

Guidelines on use of Glass in Buildings - Human Safety



Central Public Works Department



Indian Buildings Congress



Consulting Engineers Association of India

Prepared by



Confederation of Construction Products & Services

March, 2013

Guidelines on use of Glass in Buildings - Human Safety

Central Public Works Department (CPWD)
Indian Buildings Congress (IBC)
Consulting Engineers Association of India (CEAI)
Confederation of Construction Products and Services (CCPS)

Guidelines on use of Glass in Buildings - Human Safety

First Edition : November 2007

Second Print : January 2008

Third Print : April 2008

Second Edition : May 2009

Reprint : October 2009

Third Edition : March 2013

(With modified sketches and suggestions for fire safety)

Price : ₹ 300.00

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Glass and Glazing Secretariat

Deepak Gahlowt, P.K.Singh, Shashi Kant,
Birendra Prasad, Sumit Bhatia, Ankita Bhattacharya,
Anuradha Jha, Milton Sarkar, Sarita Balodhi

Layout and Cover Design

SNGRAPHIX, 9891299959

Cover Photo

Deepak Gahlowt

Confederation of Construction Products and Services

S1&S2, 2nd floor, Abhishek Tower, D-II, Alaknanda Commercial Complex,
New Delhi - 110019

Tel: +91-11-26023615, TeleFax: +91-11-26021709

email: ccps@ccpsindia.com

Website: www.ccpsindia.com

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डी. एस. सचदेव
D. S. Sachdev



निर्माण महानिदेशक
केन्द्रीय लोक निर्माण विभाग
निर्माण भवन, नई दिल्ली - 110011
Director General (Works)
Central Public Works Department
Nirman Bhawan, New Delhi - 110011
Telephone : 23062556, 23061317

FOREWORD

“Guidelines on use of glass in buildings-Human safety” has been brought out by CCPS through consensus approach involving all stake holders, representatives from CPWD, various PWDs and other Govt. departments etc. The use of glass in buildings has increased manifolds. The worldwide increase in use of glass has become a matter of concern from human safety point of view.

Recognizing the gravity of the problem and uncertainty faced by the Engineers, Architects and users, the guidelines for selection of appropriate safety glass suitable for a particular location has been brought out.

CPWD has already issued OM dated 18/02/2008 to all the officers in the department to promote awareness about Human safety while finalizing specifications for glazing. Govt. of Andhra Pradesh has also issued GO no.205 dated 27/02/2009 to ensure safe use of glass in buildings by following these guidelines.

The guidelines were reviewed by the Expert Committee constituted under the Chairmanship of Shri P. B. Vijay, former DG(W), CPWD which has representations from CPWD, CCPS, IBC and CEAI, and has suggested few modifications. Accordingly, guidelines have been reprinted in the present form and available for implementation. The purpose of guidelines is not to sell more safety glass but to exhibit the wide choice that exists and allow the use of annealed glass with precautions in order to reduce the risk of accidents.

I appreciate the efforts of the CCPS for bringing out these guidelines. I am sure these guidelines shall be useful to the architects, engineers, builders not only of Govt. Departments but also from the private sector. The adoption of these guidelines will definitely create confidence amongst engineers and architects for ensuring the safe use of glass while proposing glass in buildings.

New Delhi
May, 2009

(D.S. Sachdev)
Director General (Works), CPWD



T. NANDA KUMAR, IAS (Retd.)
Member



National Disaster Management Authority
Government of India

NDMA Bhawan
A-1, Safdarjung Enclave, New Delhi - 110029
Tel: +91-11-26701782
Fax: +91-26701783
Email: tnandakumar@ndma.gov.in

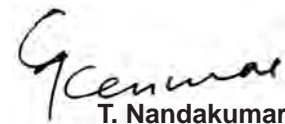
PREFACE TO THE THIRD EDITION

India as one of the fastest growing economies in the world, is witnessing entry of new products and technologies in the building materials market on a regular basis. It is not always possible, nor is it desirable for the Government to develop standards for all of them. Developing and evaluating standards through a public-private partnership by academic institutions, confederations, non-profit organizations, industries and experts is the way forward to safe-guard the interest of consumers, professionals and producers.

I am glad that Confederation of Construction Services (CCPS) - a 'not for profit' organization took the lead and initiated this project and developed "Guidelines on use of Glass in Buildings Human Safety" through PPP mode adopting a consensus approach suggesting ways to regulate glass in relation to human safety by either, restricting use of glass or specifying Safety Glass at critical locations where chances of injury due to impact and glass breakage are high. The imperative is 'buildings should be safe!'.

Looking at the volume of the glass being used in building industry, the relevance of these Guidelines have become more pertinent and attracted the attention of policy makers and professionals. I am informed that so far these Guidelines have been mandated by 13 States, Central and State Government departments and PSUs which include Government of Andhra Pradesh, Government of Rajasthan, Central PWD, Greater Hyderabad Municipal Corporation, NBCC, Airport Authority of India, Government of Manipur PWD, Government of Delhi PWD, Delhi Development Authority, Rajasthan Housing Board, Town Planning Department, GoR, Haryana PWD, A & N Islands PWD.

