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Thermal Concepts of Building Coatings to Create a Cool & Comfortable Indoor Environment for Composite Climate

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Abstract - *Study includes the use of certain envelops (wall & ceiling) that are mounted to keep the building cool & comfortable. As we know the world is changing, thus surrounding also changing both internally & externally. The objective of this study is to identify the best coatings that suit the environment & affecting the indoor thermal comfort conditions to suit present day lifestyle. The study attempts to calculate the thermal values in Celsius degrees for composite climate of different buildings with the same orientation but different building envelops to check its inside & outside temperature. Depend upon study of building envelop from these case studies the good envelop of building can be identified which can help in reducing the electrical loads too. It is already considered that the use of air conditioning system provided to create a cool environment which helps to comfort the human body. So to study, the thermal concepts of building coatings to create a cool & comfortable indoor environment for composite climate (case in Aligarh city) just to check the saving electricity cost during peak load hours & to provide a human comfort with optimal use of resources can be achieved. This study critically analyses various coatings & its utilization to give the cool & comfort feeling inside the building and its significance in energy conservation. Building that have different coatings (glass, tiles, wood, net, plaster with openings etc.) over the external walls & roofs can also provide an aesthetical, economical, and technical solution for electricity self-sufficiency in buildings. The study is of relevance for utilizing proper materials & systems for improving thermal comfort in modern buildings for a particular climatic zone (composite climate).*

Key Words: **Air Conditioning, Building Envelop, Cooling, Composite Climate, Human Comfort, Modern Buildings, Suitability of Coatings**.

1. INTRODUCTION

Due to high temperature outside the environment affects the internal environment of the building too. COMPOSITE CLIMATE- The centre region of India covers composite climate. Two Main Seasons – Hot & Dry, Warm & Humid, The Cities includes New Delhi, Kanpur, Allahabad & the Temperature in Summer in between 32-43' C (Day Time) & 27-32`C (Night time), In Winter - 10-25`C (Day) 4-10`C (Night) along with the Humidity: 20-25% -Dry Periods 55-95% - Wet Periods. The solar radiation in summers with high intensity [1] (Anjali.S, 2018). So to study the buildings with same orientation may help, the main focus is to provide human comfort with optimal use of resources & to save electricity mostly utilized in summers due to the excess use of air conditioners. The reasons for high rate of energy consumption is the bad lifestyle which is unmatched to their proper standards. Likewise, the usage of air conditioning systems. It surely provides human comfort inside the building on the other hand it affects the outer environment. But to decrease the use of Air conditioning some techniques can be applied like the use of some coatings as tiling's, painting, glass, green & blue space. At this time the energy consumption per unit area in India of any building having an exterior wall, the roof and the window are double triple than developed countries. [2] (Shukla, 2014). Today they are also applied on the outside vertical surfaces & ceilings to prevent overheating during summer. As it is used to change the reflective properties of the surfaces, changes the thermal performance of the whole building envelop [3] (Synnefa, 2006). (alii, 2011) present an experimental study about the impact of coatings on building surface, temperatures, air temperature, globe temperature, energy consumption & thermal comfort. The result showed that depending upon location, season & orientation, exterior & interior surface temperatures can be reduced by up to 4.7 degree Celsius respectively using different coatings.

1.1 Orientation and the Shading

Roof overhang is provided for south-facing windows. In winters some sun rays might be desirable to allow into south-facing windows, for this wide roof required with overhang above it. For North facing windows there is no need of any shading because the sun rays coming in early morning or late in the afternoon in summer and in other time it stays away from the glass of windows. Most of the problem arises in east and west facing windows from heat gain and glare. So it is the best way to block the sun rays with the help of vegetation like trees, shutters etc. to avoid both heat and glare. It is also estimated that to reduce the areas with high glaze of buildings facing in the directions like west and east where the non-air conditioned spaces used as buffering or insulating zones. [4] (Research Institute as Florida Solar Energy Center (FSEC), 2007-14).

1.2 Quality of Life

As we know with certain studies, that the human body adjusts itself to fight against excess heat through physiological heat adaptation provided by our cardiovascular, endocrine, and renal systems. [5] (Paul Osmond, 2017). However, human body starts to feel uncomfortable when the surrounding temperature reaches to 36-38°C. As it means the indoor temperature should be in between 30-32°C because it is almost 5-6°C less than the outer temperature. Thermally comfortable city environments promote outdoor activities, public life and health. Results may also increase and prevents outdoor heat stress and energy demand during summer seasons like in India in-between May – August. It is also estimated that temperature ranges greater than about 22°C, with each 1°C it increases electricity demand by 2.6%. So it is important to control outdoor as well as indoor temperature to decrease the demand of air conditioners. So that it can be helpful way to reduce carbon emissions in our cities [5]. (Paul Osmond, 2017). It is an assumption for thermal comfort that if there is any change from comfort to discomfort then people do whatever they need to restore their comfort, so it is important to understand the concept of thermal comfort. It means it completes the requirement to feel comfort within the body and soul inside the building. For this an opportunity plays their very best role because it creates the happiness within the environment and body. The changing phenomena in indoor temperature is about one-third of the outdoors, where the occupant controls the indoor. So it is necessary to understand quality and quantify by taking proper measures so that there will be no further problems creates after completion of work. [6] (Singh, 2016).

1.3. Climate affects clothing (physical) as well as behavior (psychological) personality of humans:

The range for comfortable temperature in humans is very narrow as prescribed by Indian codes which is around (23–26 °C) for summers, and to maintain it we require energy which is automatically rising phenomenally. The standard comfort range is in between (26.0–32.5 °C). Many adaptations were taken by occupants and for this it requires different measures like-

- Environmental controls,
- Clothing,
- Metabolism and Many behavioural actions.

It is also studied that the behavioural adaptation was better as well as restricted in summers for higher economic groups always. So the Thermal tolerance was limited in the utilization of A/c's, which thus resulted in "thermal indulgence". [7] (Indrāvati, 2010).

1.4. Human comfort environment:

To Humans have tendency to feel comfortable in a very narrow range, just by having cool and comfortable zone within an area in their room atmosphere. There are several parameters like- specific temperature, air movement and relative humidity that increase/ decrease heat transfers from the human body to the comfort range.

