IMPACT OF POOR THERMAL DESIGN ON LIVABILITY IN MUMBAI'S SRA BUILDINGS

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ABSTRACT

The Slum Rehabilitation Authority (SRA) housing in Mumbai was created to move people from slums into proper buildings. The main goal was to give them safe and better homes. However, many studies show that these buildings do not properly consider thermal design, such as good natural ventilation, enough sunlight, and proper airflow inside the rooms. Because of this, the living conditions in these buildings are not always comfortable. This paper studies how poor thermal design in SRA buildings affects indoor air quality, people's health, and their overall well-being, especially in Mumbai's hot and humid weather. The findings show that weak design increases heat inside homes, reduces air movement, and causes poor indoor air quality, which lowers the overall quality of living.

INTRODUCTION

Mumbai's housing shortage has led to the redevelopment of slum areas through the Slum Rehabilitation Authority (SRA) scheme. Although these projects provide permanent homes, many residents experience uncomfortable indoor conditions, such as high heat and poor air movement. Thermal comfort is important because it affects people's health, daily activities, and overall quality of life in crowded residential buildings. Thermal comfort means how comfortable people feel with the temperature inside their homes. It depends on factors like temperature, humidity, air movement, clothing, and activity level. In hot and humid cities like Mumbai, good natural ventilation and smart building design are very important to keep homes comfortable without depending too much on-air conditioners.

AIM

The purpose of this study is to examine how poor ventilation and inefficient building design affect thermal comfort in Slum Rehabilitation Authority (SRA) buildings. The study aims to identify the main factors causing indoor discomfort and provide recommendations for low-cost, passive strategies to improve living conditions and occupant comfort.

LITERATURE REVIEW

Definition of SRA

SRA is Slum Rehabilitation Authority. It is a government initiative of providing self-contained residential accommodation to the underprivileged or the urban poor. According to information published on Indian Express Website household earning below Rs 3000/-per month categorized as belonging to the economically weaker section. This income level has now been raised to Rs.6000/=per month. This will increase economically weaker section (EWS) number by almost 40 percent.

It is estimated that of a total urban population of 286 million almost 81 million account for urban poor. EWS and LIG household together loosely constitute the urban poor.

Working of SRA

The Government has therefore designed development schemes for providing residential accommodation to the underprivileged part of society. Slum dwellers are rehabilitation through development by the Government under different section of Development Control Rules. Under these schemes the slum dwellers are accommodated in multi-storeyed buildings developed for the purpose with a provision of self-contained tenement of 259 Sq. ft carpet area. This area has seen an increase from initial 180 Sq. ft. carpet to 225 Sq. ft carpet to the present 259 Sq. ft.

STUDY OF SRA SCHEMES TYPOLOGY AND CONFIGURATION

Usually, SRA schemes are developed under 3 configurations depending upon factors such as

- Area of plot
- Shape of plot

a) Configuration 1

- The buildings are designed separately each having their own set of amenities.
- In some cases, if possible separate entrances are also given

b) Configuration 2

- The buildings are designed to have a common wall in between them.

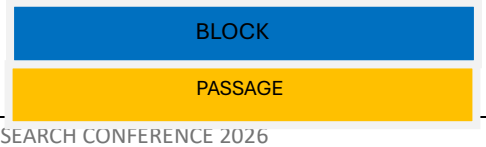
c) Configuration 3

- The buildings are designed as single units in which the lower floors are for the SRA component and the above floor are for the sale component.

SRA SCHEMES PLANNING TYPOLOGY

a) Planning typology – 1

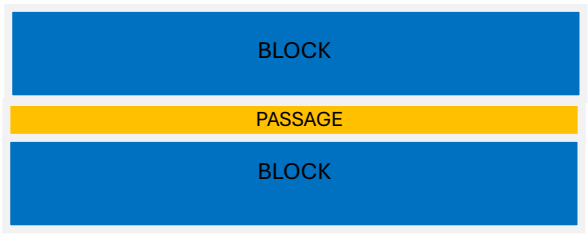
- Planning typologies are usually designed taking into considerations such as
- The size or the shape of the plot.
- Areas available for the SRA building on plot.



