Urban Energy Technical Note

03

Sun Shading

The most significant factor affecting the built environment in the East Africa region is solar energy, which impacts on it throughout the year. The shapes of buildings and spaces have a great effect on indoor temperatures. When designing a new building, it is very important to pay attention to the needs of its users and to consider the environment they are likely to spend most of their time in. The building should be user friendly and comfortable. Factors to consider for adequate indoor comfort are daylight, room temperature and air quality.

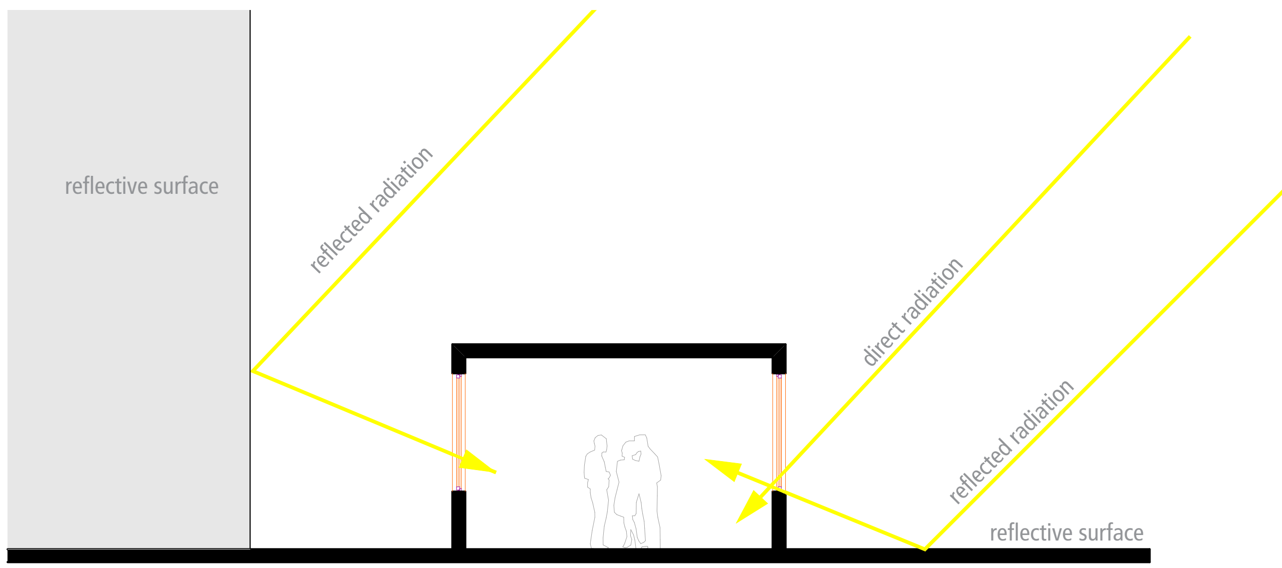
The use of shading devices is one of the passive strategies for improving indoor thermal conditions especially during the hot months. Appropriate and well-designed solar shading devices can dramatically affect indoor conditions by controlling indoor illumination from daylight, solar heat gains and glare while at the same time maintaining a view out through windows, thus saving thermal energy, providing light and maintaining visual comfort.

For shading devices to be effective, designers should be aware of the path of the sun at the site, its elevations on different days, and azimuth angles throughout each day of the year.
This study of the sun is critical at the beginning of the design process, so that optimal shading can be provided where it is needed. Use of different shading systems is also a way of varying façade design and the architectural elements used, making each building special and unique.

To help size the shading device to be used, a Sun Path Diagram should be used to find the solar altitude and azimuth for any given time. To do this, choose the sun path diagram with the latitude closest to the site. Find the intersection of the two curves corresponding to the month and hour of interest. From this point, read the solar altitude and azimuth. This is the sun's position at that month and hour.

This technical note looks at practical issues associated with external shading, one of the techniques used to shade the building passively. Other methods include internal shading devices e.g. curtains, blinds etc. and the glass itself e.g. low emissivity glass tinted glass.

Fig. 01: **Solar Radiation Sources that may require shading**



Sun Path Analysis

The sun's changing position in the sky throughout the year can be conveniently represented by the sun path diagram. It is represented with a coordinate system (altitude and azimuth) and can be read off directly from the diagram for any time of the day and month. This is useful in providing a summary of the solar position that should be considered when designing. The most used systems are the polar and the cylindrical sun path diagrams.

