The Effect of Trees on Thermal Comfort of Buildings at Hyderabad

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Abstract: This paper examines the effect of vegetation on buildings at macro and micro climate levels. The vegetation judiciously put its impact on environment through strategic landscaping and careful selection of flora. Plants have potential to moderate environment, save energy & resources and develop a beautiful visual look of an area. Strategically and historically human has learned that by placing vegetation around a building is means of cooling and beautifying the space. Obviously, it reduces temperatures & humidity, control dust & smoke through natural phenomenon of plant's living and breathing. Plants inhale carbon dioxide in the day time and release oxygen in return. This process reverses in the night. Naturally the need of oxygen is high in day time and low in night therefore this phenomenon of inhaling of plants in day and night times serves humanity and people take advantage of this system and use the plantation in their living environment. The effects and impacts of the vegetation were measured by means of analyzing two blocks of apartment having same location and design. One is garlanded with plants and other was left barren. Moreover the climatic data was measured in between Feb 2018 to May 2018, for this purpose data logger was installed on both building to record mean radiant temperature of both buildings at same time. The results were interesting the indoor temperature of -shaded building was recorded in between of 37.5°C to 31.1°C. Whereas the shaded building remain maintained at 34.2°C to 24.2°C . The initial findings demonstrate that sensible vegetation can help in reducing temperature in buildings and allows breeze and fresh air to penetrate inside a building without contamination as trees filter out air that contains dust, smoke, chemicals and organic particles in it.

Keywords: *Effect of vegetation on buildings, Macro and micro climate, Plants inhale carbon dioxide, Garlanded with plants, Sensible vegetation*

1. Introduction

The Population growth, change in urban land morphology, reduction of vegetation, increase in density as well as number of vehicles in the city are main causes of global warming and urban heat island. Air pollution and temperature are increasing in urban areas. As temperature rises it produces heat waves that put adverse impact on human comfort and it will also influence on their capacity of work. As the Temperature increases it will not only develop unfordable environment but it also effects on human health. In the sultry climate the spaces that are open, are highly visible to radiations of sun, the spaces in sultry climates are exposed to solar radiation. Due to this the outdoor energy budget increases that leads to increase in urban heat island and also reduces the thermal comfort of humans.[1]

However the trees are the ambient source that not only effect on the microclimates through the radiations control but it will also helpful to effect the energy budget in buildings. Densely populated trees not only reduce the speed of wind but it also provides the protection for buildings from the urban infrastructure. The trees and vegetation play vigorous role to mitigate the effect of urban heat island. Vegetation not only provides Eva-transpiration shading and cooling benefit. But it is also the source of ease in urban environment. Urban vegetation not only provides way of adaptation and improvement to climate change but it will also helpful to reduce the urban heat islands effects.

.Vegetation and the manifestation of greenery affect air movement but also turn alter the local temperature .It mends thermal comfort and decrease cooling energy utilization and provide the protection for building from urban infrastructure [2]

Rise in temperature in the urban environment is mostly accompanied by heat waves. Due to high humidity and temperature these waves regulate to create negative impact on human being. These not only influence on human body

equilibrium but it will also produce thermal discomfort. This can be resulted in the heat stress. The external shading devices, the surface color, insulation and layout effects the energy consumption and thermal performance and also indirectly improves the building's thermal performance. The landscape structures and the proper landscaping, also have ability to improve thermal performance as they reduce the amount of radiation falling on the building by providing shading, moderating the temperatures, initiating the process of evapotranspiration and controlling the wind direction to keep the building warm or cool. Moreover the external

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spaces design needs to be highly prioritized as they will affect the building interior.[3] In recent years the role of landscaping in regulating the microclimate has been discovered all over the world. The problems of heavy urban built environments can be resolved by ecological measures i.e. landscaping. Vegetation not only increase environmental value by reducing energy consumption in individual buildings but also increases the energy efficiency of the community as a whole. This thing creates effective influence on a building's microclimate and its thermal performance. Hence, landscaping plays significant part in providing the cool microclimate and can directly affect the comfort level of an interior space. Vegetation means all plant life in a specific area, such as the grasses shrubs and trees and lawn. It effect solar radiation, air flow, humidity and air temperature. Among different landscape strategies to modify the microclimate, the three main purposes of vegetation are to provide shade, to control the flow of air and evapotranspiration.