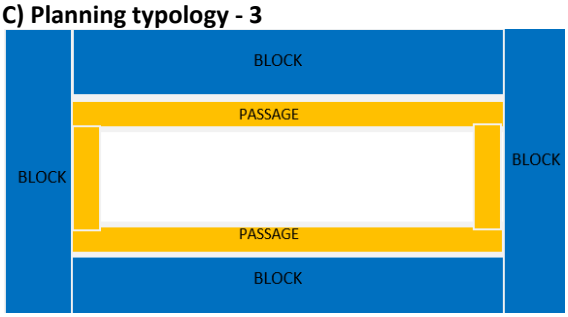
- The buildings are designed
- In a linear way the tenements are grouped only on one side of the corridor
- All the tenements on floor open into a common corridor from one edge only.

b) Planning typology - 2

- The building is designed in a way the tenements are grouped on one both sides of corridor.

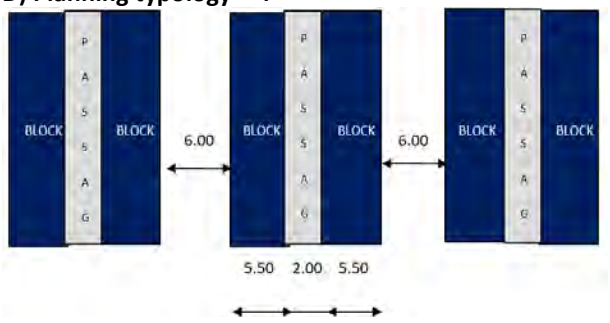


C) Planning typology - 3



- The building is designed with a central chowk. This is not a prevalent typology due to size and shape of the plot buildings are designed with a chowk to accommodate.

D) Planning typology – 4



- The following is the typical arrangement of the buildings is designed in the above manner with a minimum distance of 6 m between each other.

THERMAL COMFORT AND SRA

Definition of Thermal Comfort: ANSI/ASHRAE Standard 55 define thermal comfort as the condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation.

Study of thermal comfort: Overview

Although human beings have the capacity to adapt to wide variation in their environment while continuing to function, their productivity does vary according to the conditions in their immediate environment. Benefits associated with improvements in thermal environment are:

- Increases attentiveness and fewer errors
- Increases productivity and improved quality of products and services
- Lower rates of absenteeism and employee turnover
- Fewer accidents
- Reduced health hazards such as respiratory illnesses

As discussed earlier the small areas or spaces under the SRA schemes will be highly populated giving rise to health problems concerning issues such as

- Heat increase and impact
- Humidity increase
- Absence of Natural Ventilation
- Pollution

For comfort and efficiency, the human body requires a fairly narrow range of environmental conditions compared with the full scope of those found in nature. The factors that affect humans pleasantly or adversely include:

- Temperature of the surrounding air
- Radiant temperatures of the surrounding surfaces
- Temperature of the interior due to the activity undertaken
- Humidity of the air
- Air motion
- Odours
- Dust
- Aesthetics
- Acoustics
- Lighting

The first four relate to thermal interactions between people and their immediate environment. Children who will be the future are affected most as they are more susceptible to pollutions than adults. Children are much closer to the ground, and as a result, breathe in more of the heavier airborne chemicals than adults. Infants and young children breathe through their mouths, more so than do an adult, which increases the risk of frequent illness. This means indoor pollutants, such as certain chemicals, particles and allergens, can cause more severe health effects in the future generation children breathe in a greater volume of air than adults. Their respiratory organs, immunity and neurological systems are still developing. Children have a higher heart rate than adults, which allows substances are absorbed into the blood to permeate in the tissues faster.

