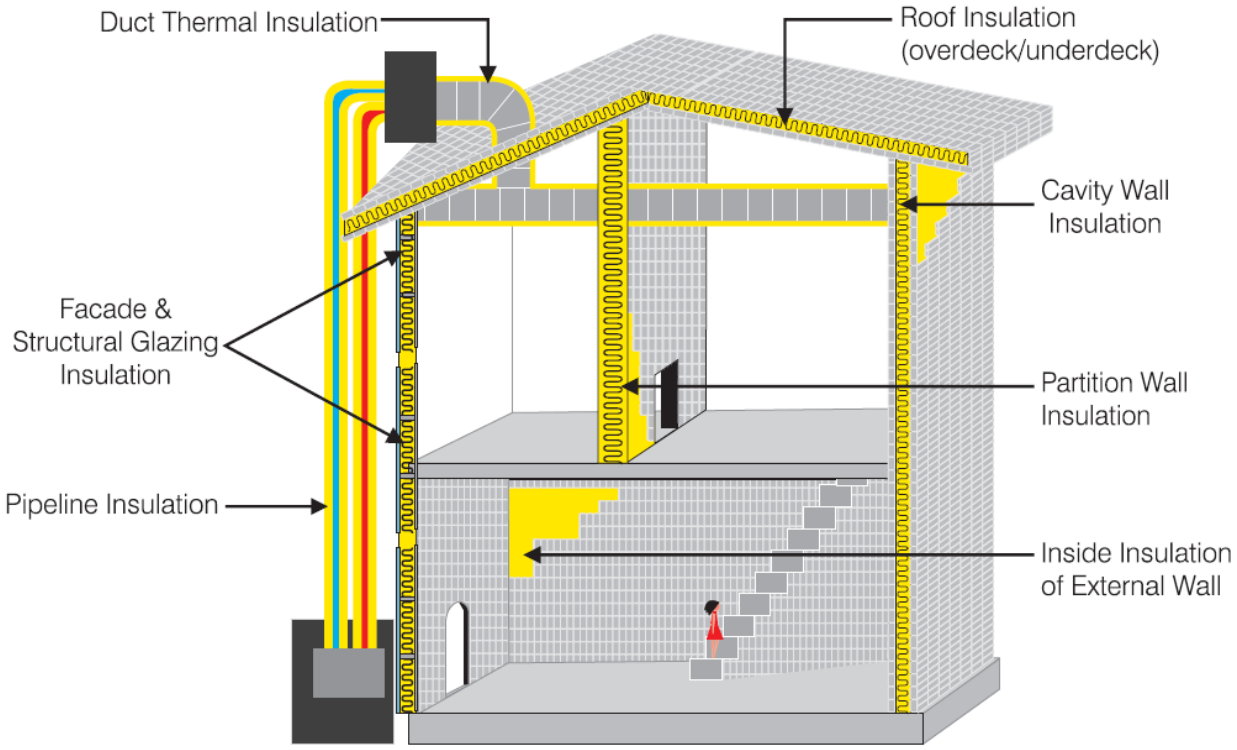
- Why redesigning and retrofitting with insulation make sense
- Various forms of insulation and their applications
- Parameters of insulation
- Thermal comfort and Energy efficiency – case studies
- Building Envelope insulation– redesigning and retrofitting

Why redesigning and retrofitting with Insulation is important

- Insulation helps to attain required energy efficiency to meet sustainability goal
- Research shows in India for every 1^{o}C rise in temperature above 27 ^{o}C there is 2-4 % loss in productivity. High temperature leads to more day-offs and sickness related to heat stress. Hence it has direct impact on real GDP.
- Most of the existing buildings are uninsulated- it causes thermal discomfort and higher energy expense
- Effect of climate change is more prominent than ever - more heat waves leads to unbearable summers causing extreme energy demand (* Peak demand/day in Delhi : 7000MW +)

Why building insulation is necessary to fight climate change

- Cooling and heating energy demand in building can be met with best efficiency and lowest possible cost.
- Building insulation probably is the only element in the building that saves energy, without consuming any, during its use (compare LED and efficient A/C)
- Building insulation also helps to meet acoustic privacy of the building
- Long life – once installed it is expected to function as long as building's life
- Retrofit is also possible and inexpensive
- Even for non air conditioned building thermal insulation provides thermal comfort for building occupants
- Can be reclaimed from building and reused

