Learning from Past: Case study of Gohar Mahal

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ABSTRACT

Passive solar technique is a method of collecting, storing and radiating heat energy in winter and rejects solar heat in summer. The concept is to maintain thermal comfort in the building. Adaptation of such technique is not new in India; many historical buildings are example of the same. The case taken into consideration is a heritage building- Gohar Mahal at Bhopal in Madhya Pradesh. The Gohar Mahal was built by the first women ruler of Bhopal- Gohar Begum in 1820. The paper discuss about the analysis of passive solar technique adopted in Gohar Mahal. The argument focus on effect of solar orientation, the use of thermal mass, proper ventilation and appropriate placement of window in the built envelope and its microclimate to achieve thermal comfort for the user. The Gohar Mahal is an appropriate example to explain effective utilization of site and intelligent planning for adverse climatic condition to decrease down the dependency on mechanical means. The analysis will help in catering the demand of sustainable building, which can be a measure to overcome the dependency on mechanical systems.

Keywords: Solar passive techniques, ventilation, solar orientation, sustainable, thermal mass, climate.

1. INTRODUCTION

Now a day green building or sustainable architecture is in demand. The reason for the same is to cut down the energy demand of building from non-renewable resources. Therefore there is demand of building which are less dependent on energy for their successful operation, and answer comes in the mind is Passive Solar Design. Solar passive design is a technique of collecting, storing and radiating heat energy in winter and rejects solar heat in summer. Because of the heat radiation in sun light, it creates temperature difference and results in airflow. In response to solar heat shading elements is designed, material section, orientation and opening is done to have heating and cooling effect within the built mass. India is having so many historical buildings, which was constructed by taking climate responsive as prime goal. Bhopal also known as “The city of Lakes” is situated in the central India and has humid subtropical climate, cold and dry winters, hot summer and humid monsoon. The city has great history behind.

The Gohar Mahal is situated in the upper bank of lake. The first women ruler of Bhopal named Gohar Begum in 1820 built it. It's a magnificent example of blend of Hindu and Islamic architecture. The ministry of textile and Madhya Pradesh handloom and handicrafts vikas nigam has taken initiative for maintaining the glorious historic building. INTACH has worked in its renovation and reuse purpose of the Mahal by maintaining its original fabric and construction details with new function imparted. The complex is converted into urban haat.

***Gohar Mahal**:* The splendid three storied structure, built on a contoured site having approach from road to the building at every floor. The site has the entrance from the south-east direction, where as building has an entry from lake side i-e eastern corner of the Mahal. It is having two courtyards, which divides it into three transverse mass. The total floor area of the Gohar Mahal is 650 sqm. with massive load bearing wall of brick. The top floor is enclosed with wooden frame of mansard roof covered with slate tile. The interior is finished with lath and plaster, and verandhas all around the courtyards along with direct and indirect opening in the structure. The paper discuss about various climate responsive feature of Gohar Mahal and thrust area is to analyze various passive solar techniques inculcated in the planning of Gohar Mahal. The analysis will help in learning the indigenous techniques adapted in past and its result, which is answer of now a day energy crises and sustainable solution for better future. The various passive solar features of magnificent Gohar Mahal are discussed as following:

Fig1: The Gohar Mahal **Source: wikipedia.org**

Courtyard- the breathing space: The Gohar Mahal is divided into three part with two central courtyard. Courtyard is an affective technique of shading, and also allowing light to enter inside the building. It helps in maintaining pressure difference between hot air and cool air, which results in air flow. To humidify the air, water sprinkler was used, hence thermal comfort is achieved. To minimize the heating of external wall verandhas were used, which helps in attaining thermal buffer by cutting off the heat and glare. The arcade along the periphery of courtyard helps in maintaining the inside temperature by cutting the direct sunlight to enter the building. The parapet along the courtyard are of low height and roof slope inward, towards courtyard for better Hence the courtyards act as prime area for air exchange and day light which contributes in maintaining the temperature cooler with proper lighting of interior space.

Fig2: Deep Verandahs around courtyard to cut direct sunlight Source: www.flickriver.com

Building envelop: Building envelop contributes primarily for the heat exchange of built up mass. The first and most important thing to be considered is the heat loss and gain in a built up mass is the material used. The effectiveness depends on decapitation of heat from wall and roof.

Wall: The massive wall of Gohar Mahal is made up of adobe bricks with some space made of stone. The mud construction is an indigenous technique adopted in central India. As availability of mud is in abundant and respond to the climatic condition of the site, it was basicly used as prime construction material. The thickness of walls of gohar Mahal varies from 1500cm to 60cm depending upon the location and purpose on the space. The adobe construction is very energy efficient being warm in winter and cool in summer. The thick solid adobe walls posses the property of thermal mass, because of which the adobe brick are heated by sun light it holds heat and decapitate it slowly at night which is preferred in winter. To prevent from vive versa, sun is kept

off from adobe wall by means of over hangs, shading device, verandas, and proper orientation, so that they stay cool during the day and night of summer.