FACTORS THAT AFFECT THERMAL COMFORT IN SRA

Density Of People: The number of people who are residing in SRA tenement is generally high. The area allocated to each tenement is 259 Sq.ft. the inhabitants of these tenements vary from 5 – 14. Generally, in a regular MIG household an area of 500 sq.ft is considered for a family of 5. Kitchen area is small, up to 60 sq.ft only or provision of alcove. Hence more heat built up.

Regular MIG House	=No Of People _ 5 Nos.
Inhabitants of SRA Tenements	=5-14 Nos.
	+
Small Kitchen Area	= More Heat Built Up
	+
Less Open Spaces	=Heat Built Up Outside
	+
Density Of People	=Resident Population + Per Acres Increase
	+
Kitchen	=Small Area / Alcove
	+
Building Components	=Not Heat Resistant
	=

THERMAL DISCOMFORT

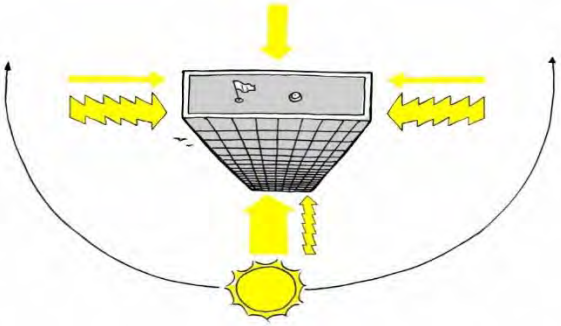
RESEARCH METHODOLOGY

Issues in SRA buildings:

- The plots in Mumbai are already demarcated. The slums develop in left over or crammed areas. Sometimes there is an encroachment of land. This causes no cross ventilation.

Crammed areas_ No cross ventilation

- It is difficult to orient the buildings for Wind or Sun. If such a chance exists this prime location on the plot is reserved for the Sale Component. This causes thermal discomfort to the inhabitants.



Difficult to orient the buildings for Wind or Sun_ Causes thermal discomfort

- Tenements under these schemes have a small area or Alcove adjacent to living area provided for cooking purposes. Cooking zones emit a very large amount of heat Due to activities such as cooking, steaming, frying and baking for concentrated amount of time. This causes increase in temperature levels. Which leads to heat stress and heat stress leads to Sick Building Syndrome.

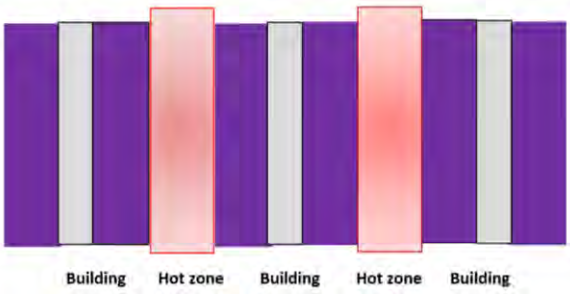
- Existing SRA building LOCATION _MALPA DONGRI ON PLOT BERARING C.T.S.NO.405, ANDHERI EAST, MUMBAI.
- Kitchen area emits heat increases temperature

Inhabitants of SRA schemes are Underprivileged people and can ill-afford comfort by mechanical means uncomfortable stay over a period of time can give rise to health issues.

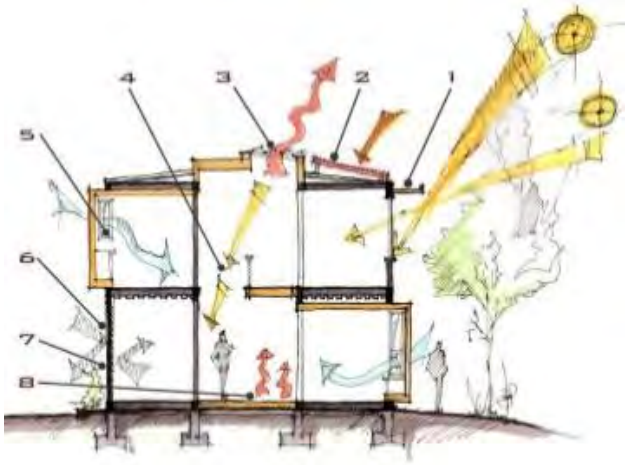
Underprivileged people_ Can ill-afford comfort by mechanical means