The energy of building can potentially be modified if the Shade Trees are located strategically with right form and species around a buildings and also the microclimate of building is modified by its building energy use. And the shading that they are provided can not only reduce the amount of heat radiations absorbed and stored by buildings and other built surfaces. [4],,. The process of transpiration and evaporation reduces the urban temperature with the help of vegetation. It is the process in which the plants are draws the moisture in the ground that uses what its need to grow by means of moderating its own temperature and the excess is transpires due to this phenomenon the surrounding air becomes cool therefore the vegetation that is properly located surrounding a building not only provide the cooling effect but it also effect on the building micro climate. It is also used as the barrier or wind break that not only controls the wind but also provides the connective cooling and more effective ventilation of surfaces of building by directing and channeling air. flow [5]

The vegetation that is used in the design of landscaping could greatly be increased with the help of quantitative evidence of the energy saving. The quantitative research need to better predict the vegetation effect and the elements of landscape on the buildings, microclimate and energy use. [6]

Based on this background this paper considers the effect of vegetation especially trees that help to reduce the thermal effect of urban heat island and enhance thermal comfort on urban built environment. This paper compares the indoor and outdoor temperature of two identical residential building located at WAPDA colony Hussainabad Hyderabad. One is shaded with trees named building B, while the other is unshaded or building A. Humidity was also measured in both buildings in order to analyze the effect of trees on buildings. Building A and B both were facing towards south.

2. Research Area and Climatic Description

The research was carried out at WAPDA colony Hussainabad, Hyderabad. It is residential neighborhoods with different category of multi-story building. The area experiences the arid climate where days are hot and dry while the nights are cool. The annual average temperature ranges between 25°c in January to 41.6ºc in the month of May.

Figure.1. Unshaded building/ building A

Figure.2. Shaded Building or building B

3. Methodology

3.1 Measurement Programed and Instrumentation

The data was collected through questionnaire through survey analysis and by installation of devices in both buildings. The device was installed and indoor temperature and humidity of buildings were monitored Measurement programmed was designed to measure the temperature difference of indoor and outdoor of shaded and unshaded buildings for four-month period, from February 2018 to May 2018. The readings were measured every day of both buildings. The monitored temperature and humidity of both building were different due to difference in shade that effect on the buildings. The readings through the device were taken three time a day at morning, noon and night times.

3.2 Relationship between Outdoor Temperature and Humidity

The difference between indoor and outdoor humidity and temperature shows that rise in humidity will results in the temperature increase. Building B has stronger relationship for outdoor space than the space covered by Building A. This is because there is direct insulation in the building B outdoor space the position of Building B has reduced insulation through the tree canopy. It was recognized that the use of trees and vegetation to shade surfaces interrupts the solar radiation and develops reflectivity to increase on surfaces such as roofs through reducing the quantity that was absorbed by solar radiation.

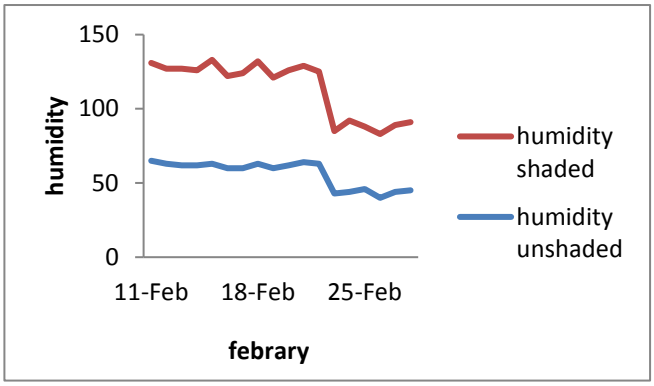


Fig.3. Humidity graph of shaded and unshaded building in the month of February.