CCPS is bringing out the third edition of the Guidelines incorporating the latest provisions and modifications in the field. I hope that more State Governments/UTs and departments will come forward and include the recommendations of the Guidelines in the Building Byelaws/specifications for strict compliance and implementation to ensure human safety while using glass in buildings. I appreciate the efforts of CCPS and support of AGP-AIGMF to shoulder the responsibility of such an important human safety issue and I am sure that these Guidelines will act as a beacon to the building professionals.


T. Nandakumar

Member

National Disaster Management Authority
New Delhi

New Delhi
March 2013

P. B. Vijay
B.E. (Hons), M. Tech. (Struct.) FIE, MICA
Former Director General, Central PWD

A-39/B DDA Flats
Munirka
New Delhi - 110 067

PREFACE TO THE SECOND EDITION

Guidelines on Use of Glass in Buildings - Human Safety, brought out by Confederation of Construction Products and Services in November 2007 have drawn the attention of all concerned including Government Departments, Bureau of Indian Standards and professionals in the Country. To create awareness and implement these Guidelines through inclusion in Building Byelaws and Specifications, CCPS approached various Ministries, Central and State Government Departments, Development Authorities, Municipalities, Professional Societies, Builders, Individuals etc.

Since the main concern was of human safety, an Expert Committee was constituted in May 2008 to review and analyse the CCPS Guidelines, having representations from Indian Building Congress (IBC), Consulting Engineers Association of India (CEAI), Central Public Works Department (CPWD), Confederation of Construction Products and Services (CCPS) and other stake holders. Expert Committee met over five meetings and suggested amendments which have been included in this modified edition.

The Guidelines are practical, relevant and easy to use. I am sure that these Guidelines would prove very useful for the construction industry. I also hope keeping in view the spectacular increase in use of glass in buildings, Local Bodies and Government Departments will come forward to include provisions from these Guidelines in their Building Bylaws and Specifications to ensure human safety.

I am grateful to Sh. K.K. Kapila, President, IBC and CEAI for his initiative in getting the document examined through an Expert Committee. I am thankful to all the Committee Members for their valuable inputs in improving the basic document prepared by the CCPS. I specially thank Sh. D.S. Sachdev, Director General, Central PWD for providing expert opinion and endorsing the document for adoption by the professionals. The support of Indian Glass Manufacturers' Association (IGMA) for this project is appreciable.

New Delhi
May, 2009



(P.B. Vijay)
Chairman, Expert Committee

PREFACE

The Confederation of Construction Products and Services (CCPS) with the support of I Glass is happy to release “Guidelines on use of Glass in Buildings - Human Safety”.

In the modern lifestyle, increased Glass use in buildings offers many advantages. Those who spend more time indoors have intuitively understood benefits of improved daylight and vision on human psychology and health, and recent research findings underscore these indisputably. However this increased use of glass in Indian buildings is not without risks. Wrong selection of glass type is widespread and does result in increased heat gain/loss in buildings and the higher risk of injuries to humans. These are side affects that the building industry is only recently beginning to recognize in India.

The Energy Conservation Building Code 2007, prepared by the Bureau of Energy Efficiency that sets minimum efficiency standards for external wall, roof, glass structure, lighting, heating, ventilation and air conditioning of the commercial buildings, is a good beginning in the area on energy conservation. CCPS was also actively involved in the preparation of the ECBC. However the risk of human injury associated with the increased glass use was out of scope of the ECBC, and remains unaddressed by this or any of the previous standards.

The “Guidelines on use of Glass in Buildings - Human Safety” prepared by CCPS thus address a very important need in the industry. These Guidelines, for the first time in Indian construction industry, have been prepared using the consensus process entirely lead by the private sector, and supported not only by the industry but also the government and other stakeholders.

The process has involved the stakeholders in preparing these guidelines through the Steering Committee, which has decided the scope and the methodology, and at each stage suggested the changes and approved the drafts. In order to ensure the integrity of the process the changes at each stage were discussed and minutes have been documented. The meetings have been held at Delhi, Mumbai and Bangalore, so as to ensure the participation of various organizations and professionals throughout India.

Finally for a period of one month the draft guidelines were made available for public review. The guidelines have been sent to over 1000 architects, builders, contractors, government officials from municipalities, development authorities and others for comments. The feedback received has been presented to the Steering Committee and the final draft in the form of this publication has been approved in the steering committee meeting held on the 2nd November, 2007. A decision has also been taken to setup a review mechanism for regularly updating the guidelines in view of changes in the building environment and capabilities in the industry. This will ensure that the document remains updated and answers the need of times in the future also.

We would like to thank all the members of the Steering Committee, special invitees and all those who have taken some time out from their busy schedule to contribute to making of this document. Without their interest and efforts, this guideline would not have taken shape. I would also like to thank the Secretariat at CCPS that has worked to research and draft and redraft the document; and has coordinated and brought on one platform a very distinguished Steering Committee.

I believe that this document will be helpful to all those who are specifying glass for use in buildings and those who are manufacturing and processing glass for buildings and ultimately will help us improve safety and well being of the users.

We will look forward to your comments and suggestions for improvements in days to come.

Deepak Gahlowt, Architect,
Convener
Confederation of Construction Products and Services (CCPS)

New Delhi
November 2007

1.0 Scope

1.1 The scope of these guidelines covers minimum human safety requirement subjected to various kinds of human impact, precautions against risk of fall and falling glass. Conditions outside of 'human impact' are not in the purview of this document.