- In terms of planning the slums which were originally horizontal in spread will now be developed in a vertical manner. An additional vertical sale component will be added.
- The load on the base infrastructure will be doubled. In metropolitan city like Mumbai which already has around 55% of its population living in slums and occupying only 12.85% of its land the situation will be grim in near future.
- The SRA building is constructed by the developer. The developer has a vested interest in the sale component. Hence maximum advantages in terms of orientation, planning aspects, construction material are provided for the sale building. This causes thermal discomfort.
- The inhabitants of these SRA tenements vary from 5-14. Generally, in a regular MIG household an area of 500 sq.ft is considered for a family of 5. kitchen area is small, up to 60 sq. ft only or provision of alcove. Hence more heat built up. This causes thermal discomfort.
- SRA components and above floors are for sale components. Due to the above change, hot zones are formed between buildings due to very less open space

between them. This creates an uncomfortable atmosphere because there is no scope for heat removal.

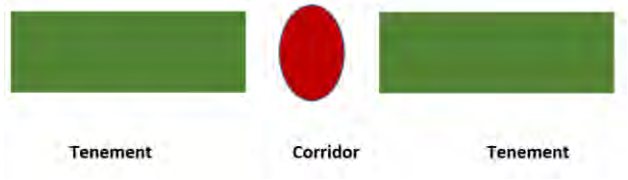


- Building envelopes are not climate responsive, this causes thermal discomfort to the inhabitants.



Building envelope not climate responsive

- Under SRA schemes usually the building has a doubly loaded corridor hence cross-ventilation cannot be considered as a ventilation option in most situations. This causes thermal discomfort.



Doubly loaded corridor_ No cross-ventilation

NEED FOR THERMAL COMFORT IN SRA SCHEMES

In metropolitan areas like Mumbai which are already vastly developed, plots are divided and built upon. Thermal comfort aids such as orientation to sun/wind prevalent direction, landscaped areas, open spaces are already compromised due to various conflicting conditions. Thermal comfort can also be said to be absence of discomfort. Thermal Comfort can thus be achieved through removal of factors causing discomfort. Thermal discomfort has been known to lead to sick building syndrome symptoms. The combination of high temperature and high relative humidly leads to heat stress. In a need for space in SRA schemes the SRA buildings are delineated to a corner position which is a compromise and giving rise to discomfort condition on various aspects. Inhabitants of SRA Schemes are the underprivileged people and can ill-afford Comfort by mechanical means Uncomfortable stay over a period of time can give rise to health issues. Hence the need to provide them with a comfortable condition. Thermal Comfort codes in India ASHRAE 90.1 – Air conditioned commercial and residential. ASHRAE 55 – Adaptive thermal comfort for naturally ventilated buildings.
INDIAN STANDARD – there is no standard established
All the above aspects make need to have such schemes as thermally comfortable to the inhabitants as possible.

SRA TENEMENTS AND THERMAL COMFORT

Government initiative: As per SRA development rule the slum dwellers are given a self-contained tenement on the land where slums existed.

SRA building + Sale Building: As an incentive to the developer who develops the SRA Schemes an increases F.S.I is permitted on the same plot. The developer is allowed to construct separate accommodations for sale purpose which can be sold to the remaining population.

Relaxed rules for SRA Buildings: The open space & height restriction are relaxed for such SRA building development.

Increase in per acre density in that area: This initiative of having a sale component along with the redevelopment of existing slum dwellers effectively increases the per acre density of the plot.

