Thermally Responsive Building Materials and Technologies

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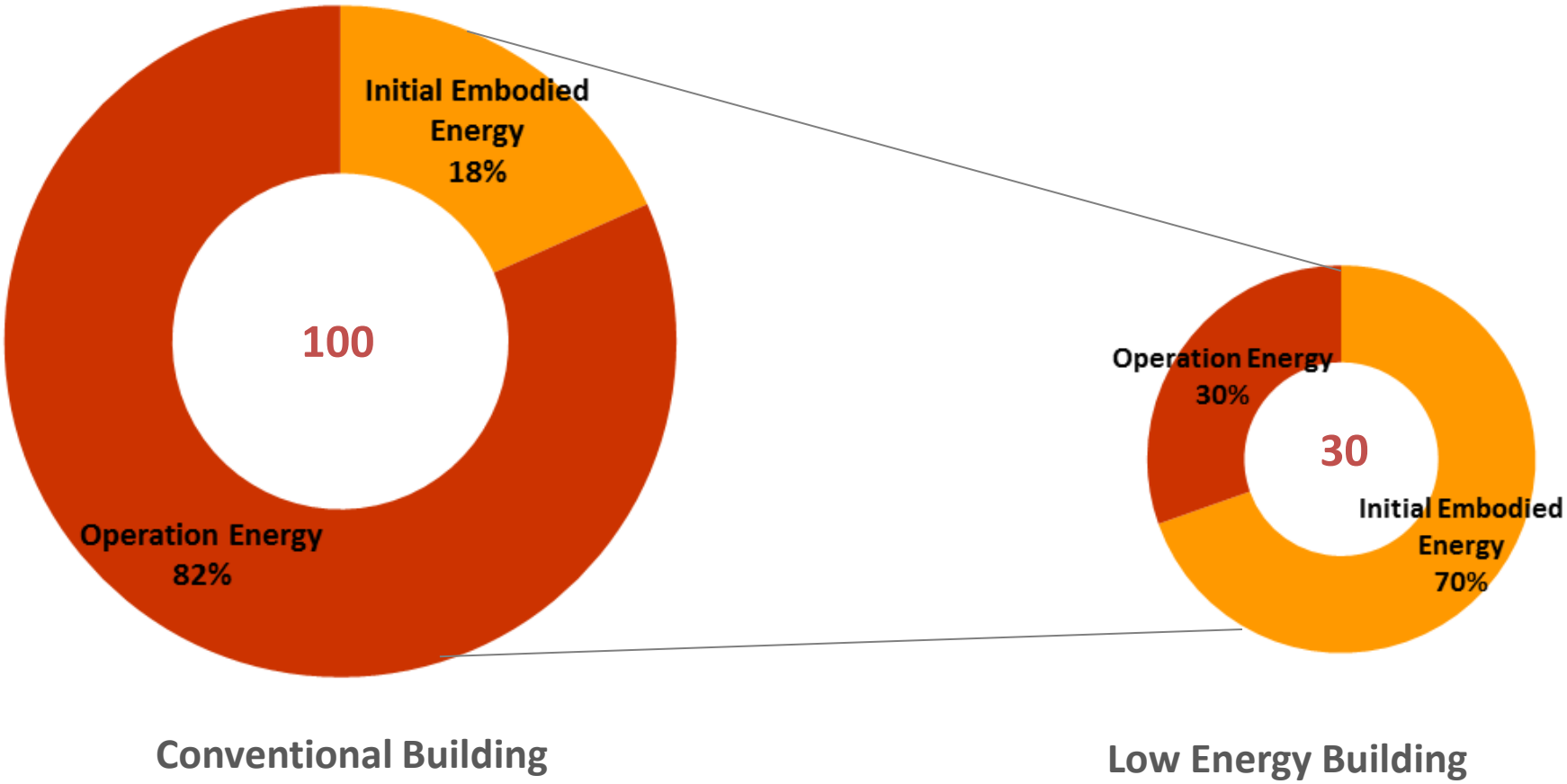
Energy Efficiency in Buildings

