Thermally Appropriate Building Material Technologies

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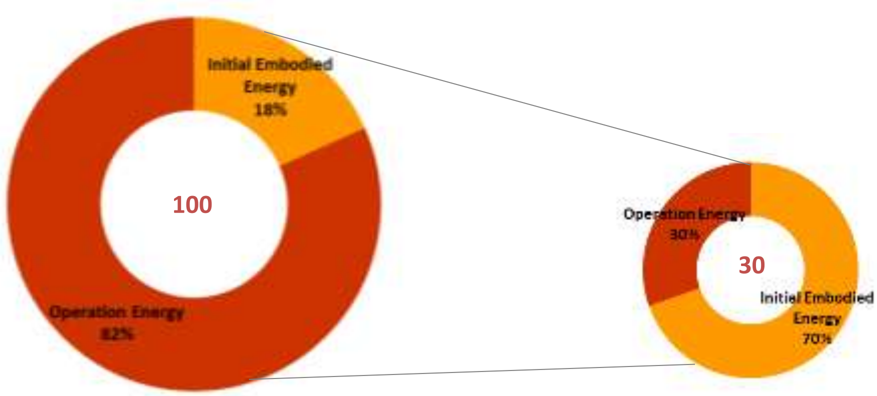
Energy Efficiency in Buildings

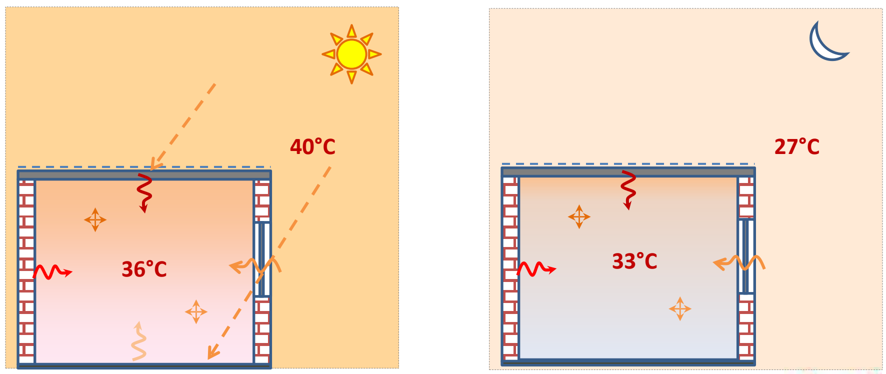


Conventional Building

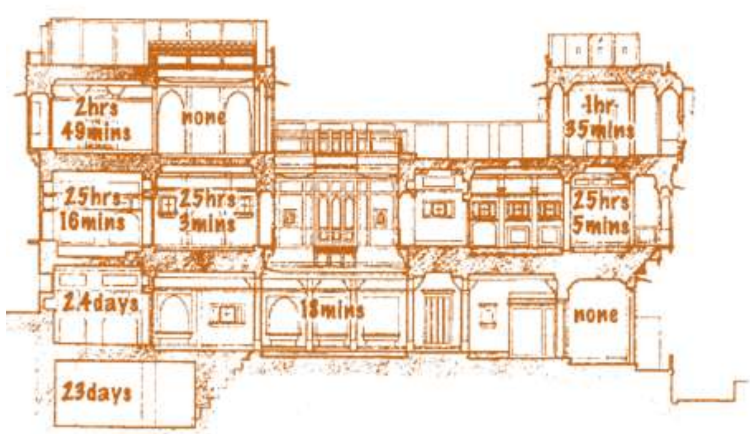
Low Energy Building

Thermal Performance of Building Materials

- Indigenous materials
- Thermally appropriate materials

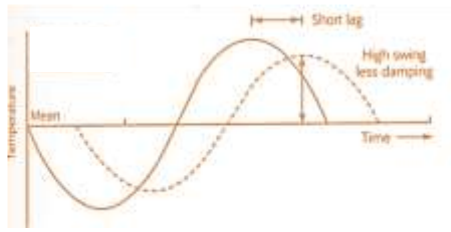


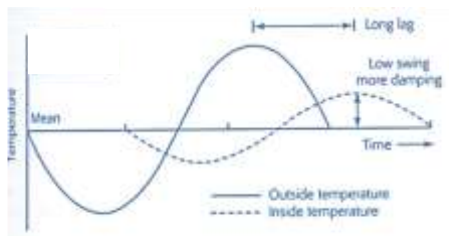
Thermal Performance of Building Materials



