An Evaluation of Architectural Building Design Parameters in Dry Zone

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ABSTRACT: Overheating of indoor environments has become a major issue in most of the dry zone areas in equatorial tropics. Therefore, passive design strategies in modifying the indoor overheating are significant in promoting indoor thermal comfort for creating healthy interiors.

There are basic design strategies that were built by the professionals in long time as passive architecture. These strategies differ in accordance with the climate, context, design and social aspects. As an integral part of the physical environment the variations in the localized climate around a building termed as its "Micro Climate", has therefore received considerable attention in the context of building design to create a favorable indoor environment.

When considering the rural developments in Sri Lanka, most of the rural areas are located in the dry zone, and based on agriculture. Further these houses are often designed without taking the climate into account sufficiently. Also, factors such as the surrounding environment / its characteristics, orientation and architectural design of the building, selection of building materials, etc. are not emphasized. Consequently, buildings often have a poor indoor climate, which affect the comfort, health and efficiency.

Furthermore, introducing specific design strategies and developing them as design guidelines which can be specifically applied to the dry zone, play a vital role to increase the indoor thermal comfort level of the dry zone residential buildings.

Key words: Environmental performance, Micro climate, Indoor thermal comfort

1 INTRODUCTON

"I know that architecture is life; or at least it is life itself taking form and therefore it is the trust record of life as it lived in the world yesterday, as it is living today or ever will be lived. So, architecture I know is to be a great spirit ……."

"Architecture is that great living creative spirit which from generation to generation, from age to age, proceeds, persists, creates, according to the nature of man, and his circumstances as they change. That is really architecture."

(Frank Lloyd Wright, from in the Realm Ideas)

"It is about creating buildings and space that inspire us, that help us to do our jobs, that bring us together, and that become, at their best, works of art that we can move through and live in. And in the end, that is why architecture can be considered the most democratic of art forms."

(2011, President Barack Obama, Pritzker Ceremony speech)

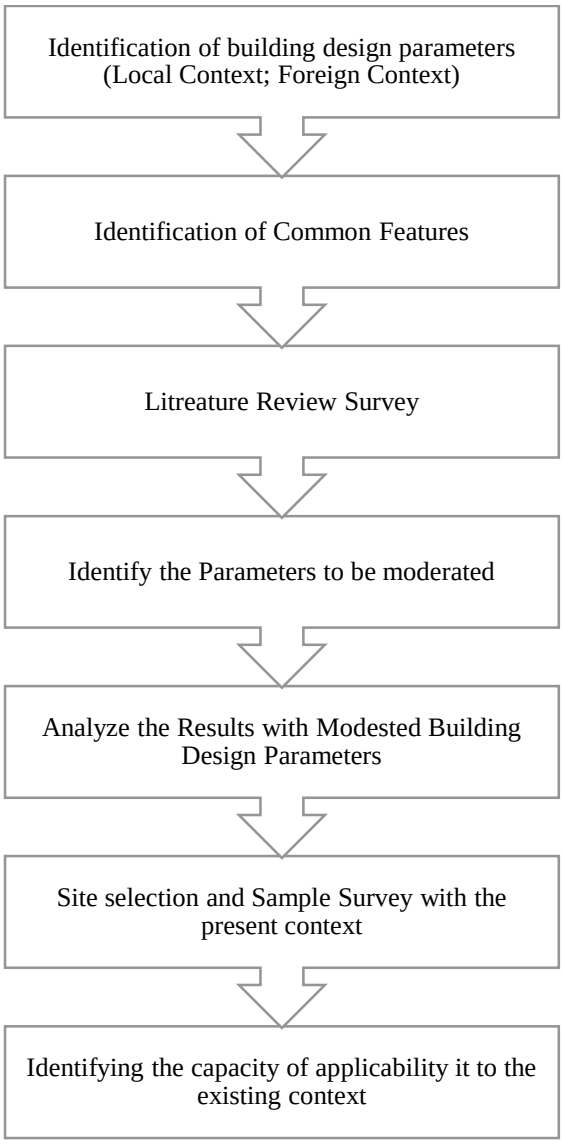
According to the above two statements, mentioned by two different people, representing two different fields, highlight the things people expect through architecture. Therefore it is the responsibility of the architects to make sure whether their designs reach the comfort levels of human beings. Further the physiological comfort levels, as well as the psychological comfort levels.

For this it is important to achieve the preferable comfort levels inside the buildings. According to the British Standard BS EN ISO 7730, thermal comfort is "the condition of mind which expresses satisfaction with the thermal environment."

When considering the traditional architecture in Sri Lanka, they were based on passive concepts from the inception stage to completion stage. But due to the complex life style of today's world, the importance of original passive concepts started to vanish from the dwellings, and the functional aspects are coming forward. Further the lack of knowledge in present passive technology increase this aspect more. Therefore, it is important to keep in mind, the

fundamental objectives of building design, to provide an efficient, comfortable and healthy environment. Hence, this paper will review building design parameters to achieve thermal comfort with the help of natural ventilation and the methods that can increase the comfort level of dry zone residential buildings by moderating those design parameters.