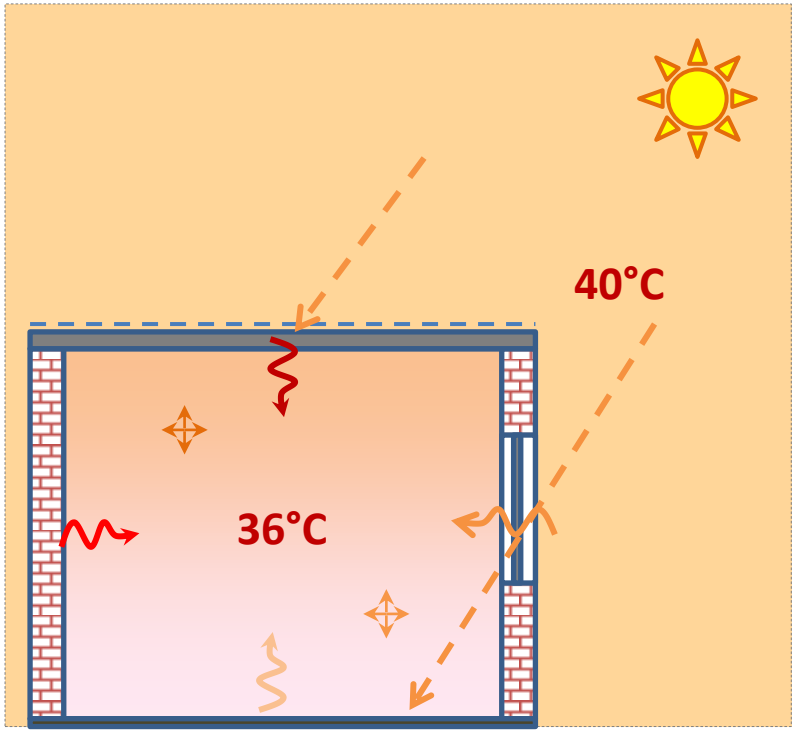


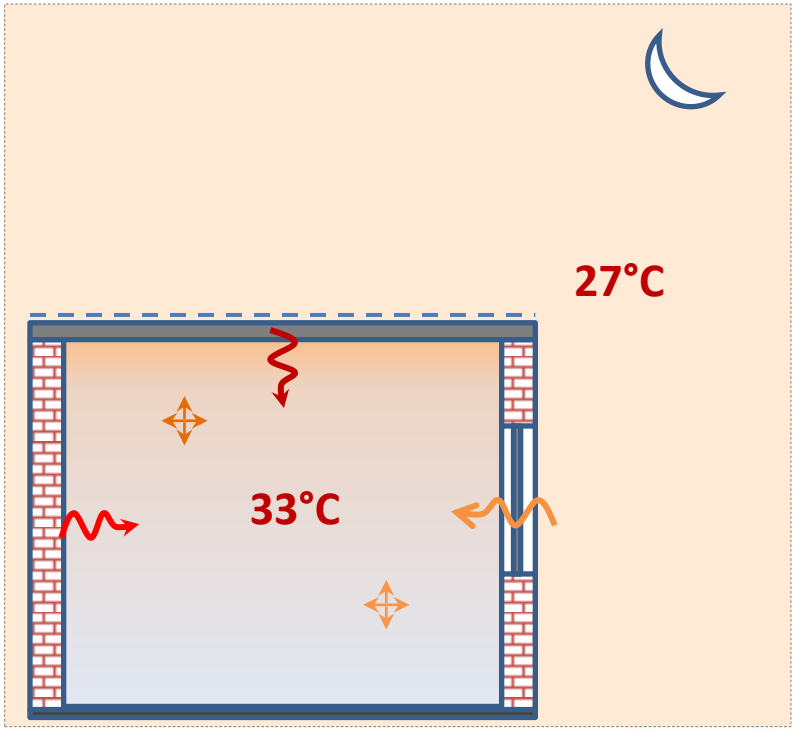
Conventional Building

Low Energy Building

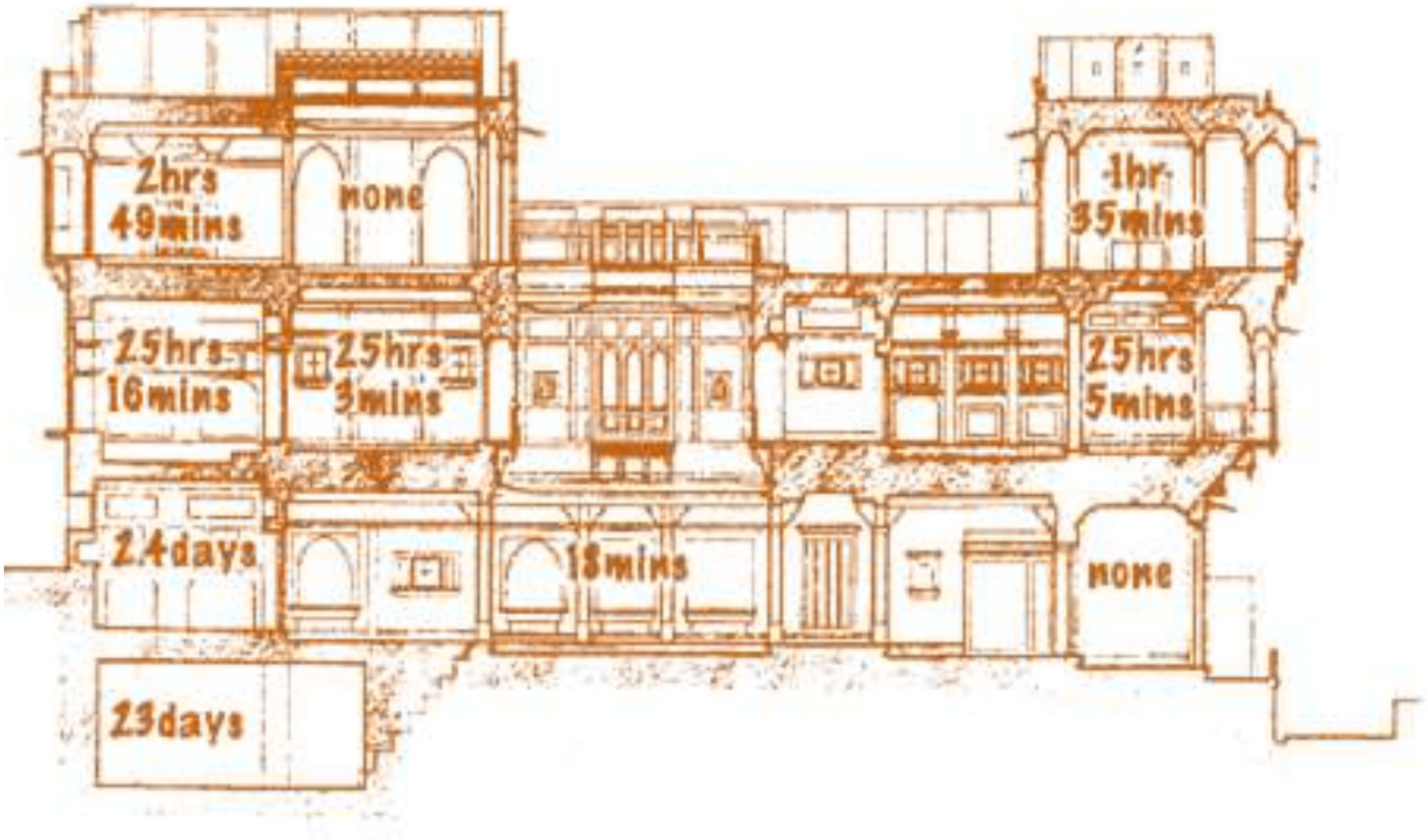
Thermal Performance of Building Materials

- Indigenous materials
- Thermally appropriate materials



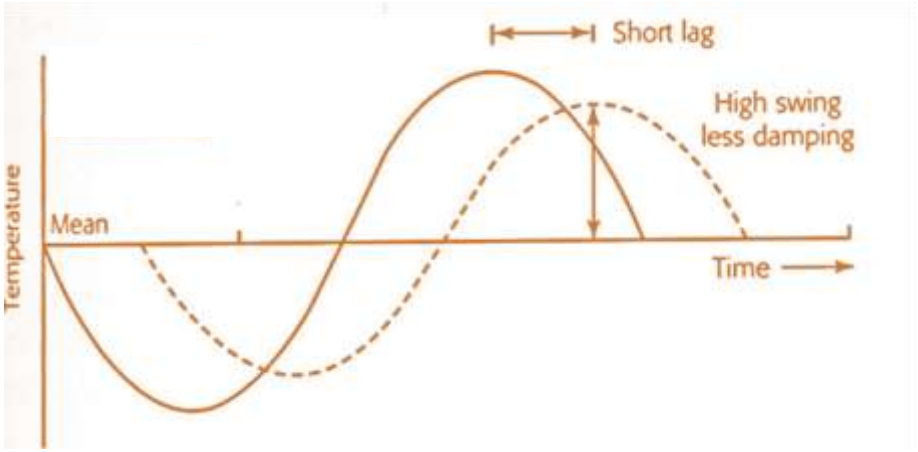


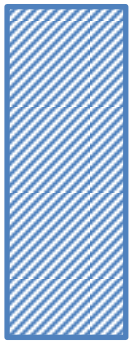
Thermal Performance of Building Materials

