

# EXTERNAL MOVABLE SHADING SYSTEMS (EMSyS) MANUAL



BUREAU OF ENERGY EFFICIENCY (BEE)  
(Ministry of Power, Government of India)  
Website: [www.beeindia.gov.in](http://www.beeindia.gov.in)







# EXTERNAL MOVABLE SHADING SYSTEMS (EMS<sub>y</sub>S) MANUAL



# EXTERNAL MOVABLE SHADING SYSTEMS (EMSyS) MANUAL

© 2021 Bureau of Energy Efficiency  
All rights reserved

Published by  
Bureau of Energy Efficiency  
4th Floor, Sewa Bhawan, R K Puram, New Delhi, India

No portion (graphics or text) of this document may be reproduced, translated, or transmitted in any form or manner by any means – including but not limited to electronic copy, photocopy, or any other information storage and retrieval system – without explicit written consent from Bureau of Energy Efficiency, New Delhi.

1st Printed: 2021

Printed in India by Innovative Designers and Printers Pvt. Ltd, Noida.

# TABLE OF CONTENTS

## MESSAGES

<i>Abhay Bakre, Director General, Bureau of Energy Efficiency.....</i>	<i>vii</i>
<i>Jonathan Demenge, Head of Cooperation and Counsellor, Swiss Cooperation office India, Embassy of Switzerland, New Delhi .....</i>	<i>ix</i>
<i>Saurabh Diddi, Director, Bureau of Energy Efficiency.....</i>	<i>xi</i>
<b>INTRODUCTION.....</b>	<b>xiii</b>

## RE-TRACTABLE AWNINGS

1. Types of Re-tractable Awning.....	3
1.1 Pivot Arm Awnings.....	3
1.2 Quarter-Round Awnings .....	3
1.3 Foldable Arm Awnings .....	3
2. Working Mechanism.....	4
2.1 Pivot Arm Awnings.....	4
2.2 Quarter-Round Awnings .....	4
2.3 Foldable Arm Awnings .....	5
3. Anchoring Mechanism.....	6
3.1 Pivot Arm Awnings.....	7
3.2 Quarter-Round Awnings .....	8
3.3 Foldable Arm Awnings .....	8
4. Applicability and Sizing .....	9
4.1 Pivot Arm Awnings.....	9
4.2 Quarter-Round Awnings .....	10
4.3 Customisable Sizing .....	11
4.4 Foldable Arm Awnings .....	11
5. Case Study .....	12
5.1 Pivot Arm Awnings.....	12
5.2 Quarter-Round Awnings .....	12
5.3 Foldable Arm Awnings .....	13

6. Maintenance .....	13
7. Key Features/Benefits.....	14
7.1 Pivot Arm Awnings.....	14
7.2 Quarter-Round Awnings .....	15
7.3 Foldable Arm Awnings .....	15
8. Accessories .....	15

## VERTICAL SCREENS

1. Types of Vertical Screens .....	19
1.1 Clutch Roller Blinds .....	19
1.2 Venetian Blinds .....	19
1.3 Outdoor Curtains .....	19
1.4 Roman Fold Blind.....	20
1.5 Roll-Up Blinds .....	20
2. Working Mechanism.....	20
2.1 Clutch Roller Blinds .....	20
2.2 Venetian Blinds .....	22
2.3 Outdoor Curtains .....	22
2.4 Roman Fold Blind.....	22
2.5 Roll-Up Blinds .....	23
3. Anchoring Mechanism.....	24
3.1 Clutch Roller Blinds and Venetian Blinds .....	24
3.2 Anchored to the Ceiling .....	24
3.3 Outdoor Curtains .....	25
3.4 Roman Fold Blinds and Roll-Up Blinds .....	25
4. Applicability and Sizing .....	26
4.1 Clutch Roller Blinds .....	26
4.2 Venetian Blinds .....	26

4.3 Outdoor Curtains .....	27
4.4 Roman Fold Blinds .....	27
4.5 Roll-Up Blinds .....	28
5. Case Study .....	29
5.1 Clutch Roller Blinds .....	29
5.2 Venetian Blinds .....	29
5.3 Roman Fold Blinds .....	30
5.4 Roll-Up Blinds .....	30
6. Maintenance .....	31
6.1 Cleaning of Blinds and Curtains.....	31
6.2 Clutch Roller Blinds .....	31
6.3 Venetian Blinds and Curtains.....	31
6.4 Clutch Roller Blinds .....	31
6.5 Venetian Blinds and Curtains.....	31
7. Key Features/ Benefits.....	32
7.1 Clutch Roller Blinds .....	32
7.2 Venetian Blinds .....	32
7.3 Outdoor Curtains .....	33
7.5 Roll-Up Blinds .....	33

## SHUTTERS

1. Types of Shutter .....	37
1.1 Shutters with Adjustable Louvers.....	37
1.2 Shutter with Fixed Louvers.....	37
1.3 Shutter with Adjustable Combination Louvers .....	37
2. Working Mechanism.....	38
2.1 Shutters with Adjustable Louvers.....	38
2.2 Shutters with Fixed Louvers .....	38
2.3 Shutter with Adjustable Combination Louvers .....	39
3. Anchoring Mechanism.....	40
3.1 Anchored from Top and Bottom Rail.....	40
3.2 Achored from the Vertical Members of the Frame .....	40
3.3 Anchored from all Four Sides of the Frame .....	41
4. Applicability and Sizing .....	41
5. Case Study .....	42
6. Maintenance .....	42
7. Key Features/ Benefits.....	43

## LIST OF ACRONYMS / ABBREVIATIONS

₹/ft²	Cost in Indian Rupees per square feet
AMP	Ampere, is a unit of electrical current
BEE	Bureau of Energy Efficiency
BEEP	Building Energy Efficiency Project
DGU	Double Glass Unit
ECBC	Energy Conservation Building Code
FDFA	Federal Department of Foreign Affairs
HDPE	High-density polyethylene
KMPH	Kilometers per hour

MoP	Ministry of Power
pH	Potential of Hydrogen
PU	Polyurethane
PVC	Poly Vinyl Chloride
SDC	Swiss Agency for Development and Cooperation
SHGC	Solar Heat Gain Coefficient
uPVC	Unplasticized polyvinyl chloride
VLT	Visible Light Transmittance
WWR	Window-to-Wall Ratio

# DEVELOPMENT TEAM

## **Bureau of Energy Efficiency**

Abhay Bakre  
Saurabh Diddi  
Akanksha Krishan  
Shatakshi Suman  
Meenal Anand  
Meenakshi Sinha

## **Swiss Agency for Development and Cooperation (SDC), India**

Johnathan Demenge  
Anand Shukla

## **Indo-Swiss Building Energy Efficiency Project (BEEP)**

### **Project Management and technical Unit (PMTU)**

## **Greentech Knowledge Solutions Pvt. Ltd**

Sameer Maithel  
Prashant Bhanware  
Vernica Prakash  
Ishita Singh

## **Effin'Art Sarl**

Pierre Jaboydeoff  
Chinar Sharma





# MESSAGE



**Bureau of Energy Efficiency**  
(Ministry of Power, Government of India)

**Abhay Bakre**

Director General, Bureau of Energy Efficiency



Government of India updated the Energy Conservation Building Code (ECBC) in 2017 to establish minimum energy performance standards for new, commercial buildings in India with revisions that are more stringent, although the code remains voluntary in nature. In 2018 Government of India launched a code for residential buildings EcoNiwas Samhita (ENS) (Part I – Building Envelope) with the aim of improving thermal comfort and energy efficiency in residential buildings. To strengthen the adoption of these codes, Bureau of Energy Efficiency has been working on several aspects crucial to limit heat gains inside a building.

Windows are a crucial component that contribute to heat gains in a building significantly. Some studies show that on any intermediate floor, over 60% of the heat gains are through windows. The use of External movable shading systems (EMSyS) such as chiks, awnings, roller blinds, and shutters ensures that over 80% of the solar radiation coming inside through windows can be minimised. This would reduce the heat gain inside the building and also provide significant decrease the air-conditioning load and in turn the electricity bill.

This manual is a compilation of such EMSyS devices available in the country elaborating on their working mechanisms and other practical aspects. It also gives an indicative pricing and expected reduction in the solar heat gains for all products. Despite being cost-effective and easy to install, EMSyS devices are not so popular in the country. This is primarily due to lack of awareness. This publication, titled External Movable Shading Systems (EMSyS) Manual, is intended to bridge this gap.

To that extent, the Manual serves a valuable purpose by documenting the variety of EMSyS devices that are available in India that suit a large section of users. I would urge all architects and developers to refer the manual and adopt the most suitable solution for their respective projects. That will help further improve energy-efficient building design and construction practices in India.

New Delhi

4th December 2021

**Abhay Bakre**

Director General

Bureau of Energy Efficiency



# MESSAGE



## **Jonathan Demenge**

Head of Cooperation and Counsellor

At the outset, I would like to express my great satisfaction and gratitude to the the Bureau of Energy Efficiency (BEE) for this successful collaboration: through the Indo-Swiss Building Energy Efficiency Project (BEEP) many great successes have been achieved.

This collaboration saw the development of an energy efficiency code document for the residential building sector, *EcoNiwas Samhita (ENS) 2018*. This manual on external moveable shading system (EMSyS) is an extension to the provisions of ENS 2018.

The concept of EMSyS derives from a simple and ancient technology which is found in buildings in many warm and cold regions and countries around the world, including in Switzerland. They have become part of the architecture. It helps blocking out the excessive the excessive heat and direct sunlight, while keeping the room inside cool. In Switzerland, very few buildings require air conditioning during the summer; but for those, installing EMSyS is a mandatory pre-requisite, which has considerable impacts in terms of reducing heat gain.

To this effect BEEP had initiated a design competition in 2015 to promote the development of indigenous EMSyS designs in the country. This led to the development of EMSyS designed and developed in India. These prototypes were later tested for their thermal performances. Later existing EMSyS products already available in India, were identified in a survey conducted under BEEP and are presented in this manual.

This manual shares all the relevant information on EMSyS products to provide a readymade design reference document for designers and developers, and motivate them to use them in buildings.

I hope that this *External Movable Systems (EMSyS) Manual* will be useful to the design professionals, and that it will contribute to BEE's efforts in mainstreaming the adoption of ENS 2018 to reduce the energy consumption of buildings in India.

New Delhi

4th December 2021

**Jonathan Demenge, PhD**

Head of Cooperation and Counsellor

Swiss Cooperation office India, Embassy of Switzerland, New Delhi



# MESSAGE



**Bureau of Energy Efficiency**  
(Ministry of Power, Government of India)

**Saurabh Diddi**

Director



The *External Movable Systems (EMSyS) Manual* is a guidance document that would help building sector professionals design buildings for thermal comfort and energy efficiency in residential buildings. In that sense, this manual adds immense value to the parent document *EcoNiwas Samhita 2018* (Part I – Building Envelope).

A lot of effort by different sets of people and institutions have gone into the preparation of this document. Guidance, innumerable reviews, unparalleled commitment and hard labour etc. are the different kinds of roles assumed by these people. Given below are the few names who have put in a substantial amount of time and effort in bringing out this document.

I am grateful to Mr Abhay Bakre, Director General, Bureau of Energy Efficiency, for his guidance to the development team. BEE places on record its gratitude to the officials of the Swiss Agency for Development and Cooperation (SDC), India – Ms Marylaure Crettaz, former Head of Co-operation and Counsellor, Swiss Co-operation office India, Embassy of Switzerland; Dr Johnathan Demengue, current Head of Co-operation and Counsellor, Swiss Co-operation office India, Embassy of Switzerland; and Dr Anand Shukla, Senior Thematic Advisor – for their constant engagement and in making available necessary technical support.

The core development team of the Indo-Swiss Building Energy Efficiency Project (BEEP) had burnt the midnight oil on several days to see to it that everything in the manual is in order. The team comprised Mr Pierre Jaboydeoff and Ms Chinar Sharma from the Swiss Project Management Technical Unit (PMTU) and Dr. Sameer Maithel, Ms Vernica Prakash, Mr Prashant Bhanware, and Ms Ishita Singh from Indian PMTU.

This document would not have been possible without the relentless efforts of Ms Akanksha Krishan, Ms Shatakshi Suman, and Ms Meenal Anandh, sector experts at BEE.

This manual would not have been complete without the support of EMSyS vendors and manufacturers. Thanks to all of them for painstakingly responding to queries and filling out detailed questionnaire in time and sharing information on their products.

While BEE proudly presents this document, we would really appreciate receiving feedback from the stakeholders of the EMSYS and building industry to make it even better in the subsequent editions. We sincerely hope this publication is of great value to one and all.

New Delhi

4th December 2021

**Saurabh Diddi**

Director

Bureau of Energy Efficiency



# INTRODUCTION

There is a trend towards increasing the window-to-wall ratio and glazing area in both commercial and middle- to high-income residential buildings. Another trend noticed is to avoid the provision of chajjas or any kind of fixed shading. These are worrying trends, as these unprotected, large glass facades and windows are the major contributors to the heat gain inside the building. In a survey carried out across 50 residential buildings spanning over 7 cities, the windows and the shading designs were found to have no co-relation to the local climatic conditions.

Windows serve multiple purposes of providing ventilation, daylighting, outdoor view, etc. However, the excessive heat gain through windows due to radiation is usually neglected in the design of new buildings and the buildings are not adequately shaded. Adequate shading is needed for optimising lighting, controlling glare, improving the thermal comfort, reducing the heat load, and hence in reducing the requirement for electricity for cooling and lighting to make buildings visually and thermally comfortable.

## WHAT IS SHADING?

Shading is a simple method to block the excessive heat and radiation from the sun to get inside a building. This can be achieved by using simple architectural elements, which may be fixed or sophisticated movable systems outside the window. The primary objective is to block the intense solar radiation from falling on the glazed surface and entering the building during summer while allowing the solar radiation to enter during the winter months.

## EXTERNAL MOVABLE SHADING SYSTEMS

While fixed shading elements such as chajjas, box windows, and vertical fins are extremely important and can provide shading on the northern and southern facades of the building when the sun is high up, it is dynamic/movable shading that can protect the eastern and western facades from the angular sun. Also, in a tropical country like India, which receives high amount of solar radiation, a significantly large fraction is in the form of 'diffused' radiation because of dust and clouds present in the atmosphere. In Delhi, 'diffused' solar radiation accounts for almost 50% of the total solar radiation during the peak summer season. While fixed shading is useful to protect from 'direct' solar radiation, it has limited effectiveness against 'diffused' radiation. An external movable shading device/system (EMSyS) can be adjusted in different positions depending on the sun's trajectory throughout the day and block solar radiation from entering the building as they are placed outside the glass of the window. Such systems have the potential to reduce up to 80% solar gains coming inside the building through windows.

## PERFORMANCE RESULTS OF EMSyS IN A REAL-LIFE BUILDING

While there is a huge potential of EMSyS for improving thermal comfort and saving cooling electricity, the evidence or real-life monitored data is hardly available in the public domain, especially in India. To address this gap, a real-life performance study was conducted to measure EMSyS performance under BEEP. The objective of the study was to quantify the impact of EMSyS in reducing the indoor temperatures in NV mode and in reducing the space cooling load in AC mode.

A simplified methodology for performance monitoring of EMSyS was developed for naturally ventilated (NV) mode as well as air-conditioned (AC) mode. One test room in each of two identical flats, one above the other, was selected for monitoring in a residential building in the NCR region which falls in the composite climate zone. One test room had EMSyS installed while the other had regular internal curtains (IC). Among different EMSyS products available, vertical screens were used for this monitoring study.

In both cases the measurements were first done for a week's duration in March and subsequently in June. The peak operative temperature<sup>1</sup> in the room having EMSyS was lower by 3.5°C as compared to the room having IC which was observed during clear days with high direct normal irradiance<sup>2</sup> (DNI). While around 32% reduction in cumulative cooling delivered was observed in test room with EMSyS compared to the cooling delivered in the test room with IC.

Following the field measurements, a simulation-based study was also carried out to check the thermal performance of EMSyS in different seasons, building orientation, location and glazing types. The key findings are:

- Orientation: The thermal comfort and energy savings potential for west and east facing windows was much higher as compared to windows facing north or south. Hence, using EMSyS should be prioritized for the East and West facades.
- Location: Cities and towns which have high solar radiation and dry climates see better performance by using EMSyS.
- Glazing systems: EMSyS with single glazing can give equivalent or better results in controlling indoor temperatures and reducing the cooling load as compared to high-performance double-glazing units. It also offers an advantage of better daylighting over using internal curtains with high-performance glass.

## ABOUT THE MANUAL

This manual is a compilation of external movable shading products available in the Indian market. The information was collected by the development team through a market survey. These products are classified into three categories: Retractable Awnings, Vertical Screens, and Shutters. The manual aims to give comprehensive information to building designers and homeowners on these products and help them decide on the best ones suited to reduce solar heat gains in their projects/homes.

<sup>1</sup> Operative temperature is a simplified measure of human thermal comfort derived from air temperature, mean radiant temperature and air speed. It is useful in assessing the likely thermal comfort of the occupants of a building.

<sup>2</sup> Direct Normal Irradiation (DNI) is the amount of solar radiation received per unit area by a surface that is always held perpendicular (or normal) to the rays that come in a straight line from the direction of the sun at its current position in the sky.