In a normal relaxed condition, the human body tends to exchange 100 W when resting, 1000 W when working and 2000 W when exercising [8] (Mehling, 2008). We need conduction, convection, radiation and evaporation to check the comfort range through this. Buildings provide shelter to humans & coatings provides the comfort zone within it.

2. DIFFERENT ELEMENTS OF COATINGS:

2.1 High Albedo:

Light-coloured walls are coolest, Shiny, bare-metal walls tend to not be cool because they are slow to release absorbed heat. It is also found that cool walls could lead to annual heating, ventilation, and air conditioning (HVAC) energy cost savings up to 11% for stand-alone retail stores, 8.3% for single-family homes, and 4.6% for medium-sized office buildings. The latest study (Levinson) said. Cool walls play a best role for hot and sunny climate. Many systems are used to provide cool & comfortable indoor environment like Expanded Polystyrene lightweight foam concrete panels, passive cooling techniques, Insulation, shading of roof, shading by trees & vegetation, Passive downdraft evaporative cooling (PDEC) etc.

2.2 Urban Space Material:

Urban space needs the pavement & the facades that helps to reach from one place to another for movements, trading, meetings and communication the possibility to cross or reach destination to satisfy the users need dealing with the perception of the space. Natural material properties used to classify energy performance. [9] (Dessì, 2011) Such so-called cool materials can be applied as urban paving, building roofs and walls.

2.3 High Albedo Roof Surfaces:

These roofs are used with white coatings which can radiate up to 75% of incident solar energy. For the best result, a high-albedo cool roof absorbs about 300W/m2

Tiles and concrete slabs are common materials to have a thermal emittance of 85% and above. the coating reduced the peak air conditioning energy demand by 25%. [10] (htt4)

2.4 Shading by Textured Surfaces:

These textured surfaces are helpful to create shades to building element. Highly textured walls have a portion of their surface in shade which can increase the outer surface coefficient, which permits the facade surface to stay cooler as well as to cool down faster at night. [11] (Kamal, 2012).

2.5 Shading by Sunshades, Louvers:

Having benefits like it provides quality of natural lighting that can run into the interiors. The main effects can be clearly notified by placing the sunshades in proper direction or orientation of the building façade. For example, a very effective at shading in direction to south-facing windows in the summer when sun angles are high can be simply fixed up with overhangs. [11] (Kamal, 2012).

3. Certain materials, techniques and systems for comfortable indoor environment:

The natural resources have been consumed in a large form of energy usage in building / construction industry. Several materials, techniques and systems have been considered to control the inside temperature in today's scenario.

3.1. Glass Fibre Reinforced Gypsum (GFRG):

One such solution used as a material to construct all types of structural members are for using hollow panels infilled with reinforced concrete (RC), commercially known as Rapid wall in the industry.

It has almost 50% lesser embodied energy compare to conventional building system. The material on buildings offer better interior thermal comfort even during the hottest days. These are available in panels forms. One of the used example for the GFRG demonstration building, built inside IIT Madras campus, is considered or assessing sustainability.

The difference in their temperature is found to be of 2°C by the use of GFRG panels. The number of discomfort hours was considerably less. [12] (Gauri krishna, 2019).

3.2. EPS (Expanded Polystyrene Lightweight Foam Concrete Panels):

Some benefits include the reduction in natural sand consumption, use of plastic waste, & also decrease the deadweight of the structure. Molds are arranged in the shelf next to each other for the construction of the panels to stacked as vertically. Due to the use of admixture the panels can be removed after 24hr from the molds & then left for air drying for another one week. Help to decrease the thermal activity within the building [13]. (Kasurika Dissanayake, 2016).

3.3. Roof Ponds:

It is the most important when it comes to passive measures. The most exposed part of the building is roof which can be responsible to gain heat around 50% during summers. To provide coolness to the roof by shading, increasing the roof thickness, enhancing albedo of roof, insulating the roof, false ceiling can be provided, vegetating the roof, roof ponds etc. These are helpful in providing thermal comfort in arid and warm temperature of climate. Also helps to reduce the temperature upto 5°C.[14] (Ayyoob Sharifi, 2015).

3.4. PCM Phase Change Material:

This ensures pleasant working conditions and an agreeable temperature to live and work. Apart from enhancing comfort, a large reduction in costs can also be achieved by using PCM. The PCM is best way to make the temperature comfortable & remain maintained during both times for human requirements. [15] (chattergee, 2019).

3.5. False Ceiling Tiles:

Help in allowing the savings on electricity demand. Comfortable & calm interior zone. The function of tiles is to ensure natural or mechanical ventilation in the night to allow the cold air to charge so that in day it mitigate the heat which enters the room. [15] (chattergee, 2019).

3.6. BIPV (Building Integrated Photo-Voltaic):

There are various types of PV modules that can be integrated into building envelopes, providing a great opportunity for innovative architectural design and making future buildings more aesthetically appealing. [15] (chattergee, 2019).

3.7. Passive Cooling Technique:

These techniques can help to reduce the peak cooling load in buildings, which can be helpful in reducing the size of the air conditioning equipment. It can be helpful in the period for which it is generally required. Also includes the cooling concepts which are important for like shading too. [11] (Kamal, 2012) .

3.8. Clay Tile Coatings for Steep-Sloped Cool Roofs:

These represents the traditional technique by creating in such a way that the rain water falls directly into the drainpipes. These are non-white roofing tiles. Because it has the qualities like strongly scattering, weakly absorbing, stable, non-toxic, inexpensive and white pigment for photocatalytic activity. (Bettoni, et al., 2012). Natural mineral earths may also be preferred due to high stability and weathering conditions. [16] (Anna Laura Pisello, 2013)

3.9. Induced Ventilation Techniques: Solar Chimney:

It is a device which can used to induce natural ventilation by the thermal-buoyancy effect. It absorbs the solar energy during day, so that the enclosed air is heating up and causing to rise from bottom.

The use of the solar chimney helps to begin the heat of the building structure which is cooled overnight [17]. (Barbera S., 1984).

The solar chimneys have low construction cost. It can help to make comfort interiors by cooling the building structure at night. They can also improve the comfort for the living beings inside the building during the day, if the chimney can be combined with an evaporative-cooling device. [11] (Kamal, 2012).