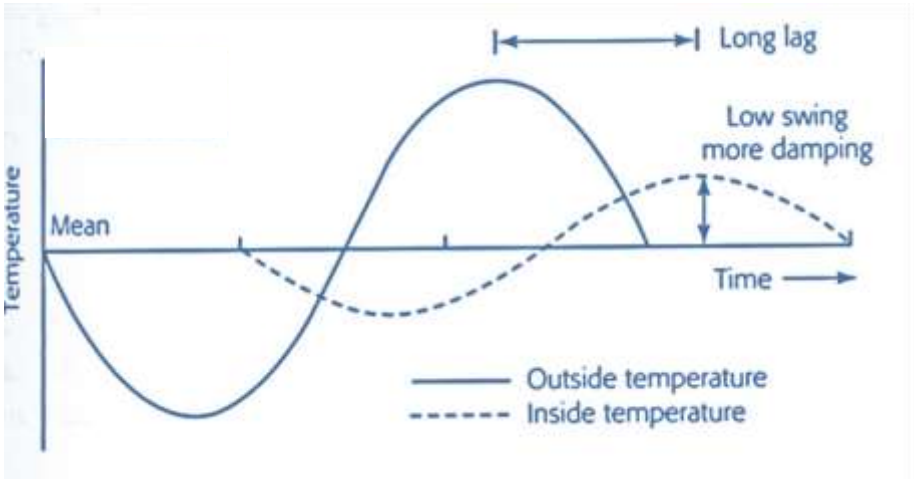


Sue Roaf et al, 2001, Ecohouse-A design guide

Thermal Performance of Building Materials







Randall McMullan 1983, Environmental Science in Building

Phase Change Materials

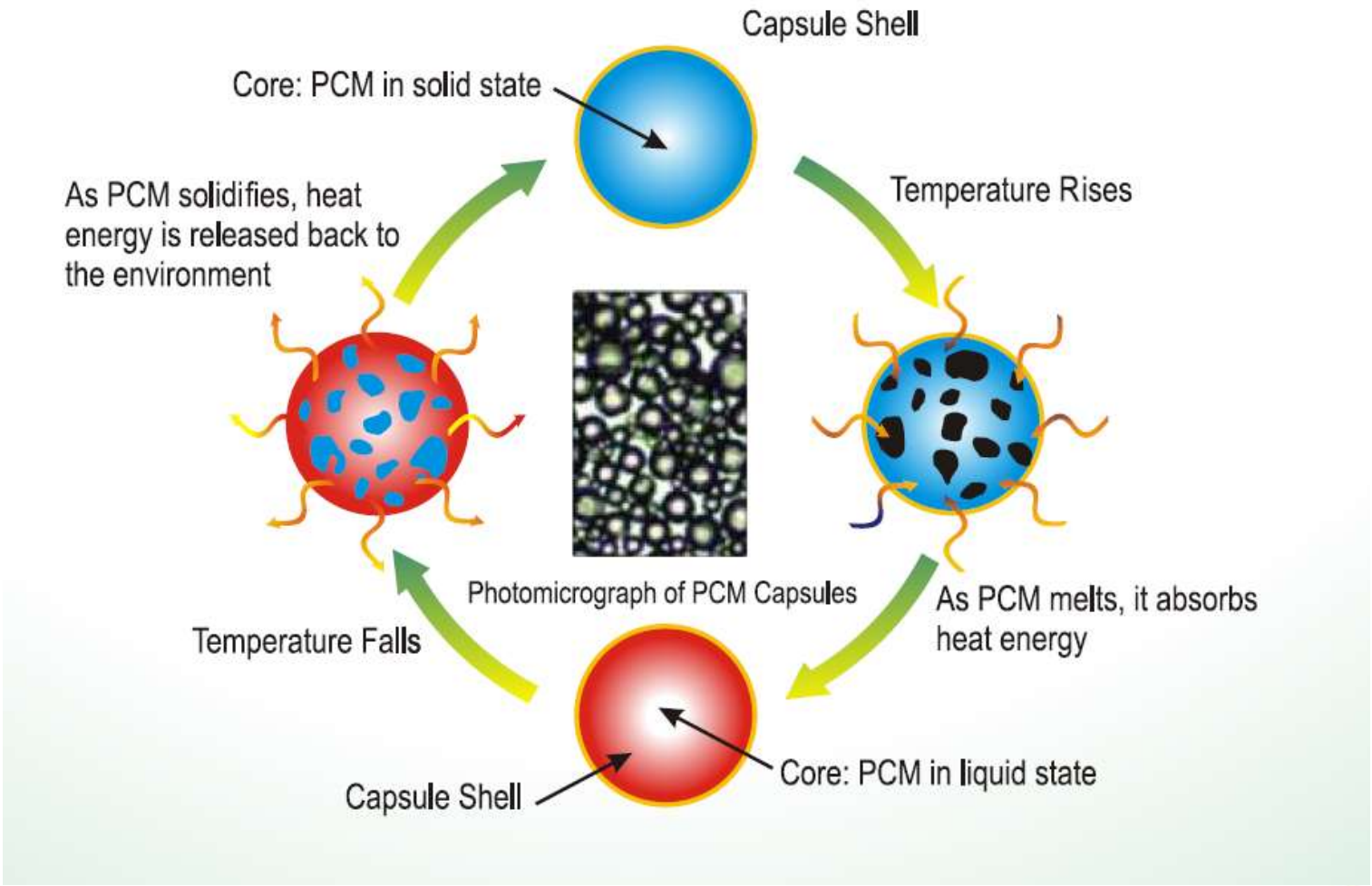
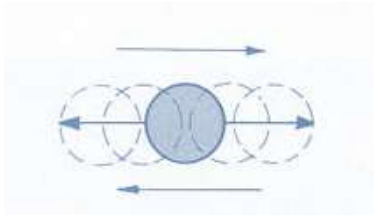
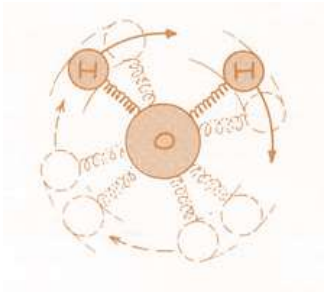
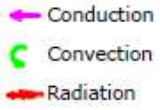


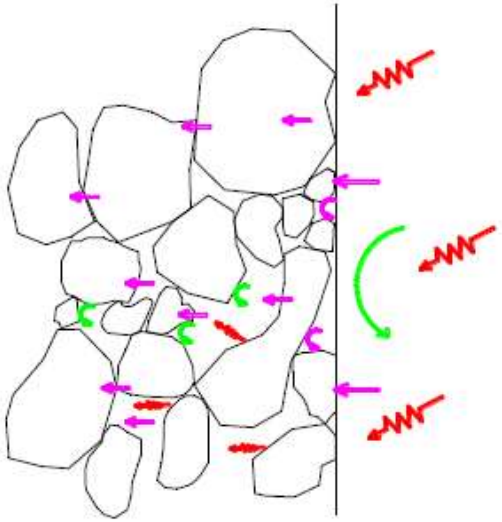
Image Courtesy: Insulla

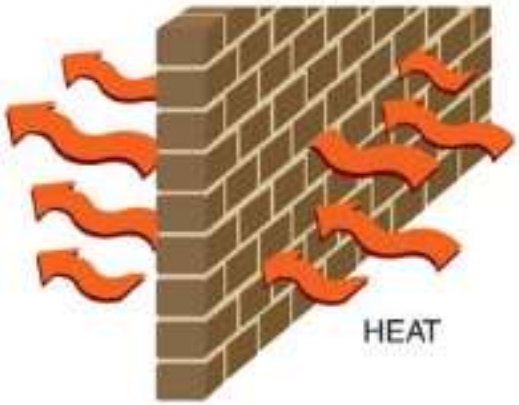
Thermal Performance of Building Materials











- Mineral Characteristics
- Heat capacity and thermal conductivity

- Density/Porosity
- Thickness

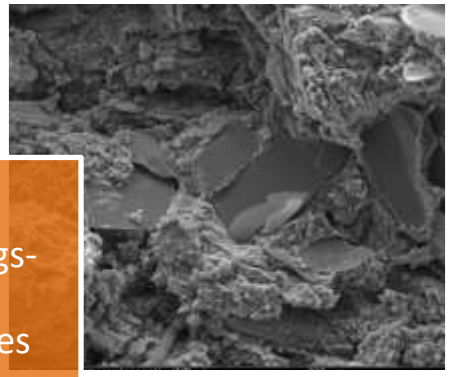
- Surface Texture
- Reflectivity

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

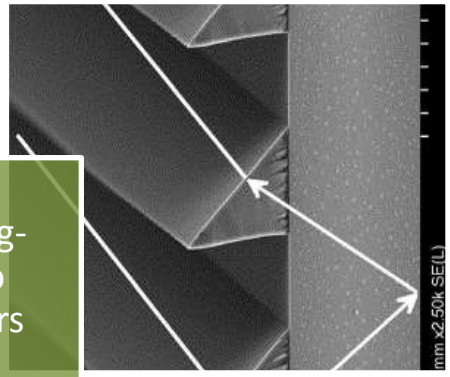
Thermal Performance of Building Materials

