

SOLAR ACCESS AND SHADOW ANALYSIS



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The term solar access can be defined as the direct solar radiation that a building can receive without any obstruction. The benefit and vitality of solar access is important for an ideal and healthy living environment. It has many advantages, such as, it provides natural light in the building interiors, provides natural heating in cold conditions and it helps to maintain a hygienic indoor environment by inhibiting growth of certain detrimental microorganisms. Sunlight due to its spectrum and high radiation intensity is utilized in therapeutic applications and in dermatology, supporting the production of vitamin D. Its UV-C component has bactericidal effects while suppressing development of bacteria and purifying environment. Many researches in the past have proven that humans need minimum 20 – 30 minutes of daily sunlight exposure as it provides Vitamin D which is essential to fight against many diseases.

This study was undertaken to establish the minimum time of solar access that will be required for the climatic conditions of Mumbai, in a season/month when insolation is crucial for healthy living conditions. Consequently, this study aims to determine the critical day of the year for which the duration of insolation must be verified by shadow analysis for buildings in the city.

Shadow Analysis of a building is a study carried out to determine how its shadow affects the surrounding environment based upon the sun's position (time of day), and the time of year. It helps planners and architects understand daylight conditions in dense urban area and provide them with a tool for designing better, more sustainable buildings and urban spaces. The impact is in the terms of

number of hours of solar access for structures in the vicinity that will be affected due to the shadow of the subject structure.

STANDARDS FOR SOLAR ACCESS ACROSS THE WORLD

There are standards stipulated by certain countries regarding solar access. These requirements are stipulated depending upon the climatic conditions in the specific country. Enlisted below are available regulations world over.

From the above Tables 1 and 2 giving the World wide scenario for Sunlight and Solar access regulations it is seen that all the countries (except Slovenia) are recommending analysis on 21st March. The average sunlight hours benchmark observed is 3 hours or 30% of analysis hours.

Also, from the Table No. 2 it is apparent that the average temperature for all the countries listed apart is less than 20° C, where-

TABLE 1 SUNLIGHT DURATION REQUIREMENTS/LEGISLATION

| S.No. | Country | Regulation |
|-------|----------------|---|
| 1 | Czech Republic | At least 1.5 hour on March 1 st |
| 2 | Estonia | 3 hours of sunlight during the summer months, i.e. April 22 nd to August 22 nd |
| 3 | Germany | At least 4 hours on March 21 st & 1 hour possible insolation on January 17 th |
| 4 | Italy | At least 2 hours of sun per day in the period February 19 th to October 21 st |
| 5 | Netherland | At least 2 hours of sunlight per day in the period February 19 th to October 21 st At least 3 hours of sunlight per day within the period January 21 st to November 22 nd |
| 6 | Poland | At least 3 hours on March 21 st and September 21 st between 8:00 - 16:00 in schools and buildings for childcare while 7:00 - 17:00 in residential buildings on the equinox, - at least 1,5 hour if department has only living room, - at least 4 hours for children play areas in outdoor or at least 2 hours in centre of towns on March 21 st and September 21 st between 8:00 - 16:00. |
| 7 | Slovakia | At least 1,5 hour in low densely area and at least 1 hour in high densely area in the period March 1 st to October 13 th |
| 8 | Slovenia | At least 2 hours on December 21 st , 4 hours on March 21 st /September 23 rd and 6 hours on July 21 st - insolation of 1 hour on December 21 st 3 hours on March 21 st and September 23 rd |
| 9 | Sweden | At least one room or separable part of a room shall have access to direct sunlight, - at least 5 hours sunlight between 9 am and 5 pm at spring and autumn equinox. |
| 10 | UK | 25% of probable sunlight hours, at least 5% of probable sunlight hours from 23 rd September to 21 st March. "No more than 40% (preferably no more than 25%) of any garden or amenity area should be prevented by buildings from receiving any sun at all on 21 st March" |
| 11 | Australia | At least 70% of apartments in a building receive a minimum of 2 hours direct sunlight between 9am and 3pm at mid-winter. In all other areas, living rooms and private open spaces of at least 70% of apartments in a building receive a minimum of 3 hours direct sunlight between 9am and 3pm at mid-winter |
| 12 | India | The shadow on parks, streets and other buildings must be minimized through a proper analysis. |

as for the city of Mumbai the average temperature is 28°C since it falls in the tropical climate zone.