## READING THE MANUAL

The introductory page in each category comprises the anatomy of the product and key performance parameters of the best performing product in the three categories. Each category of products has information, which is divided in eight sections:

1. Types of products in each category
2. Working mechanism
3. Anchoring mechanism
4. Applicability and sizing of products
5. Relevant case studies
6. Maintenance Methods
7. Key Features/ Benefits
8. Accessories



# RE-TRACTABLE AWNINGS

Composed of fabric that is stretched and retracted on a sub-structure designed as a truss, space frame or a planar frame depending on the applicability

## SOLAR HEAT GAIN COEFFICIENT<sup>3</sup>

### PIVOT ARM (SIMPLE TYPE) AWNING

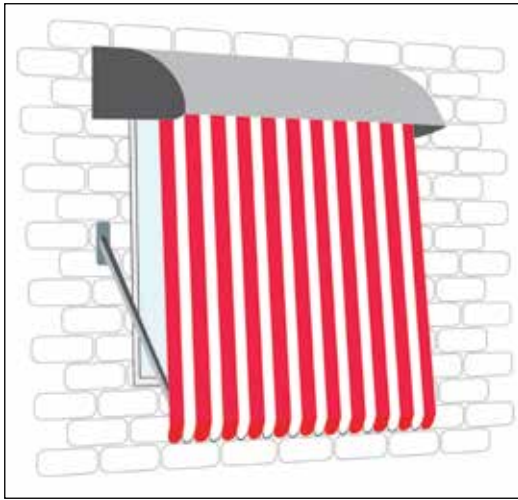
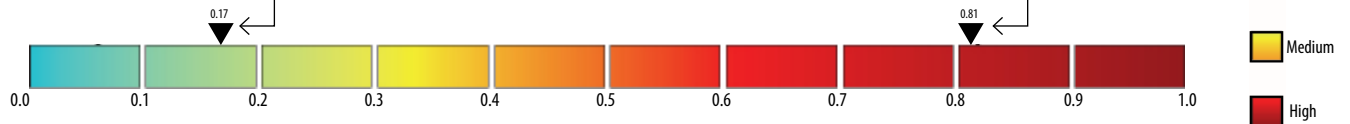


Fig. A: Closed Position



Fig. B: Open Position



<sup>3</sup> Solar Heat Gain Coefficient (SHGC) is a measure of the amount of solar radiation (heat) passing through the entire window, including the frame.

## ANATOMY OF RE-TRACTABLE AWNING

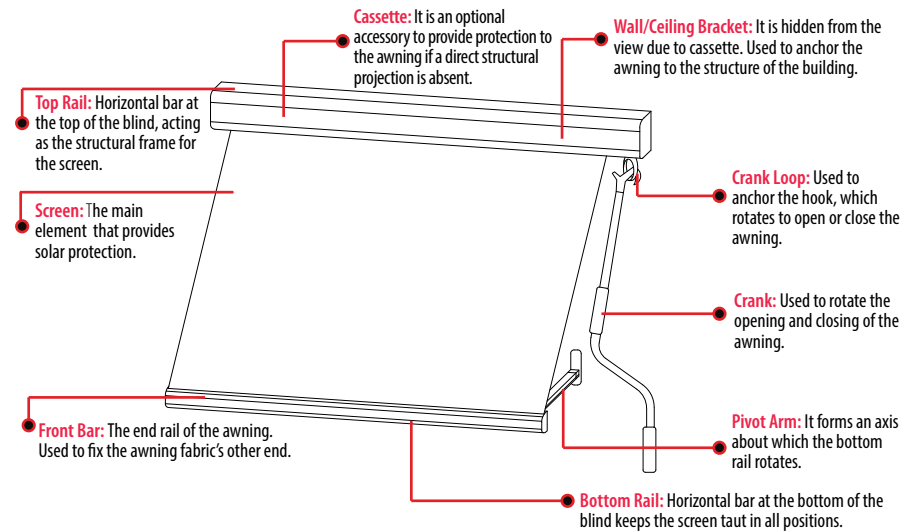


Fig. C: Anatomy of Re-tractable Awning

## MATERIAL



Fig. D: Options for Awning's Frame

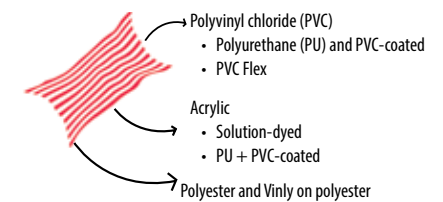
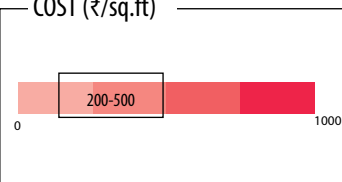


Fig. E: Options for Awning's Fabric

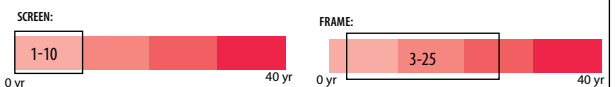
## COST (₹/sq.ft)



## WIND TOLERANCE



## LIFESPAN



\* The SHGC of the product is dependent on its material properties.

# 1. TYPES OF RE-TRACTABLE AWNING

## 1.1 PIVOT ARM AWNINGS

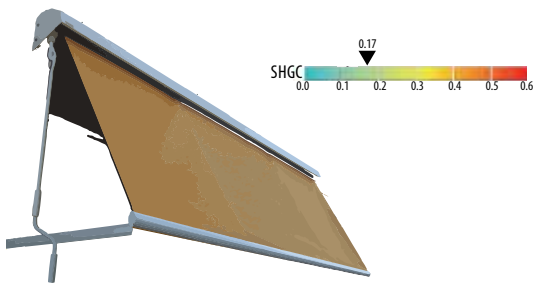


Fig. 1.1a: Pivot Arm (simple type) Awning

It operates on extendable arms, which are fixed to the exterior wall. The arms pivot in an arc, allowing the blind to extend and retract before locking into position.

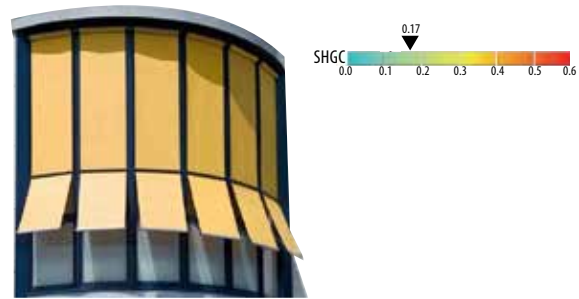


Fig. 1.1b: Pivot Arm (valance type) Awning

It consists of an additional horizontal member that fixes the length of the awning's fabric and makes this area like an immovable panel. The remaining length is connected to a pivot arm, which becomes the movable panel.

## 1.2 QUARTER-ROUND AWNINGS

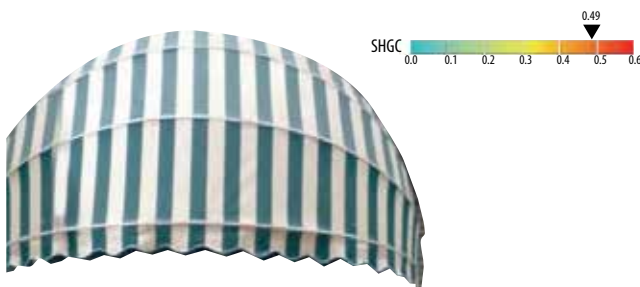


Fig. 1.2a: Quarter-round Foldable (spherical) Awning

This awning has the shape of a quarter sphere, and hence all the dimensions (height, projection length, and radius) are equal. (Also known as Bull Nose Awning)



Fig. 1.2b: Quarter-round Foldable (rectangular) Awning

The rectangular awning has multiple panels that are attached radially to the corner, which forms the sub-structural space frame. These panels are installed with solar fabric. The awning is pulled together and stretched on a rope and pulley system.

## 1.3 FOLDABLE ARM AWNINGS



Fig. 1.3a: Foldable Arm Awnings

It has a base planar frame of aluminium, which has pre-tensioned arms to support the stretching and retraction of the awning while sustaining wind and rain.

## 2. WORKING MECHANISM

### 2.1 PIVOT ARM AWNINGS

#### 2.1.1 CRANK-SHAFT GUIDED SYSTEM

A pivot arm awning pivots on a crank-guided system. The pivoted arm rotates depending on the length of the fabric, which is let loose by the user.

1. The fabric is rolled up to close the awning.
2. The fabric is rolled down to open the awning.
3. The fabric is directly attached to the bottom rail, which is fixed to the pivot arm. As there are no vertical members connecting the top rail and the bottom rail, the tension of the fabric locks the pivot arm in position.
4. It is useful in areas with frequent rainfall, as the fabric keeps taut in every position and does not let the water pool on the fabric and the user can be carefree.



Fig. 2.1a: Awning Frame



Fig. 2.1b: Transition of Pivot Arm Awning from Open to Closed Positions

### 2.2 QUARTER-ROUND AWNINGS

#### 2.2.1 ROPE AND PULLEY SYSTEM

A quarter-round foldable awning has two types of pulleys: movable pulley and fixed pulley.



Fig. 2.2a: Frame of Quarter-round Awning

A movable pulley is attached to each panel of the awning while a fixed pulley is attached to the main frame, which is installed on the wall.

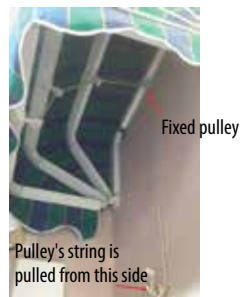


Fig. 2.2b: Inner View of Quarter-round Awning

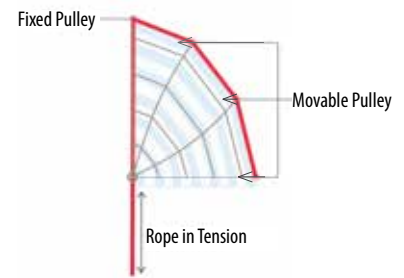


Fig. 2.2c: Rope and Pulley System

The string is used to pull all the movable pulleys together. When the tension of the string is released, the awning falls back to its open position due to gravity.



Fig. 2.2d: Closed Position



Fig. 2.2e: Open Position

## 2.3 FOLDABLE ARM AWNINGS

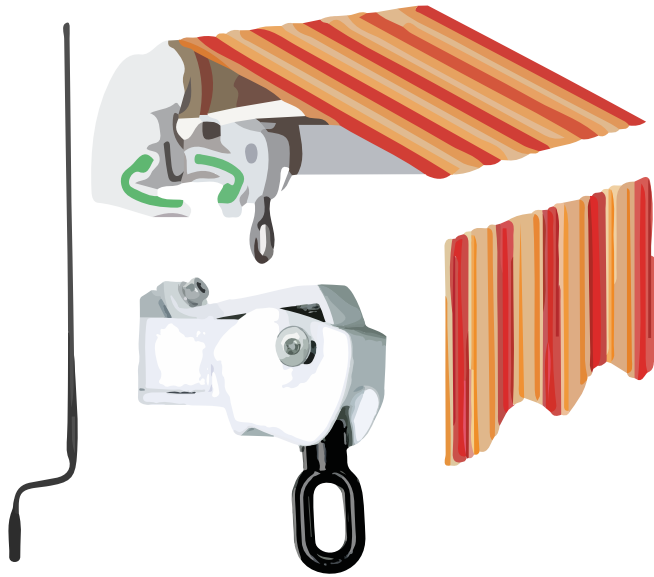


Fig. 2.3a Crank-shaft Guided System

### 2.3.1 CRANK-SHAFT GUIDED SYSTEM

In this mechanism, a simple rod is employed to open and close the awning. The crank is hooked to the roller and rotated clockwise; this motion releases the tension arms to stretch out and open. When the roller is rotated in anti-clockwise direction, the awning retracts.

There are two hooks in the awning:

1. For opening and closing the awning.
2. For adjusting the pitch of the awning.

### 3. ANCHORING MECHANISM

All types of awning's frame have the following elements:

1. The structural load-bearing elements.
2. The elements that enable retractions.
3. The elements that form a connection between movable and fixed elements. They might serve the combined purpose of the above two.

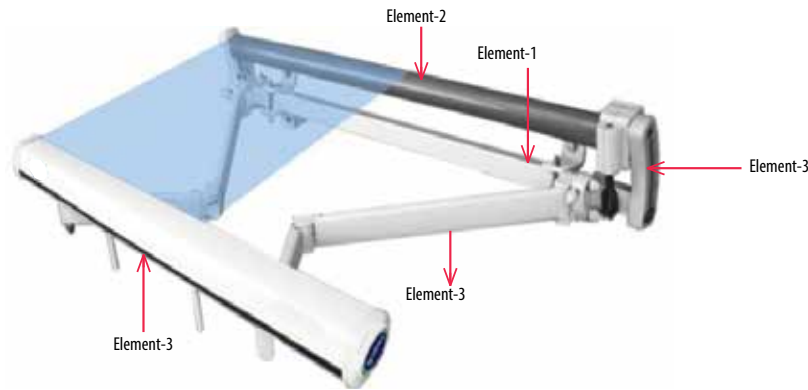


Fig. 3a: Anchoring Components of Awnings

The load-bearing element is anchored to the building structure in the following ways:

1. Wall-mount Brackets: The load-bearing element of the awning is bracketed to the wall, with specially designed wall-mount brackets.



Fig. 3b: Anchoring Brackets for Awnings

2. Ceiling-mount Brackets: The load-bearing element of the awning is bracketed to the soffit/ceiling, with specially designed wall-mount brackets or di-casted steel L-brackets.



Fig. 3c: Awning Anchored with Ceiling Brackets



3. Cable-guided Installation: The cable is installed at soffit mount fixture, which is anchored to the floor or wall near the bottom rail of the awning, with a suitable bracket. The cable's tension is ensured while securing it.



Fig. 3d: Cable-guided Installation

### 3.1 PIVOT ARM AWNINGS

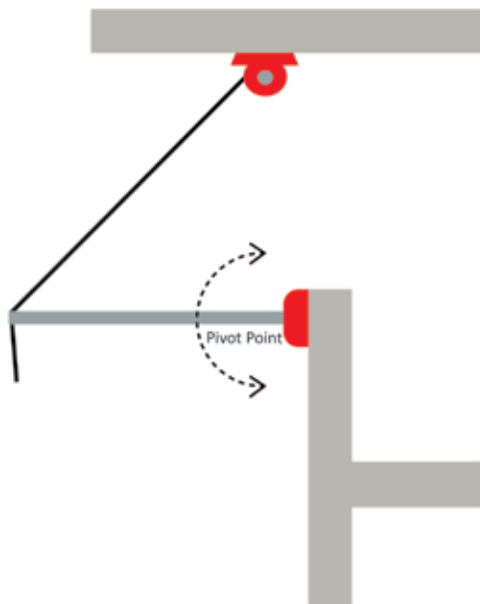


Fig. 3.1a: Ceiling Mount

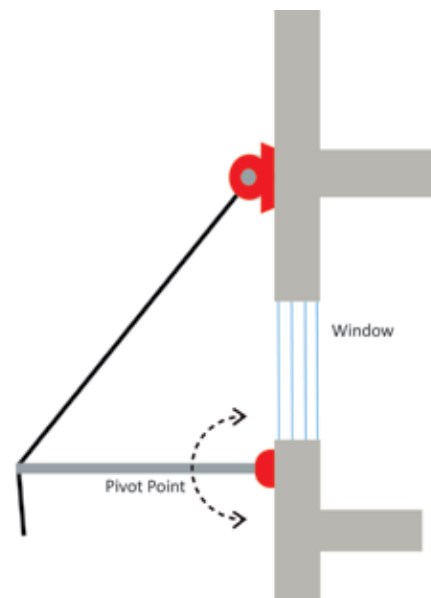


Fig. 3.1b: Wall Mount

## 3.2 QUARTER-ROUND AWNINGS

It is wall-mounted on three sides.