3.10. Photovoltaic Roof Tiles:

The cost of these tiles by installing over the roof not only to generate electricity but also for aesthetical purpose by cladding it. These tiles can be placed over the wooden battens which is placed over the roof and run in all directions with the help of nails. These battens are further nailed over the rafters which are over the structure of the roof. Tiles must overlap with a minimum thickness of 75mm.

So there are many possible solutions in its varieties which are present in various forms for connecting interlock of PV tiles for producing a required shape of tiles. [18] (S.C., 1994) .

The purpose of the material of this photovoltaic roof is to give Insulation, Provides extra waterproof barrier, Dust prevention, Air prevention.

- It will be a reality in near future as a power generation in urban area.
- Photovoltaic roof tiles are mostly applied in UK.

Also termed as green energy.

4. CLASSIFICATION OF REFLECTIVE MATERIALS:

These are classified in to four categories:

- natural materials with high reflectivity to solar radiation (e.g. white marble)
- very high reflective white artificial coatings
- colored coatings with high reflectivity in the infrared part of the solar spectrum,
- intelligent coatings with nanotechnology additives, such as thermochromics paints and materials that present enhanced optical and thermal properties
  (Santamouris, 2015b)

The application of reflective coatings on exterior roof or wall (building envelops) helps in reducing surface temperatures in the summer. [19] (Yang, 2019).

4.1 Metal Oxide Pigment:

Provides benefits in outdoor coatings like durability, chemical resistance and heat stability. Materials with different colours, pigments and dyes, absorb and reflect radiation in the visible range (approximately 400 to 700 nm). Can also reflect and absorb in the near-infrared region (700 to 2500 nm) of radiation.

These coatings can be used for roofing and cladding over the buildings. So it helps also to decrease the internal temperature of the building by total solar reflectivity, which provides cooling while there is sunlight too. [20] (biller, 2010) .

4.2. Reflective Sheeting Material:

It helps in reflected elements which can be repeated. Thus, reflection should be in uniform and broad form.

4.3. Flexible reflective skylight tubes:

These are used to bring natural light from the sky inside the building, for the purpose of illumination. These are helpful in total internal reflection. These of various angled forms of design. The reflective material of these tubes can be start from an entrance-point located on its roof or one of its external walls. Diffusers are set up inside the building to spread the light. [21] (htt9)

THERMAL ASSESSMENT OF DIFFERENT BUILDINGS WITH DIFFERENT COATINGS OF REGION ALIGARH, INDIA
QUESTIONNAIRE SURVEY

1. What is your approximate monthly electricity bill, in summers?.....

2. What type of building façade (coating) do your building have?.....
A) Plaster, B) Wood, C) Glass, D) Net, E) Tiles, F) Plaster with openings

3. Do your roof have a tiling?.....

4. What type of clothing do you prefer to wear in summers?
.....

5. At presently, how do you feel?
A) Hot, B) Warm, C) Slightly Warm, D) Neutral / Normal, E) Slightly cool, F) Cold.....

6. What do you prefer to feel?
A) Much Warmer, B) A bit warmer, C) No change, D) A bit cooler, E) Much cooler.....

7. Which activity you did in the last 15 minutes?
A) Sleeping, B) Sitting (relaxing), C) Sitting (working), D) Standing (relaxing), E) Standing (working), F) Walking (indoors), G) Walking (outdoors), H) Exercising.....

8. Is this environment is being acceptable to you? Yes /No.....

9. Are you feeling Comfortable? Yes / No.....
Any suggestions?.....
...

10. Are you sweating?
A) No, B) Slightly, C) Moderate, D) Profusely.....

11. How often do you use the below controls?
A) External Doors,
a) Open mostly b) closed mostly c) Half open/ half closed d) Open in morning & evening
e) Open in daytime f) Open in night time.....
B) Balcony Doors,
a) Open mostly b) closed mostly c) Half open/ half closed d) Open in morning & evening
e) Open in daytime f) Open in night time.....

C) Windows,
a) Open mostly b) closed mostly c) Half open/ half closed d) Open in morning & evening
e) Open in daytime f) Open in night time.....

D) Blinds / Curtains,
a) Open mostly b) closed mostly c) Half open/ half closed d) Open in morning & evening
e) Open in daytime f) Open in night time.....

12. What are the reasons for not using/ using above controls?
A) Dust, B) Too hot outside "loo", C) Noise, D) Glare, E) Privacy, F) All

13. What are the reasons for not using/ using controls?
A) Fan: on/off, B) Air cooler: on/off, C) Air conditioner: on/off, D) Mats: Yes/ No,
E) Extended shades to windows: Yes/No.....

14. Any suggestions ?.....

5. CASE STUDIES:

Study of thermal comfort in buildings for satisfaction of peoples and to solve the related problems in order to enjoy thermal comfort is a way beyond the cooling.

As we already know that the systems, techniques, materials, coatings related to cooling's in buildings may require the electricity's. With the advantage there is an equal disadvantage by maintenance.

So my study involves a such type of work that should be easy, one-time investment, cost effective, aesthetically appealing, electricity saving cost, and satisfy the human thermal comfort.

It involves the study of different houses with different building facades (coatings) like-

With plaster, without plaster, Wood, Glass, Net, and Tiles.
These having the same orientation (S-W), height (2-storey building) in the local area of a city (Aligarh, U.P) that is having a Composite climate.