STANDARDS FOR MUMBAI REGARDING SOLAR ACCESS AND SHADOW CONDITIONS

Presently, there are no norms in Mumbai regarding time of the year, time of the day or the mandatory duration of solar access (hours) for an affected structure to be considered as a recommendation for shadow analysis studies. The only guideline available for Mumbai, is the requirement stated by the HRC Committee MCGM, for Shadow Analysis study to be carried out for high rise structures in Mumbai as a part of High-Rise clearance. It states that "the shadow on parks, streets and other buildings must be minimized after carrying out a proper analysis and mitigation plan" and "Minimum distance from one property to another (especially high rise) or buildings within the plots should be based on the shadow analysis."

DETERMINATION OF CRITICAL CONDITIONS FOR MUMBAI CITY FOR SHADOW ANALYSIS

To establish these critical conditions for Mumbai, we have analysed various scenari-

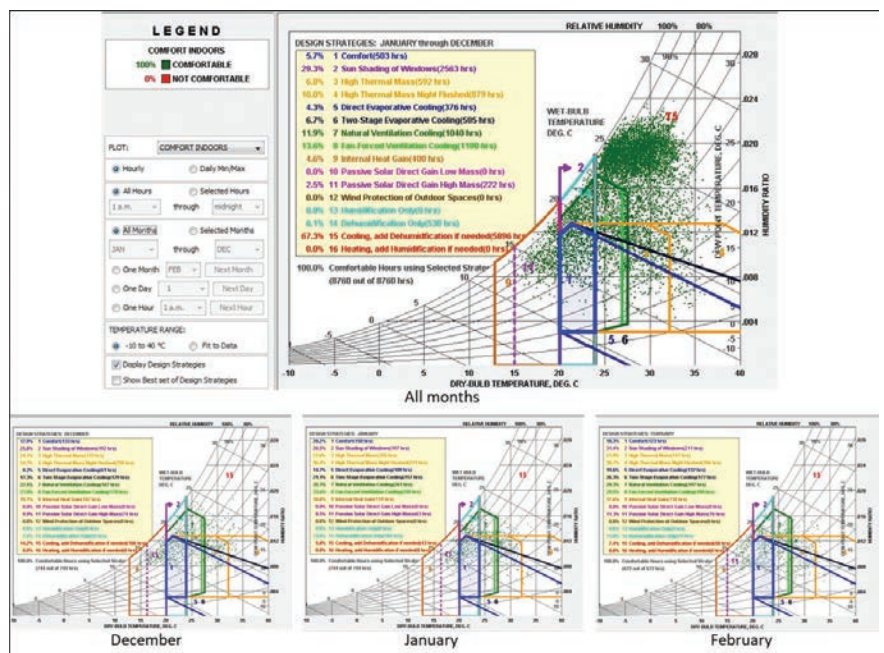


FIGURE 1: PSYCHROMETRIC CHARTS FOR MUMBAI

os that are typically experienced in the city during different seasons. The psychrometric chart for Mumbai for the whole year as well as three specific months of December, January and February are given below which specify the wet bulb temperature, dry bulb temperature, relative humidity. Based on these the chart also specifies indoor comfort conditions and design strategies.

As it can be observed from the psychrometric charts, passive heat gain is not required in Mumbai, even in December, January & February. Hence it is not advisable to provide direct solar access to build-

ings in these months.

In order to ascertain the critical conditions a study done in KIMS Hospital in Bhubaneswar, Orissa is considered here. The study shows that the survival of the bacteria on the host depends on the components of the environment especially temperature, humidity, exposure to sunlight, pH and salinity. The colonization of bacteria responsible for skin infections increases with hydration of the skin. This peaks when both temperature and humidity are high, promoting sweat production. The analysis determined that the average maximum temperature above 33° C coinciding with average Relative Humidity (RH) ranging between 55% & 75% is most favourable for occurrence of dermatological infections. The data recorded for the analysis shows that these conditions are most favourable during late summers and early monsoons i.e., June month. According to Mumbai weather data, only 302 annual hours fall under such conditions with 85% of hours under March – June Months.

Similarly, in a different study it has been proven that the mould growth is also related to the High RH in damp areas and usually takes place when the RH is above 75%. When compared with the Mumbai climate data, it was found that the city experiences almost 4650 Annual hours with RH above 75% and approximately more than 60% of these annual hours falls between 21st March to 21st September making favourable conditions for mould growth. Following figure 2 gives the concise details for bacterial and mould growth conditions in Mumbai.

