Green Building Features for Climate Resilient Buildings

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Presentation Outline

• Climate Vulnerabilities
• Climate Resilient Features for Built Environment
• GRIHA and resilience
Changes in many extreme weather and climate events have been observed since about 1950. Some of these changes have been linked to human influences, including:

- Decrease in cold temperature extremes
- Increase in warm temperature extremes
- Increase in extreme high sea levels and
- Increase in the number of heavy precipitation events in a number of regions.

https://biocreativity.wordpress.com
Impact of Climate Change on Built Environment

**Climate Hazards**

- Increase in Temperature
- Increase in Precipitation
- Increase in Sea Level & sea surface temperature

**Extreme events & Impact on Built Environment**

- Heat waves, Drought, wildfires, GLOFs
- Floods, intense rain fall
- Storm surges, cyclones, floods
Widespread impacts attributed to climate change based on the available scientific literature since the AR4

Source: IPCC Assessment Report 5
Coastal systems and low-lying areas are at risk from sea-level rise, which will continue for centuries even if the global mean temperature is stabilized.

Source: IPCC 5th Assessment Report
Defining Climate Resilient Housing

Climate Resilient Design Features make homes resilient to climate vulnerabilities, such that they maintain an acceptable level of functioning and structure.
Uttarakhand: impacts of unrestrained urbanization
Design Features for Climate Resilient Affordable Housing

Floods, GLOFs, Landslides & Heavy Precipitation

For Settlement level

- Developments to adhere to natural site contours.
- Construction on natural drains to be avoided.
- Development to be planned in a manner to leave natural vegetation protected.
- Grading large flat terraces on hill side sites should not be allowed.
- Developments should integrate an effective storm water management system – infiltration trenches, retention ponds, downstream flood control measures.
- Reduce impervious paving
- Erosion and sedimentation control measures through swales, sedimentation pits, vegetation growth on exposed soils along with mulching.

(Source: Steep Slope Development Guidelines, City of Nanaimo)

http://sd.defra.gov.uk/2011/05/surface-water-management-and-future-water-supplies/)
Erosion control measures especially important for construction on slopes; absence of such measures often trigger landslides and failure of storm drainage systems (man-made/natural)
SuDS Approach:

A must have at building, community and settlement level

SuDS are a sequence of management practices, control structures and strategies designed to efficiently and sustainably drain surface water, while minimising pollution and managing the impact on water quality of local water bodies.
Design Features for Climate Resilient Affordable Housing

Floods, GLOFs & Heavy Precipitation

Building level

- Buildings with High Plinth.
- Raised floor level to prevent flood water entering inside the house.
- Basements for new construction should not be allowed in urban areas prone to flooding.
- Isolated RCC Foundations in hilly terrains with tie beams.
- Overhangs above openings.
- Homes to have attached toilets.
- Bitumen based damp proof course at plinth level and water proofing on roofs.
Design Features for Climate Resilient Affordable Housing

Cyclones, Floods & Storm Surges in Low lying coastal areas

- Deep Foundations – Pile foundations for Large buildings and RCC Strip foundation for homes
- Buildings with High Plinth, preferably 6” above highest flood level mark.
- Raised floor level to prevent flood water entering inside the house. Building on stilts.
- Basements for new construction should not be allowed in urban areas prone to flooding.
- Anchoring between building components.
- In low lying coastal areas, developments should be considered on higher grounds, or ground should be raised artificially.
- Construction of embankments or dykes is key for low lying settlements near coastal areas.

http://en.wikipedia.org/wiki/Levee
Design Features for Climate Resilient Affordable Housing

Cyclones, Floods & Storm Surges in Low lying coastal areas

- If higher grounds are not available, then settlements should be constructed on artificially raised grounds.
- Tree plantation to protect from cyclonic winds.
- Adopt a non regular layout in place of straight rows to prevent tunnel effect during cyclones.
- Square, hexagonal and round plan is safer than long rectangular plan.
- Pyramid shape roof is ideally suited.
GRIHA-Green Rating for Integrated Habitat Assessment

Tool to facilitate design, construction, operation of a green building, and in turn measure “greenness” of a building in India