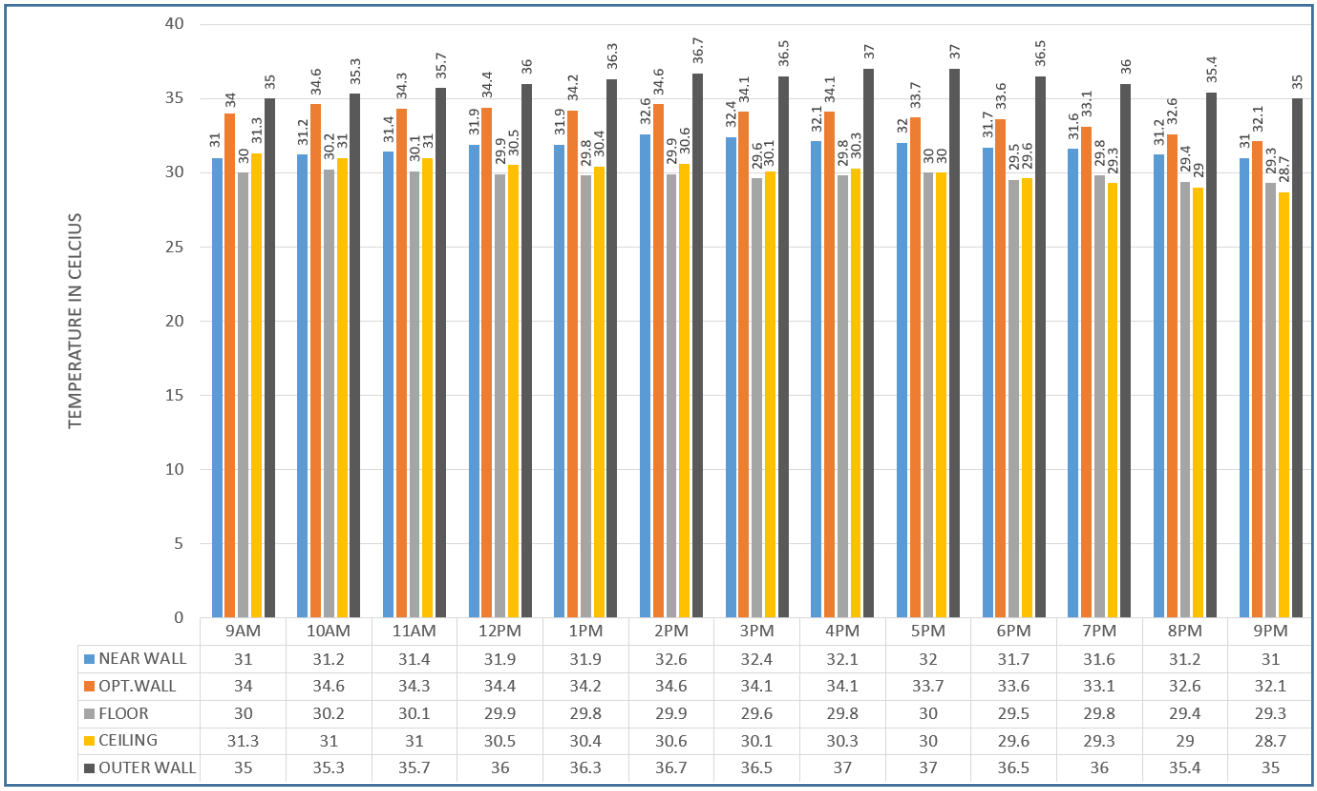
With the help of by taking the temperatures of different positions of an area of a room which is somewhat similar to this- (12ft x 14ft x 11ft), in between from 9a.m. to 10p.m. of one hour intervals.

The experiments are conducted in the month of early March, April, May, June, July and August (SIX MONTHS).

The results were obtained during examinations while maintaining the rooms under natural ventilation. The temperature is taken by a device named as FLUKE IR Thermometer (style 62max).

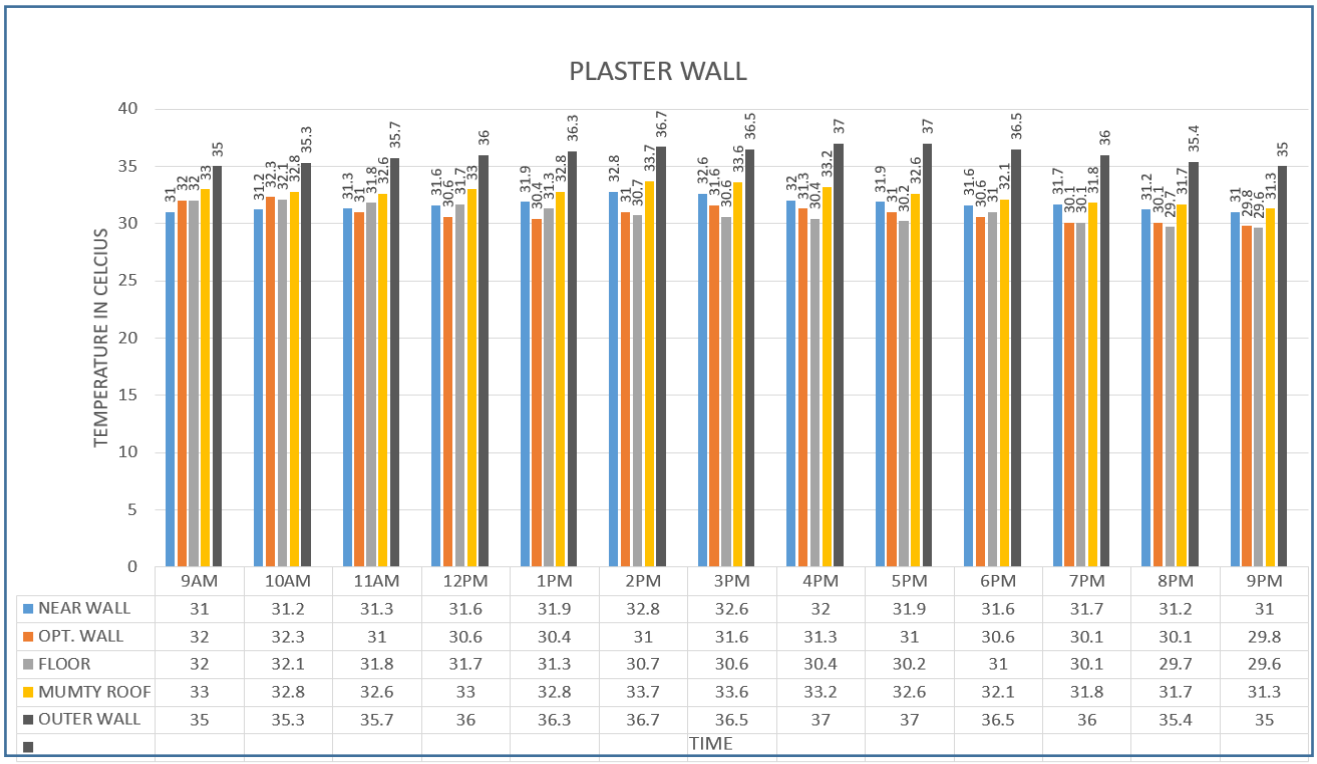
Figure 1– IR Thermometer (htt1)

Let us take a case of month June:



