Transmission of Sunlight to Dark Apartments in Densely Populated Towns and Cities

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Abstract— This work presents a solution for transmission of sunlight to the flats and apartments in densely populated urban areas where the sunlight is unable to reach due to hindrance by the tall buildings or towers or any other obstructing structures. This paper describes the use of mirrors and 90 degree prisms to transmit the sunlight to such dark and inaccessible apartments by reflection and refraction. Such an arrangement will reduce the requirement of artificial lights, thereby saving electricity and it will also help the occupants to enjoy the natural sunlight. The arrangement of mirrors and prisms can be achieved for small buildings, bungalows, cottages or hutments. This arrangement can also be used in commercial buildings or hotels where sunlight is unable to reach directly due to certain obstructions.

Key words: Sunlight, Densely populated urban areas, Dark Apartments, Mirrors, 90 Degree Prisms

I. INTRODUCTION

In Urban areas, Due to ever increasing population, the need for housing is on continuous rise and it has Always been one of the topmost priorities of the Government. Keeping in mind about the constraint of "Available Land", the buildings are being constructed very close to each other, with practically very less Space between them. Since there is no scope for Horizontal expansion due to limited land, Buildings are being extended in the vertical direction upwards. In such situations, where buildings are constructed too close to each other, it has been observed that the apartments in such buildings do not receive proper sunlight and as a result of this, these apartments always remain dark which leads to various problems such as dampness in the walls of the buildings, growth of insects and pests, invasion of rodents and it also adversely affects the health of the occupants. Those who live in areas with fewer daylight hours are more likely to have a number of cancers than those who live where there's more sun during the day, according to a study from Environmental Health Perspectives. These cancers include: Colon cancer, Hodgkin's lymphoma, Ovarian cancer, Pancreatic cancer, Prostate cancer. Also, in such apartments due to insufficient sunlight, the use of artificial lightening during daytime becomes necessary which leads to the excess usage of electricity and thereby increasing the cost and expenses of living and also, artificial lightening cannot match natural sunlight in terms of intensity and coverage.

The Solution for the above problem makes use of the following principles of light:

A. Reflection

Reflection is when light bounces off an object. If the surface is smooth and shiny, like glass, water or polished metal, the light will reflect at the same angle as it hit the surface. This is called specular reflection.

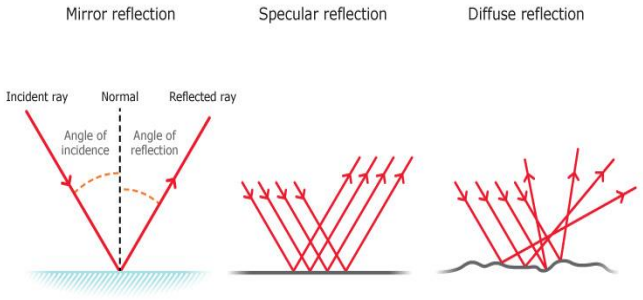

Fig. 1: Types of Reflection

B. Refraction through Prism

A right angle prism is used to change the direction of light by 90 degrees as shown in the picture below:

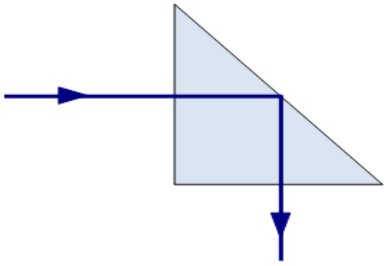

Fig. 2: Refraction through 90 degree prism

The light ray enters the prism along a normal and continues straight on until it hits the back face of the prism. Since the critical angle for a glass-air boundary is 42° any light which hits the boundary at 45° will be totally internally reflected.

Total internal reflection occurs here because light strikes the surface at 45 degrees which is greater than the critical angle. The light ray then emerges from the prism along a normal and so continues straight through the glass surface.