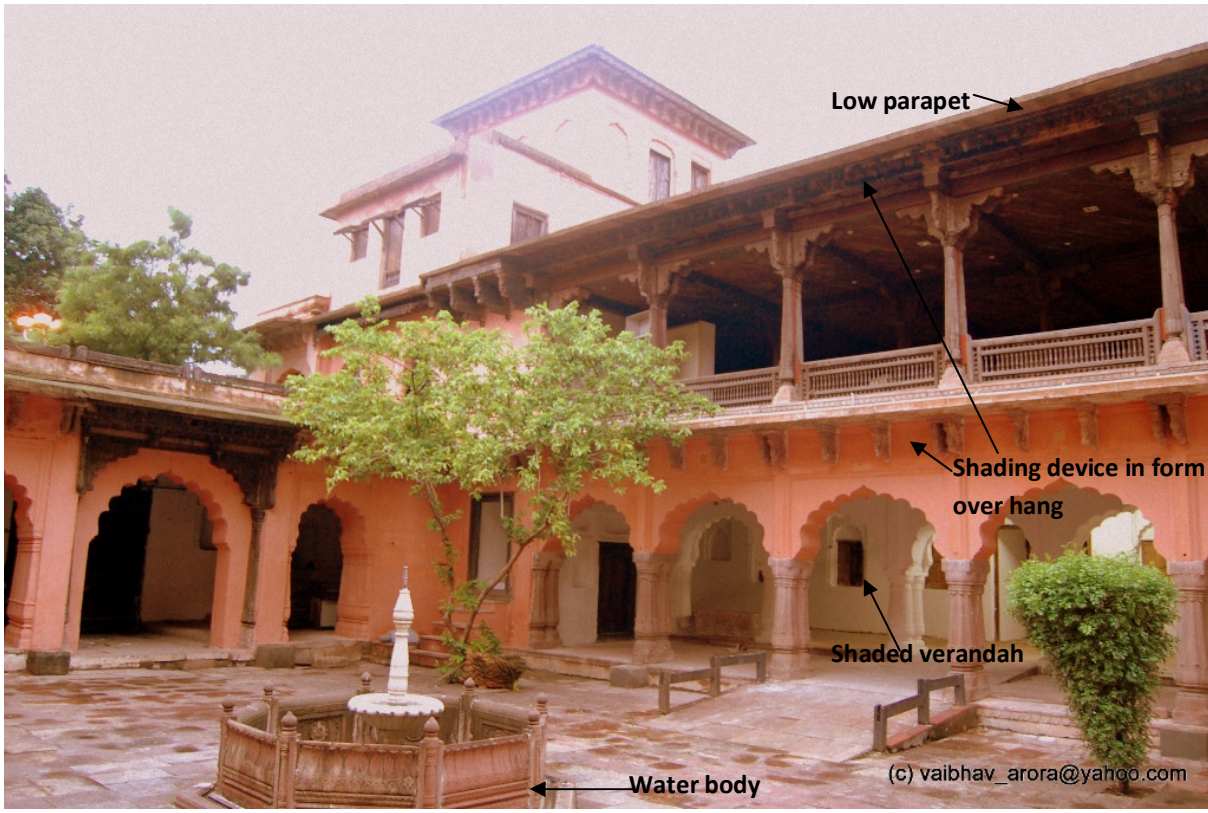

Fig3: The courtyard of Gohar Mahal with water body and arcade verandahs as shading element. Source: www.indiamike.com

The Gohar Mahal is oriented in east-west direction, with courtyards and verandahs all around to achieve the thermal mass property of adobe. Adobe wall also absorb sound and reduces echo, which helps in maintaining the privacy of space.

Roof and floor: The rooms placed at the lake side are double roof. The secondary roof or false ceiling provided below the structural roof is provided by gap. This gap between the two ceiling comprises of air, which is a non conductor of heat, hence reduces the transmission of heat from roof to interior of building. Few rooms are provided with high ceiling and small opening near roof. As warm air rise up because of its light weight and escapes from the opening at the top, at the same time cold air is replaced. The repetition of phenomenon results in good airflow within the space. Hence the desired thermal comfort is achieved in interior.

Openings: The openings are provided in form of door, window and ventilators for adequate ventilation. Ventilation refers to exchange of air from outside, as well as flow of air within the building. Natural ventilation is done by pressure difference between indoor and out-door air and with effective opening for the escape for warm air. To achieve this ventilators are placed near the roof. To cut off the direct sunlight the ventilators are inclined from outside to inside because of which indoor space temperature is maintained cool. To enhance air circulation/ flow numbers of Jharokhas are provided.

Fig4: The wind catchers of Gohar Mahal Source: http://www.tripadvisor.com

For better pressure difference for flow of air, hexagonal wind catchers are provided. Windows are oriented according to prevalent wind direction. The window openings are placed in the exterior as well as in the interior wall towards the verandahs and courtyards.

