SUN SHADING CATALOGUE

Adequate shading: Sizing overhangs and fins
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Prepared by:       Jerusha Ngungui
Design and layout:  Jerusha Ngungui
1. INTRODUCTION

The indoor thermal comfort of a building depends on several factors which include the prevailing climatic conditions, site location, building orientation and building materials used. All these factors, if not appropriately considered in the building design, can result to discomfort for the occupants and or increased energy consumption in a bid to reach optimal comfortable conditions.

Regions located near the equator such as Nairobi 1° 17’ S, 36° 49’ E receive far more solar radiation compared to those located farther from the equator such as London 51° 30’ N, 0° 7’ W. Glazed surfaces are the easiest ways for solar radiation to penetrate buildings. The amount of solar radiation and visible light transmitted inside a building depends on the type of glazing used. For example, commonly used clear glass transmits more than 80% of incident solar radiation and more than 75% of visible light. This solar radiation penetration can be favourable or extremely unfavourable depending on the prevailing climatic conditions, season, time of day, function of the building and space use (occupant’s activity).

Therefore, in hot tropical climates, it is necessary to eliminate the penetration of solar radiation into buildings through glazed surfaces through strategies such as appropriate building orientation (along the east – west axis), adequate sizing of openings (window to wall ratio), proper location of openings (facing north and south), careful selection of glazing properties and appropriate solar protection using sun shading devices.

External shading devices are desirable in hot climates for the control of solar heat gains in buildings by intercepting unwanted solar rays especially during the overheated periods thus substantially reducing the cooling load resulting to huge energy savings. They must be carefully designed and oriented to maximise shading during the overheated periods in order to reduce heat gain and to maximise solar heat gain during the cold / under heated periods.

For the tropical climates, the most appropriate building orientation to minimise solar heat gain is along the east – west axis with the long façades of the building facing north and south. However, site constraints (such as topography, surrounding buildings, street etc.) and conflicting wind direction may not favour this type of orientation. This may result to major openings being exposed to direct solar radiation hence necessitating the need for solar protection.

This document illustrates how to properly size shading devices for windows on different orientation in different latitudes at selected cut-off times. The six major latitudes considered include 0°, 2° S, 4° S, 6° S, 8° S and 10° S while the sixteen different orientations that are considered for the vertical reference surface are N, E, S, W, NNE, ESE, SSW, WNW, NE, SE, SW, NW, ENE, SSE, WSW and NNW.

The British High Commission building in Kampala, Uganda is located on a steep site that conflicts with the sun’s movement. This resulted to the long sides of the main building facing directly east and west. This contradicts the recommended building orientation with the long sides facing north and south and minimal openings on the east and west facing facades to minimize unwanted solar heat gain.

Multiple horizontal fired-clay louvres were thus designed and installed on the west facing openings for sunshading.
ADEQUATE SHADING: SIZING OVERHANGS AND FINS

In order to avoid unwanted heat gains and glare, windows should ideally be shaded during all daylight hours in the tropics. However, by doing so, it might result in impractical overhangs and fin designs especially in the early morning and late afternoon hours when the sun is low in the sky. This document attempts to develop a more practical design solution for different latitudes and orientations based on the following assumptions:

1. Heat gain is less of a concern during early June in the southern hemisphere as low temperatures are usually experienced than other times of the year.
2. Heat gain is of less concern during the early morning hours before 9 am where it is welcome into the building when the temperatures are lower than other times of the day.
3. Occupancy hours that have been considered are assumed to be 9 am to 4 pm. The exterior shades design in this section will shade windows completely during these hours.
4. Interior shades can be used to eliminate glare when necessary.
5. The different climates in which the representative cities occur have not been considered in the design of the shading devices.

2. THE SUN’S POSITION

To control heat gain and provide adequate shading, it is important to have a good understanding of solar geometry, solar radiation and solar energy in various hours of the day and during different seasons. This is essential in order to: design for passive heating and cooling; orient buildings properly; understand seasonal changes within the building and its surroundings and design shading devices.

2.1. SOLAR GEOMETRY

The earth’s movement around the sun results to different solar paths characterised by variable heights and lengths depending on the time of the year and latitude. The sun’s apparent movement is from the east to west. Its position at different times of the year can be found though two angular coordinates namely (Figure 1):

- **Solar altitude** $\beta$, represented by the angle between the line joining the centre of the sun with the observation point and the horizontal plane
- **Solar azimuth** $\alpha$, which is the angle, measured on the horizontal plane, from the south-pointing coordinate axis to the projection of above joining line.