Roof Coatings- Cenospheres

Roof Coatings- Mica particles



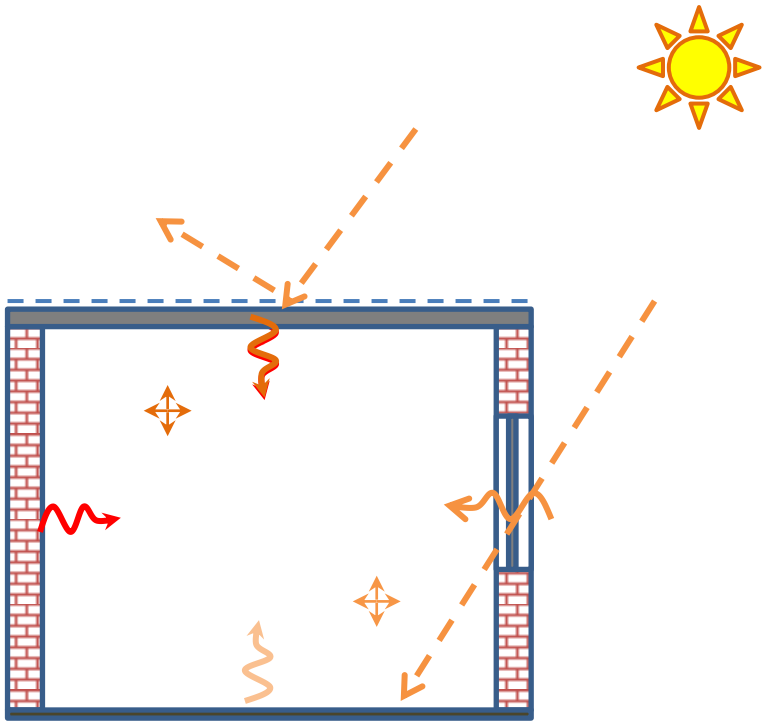
Glazing- Nano Louvers



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

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

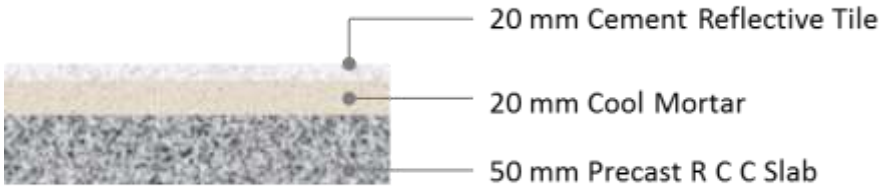


Hypothesis

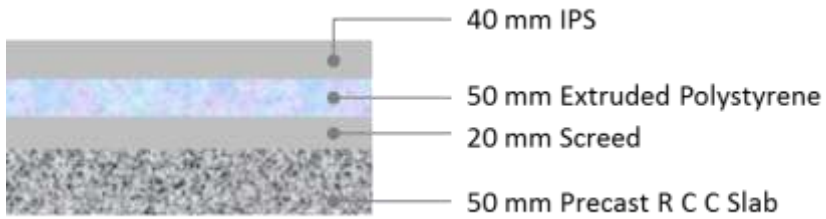
- Maintaining the surface temperature equal to or lower than the air temperature by reflecting back the solar radiation and further using minimal heat insulation performs better than a highly insulated surface.