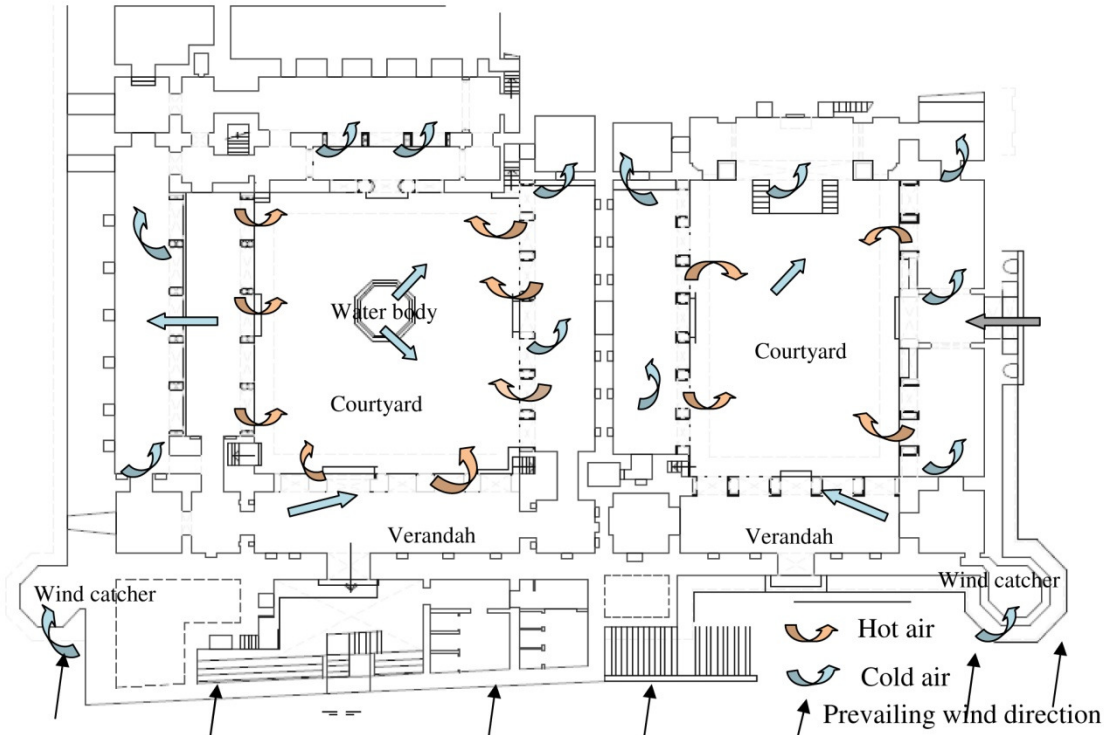

Fig5: Ground floor plan of the Gohar Mahal showing wind movement Source: Report on Gohar Mahal (INTACH Delhi)

Fig6: The shading device supported with decorative stone brackets. Source: www.flickriver.com

Shading device: Shading devices helps by facilitating in control of sunlight required in interior, by cutting off the harsh summer sun and to gain direct solar radiation in winter. The over hangs are provided on all the four side of the Gohar Mahal. The shading devices are 900mm wide with slight slope towards outside of the building for easy run-off of rainwater and curtail the undesired sunlight. Decorative stone brackets support the shading devices in form of overhangs. Hence the only desired sun light is allowed within the built up mass to achieve the thermal comfort.

Building materials: The building material selected for the construction of building plays a vital role. The material contributes in heat exchange and the thermal mass of building, which helps in cutting down energy requirement as well as maintains indoor human comfort. The building material used in various building component of the Gohar Mahal are: Adobe sun dried bricks, stone, timber, lime, surkhi. The materials are intelligently used according to its thermal conductivity like massive adobe sun dried brick for walls, at some places stones are also used. Timber is used for door and window frame, floor joist and roof joist as timber is having low thermal conductivity, good tensile strength and restrict no air and light to enter the space. To attain smooth finish and acoustics plastering with mud and lime surkhi is done.

2. CONCLUSION

The Gohar Mahal is an appropriate example to learn effective utilization of site and intelligent planning for varying climatic condition to decrease down the dependency on mechanical means. The Gohar Mahal is having perfect east-west orientation to avoid direct sunlight, heat and glare. The use of thermal mass in form of adobe walls, proper ventilation and appropriate placement of window for entry of cold air and escape of hot air in the built envelope. The microclimate is maintained by providing water body at the center of courtyard for the thermal comfort of user. The appropriate uses of low thermal conductive material for construction add to achieve the required comfort level. This gives us inspiration to respect the site and its surrounding with strong consideration for climatic condition will help to make a building energy efficient with low maintenance cost. The material selection for the construction work should be according to the need of thermal comfort neither based on the materials that are in fashion. Now a day the buildings are made, keeping aesthetics in consideration and sacrificing light, ventilation and solar orientation, which results in increased dependency on mechanical means for heating and cooling. There are many such historical buildings are available in India, which gives us the lesson to learn from the past techniques adopted to conserve non-renewable resources.

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