Building envelope not climate responsive : The plots in Mumbai are already demarcated. The slums develop in left over or crammed area. Sometimes there is an encroachment of land.

It is difficult to orient the buildings for Wind or Sun. It such a chance exist this prime location on the plot is reserved for the sale component.

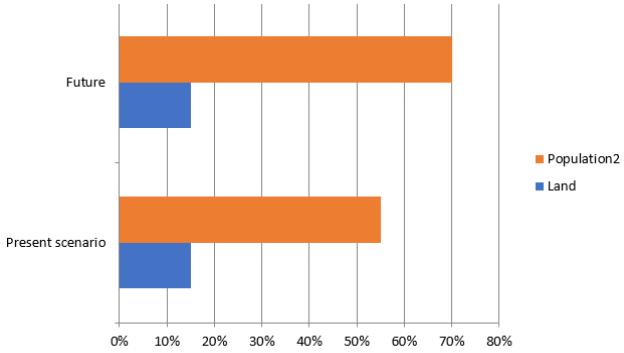
Causes thermal discomfort to the inhabitants –

RESULTS

The above issues of relaxed open space increase in per acre density and the building envelope not being climate conductive leads to a thermal Discomfort within the inhabitants. The Government of Maharashtra has taken the onus of developing such areas under SRA schemes. The slums dwellers are given a self-contained independent residential block. Each dwelling is 259.00 Sq. fts or 25.03 Sq.mts. As an incentive for such development the development the developers can build an additional residential saleable component on same premises. This gets translated into an F.S.I of 2.5 – 4. And it is considerable now in practice and thus effectively doubling

the density of the place. In terms of planning the slums which were originally horizontal in spread will now be developed in a vertical manner. An additional vertical sale component will be added. The load on base infrastructure will be doubled. In Metropolitan city like Mumbai which already has around 55% of its population living in slums and occupying only 12.85 % of its land the situation will be grim in near future.

The graph below shows a graphical representation of the same



Graph with increase in population to area
Population showing a growth in population

As per the points discussed in issues of SRA, it is referred that thermal comfort is very essential for human being's residents in SRA schemes are not thermally comfortable due to various factors as seen earlier. The building chosen for the case study was one of the buildings found to be compromised. The government of Maharashtra has taken the responsibility of developing such areas under SRA schemes. The inhabitants of these SRA tenements vary from 5-14. Generally, in a regular MIG household, they are considered for a family of 5. kitchen area is small, up to 60 sq. ft only or provision of alcove. Hence more heat built up. This causes thermal discomfort.

Also, the SRA building is constructed by the developer. The developer has a vested interest in sale component. Hence maximum advantages in terms of orientation, planning aspects, construction material are provided for the sale building. And in terms of planning the slums which were originally horizontal in spread will now be developed in a vertical manner. An additional vertical sale component will be added. Also, due to the above change hot zones are formed between buildings due to very less open space between them. This creates an uncomfortable atmosphere within because there is no scope for heat removal. Hence this causes thermal discomfort. The SRA building thus stand compromised. Hence the need for the study.

NATURAL VENTILATION POTENTIAL

Natural ventilation is a low-cost way to improve thermal comfort in SRA buildings, but its effectiveness depends heavily on design and layout. Buildings that lack strategic window placement, airflow paths, and orientation often fail to achieve sufficient air movement, even in windy conditions.

CONCLUSION

Natural ventilation can greatly improve comfort inside SRA buildings if it is planned and designed well. However, many existing homes do not allow enough air to flow properly, which causes high heat and discomfort for residents. This study shows that building design directly affects people's comfort and health. Therefore, future low-income housing projects should focus more on good ventilation while planning and construction.

REFERENCES

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- *Field evidence linking poor ventilation and light in SRA buildings to higher disease incidence like tuberculosis.*
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- *Research noting extremely high indoor particulate pollution levels in some SRA dwellings due to inadequate ventilation.*