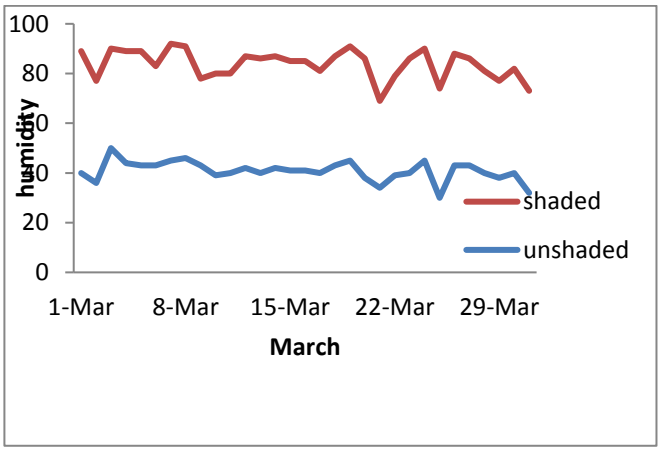


Figure .4 Humidity graph of shaded and unshaded building in the month of march.

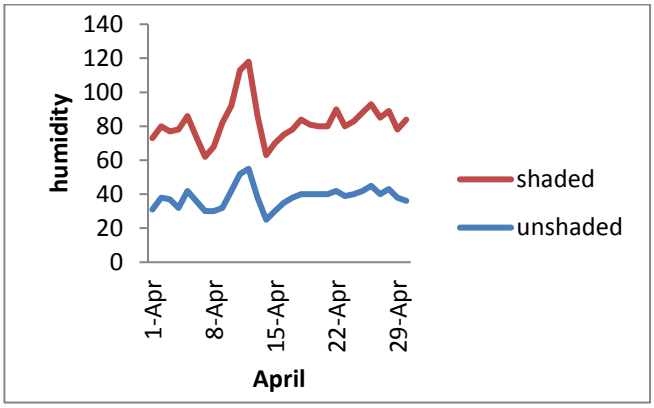


Figure. 5. Humidity graph of shaded and unshaded building in the month of April

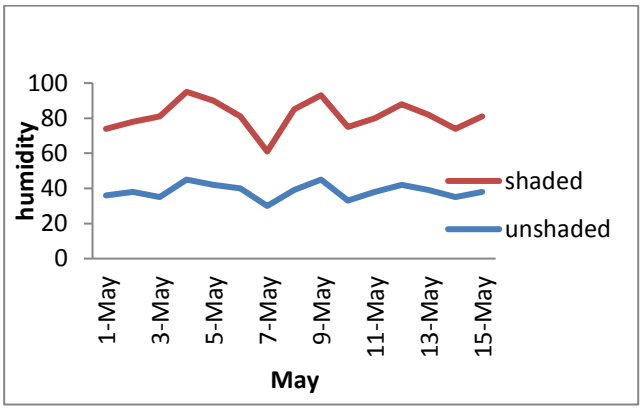


Figure.6. Humidity graph of shaded and unshaded building in May

3.3.Indoor–outdoor Temperature Differences Of Unshaded Building.

The temperature of the outdoor is relatively higher than that of indoor throughout the day. At the time of sunrise and sunset the corresponding temperature of outdoor increases and reduces faster than the indoor temperature. Throughout the day, especially between the 10:00 hr. and 17:00 hr., the temperatures of the outdoor are relatively higher than the indoor. The maximum temperature difference happened in in February the maximum difference of temperature is with a value of 34°C and the minimum difference while the maximum indoor temperature difference was 36.4°C while minimum was 30.2°C. Outdoor temperature difference in the month of March was 43ºc and minimum was 26ºc while the maximum indoor temperature difference was 36.4ºc while minimum was 30.2ºc.

In the month of April the maximum outdoor temperature difference was 43°C while the minimum temperature difference was 26°C. The indoor maximum temperature difference was 36.4°C besides the minimum temperature difference recorded was 30.2°C. In the month of May the maximum outdoor temperature difference was 43ºC .And the temperature difference minimum of indoor was 28°C while the maximum indoor temperature difference was 37.5°C and the minimum temperature difference was 31.1°C.