Sue Roaf et al, 2001, Ecohouse-A design guide

Thermal Performance of Building Materials





Randall McMullan 1983, Environmental Science in Building

Phase Change Materials

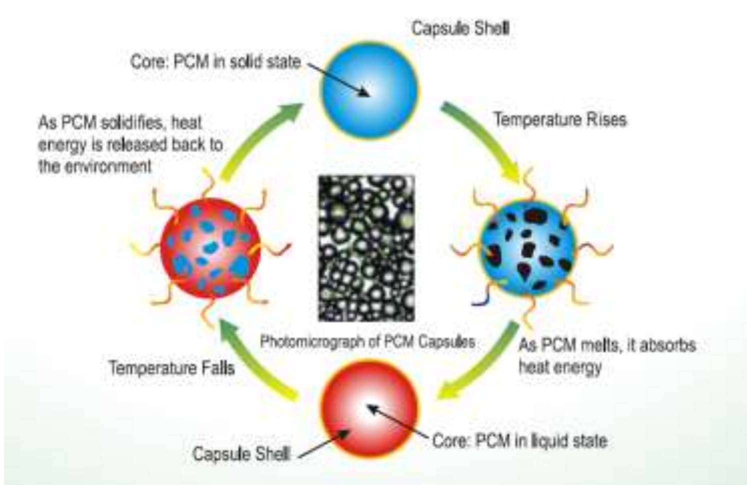
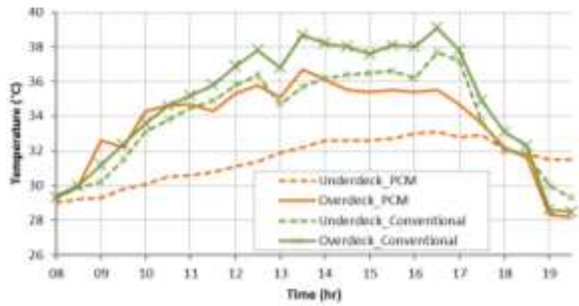
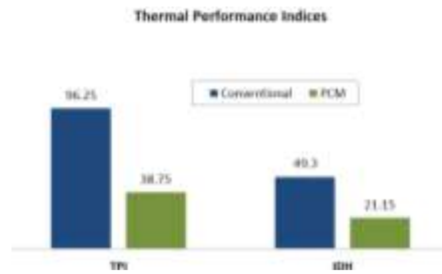


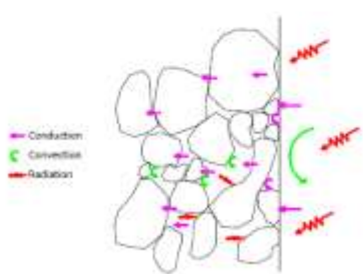
Image Courtesy: Insulla

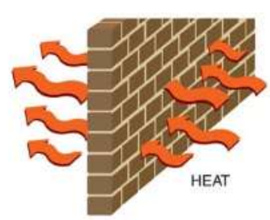
Phase Change Materials





Thermal Performance of Building Materials





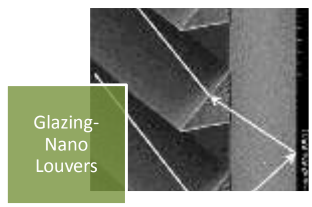
- Mineral Characteristics
- Heat capacity and thermal conductivity

- Density/Porosity
- Thickness

- Surface Texture
- Reflectivity

N C Balaji et al, 2014, Discerning heat transfer in building materials; Jacqueline D. Spears & Dean Zollman, 1990, Fascination of Physics

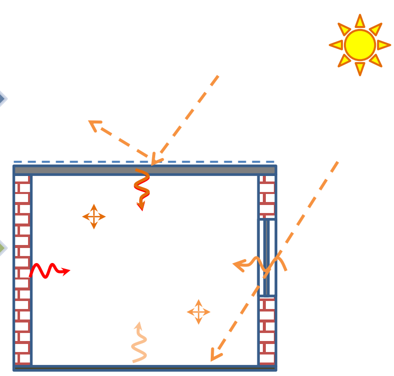
Thermal Performance of Building Materials