![Angular coordinates of the sun](image)
2.2. SUN PATH DIAGRAMS

Sun path diagrams are a convenient way of representing the sun’s changing position in the sky throughout the year. They are projected onto a horizontal plane, on which the four cardinal points (North, South, West and East) are represented. The plane has a base with concentric circles and radial lines (Figure 2). The position of the sun at any time of the day can be plotted on the horizontal plane. It is therefore possible to develop specific diagram for any latitude.

The values of solar altitude $\beta$ are represented by the circumferences (outermost corresponds to $\beta = 0^\circ$, horizon, while the centre corresponds to $\beta = 90^\circ$, zenith). The values of solar azimuth $\alpha$ are indicated by the radial lines, and can be read out as the angular distance from the south-pointing coordinate axis.

2.3. SHADING PROTRACTOR

The solar shading protractor (Figure 3) is another useful tool which allows one to study the effects of sunshades, overhangs and fins on the building façades. It has the same dimensions as the polar diagram and can be overlaid to it to show the shading effects caused by vertical and horizontal overhangs, with respect to a specific point of view, which must coincide with the centre of the chart. This produces the shading mask of the solar shading device.

The pseudo-horizontal curved lines represent the influence of shadows created by overhangs characterized by horizontal edges parallel to the façade, and are drawn by calculating the angle $\varepsilon$ (VSA – Vertical Shadow Angle) (Figure 4). This is the angle lying in a vertical plane orthogonal to the façade, formed by the horizontal line passing through the analysis point P and the line joining this point with the outer edge of the horizontal overhang. The corresponding values can be read on the vertical lower semi axis of the diagram.

Figure 2 Polar sun path diagram at the equator
The pseudo-vertical curved lines, which are the extensions of the concentric semicircles contained in the upper half of the diagram and converge at point B, take into account both the influence of shadows created by horizontal overhangs with edges perpendicular to the façade, and the influence of the upper limits of vertical overhangs (Figure 5). These lines are identified through the calculation of the angle $\sigma$, lying in the plane of the façade and formed by the horizontal line passing through the point P and the line joining P with the terminal point of a horizontal overhang or with the upper limit of a vertical overhang. The values of $\sigma$ are readable on the upper vertical semi axis in correspondence of its intersection with the semicircles.

Appropriate and well-designed sun shading devices can dramatically affect indoor conditions by controlling indoor illumination from daylight, solar heat gains and glare.
The radial lines that branch out from the centre in the bottom half of the diagram represent the influence of shadows generated by vertical overhangs (Figure 6). These lines indicate the value of the angle $\omega$ (HSA – Horizontal Shadow Angle), lying in the horizontal plane orthogonal to the façade and formed by the horizontal line, perpendicular to the façade, passing through the point $P$ and the line joining this point with the outer edge of a horizontal overhang. The values of $\omega$ are readable on the external circumference of the diagram and are symmetric with respect to $B$. 

**Figure 5** Construction lines of $\sigma$

**Figure 6** Construction lines of $\omega$
3. SHADING DESIGN

When attempting to shade a window two important shadow angles must be considered. These are the horizontal shadow angle (HSA) and vertical shadow angle (VSA). These angles express the sun’s position in relation to a building façade at a given orientation and can be used to show the performance of a given shading device based on the shade it produces.

3.1. HORIZONTAL SHADOW ANGLE (HSA)

The horizontal shadow angle (HSA) describes the performance of a vertical shading devices. It is the difference in azimuth between the sun’s position and the orientation of the building façade under consideration (Figure 7). It can be calculated using the following equation:

\[ \text{HSA} = \text{AZI} - \text{ORI} \]  
(eq.1)

3.2. VERTICAL SHADOW ANGLE (VSA)

The vertical shadow angle (VSA) is required for (or cast by) horizontal shading devices. It is the angle between a horizontal plane of the building façade under consideration and a tilted plane which contains the sun or the edge of the shading device (Figure 8). The following equation can be used to calculate VSA.

\[ \text{VSA} = \arctan\left(\frac{\tan(\text{altitude})}{\cos(\text{HSA})}\right) \]  
(eq.2)