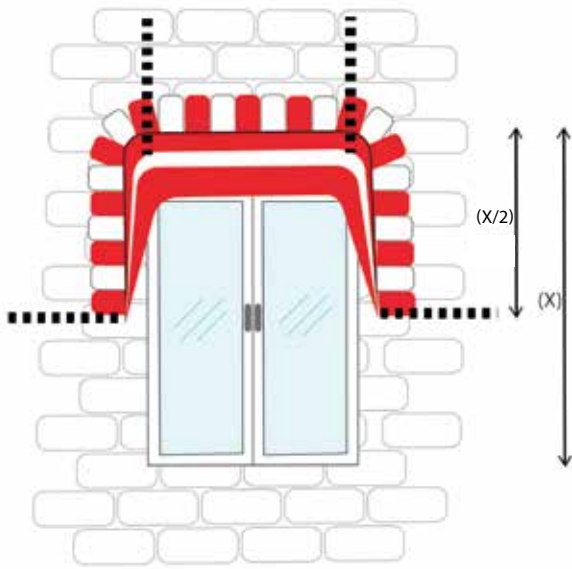


Fig. 3.2a: Anchor Points of the Awning

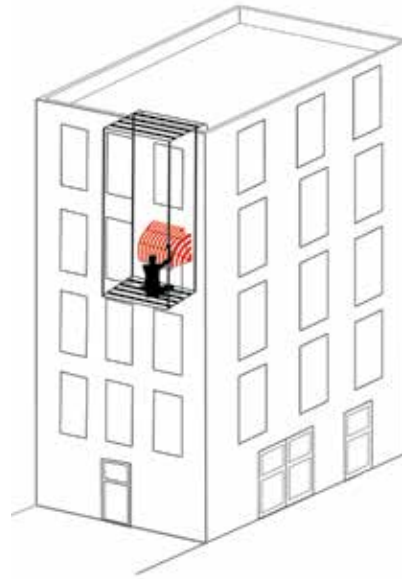


Fig. 3.2b: Awning Installation Method

## 3.3 FOLDABLE ARM AWNINGS

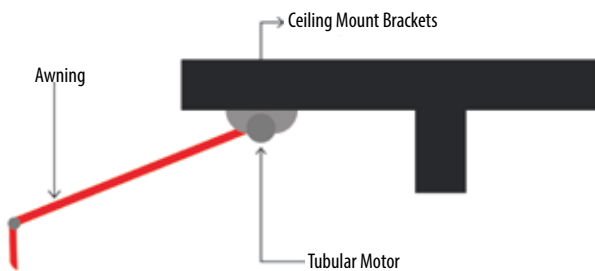


Fig. 3.3a: Ceiling Mount

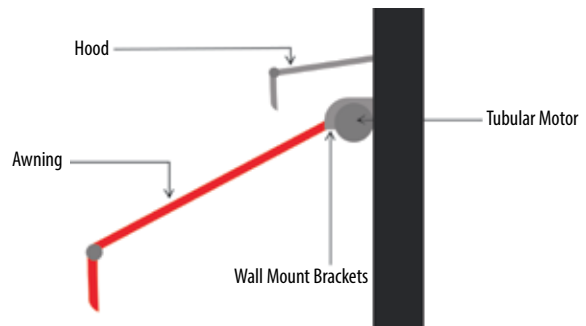


Fig. 3.3b: Wall Mount



# 4. APPLICABILITY AND SIZING

## 4.1 PIVOT ARM AWNINGS

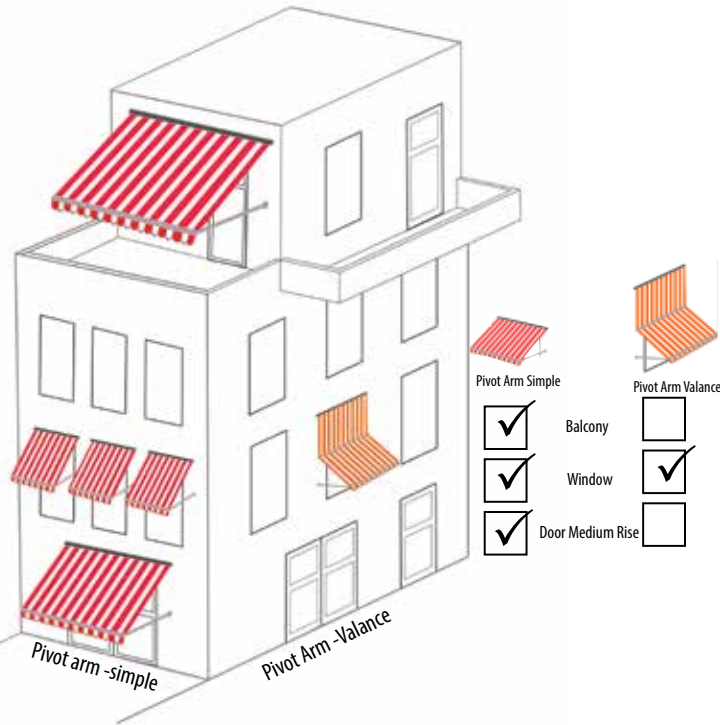


Fig. 4.1a: Applicability of Awning based on Building Component

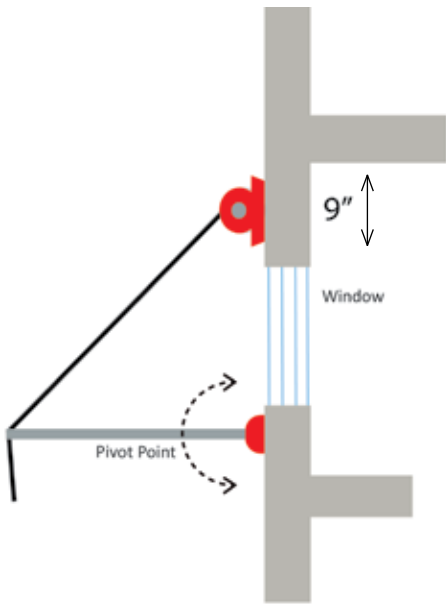


Fig. 4.1b: Mounting Space

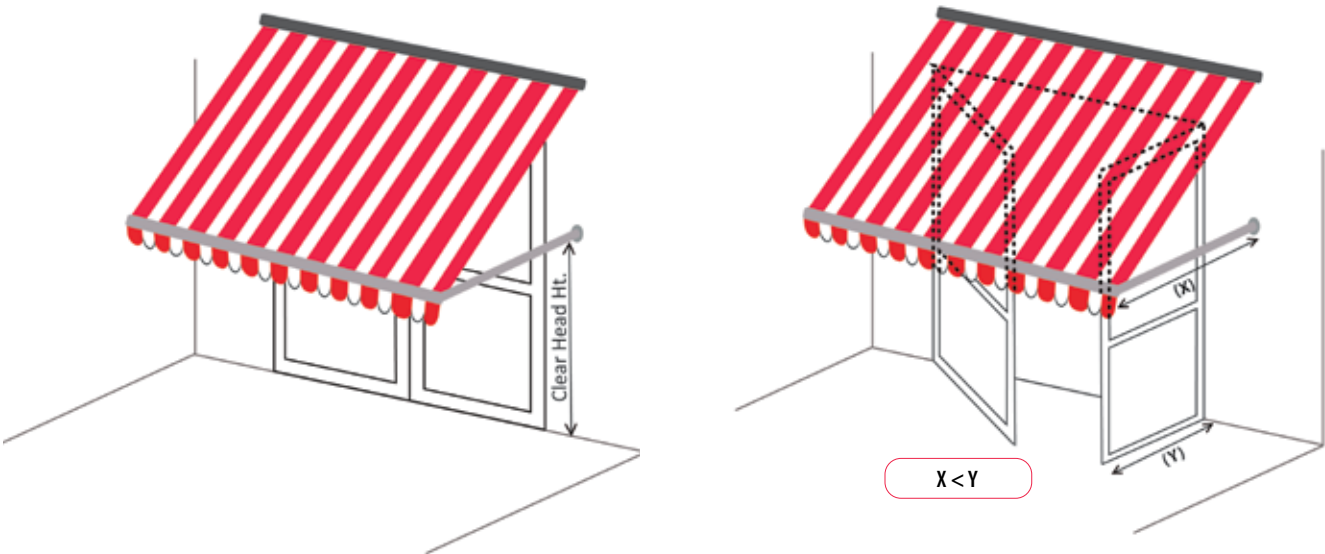


Fig. 4.1c: Optimum Sizing

## 4.2 QUARTER-ROUND AWNINGS

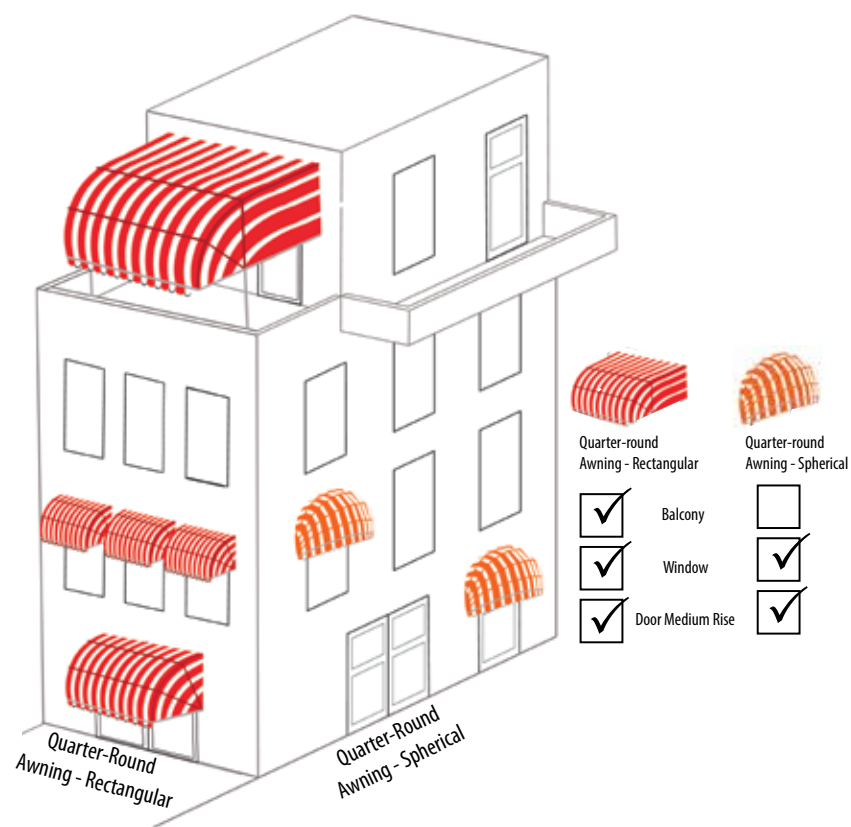


Fig. 4.2a: Applicability based on Building Component

### 4.2.1 MOUNTING SPACE

Outdoor mounting access required.

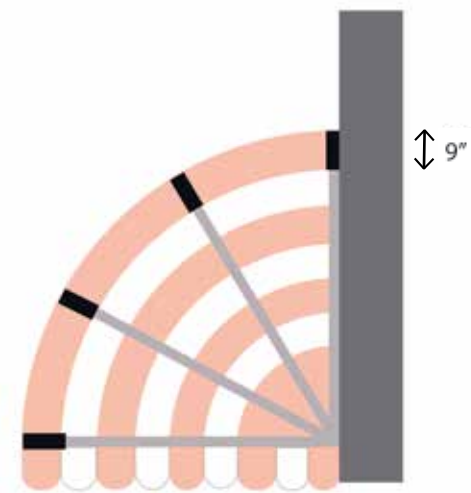


Fig. 4.2b: Mounting Space

### 4.2.2 SIZING

The height of the awning should be half the height of the window.

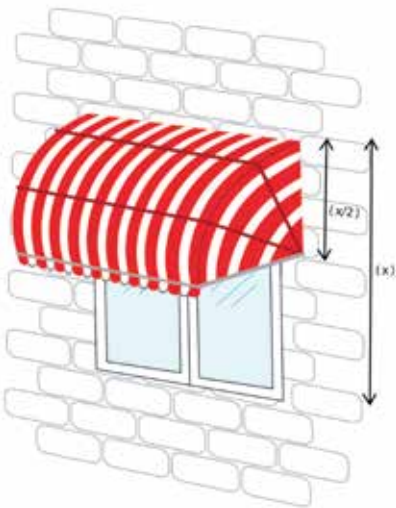


Fig. 4.2c: Sizing of Awning with respect to the Window

## 4.3 CUSTOMISABLE SIZING

The height of the awning can be compressed to maximum half the projection length.  $X \geq Y/2$



Fig. 4.3a Side View of Quarter-Round Foldable, Rectangular Awning

For large spans, the awning can be extended by a combination of fixed and re-tractable awning.



Fig. 4.3b Perspective View of Quarter-Round Foldable, Rectangular Awning

## 4.4 FOLDABLE ARM AWNINGS

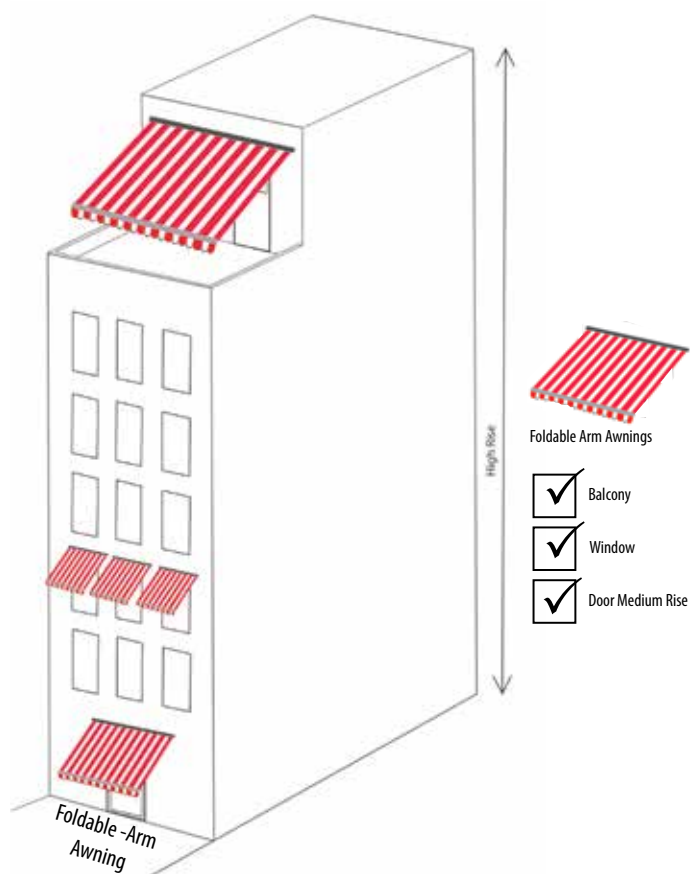


Fig. 4.4a: Applicability based on Building Component

Outdoor mounting access required.

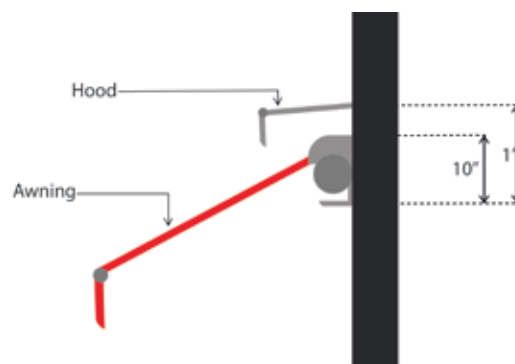


Fig. 4.4b: Mounting Space

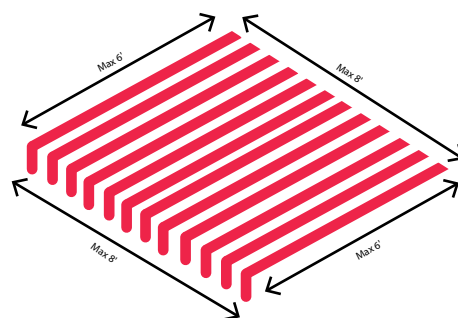


Fig. 4.4c: Sizing (Sizing varies based on the manufacturer.)

## 5. CASE STUDY

### 5.1 PIVOT ARM AWNINGS

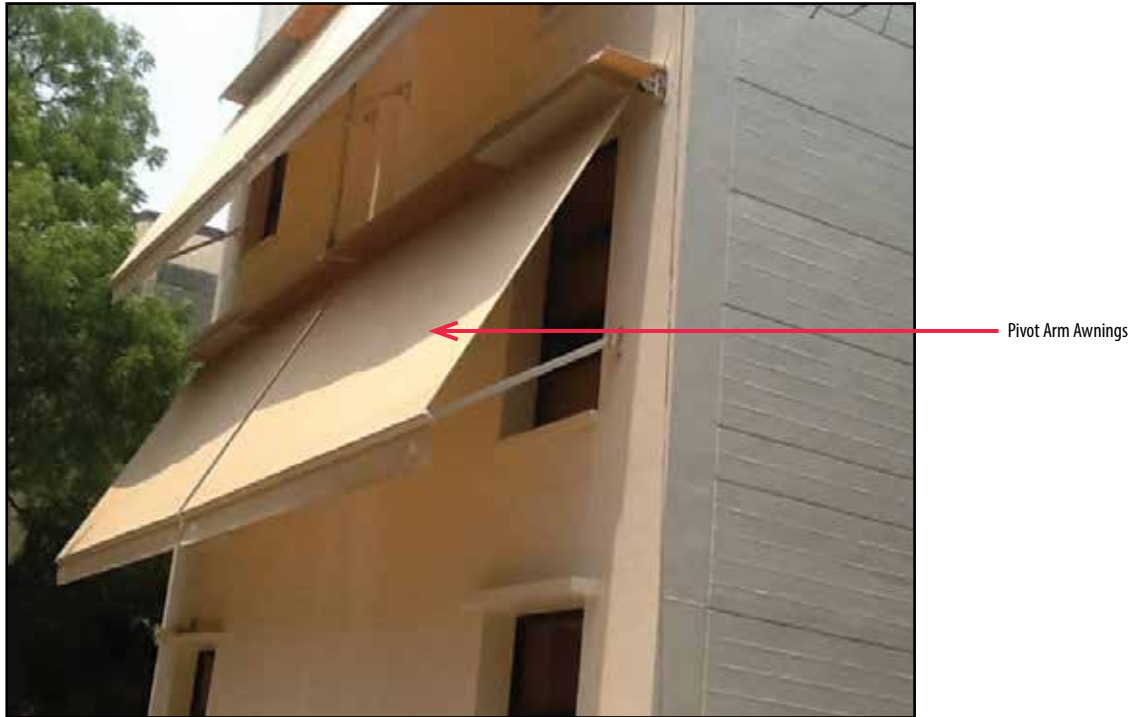


Fig. 5.1: Pivot Arm Awnings: Private Residence, New Delhi

### 5.2 QUARTER-ROUND AWNINGS



Fig. 5.2: Pivot Arm, Quarter-round Fold (Spherical and Rectangular) Awnings: Private Residence, New Delhi



### 5.3 FOLDABLE ARM AWNINGS



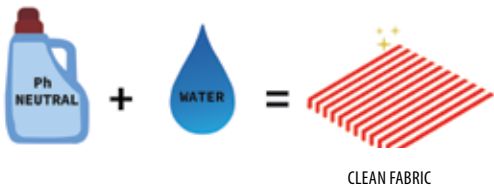
Foldable Arm Awning

Fig. 5.3: Foldable Arm Awnings: Private Residence, New Delhi

## 6. MAINTENANCE

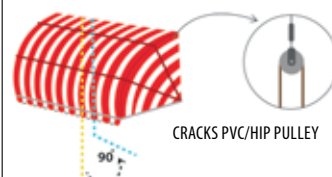
₹ 90/50 ft<sup>2</sup>

Cost of the pH neutral detergent: ₹ 90/50 g at the frequency of 3-4 months.



₹400/50 ft<sup>2</sup>

The manual pulley system can break or crack if not operated at 90 degrees. The system needs to be replaced after four or five years.



PVC joints and hinges at the corner can crack in hot and humid climate.

₹ 2000/50 ft<sup>2</sup>

Special Coated Fabric for Chemical Cleaning

Cost of the cleaning solution: ₹ 2000/8 ounces depending upon the dirt accumulated.



₹ 100-300/50 ft<sup>2</sup>



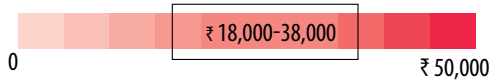
If water accumulates in the awning fabric, it can cause irreversible fabric stretching, which may result in the replacement of the fabric.



#### Motorisation:

All awnings can be motorised.  
and automated as per user preference.

Additional Cost for Motorisation (₹/piece):



#### Retrofitting:

EMSyS retractable awnings can be retrofitted.



#### Overheating in Motor:

Usage of the motor extensively (i.e., extracting and re-tracting awning alternatively without any break) can cause the motor to heat up and stop working temporarily, till the motor cools down.

## 7. KEY FEATURES/BENEFITS

### 7.1 PIVOT ARM AWNINGS

Stays taut in all positions preventing water pooling.



Fig. 7.1a: Protects from Rain

Allows ventilation while covering the complete elevation of the window.