1.2 This guide does not assume that the safety glass used in accordance to this document will not be broken under all human impact conditions, rather:

- a) It will not be broken under most likely forms of human impact, and
- b) Even if it breaks the likelihood of cutting or piercing injuries will be minimized by virtue of the protection given to the glass, or by the limited size or increased thickness, or by the fracture characteristics of the glass.

1.3 Further this guide does not deal with the safety and security of people or goods in relation to risks of:

- a) Vandalism, riots, burglary or break in protection,
- b) Fire arm protection,
- c) Protection from explosion (terrorist attack),
- d) Natural disasters like Earthquake, Cyclone, Fire etc., and
- e) Plastic glazing, safety and security glazing etc.

1.4 In circumstances wherein the requirements of other standards exceeds the requirements of this guideline and in such cases the higher requirement shall become applicable. For preliminary suggestions on fire safety refer Annexure 4.

1.5 The use of this document must also be in conformity with all other relevant codes on fire safety, structural stability, natural disasters, safety and security etc.

2.0 Safety Glass

2.1 Glazing material constructed, treated or combined with other materials so as to reduce, in comparison with ordinary sheet, float or plate glass, the likelihood of injury to persons by objects from exterior sources or by these safety glasses when they may be cracked or broken.

2.2 The following are the products in the scope of this document that may be used in safety glazing provided they meet the Bureau of Indian Standards (BIS) conditions and are marked accordingly. Safety glass shall be of four types as follows:

- a) Toughened Safety (Tempered) Glass (TS),
- b) Toughened Float Safety Glass (TF),
- c) Laminated Safety Glass (LS), and
- d) Laminated Float Safety Glass (LF).

(IS : 2553, Part 1)

(Glass at 'b' & 'd' shall be preferred, since glass at 'a' & 'c' are commercially obsolete.)

2.2.1 Toughened (Tempered) Safety Glass : A single piece of specially heat-treated glass, with a stress pattern such that the piece when fractured reduces to numerous granular fragments, with no large jagged edges.

(IS : 2553, Part 1)

2.2.2 Laminated Safety Glass : Two or more pieces of glass held together by an interleaving layer or layers of plastic materials. The laminated glass will crack and break under sufficient impact, but the pieces of glass tend to adhere to the plastic and do not fly. If a hole is produced, the edges are likely to be less jagged than that would be the case with ordinary glass.

(IS : 2553, Part 1)

2.3 Safety glass can be flat or curved and of any type which includes Clear, Tinted, Coated, Frosted, Decorative or Mirror. TS and TF glasses shall satisfy the relevant resistance to shock test, fragmentation test and warp test and LS and LF glass shall comply with light stability test, boil test and fracture and adhesion test in accordance with IS 2553 (Part 1).

2.4 PRECAUTIONS

2.4.1 All heat strengthened/heat-treated glasses are not safety glasses and all laminated, toughened and safety organic coated glasses are not safety glasses. Heat strengthened glasses are not classified as safety glasses unless laminated to meet the tests specified for safety glass in Annexure 3 of this document. Glass laminated with other than polyvinyl butyral (PVB) may not classify the requirement of safety glass. Only glass that meets the test criteria as defined at Annexure 3, Table F is expected to qualify as safety glass.

3.0 Application/Installation

3.1 GENERAL SAFETY CONSIDERATION¹

3.1.1 Many human impact injuries are due to failure to take reasonable safety precautions. Some materials, such as glass, may break under impact and cause injury. Most people are aware of this and treat such materials with due care. However a person's ability to perceive this potential risk and to cope with it can vary. Safety standards are therefore based on a number of factors including the assumption of a reasonable level of awareness and behaviour and also suitable product design and choice of materials.

3.1.2 Accident statistics show that glazing in some locations in buildings is more vulnerable to human impact than in others. These critical locations are:

- a) In-and-around doors (particularly side panels may be mistaken for doors), and
- b) At low levels in walls and partitions.

3.1.3 The designer or specifier, should take precautions to reduce the risk of injuries from accidental human impact in these locations by:

- a) Selecting glass of a suitable type, thickness and size, primarily with reference to impact behaviour and safety characteristics as established by testing in accordance with this guide,
- b) Providing mechanical protection to glass in critical locations to prevent fall of glass under impact, and
- c) Enhancing a person's awareness of the presence of glass by incorporating manifestation as mentioned in clause 3.4.

3.1.4 Glass in locations other than critical locations is not likely to be subjected to human impact and consequently not likely to cause injury.

3.2 DESIGN CONSIDERATION¹

3.2.1 The principal design considerations to be taken into account by the designer, or specifier, when selecting glass should be:

- a) The properties of materials, in particular their breakage characteristics,
- b) Structural integrity of glazing systems supporting the glass,
- c) The type of the building and its use, in particular the number and likely behaviour of the people expected to be in close proximity to the glass in critical locations,
- d) Requirements for fire, security and wind loading,
- e) Thermal breakage, energy efficiency and deflection, vision, acoustics and other consideration, and
- f) Impact of trolleys, carts, luggage etc. have to be considered when required.

3.3 INSTALLATION OF GLASS

3.3.1 Design of the glazing system should be such that it has the ability to hold glass in place and prevent it from falling out as a whole.