3.3. SHADE DIMENSIONS

These two angles, HSA and VSA, can then be used to determine the size of the shading device required for a window. The depth of the overhang, its width (additional projection from the side of the window (Figure 9)) and the fins can be determined using the following equations:

\[ \text{Overhang Depth} = \frac{\text{Height}}{\tan(\text{VSA})} \]  
\[ \text{Width} = \frac{\text{Depth}}{\tan(\text{HSA})} \]  
(eq.3)
4. **SHADING DESIGN STEPS**

The following steps may be used to determine the appropriate size of the shading devices:

1. Determine the overheated period i.e. the dates and times when shading is desired. For this exercise, shading was designed for all the months between 9 AM and 4 PM.

2. Use the appropriate sun path diagram (suitable for the location in question) to obtain the azimuth and altitude of the sun at each time of the cut-off periods.

3. Use the solar shading protractor to determine the HSA and VSA. They can also be established using equations 1 and 2.

4. Design the actual shading device to satisfy the performance specifications.

The above method gives a simple tool that is useful at the early stages of the design phase to define the optimum geometry of a shading device just by considering the position of the sun.

The following section illustrates the recommended size of overhangs and fins to completely shade the opening during the periods looks at latitude 0 represented by Garissa, Kenya.
ADEQUATE SHADING: SIZING OVERHANGS AND FINS

LATITUDE 0 - Garissa, Kenya 0° 27’ S, 39° 39’ E

North windows (N)

An overhang at a cut-off angle of 55 degrees (or depth equivalent to 0.7 times the window height). A vertical fin in addition to the overhang will provide complete shading. The vertical fin should have a cut-off angle of 61 degrees (depth should equivalent to 0.57 times the window width).

East windows (E)

A combination of overhangs with a cut-off angle of 39 degrees (or depth equivalent to 1.23 times the height of the window being shaded) and side fins that are 1.77 times the width of the window, or cut-off angle of 30 degrees.

South windows (S)

An overhang at a cut-off angle of 57 degrees (or depth equivalent to 0.66 times the window height). A vertical fin in addition to the overhang will provide complete shading. The vertical fin should have a cut-off angle of 61 degrees (depth should equivalent to 0.56 times the window width).

West windows (W)

A combination of overhangs with a cut-off angle of 36 degrees (or depth equivalent to 1.39 times the height of the window being shaded) and side fins that are 1.85 times the width of the window, or cut-off angle of 28 degrees.
A combination of overhangs with a cut-off angle of 42 degrees (or depth equivalent to 1.11 times the height of the window being shaded) and side fins that are 1.28 times the width of the window, or cut-off angle of 38 degrees.

Overhangs with a cut-off angle of 37 degrees (or depth equivalent to 1.35 times the height of the window being shaded).

A combination of overhangs with a cut-off angle of 39 degrees (or depth equivalent to 1.23 times the height of the window being shaded) and side fins that are 1.20 times the width of the window, or cut-off angle of 40 degrees.

Overhangs with a cut-off angle of 32 degrees (or depth equivalent to 1.57 times the height of the window being shaded).
ADEQUATE SHADING: SIZING OVERHANGS AND FINS

Recommendations

Overhangs with a cut-off angle of 36 degrees (or depth equivalent to 1.36 times the height of the window being shaded).

Overhangs with a cut-off angle of 37 degrees (or depth equivalent to 1.31 times the height of the window being shaded).

Overhangs with a cut-off angle of 33 degrees (or depth equivalent to 1.53 times the height of the window being shaded).

Overhangs with a cut-off angle of 33 degrees (or depth equivalent to 1.52 times the height of the window being shaded).
ADEQUATE SHADING: SIZING OVERHANGS AND FINS

East north east (ENE)

Overhangs with a cut-off angle of 36 degrees (or depth equivalent to 1.40 times the height of the window being shaded).

South south east (SSE)

A combination of overhangs with a cut-off angle of 43 degrees (or depth equivalent to 1.06 times the height of the window being shaded) and side fins that are 1.27 times the width of the window, or cut-off angle of 38 degrees.

West south west (WSW)

Overhangs with a cut-off angle of 32 degrees (or depth equivalent to 1.59 times the height of the window being shaded).