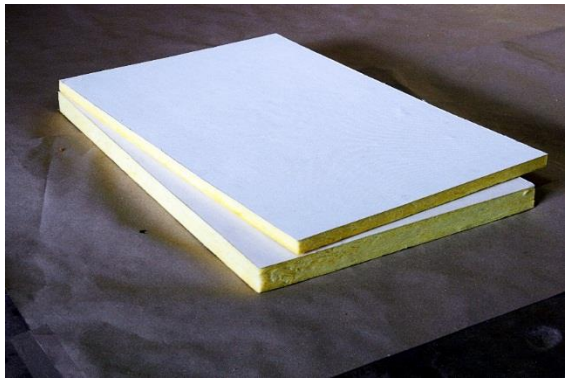


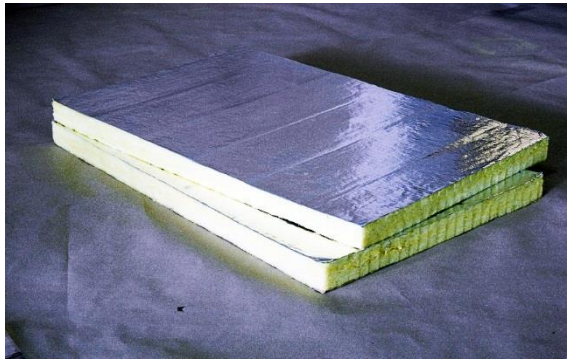
Thermal transmittance value-guidelines

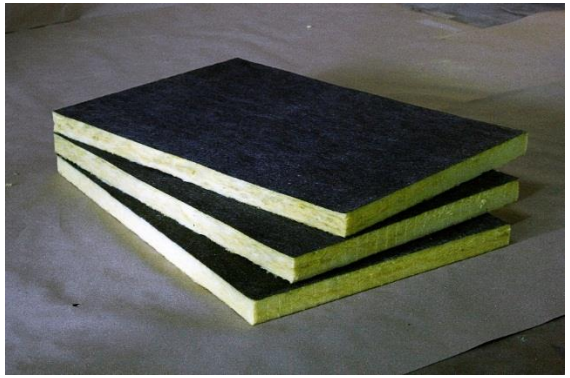
ECBC for non-residential: U (ECBC 2007) <= 0.409 W/m2.K to U(ECBC 2017) <=0.33 W/m2.K- more stringent prescriptive U-value

ECBC-R/Eco-Niwas: U-value (roof) <= 1.2 W/m2.K; RETV (Residential Envelope Transmission Value) <= 15 W/m2

IGBC rating system for new construction : U-value (roof) <= 0.5 W/m2.K (H&D, W&H, Com, Cold)







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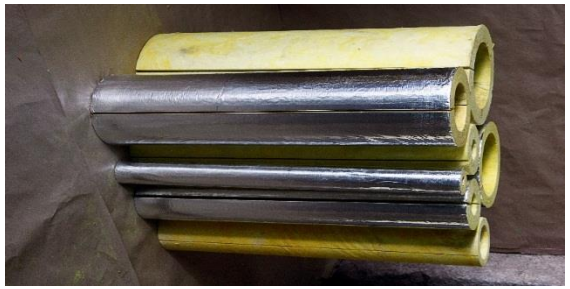
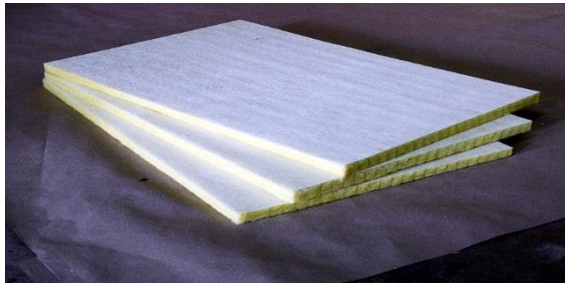
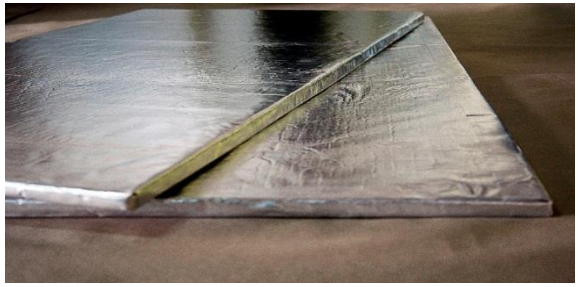


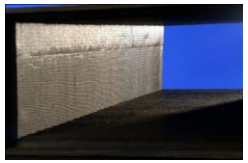




Parameters of insulation materials

Fire safety

Moisture



Thermal conductivity

Thermal resistance

Odor emission

Acoustic absorption

Shot content

Strength

Vibration & Jolting

Noise Isolation

Resiliency

Fire safe parameters of insulation

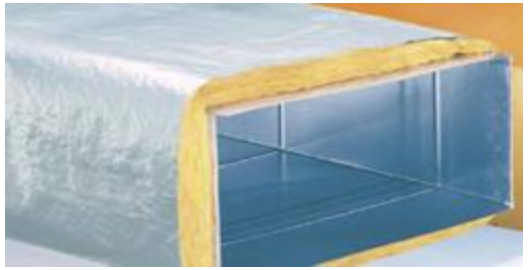
Fire Test	Importance/ Best results	Testing Standards
Non Combustibility	Highest standard for fire test. To determine the materials which is completely fire-safe	British Standard 476 Part 4 & IMO
Ignitibility	Best class: Designated as 'P' – not easily ignitable (desirable parameter)	British Standard 476 Part 5
Fire Propagation	Total Index, I<12 Sub index, i1<6. Check limited propagation of fire w.r.t time	British Standard 476 Part 6
Surface Spread of Flames	Best class : Class 1	British Standard 476 Part 7
Class 0 as in The Building Regulation 2000*	Class 0	British Standard 476 Part 6 & 7
Fire Spread Index	Class A (best class), FSI <25	American Standard-ASTM E 84 and Underwriter Laboratory (UL) 723
Smoke Density	Class A (best class), SDI < 50,	American Standard-ASTM E 84 and Underwriter Laboratory (UL) 723
FM Approval	Approval for Metal building envelope application	Class No. 4880. Approval standard for Class 1 Fire rating of insulated wall, roof/ceiling, and exterior wall system