Polar sun path diagram:

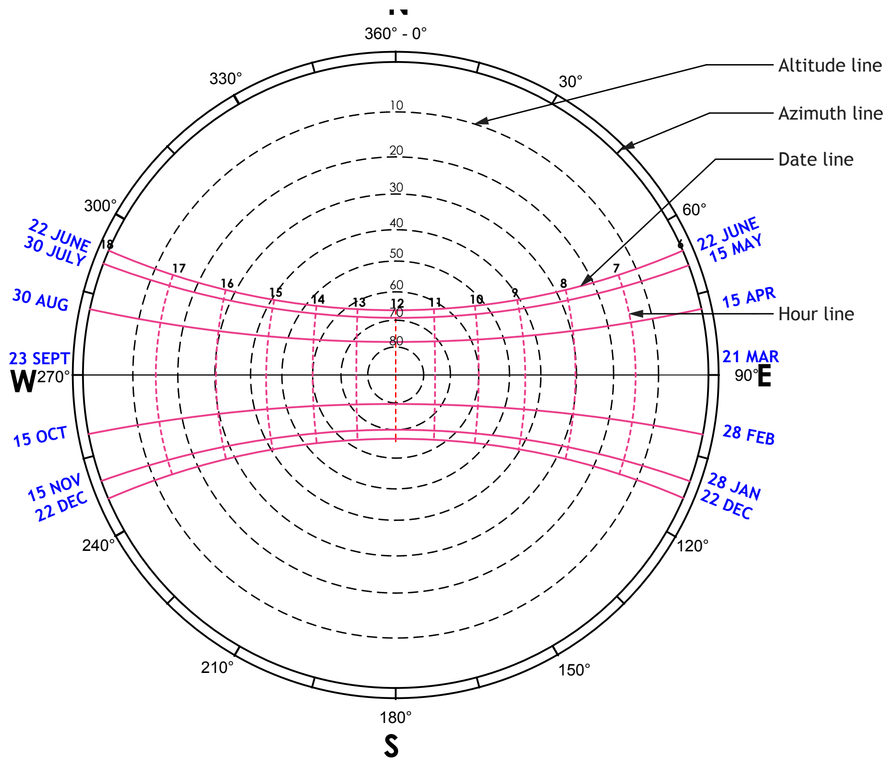
The polar representation gives the image of the celestial sphere by placing itself right above the zenith (the point of the sky directly overhead) of the area under consideration. In this type of representation, lines of equal solar altitude are spaced widely apart near the zenith of the sky but are concentrated quite closely together near the horizon. Each sun-path line is generated by determining the exact position of the sun as it passes through the sky (hourly) for each date. This is then projected from the sky dome onto the flat image.

Reading the Position of the Sun (altitude and azimuth):

1. Select the chart of the correct latitude (each location has a different chart).
2. Select one date line to be analysed.
3. Select the hour line and mark its intersection with the date line.
4. Read from the concentric circles the altitude angle (sun's height from the ground).
5. Lay a straight line from the centre of the chart, through the marked time point to the outer circle and read the azimuth angle (sun orientation related to the north).

To find the optimal building orientation, place the building plan in the centre of the diagram, aligning it with the orientation under consideration.

Fig. 02: **Polar sun path diagram for Latitude 0° (E.g. Eldoret town 0°31'N 35°17'E)**



Solar control through shading devices is most effective when designed specifically for each façade, since time and duration of solar radiation vary with the sun's position in the sky - its altitude and azimuth.

Shading Strategies

The main objective of providing shade is to control intense direct sunlight to ensure a comfortable work and living space. It enables the occupant's thermal and visual comfort and minimises mechanical cooling loads.

External shading systems are the most effective way of controlling solar gain in buildings with highly glazed facades. These can either be devices attached to the building envelope or extensions of the envelope itself. An external shading system has the advantage of blocking the solar radiation before it penetrates the building, but has the disadvantage of exposure to the climatic elements for maintenance. The size and position of these external shading elements can be calculated so as to cover the windows on the most problematic hours. This reduces the energy consumption of building cooling.

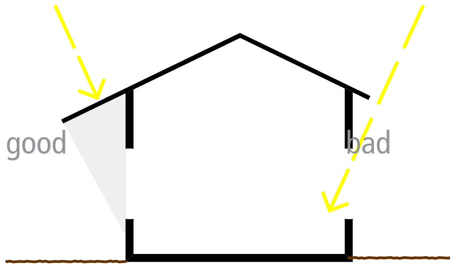
Thus, the design and construction of external shading devices require careful study and proper design to provide their effective functions.

