

# Sustainability Potential in Heritage of Gwalior City

Ar. Ashish Sharma

Assistant Professor, Amity University Madhya Pradesh, Gwalior, India

**ABSTRACT:** One of the famous examples of architectural heritage is Gwalior City which is comes under extreme climatic zone. The heritage and ancient buildings of Gwalior are the finest example of sustainable architecture and energy efficient building and the landscaping that provides a soothing and fresh environment. Planning of urban areas, the various elements and techniques like "jaali" pattern and "jhilmill windows" and so many others which are constructed to achieve the thermal comfort and energy efficiency. This paper discusses about the energy efficiency in ancient and heritage buildings of Gwalior and different elements and effective techniques that were used in those buildings to overcome the adverse climatic conditions and other socio and environmental problems in today's world by learning form the past and construct a sustainable future.

**KEYWORDS:** Energy Efficiency, landscape, Architectural Heritage.

## I. INTRODUCTION

Energy the first word that comes in our mind when we talk about the life or evolution of the universe. It is one of the major basic needs with the starting of the human civilization. Our ancestors are always working for their comfort and basic needs and the first requirement they realises for their comfort and basic needs is energy and fire is one of the greatest invention in the field of sources of energy by our ancestors. but the journey for the practices and searches for the energy resources not stopped here with continuous increase in population the need of energy increases hence there is a new terminology came known as energy consumption and with continuous and dramatic increase in energy consumption the need of energy efficient approaches are introduced and now a day it became the major burning topic in development. In the meantime the India population in the past 15years has grown from 1.06 billion to 1.3 billion containing 17.5% of the world population and projected to be the world most populated country by 2022. By the end of the century more than 60% of the world population will be living in urban conglomerate. At present 20% of the world population consuming more than 80% of the total energy simultaneously creating the equivalent pollution and it is the key concern that 60% of the energy consumed for the production and running of the building. From 2005 to 2014 the total energy consumption in India increases from 15146 PETA joule's to 24071 PETA joule's and the per capita energy consumption increases from 13694.83 mega joule's to 19522.15 mega joule's, according to the IEA statics for energy balance for 2004 – 2005 the total final energy use globally account for 7209 mtoe by buildings hence these data clears the need of thinking and adaptation for energy efficient building. During the ancient period the dramatic increase in population and the due to it tremendous increase in need of energy our ancestors work effectively to solve this serious and major issues. Heritage buildings are sustainable and it can be self declared that they are still in very well condition from ancient era till now. In ancient time there is no such major resource of energy which helps the comfort and basic needs but problems are always there so they adapt some effective and efficient techniques and solution. Start by looking on how the techniques and Architectural solutions developed over years. Up to the dominance of the modern movement, bio-climatic issues were more evident in vernacular than official architecture if we are talking about the global context like natural lighting as in the Pantheon in Rome or the great Gothic cathedral but when we are talking about the Indian heritage we look forward about the cultural and Architectural diversity of it. India is rich in all type of climate and hence India is more diverse in context of architectural and cultural aspects. Looking for a single climate or locality Gwalior having a great heritage value Gwalior comes under the extreme climatic zone hence this place facing a lot of climatic issues, throughout the ages the site and climate sensitive issues were taken in stride as a natural issue for

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 3, March 2017

different reasons of which the more important were: the slow pace of evolution which allowed for learning by trial and error. The local character of construction and material and the need to make the best use of the limited resources and means that was available. Our ancestors come up with great solution like jhilmil Windows and other techniques and materials like natural colour etc. which are more efficient and useful with great economical and ecological means. Hence there is a need to study our heritage and discuss about the possibilities and applicability of those solution in our modern architecture with some necessary implications to achieve energy efficiency, reduce carbon emissions and less impact on our environment with great economical means.

## II. OBJECTIVE

The location is preferred due to various reasons. From centuries it has been part of rich and adverse culture where all types of communities exist. Secondly and foremost, a strong initiative can be taken to improve the versatility of architecture in the Gwalior keeping its heritage value, culture and tradition alive, a study whether these practices are energy efficient. A very different kind of architectural element and technique can be visualized in every ancient building and indigenous housing of the Gwalior and so far they are sustainable and capable of fighting with the adverse climatic condition of Gwalior and maintain the user comfort till now. The objective of this research is to identify whether these buildings are energy efficient and at what extent they are energy efficient and what are the approaches and principal used to make them energy efficient and how these techniques and principal can be implemented in our present era of architecture

**1. Gwalior the city of heritage** The three words i.e. culture, heritage and architecture are extremely correlated to each other. However culture, heritage and architecture have their own independent identity and existence but at the same time each is dependent on the other as well. Heritage and architecture is the key point to identify the culture. Gwalior is one of the counter magnet city of Madhya Pradesh and is major historic city of India. It occupies a strategic location in grid region of India. And is one of the ancient and heritage cities of India

*1.1. Geographical condition* Gwalior is located at 22.22`N 78.18`e in northern Madhya Pradesh (a major state of India). It has an average elevation of 197 metres and spread over 5214km sq.

