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V Manish Prasad is an Architect, Urban Designer. Currently working as guest faculty in dept of architecture, UVCE. He is passionate about Sustainable architecture and Urbanism having studied Architecture in SJBSAP and Master of Architecture in Urban Design from BMSSA. Also has been actively involved in various types and scales of projects such as Residential, Public buildings, Apartment's etc.

Low carbon emission in public buildings through passive architecture

Abstract

Many public buildings are evolving with different amenities and activities in them but are forgetting the core importance of sustainability or carbon neutrality in buildings, which is a major important aspect in the recent past, and also public buildings are now getting compromised due to unsustainable practices and more of a carbon footprint and emission in recent urban areas. However, excessive land encroachments and more concretization in present cities are contributing towards degradation of the natural environment, which in turn is impacting human health. Both public and commercial sector buildings add energy consumption from both the electricity used and in manufacturing, construction, and transport of building materials, etc. Also, these buildings contribute 40% of global CO₂ emissions. So the focus of the study is to utilize the different mechanisms like passive solar, ventilation, cooling, shading, daylight techniques, etc. To overcome the above-mentioned problems and bring this gap to the forefront and attempt to bring the ecological balance in nature in relationship with urban public buildings and elements of nature like light, air, earth, and water for sustainable practices through architectural and planning strategies and design solutions of passive architecture and planning.

Keywords :

Urbanscape; Concretization; Carbon footprint; Passive architecture; Sustainability;

1. Introduction

Practically all buildings in large cities in the world are focusing or evolving by providing different amenities and activities in them by neglecting major aspect of carbon neutral architecture or carbon neutrality in buildings of all kinds mainly public, with the increase of 70% of carbon emission from year 1992 to 2004 which is projected to grow faster in current technologies and trends. The rapid growth and expansion of building areas with energy consuming equipments especially in public buildings is responsible for 30% of global energy related CO₂ emission. This can be avoided through several methods which are cost and energy efficient from passive design architecture and its several useful methods by improving its energy efficiency of heating & cooling, building envelopes, lighting and appliances.



Switching to renewable energy source from fossil fuels which lowers CO₂ emission factors which makes an impact in the building sector.

2. Need for the study

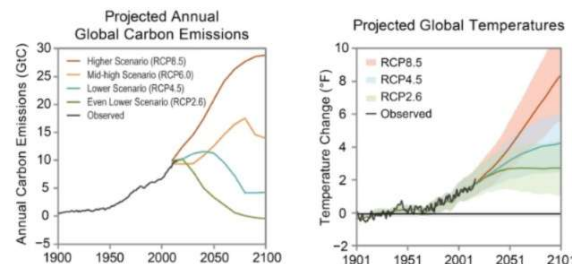
The purpose and intent of the study is to analyse energy and carbon emission framework which calculates the contribution of different types of building sector currently focusing on public buildings in order to achieve carbon neutral architecture by mitigating carbon emission on regional scales in recent times through passive architecture principles and strategies with case studies of low carbon emission public buildings, passive design along with low carbon emitting building materials. The work is focused on to solve the conflicts associated with buildings energy demand, carbon emission and its reduction through passive design strategies. Mitigation of final energy use, primary energy use or carbon emission may require different tech and passive design solutions. The largest share thermal energy is used mainly for heating and cooling in public buildings where more energy and electricity is used. This generates the need to the following Research Questions :

- Why is low carbon emission needed in public building sector.
- How do passive design techniques reduce carbon emission and why is it required.
- Which are the preferred low carbon emission building materials and techniques of passive architecture used for construction.

3. Overview of carbon emission in building sector.

As a important contributor to global carbon emission the building sector which includes building construction, needs to be taken care urgently because the sector is responsible for carbon emission at 38 per cent which inturn reflect to more energy demand and emission, at the same time temperatures are increased and are projected to increase even more and the demand for cooling is increased. Public building sector is a long part of society infrastructure with social and cultural history. Carbon emission which makes the climate hazard will cause loss of life , injury and health impacts which damages to infrastructure and livelihoods of people. Over next two decades temperatures are projected to increase by 0.3-0.7 °C.

Figure 1 : Trends and forecast scenarios of annual carbon emission with mean world temperatures



Source: Wuebbles et al., 2017

The building and construction field are the largest producer of green house gases by accounting 37% of global emissions because of production and use of materials like steel , cement and aluminium having a more significant carbon footprint. To mitigate the buildings carbon emission occurring from production of materials and design such as cement and steel etc have slowed to address the challenge nationally must collabarated with eachother together from all stakeholders



across the cycle of building sector both in formal and informal setting. So how to reduce carbon emissions in public buildings is by using energy which are renewable for generating power with reduced consumption of energy in public buildings can help out reduce carbon emission in it. Green house gas emission from On-Site transportation and construction waste disposal during construction process emits more carbon pollution to atmosphere hence creating global warming, also 6-8 % of carbon is emitted due to shifting of materials during on going construction like excavators, cranes and lorries on site. Hence the combustion of fuels and fumes from the vehicles on site emits carbon to the atmosphere which causes major air pollution during construction of public buildings in large scale. Urban public buildings like office, schools, transportation and hospital buildings are major contributors to carbon emissions.