What gets measured gets managed
Sustainable urban drainage/Rain water harvesting to reduce flooding
SUDS strategies

- Rainwater harvesting
- Detention basin
- Swales
- Wetlands
- Permeable interlocking concrete pavers (PICP)
- Concrete grid pavers (CGP) "Turfstone"
- Porous concrete (PC)
- Porous asphalt (PA)
- Plastic turf reinforcing
Design Features for Climate Resilient Affordable Housing

Increasing Temperatures & Heat Stress

For settlements

- In urban areas, one of the reasons for increase in temperature is urban heat island effect. Thus, reduced impervious pavements, increase in vegetation and shaded as well as light coloured building surfaces help maintain cooler microclimate.
GRIHA as a change agent in site management and design approach and a tool to promote adaptation/mitigation
Preserve protect vegetation and reduce paved areas: controls urban heat island
Reduced paving and green spaces
Reduced paving and green spaces: difficult to implement in urban areas due to conflicting statutory requirements
Promoting adaptive comfort and energy efficiency: GRIHA approach
For conserving energy – in a cost-effective manner

- Passive design of building
- Use of Efficient Systems
- Use of Renewable Energy

Cheapest Solution

Most Expensive Solution
Design Features for Climate Resilient Affordable Housing

**Increasing Temperatures & Heat Stress**

*For New Construction*

- Solar control strategies like shading, orientation and building morphology to reduce external heat gains and maintain comfortable indoor conditions.
- Increase in vegetation around the house.
- Increase in ventilation through optimization of window design and size.
- Cool roof/Roof Garden
- Use of thermal storage through building materials like local stone and stabilized earth blocks.
Green Roof

Terrace Garden Roof:
Earth + vermin compost + fiberglass mesh + cement + sand + grit + water proofing + RCC

Insulated Roof:
Waste brick + lime + sand + Waste Thermocol + RCC
Passive Solar House Design in Cold Climate Zones

Direct gain (DG)
Attached Green House
Solar Wall (SW)
Energy efficient CFL tubes
## On site monitoring

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<th>Parameters</th>
<th>DG</th>
<th>SW</th>
<th>AGH</th>
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<td>Inside temperature (°C)</td>
<td>23.4</td>
<td>19.9</td>
<td>21.1</td>
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<tr>
<td>Inside lux (Middle of room)</td>
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<td>210</td>
<td>160</td>
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<tr>
<td>Outside temperature (°C)</td>
<td>17.9</td>
<td>17.9</td>
<td>17.9</td>
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<tr>
<td>Relative Humidity (%) inside</td>
<td>26</td>
<td>20</td>
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Retrofit of Existing Housing to add climate resilience

**Floods & Heavy precipitation**
- Water proofing on roof and plinth level (Grouting)
- Water proofing on walls
- Protecting openings with overhangs
- Storm water Drainage systems

**Increase in temperature and Heat Stress**
- External insulation on the roof

**Cyclone, storm surges**
- Replacement of GI sheets in roof with composite boards anchored with the structure.
- Strengthening plinth and then caping with concrete.
- Tiling of walls for salinity resistance
House Design proposed for Multiple Hazard Locations

- RCC Gable roof ⑥, Damp proof course (DPC) ⑥
- Hollow Concrete Block Masonry ④ ⑤
- Ring beam at Sill level and Lintel level ② ⑦
- Bitumen based DPC ① ③
- Raised floor ① ③

Note: *Structure of the house to comply with the earthquake resistant design specifications provided in NBC

Proposed for Developer build Multi-Storey Climate resilient Home

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<tbody>
<tr>
<td>①</td>
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<td>Heavy Rains</td>
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<td>Earthquake</td>
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</table>
House Design proposed for Multiple Hazard Locations

- Ferro-cement roofing on bamboo supporting structure
- Lintel & Sill beams with Bamboo Reinforcement
- Bitumen based DPC above Plinth Beam
- Buttress
- R C Strip foundation

*Note: Structure of the house to comply with the earthquake resistant design specifications provided in NBC

Proposed for Self construction Climate resilient Home
Thank You
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