Bhavani Balakrishna, 2011, Ceramic Insulation Paints: The need for Insulating construction materials, Gu¨ nther Walze et al, 2005, Combination of microstructures and optically functional coatings for solar control glazing

The Issue and Solution

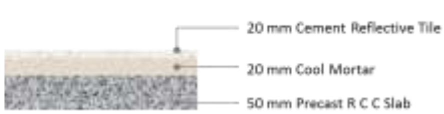
Issue	Solution
Major source of heat gain by the roof is absorbed solar radiation	Reflect incident solar radiation using high albedo surface
Heat gain through roof elevates ceiling surface temperature and causes radiant heat load inside the building	Store absorbed radiant heat for longer time by using heavier materials
When hot ambient air touches these surfaces, the inside air might become hotter than outside	Make indoor surface temperatures near to air temperatures, reduce heat load



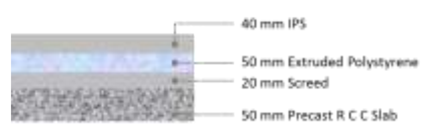
Hypothesis

- Maintaining the surface temperature equal to or lower than the air temperature by reflecting back the solar radiation and further using minimal heat insulation performs better than a highly insulated surface.
- Light and highly resistive materials (low heat capacity) have a minor impact in un- conditioned buildings located in hot dry climates when surfaces are either reflective or shaded