- 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

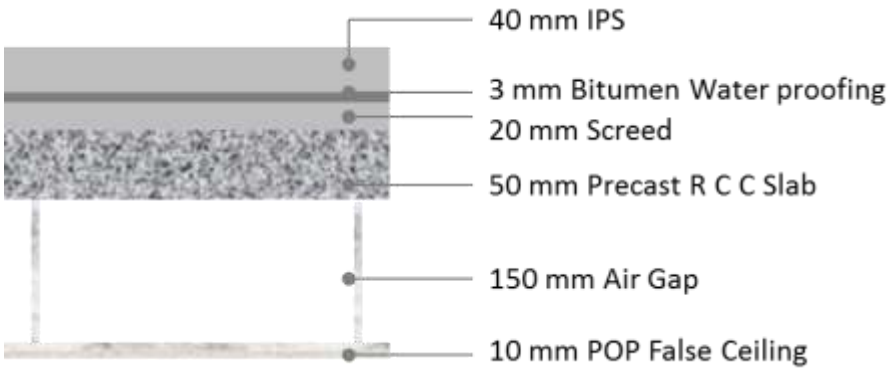
Experimental Setup



Roof 1_ Cement Tile

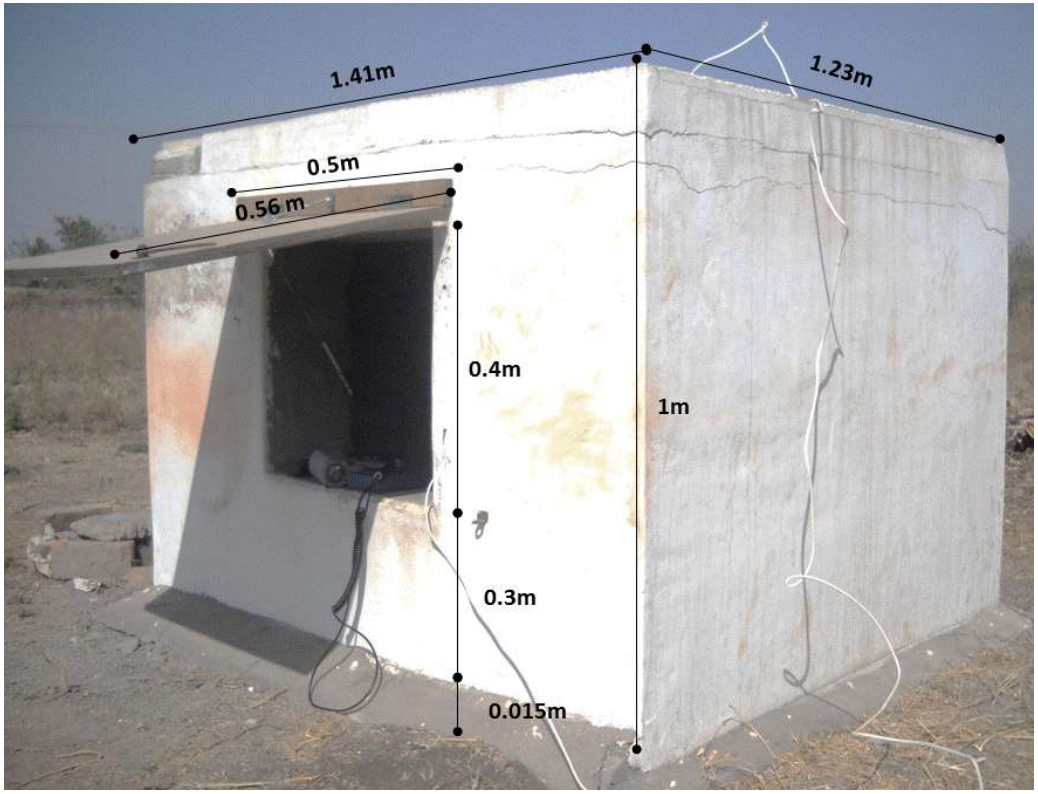


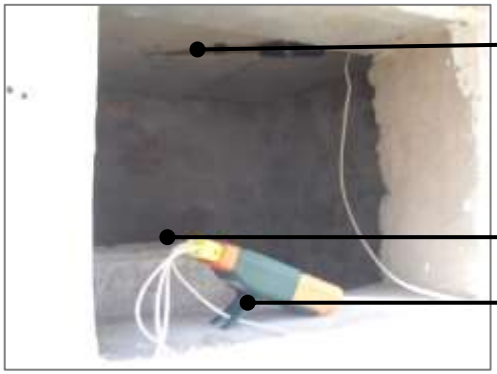
Roof 2_ XPS



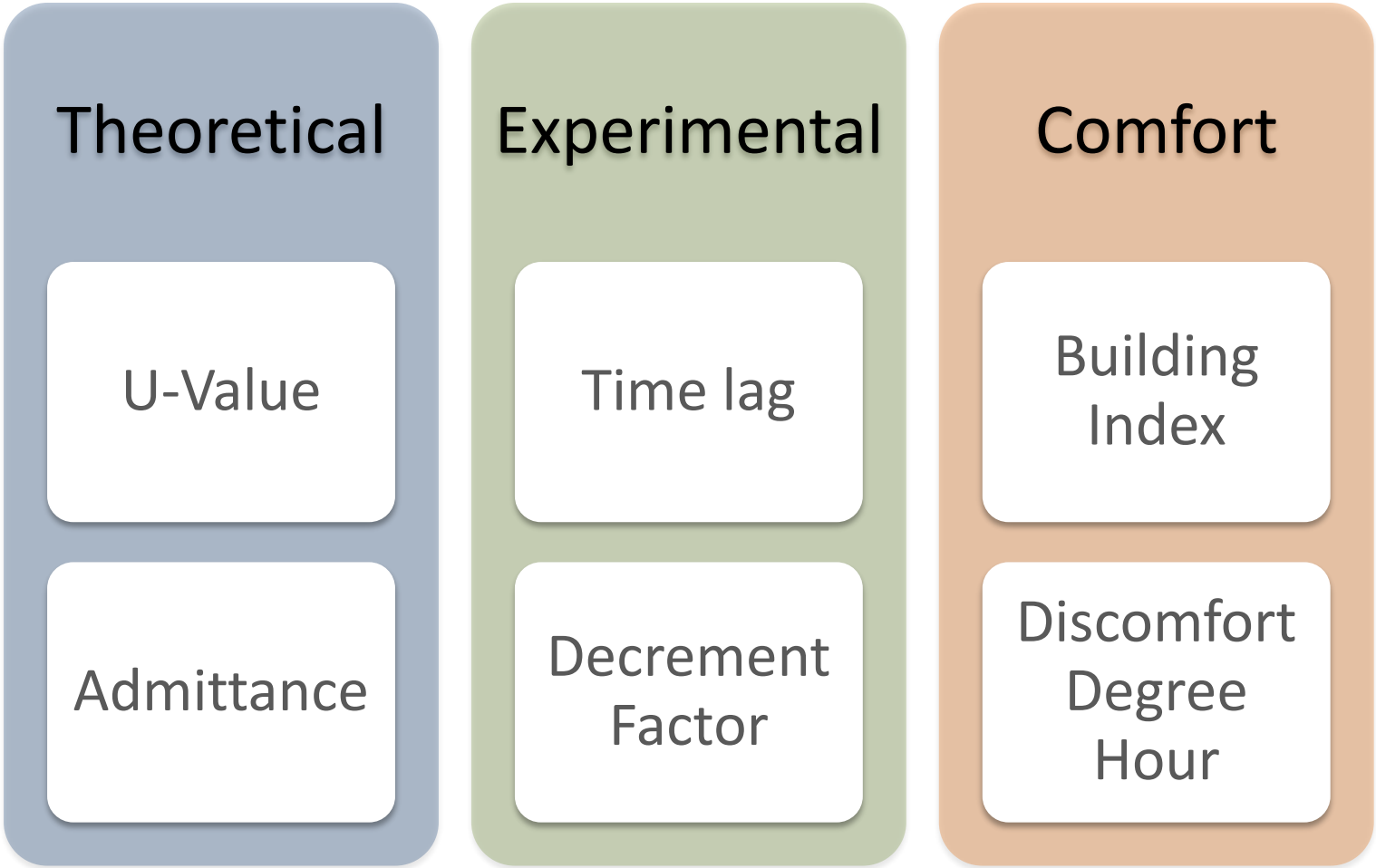