North north west (NNW)

A combination of overhangs with a cut-off angle of 39 degrees (or depth equivalent to 1.23 times the height of the window being shaded) and side fins that are 1.23 times the width of the window, or cut-off angle of 39 degrees.
5. **RECOMMENDATION FOR OVERHANG AND FINS SIZES**

An in-depth analysis was done for openings in different orientations in southern latitudes of 0, 2, 4, 6, 8 and 10 represented by the following locations: Garissa, Makindu, Mombasa, Dar es Salaam, Mbeya and Mtwara.

### LATITUDE 0

**GARISSA, Kenya 0° 27’ 25” S, 39° 39’ 30” E**

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### LATITUDE 2 S

**MAKINDU, Kenya 2° 16’ 30” S, 37° 49’ 12” E**

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**Adequate Shading: Sizing Overhangs and Fins**

### Latitude 4° S

**Mombasa, Kenya 4° 3’ 0” S, 39° 40’ 0” E**

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### Latitude 6° S

**Dare Salam, Tanzania 6° 48’ 0” S, 39° 17’ 0” E**

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**ADoQUATE SHADoING: SIZING OVERHANGS AND FINS**

**LATITUDE 8° S**

MBeya, Tanzania 8° 54' 0" S, 33° 27' 0" E

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<tr>
<td>North North West</td>
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<td>1.31</td>
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<tr>
<td>West South West</td>
<td>41</td>
<td>1.13</td>
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</tbody>
</table>

**LATITUDE 10° S**

MtwarA, Tanzania 10°16’25” S, 40°10’58” E

<table>
<thead>
<tr>
<th>Orientation</th>
<th>OVERHANG</th>
<th>FIN</th>
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<td>PF</td>
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<tr>
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<td>1.95</td>
</tr>
<tr>
<td>West South West</td>
<td>36</td>
<td>1.38</td>
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</table>
Several methods can be used to design sun shading devices. They can vary in size without changing their shading characteristics, as long as the ratio of the depth to the spacing of the elements or height of the window to be shaded (projection factor) or the cut-off angles (VSA and HSA) remain constant.

Examples of multiple design options with similar shading performance for latitude 6 S represented by the city of Dar es Salaam, Tanzania (6° 48’ S, 39° 17’ E) are presented in this section for overhang and fins.

**SHADING DEVICE OPTIONS**

**North facing windows** (VSA - 47° and HSA - 57°)

**South facing windows** (VSA - 60° and HSA - 65°)

North and South facing windows can be shaded using horizontal shading devices. Various configurations can be used as long as the cut-off angles remain unchanged. For this orientation, vertical fins in addition to the overhangs will provide complete shading from east and west as the sun rises and sets respectively.
North facing windows (VSA - 47° and HSA - 57°)

South facing windows (VSA - 60° and HSA - 65°)

Axonometric view of the shading device
ADEQUATE SHADING: SIZING OVERHANGS AND FINS

North facing windows (VSA - 47° and HSA - 57°)

South facing windows (VSA - 60° and HSA - 65°)

Axonometric view of the shading device
East and West facing orientations have low cut-off angles for shading which may result in deep single overhangs and fins that may not be practical to build. More practical solutions suitable for these orientations include multiple louvers (while maintaining the same cut-off angle) or use of egg-crate devices.
ADEQUATE SHADING: SIZING OVERHANGS AND FINS

East facing windows (VSA - 36° and HSA - 33°)

West facing windows (VSA - 34° and HSA - 32°)

Axonometric view of the shading device
Openings that are oriented due north or south such as North North East, North North West, South South East and South South West are best shaded using overhangs, fins or a combination of both for maximum solar protection.

**SHADING DEVICE OPTIONS**

**North North East facing windows**  
(VSA - 37° and HSA - 35°)

**South South West facing windows**  
(VSA - 44° and HSA - 44°)

Axonometric view of the shading device
ADEQUATE SHADING: SIZING OVERHANGS AND FINS

North North West facing windows
(VSA - 35° and HSA - 36°)

South South East facing windows
(VSA - 48° and HSA - 43°)

Axonometric view of the shading device
SHADING DEVICE OPTIONS

In the case of the following 8 orientations: North East, North West, South East, South West, East North East, East South East, West North West and West South West, use of multiple louvres is desirable to provide shading because of the low cut-off angles.