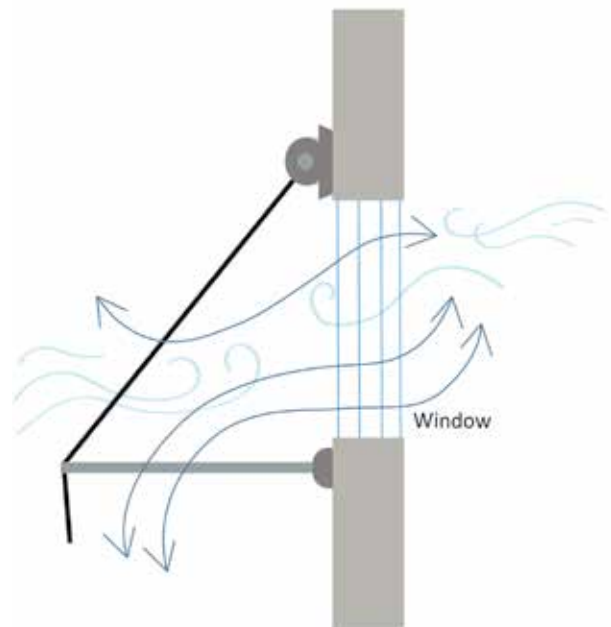


Fig. 7.1b: Natural Ventilation Capability of the Awning

## 7.2 QUARTER-ROUND AWNINGS

1. Gives a three-sided protection from the sun and rain.
2. It can be made leakproof by applying a silicon layer at the joint of the awning and the wall.

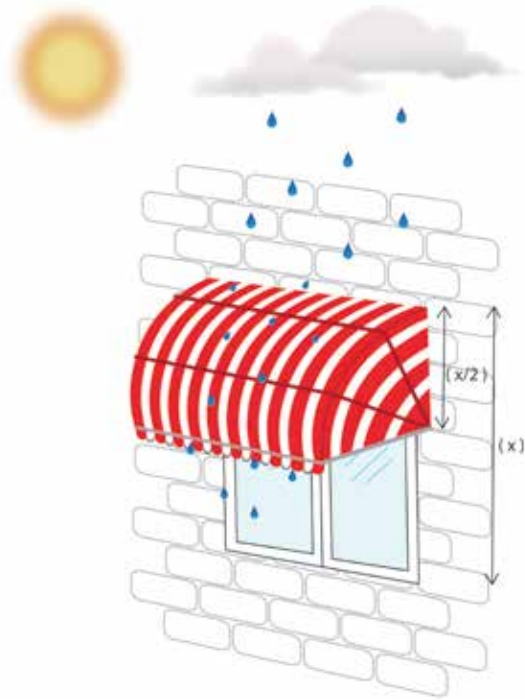


Fig. 7.2: Protects from Rain and Sun

## 7.3 FOLDABLE ARM AWNINGS

1. Perfect solution for large span shading.
2. Its slope is adjustable from  $0^\circ$  to  $45^\circ$  (approx).
3. Provides privacy as per requirement.

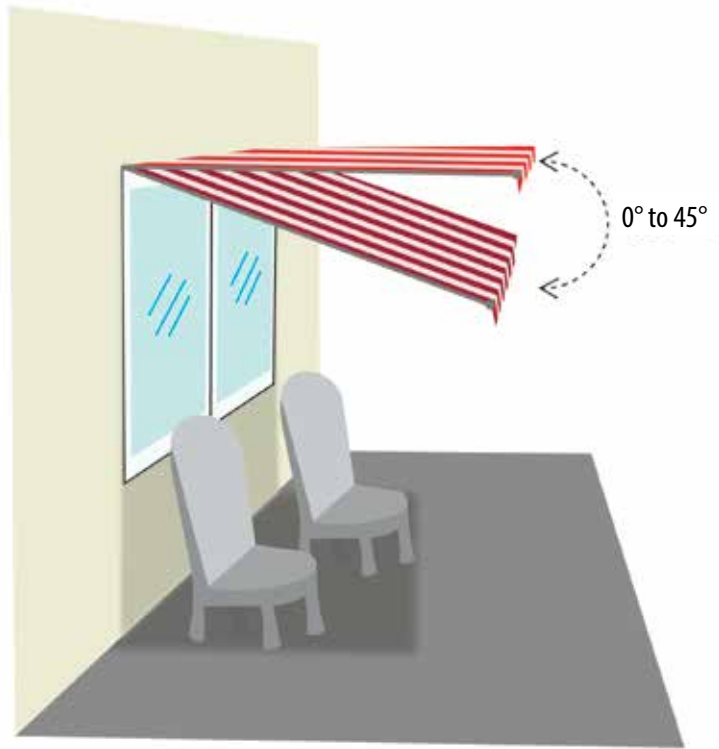


Fig. 7.3: Adjustable Pitch

## 8. ACCESSORIES

In case of no direct structural protection, a hood is installed to protect the awning.

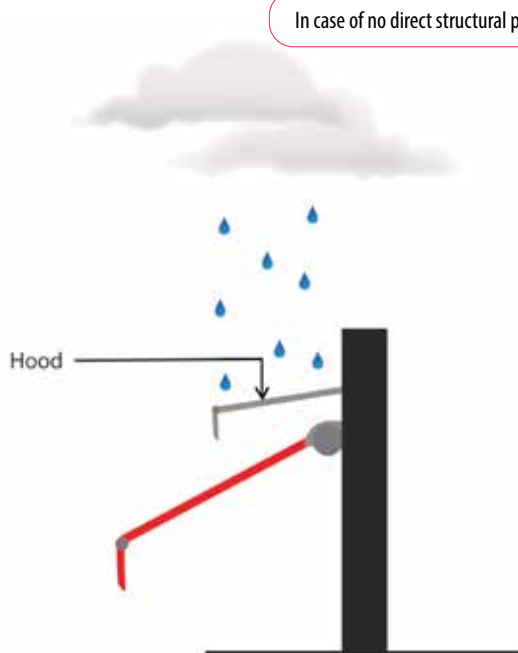


Fig. 8a: Awning with Hood



Fig. 8b: Awning without Hood





# **VERTICAL SCREENS**

Composed of fabric that provides solar protection by folding or rolling vertically up and down over the glazed surface of the opening

## SOLAR HEAT GAIN COEFFICIENT

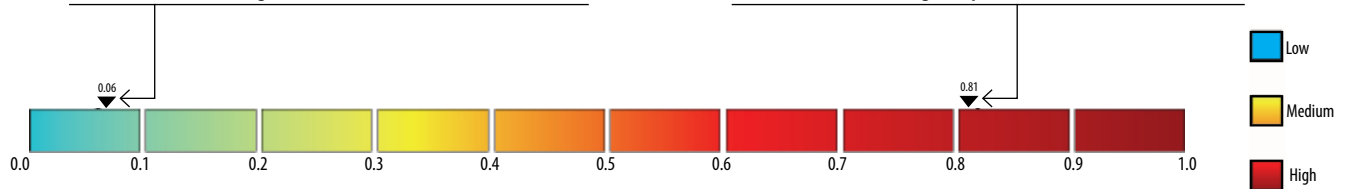
### CLUTCH ROLLER BLIND CASSETTE TRACK-GUIDED



Fig. A: Closed Position



Fig. B: Open Position



## ANATOMY OF A VERTICAL SCREEN

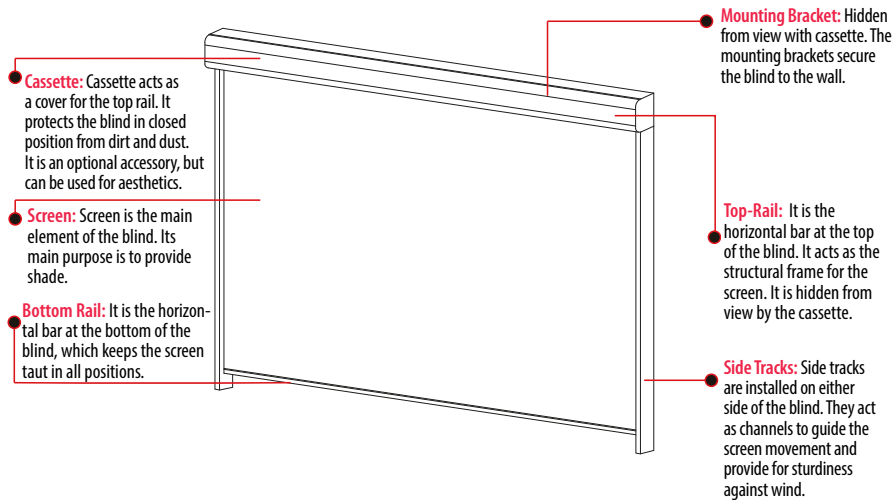


Fig. C: Anatomy of a Vertical Screen

## MATERIAL

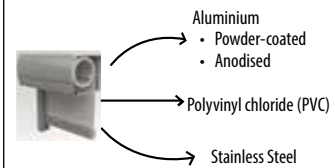


Fig. D: Options for Vertical Screens Frame

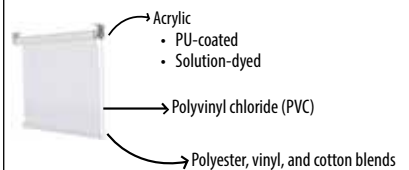
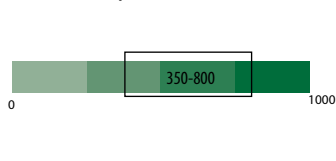
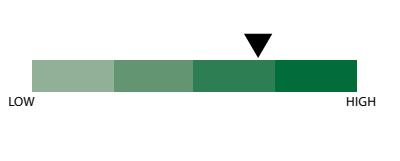


Fig. E: Options for Vertical Screens Panel

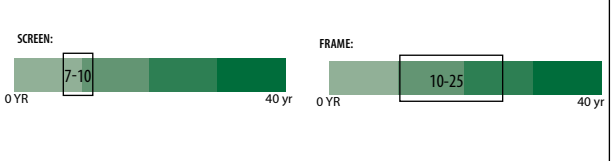
## COST (₹/sq.ft)



## WIND TOLERANCE



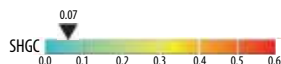
## LIFESPAN



\* The SHGC of the product is dependent on its material properties.

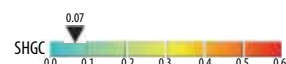
# 1. TYPES OF VERTICAL SCREENS

## 1.1 CLUTCH ROLLER BLINDS



It has the screen rolled-up on the top rail. The bottom rail scrolls up or down with the help of a guiding system to open or close the blinds.

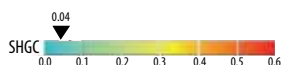
Fig. 1.1a: Clutch Roller Blinds - Simple



It has a cassette installed on its top rail for the protection of the shade, where there is no immediate projection over the shade or for aesthetic purpose.

Fig. 1.1b: Clutch Roller Blinds - Cassette

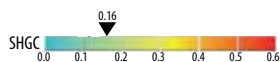
## 1.2. VENETIAN BLINDS



Instead of a screen, these blinds have equally spaced horizontal slats, which can be stacked up with the top rail to close the blind. Additionally, they come with a wand, which can be employed to rotate the slats at desired angles with respect to the angle of sun's rays.

Fig. 1.2: Venetian Blinds

## 1.3 OUTDOOR CURTAINS



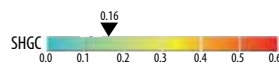
Curtains provide shading by their sliding and folding motion. They are usually suspended by a horizontal rod or channel.

Fig. 1.3: Outdoor Curtain

## 1.4 ROMAN FOLD BLIND



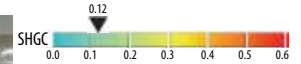
Fig. 1.4a: Roman Fold Blind - Simple



The blind is sub-divided into multiple horizontal panels. When the cord strings are pulled, the blind folds up by forming overlapping pleats of the fabric.



Fig. 1.4b: Roman Fold Blind - Sealed Panels

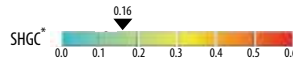


These Roman Blinds have each pleat installed as a separate panel, which can be replaced if damaged, prolonging the life of the blind.

## 1.5 ROLL-UP BLINDS



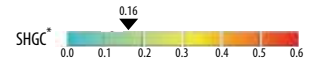
Fig. 1.5a: Roll-up Blinds - Simple



The top rail of a roll-up blind acts like a frame to anchor the screen. The bottom rail is used to roll the screen up or down.



Fig. 1.5b: Roll-up Blinds - Fixed Valance



A roll-up blind with fix valance has an additional valance screen, which is suspended to hide the cord. It acts as the locking mechanism.

## 2. WORKING MECHANISM

### 2.1 CLUTCH ROLLER BLINDS

A clutch roller blind has the screen wrapped on the top rail of the blind. It provides shade by increasing the suspension length of the screen, which unrolls from the top rail. In close position, the screen is completely wrapped on the top rail.

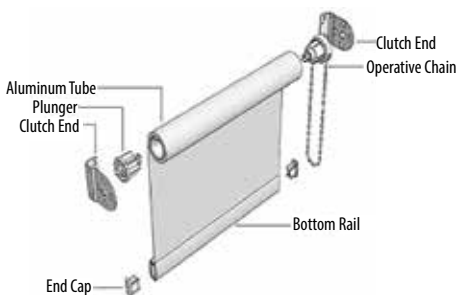


Fig. 2.1a: Components of Clutch Roller Blind

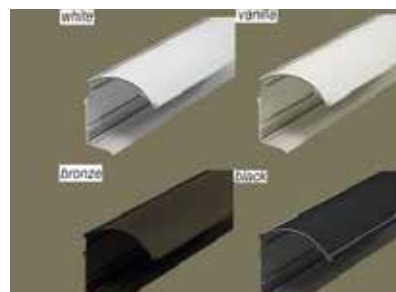


Fig. 2.1b: Cassette Designs

### 2.1.1 Clutch Roller Blinds (Simple) - Compatible Track Types

1. Cord String Guided ( Simple) - As explained in the Roman fold blinds section. (Refer 2.4.1)
2. Crank Shaft Operated (Simple) - As explained in the Roman fold blinds section. (Refer 2.4.1)
3. Cord String Guided (Cable Guided) - Similar to a simple cord string blind, these blinds have side cable as tracks to guide the blind and prevent it from blowing along the wind.
4. Crank Shaft Operated (Cable Guided) - Similar to a simple crank shaft operated blind, these blinds have side cable as tracks to guide the blind and prevent it from blowing along the wind.



Fig. 2.1.1a: Crank Shaft



Fig. 2.1.1b: Cable Anchored to Floor

### 2.1.2 Clutch Roller Blind (Cassette)

1. Track Guided Systems:  
Track guides have side channels as guiding tracks, in which the screen moves up and down. These tracks are preferred for motorised blinds as it makes the functioning easier.
2. Zipper Track Guided Systems:  
Similar to track-guided systems, Zipper tracks have a zipper installed in the track. The blind zips and unzips in the tracks when rolled up and rolled down.



Fig. 2.1.2a: Clutch Roller Blind with Side Track Guides



Fig. 2.1.2b: Zipper Track

## 2.2 VENETIAN BLINDS

Venetian blinds have horizontal slats. When the strings are pulled down, all the slats start to stack upwards and lift the blinds up.

The blinds have a two-cord system:

1. One cord is used to move the blind vertically.
2. The other cord is used for rotating the slats.

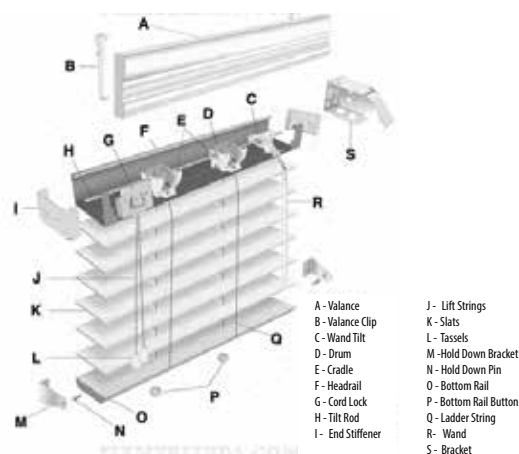


Fig. 2.2: Components of a Venetian Blind

## 2.3 OUTDOOR CURTAINS

Outdoor curtains have two types of suspension systems.

1. Rod based.
2. Channel based.



Fig. 2.3a: Outdoor Curtain



Fig. 2.3b: Curtain Channel

## 2.4 ROMAN FOLD BLIND

A Roman Fold Blind is sub-divided into multiple horizontal panels. Each panel is connected to the inner ring in two positions.

1. In the closed position, the cold string is pulled to make the panel fold to half its length and overlap with the panel above it.
2. In the shading position, the cold string is let loose so that the panel opens to its full length one by one.

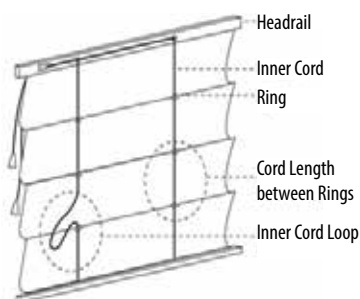


Fig. 2.4a: Components of Roman Fold Blind



## 2.4.1 COMPATIBLE TRACK TYPES FOR CLUTCH ROLLER BLINDS (SIMPLE AND CASSETTE)

### Cord String Guided – simple

The cord string and the screen are attached to the rotating tube of the top rail. As the cord is pulled from alternative ends, it rolls up or down the blind's screen, as the case may be.



Fig. 2.4b: Cord String Guided Blind

### Crank Shaft Guided – simple

A simple rod (crank shaft) is used to roll the blind up and down. The crank shaft is plugged into the top rail with the help of a hook. The rotation of the crank shaft in alternative direction results in the opening and closing of the blind.



Fig. 2.4c: Crank Shaft Operated Blind

## 2.5 ROLL-UP BLINDS

### 2.5.1 STRING AND PULLEY SYSTEM

In the string and pulley system, the string is attached to the bottom rail through the pulley. Pulling and releasing the string make the blind open and close, respectively.



Fig. 2.5a: Roll-up Blinds - Simple

### 2.5.3 ROLL-UP BLINDS: FIX VALANCE

A Roll-up Blind with fix valance has an additional valance screen. This screen is suspended to hide the cord, which works as a locking mechanism.



Fig. 2.5b: Roll-up Blinds – Fix Valance

### 2.5.2 ROLL-UP BLINDS : SIMPLE

A Roll-Up Blind's top rail acts like a frame to anchor the screen. The bottom rail is used to roll the screen up or roll it down.