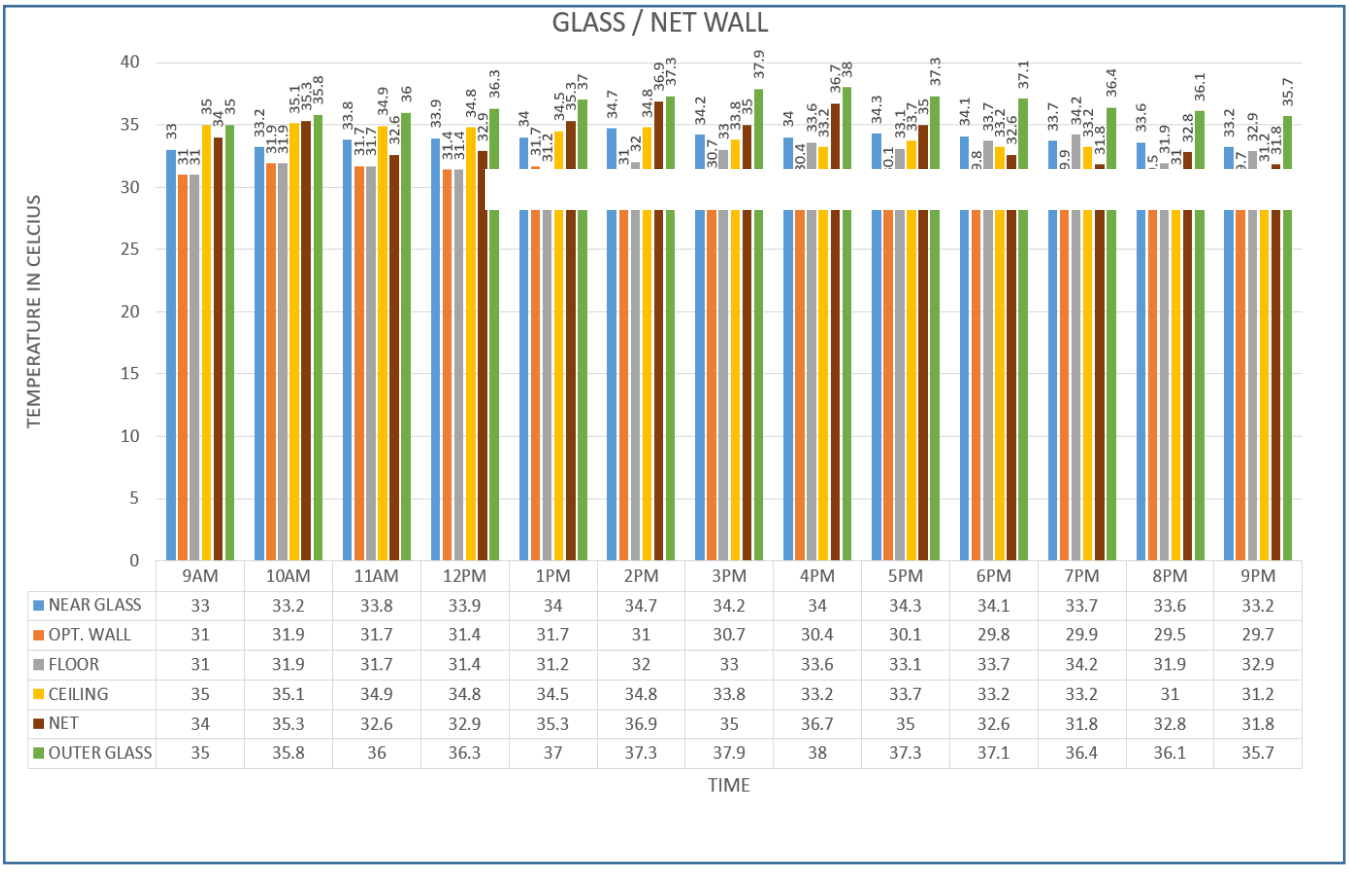
	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM
NEAR WALL	31	31.2	31.4	31.9	31.9	32.6	32.4	32.1	32	31.7	31.6	31.2	31
OPT.WALL	34	34.6	34.3	34.4	34.2	34.6	34.1	34.1	33.7	33.6	33.1	32.6	32.1
FLOOR	30	30.2	30.1	29.9	29.8	29.9	29.6	29.8	30	29.5	29.8	29.4	29.3
CEILING	31.3	31	31	30.5	30.4	30.6	30.1	30.3	30	29.6	29.3	29	28.7
OUTER WALL	35	35.3	35.7	36	36.3	36.7	36.5	37	37	36.5	36	35.4	35

Figure 2 – Growth of temperature with time in Plaster wall (with opening)