Vertical shading devices may not be practical to achieve due to the high projection factors. For these facades it is more practical to extend the horizontal overhangs from the side of the opening to achieve the desired shading.

North East facing windows (VSA - 32° and HSA - 12°)

South West facing windows (VSA - 37° and HSA - 21°)

Axonometric view of the shading device
ADEQUATE SHADING: SIZING OVERHANGS AND FINS
EXEMPLARY WORKSHOPS
ADEQUATE SHADING: SIZING OVERHANGS AND FINS

**Horizontal Shading Devices**

Horizontal louvers at the New Architecture wing, Tshwane University of Technology, South Africa

*Photo © Crafford & Crafford Architects*

This shading device is suitable for north and south facing façades. They can also work on other façades provided they are closely spaced especially for high projection factors.

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Slanted concrete louvres, TTCL building, Arusha, Tanzania

*Photo © UN-Habitat / Jerusha Ngungui*

This shading device is most effective on the east and west exposures.
Horizontal Shading Devices

Wide aluminium louvered roof, Coca-Cola East and West Africa Business Unit head office, Nairobi
Photo © UN-Habitat / Zeltia Blanco

This shading device is suitable for north and south facing façades to cut out high angle sun.

Horizontal aluminium louvered sun shading system, University of Nottingham, UK
Photo © UN-Habitat / Jerusha Ngungui

This shading device is suitable for north and south facing façades to cut out high angle sun.
The louvers parallel to the wall have the advantage of permitting air circulation near the façade.
ADEQUATE SHADING: SIZING OVERHANGS AND FINS

Horizontal Shading Devices

Horizontal aluminium louvered sun shading system, Catholic University of East Africa, Nairobi
Photo © Musau Kimeu

This shading device is suitable for north and south facing façades to cut out high angle sun.
The louvers parallel to the wall have the advantage of permitting air circulation near the façade.

Horizontal aluminium light shelves, Coca-Cola East and West Africa Business Unit head office, Nairobi
Photo © UN-Habitat Jerusha Ngungui

This shading device is suitable for north and south facing façades to cut out high angle sun.
The louvers parallel to the wall have the advantage of permitting air circulation near the façade.
Horizontal Shading Devices

Horizontal aluminium louvered sun shading system, ACROS Fukuoka building, Japan
Photo © UN-Habitat / Daniel Ndeti

This shading device is suitable for north and south facing façades to cut out high angle sun.
The louvers parallel to the wall have the advantage of permitting air circulation near the façade.

Horizontal aluminium louvered sun shading system, Strathmore University, Nairobi
Photo © UN-Habitat / Jerusha Ngungui

This shading device is suitable for north and south facing façades to cut out high angle sun.
The louvers parallel to the wall have the advantage of permitting air circulation near the façade.
Horizontal Shading Devices

Roof overhang, Strathmore University, Nairobi
Photo © UN-Habitat / Jerusha Ngungui

This shading device is suitable for north and south facing façades to cut out high angle sun.

Roof overhangs at a residential building
Photo © UN-Habitat / Vincent Kitio

This shading device is suitable for north and south facing façades to cut out high angle sun.
Horizontal Shading Devices

Extensive roof overhang, The Skills Center, Nairobi
Photo © Mathias Kestel

This shading device is suitable for north and south facing façades to cut out high angle sun.

Large roof overhangs, Eldoret International Airport, Eldoret
Photo © https://kaa.go.ke/airports/our-airports/eldoret-international-airport/

This shading device is suitable for north and south facing façades to cut out high angle sun.
Horizontal Shading Devices

Horizontal overhangs at cafeteria building entrance, Catholic University of East Africa, Nairobi
Photo © Musau Kimeu

This shading device is suitable for north and south facing façades to cut out high angle sun.