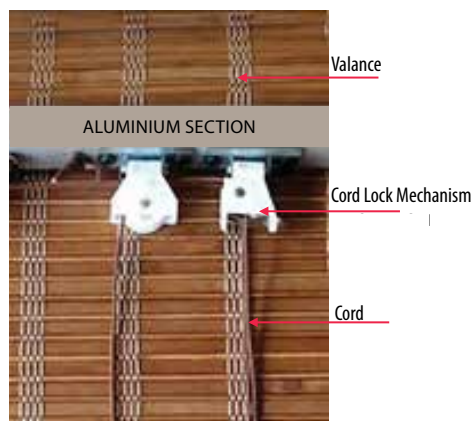


Fig. 2.5c: Cord Locking Mechanism

### 2.5.4 CORD LOCKING MECHANISM

The cord lock installed on top of the blind enables locking the cord of the blind at any desired position.



### 3. ANCHORING MECHANISM

#### 3.1 CLUTCH ROLLER BLINDS AND VENETIAN BLINDS

##### 3.1.1 ANCHORED TO THE WALL

The top rail is anchored to the wall with the help of fasteners. Hence the blind is anchored just above the window (see figure on the left).

A clutch blind with side tracks would require space on the ground or wall for fixing Venetian Blind and a clutch roller blind (simple) can be anchored to the door in a similar manner.

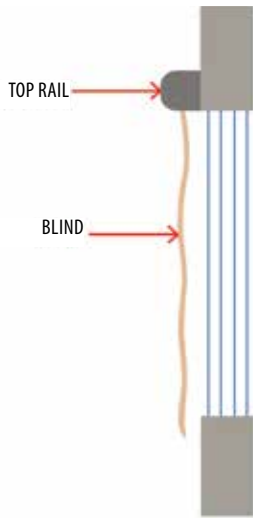


Fig. 3.1a: Blind Anchored on Wall



Fig. 3.1b: Clutch Blind with Side Tracks

#### 3.2 ANCHORED TO THE CEILING

The top rail is anchored to the soffit of the ceiling with fasteners or hooks. Hence the blind is anchored in Clutch blind with side tracks require side fixing (see image 3.2b).

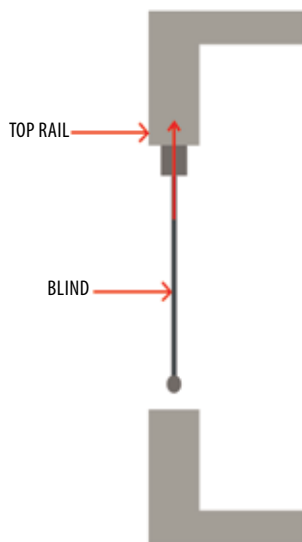


Fig. 3.2a: Blind Anchored on Ceiling



Fig. 3.2b: Clutch Blind with Side Tracks



### 3.3 OUTDOOR CURTAINS

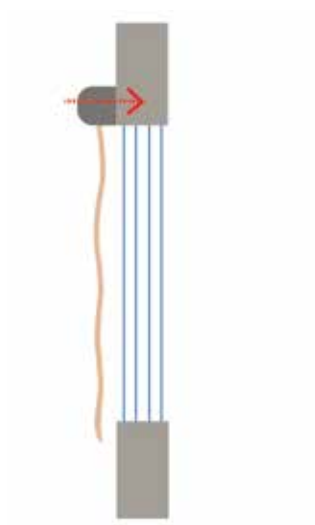


Fig. 3.3a: Anchored to the Wall

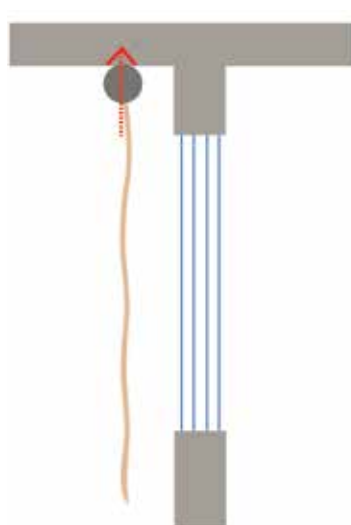


Fig. 3.3b: Anchored to the Ceiling

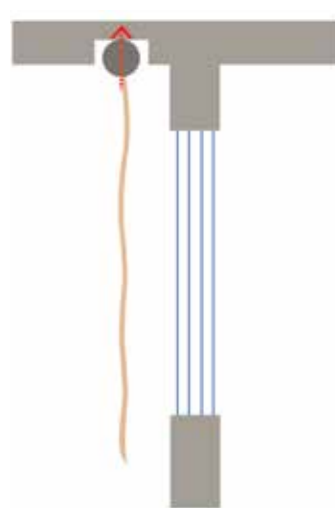


Fig. 3.3c: Anchored with Hidden Channels to the Ceiling

### 3.4 ROMAN FOLD BLINDS AND ROLL-UP BLINDS

Roll-up and Roman Blind's top rails function as the anchoring member. These blinds can be anchored in the following ways:

#### Anchored to the Wall

The top rail is anchored to the wall with the help of fasteners. Hence the blind is anchored just above the window.

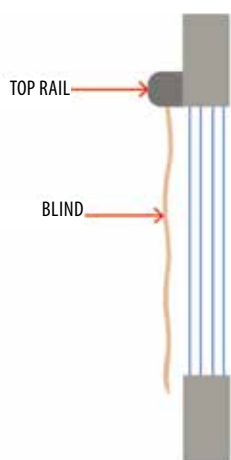


Fig. 3.4a: Blind Anchored on Wall

#### Anchored to the Ceiling

The top rail is anchored to the top of the ceiling with fasteners or hooks. Hence the blind is anchored in level with the window frame.

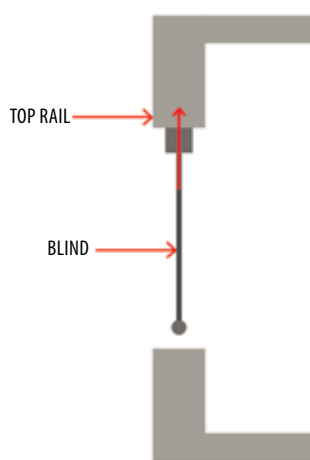


Fig. 3.4b: Blind Anchored on Ceiling

#### Anchored to the Shutter

The blinds can be anchored to the shutter frame, like in the case of a door. The top rail of the blind is anchored to the top rail of the door.

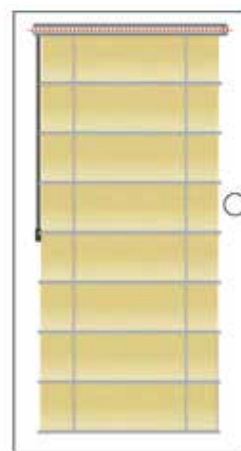


Fig. 3.4c: Anchored on Shutter

## 4. APPLICABILITY AND SIZING

### 4.1 CLUTCH ROLLER BLINDS

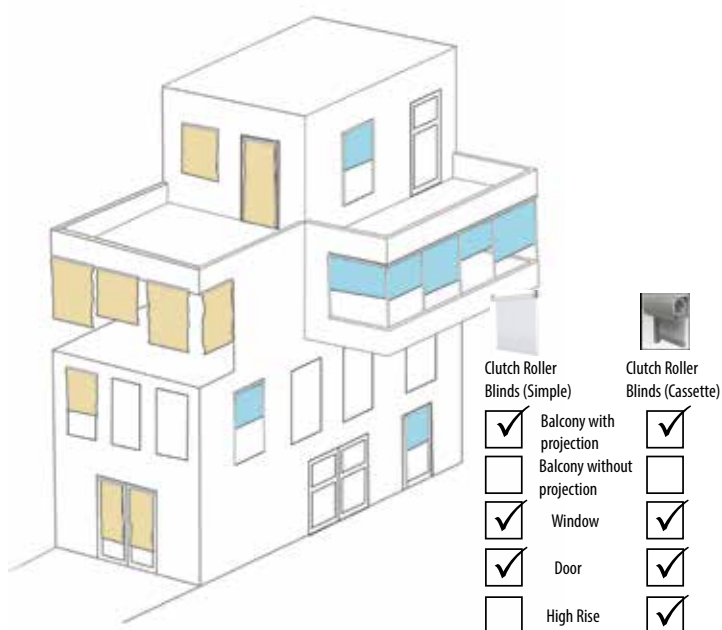
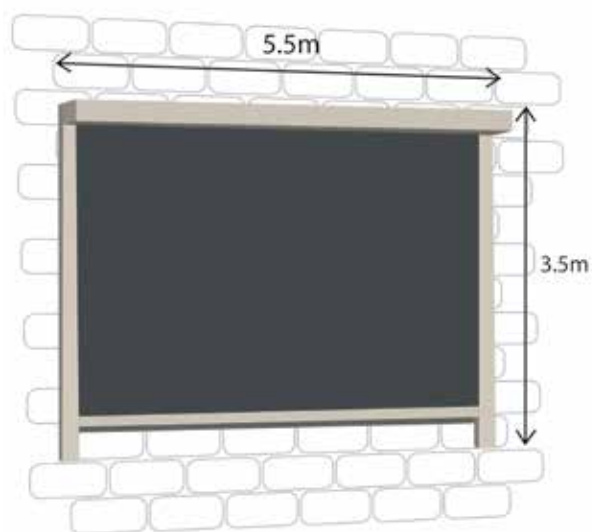


Fig. 4.1a: Applicability based on Building Component



The maximum size of blinds varies with the choice of fabric.

Fig. 4.1b: Sizing (Sizing may vary depending on the manufacturer.)

### 4.2 VENETIAN BLINDS

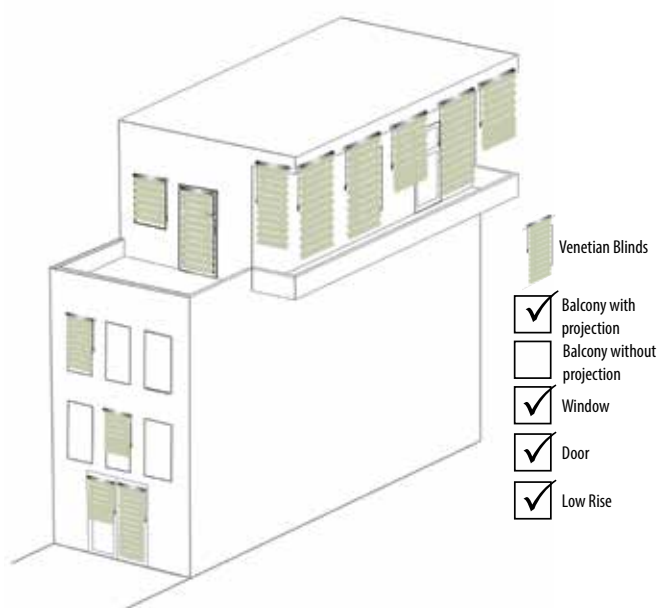
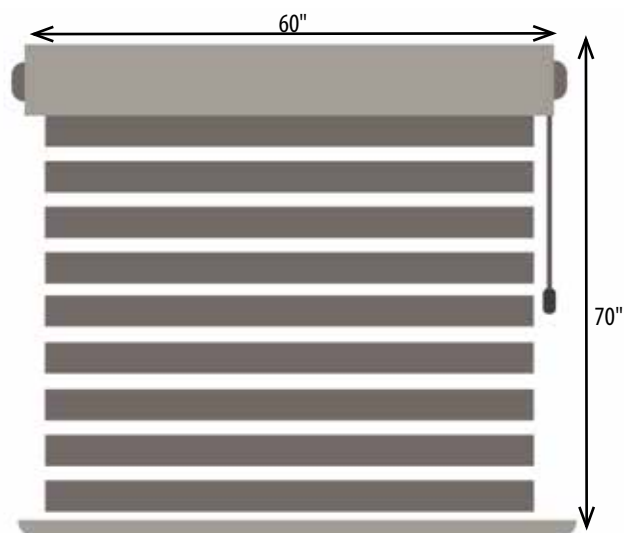


Fig. 4.2a: Applicability based on Building Component



Venetian blinds come in various slat depths; the maximum dimensions of blinds vary accordingly.

Fig. 4.2b: Sizing (Sizing may vary depending on the manufacturer.)

## 4.3 OUTDOOR CURTAINS

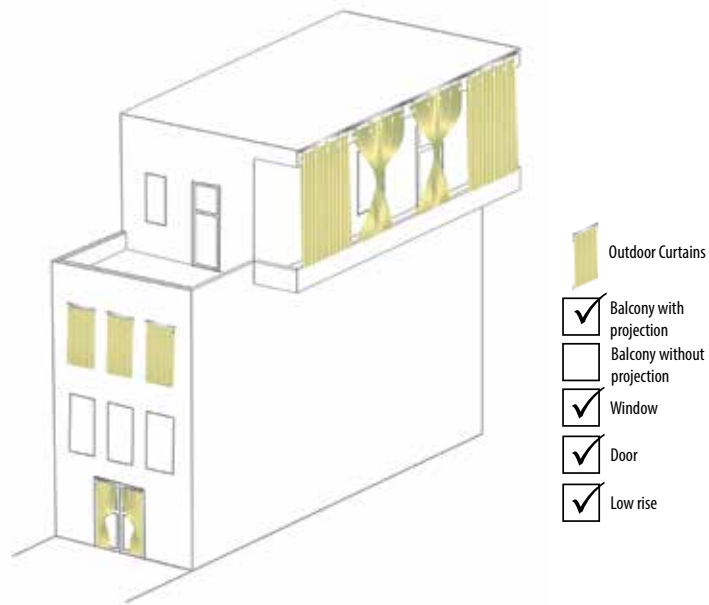


Fig. 4.3: Applicability based on Building Component

## 4.4 ROMAN FOLD BLINDS

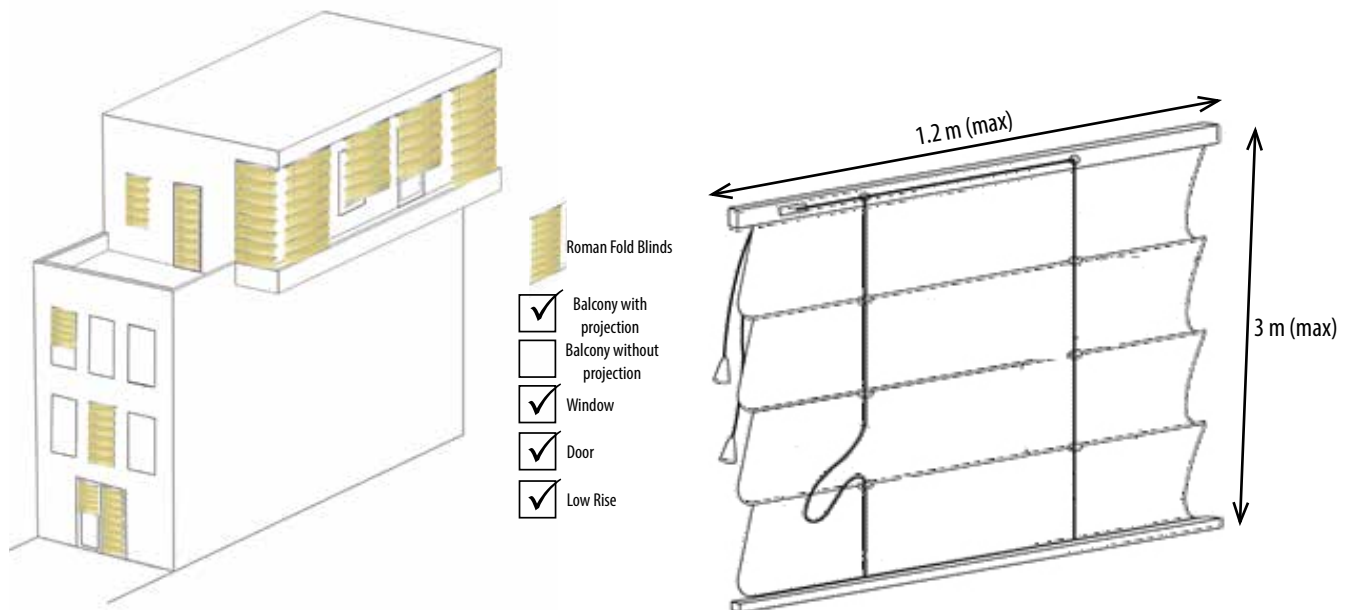


Fig. 4.4a: Applicability based on Building Component

Fig. 4.4b: Sizing (Sizing may vary depending on the manufacturer.)

## 4.5 ROLL-UP BLINDS

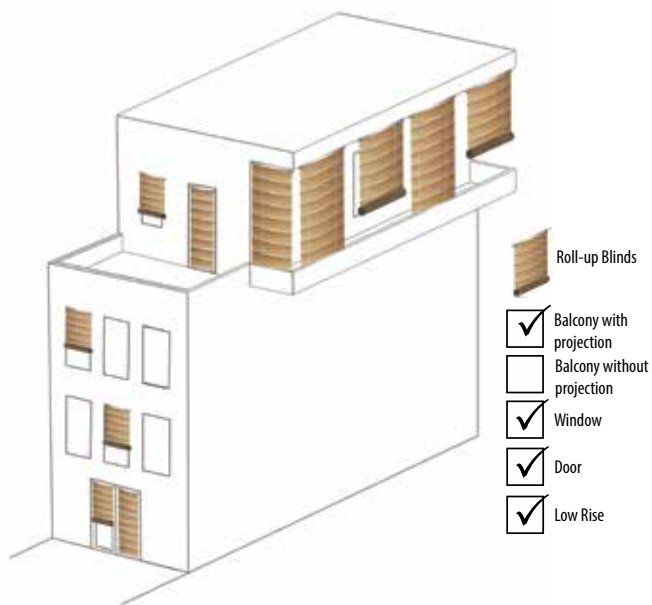


Fig. 4.5a: Applicability based on Building Component

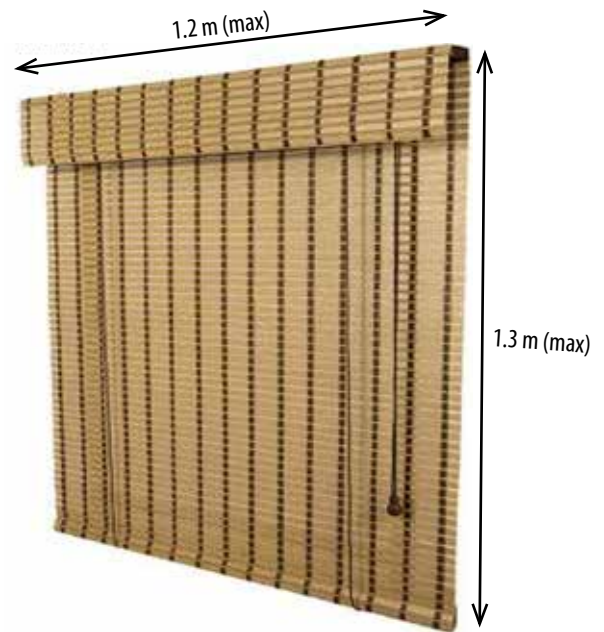


Fig. 4.5b: Sizing (Sizing may vary depending on the manufacturer.)