3.3.2 For guidance on installation of glass following standards may be referred.

- a) IS : 3548 - 1988 (Reaffirmed 2009) - Code of Practice for Glazing in Buildings,
- b) IS : 10439 - 1983 - Code of Practice for Patent Glazing,
- c) BS : 8213 - Part 4 - 1990 - Windows, Doors and Rooflights - Code of Practice for the Installation of Replacement Windows and Doorsets in Dwellings,
- d) BS : 6262 - Part 6 - 1997 - Code of Practice for Glazing for Buildings - Special Applications,
- e) BS : 8000 - Part 7 - 1990 - Workmanship on Building sites - Code of Practice for Glazing,
- f) AS : 1288 - 2006 - Section 8 and 9 - Glass in Buildings - Selection and Installation,
- g) BS : 5516 - 1 - 2004 - Patent Glazing and Sloped Glazing for buildings - Code of practice for design and installation, and
- h) Glass Association of North America Installation Guide.

3.4 MANIFESTATION²

3.4.1 Presence of glass in a door, side panel or a panel capable of being mistaken for a doorway or

¹BS 6262: Part 4: 1994 - Code of Practice for Glazing for Buildings - Safety related to Human Impact

²AS: : 1288-2006, Glass in Building - Selection and Installation

opening, which are not made apparent by transoms, colonial bars, other components of glazing system or other decorative treatment, such as being opaque or patterned, the glass be marked to make it visible.

3.4.2 Marking shall be in the form an opaque band not less than 20 mm in height and located so that the vertical distance from the floor level is not less than 700 mm from the upper edge of the band and not more than 1200 mm to the lower edge of the band.

3.4.3 The band shall be such that it is readily apparent and it can be achieved by contrasting the band with background or by increasing height of band. Safety glazing cannot be substituted by making the glass visible by marking.

3.4.4 A band or marking is not required where any one of the following applies:

- a) Height of the glass is not greater than 1000 mm at any part,
- b) The width of the glass is not greater than 500 mm at any part (this applies to overall panel assembly - not individual glass pieces in case of faceted glazing),
- c) Where there is no glass within 750 mm of the floor, and
- d) The glass is provided with at least one fixed glazing bar, firmly attached to the styles to locate and protect each face of the glass. At least one transom (glazing bar) shall be located with its upper edge not less than 500 mm and its bottom edge not more than 1000 mm above the floor level. The glazing bar shall have a face width not less than 40 mm \pm 3 mm.

3.4.5 Alternatively patterns may be used as an acceptable form of marking provided it meets the other criteria set in this guideline.

4.0 Identification of Safety Glass

4.1 All Safety glasses shall be procured from certified manufacturers and the product shall conform to relevant standards.

4.2 Either a label that cannot be removed and reused or a permanent mark on the glass surface shall mark all the panels of safety glass according to Bureau of Indian Standards (BIS).

4.3 Each label must contain the ISI mark as prescribed by the BIS, manufacturers name, registered trademark or code of the manufacturer or supplier, type of safety glass material, the standard or guidelines to which the safety glass has been tested and the grade of test classification.

5.0 Critical Locations

5.1 DEFINITION

5.1.1 Critical locations are parts of a building most likely to be subjected to accidental human impact.

5.2 CLASSIFICATION OF CRITICAL LOCATIONS³

5.2.1 Where any glazing is within 1.5 metre above the floor level of a building, it is considered likely to be subjected to human impact and hence, shall comply with the human impact safety requirements of this guide. Safety glazing material should also be used:

- a) Where there is danger of falling infill glass materials from overhead glazing,
- b) The danger of falling due to a change in floor level, and
- c) In case of balustrades, stairs and floors.

5.2.2 Accident statistics show that the glazing in some locations in buildings are more vulnerable to human impact than in others. These critical locations, some of which have been shown in Table A, include the following:

- a) In-and-around doors, low windows,
- b) Panels mistaken for a doorway or opening,
- c) Panels at low levels in walls and partitions,
- d) Bathrooms,
- e) Building associated with special activities, e.g. gymnasias, enclosed swimming pools etc.,
- f) Schools and child care facilities, and
- g) Nursing Homes and aged care facilities.


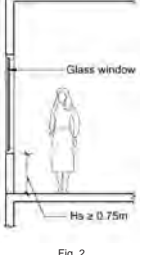
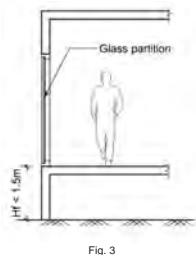

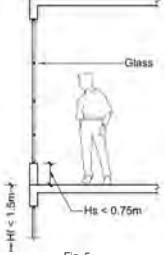
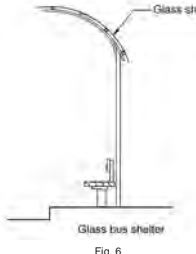


³AS: : 1288-2006, *Glass in Building - Selection and Installation*

5.2.3. Precautions should be taken to reduce the injuries that can result from glass breakage by:

- a) Selecting glass of a suitable type, thickness and size,
- b) Enhancing a person's awareness of the presence of glass by making glass visible (manifestation), and

- c) Minimizing manual handling of large pieces of glass during installation.

5.2.4. Based on the above facts and to avoid confusion regarding the type of the glass for a particular location as mentioned above, this guide has given details on the basis of five critical locations found in common accidental cases.