Roof 3_ POP False Ceiling

Experimental Setup

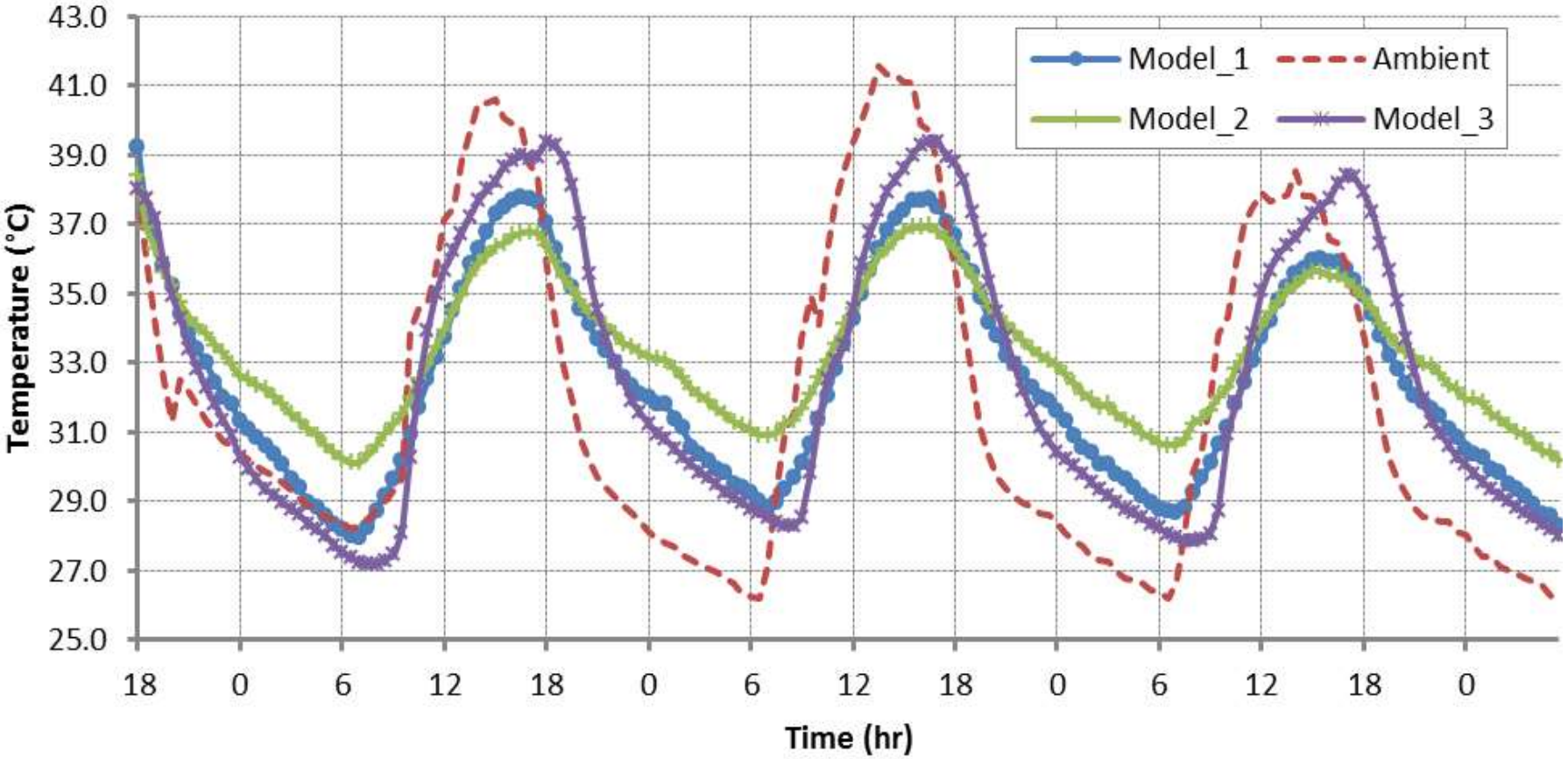




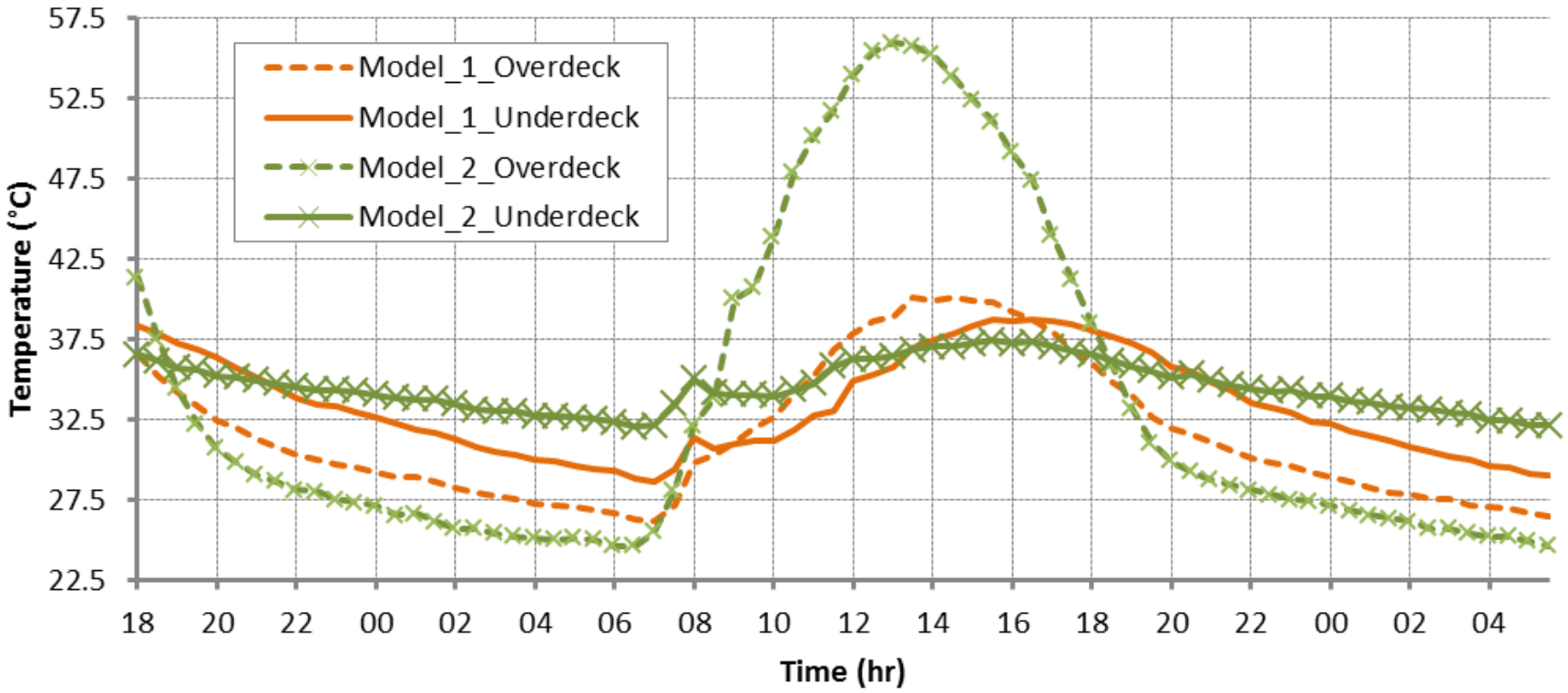
Performance Indices



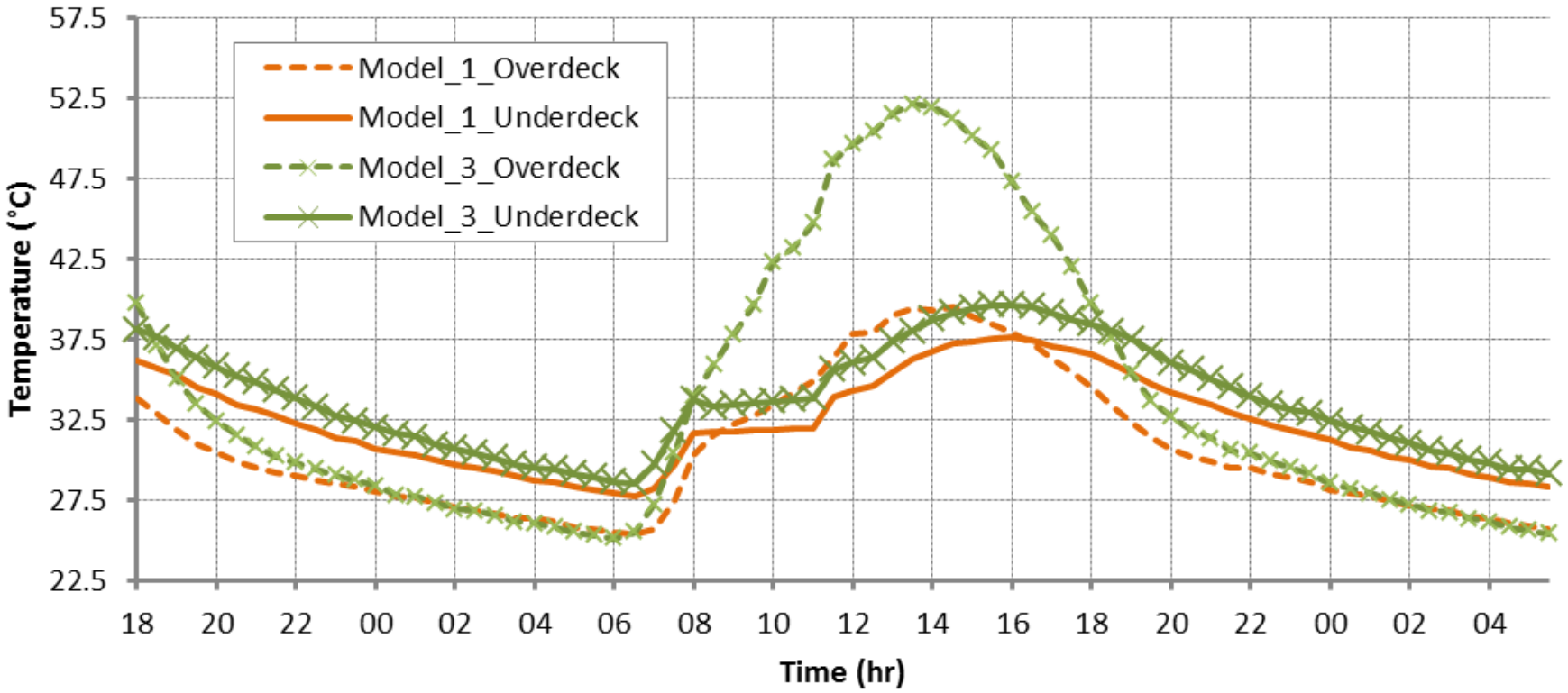
Air Temperature



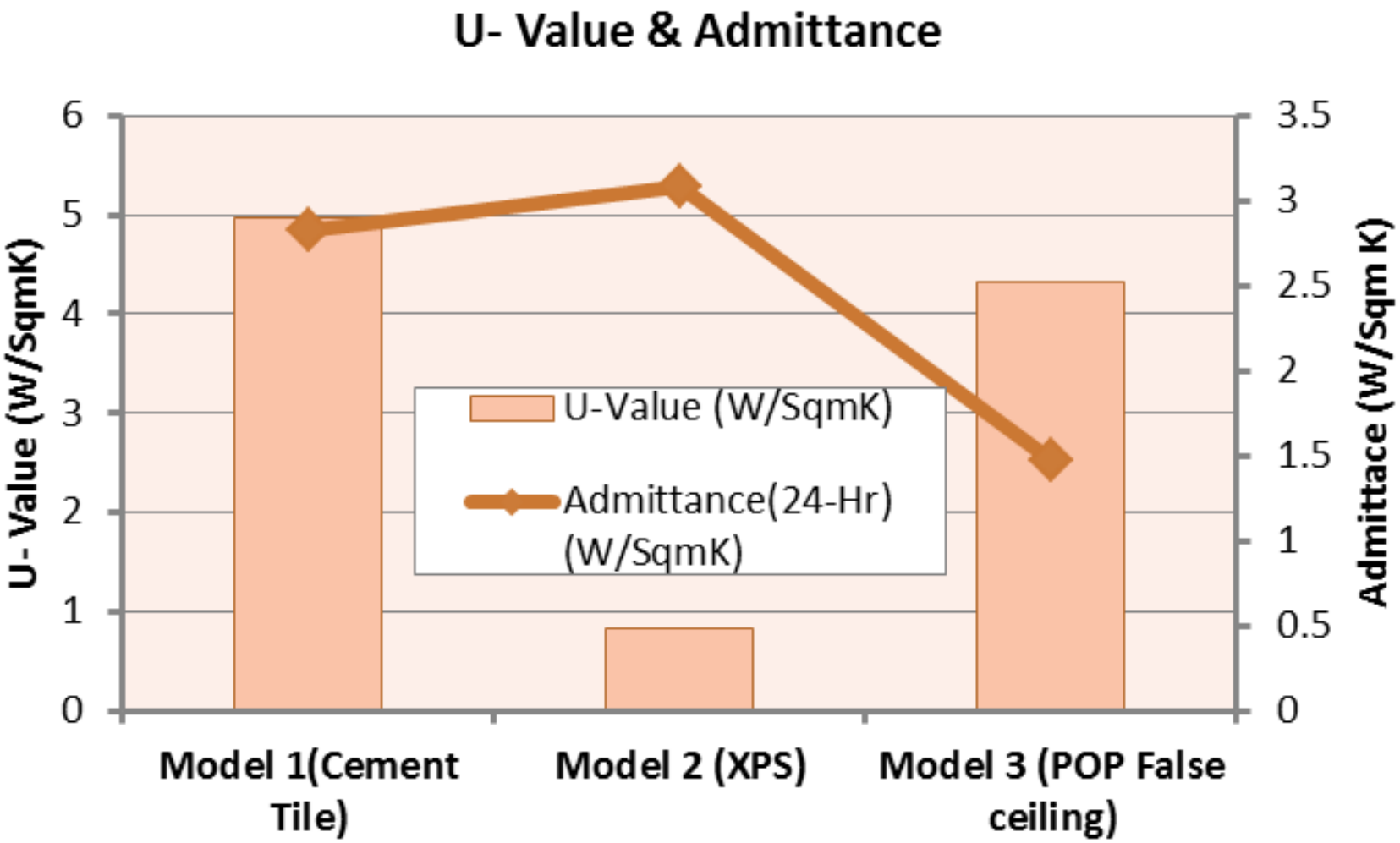