*1.2. Climatic condition* Gwalior has a sub-tropical climate with hot summers from late March to early July, the humid monsoon season from late June to early October, and a cool dry winter from early November to late February.

*1.3. Socio economic condition* As of 2011's India census Gwalior has a population of 2032036.in which 1273792 is the urban population and 758244 is the rural population. Hinduism is practiced by the majority of the people in Gwalior (88.84%). Other religions practiced include Islam (8.58%), Jainism (1.41%), Sikhism (0.56%) and Christianity (0.29). Hindi and the Marathi is the major language of the city. Gwalior is surrounded by 3 Industrial areas – Sitholi, Banmore and Malanpur. In ancient time Gwalior have big manufacturing industries like jc mills Gwalior Grasim but now only j.b. mangharam left but many industries are there in the three sectors. The major source of economy of Gwalior is Gwalior trade fair(started in 1905) starts in second week of January until February. And the major market and sources of economic revenue are maharaj bada,ghas mandi, loha mandi, hazira and having three shopping malls.

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 3, March 2017

**2. Heritage value** Gwalior is an eclectic mix of the Tangible and Intangible, manifested in its rich Cultural Landscapes. The conservation and preservation of heritage in Gwalior is undertaken by the Archaeological Survey of India, It has also prepared a listing of about 187 important monuments in various parts of the city. The tangible heritage includes the Gwalior fort, maqbara of tansen, maqbara of mohamad gaus maharaj bada, The intangible heritage includes the natural landscapes, and the cultural heritage in form of musicians, dancers and writers.

In tourism Gwalior is the most visited city in the Madhya Pradesh and is consider as the world heritage site by UNESCO

**3. Examples of energy efficient practices in built heritage of Gwalior** Gwalior is rich in heritage and culture and are energy efficient there were many energy efficient practices and techniques that can be visualised in the heritage of Gwalior such as the planning concept like badas and many architectural elements like jali patterns and the jhilmil windows and some techniques like using the reflection principal to lighten up the entire room with less energy consumption, the natural cooling of air, use of energy efficient materials having low thermal conductance (U value) high specific heat capacity and high resistance value (R value) like stone (red sand stone) natural colours the traditional lime mortar and some other metal and reflective materials like emerald, mirrors and are used according to the place and orientation of the building in very well manner. The building envelop and the overall dimension of the building is also plays an important role which makes the principal workable and the building energy efficient

**4. Maqbara of Mohammad gaus: A case study** Spectacular tomb of Mohammad Ghaus is a world famous architectural monument from the history. It was built in 38 years in Akbars Era from the the Kings treasure under the guidance of Mohammad Ghaus's son and king Akbar. a famous pilgrimage center of both Muslims and Hindus. The mausoleum of Ghaus Mohammad exhibits typical Mughal architecture, its hexagonal pillars and screens using pierced stone technique are simply marvelous.

**6.1. An eye view to its marvellous beauty and architecture:** The building is square in plan and topped by a squat dome. It has hexagonal domed kiosks at its corners together with sloping eaves that project from exterior, features both taken from the Hindu architectural tradition. The tomb walls are made of pierced stone screens carved in geometric designs which allow light and air to filter into the interior chamber and create a cool, meditative atmosphere. The large central dome of the saint's tomb tops the actual enclosed and walled large single room that houses the tomb, and the surrounding structure is more like a verandah with jaalis (perforated stone screens), which gives the structure a larger "enclosed" appearance than it actually has. The central dome with four small chattris (domed pavilions) resting on a prominent rectangular base has a shape much like many domes found in central India.

**6.2. Location:** the tomb of mohammad ghaus is loacated at ghauspura Gwalior to the east of the town.

**6.3.Past scenario:** on the historical point of view it was built by akbar under the guidance of mohammad ghaus son on the loving memory of sufi saint mohammad ghaus(16<sup>th</sup> century) he is the teacher of mughal emperor and tansen(the famous musician in the akbar court) and this large tomb built during the second half of the 16<sup>th</sup> century it is surrounded by graves and smaller pavilion tombs, including that of Tansen.

**5. Energy efficient approaches:** to know the efficient approaches first we have to go through the number of causes which needs energy like a building will consume for many purposes like thermal comfort, lighting, ventilation, noise reduction etc.

**6. Technique and principal used by them:**

**6.1. Orientation of the building:** the building is oriented in such a manner that maximum wind can intake so to resolve this issue they make the building symmetric and put performable jali all over the facades of the building so that the maximum wind can intake.

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 3, March 2017

6.2. *Volume of the building*: the volume of the building plays an important role in maintaining the thermal comfort of the building.

6.3. *The openings*: the openings at the maqbara of mohammad ghaus are placed in such a manner that they first place the bigger opening than smaller one and than one more small opening to enter in the maqbara.

7. *Elements*: the major elements that makes the building energy efficient are:

7.1. *Jaali* : the jaali are basically an architectural element of mughal architecture. This form is not only for decoration purposes but this is the application of wind behaviour to maintain the thermal comfort of building.

7.1.1. *What jaali is*: the jaali is a perforated stone or latticed screen, usually it is an ornamental pattern constructed through the use of geometry and calligraphy but later on the mughal use some leafs and flower pattern .