Table A - Type of glass to be used at different critical locations/cases (to be read in association with notes only)					
	Case 1 Vertical walls with residual protection# or $H_s \geq 0.75m$ (not likely to be subjected to human impact)	Case 2 Vertical walls $H_s < 0.75m$ & $H_f \leq 1.5m$ (human impact but no risk of fall)	Case 3 Vertical walls $H_s < 0.75m$ & $H_f > 1.5m$ (human impact and risk of fall both)	Case 4 Horizontal or Sloped Glazing (risk of fall)	Case 5 Glass acting as a balustrade / parapet / railing (human impact and risk of fall both)
	 		 	 	
Type of glass	Any glass*	Safety glass	Safety glass**	Laminated safety glass	Laminated safety glass
Examples	# Residual protection is the safeguard provided to avoid the impact of human being to glass. It is provided on the side of glass where there are chances of Human impact. It can be achieved by providing protection in form of a sill structure or transom, chair rail or a grill inside. Refer note 6 against falling of glass. Also see sketches at Annexure 1. *Safety glass is not mandatory	- Doors - Side Panels - Curtain Walls - Glazed Area - Doors in Bathroom, a) Fully Framed b) Partially Framed c) Frameless - Façade - Windows - Internal Partitions and Doors - External Façade and Doors on ground floor, above floors with terraces outside. Also see sketches at Annexure 1.	- Curtain Walls - Façade - Spandrels - High Activity Area - High Risk Area - To avoid risk Also see sketches at Annexure 1. **Laminated float glass is preferred	- Roof (Skylight roof) - Ceilings - Bus Shelters - Floors - Stairs - Sloped Façade For definition of sloped glazing please refer to Annexure 5 Also see sketches at Annexure 1.	- Balustrades - Parapet - Railing Also see sketches at Annexure 1.

NOTES TO TABLE A

Note 1: 'Hf' corresponds to height of fall of human or glass in case of change in level and 'Hs' corresponds to the sill height with reference to floor height.

Note 2: In case of mirror glazing, it should conform to the requirements of other safety glasses unless it is fully backed by a solid material.

(AS : 1288-2006)

Note 3: In case 2 and 3, if the smaller dimension of the pane is 250 mm or less and its area is 0.5 sqm or less, glass not conforming to safety glass requirements may be used, provided that its nominal thickness is not less than 6mm. (applicable to vertical glazing)

(BS : 6262 - Part 4 - 1994)

Note 4: Toughened or Laminated safety glass should meet respective test requirements as mentioned in Annexure 3 of this document to qualify as safety glazing.

(IS : 2553 Part 1)

Note 5: The effective Toughened safety glass thickness and/or Laminated safety glass configuration shall be determined case by case with regard to:

- Other solicitations (wind load, snow load, dead load, and human load)
- The overall dimension (length / width, or surface)
- The aspect ratio of the glass (length / width)
- The glazing fixing type (framing, bolted system, structural system etc.).

(AS : 1288-2006)

Note 6: Precautions against chances of injuries due to broken glass falling on people:

(a) Broken annealed glass falling on people can cause grievous or even fatal injuries; hence it is recommended to use safety glass in locations other than defined in case 1 where the risk of people getting hurt by falling glass is high.

(b) Toughened (tempered) glass has a safe breakage pattern, as it breaks and disintegrates into small and relatively harmless particles. However thick toughened glass particles may stay interlocked and fall as lumps of these multiple particles and can cause a minor or medium injury mainly due to the weight of the cluster.

(c) Laminated safety glass will generally not fall out of fixing. However, where laminated glass with both glasses toughened is used for horizontal or sloped glazing, it may crumble as a blanket and fall out of fixing in the event of failure of both toughened glasses. This factor needs to be considered while designing horizontal and sloped glazing.

(d) Any broken glass in any glazing should be removed immediately on breakage.

(e) Strength of the glazing system should be such that it has the ability to hold glass in place and prevent it from falling out as a whole.

Note 7: For inclusion of glass in furnitures the following standards may be referred:

(a) BS : 7499 - 1991 - Specification for inclusion of glass in the construction of furniture, other than tables or trolleys, including cabinets, shelving systems and wall hung or free standing mirrors.

(b) BS : 7376 - 1990 - Specification for inclusion of glass in the construction of tables or trolleys.

(c) IS : 7760 - 1985 - Specification for steel glass-front cabinet.

(d) BS EN : 1727 - 1998 - Domestic furniture, storage furniture, safety requirements and test methods.

(e) BS EN : 1153 - 1996 - Kitchen furniture, safety requirements and test methods for built-in and free standing kitchen cabinets and work tops.

Note 8: In case of external laminated glass facades, openable portions have to be left at regular distances for fire fighting and smoke exhaust.

Note 9: If Insulating Glass Unit (IGU) is used in situations mentioned in this guide then any one of the following will apply:

i) If IGU is installed in areas subjected to human impact on either side then both the panes of the unit shall meet the requirements of this guide.

ii) In situations where access is restricted to one side of the unit, then only the accessible side should meet the requirements of this guide

(AS : 1288-2006).

Note 10: For definitions and explanation of terms see Annexure 5.