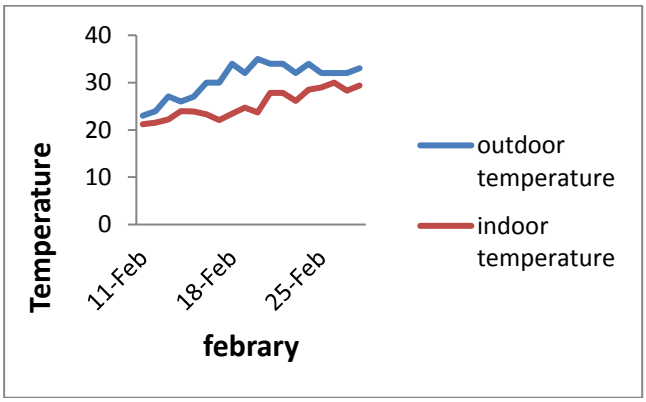


Figure7.Graph of un-shaded building in the month of February

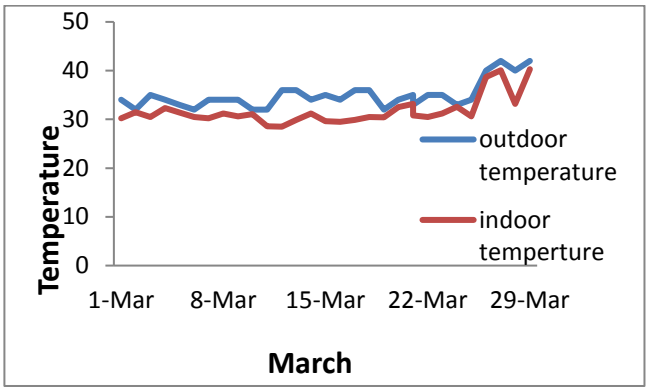


Figure.8.Graph of un-shaded building in the month of March

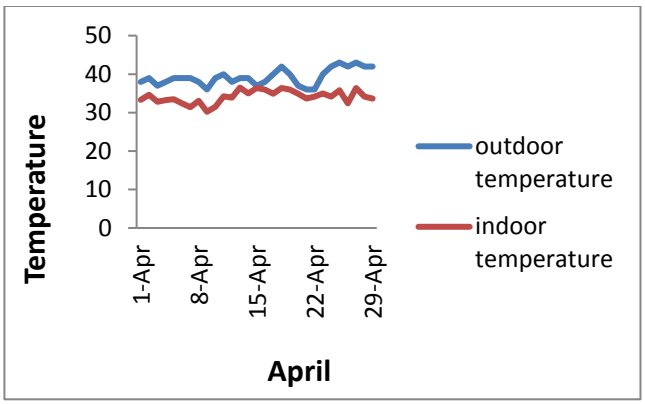


Figure.9. Graph of un-shaded building in the month of April.

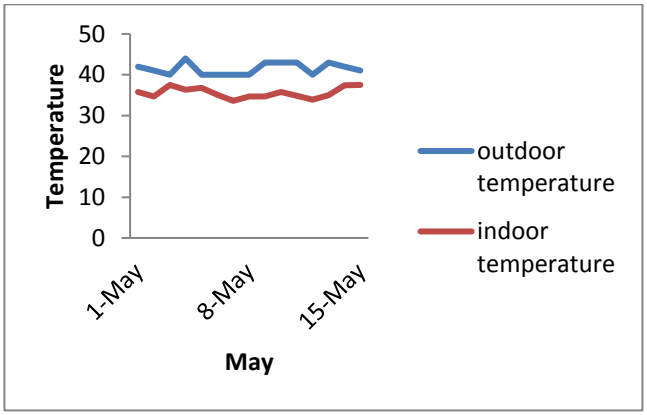


Figure.10.Graph of un-shaded building in the month of May

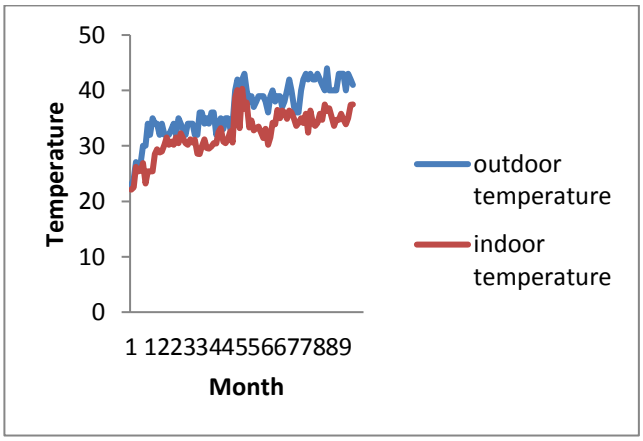


Figure.11. Graph of un-shaded building of all months

3.4.Indoor–outdoor Temperature Differences of Shaded Building

The indoor temperature difference was relatively lower than that of the outdoor temperature. In the month of February, maximum temperature difference occurred was 34° C while the minimum difference was 22 °C. The maximum indoor temperature difference was 30.3 C °and minimum was 20 °C.