## 5. CASE STUDY

### 5.1 CLUTCH ROLLER BLINDS



Fig. 5.1: Private Residence at Chennai

### 5.2 VENETIAN BLINDS



Fig. 5.2: Bengaluru, Karnataka

### 5.3 ROMAN FOLD BLINDS



Roman Fold Blinds

Fig. 5.3: Verandah View of a Private Residence

### 5.4 ROLL-UP BLINDS



Roll-Up Blinds

Fig. 5.4: Verandah View of a Private Residence

## 6. MAINTENANCE

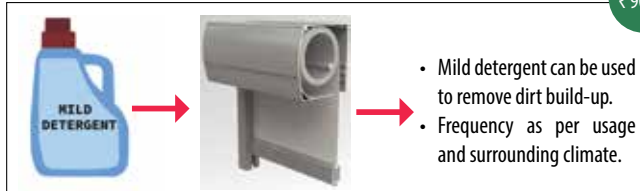
### 6.1 CLEANING OF BLINDS AND CURTAINS

In general, a mild detergent can be used for cleaning all types of blinds and curtains to remove dirt and corrosion-induced rust.

### 6.2 CLUTCH ROLLER BLINDS

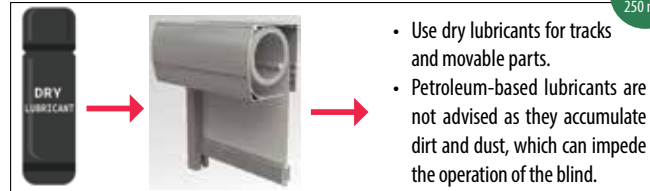
#### MILD DETERGENT

₹ 90/kg



#### DRY LUBRICANT

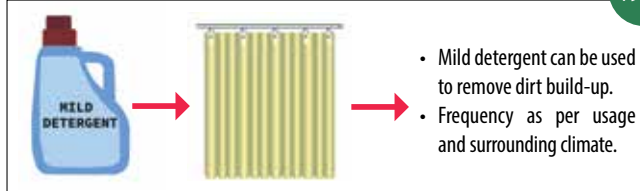
₹ 970/  
250 ml



### 6.3 VENETIAN BLINDS AND CURTAINS

#### MILD DETERGENT

₹ 90/kg



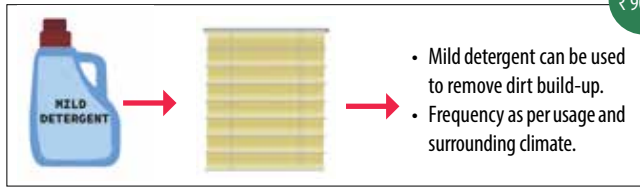
#### VACUUM CLEANING



### 6.4 CLUTCH ROLLER BLINDS

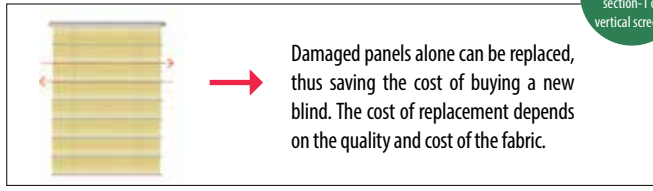
#### MILD DETERGENT

₹ 90/kg



#### REPLACEMENT OF PANEL

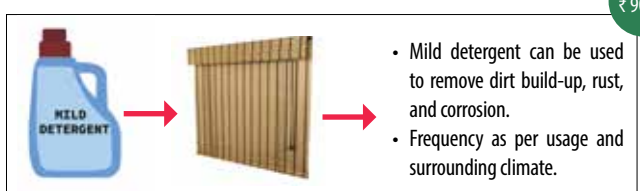
Material plus  
labour cost as per  
section-1 of  
vertical screens



### 6.5 VENETIAN BLINDS AND CURTAINS

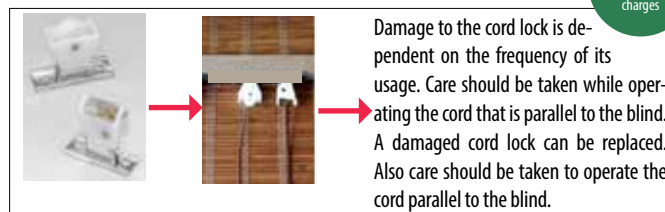
#### MILD DETERGENT

₹ 90/kg



#### REPLACEMENT OF CORD LOCK

Cost of cord  
lock plus labour  
charges

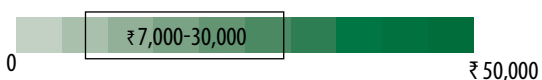


#### Motorisation:

Roman and Roll-up blinds can be motorised and automatised as per the preference of a user.

Roll-up blinds are not motorised usually.

Cost of Motorised Vertical Screens (₹/sq.ft):



Vertical screens can be retrofitted.



## 7. KEY FEATURES/ BENEFITS

### 7.1 CLUTCH ROLLER BLINDS

Zipper tracks are more efficient in windy conditions compared to other vertical screens.



Fig. 7.1: Clutch Roller Blinds

### 7.2 VENETIAN BLINDS

Venetian Blinds reflect diffused daylight in the interior space and create more daylit areas.

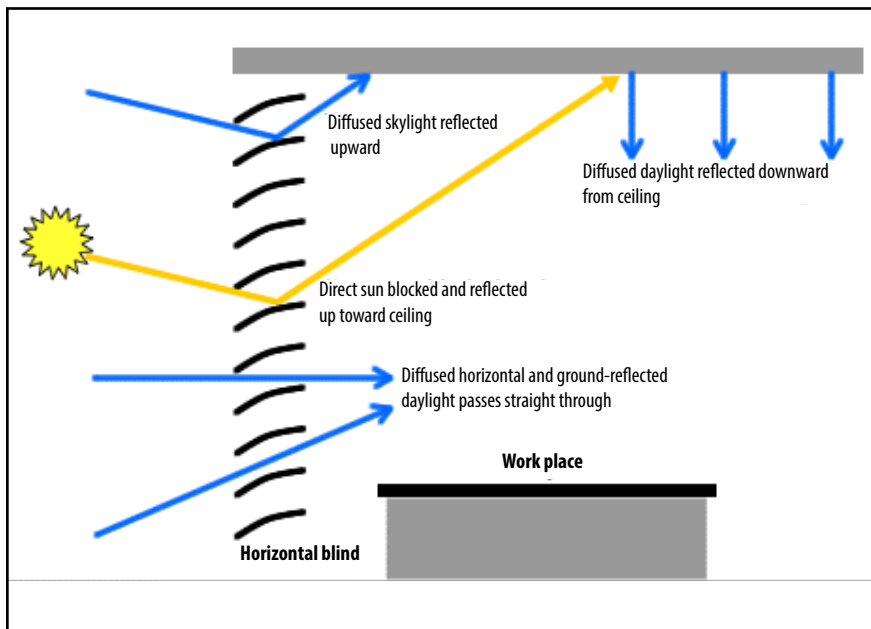


Fig. 7.2: Venetian Blinds



## 7.3 OUTDOOR CURTAINS

As curtains have slits, they let a through-passage even in completely open position.



Fig. 7.3: Outdoor Curtains

## 7.4 ROMAN FOLD BLINDS

1. Each panel can be removed separately without replacing the whole blind.
2. Monsoon blinds are mainly Roman blinds with water-proof screens for the panels.

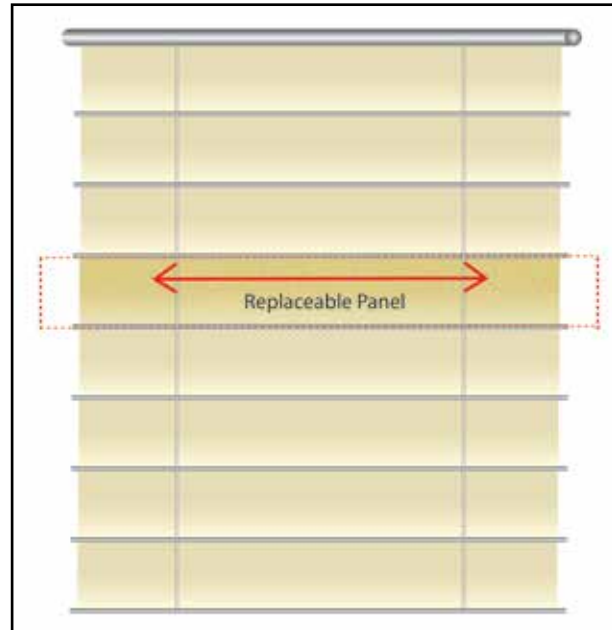


Fig. 7.4: Roman Fold Blinds

## 7.5 ROLL-UP BLINDS

1. The cord-locking mechanism enables easy operation.
2. Roll-up blinds are the most commonly available blinds.
3. Roll-up blinds are available in natural material such as bamboo.

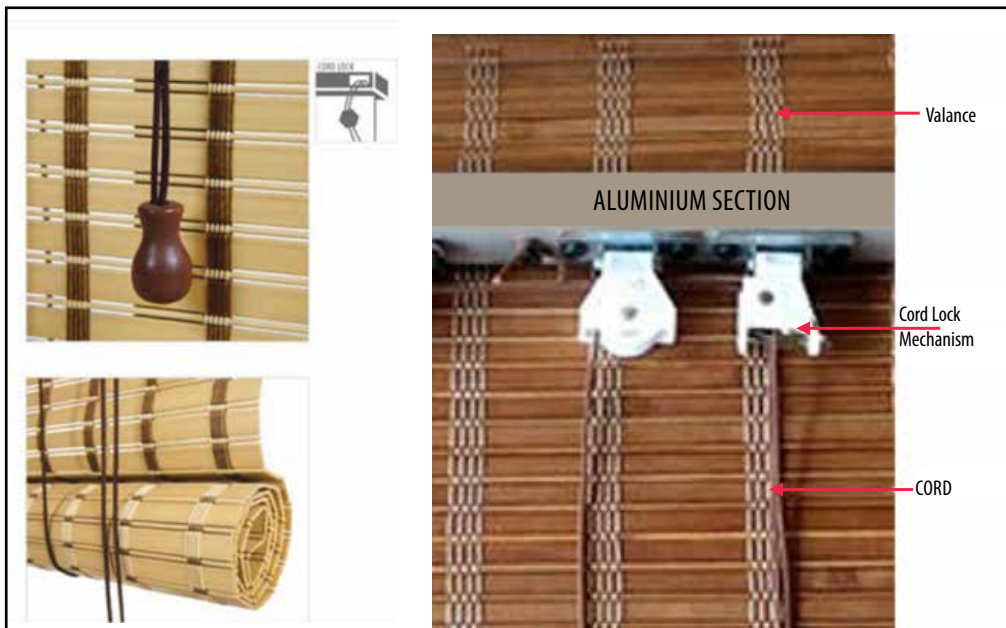


Fig. 7.5: Cord Lock Mechanism



# SHUTTERS

Composed of solid materials such as wood and PVC and are designed as louvers or solid in-fill panels.  
The glass panel of the opening is inside, while the shutter faces the outside.

## SOLAR HEAT GAIN COEFFICIENT

### SHUTTER WITH ADJUSTABLE LOUVER



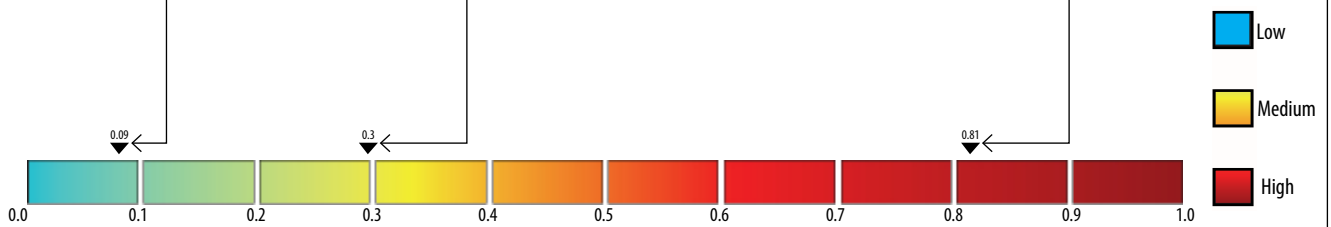
Fig. A: Shutter - Louvers at 0°



Fig. B: Shutter - Louvers at 45°



Fig. C: Shutter - Open State



## ANATOMY OF A SHUTTER

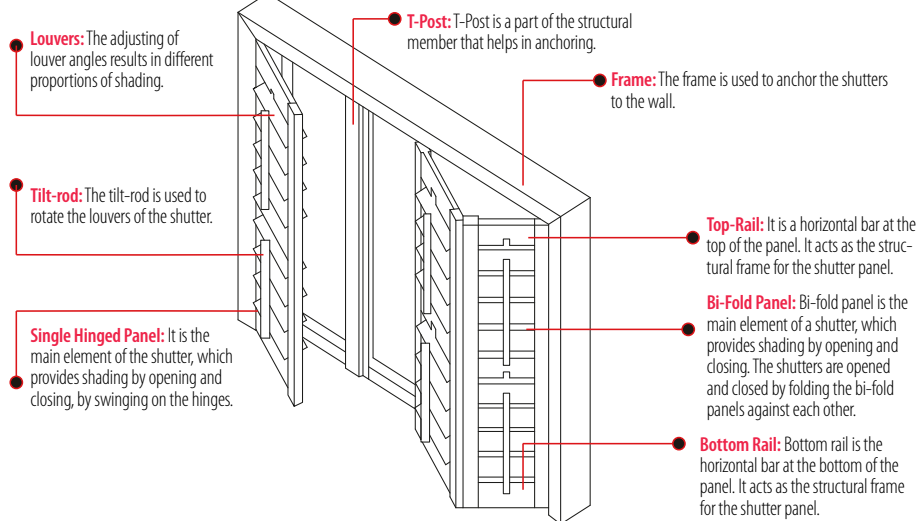


Fig. D: Anatomy of a Shutter

## MATERIAL

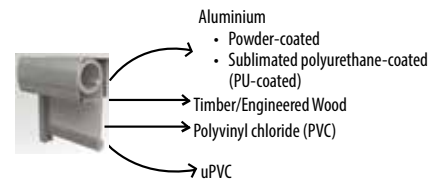


Fig. E: Options for Shutter Frames

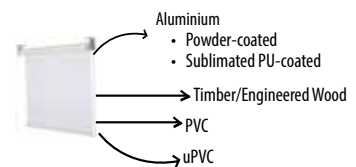
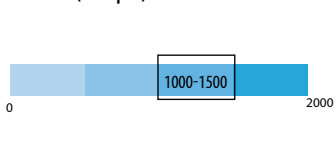
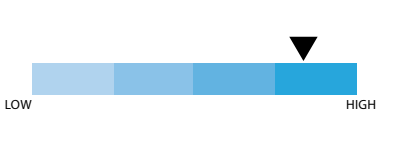


Fig. F: Options for Shutter's Panel

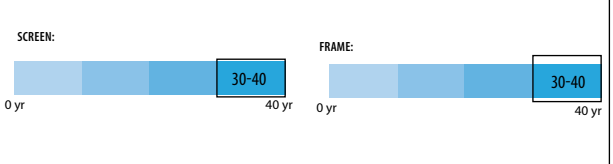
## COST (₹/sq.ft)



## WIND TOLERANCE



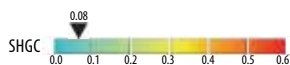
## LIFESPAN



\*The SHGC of the product is dependent on its material properties.

# 1. TYPES OF SHUTTER

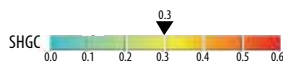
## 1.1 SHUTTERS WITH ADJUSTABLE LOUVERS



An external shutter with rotatable louvers, which operate with the help of an in-built lever or a rod slider.

Fig. 1a: Shutters with adjustable Louvers

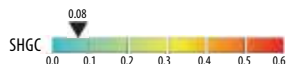
## 1.2 SHUTTER WITH FIXED LOUVERS



An external shutter having fixed louvers.  
The angle of tilt of the louvers can be customised.