Summary

Requirements for Use of Glass in Buildings - Human Safety

1.0 Scope – The scope of these guidelines covers minimum safety requirements subjected to various kinds of human impact, precautions against risk of fall and falling glass.

2.0 Safety Glass – Safety Glass shall be of four types as follows:

- a) Toughened Safety (Tempered) Glass (TS),
- b) Toughened Float Safety Glass (TF),
- c) Laminated Safety Glass (LS),
- d) Laminated Float Safety Glass (LF).

Glass at 'b' & 'd' shall be preferred, since glass at 'a' & 'c' are commercially obsolete.)

3.0 Critical Locations – Critical locations are parts of a building most likely to be subjected to accidental human impact. Where any glazing is within 1.5 metre above the floor level of building, it is considered likely to be subjected to human impact and hence, shall comply with the human impact safety requirements as laid down below. Safety glazing material should also be used:

- a) Where there is danger of falling infill glass materials from overhead glazing,
- b) Where there is danger of falling due to a change in floor level, and
- c) In case of balustrades, stairs and floors.

However, if the smaller dimension of pane is 250 mm or less and its area is 0.50 sqm or less, glass not conforming to safety requirements can also be used.

3.1 Classification of Critical Locations – The critical locations with appropriate types of glass allowed for use are listed in the following five cases.

Case1: Glass used as Vertical Walls (not likely to be subjected to Human Impact)
 $H_s \geq 0.75\text{m}$ or with Residual Protection
Type of Glass to be used: Any glass (Safety Glass not mandatory)

Case 2: Glass used as Vertical Walls (Human Impact but no risk of fall)

$H_s < 0.75\text{m}$ and $H_f \leq 1.5\text{m}$

Type of Glass to be used: Safety Glass (TF or LF)

Case 3: Glass used as Vertical Walls (Human Impact and risk of fall both)

$H_s < 0.75\text{m}$ and $H_f > 1.5\text{m}$

Type of glass to be used: Safety Glass (LF preferred)

Case 4: Glass used in Horizontal or Sloped Glazing (Risk of fall)

Type of glass to be used: Laminated Safety Glass (LF)

Case 5: Glass acting as a balustrade, parapet or a railing (Human Impact and risk of fall both)

Type of glass to be used: Laminated Safety Glass (LF)

Residual protection is the protection provided to avoid the impact of human being to glass. e.g. sill structure or transom, balustrade or railing, or grill inside.

H_s = Sill height, H_f = Falling height in case of change in level between the two sides of glass

4.0 Manifestation – Clear glass panels capable of being mistaken for an unimpeded path of travel should be marked to make them visible by incorporating manifestation. Manifestation employed shall be in form of opaque band of size not less than 20 mm in height and located at vertical distance from floor level to not less than 700 mm from upper edge of band and not more than 1200 mm to lower edge of the band. The manifestation shall preferably be permanent, e.g. etching of the glazing, but alternatively, if applied materials are used they shall be durable and not easily removed.

5.0 Identification of Safety Glass – All Safety Glass shall be indelibly and distinctly marked with type of glass, name or logo to identify the manufacturer, thickness of glass and BIS certification mark. Stickers are not permitted for these markings.

6.0 Safety Glass Test requirements – TS and TF glasses shall satisfy the relevant resistance to shock test, fragmentation test and warp test and LS and LF glass shall comply with light stability test, boil test and fracture and adhesion test in accordance with IS : 2553 (Part 1).

7.0 Precautions – The following precautions should be taken to reduce the injuries that can result from glass breakage by:

- a) Selecting glass of a suitable type, thickness and size,
- b) Enhancing the person's awareness of the presence of glass by making glass visible (manifestation),
- c) Minimizing manual handling of large pieces of glass during installation,
- d) In case of external laminated glass facades, openable portions have to be left at regular distances as required for fire fighting and smoke exhaust,
- e) When laminated glass with both glass panes toughened is used for horizontal or sloped glazing, it may crumble as a blanket and fall out of the fixing, in the event of failure of both toughened glasses. Consider this factor while designing.
- f) Any broken glass in any glazing should be removed immediately.

Annexure 1: Sketches of examples for cases 1 to 5, Table A

CASE 1: Vertical walls - with residual protection or $H_s \geq 0.75\text{m}$ (not likely to be subjected to human impact).

