Guideline for Sustainable Energy Residences in Sri Lanka
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1. Sustainable Design - Climate and Thermal Comfort

1.1 Climate of Sri Lanka

- **Classification**
  
  Location - 5⁰55' to 9⁰ 51' North latitude and between 79⁰42' to 81⁰53' East longitude
  
  TROPICAL climate

- **Topography**
  
  Central part - Mountainous, remainder - flat except for several small hills

- **Rainfall**
  
  mean annual rainfall varies from under 900mm in the driest parts (South-Eastern and North-Western) to over 5000mm in the wettest parts (Western slopes of the central highlands)

- **Temperature**
  
  mean annual temperature varies from 27⁰C in the coastal lowlands to 16⁰C at Nuwara Eliya, in the central highlands
Average Annual Temperature and Rainfall

Average Annual Temperature (°C)

Average Annual Rainfall (millimeter)
Thermal Comfort

- Thermal comfort is generally defined as that state of mind which expresses satisfaction with the thermal environment (ANSI/ASHRAE Standard 55-2013)

- Measured by considering following comfort variables
  - Air temperature
  - Mean radiant temperature (depends on the surface temperature)
  - Air velocity
  - Relative humidity
  - Activity levels
  - Thermal resistance of clothing
Passive design

- Way of improving indoor thermal comfort, without using an active system such as electric fans, air conditioners thereby reducing the overall energy usage.
Passive design strategies

Strategy 1
Start at the neighbourhood
- Sun and building orientation
- Laying out of streets/building Plots

Strategy 2
Shading
- Shading by external features
- Shading by building features

Strategy 3
Ventilation
- Wind directions and building siting
- Building shell and openings

Strategy 4
Material selection
- Thermal mass
- Insulation
- Colour of surfaces
Strategy 1

Start at the neighbourhood

- Understanding the sun path diagram
• Building Orientation- long axis in east west direction
Strategy 2
Shading

- Shading by external features
  - Use neighbourhood land forms, structures and vegetation
Shading by external features

- Use ground cover and planting to cool
Shading by internal features

- Zone the house and avoid direct heat gain to habitable spaces
Shading by internal features

- Use green facades and green roofs
Sun Energy is Intercepted by leaves

Reflected (20%-30%)

Absorbed Heat is Dissipated through evapotranspiration

 Incident Sunlight (100%)
Shading by internal features

- Provide shading for glazing exposed to sun

- Standard Horizontal shading devices

- Standard Vertical shading devices

- Drop edge for lessen the projection

- Slope it down for lessen the projection

- Substitute louvers for the solid dropped edge to let in more light

- Diffuse shading devices

- Breakup an overhang for less projection

- Breakup an overhang for less projection
Strategy 3

Ventilation

- Main Wind Directions and Building Siting

  Two main wind patterns: From North East (December to February)
  From South West (May to September)

- Types of Ventilation
  - Cross ventilation (Pressure Difference)
  - Ventilation using stack effect (Temperature Difference)
Cross Ventilation and Stack Effect

Stack ventilation on a still day

Combined stack and cross ventilation

- Stale, warm air
- Fresh air
- Stack ventilation
- Cross ventilation
- Stale, warm air

Fresh air
- Orient the building to catch maximum wind

- Use neighbourhood land forms, structures and vegetation to increase exposure to wind
Shaded courtyards with evaporative cooling collects "Tank of cool air"

Plants cooling courtyards
• Shape and orient building shell and openings to catch maximum wind
• Use open plan interior to promote air flow

Fig 27: Use Open Plan Interior to Promote Air Flow.

Demonstrates the effect of the partition on air flow. The marker denotes the crucial zone where ventilation is most needed.
• Use Vertical air shafts to promote air flow

• Use monitor roofs for stack effect ventilation
Impact of wind direction – simulation models

Fig 31: Plan View of Wind from South - Single Storey House

Fig 32: Plan View of wind from South-West - Single Storey House
Strategy 4

Material Selection

- Use Insulation for roof and walls (reduce overall U value)
- Apply High Reflectance material/paint for walls and roofs (reduce surface temperature)
- Low thermal mass material is better for Sri Lanka, where the day night temperature difference is low
- Use low e-glass (double glazed) or coatings for windows exposed to sun (reduce solar radiation/conduction heat gain)
Thermal mass
Effects of roof insulation
### Solar reflectance index of selected material

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Thank you