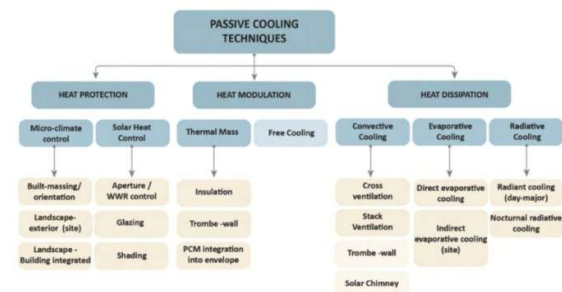
4. Importance of Passive architecture and its techniques in mitigating carbon emission

Passive architecture strategies are very important for reducing energy consumption with improved indoor comfort, these techniques lowers electric bills, reduces the strain on power grids. Also techniques like trombe wall are best suited to hot and dry, hot and humid conditions, which resulting in energy efficient cooling solutions

4.1 Classification of passive techniques and strategies

Passive design technique is categorized into cooling, lighting and heating methods

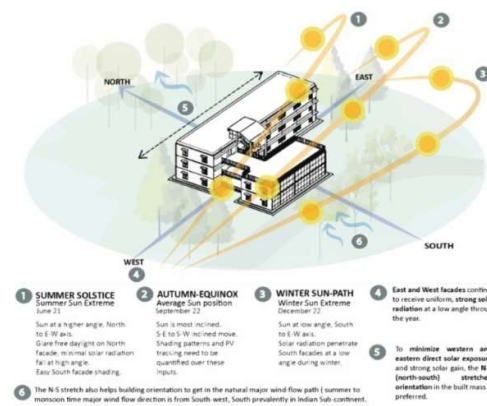
Figure 2 : Passive Cooling techniques



Source: Bhamare, Rathod and Banerjee 2019

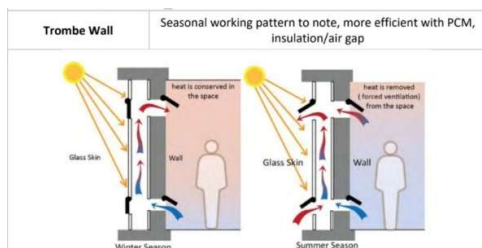
Building massing/orientation is a positioning a building that the longest side face the north and south will reduce the direct sunlight helping to keep building cool.

Figure 3 : Building orientation with advantages of solar gain and with flow of wind



Thermal mass with the help of trombe wall help to store heat inside the structure of building and fluctuates the indoor temperature in medium range.

Figure 5 : Depicts thermal mass in trombe walls



Source: Al-Sanea, Zedan and Al-Hussain 2013

Green roof benefits urban environment and building efficiency, they reduce absorption of heat from vegetation on roof which leads to cool temperature indoor with less dependency on air conditioning. This natural solution mitigates peak day time temperature .

Figure 6 : Green roof with its working details



Source: blog.denbow.com/greenroof-layers

Sola tubes collect natural solar light and distribute light into interior spaces from roof top, also these sola tubes make the space lighten without using electricity.

Figure 7 : Image depicts Solatubes working mechanism

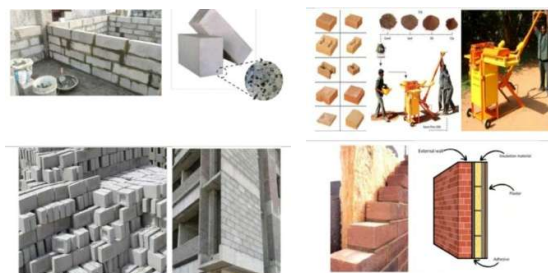


Source: lightsandlights.com

5. Application of low carbon emitting building materials

Materials like AAC block, Fly ash brick, Porotherm block with fibre glass, CLC block and Compressed stabilized earth blocks reduces the heat gain indoor space and insulation materials are eco-friendly insulation which is cellulose based with high durability.

Figure 8 : Different types low carbon emission building materials



Source: IGBC 2022, Sameer Maithel, Rajan Rawal 2023, GHTC 2021, BEE 2017.

6. Case studies of Low Carbon emission in public buildings

This section presents frameworks used to access and identify the projects with low carbon emission strategies using the strategies identified in above previous sections. In the framework it has different criteria involved relating to passive and low carbon emission strategies of various parameters in different buildings.

Table 1: Casestudy examples framework

Criteria	Case study-1	Case study-2	Case study-3
Name	Treglow n Court	Greenhill Primary School	Welsh Governme nt offices
Location	Wales	Wales	Wales



Building type	Public Office	Education	Public Office
Passive design and low carbon emission strategy	- Passive stack ventilation. - Nature roof or green roof to attenuate rainwater run-off - Grey water recycling is used for flush WC's	Insulated building envelope. - Thermal efficiency using trombe wall. - Electricity generation with solar	- Pond water cooling which is evaporative cooling. - Natural ventilation via stack effect - Fixed solar shading is provided

7. Conclusion

Public buildings emit carbon emission in terms of use of electric energy and mechanical energy because public buildings like hospitals, schools and offices etc with natural ventilation and natural sunlight being neglected as they go with mechanical ventilation and lighting and use of materials like glass and unsustainable materials are more in it. So here is a model which involves strategies of passive architecture which enhance the design of public buildings through different passive design techniques like use of green roof and trombe walls which provides more insulation in the place where more number heat is generated previously. Use of solar tubes and wind catchers for good lighting and ventilations, earth berm walls, porothermo walls and AAC blocks can be

used which promotes sustainability and decreases carbon emission. Use of cross ventilation to allow cool breezes to flow through and use of stack ventilation by placing operable skylight or clerestory windows along with using shading devices helps prevent heat gain and glare. Use of passive architecture elements like courtyards and techniques like evaporative cooling in public buildings promotes sustainability and climate responsive architecture and promotes less carbon emission in building. Hence carbon neutral architecture is achieved through passive architecture.

8. References

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