In the month of March maximum outdoor temperature difference was 43ºc and minimum was 26°C while the maximum indoor temperature difference was 37.1C° and the minimum indoor temperature difference was 21.3°C. In April the maximum outdoor temperature difference was 43°C while the minimum temperature difference was 26°C. The indoor maximum temperature difference was 34.2°C while the minimum difference of temperature was 25.2°C. In the month of May the maximum outdoor difference of temperature was 43°C and the minimum temperature difference of indoor was 28°C while the maximum indoor temperature difference was 34.2°C and the minimum difference of temperature was 24.2°C.

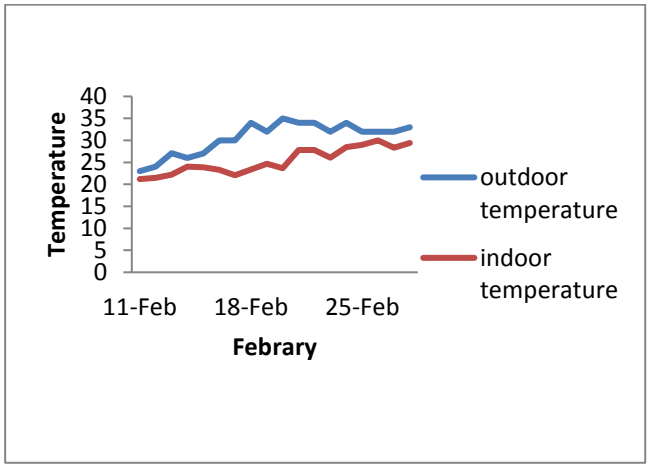


Figure.12.Graph of shaded building in the month of February.

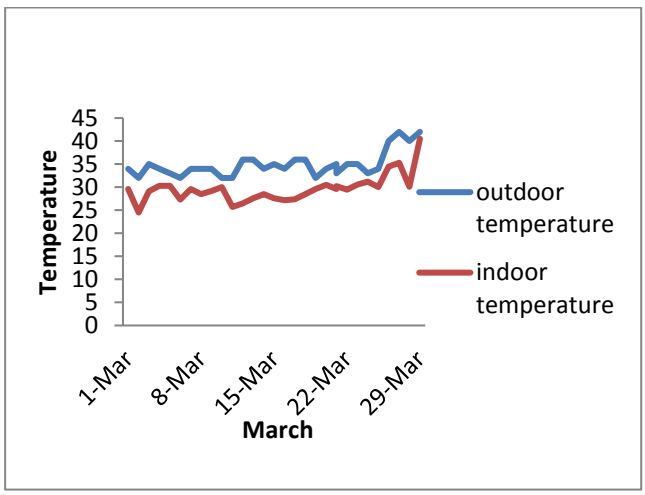
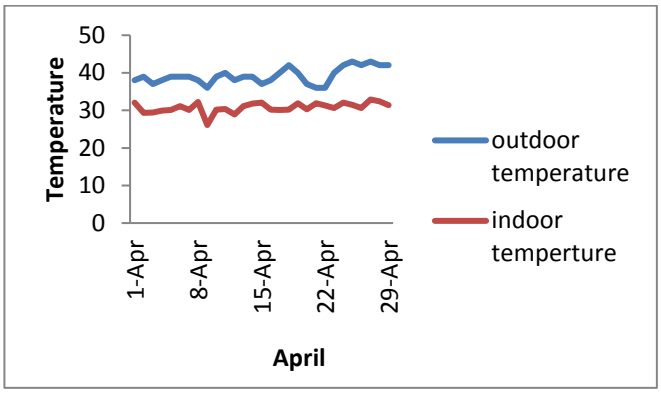