II. ARRANGEMENT OF MIRRORS AND PRISMS

The arrangement and set up of the Mirrors and Prisms involve simple Geometric principles and is based on the laws of refection and the laws of refraction of light. A set of mirrors and prisms are fixed on the parapet wall of the terrace of the buildings. The number of mirrors and prisms depend on the size and dimensions of the building and the number of apartments in the building. In case of bungalows, cottages or hutments, the arrangement can be done on the roof.

The orientation, inclination of the mirrors and the prisms on top of the building depend on the location of the building in terms of latitude and Longitude, the Orientation of the building i.e. east-west, north-south and the relative position of sun throughout the day with respect to the windows of the building. The mirrors are so arranged, that when sunlight is incident on them, it gets reflected (Specular Reflection) and travels parallel to the floor of the terrace of the building and is incident perpendicular to the vertical face of the building arranged on the opposite parapet wall. A general arrangement of the mirrors and prisms in terms of orientation and inclination and the path followed by sunlight due to reflection and refraction is shown in figure 3.

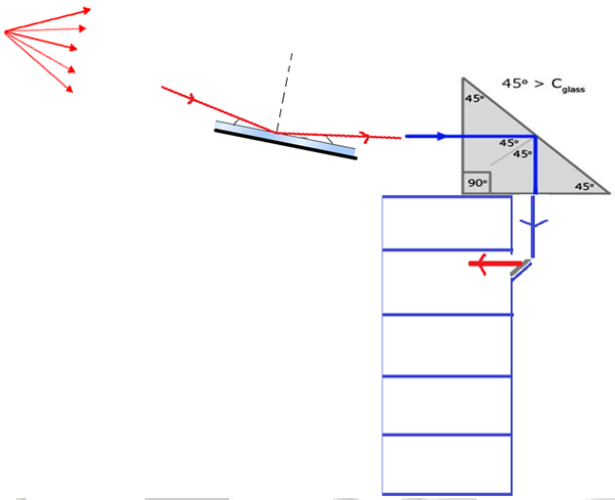

Fig. 3: Orientation and inclination of mirrors and prisms and the path followed by sunlight

The figure shows just a schematic and conceptual arrangement of the mirrors and prisms on top of the building. Sunlight after getting refracted by 90° through the right angled prism travels vertically down parallel to the face of the buildings. This refracted sunlight can be transmitted inside the apartments by opening the ventilator above the windows as shown in figure 3 or it can be left as it is and can be allowed to fall vertically downward. Thus with the help of such an arrangement, sunlight can be easily transmitted into the houses or in front of the buildings.

III. Model Of The Set Up And Arrangement

Fig. 4: Experimental model

A model of a building surrounded by buildings on all the sides was created to depict the actual scenario and mirrors and prisms were arranged on the top of the building as seen in the figure 4. The building seen is a four storey building in which the apartments Mirrors were also fitted to the ventilators of the apartments. An infrared Laser pointer was used to visualize the actual transmission of light by the way of reflection through the mirrors and the refraction through the prisms. A closer look of the actual arrangement of mirrors and prisms is seen in figure 5.

Fig. 5

IV. Results And Discussions

Thus, with the help of a Laser Infrared Pointer, the path of transmission of sunlight can be studied and the arrangement of mirrors and prisms can be modified as per the physical conditions of the building, its location, position of sunrise and sunset. The experimental model also helps to decide about the requirement of number of mirrors and prisms as per the number of apartments in the building. It is very important that the sunlight should be incident perpendicularly to the vertical face of the building so that it can be refracted vertically downwards parallel to the face of the building. The results were very accurate and were desirable.

V. Conclusion

In this work, the setup of mirrors and prisms is shown for the effective transmission of sunlight to the dark apartments of the buildings where sunlight cannot directly reach. Thus, the apartments which were dark before can be enlightened by sunlight through this arrangement. This helps in avoiding ill effects like dampness of walls, growth of insects and pests and it will also allow the occupants to enjoy natural sunlight thereby reducing the need of artificial lightening leading to saving of energy and cost.

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