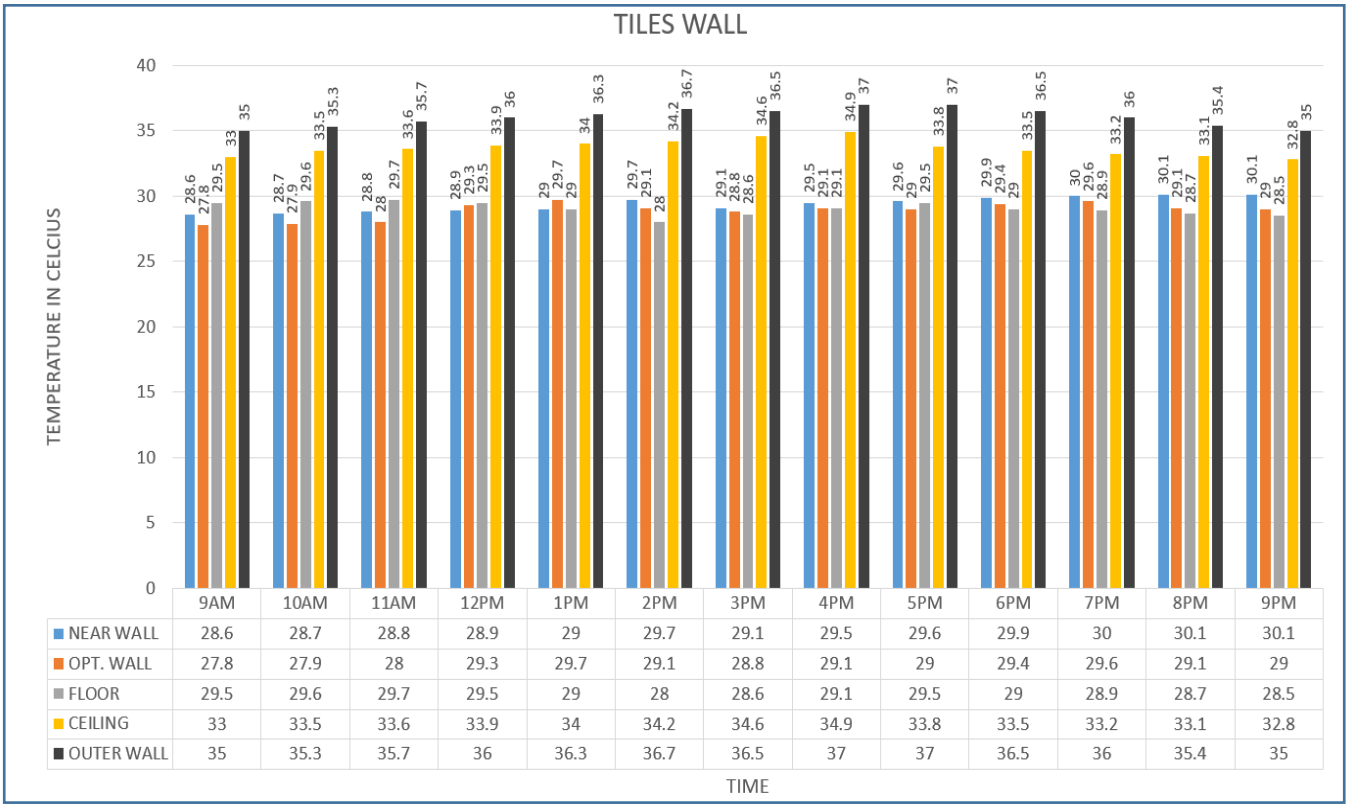
	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM
NEAR WALL	31	31.2	31.3	31.6	31.9	32.8	32.6	32	31.9	31.6	31.7	31.2	31
OPT. WALL	32	32.3	31	30.6	30.4	31	31.6	31.3	31	30.6	30.1	30.1	29.8
FLOOR	32	32.1	31.8	31.7	31.3	30.7	30.6	30.4	30.2	31	30.1	29.7	29.6
MUMTY ROOF	33	32.8	32.6	33	32.8	33.7	33.6	33.2	32.6	32.1	31.8	31.7	31.3
OUTER WALL	35	35.3	35.7	36	36.3	36.7	36.5	37	37	36.5	36	35.4	35

Figure 3 – Growth of temperature with time in Plaster wall



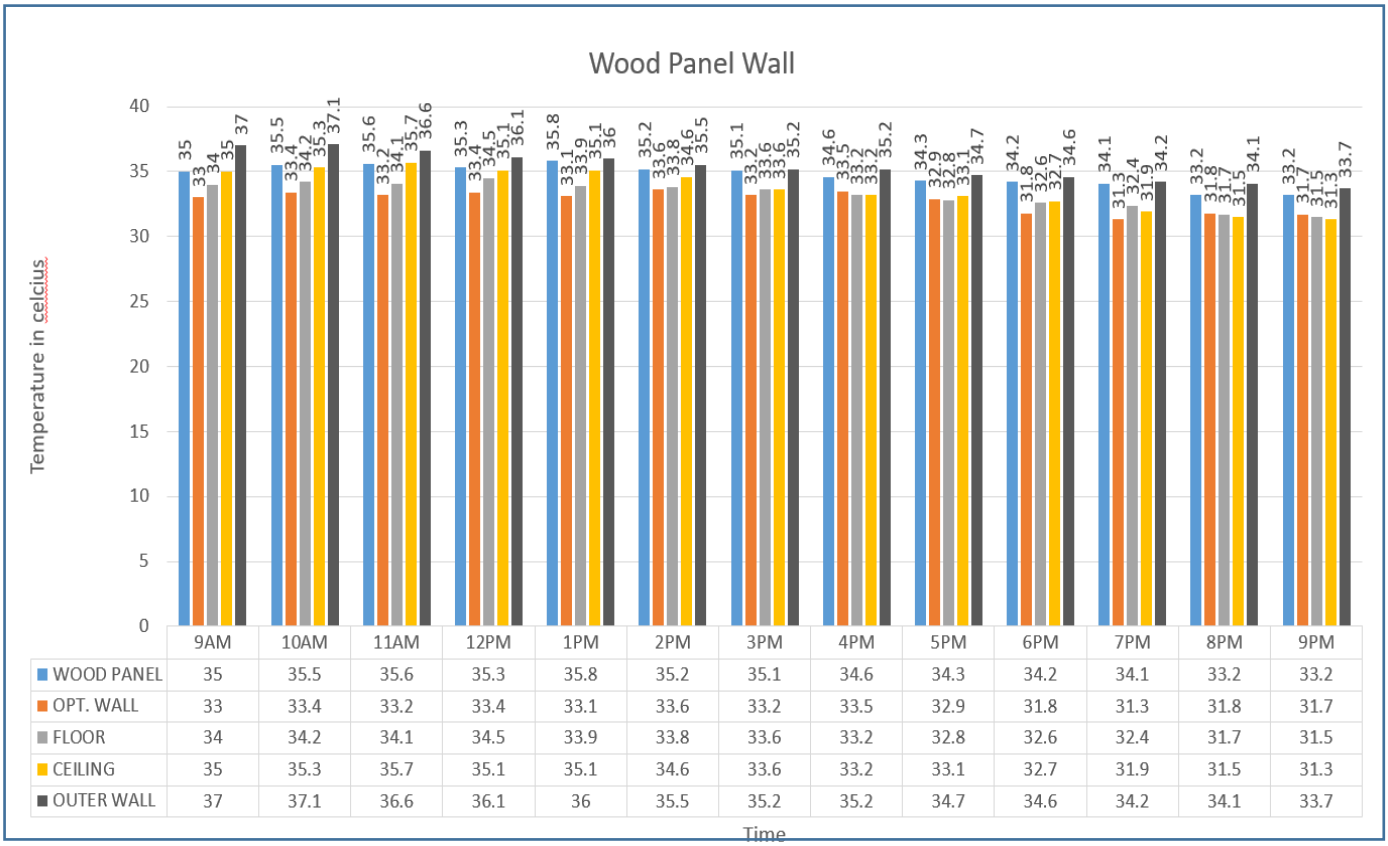
	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM
NEAR GLASS	33	33.2	33.8	33.9	34	34.7	34.2	34	34.3	34.1	33.7	33.6	33.2
OPT. WALL	31	31.9	31.7	31.4	31.7	31	30.7	30.4	30.1	29.8	29.9	29.5	29.7
FLOOR	31	31.9	31.7	31.4	31.2	32	33	33.6	33.1	33.7	34.2	31.9	32.9
CEILING	35	35.1	34.9	34.8	34.5	34.8	33.8	33.2	33.7	33.2	33.2	31	31.2
NET	34	35.3	32.6	32.9	35.3	36.9	35	36.7	35	32.6	31.8	32.8	31.8
OUTER GLASS	35	35.8	36	36.3	37	37.3	37.9	38	37.3	37.1	36.4	36.1	35.7