A system of wide roof overhangs and louvres in a vertical plane, British High Commission, Harare, Zimbabwe
Photo © The Manser Practice

Multiple horizontal louvers are effective in blocking out low angle sun especially from east and west.
Louvers parallel to the wall opening cuts out the lower rays of the sun.
**Horizontal Shading Devices**

**Horizontal overhangs at the House of Culture, National Museum of Tanzania**  
*Photo © Tengbom Architects / Inger Thede*

*This shading device is suitable for north and south facing façades to cut out high angle sun.*

**Overhangs above windows, IEET Building, Jomo Kenyatta University of Agriculture and Technology, Juja, Kenya**  
*Photo © UN-Habitat / Jerusha Ngungui*

*This shading device is suitable for north and south facing façades to cut out high angle sun.*
ADEQUATE SHADING: SIZING OVERHANGS AND FINS

Horizontal Shading Devices

Stainless steel louvered shading screen, Umoja House, Dar es Salaam
Photo © The Manser Practice Architects

Multiple horizontal louvers are effective in blocking out low angle sun especially from east and west.
Louvers parallel to the wall / opening cuts out the lower rays of the sun.
**Horizontal Shading Devices**

- **Vertical strip parallel to the wall and dropped off from a solid overhang**, United Nations Office in Nairobi
  
  *Photo © UN-Habitat / Jerusha Ngungui*

- **A perforated solid strip hung from a solid horizontal overhang** is effective on the north and south facing façades.
  
  *Since it is also effective in cutting out the lower rays of the sun, it may be used on the east and west façades.*

- **A solid strip hung from a solid horizontal overhang** is effective on the north and south facing façades.
  
  *Since it is also effective in cutting out the lower rays of the sun, it may be used on the east and west façades.*
ADEQUATE SHADING: SIZING OVERHANGS AND FINS

**Horizontal Shading Devices**

Vertical strip parallel to the wall and dropped off from the overhang, Bruce House, Nairobi  
Photo © http://bauzeitgeist.blogspot.co.ke/2013/08/hauptstadt-von-ostafrika.html

A solid strip hung from a solid horizontal overhang is effective on the north and south facing façades.

Since it is also effective in cutting out the lower rays of the sun, it may be used on the east and west façades.
Horizontal Shading Devices

Horizontal overhangs above windows, Kenwood house, Nairobi
Photo © https://twitter.com/HistoryKe/media

This shading device is suitable for north and south facing façades to cut out high angle sun.

A combination of overhangs and fins, Charles Sturt University, Australia

This shading device is suitable for north and south facing façades to cut out high angle sun.
ADEQUATE SHADING: SIZING OVERHANGS AND FINS

Horizontal Shading Devices

**Horizontal fired-clay louvers, British High Commission, Kampala**
Photo © Kilburn Nightingale Architects / Richard Nightingale

Multiple horizontal louvers are effective in blocking out low angle sun especially from east and west.
Louvers parallel to the wall / opening cuts out the lower rays of the sun.
Horizontal Shading Devices

Horizontal louvers, Strathmore University, Nairobi
Photo © UN-Habitat / Jerusha Ngungui

Multiple horizontal louvers are effective in blocking out low angle sun especially from east and west.
Louvers parallel to the wall / opening cuts out the lower rays of the sun.

Horizontal louvers hung from solid overhangs, Mombasa
Photo © UN-Habitat / Jerusha Ngungui

Multiple horizontal louvers are effective in blocking out low angle sun especially from east and west.
Louvers parallel to the wall / opening cuts out the lower rays of the sun.
Horizontal Shading Devices

Horizontal louvers hung from solid overhangs, Nyati House, Nairobi
Photo © UN-Habitat / Jerusha Ngungui

Multiple horizontal louvers are effective in blocking out low angle sun especially from east and west.
Louvers parallel to the wall / opening cuts out the lower rays of the sun.

Horizontal overhangs and louvers, HM Revenue & Customs, Nottingham, UK
Photo © UN-Habitat / Jerusha Ngungui

Overhangs are effective on the north and south facing openings.
Louvers parallel to the wall / opening cuts out the lower rays of the sun.
Horizontal Shading Devices

Multiple horizontal louvers are effective in blocking out low angle sun especially from east and west. Louvers parallel to the wall / opening cuts out the lower rays of the sun.

This shading device is suitable for north and south facing façades to cut out high angle sun.
ADEQUATE SHADING: SIZING OVERHANGS AND FINS

**Horizontal Shading Devices**

Deeply recessed windows, Strathmore University, Nairobi
Photo © UN-Habitat / Jerusha Ngungui

*This shading device is suitable for north and south facing façades to cut out high angle sun.*

Deeply recessed windows, Japan
Photo © UN-Habitat / Daniel Ndeti

*This shading device is suitable for north and south facing façades to cut out high angle sun.*
Horizontal Shading Devices

Deeply recessed windows at a residential house in Madrid, Spain
Photo © UN-Habitat / Jerusha Ngungui

This shading device is suitable for north and south facing façades to cut out high angle sun.