Environment, Health & Safety: Product testing

Performance parameters	Test method
Emission parameter- Total Volatile Content (TVOC)	Small scale environmental chamber determination of organic emission from indoor materials (ASTM D 5116)
Emission parameter- Phthalates	
Emission parameter-Formaldehyde	
Emission parameter- 4-Phynylecyclohexen	
Prohibited flame retardant- Halogenated binding agent and Halogenated flame retardant, Ozone Depleting substances, Polybrominated Biphenyls, Polybrominated Diphenyl Ethers and Short Chain Paraffin	Gas chromatograph with mass selective detector (GC-MSD)
Hazardous substance –Halogenated solvent, Aromatic solvent	Headspace-Gas chromatography (HS-GC-MSD)
Hazardous substance –Mercury, Lead, Cadmium	Inductively coupled plasma atomic emission spectroscopy (ICP-AES)
Hazardous substance – Hexavalent Chromium	UV-Vis spectrometer
Hazardous substance-Tin	Inductively coupled plasma atomic emission spectroscopy (ICP-AES)
Hazardous substance- Asbestos	US NIOSH 9002

Various applications of insulation material

Duct Insulation-Thermal



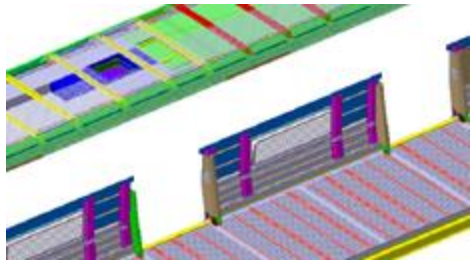
Underdeck

Pre Engineered Building

Wall Insulation

Façade/ Spandrel Insulation

Rail/Metro rail coach-wall/roof/HVAC

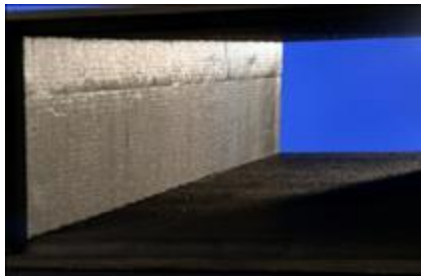


Bus body insulation

Shipbuilding-MFMB

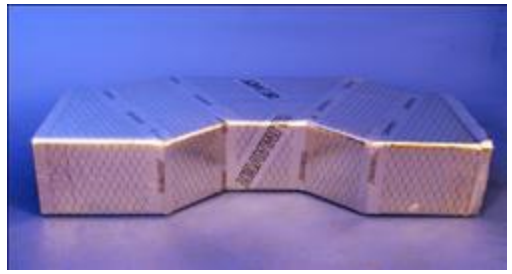
Partitions insulation

Duct Acoustic



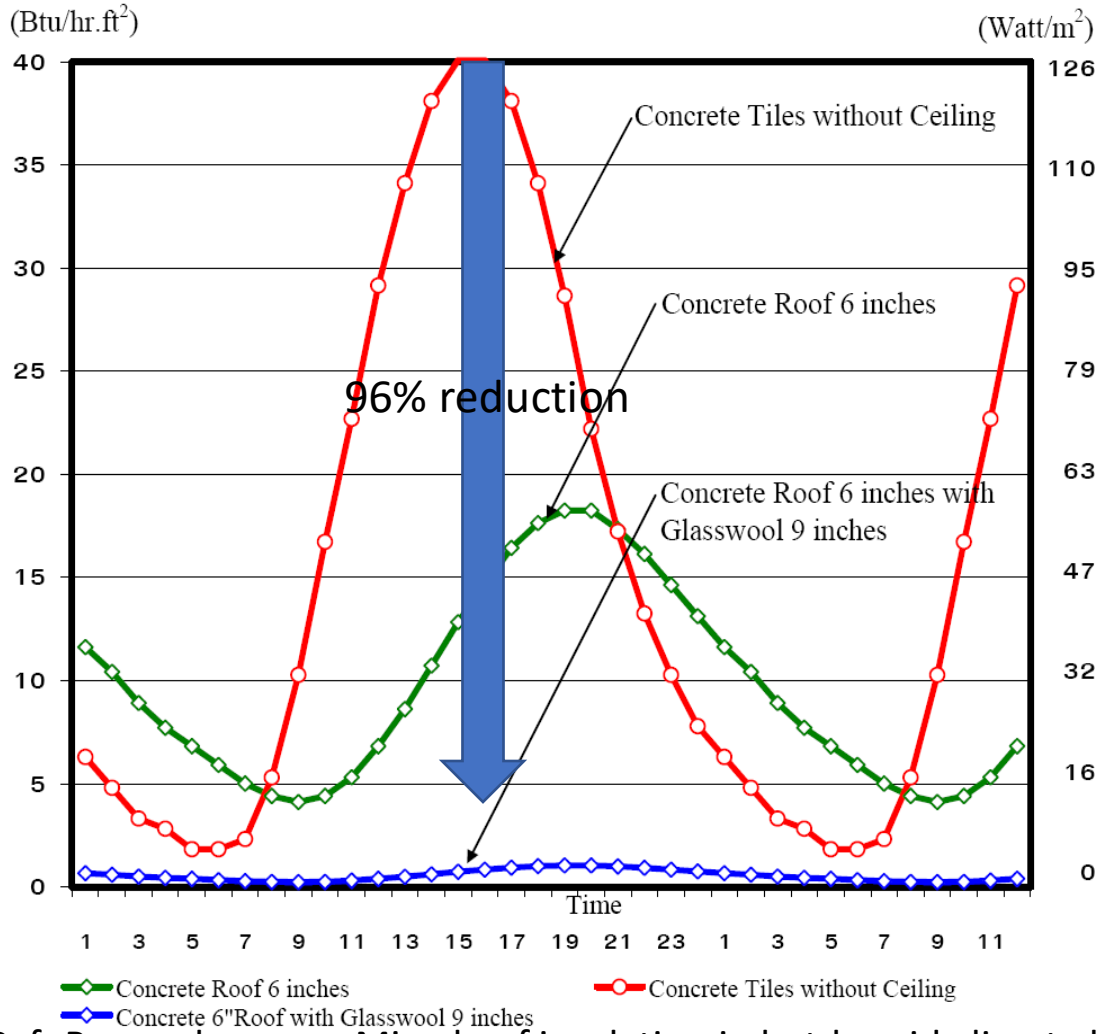
False Ceiling

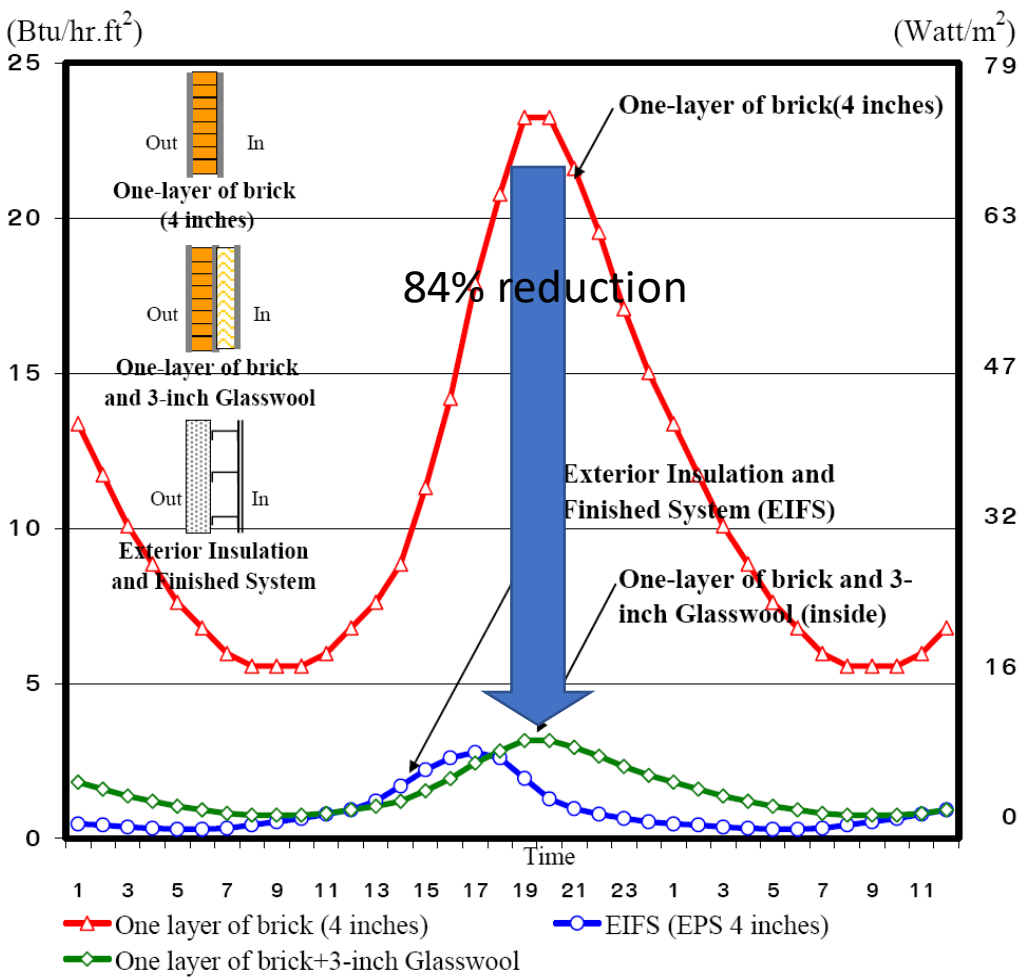
Preinsulated duct



Effect of insulation in building

- 84% reduction in the heat transfer when a brick wall is insulated with 3 inch-thick Glass wool
- Similar demonstration made for roof with conventional insulation options