Surface Temperature



Surface Temperature



Performance Indices



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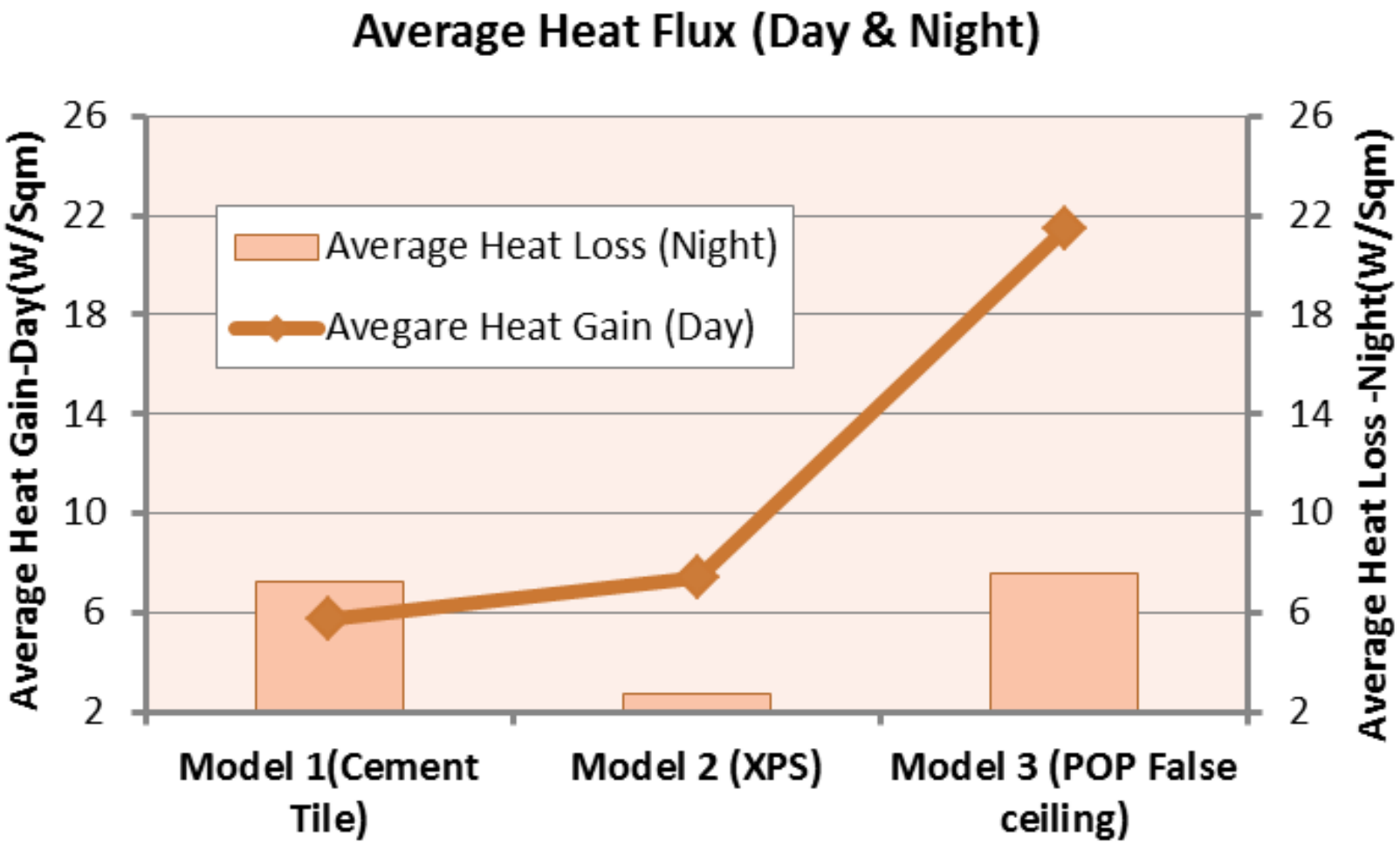

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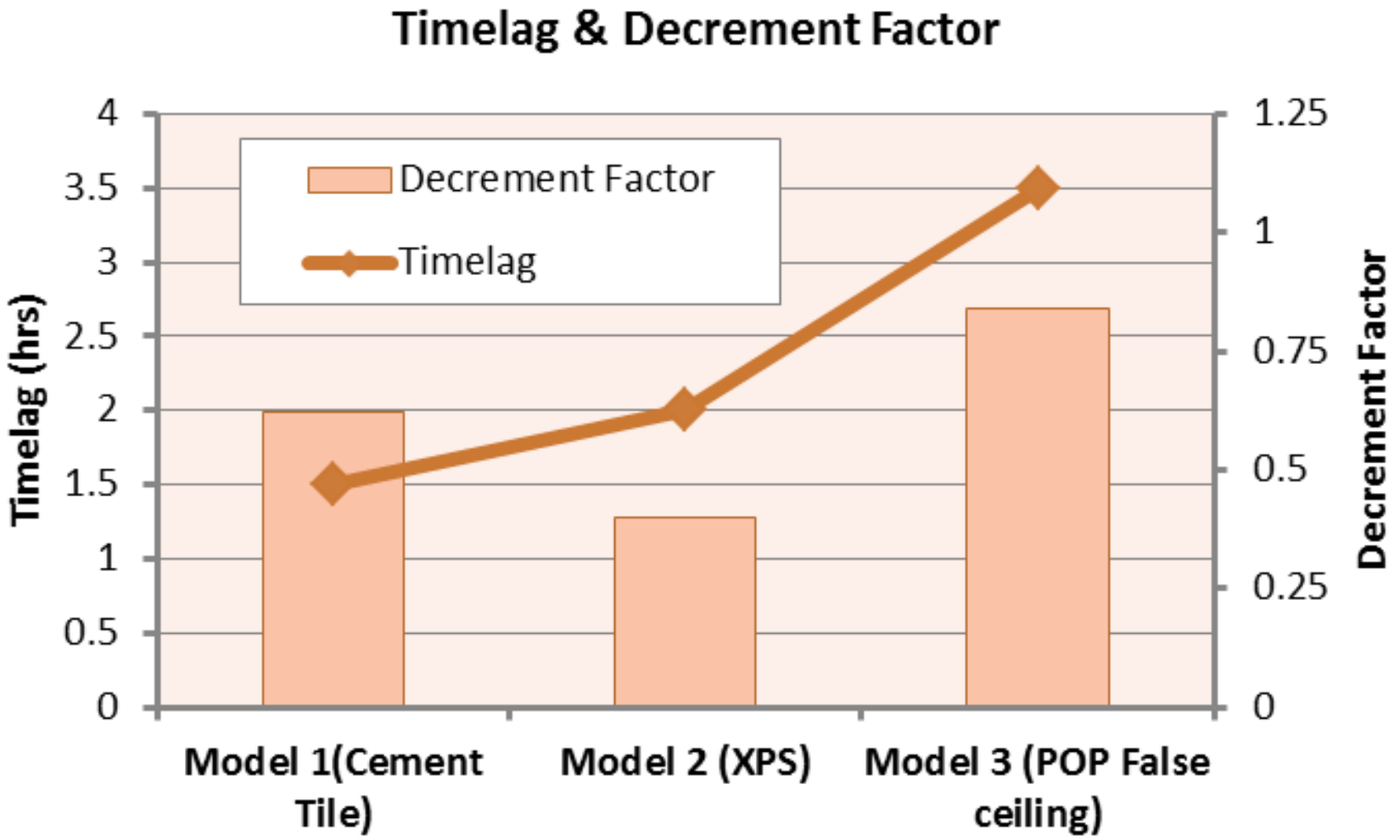