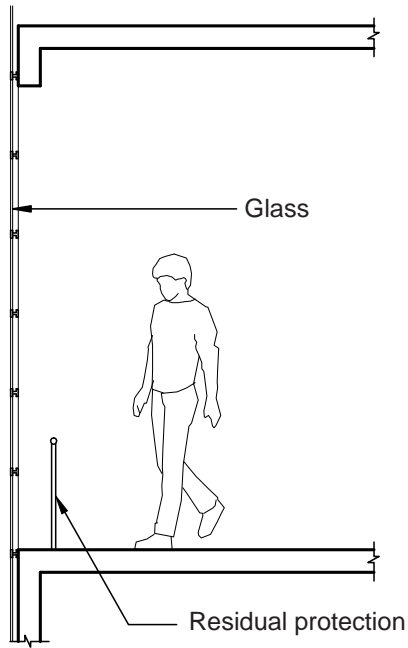


Fig.9

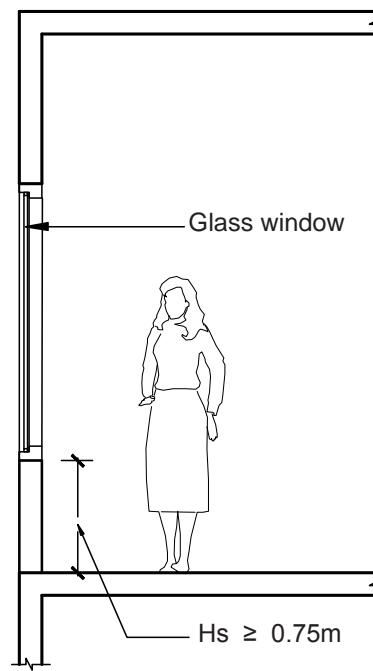


Fig.10

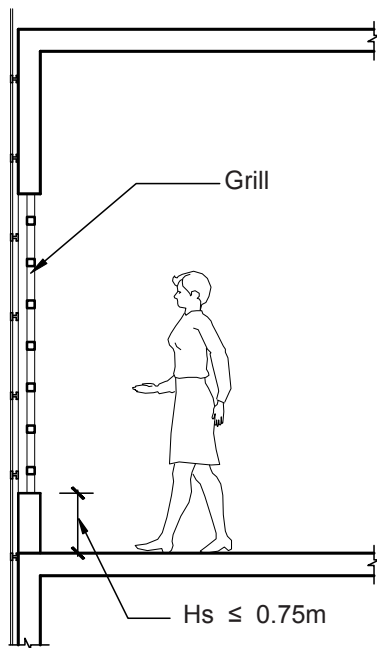


Fig.11

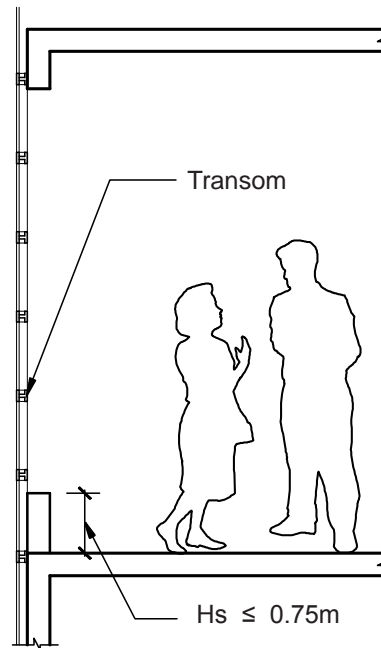


Fig.12

CASE 2: Vertical walls : $H_s < 0.75\text{m}$ & $H_f \leq 1.5\text{m}$. (human impact but no risk of fall).

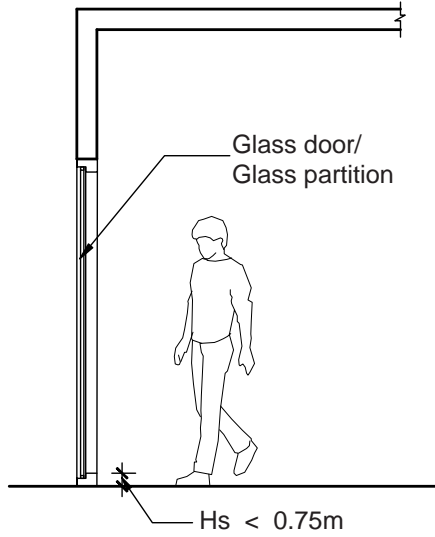


Fig.13

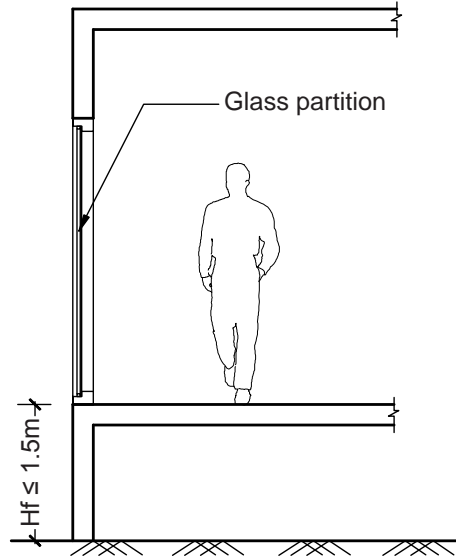


Fig.14

CASE 3: Vertical walls : $H_s < 0.75\text{m}$ & $H_f > 1.5\text{m}$. (human impact and risk of fall both).