Ref: Research paper- Miracle of insulation in hot-humid climate building, S Pongsuwan, IJRE V4,2009

Energy saving – case study

Location: Bulandshahr (U.P), Summer, Average DBT: 41.6 C, Inside temperature 23.8 C and 55 % RH (Airconditioned). Maximum 2 walls per room of were exposed to outside ambient and those walls were insulation in 3rd case		Base case: No insulation, RCC roof and Brick wall (Case 1)			Underdeck insulation- 24 Kg/m3-100mm, No wall insulation (Case 2)				Underdeck insulation- 24 Kg/m3-100mm + Wall insulation 24 Kg/m3-50mm (insulation applied only on the wall exposed to outside) (Case 3)			
		KWH	Time (hrs)	Average	KWH	Time (hrs)	Average	KWH saving (%)	KWH	Time (hrs)	Average	KWH saving (%)
	Room 1	28.24	1380		21.24	1262			22.13	1411		
	Room 2	37.95	1380		24.9	1400			14.11	1106		
	Room 3	24.17	824	0.0242	28.25	1380	0.0185	23.76	23.54	1320	0.0152	37
	Room 4	31	1430		20.86	1120			19.1	1340		
	Total	121.36	5014		95.25	5162			78.88	5177		

Thermal comfort – metal roof

Factory building Location: Pune	Outside Ambient (°C) [A]	Surface temperature from underside (°C) [B]	Inside temperature (°C) [C]	Thermal comfort (°C)
Bare steel roof	40 - 42	45	40 - 43	NA
Roof with 16Kg/m3-50mm FSK insulation	40 - 42	36	33 – 36	Min: 4 °C Max: 10 °C

Thermal comfort – RCC roof

School hostel Location: Delhi	Outside Ambient (°C) [A]	Surface temperature from underside (°C) [B]	Inside temperature (°C) [C]	Thermal comfort (°C) [D = A- C]
RCC 150mm	42 - 44	36 - 38	36 - 38	Min: 4 Max: 6
Roof with 48Kg/m3-50mm insulation+ Gypsum board ceiling	42 - 44	33 - 35	33 - 35	Min: 7 Max: 9

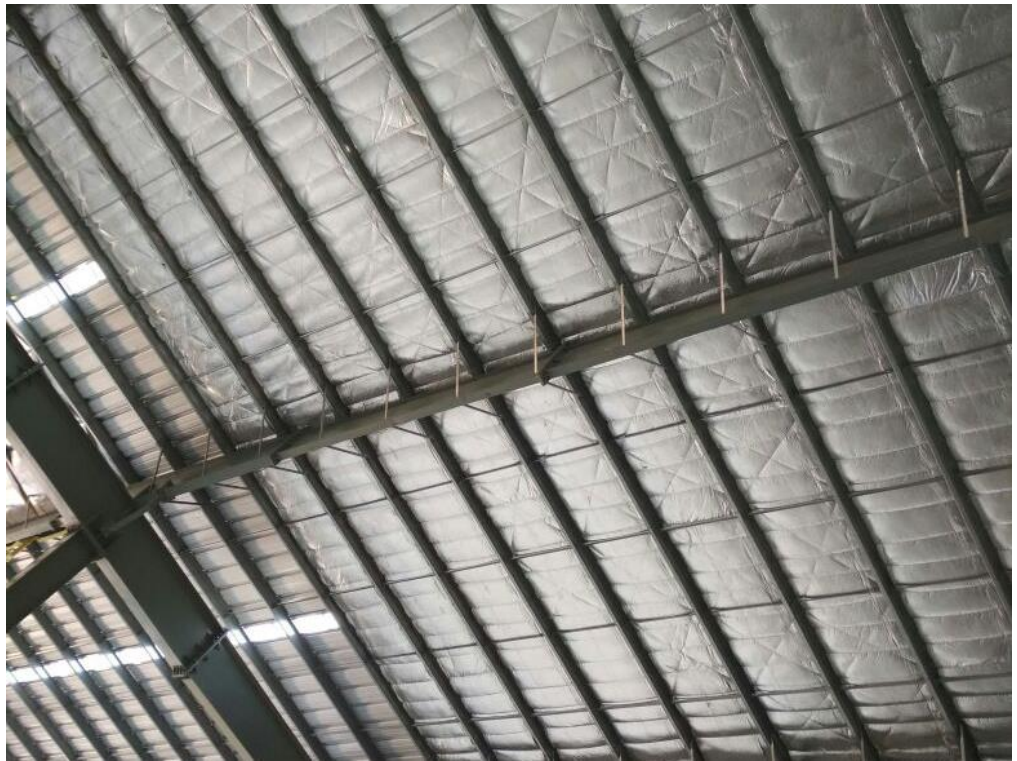
Retrofit with Under-deck insulation with plaster