Figure 4 – Growth of temperature with time in Glass / Net wall



	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM
NEAR WALL	28.6	28.7	28.8	28.9	29	29.7	29.1	29.5	29.6	29.9	30	30.1	30.1
OPT. WALL	27.8	27.9	28	29.3	29.7	29.1	28.8	29.1	29	29.4	29.6	29.1	29
FLOOR	29.5	29.6	29.7	29.5	29	28	28.6	29.1	29.5	29	28.9	28.7	28.5
CEILING	33	33.5	33.6	33.9	34	34.2	34.6	34.9	33.8	33.5	33.2	33.1	32.8
OUTER WALL	35	35.3	35.7	36	36.3	36.7	36.5	37	37	36.5	36	35.4	35

Figure 5 – Growth of temperature with time in Tiles wall



	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM	7PM	8PM	9PM
WOOD PANEL	35	35.5	35.6	35.3	35.8	35.2	35.1	34.6	34.3	34.2	34.1	33.2	33.2
OPT. WALL	33	33.4	33.2	33.4	33.1	33.6	33.2	33.5	32.9	31.8	31.3	31.8	31.7
FLOOR	34	34.2	34.1	34.5	33.9	33.8	33.6	33.2	32.8	32.6	32.4	31.7	31.5
CEILING	35	35.3	35.7	35.1	35.1	34.6	33.6	33.2	33.1	32.7	31.9	31.5	31.3
OUTER WALL	37	37.1	36.6	36.1	36	35.5	35.2	35.2	34.7	34.6	34.2	34.1	33.7