2 METHODOLOGY



3 CLIMATIC CONDITIONS

"Temperature" is the most commonly used indicator of thermal comfort, and it is easy to use and most people can relate to it. But although it is an important indicator to take into account, air temperature alone is neither a valid nor an accurate indicator of thermal comfort or thermal stress. Air temperature should always be considered in relation to environmental and personal factors.

There can be identified six main factors which affect thermal comfort, as environmental factors and personal factors. These factors may be independent of each other, but together contribute to the occupants' thermal comfort.

Environmental factors:-

- Air temperature and surface temperature
- Air movement and air velocity
- Relative humidity
- Solar radiation

Personal factors:-

- Clothing insulation
- Metabolic heat

Therefore it is necessary to consider about these parameters at the sketch design stage of a building design. Further those factors can develop under following subjects.

- Layout	- Openings
- Spacing	- Walls
- Air movement	- Roofs
- Outdoor sleeping	- Rain protections

4 GUIDELINES IN THE PRESENT CONTEXT

To establish the minimum comfort levels in the dwellings, local authorities introduced several design guidelines and in the present context, UDA guidelines act a major role. Following are some of the guidelines introduced by the UDA to achieve the minimum comfort levels of residential buildings.

Specification as to lots

Character of building	Minimum site area (sq.m)	Minimum width of site (m)
All building except those included below	150	6
Public assembly buildings and public buildings	300	12

Maximum lot coverage

Character of building	Minimum lot coverage (%)	Minimum open space at the ground level (%)
Dwelling units	66 ½	33 ½

Aggregate unobstructed area of openings

Category	Aggregate unobstructed area of opening for natural lighting and ventilation	% of area openable
Bath room and toilet	1/10	100
Vehicle parking garage	1/10	50
Factories and warehouses	1/10	50
All other rooms	1/7	50

Aggregate unobstructed area of openings

Room	Minimum extent (sq.m)	Minimum length (m)	Minimum width (m)
Where there is only one room in dwelling unit	11.0	-	3.0
Where there are more than one room in a dwelling unit			
First room	8.5	-	2.4
Additional room	7.5	-	2.4
Kitchen	5.5	-	1.8
Kitchen alcove	-	0.9	0.4

Internal clear dimension of bath rooms & toilets

Room	Minimum width (m)	Minimum length (m)
Bath	0.9	1.2
Toilet	0.9	1.2
Combined bath and toilet	0.9	1.7

Aggregate unobstructed area of openings

Category	Aggregate unobstructed area of opening for natural lighting and Ventilation	% of area openable
Bathroom and toilet	1/10	100
Vehicle parking garage	1/10	50
Factories and warehouses	1/10	50
All other rooms	1/7	50

(Planning & Building Regulations Made easy, 2005)

5 STRATEGIES IDENTIFIED THROUGH PAST RESEARCHES

When considering the past researches and the important strategies identified by them, most of them recommended the use of ventilation strategies. Especially for natural ventilation systems such as, stack effect, solar chimney, etc. Nowadays, there are many new strategies and passive systems that help in achieving comfort levels inside the buildings.

1) A study in Spain
   Approach – To improve the passive night ventilation in public social housing by applying the solar chimney concept.

   Macias et al. (2006) used an acceptable high thermal mass in building construction to collect solar energy during the afternoon in their concrete walls. (50°C) For every flat there was a separate chimney with a swinging flap at top, and while collecting energy the flap was closed. Then, during night when the ambient temperature drops to about 20°C the flaps at the top were opened generating a draft through flats, cooling down the thermal mass of the ceiling and walls.

2) A study in Thailand
   Approach – The effect of solar chimneys and/or water spraying on a roof on natural ventilation.

   When the ambient temperature was 40°C, they achieved the maximum of 3.5°C reduction in temperature for the case of separate chimney, and a maximum of 6.2°C reduction in temperature for the combined effect of charging solar chimney and spraying water. Also they reported that the temperature difference between the inlet and outlet of the solar chimney tends to decrease during the period of high solar radiation and high ambient temperature. As a result, spraying water increases the temperature difference and consequently the air flow rate through the chimney.

(Amr S.H., Yoshino H., Abdelsamei M., and Magdy M.R., 2012)

6 CONCLUSION

Several researches and studies identified that the integration of different strategies are more efficient than applying individual design strategies to increase thermal comfort. Most of them recommended the use of ventilation strategies. Such as, natural ventilation, cross ventilation, the window-to-wall ratio, building orientation relative to prevailing wind directions, etc. Because of that, more experiments are still needed to be done so as to identify the performance of the integrated systems. Further it is necessary to optimize and control the strategies to provide the comfort levels in dry zone residential buildings.

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