- Insulation application underside of true ceiling
- Long and strong insulation boards with minimum undulation
- Special plaster are applied on the exposed face of the insulation board
- Excellent thermal performance
- Excellent acoustic absorption and impact isolation

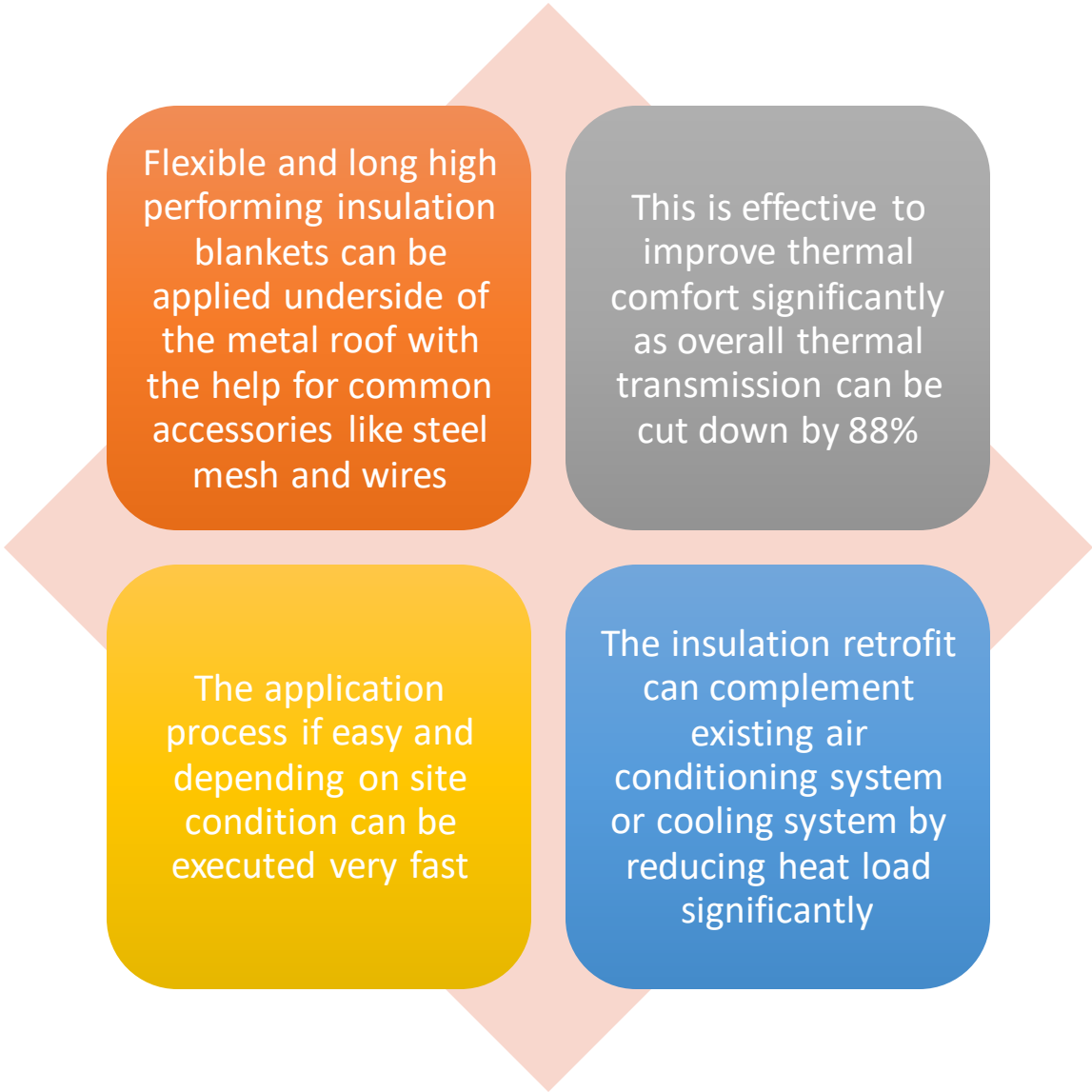
Under-deck insulation with false ceiling

- Alumiunum foil laminated insulation boards are fixed to the true ceiling with the help of polyamide fasteners
- Supports of the false ceiling taken from true ceiling and grid system are installed. Later false ceiling boards/tiles should be installed
- Excellent thermal performance
- Excellent impact noise isolation