Types of external shading systems

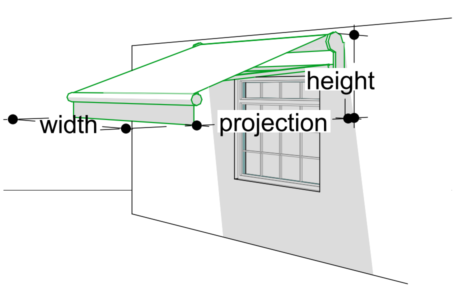
Fig. 03: **Horizontal Shading Devices**

Horizontal Shading Devices

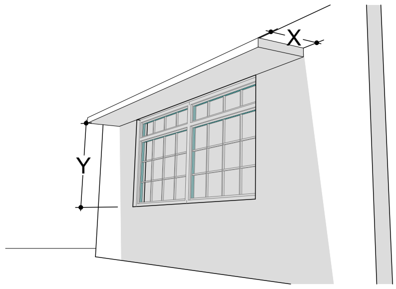
These are placed horizontally in front of or above the window, shading it from the sun. These devices are in the form of roof eaves, awnings above windows, horizontal projections, balconies etc. They are desirable for providing effective shading for the floor level directly below them at the peak point of the day. The amount of light admitted into the room, and the length of the shade is dependent on the depth of the overhang. It should, therefore, be carefully considered during the design process. In tropical climates, horizontal shading devices are effective on the north and south facing façades



Roof overhang



Awning above window



Over hang

Fig. 04: **Vertical Shading Devices**

Vertical Shading Devices

As the angle of the rising or setting sun is very low, roof overhangs are ineffective for east and west facing windows and therefore vertical sun shading devices should be used instead. They can be in the form of vertical fins, lattice screens, egg-crate shading or mixed height planting of shrubs and trees.

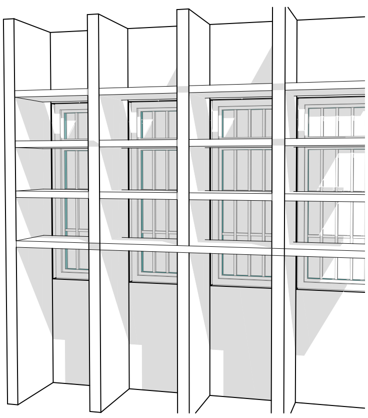
Parliament Building, Nairobi © UN-Habitat / Jerusha Ngungui

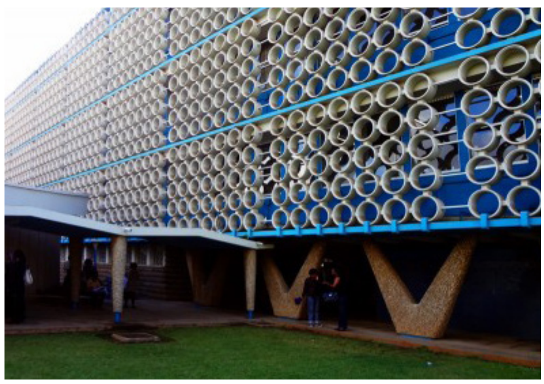
Fig. 05: **Egg crate Shading Devices**

Egg crate Shading Devices

Egg crate types are a combination of horizontal and vertical types. They effectively block the low morning and afternoon sun and are recommended for walls facing north east, south east, north west and south west.

Due to its high shading efficiency, this type of shading system is often used in hot climates.





Hyslop Geography Building, University of Nairobi © Edwin Seda

Other shading strategies

Design the building to shade itself

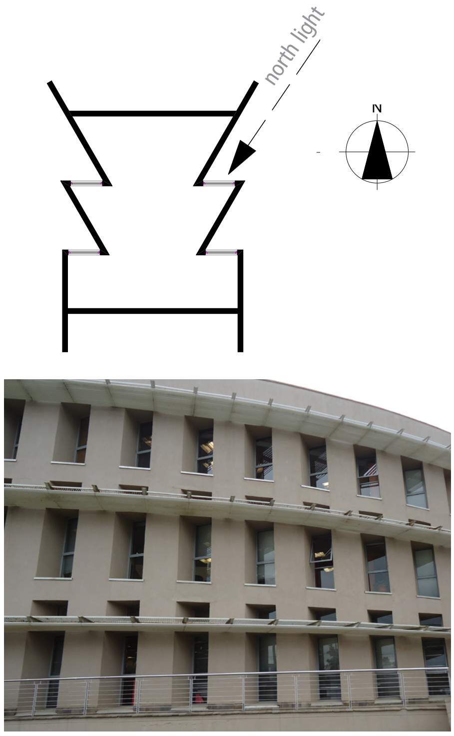
The form of the building itself can be used for external shading.

- The use of deeply recessed windows makes the entire wall around the opening an effective shading device, minimizing solar heat gains without reducing natural light and view (fig. 06).
- A cantilevered floor can be used to shade windows on the level below it.
- Windows on the east and west facades can be oriented north or south for sun control (fig. 07).
- Use of inclined glass is effective in controlling the penetration of the solar radiation into the building by reducing the area of glass exposed to the sun.

Fig. 06: **Deeply Recessed windows**

Students' Center Building, Strathmore University, Nairobi © UN-Habitat / Jerusha Ngungui

Fig. 07: **Variation of window opening orientation**



Windows are deeply recessed and oriented north to prevent direct solar radiation
Coca-Cola Building, Nairobi
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