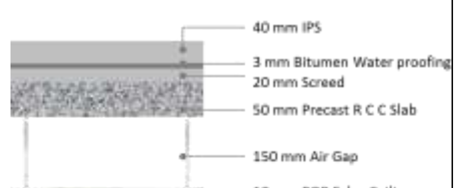
Experimental Setup



Roof 1_ Cement Tile

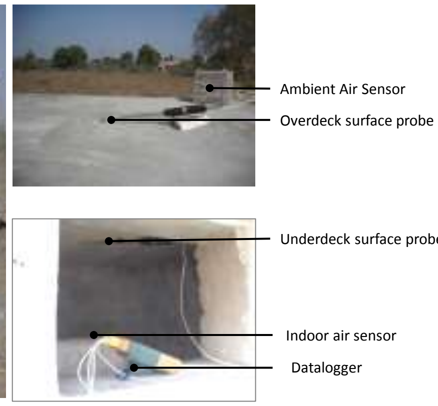


Roof 2_ XPS



Roof 3_ POP False Ceiling

Experimental Setup



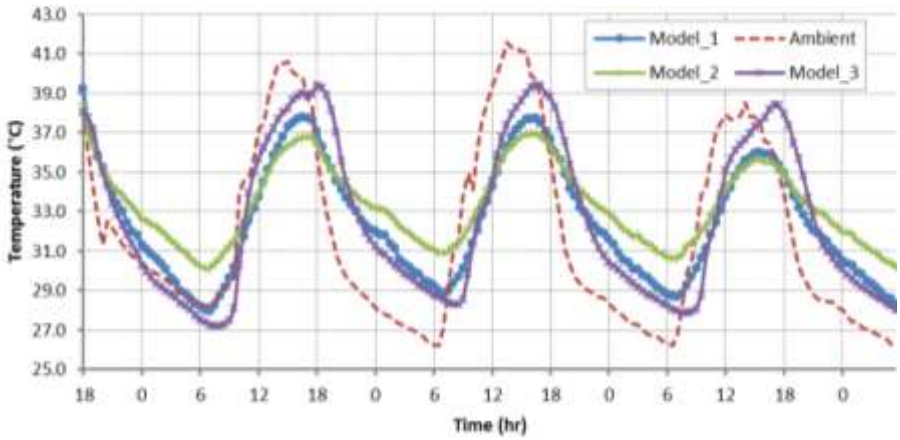
Performance Indices

Theoretical
- U-Value
- Admittance

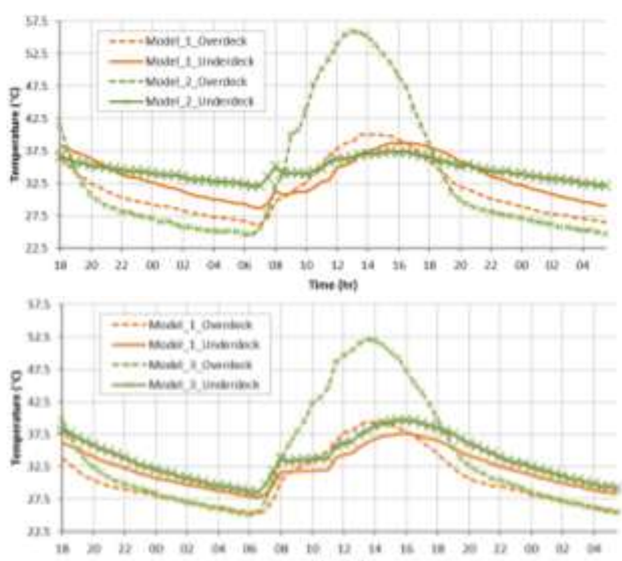
Experimental
- Time lag
- Decrement Factor

Comfort
- Building Index
- Discomfort Degree Hour

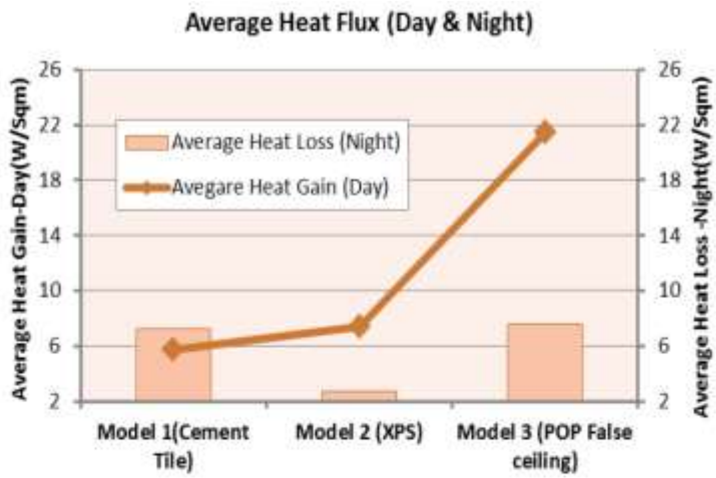
Air Temperature



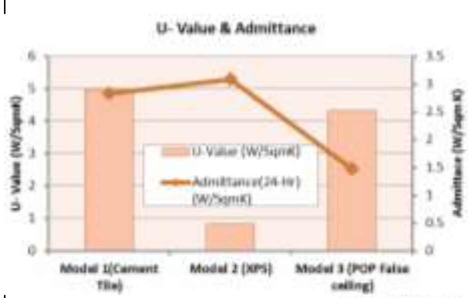
Surface Temperature



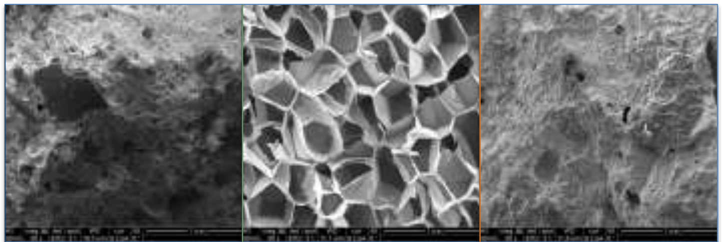
Performance Indices



Performance Indices



Physical Structure



Cool mortar -Model 1		Extruded Polystyrene- Model 2		POP false ceiling board-Model3	
Conductivity	0.451	Conductivity	0.028	Conductivity	0.499
Specific heat	0.87	Specific heat	1.25	Specific heat	0.2
Density	1850	Density	34	Density	1080
Volumetric Heat Capacity	**1925**	Volumetric Heat Capacity	**1290**	Volumetric Specific heat	**764**

Conclusions

- Innovative indigenous materials like cement tile performs better in 24-hour occupied residential buildings in hot and dry climates due to its high volumetric heat capacity.
- Indicators like Discomfort Degree Hour & heat flux clearly show better thermal performance of the cement tile
- There is a need for a more specific and climate wise thermal performance indices for the codes like Energy Conservation Building Code (ECBC) of India

Thank You

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