Materials & Energy Efficiency
BUT TODAY THE SCENARIO IS DIFFERENT......
Buildings Responsible for 1 in every 3 tons of CO2 emission...

- 12-15% Fresh Water Consumption
- 40% Solid Waste Generation
- 40% Energy Consumption

Need for Energy Performance
Need for Energy Performance

Building contribution to CO₂ emissions

- Transportation: 32%
- Buildings: 43%
- Industry: 25%
- Residential: 21%
- Commercial: 17%
- Industrial: 5%

Source: Pew Center on Global Climate Change
Energy Consumption of the Building

- Air Conditioning: 57%
- Lighting: 22%
- Misc. Equip.: 16%
- Fans: 5%
- Internal gains: 25%
- Glazing: 55%
- Roof: 12%
- Wall: 8%

HEAT GAIN

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Opaque Construction – Wall & Roof

Most Common Assemblies

- **RCC Walls**
  - U-value: 1.95 W/m² deg K
  - Heat Storage higher
    - Due to high mass

- **Concrete Roof**
  - U-value: 2.5 – 3.0 W/m² deg K

**Efficient roof in a flat building**

**Efficient wall in multi-storied building**
Opaque Construction – Wall

WALL OPTIONS

- Brick wall with insulation
  - Extruded polystyrene, Expanded polystyrene (thermocol), Glass wool, etc.
- Double wall with air cavity/Insulation
- Concrete blocks
- Flyash bricks
- Autoclaved Aerated Concrete Blocks (AAC)
- Flyash/AAC Blocks with insulation
Thermal & Cost performance - Wall

Thermal values of Materials

- AAC blocks: 0.8
- Flyash bricks: 1.2
- Brick: 1.45
- Concrete: 1.6
Opaque Construction – Wall

**Brick**
- It is made by mixture of clay(alumina), Sand, Lime, iron oxide and Magnesia
- Red bricks are strong, hard, durable, therefore they are used as a structural material
- A raw material is easily and cheaply available.
- Red bricks are heavy in weight so that the structure needs to withstand greater weight, and hence construction cost increases.
- Less carpet area available compared to block work.
- The speed of construction of the brick wall is slower than the block construction

**AAC**
- It is made from the mixture of fly ash, cement, lime, gypsum and an aeration agent
- AAC Block can be used to build internal and external walls
- Availability in adequate quantities is an issue.
- AAC blocks reduces the load on foundation due to its light self-weight and saves consumption of steel.
- More carpet area available due to less thickness of the block
- Speedy construction of wall due to the bigger block size, light in weight and less number of joint.
ROOF OPTIONS

- Slab with Insulation (Overdeck/Underdeck)
  - Extruded polystyrene, Expanded polystyrene (thermocol), Glass wool, etc.
- Slab with brickbat coba
- Terrace Garden
- High Reflective Paint

Thermal Image of the terrace garden

Vegetated Landscape helps in reducing the Heat Island effect.
Insulation materials

- Glass wool stuffed
  - U value: 0.53 W/m²°K
- Thermocol
  - U-Value: 0.47 W/m²°K
- Expanded Polysterene
  - U-Value: 0.34 W/m²°K

Thermal and Cost Performance - Roof

- Rockwool
- XPS
- EPS
- PU board
- PU Foam
Selection of glass is crucial factor in building design

Fenestration – Glass

Ample Daylight

Less Heat gain

Absorbed solar radiation conducted through the frame

Directly transmitted solar radiation through the glazings (includes both light & heat)

Reflected solar radiation

Glazing-absorbed solar radiant heat

Outward flowing fraction of glazing absorbed radiation

Inward flowing fraction of glazing absorbed radiation

Heat conducted through the glass

Heat conducted through the frame
Scientific Analysis – Study of Glass

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Glass in Residential

- Glass shade in NEUTRAL shade
- Single Glazing Unit
- Cheapest Possible Glass

Case Study - Residential
With respect to Daylight and Energy

G+19 floors
Bedrooms & Living rooms treated as conditioned
WWR: 23%
Almost 34%
Window Wall Ratio on the West Facade
Glass in Residential

SGU- 5 mm- SHGC 0.83 and VLT 89%

Average lux level achieved 1398.84 lux
Glass in Residential

SGU- 6 mm- SHGC 0.67 and VLT 67%

Average lux level achieved 1021.05 lux
Glass in Residential

SGU- 6 mm- SHGC 0.56 and VLT 51%

Average lux level achieved 781.53 lux
Glass in Residential

SGU- 6 mm- SHGC 0.44 and VLT 37%

Average lux level achieved 537.52 lux
Glass in Residential

DGU- 6-12-6 mm- SHGC 0.28 and VLT 37%

Average lux level achieved 537.52 lux

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Glass in Commercial

- Glass of any shade as per consultants/architects requirement
- High performance Double Glazing Unit

Case Study- Commercial

Window-to-wall ratio (WWR)

G+19 floors

All the office area treated as conditioned
Conditioned Area – 75,000 sqm

Design to be compared with ECBC code
Base Line WWR – 40%
Glass in Commercial

Window to wall ratio of the project – 71%

- Base case: 100%
- WWR-71% with glass 1 (SHGC: 0.49): 107%
- WWR-71% with glass 1 and shading: 103%
- WWR-71% with glass 2 (SHGC: 0.31) and shading: 101%
- WWR-71% with glass 3 (SHGC: 0.2) and shading: 99%
Window to wall ratio of the project – 71%

Average lux level achieved 715 lux, with glass of SHGC 0.31 and VLT 0.35
Window to wall ratio of the project – 49%
Window to wall ratio of the project – 49%

Average lux level achieved 433 lux, with glass of SHGC 0.31 and VLT 0.35
Window to wall ratio of the project – 35%
Window to wall ratio of the project – 35%

Average lux level achieved 301 lux, with glass of SHGC 0.31 and VLT 0.35
## Comparison of Envelope Materials

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Building Components</th>
<th>Conventional</th>
<th>“U” value</th>
<th>IGBC Homes</th>
<th>“U” value</th>
<th>% Reduction in Heat Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>External Wall</td>
<td>Clay Bricks</td>
<td>2.03 w/sq.m.*k</td>
<td>AAC Blocks</td>
<td>0.79 w/sq.m.*k</td>
<td>39%</td>
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<tr>
<td>2.</td>
<td>Roof</td>
<td>No Insulation</td>
<td>3.92 w/sq.m.*k</td>
<td>2” XPS/PUF/PIR</td>
<td>0.33 w/sq.m.*k</td>
<td>8.5%</td>
</tr>
<tr>
<td>3.</td>
<td>Glazing</td>
<td>Single Glazing</td>
<td>5.7 w/sq.m.*k</td>
<td>Double Glazing</td>
<td>1.7 w/sq.m.*k</td>
<td>31.5%</td>
</tr>
</tbody>
</table>
Different climate zones have different impact on the same material and construction assembly.

Scientific analysis help to chose the correct materials with actually laying a brick!!

The impact of architecture design, passive cooling techniques help to trade-off few of “not so Green materials”

Don’t copy blindly. Each project is different and unique.
Thank You..!!

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