CONCLUSION

- On analyzing the World wide scenario for Sunlight and Solar access regulations, it has been observed that all the countries (except Slovenia) are recommending analysis on 21st March.
- Based on the World wide scenario for Sunlight and Solar access regulations, the average sunlight hours benchmark observed is 3 hours or 30% of Analysis hours.
- Due to Monsoon during June, July and August, there is a high risk of Bacterial infection and mould growth. But, due to Higher Altitude of Sun on these 3 months, all the facades receive adequate solar radiation to prevent the risk.
- From Psychrometric chart, Passive heating is definitely not required for Warm and Humid Climate of Mumbai.
- Based on the study, it is recommended to carry out the shadow analysis for Annual average the impact should not be more than 30% of Analysis Hours.

THE TEMPERATURE CONDITIONS FOR THE COUNTRIES MENTIONED IN THE TABLE NO. 1 ARE GIVEN IN TABLE NO. 2.

| S. no. | Country | Climate Zone | Average Temperature (OC) | Time Period | Sunshine Hours Required |
|--------|----------------|---------------------------------|--------------------------|---|-------------------------------|
| 1 | Czech Republic | Temperate | 18 | March 1 st | 1.5 |
| 2 | Estonia | Temperate & Mild | 5 | April 22 nd to August 22 nd | 3 |
| 3 | Germany | Temperate & Marine Climate | 10 | January 17 th | 1 |
| | | | | March 21 st | 4 |
| 4 | Italy | Mediterranean Climate | 17 | February 19 th to October 21 st | 2 |
| 5 | Netherlands | Temperate Maritime Climate | 10 | February 19 th to October 21 st | 2 |
| | | | | January 21 st to November 22 nd | 3 |
| 6 | Poland | Temperate Climate | 8 | March 21 st & September 21 st | 3 |
| 7 | Slovakia | Temperate & Continental Climate | 11 | March 1 st to October 13 th | 1.5 |
| 8 | Slovenia | Continental Climate | 11 | December 21 st | 2 |
| | | | | March 21 st | 4 |
| | | | | July 21 st | 6 |
| | | | | September 23 rd | 4 |
| 9 | Sweden | Mild climate | 7 | April to May | 5 |
| 10 | UK | Temperate maritime Climate | 13 | 23 rd September to 21 st March. | 5% of probable sunshine hours |
| | | | | 21 st March to 23 rd September | 25% |
| 11 | Australia | Temperate Climate | 17 | June & July | 2 |
| 12 | India (Mumbai) | Tropical Climate (Warm & Humid) | 28 | No Standards Available | No Standards Available |

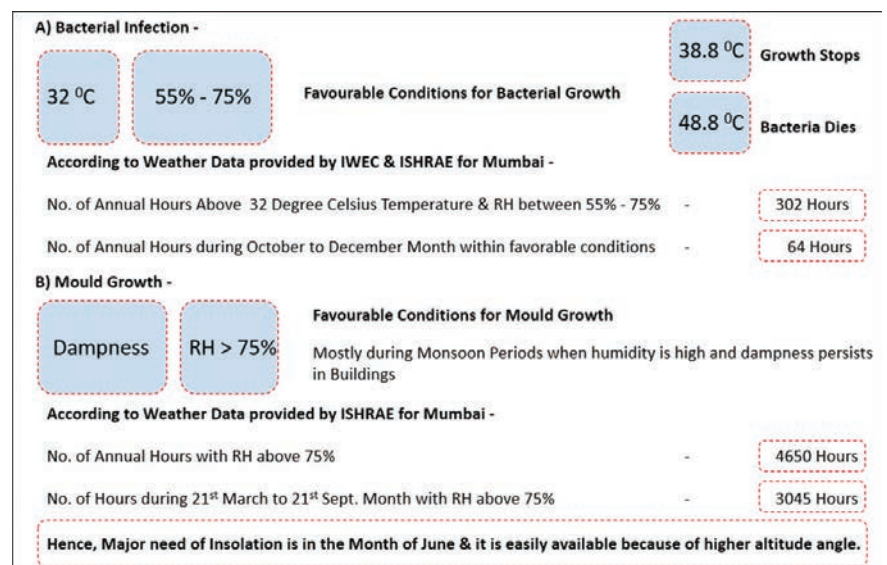


FIGURE 2: FAVOURABLE CONDITIONS FOR BACTERIAL INFECTION AND MOULD GROWTH IN MUMBAI