Deeply recessed windows, Uganda Martyrs University
Photo © UN-Habitat / Jerusha Ngungui

This shading device is suitable for north and south facing façades to cut out high angle sun.
Slanted vertical fins, Parliament building, Nairobi
Photo © UN-Habitat / Jerusha Ngungui

Slanted vertical fins, Continental House, Nairobi
Photo © UN-Habitat / Jerusha Ngungui

Slanted vertical fins are most effective on east and west exposures.

Slanted vertical fins are most effective on east and west exposures.
**Vertical** Shading Devices

Vertical fins, Aga Khan Primary School, Kisumu
Photo © UN-Habitat / Jerusha Ngungui

*This shading device is most effective on the near-east, near-west exposures.*

Vertical fins, Catholic University of East Africa, Nairobi
Photo © Musau Kimeu

*This shading device is most effective on the near-east, near-west exposures.*
ADEQUATE SHADING: SIZING OVERHANGS AND FINS

**Vertical Shading Devices**

Vertical fins, ADD building, University of Nairobi  
Photo © UN-Habitat / Jerusha Ngungui

*This shading device is most effective on the near-east, near-west exposures.*

Vertical fins, Bath College, Bath, UK  
Photo © UN-Habitat / Jerusha Ngungui

*This shading device is most effective on the near-east, near-west exposures.*
**Vertical Shading Devices**

This shading device is most effective on the near-east, near-west exposures.

Vertical fins, ADD building, Longonot Place, Nairobi
Photo © UN-Habitat / Jerusha Ngungi

Vertical concrete fins, building in Japan
Photo © UN-Habitat / Daniel Ndeti

This shading device is most effective on the near-east, near-west exposures.
**Vertical Shading Devices**

Pre-cast concrete vertical fins, Nairobi
Photo © UN-Habitat / Jerusha Ngungui

This shading device is most effective on the near-east, near-west exposures.

Concrete vertical fins, Mombasa
Photo © UN-Habitat / Jerusha Ngungui

This shading device is most effective on the near-east, near-west exposures.
**Vertical Shading Devices**

Pre-cast concrete vertical fins, Mombasa
*Photo © UN-Habitat / Jerusha Ngungui*

This shading device is most effective on the near-east, near-west exposures.

Slanted vertical fins, Associacao Brasileira da Imprensa (ABI), Brazil
*Photo © http://rwarquitetura.blogspot.co.ke/2014/05/neuronios-documentario-os-irmaos-roberto.html*

Slanted vertical fins are most effective on east and west exposures.
ADEQUATE SHADING: SIZING OVERHANGS AND FINS

**Vertical Shading Devices**

Precast concrete vertical fins, Jogoo House B, Nairobi
Photo © Isabelle Prondzynski
https://www.flickr.com/photos/prondis_in_kenya/5078860149/

This shading device is most effective on the near-east, near-west exposures.

Slanted fins, Prudential Assurance Building, Nairobi
Photo © Isabelle Prondzynski

Slanted vertical fins are most effective on east and west exposures.
Vertical Shading Devices

**Vertical fins, Sukari house, Dar es Salaam, Tanzania**  
*Photo © Brian J. McMorrow*

This shading device is most effective on the near-east, near-west exposures.

**Rotating vertical fins, New Architecture wing, Tshwane University of Technology, South Africa**  
*Photo © Crafford & Crafford Architects*

Rotating vertical fins are the most flexible and adjustable for daily and seasonal conditions and are most effective on east and west exposures.
Vertical Shading Devices

Vertical fins, The Torre Europa building, Madrid, Spain
Photo © UN-Habitat / Jerusha Ngungui

This shading device is most effective on the near-east, near-west exposures.
**Vertical Shading Devices**

Precast concrete vertical fins, Library building at the University of Nairobi, Kabete Campus
Photo © UN-Habitat / Vincent Kitio

*This shading device is most effective on the near-east, near-west exposures.*

Precast concrete vertical fins, University of Nairobi, Kabete Campus
Photo © UN-Habitat / Vincent Kitio

*This shading device is most effective on the near-east, near-west exposures.*
Eggcrate Shading Devices

Hyslop Building, University of Nairobi
Photo © Edwin Seda

This shading device is most effective on the east and west exposures.