Figure 6 – Growth of temperature with time in Wooden Panel wall

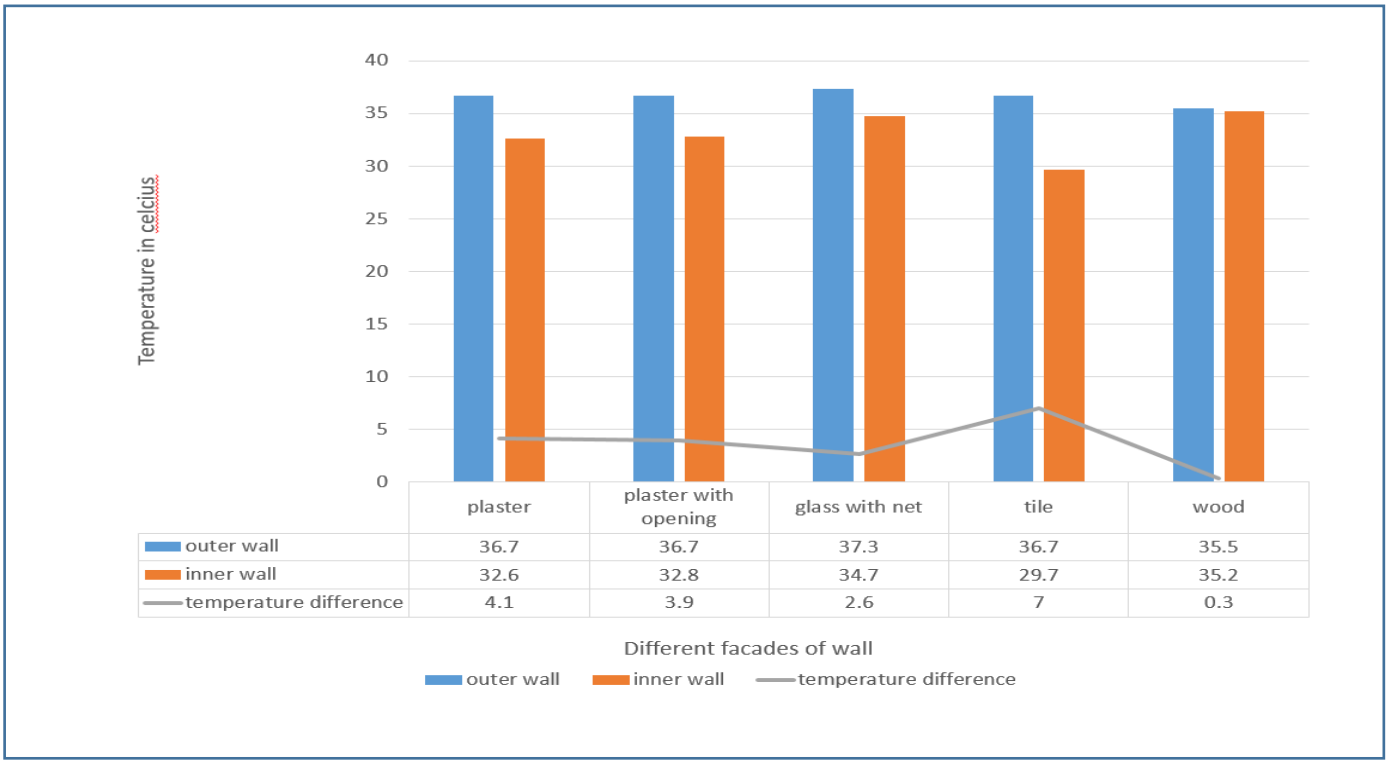


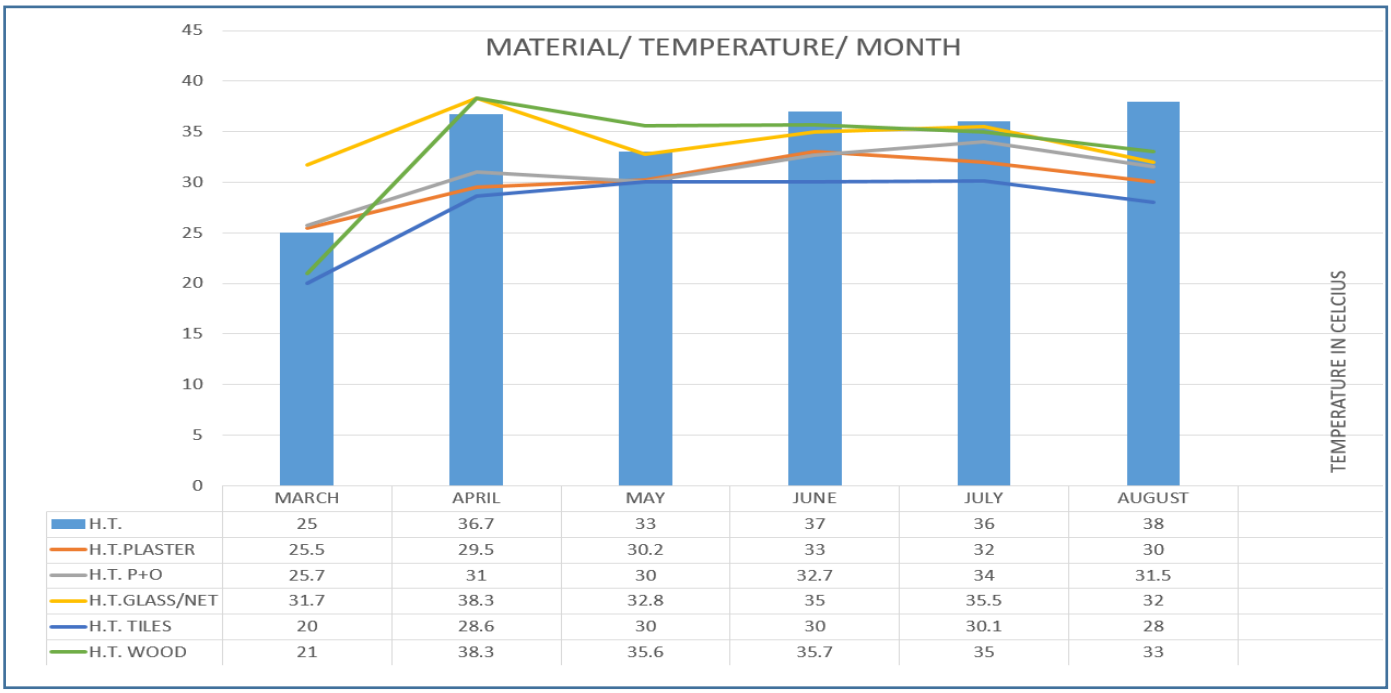
Figure 7– Difference in relation of two opposite walls of different facades at 2p.m. time

It was conducted in early June when the outer temperature may reach up to 35-45°C. Outer temperature was quite high with harsh heat of sunrays. Site conditions was same as above case.

- With simply Plaster façade and plaster (with opening) the internal temperature is in between 31-34°C, which cannot be tolerated.
- With glass/net facade the internal temperature is in between 31-38°C, which is unbearable.
- With tile facade the internal temperature is in between 28-30°C, which provide the comfort within an area.
- With wood facade the internal temperature is in between 34-36°C, which is too high.

6. CONCLUSIONS:

The most preferable façade in all above is Tiles for the month June, concluded result from above case study graph 7. The experiment was done to record the temperature at every hour, and the readings were taken continuously for around 5-6 days of every month in between 9am to 9pm. After analysis of six months, it is observed the difference in temperatures in graph figure7 that the temperature inside the Tiles façade buildings is lesser than the other external facades. It helps to define the number of discomfort hours was considerably less.



	MARCH	APRIL	MAY	JUNE	JULY	AUGUST
H.T.	25	36.7	33	37	36	38
H.T.PLASTER	25.5	29.5	30.2	33	32	30
H.T. P+O	25.7	31	30	32.7	34	31.5
H.T.GLASS/NET	31.7	38.3	32.8	35	35.5	32
H.T. TILES	20	28.6	30	30	30.1	28
H.T. WOOD	21	38.3	35.6	35.7	35	33

Figure 8– Difference in relation in types of materials with temperature at its peak in different months.

In this graph, figure 8 showing the data having temperature on one axis (Y- axis) and months from March to August (six months) data on another axis (X- axis) both clarify the temperature (average maximum °C).

The lines showing in the graph represents the material as using over the façade of the building. Single line of one material is run through the six months' data by collecting the highest indoor temperature of the building by applying it.

1- The orange line defines the plaster as a used material for façade which is in between all the five lines which clarify that it's an average material to be used.

2- The grey line defines the plaster with opening as a used material for façade of the building which is also in average range of perfection.

3- The yellow line defines the glass / net as a used material for façade of the building which is at the top in the graph clarify that it's not a good choice for finding the right material.

4- The blue line defines the tiles as a used material for façade of the building which is in bottom of the graph showing the declining range of temperature, and somehow in the list of perfection.

5- The green line defines the wood as a used material for façade of the building which is at the top most in the graph clarify that it's not a good choice for finding the right material.

So the nearest option can be concluded from the above materials is TILES.
Moreover, the Tile façade buildings offer better interior thermal comfort even during the hottest days.

As it is observed that the walls that having Tiles as coating somewhat works like cool walls having albedo coating which helps to reduce the inside temperature of the building to give the level of comfort in humans. The Tile walls can also reflect a higher fraction of direct incoming sunlight than average exterior walls means it can release absorbed heat.

Tiles façade with light colored tiles should reflect at least 35-40% from solar radiation. The study assumed that an average wall that is not cool (without tiles) reflects 15-20% of sunlight.

As it provides energy cost savings save as much as of energy that helps in high scope for significant saving in peak electricity demand, which can reduce the usage of air conditioners which unnecessary increase the electricity cost.

Along with the saving of cost & comfort with cool internal environment it also helps in Aesthetical look too.

So these cases can be helpful for different cities with same climatic conditions (composite climate) like in Aligarh.

It may be costly to use Tiles but it will be a onetime investment which can be helpful in further deduction in monthly electricity bills during summer seasons.

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