Bringing Sun into Buildings

Dr. Benny Raphael

SMART SYSTEMS

14 | HOMEBUY EXPRESS | NOVEMBER '15

Bringing sun into buildings

The building envelope can be engineered to bring in the right amount of light and ensure it gets uniformly dispersed. Excellent simulation tools predict the amount of heat and light that get transmitted.

Dr. Benny Raphael

Buildings consume almost 40 per cent of all the electricity generated in the country and much of the power

efficiency measures into building designs. But both expensive and inexpensive solutions are available and

space planning since sunlight need not be transmitted along a straight line to illuminate required areas. However,

Article published in the Home Buy Magazine of CREDAI

Buildings consume almost 40% of the electricity produced in India and a substantial part of this is for electrical lighting. It is clear that huge savings in energy can be achieved by introducing more daylight into buildings. Perhaps compared to the monetary savings to individuals, the benefits to the society are more important. The energy demand is increasing and since the electricity supply is not able to keep pace with the demand, power cuts are common in most parts of India. By reducing the energy demand, we are able to ensure reliable power supply to common people and reduce the potential environmental impacts of installing new massive power plants.

Currently not much attention is paid to daylighting design in residential buildings. There is a common misconception that it is prohibitively expensive to introduce energy efficiency measures into building design. It is emphasized that there are both expensive and inexpensive solutions available and a careful decision should be made based on the estimated cost and benefits. For example, commercial products are available that bring solar light into buildings through optical fibres. This solution provides good flexibility in space planning since sunlight need not be transmitted along a straight line to illuminate required areas. However, this requires expensive components such as a solar tracker and precisely aligned connectors for high efficiency. The total cost of the system makes it less attractive to developers of ordinary residential buildings.

However, there are many low hanging fruits that anybody can pick up easily. One simple solution is to make the building design more porous by introducing openings wherever possible. Light wells, skylights and atriums are very effective in bringing sunlight into buildings, but these have to be carefully designed in order to avoid too much heat getting transmitted. Today simulation tools are available that help evaluate designs and predict the amount of heat and light that get transmitted. The building envelope should be engineered to bring in the right amount of light and ensure that it is uniformly distributed.

Large skylights tend to bring in too much heat into buildings in the tropical climatic conditions of most Indian cities. An alternative to this is a concept called as a micro-light pipe. These are small pipes of diameter less than 100 mm and are distributed at regular spacing on the roof. The pipes bring in sunlight through the roof which is then spread out into the room using a diffuser that ensures fairly uniform distribution. By keeping the diameter of the pipe small and avoiding transmission of direct sunlight,

concentration of light and heat at discrete spots in the room can be avoided. A picture of a micro-light pipe is shown in Figure 1. If the roof is made of reinforced concrete, the steel pipe can be placed in the formwork an concrete can be poured as in the standard construction practice. The pipe is designed to keep the concrete slab strong and to avoid water leaking through the joints. The diffuser is fixed under the ceiling after the roof is completed. The diffuser consists of mirrors that are carefully arranged to reflect light such that direct sunlight does not reach the occupants.

Where it is not possible to introduce openings, light could be redirected through the use of reflective surfaces and mirrors. Figure 2 illustrates the concept of a light shelf in which mirrors are used to reflect sunlight to the ceiling from where it gets diffused into the room. By blocking direct sunlight into the room and by allowing only light reflected by the ceiling, discomfort due to solar heat is also eliminated. The light shelf usually consists of an external part (A) which is fixed outside the window and an internal part (B) which is inside the building. The geometry of the light shelf and its size should be adjusted to the specific conditions of the room for maximum effectiveness. Curved surfaces have been proposed, but this is likely to increase manufacturing cost. Flat surfaces made of glass mirrors or polished metal sheets are found to be effective, provided that the dimensions are calculated correctly through simulations, in order to ensure that excessive light and glare are not present. The performance of the light shelf depends on the material properties of the reflecting surface, ceiling and the glass, in addition to the geometry.

It is expected that with more widespread adoption of these simple ideas, lighting energy consumption can be reduced significantly. This will help us move towards environmental sustainability.

Figure 1. A micro-light pipe

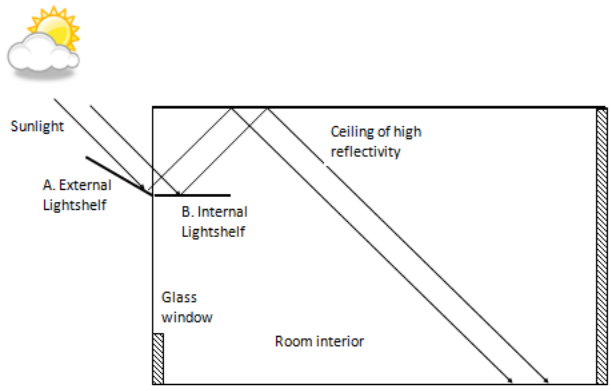

Figure 2. A light shelf reflects sunlight deeper into the interior of the room