7.1.2. *Architectural features of jaali*: at the maqbara of mohammad ghaus the jaali is 2 inch thick made of perforated stone and is of square pf 75\*75 cm.

7.2. *Roofing*: the roof contain a huge dome and are made of stone where lime mortar works as a binding material and are reinforced by copper the height of the roof is 45 feet

7.3. *Ceiling*: the ceiling of the maqbara is decorated with fresco which is made of natural colours( made of flower leafs and gold water)

7.4. *Pavements*: the pavements are of stone with slopes

7.5. *Wall*: the wall is of stone (red sand stone) having thickness of 1 meter and most of the surface of the wall is filled with jaali.

7.6. *Corridors*: the corridors are arranged in a symmetrical pattern around the central part of the maqbara. And is work as a buffer zone and also as a thermal insulating space .the corridors are 15 feet wide.

7.7. *Openings*: there were two openings in the entrance. The first opening which is the main access to the maqbara is 6.5 feet wide and the height is 45 feet made with stone and lime mortar the huge pillars and the opening is supported with the architectural elements and the second opening is 2.45 feet wide with height of 5 feet and the facades of the wall containing the second opening is consist of jaalis which stop the wind to enter directly first it goes from wider opening than through the narrow opening.

7.8. *Windows*: there is no windows in maqbara of mohamad ghaus it consist of huge jaali all over the facades with symmetrical square shapes.

7.9. *Shades*: the shades are provide to prevent the building from rains and avoid them from direct sun radiation it is 8 feet long and fixed with copper reinforcement

7.10. *Interior space*: the interior space is the place where the tomb of mohammad ghaus is placed and is surrounded by 1 meter thick wall made of stone which consist of jaali which cover most of the spaces.

8. *Discussion on findings*: The building itself is sustainable from the ancient period

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: [www.ijirset.com](http://www.ijirset.com)

Vol. 6, Issue 3, March 2017

The main opening of the building is oriented towards north because the wind flow from north in Gwalior and the whole building facades consist of perforated jaalis which have its own contribution to make the building energy efficient.

The building constructed with the material which are itself energy efficient like the natural color lime mortar and the perforated stone.

The natural color not only makes the ceiling appealing but also fire resistant and is sustainable and is respond to the environment.

The mortar as a binding material which not only make it sustainable but also the lime provide good thermal effect

The walls are thermally insulated because they are made of mint sand stone and I meter thick

The volume of the building and the verandah surrounding the interior chamber will lower the temperature of the building.

Jaali the jaalis are constructed over all the vertical facades of the building which is not only for the aesthetical purposes these jaalis are to provide the thermal comfort as well as proper lightning and fresh and cool air.

This jaali provide a narrow opening to the air and due to this the air velocity increases and according to the Bernoulli principle when the air velocity increases it will decreases the pressure and due to decrease in the pressure of air

according to the gay lussacs law (  $p \sim t$  ) the temperature also decreases.

The jaali also provides the day light the carved surface of the jaali will lighten up the interior and avoid the direct heat radiation of the sun which prevents the building form increase in temperature.

These jaali also provides a proper ventilation.

The openings of the building is placed in such a way that the wind coming from the north will directly enters in to the bigger openings and then the smaller opening which again increases the velocity of the air and the same phenomenon occurred and the indoor temperature of the building will maintain.

The perforated stone and the thickness of the wall and the sharp carving of the jaalis and the volume help in noise reduction.

### III. CONCLUSION

The Indian culture and the heritage have its own signification but apart from this the architectural style and the techniques which are not only aesthetically beautiful but also have a scientific approach toward the sustainability and energy efficiency. The paper conclude that the ancient building and the heritage of Gwalior are energy efficient and have its own architectural style and are capable of fighting with the adverse climate of the Gwalior the building uses very simple adaptive and energy efficient technique and approach like the simple phenomenon of air behaviour and the reflection principle.

the heritage of the Gwalior needed to study and thinking about the implementation in the modern era of architecture to full fill the users need without compromising with the nature and its resources and make the building and our planet energy efficient. The major techniques and architectural elements like jaali pattern, natural colour, lime mortar and the other construction material and there interrelation. The volume and the proportion of the building are needed to be study and finding some new techniques.

### REFERENCES

- [1] Arvind Krishnan. Climate Responsive Architecture: A Design Handbook for Energy Efficient Buildings.
- [2] Alexandra Troi. Energy Efficiency Solutions for Historic Buildings: A Handbook.,January 2015.
- [3] Energy Statics, Ministry of Statistics and Programme Implementation ,Government of India,2015.
- [4] Roger Hunt, SPAB briefing: energy efficiency in old buildings ISSN 2054-7684.
- [5] IGBC green rating systemby the Indian Green Building Council 2014.
- [6] Maarten Vieveen,Adaptive energy efficiency in historical building .
- [7] Gwalior climate available online at [https://www.meteoblue.com/en/weather/forecast/week/gwalior\\_india\\_1270583](https://www.meteoblue.com/en/weather/forecast/week/gwalior_india_1270583).