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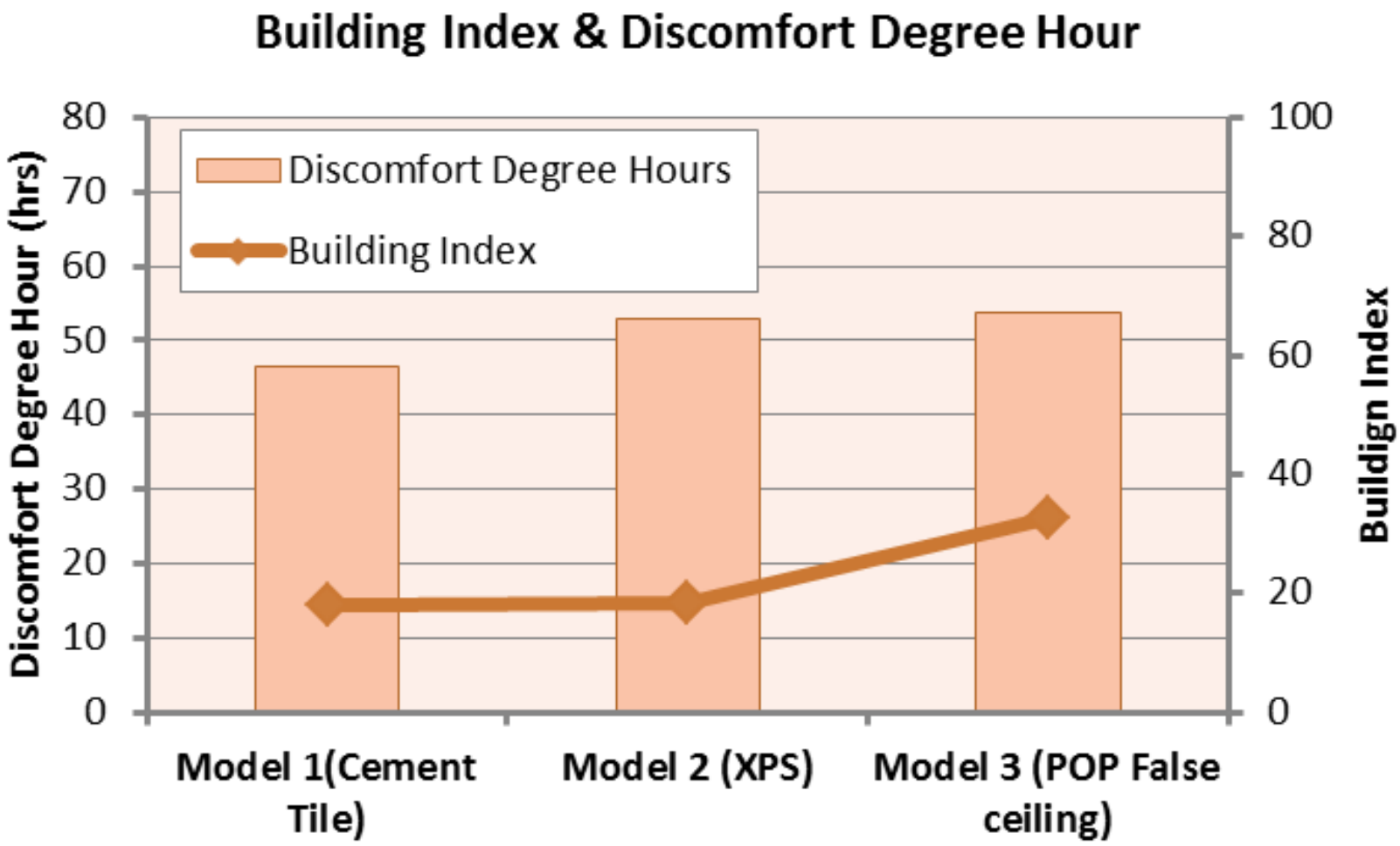
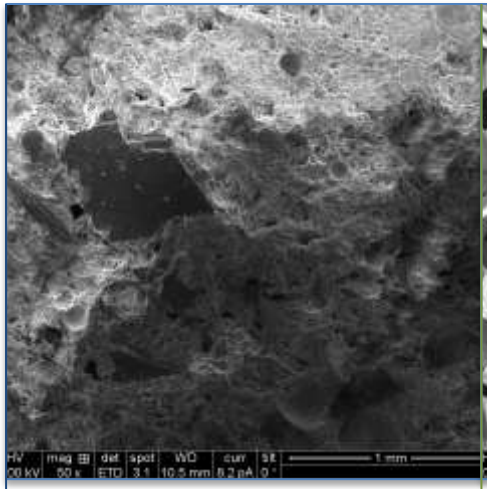


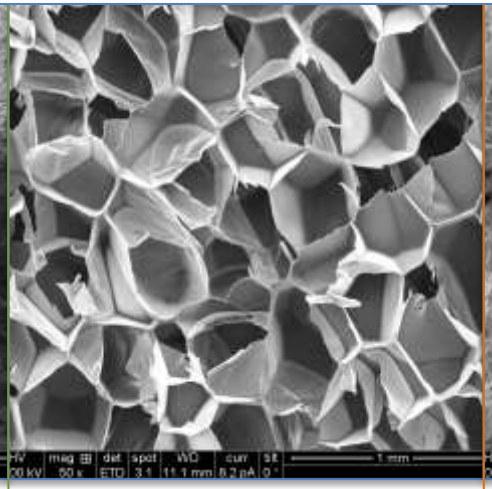
Physical Structure



Cool mortar -Model 1

Conductivity	0.451
Specific heat	0.87
Density	1850

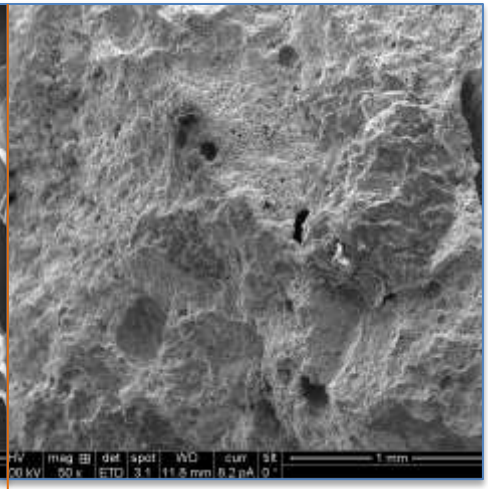
Volumetric Heat Capacity **1925**



Extruded Polystyrene- Model 2

Conductivity	0.028
Specific heat	1.25
Density	34

Volumetric Heat Capacity **1290**



POP false ceiling board- Model3

Conductivity	0.499
Specific heat	0.2
Density	1080

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 by 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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