Fig. 1b: Shutter with Fixed Louvers

## 1.3 SHUTTER WITH ADJUSTABLE COMBINATION LOUVERS

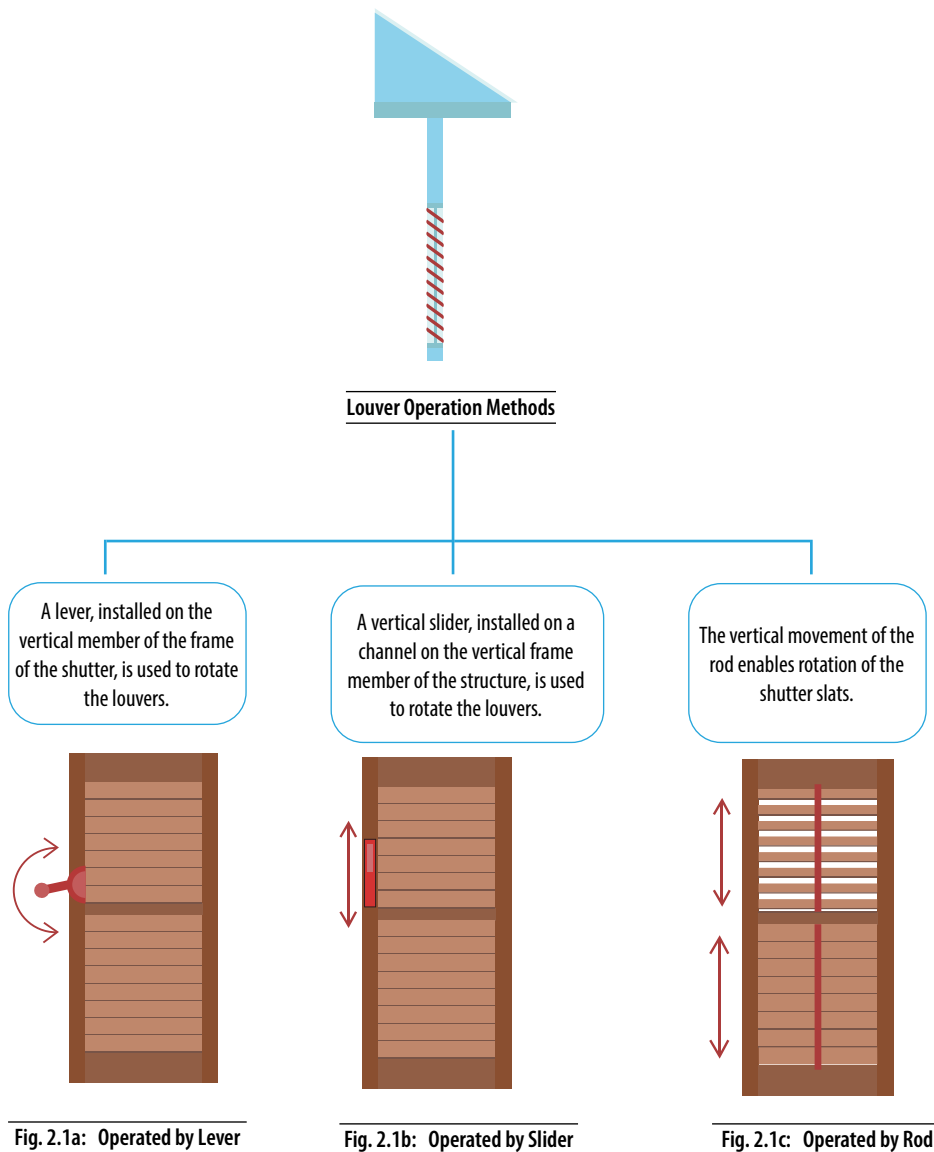


A shutter with alternative sets of louvers, operated with the help of two levers.

Fig. 1c: Shutter with Adjustable Combination Louvers

## 2. WORKING MECHANISM

### 2.1 SHUTTERS WITH ADJUSTABLE LOUVERS



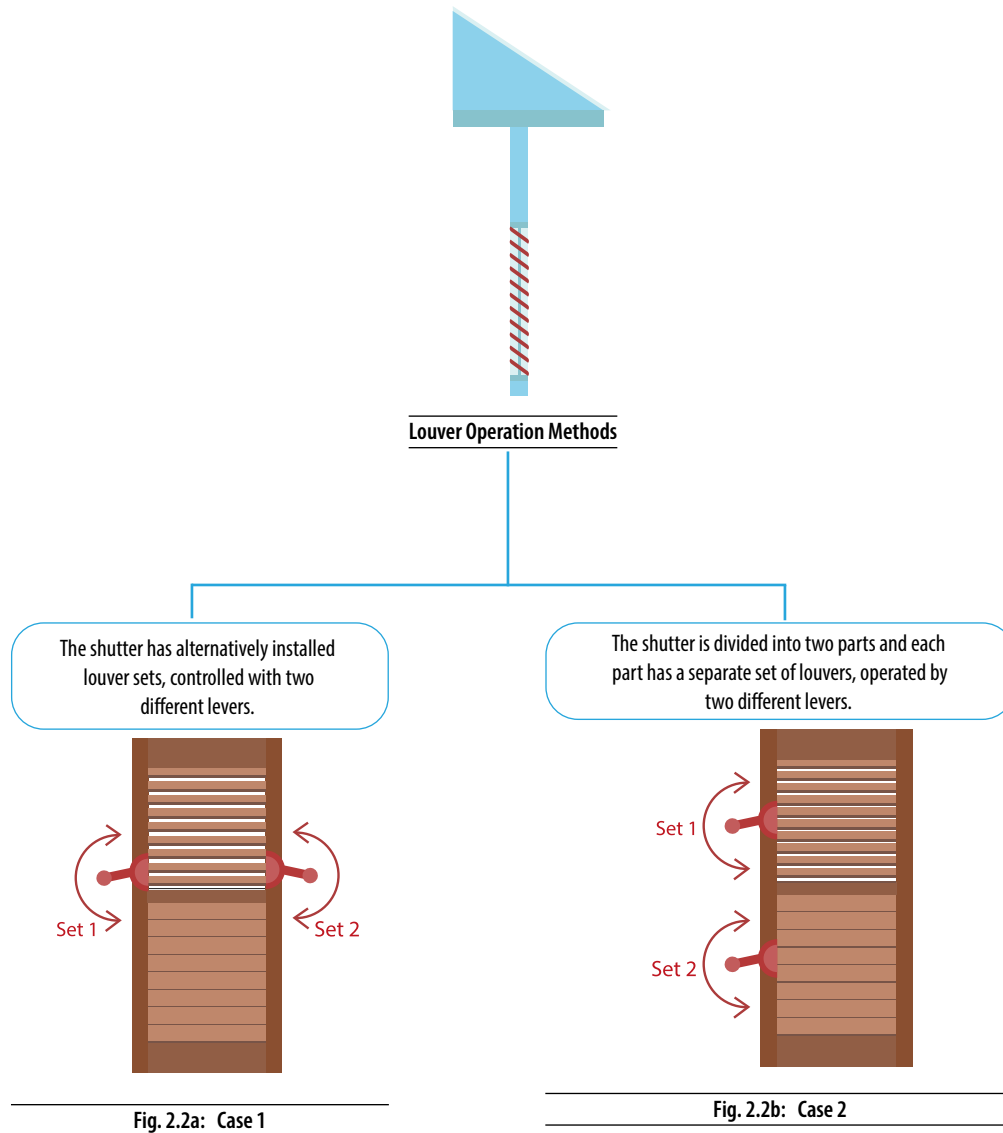
### 2.2 SHUTTERS WITH FIXED LOUVERS

The various opening states of a shutter are used as a dynamic shading state for various angles of the Sun. The common operating shutter methods available are as follows:

1. Sliding Shutter
2. Sliding and Folding Shutter
3. Hinged Shutter
4. Fixed Shutter

## 2.3 SHUTTER WITH ADJUSTABLE COMBINATION LOUVERS

They have two louver sets in a single shutter with the following configuration.



### 3. ANCHORING MECHANISM

---

#### 3.1 ANCHORED FROM TOP AND BOTTOM RAILS

Shutters can be anchored through Frame or channels provided only on top rail or bottom rail or both.

Compatible working mechanisms:

1. Sliding shutter
2. Sliding and folding shutter



Fig. 3a: Anchored from Top and Bottom Rails

#### 3.2 ANCHORED FROM THE VERTICAL MEMBERS OF THE FRAME

The shutter are anchored to the vertical members and usually over a swing opening.

Compatible working mechanism:

1. Side hinged shutter



Fig. 3b: Anchored from the Vertical Members of the Frame



### 3.3 ANCHORED FROM ALL FOUR SIDES OF THE FRAME

The shutter is anchored to all four sides of the frame.  
Compatible working mechanism: Fixed Shutter

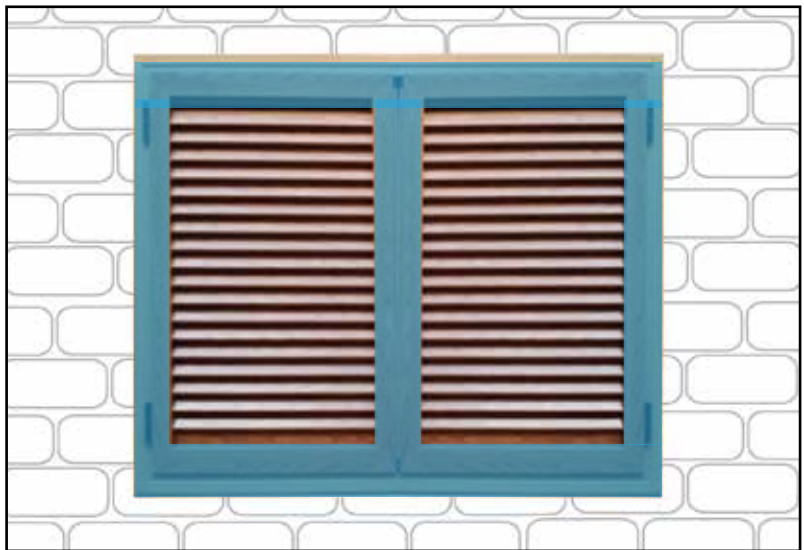


Fig. 3c: Anchored from the Vertical Members of the Frame

## 4. APPLICABILITY AND SIZING

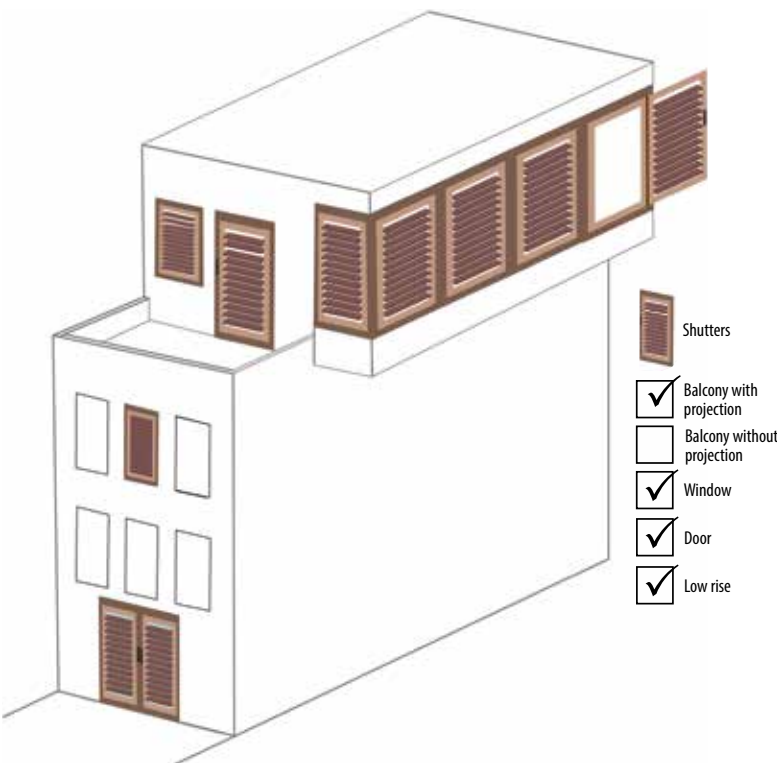


Fig. 4.1a: Applicability based on Building Component

Sizes can be customised, but with limitations that vary depending on the material used. For aluminium louver shutter, the maximum size is 3 x 8 ft.



Fig. 4.1b: Sizing (Sizing varies based on the manufacturer.)

## 5. CASE STUDY



Shutter with Adjustable Combination Louver Window

Fig. 5: Shutter with Adjustable Combination Louver Window in a Private Residence at Ahmedabad

## 6. MAINTENANCE

### 1. Mild Detergent (Rs 90/kg)

Mild detergent can be used to remove dirt build-up, rust, and corrosion. Frequency as per usage and surrounding climate.

₹ 90/kg



### 2. Dry Lubricant (Rs 970/250 ml)

Dry lubricant for louver tracks and blade hinges. Petroleum-based lubricants are not advised as they accumulate dirt and dust, which impedes the operation of the louver. Frequency as per usage and surrounding climate.

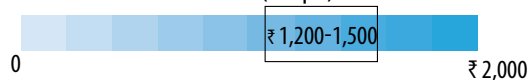
₹ 970/  
250 ml



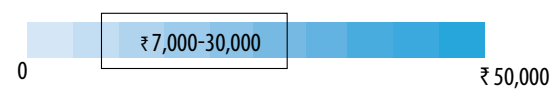
### Motorisation:

All shutters can be motorised and automatised as per the preference of a user.

Cost for Motorised Shutters (₹/sq.ft):

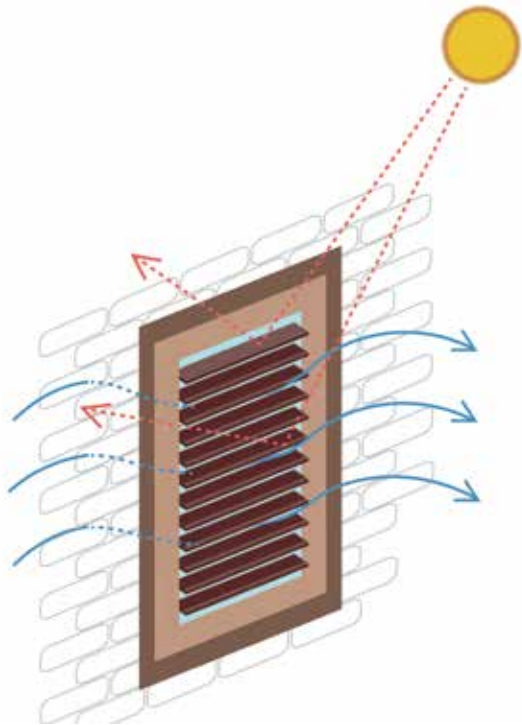


Additional Cost for Motorisation (₹/piece):



EMSys-Shutters can be retrofitted.

## 7. KEY FEATURES/ BENEFITS



1. Allows air circulation while providing shade from direct solar radiation.
2. Provides for a view outside with privacy.
3. Provides for security as the louvers cannot be manually removed from the shutter.

Fig. 6: Louvered Shutters Enable Ventilation while Protecting from the Sun

A few suggestions on how to operate the shutters in different seasons is given below.

For Summer Months

- Preferred louver angles during summer months to block direct solar radiation:  $0^\circ - 90^\circ$
- Preferred louver angle for natural ventilation during night:  $90^\circ$  (perpendicular to the wall)

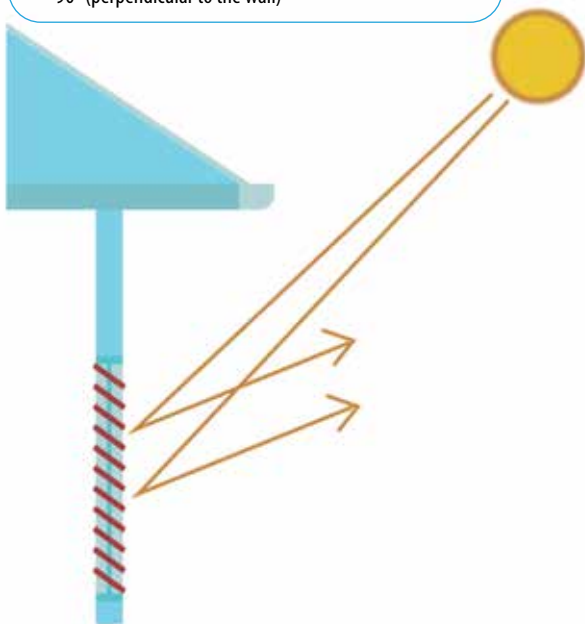


Fig. 7a: Louver Angle for Summer Months

For Winter Months

- Preferred louver angles during winter months to allow direct solar radiation:  $90^\circ - 180^\circ$
- Preferred louver angle to prevent heat loss during night:  $0^\circ$  (parallel to the wall)

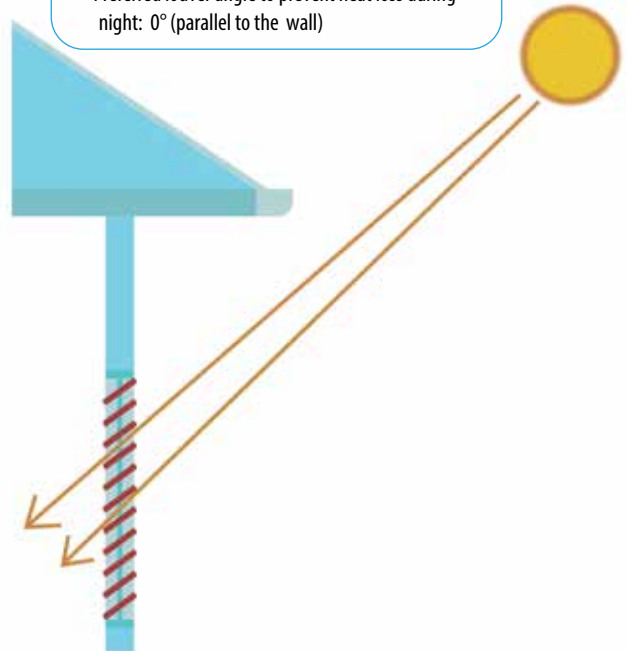


Fig. 7b: Louver Angle for Winter Months

# COMPARISON OF COST VS LIFESPAN

A comparison of the three categories of EMSyS products covered in the manual with reference to their life and initial cost is given in the following graph. The most long-lasting external shading product is an external shutter made out of wood or metal. Though it is the most expensive among the three categories, it is also the best performing product with the lowest solar heat gain coefficient in the closed position and will last almost as long as the building itself. In the case of re-tractable awnings and vertical screens, the frames have a fairly long lifespan, while the fabric or the screen material may need to be replaced at regular intervals. Between the two, vertical screens provide better shading compared to re-tractable awnings.