Metal Roof and Wall Insulation retrofit



Metal Roof and Wall retrofit/redesigning with insulation

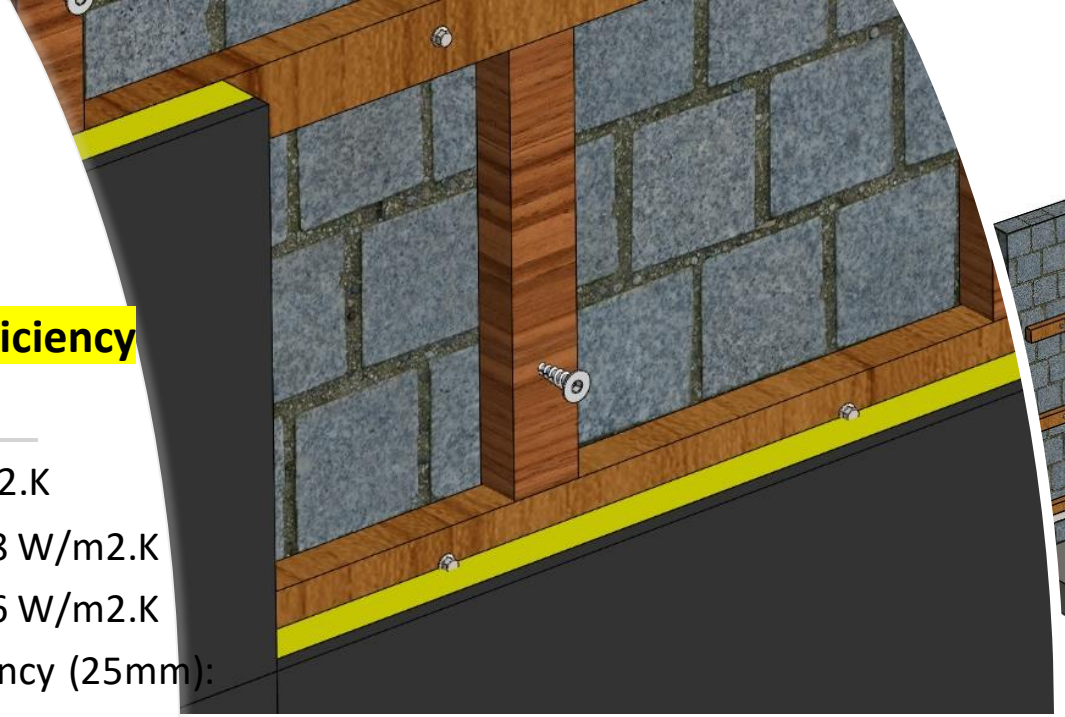


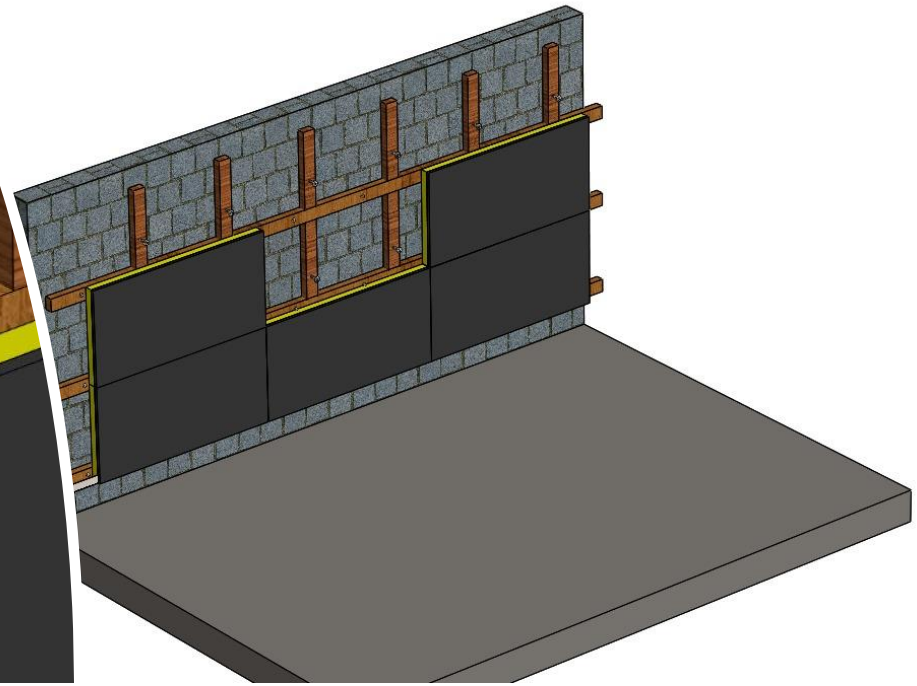
Wall Insulation Lining retrofit

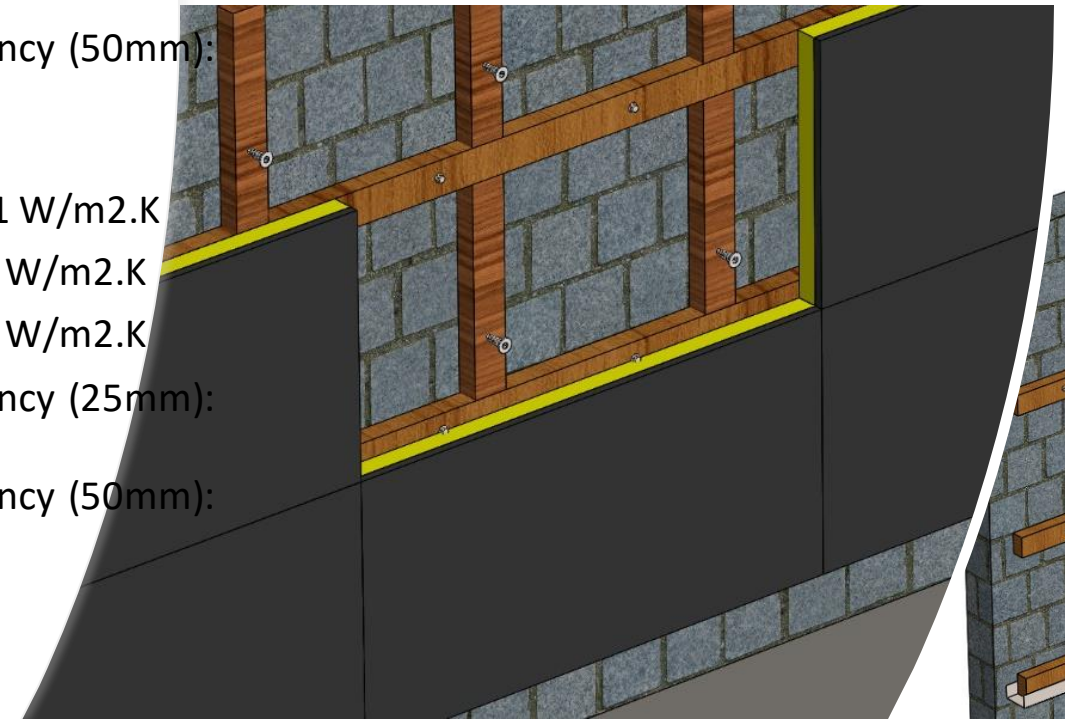
35%-85% higher thermal efficiency

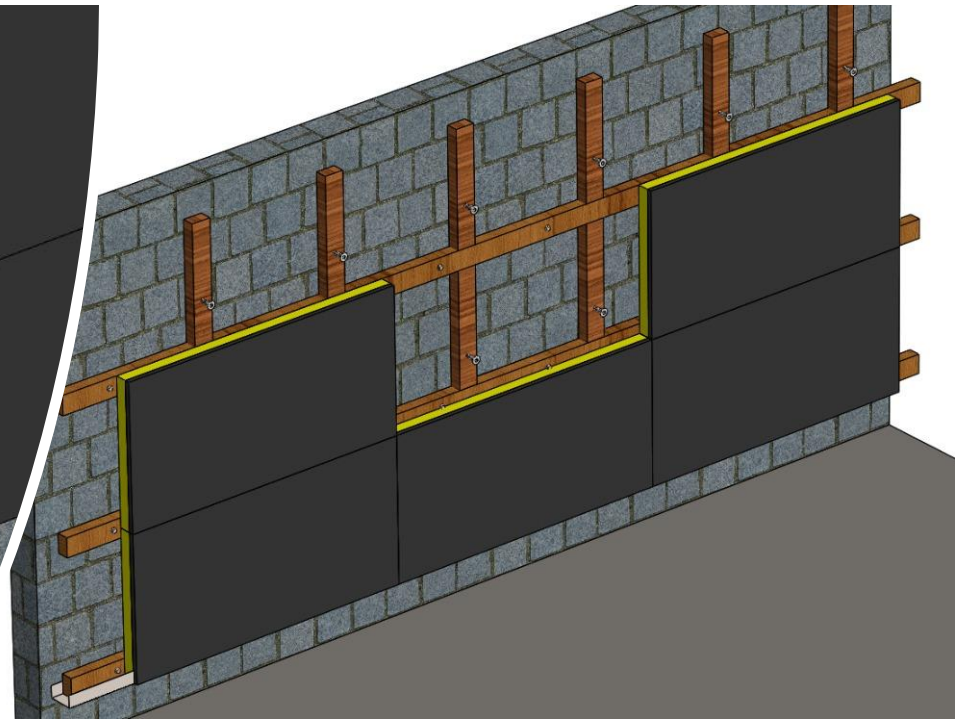
- U (uninsulated-brick): 3.7 W/m2.K
- U (brick, insulated-25mm): 0.98 W/m2.K
- U (brick, insulated-50mm): 0.56 W/m2.K
- Improvement in thermal efficiency (25mm): 74%
- Improvement in thermal efficiency (50mm): 85%

- U (uninsulated-AAC block): 0.71 W/m2.K
- U (AAC, insulated-25mm): 0.46 W/m2.K
- U (AAC, insulated-50mm): 0.34 W/m2.K
- Improvement in thermal efficiency (25mm): 35%
- Improvement in thermal efficiency (50mm): 52%









Q & A

Thank You

Biswajit Roy
Mobile: +91 9873436527
Email: biswajit@twigafiber.com

U.P. Twiga Fiberglass Ltd
Twiga House
3, Community Centre
East of Kailsah
New Delhi. India. Pin 110065
Website: www.twigafiber.com
E-mail: marketing@twigafiber.com
Phone: +91 11 26460860