Uganda National Theatre and Cultural Centre
Photo © https://www.jamiiforums.com/threads/kampala-city-gallery.1169398/page-6

This shading device is most effective on the east and west exposures.
Eggcrate Shading Devices

National Housing Corporation, Nairobi
Photo © UN-Habitat / Jerusha Ngungui

This shading device is most effective on the east and west exposures.
Eggcrate Shading Devices

Extensive use of horizontal and vertical shading devices, Kenindia Building, Nairobi
Photo © UN-Habitat / Jerusha Ngungui

This shading device is most effective on the east and west exposures.
Eggcrate Shading Devices

This shading device is most effective on the east and west exposures.

Eggcrate shading, House of Culture, National Museum of Tanzania
Photo © Tengbom Architects / Inger Thede

Vent blocks acting as eggcrate shading devices, Travellers beach, Mombasa
Photo © UN-Habitat / Jerusha Ngungui

This shading device is most effective on the east and west exposures.
**Eggcrate Shading Devices**

ADEQUATE SHADING: SIZING OVERHANGS AND FINS

University of Nairobi, Kabete Campus  
Photo © UN-Habitat / Vincent Kitio

This shading device is most effective on the east and west exposures.

Watamu, Malindi  
Photo © UN-Habitat / Vincent Kitio

This shading device is most effective on the east and west exposures.
Eggcrate Shading Devices

Capetown, South Africa
Photo © UN-Habitat / Vincent Kitio

This shading device is most effective on the east and west exposures.
Eggcrate Shading Devices

Concrete lattice screens, Makerere University’s Main Library building, front view
Photo © E. Kissel

This shading device is most effective on the east and west exposures.

Vent blocks used for shading, Jaramogi Oginga Odinga Teaching and Referral Hospital

This shading device is most effective on the east and west exposures.
Eggcrate Shading Devices

Extensive use of horizontal and vertical shading devices, IPS Building, Nairobi
Photo © Musau Kimeu

This shading device is most effective on the east and west exposures.
**Eggcrate Shading Devices**

Eggcrate shading devices are most effective on the east and west exposures.

**Varsity Plaza, Kisumu**
*Photo © UN-Habitat / Jerusha Ngungui*
Eggcrate Shading Devices

Lacy, structural skin, Tudor Apartments, Mombasa, Kenya
Photo © Urko Sanchez Architects / Javier Callejas

This shading device is most effective on the east and west exposures.

Shading screen, Masdar Institute of Science and Technology, Abu Dhabi
Photo © UN-Habitat / Vincent Kitio

This shading device is most effective on the east and west exposures.
Eggcrate Shading Devices

The Technology
School of
Guelmim, Morocco
Photo © FG+SG / Fernando Guerra

This shading device is most effective on the east and west exposures.

Kenya Parliament,
Nairobi, Kenya
© https://www.
pinketsandroses.
com/2017/11/04/
parliament-of-kenya-
arhitectural

This shading device is most effective on the east and west exposures.
Eggcrate Shading Devices

Ministry of Education and Health, Rio de Janeiro, Brazil
Photo © Roberto Rocco

This shading device is most effective on the east and west exposures.
Vertical fins are most effective on the near-east, near-west exposures while the shading screen is most effective on the east and west exposures.
Eggcrate Shading Devices

Screen lattice facade, Kenneth Dike
Library at University of Ibadan in Oyo
Nigeria
Photo © Michael Sean Gallagher

This shading device is most effective on the east and west exposures.

Punjab and Haryana High Court
Photo © http://architectuul.com/architecture/view_image/city-of-chandigarh/4583

This shading device is most effective on the east and west exposures.
Eggcrate Shading Devices

Chandigarh College of Architecture, India
Photo © http://corbusier.totalarch.com/chandigarh_college

This shading device is most effective on the east and west exposures.

Bank of Uganda, Kampala, Uganda
Photo © https://www.pinterest.com/

This shading device is most effective on the east and west exposures.
BIBLIOGRAPHY


The project Promoting Energy Efficiency in Buildings in East Africa is an initiative of UN-Habitat in collaboration with the United Nations Environment Programme (UNEP), the Global Environment Facility (GEF) and the governments of Kenya, Tanzania, Uganda, Rwanda and Burundi.