Figure13. Graph of shaded building in the month of March



` Figure14 .Graph of shaded building in the month of April

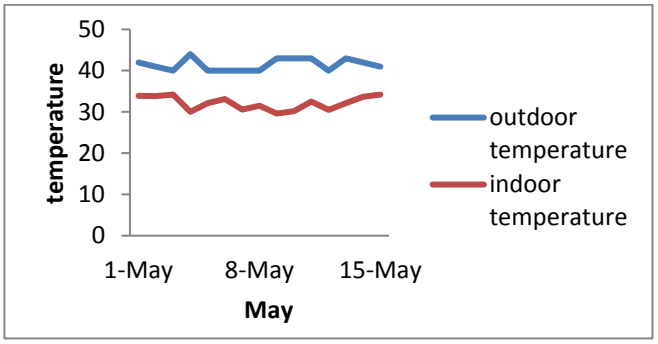


Figure15 .Graph of shaded building in the month of May

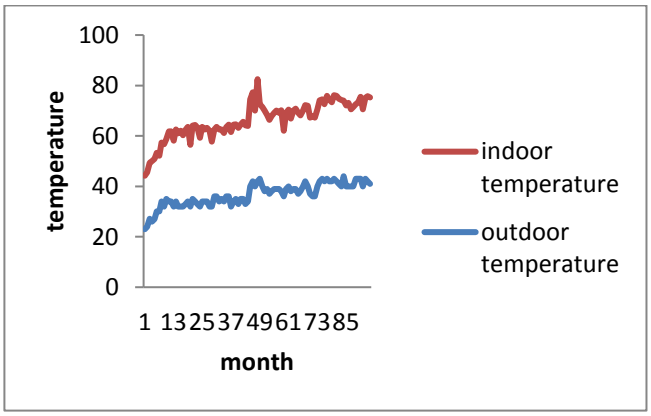


Figure .16: Graph of shaded building of all month

4. Result and Discussion

4.1 Comparison Of Temperature And Humidity

The result show that there are temperature differences between both buildings, that is building shaded with trees and unshaded building. The humidity and temperature in buildings were compared. The temperature variations found in both buildings were different. Building B that was shaded with trees and vegetation show less indoor temperature and the result show that there is temperature variation of both buildings that also effect on the cooling demand of the occupants. While the building A, that is unshaded shows higher temperature of indoor that increases cooling demand of the inhabitants and also rate of energy consumption of bill was high. The internal space of B Building found to be cooler at night while little warm at day while the indoor temperature of unshaded building found warm all time of day.

4.2 Effect Of Solar Radiation On Shaded And Unshaded Buildings

The outcomes of result show that the building that is shaded with trees receive less solar irradiance because tree prevent the direct rays of sun to fall on the building due to this the magnitude of warmth is less as compared to unshaded building. While on the unshaded building the sun rays directly fall on the building. Due to this the occupants feel uncomfortable in the building. This direct solar radiation also increases the cost of bill and the indoor temperature that was calculated through the device show higher temperature and in unshaded building.

4.3. Findings

The data that was found through the surveys and by the installation of device in the shaded and unshaded building shows, that there is difference between the mean radiant temperature of shaded and unshaded building. The difference between outdoor temperature and unshaded building is 1.5ºC in the month of Feb. and 1.5ºC in month of March. 2.5ºC in month of April and 3.5ºC in month of May. The difference between outdoor temperature and shaded building was 3.2ºC in the month of Feb. and 6.1ºC in the month of March. 6.5ºC in month of April and 7.4ºC in month of May. The temperature difference between shaded and shaded building was 2.7ºC in the month of Feb. 4.6ºC in the month of March. 4.8ºC in the month of April and 4.9ºC in the month of May.

The result demonstrates that the building that is shaded with tree and vegetation reduces the indoor temperature and occupant also feels thermally comfortable. The result shows that suitable use of vegetation helpful to reduce the energy consumption that is required to cool buildings during the season of summer. This could make redundant the installation of air conditioners and reduces the high cost associated with the such cooling facility.

5. Conclusions

The variation in temperature was recorded in two different structures A and B. One was shaded with trees and other stays barren shows potential impact of the plantation and vegetation on urban environment. The macro and micro temperatures demonstrated enormous difference in indoor and outdoor temperatures in the buildings. That may put socio-psycho impacts on society especially on women and children that used building almost 24 hours. Other additional benefits are saving in utility bills, filtration of air and control on germs and bacteria.

The study suggests that plants and general vegetation is a gift of God for humankind that must be sensibly used in urban context in order to reduce temperature and stresses in occupants. This also enhances the need of potential plantation culture in the urban and suburban districts of any city.

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