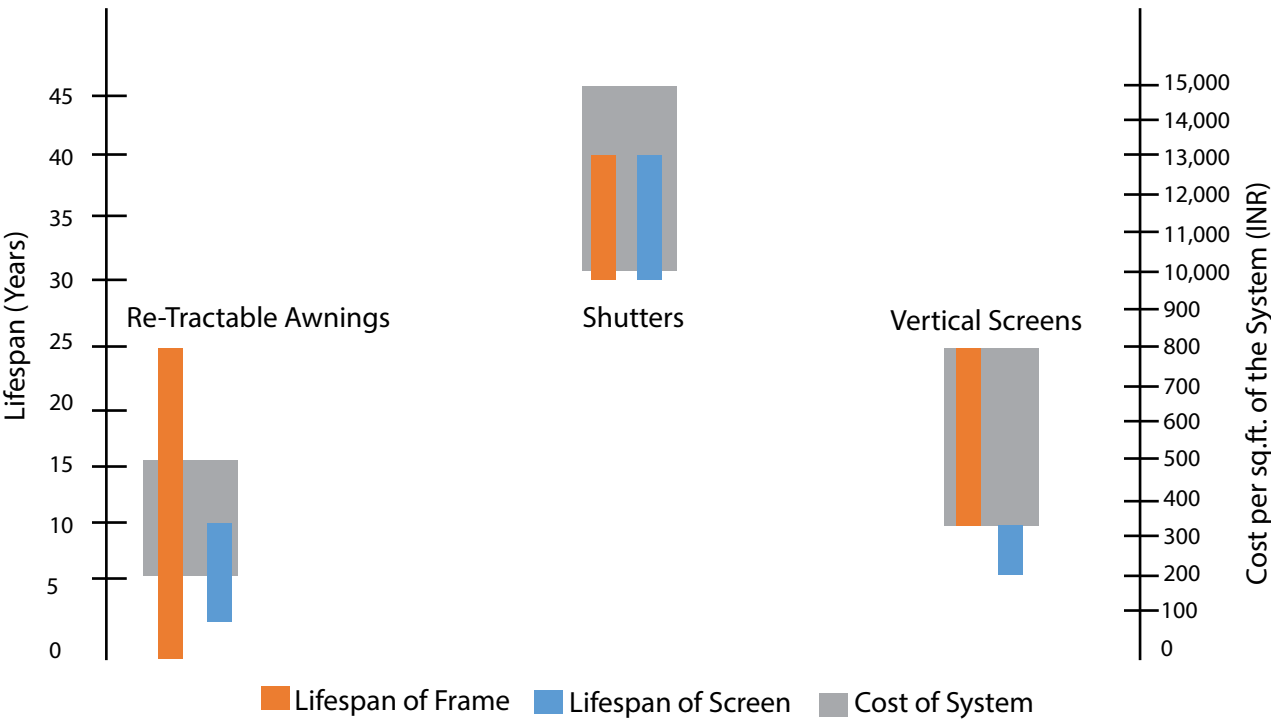


Fig. 1 Comparison of Cost vs Lifespan

# REFERENCES

## RE-TRACTABLE AWNINGS

- Fig. A: Greentech Knowledge Solutions Pvt. Ltd
- Fig. B: Greentech Knowledge Solutions Pvt. Ltd
- Fig. C: Greentech Knowledge Solutions Pvt. Ltd
- Fig. D: Greentech Knowledge Solutions Pvt. Ltd
- Fig. E: Greentech Knowledge Solutions Pvt. Ltd
- Fig. 1.1a: <http://awningswa.com.au/shop/pivot-arm-awning/>
- Fig. 1.1b: <https://www.indiamart.com/proddetail/drop-awning.html>
- Fig. 1.2a: [https://www.alibaba.com/product-detail/-F100-Small-French-Awning-Windows\\_1982856956.html?spm=a2700.details.maylike-hoz.1.3a8f1801q7jwrP](https://www.alibaba.com/product-detail/-F100-Small-French-Awning-Windows_1982856956.html?spm=a2700.details.maylike-hoz.1.3a8f1801q7jwrP)
- Fig. 1.2b: [https://www.alibaba.com/product-detail/-F100-Small-French-Awning-Windows\\_1982856956.html?spm=a2700.details.maylike-hoz.1.3a8f1801q7jwrP](https://www.alibaba.com/product-detail/-F100-Small-French-Awning-Windows_1982856956.html?spm=a2700.details.maylike-hoz.1.3a8f1801q7jwrP)
- Fig. F: <https://www.advaningshop.com/understanding-easy-pitch.html>
- Fig. 2.1a: <https://www.systemsawnings.com/drop-arm-components-photo-gallery.html>
- Fig. 2.1b: <https://www.awningsheds.com/awning-gallery/awnings-and-canopies-gallery/drop-arm-awnings>  
<https://www.systemsawnings.com/drop-arm-components-photo-gallery.html>
- Fig. 2.2a: <https://www.systemsawnings.com/drop-arm-components-photo-gallery.html>
- Fig. 2.2b: Office of Kent International Awnings (Image source: Greentech Knowledge Solutions Pvt. Ltd)
- Fig. 2.2c: Greentech Knowledge Solutions Pvt. Ltd
- Fig. 2.2d: [https://www.alibaba.com/product-detail/-F200-French-Style-Wood-Window\\_60138323712.html](https://www.alibaba.com/product-detail/-F200-French-Style-Wood-Window_60138323712.html)
- Fig. 2.2e: [https://www.alibaba.com/product-detail/-F200-French-Style-Wood-Window\\_60138323712.html](https://www.alibaba.com/product-detail/-F200-French-Style-Wood-Window_60138323712.html)
- Fig. 2.3a: [https://www.amazon.in/Advaning-USA-Manual-Retractable-Stripes/dp/B00W5YV6A2/ref=pd\\_sbs\\_201\\_1/261-0653802-9059121?\\_encoding=UTF8&pd\\_rd\\_i=B00W5YV6A2&pd\\_rd\\_r=35ff1c63-dba9-4e8f-abc0-258d954d7bd1&pd\\_rd\\_w=mMVix&pd\\_rd\\_wg=oS7F-P&pf\\_rd\\_p=fbf43daf-8fb3-47b5-9deb-ae9cce3969a9&pf\\_rd\\_r=7H511HYQDT4VRQNJGNTT&psc=1&refRID=7H511HYQDT4VRQNJGNTT](https://www.amazon.in/Advaning-USA-Manual-Retractable-Stripes/dp/B00W5YV6A2/ref=pd_sbs_201_1/261-0653802-9059121?_encoding=UTF8&pd_rd_i=B00W5YV6A2&pd_rd_r=35ff1c63-dba9-4e8f-abc0-258d954d7bd1&pd_rd_w=mMVix&pd_rd_wg=oS7F-P&pf_rd_p=fbf43daf-8fb3-47b5-9deb-ae9cce3969a9&pf_rd_r=7H511HYQDT4VRQNJGNTT&psc=1&refRID=7H511HYQDT4VRQNJGNTT)  
<https://www.advaningshop.com/understanding-easy-pitch.html>
- Fig. 3a: <https://www.systemsawnings.com/retractable-awning-components.htm>
- Fig. 3b: <https://www.systemsawnings.com/retractable-awning-components.htm>  
[https://www.amazon.in/Advaning-USA-Manual-Retractable-Stripes/dp/B00VQXSRU0/ref=sr\\_1\\_10?keywords=awnings&qid=1574150814&sr=8-10](https://www.amazon.in/Advaning-USA-Manual-Retractable-Stripes/dp/B00VQXSRU0/ref=sr_1_10?keywords=awnings&qid=1574150814&sr=8-10)  
<https://miripiri.co.in/awnings>

- Fig. 3c: <https://www.indiamart.com/proddetail/casatte-automatic-awning-20458897130.html>
- Fig. 3d: Kent international vendor's site image  
Aarcee space vendor's site image
- Fig. 4.3a: <http://www.gurunanakawnings.com/canopies-shades.html>
- Fig. 4.3b: <http://www.gurunanakawnings.com/canopies-shades.html>
- Fig. 5.1: System awning vendor's site image
- Fig. 5.2: System awning vendor's site image
- Fig. 5.3: Greentech Knowledge Solutions Pvt. Ltd

## VERTICAL SCREENS

- Fig. A: Greentech Knowledge Solutions Pvt. Ltd
- Fig. B: Greentech Knowledge Solutions Pvt. Ltd
- Fig. C: Greentech Knowledge Solutions Pvt. Ltd
- Fig. D: <http://www.thesolarshadestore.com/sites/default/files/pages/outdoor%20cassette.jpg>
- Fig. E: Brochure of Matts Corner India Pvt. Ltd
- Fig. 1.1a: Brochure of Matts Corner India Pvt. Ltd
- Fig. 1.1b: <http://www.thesolarshadestore.com/sites/default/files/pages/outdoor%20cassette.jpg>
- Fig. 1.2: <https://www.indiamart.com/proddetail/exterior-window-blind-6843677855.html>
- Fig. 1.3: [https://www.amazon.in/HIPPO-Plastic-Waterproof-Outdoor-Curtains/dp/B07DGDMRV2/ref=asc\\_df\\_B07DGDMRV2/?tag=-googleshopdes-21&linkCode=df0&hvadid=396985839981&hvpos=1o5&hvnetw=g&hvrnd=15053961058943167437&hvone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmld=&hvlocint=&hvlocphy=1007751&hvtargid=pla-837277953008&psc=1&ext\\_vrnc=hi](https://www.amazon.in/HIPPO-Plastic-Waterproof-Outdoor-Curtains/dp/B07DGDMRV2/ref=asc_df_B07DGDMRV2/?tag=-googleshopdes-21&linkCode=df0&hvadid=396985839981&hvpos=1o5&hvnetw=g&hvrnd=15053961058943167437&hvone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmld=&hvlocint=&hvlocphy=1007751&hvtargid=pla-837277953008&psc=1&ext_vrnc=hi)
- Fig. 1.4a: <https://weatherqueenshades.com/about-our-shades/>
- Fig. 1.4b: Artzz Fusion - <https://www.indiamart.com/artzz-fusion/>
- Fig. 1.5a: Greentech Knowledge Solutions Pvt. Ltd
- Fig. 1.5b: <https://ad-blinds.com/>
- Fig. 2.1a: <https://www.artfeverblinds.co.uk/info/4584972850>
- Fig. 2.1b: <http://www.thesolarshadestore.com/sites/default/files/pages/outdoor%20cassette.jpg>

Fig. 2.1.1a: <https://ad-blinds.com/>

Fig. 2.1.1b: <https://ad-blinds.com/>

Fig. 2.1.2a: <https://www.stratco.com.au/au/patios/outdoor-blinds/made-to-measure-outdoor-blinds/ambient-outdoor-blinds/>

Fig. 2.1.2b: <https://stanbondsa.com.au/ziptrak-blinds-vs-zipscreen-difference/>

Fig. 2.2: <https://www.fixmyblinds.com/identify-your-part/wood-faux-wood-venetian-blind-diagram.html>

Fig. 2.3a: [https://www.cart2india.com/window-hardware-sets/ziang-bendable-straight-curved-curtain-track-alloy-plastic-windows-and-balcony-curtain-track-soft-curved-track-curved-track-rail-slide-rail-accessories-2-meters/00000000004354558543?gclid=Cj0KCQiA6lHwBRC-JARIsALNjViWS59PJtKXHgiVGfKRfUWJ4m\\_XcdtI0yVWQGILFuNP4DZCqjna\\_80aAIF8EALw\\_wcB](https://www.cart2india.com/window-hardware-sets/ziang-bendable-straight-curved-curtain-track-alloy-plastic-windows-and-balcony-curtain-track-soft-curved-track-curved-track-rail-slide-rail-accessories-2-meters/00000000004354558543?gclid=Cj0KCQiA6lHwBRC-JARIsALNjViWS59PJtKXHgiVGfKRfUWJ4m_XcdtI0yVWQGILFuNP4DZCqjna_80aAIF8EALw_wcB)

Fig. 2.3b: <http://www.thesolarshadestore.com/sites/default/files/pages/outdoor%20cassette.jpg>

Fig. 2.4a: <http://www.healthycanadians.gc.ca/recall-alert-rappel-avis/hc-sc/2009/13359a-eng.php>  
<https://in.pinterest.com/pin/533746993321871444/?lp=true>

Fig. 2.4b: <https://www.archiexpo.com/prod/mottura/product-61328-746328.html>  
<https://stanbondsa.com.au/how-to-fix-a-broken-roller-blind-chain/>

Fig. 2.4c: <https://www.waverley.co.uk/operational-considerations-roller-blinds/>  
[https://www.amazon.in/Exotica-Balcony-Blinds-Roller-Blind/dp/B07SL3V9HD?tag=googinhydr18418-21&tag=googinkenshoo-21&asc-subtag=\\_k\\_CjwKCAjwxt\\_tBRAXEiwAENY8hXsRugyQx7a63ZtS1IWT8mRurA5VcmHnoINyH8\\_OJLg7gMaLhm2a9hoC6wYQAvD\\_BwE\\_k\\_&gclid=CjwKCAjwxt\\_tBRAXEiwAENY8hXsRugyQx7a63ZtS1IWT8mRurA5VcmHnoINyH8\\_OJLg7gMaLhm2a9hoC6wYQAvD\\_BwE](https://www.amazon.in/Exotica-Balcony-Blinds-Roller-Blind/dp/B07SL3V9HD?tag=googinhydr18418-21&tag=googinkenshoo-21&asc-subtag=_k_CjwKCAjwxt_tBRAXEiwAENY8hXsRugyQx7a63ZtS1IWT8mRurA5VcmHnoINyH8_OJLg7gMaLhm2a9hoC6wYQAvD_BwE_k_&gclid=CjwKCAjwxt_tBRAXEiwAENY8hXsRugyQx7a63ZtS1IWT8mRurA5VcmHnoINyH8_OJLg7gMaLhm2a9hoC6wYQAvD_BwE)

Fig. 2.5a: <https://www.indiamart.com/proddetail/exterior-pvc-blinds-10890649848.html>

Fig. 2.5b: <https://ad-blinds.com/>

Fig. 2.5c: [http://www.artfulhome.in/bamboo\\_blinds/pvc\\_outdoor\\_blinds.htm](http://www.artfulhome.in/bamboo_blinds/pvc_outdoor_blinds.htm)  
<https://www.fixmyblinds.com/blind-categories/woven-wood-blind.html>

Fig. 3.1b: <https://www.stratco.com.au/au/patios/outdoor-blinds/made-to-measure-outdoor-blinds/ambient-outdoor-blinds/>

Fig. 3.2b: <https://crownblinds.com.au/outdoor-blinds/>

Fig. 4.5b: <http://ad-blinds.com/portfolio/all-weather-blind/>

Fig. 5.1: <https://balcozy.com/>

Fig. 5.2: <https://www.indiamart.com/proddetail/outdoor-venetian-blinds-21335329973.html>

Fig. 5.3: Artzz Fusion - <https://www.indiamart.com/artzz-fusion/>

Fig. 5.4: [http://www.artfulhome.in/bamboo\\_blinds/pvc\\_outdoor\\_blinds.htm](http://www.artfulhome.in/bamboo_blinds/pvc_outdoor_blinds.htm)

Fig. F: <https://www.renson.eu/nl-nl/producten-zoeken/zonwering/doekzonwering/fixscreen/fixscreen-mono-ak-evo>  
<https://www.renson.eu/nl-nl/producten-zoeken/zonwering/doekzonwering/fixscreen/fixscreen-mono-ak-evo>

Fig. G: <https://www.renson.eu/nl-nl/producten-zoeken/zonwering/doekzonwering/fixscreen/fixscreen-mono-ak-evo>  
Fig. H: <http://ad-blinds.com/portfolio/all-weather-blind/>  
Fig. I: <https://www.fixmyblinds.com/blind-categories/woven-wood-blind.html>  
Fig. J: [http://www.artfulhome.in/bamboo\\_blinds/pvc\\_outdoor\\_blinds.htm](http://www.artfulhome.in/bamboo_blinds/pvc_outdoor_blinds.htm)  
Fig. 7.1: <https://forums.hardwarezone.com.sg/homeseekers-homemakers-74/outdoor-roller-blinds-condo-pls-recommend-5970940.html>  
Fig. 7.2: <http://intelliblinds.com/tradespace.html>  
Fig. 7.3: Greentech Knowledge Solutions Pvt. Ltd  
Fig. 7.4: Greentech Knowledge Solutions Pvt. Ltd  
Fig. 7.5: [http://www.artfulhome.in/bamboo\\_blinds/pvc\\_outdoor\\_blinds.htm](http://www.artfulhome.in/bamboo_blinds/pvc_outdoor_blinds.htm)

## SHUTTERS

Fig. A: Greentech Knowledge Solutions Pvt. Ltd  
Fig. B: Greentech Knowledge Solutions Pvt. Ltd  
Fig. C: Greentech Knowledge Solutions Pvt. Ltd  
Fig. D: Greentech Knowledge Solutions Pvt. Ltd  
Fig. E: Greentech Knowledge Solutions Pvt. Ltd  
Fig. F: Greentech Knowledge Solutions Pvt. Ltd  
Fig. 1.1: Greentech Knowledge Solutions Pvt. Ltd  
Fig. 1.2: <https://dir.indiamart.com/impcat/louvered-exterior-shutters.html>  
Fig. 1.3: <http://www.louvers.co.in/index.php?c=photos&catid=6>  
Fig. 3a: <https://www.zebrablinds.com/blog/5-things-to-know-before-buying-plantation-shutters-8-2019-32/>  
Fig. 3b: <https://www.indiamart.com/proddetail/teak-wooden-window-shutter-12744568355.html>  
Fig. 3c: Greentech Knowledge Solutions Pvt. Ltd  
Fig. 4.1b: <https://dir.indiamart.com/impcat/louvered-exterior-shutters.html>  
Fig. 5: <http://www.louvers.co.in/index.php?c=photos&catid=6>





## Indo-Swiss Building Energy Efficiency Project

---

The Indo-Swiss Building Energy Efficiency Project (BEEP) is a bilateral cooperation project between the Ministry of Power (MoP), Government of India and the Federal Department of Foreign Affairs (FDFA) of the Swiss Confederation. The Bureau of Energy Efficiency (BEE) is the implementing agency on behalf of the MoP while the Swiss Agency for Development and Cooperation (SDC) is the agency in charge on behalf of the FDFA. The Project Management and Technical Unit (PMTU) is responsible for programme implementation, which includes selected technical work, management tasks programme, and programme outreach.

## About Bureau of Energy Efficiency

---

Bureau of Energy Efficiency (BEE) is a statutory body under the Ministry of Power, Government of India. It assists in developing policies and strategies with the primary objective of reducing the energy intensity of the Indian economy. BEE coordinates with designated consumers, designated agencies, and other organizations to identify and utilise the existing resources and infrastructure in performing the functions assigned to it under the Energy Conservation Act.

### For further information



Bureau of Energy Efficiency  
Ministry of Power, Government of India  
4th Floor, SEWA Bhawan  
R. K. Puram, New Delhi - 110 066 (INDIA)  
Website: [www.beeindia.gov.in](http://www.beeindia.gov.in)

Project Management and Technical Unit  
Indo-Swiss Building Energy Efficiency Project  
Telefax: +91 11 45535574  
Email: [pmtu@beepindia.org](mailto:pmtu@beepindia.org)  
Website: [www.beepindia.org](http://www.beepindia.org)