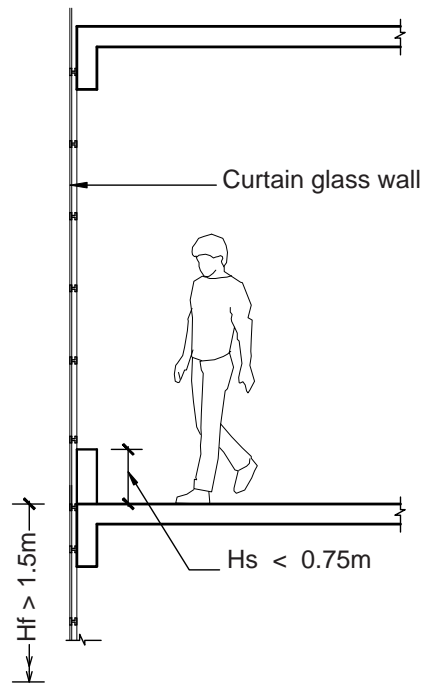


Fig.15

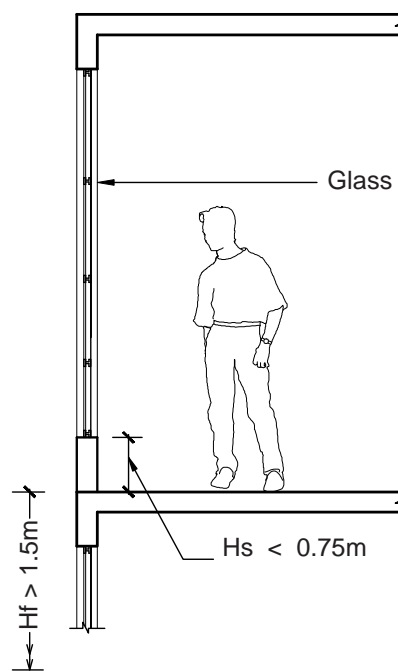


Fig.16

CASE 4: Horizontal or Sloped Glazing (risk of fall).

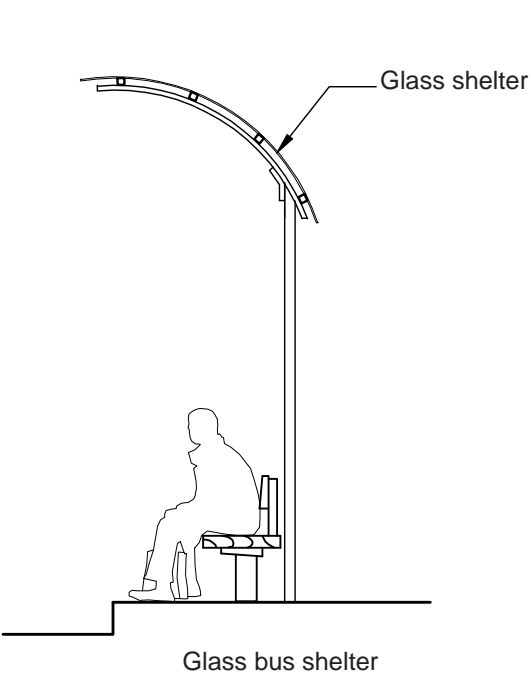


Fig.17

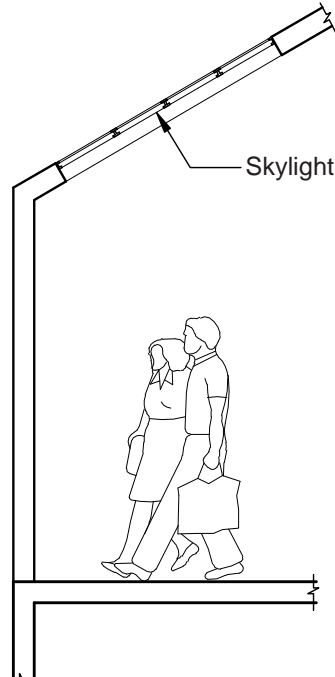


Fig.18

CASE 5: Glass acting as a balustrade, parapet or a railing (human impact and risk of fall both).

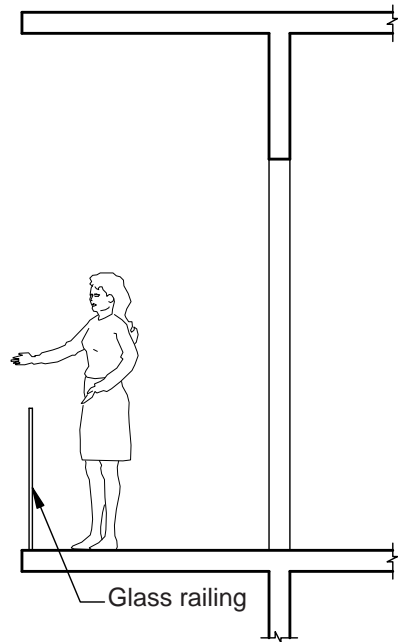


Fig.19

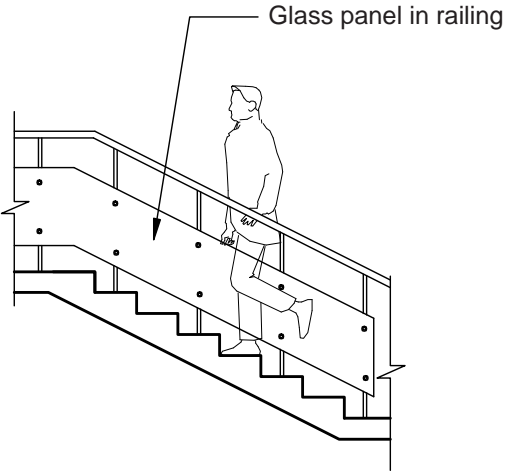


Fig.20

Annexure 2: Correlation between maximum glass area and glass thickness (Impact Load)

The annexure prescribes minimum thickness requirement based on area of pane of glass subjected to human impact. The annexure details out the minimum thickness requirement for various support condition as well as height of residual protection by provision of Sill, Chair Rail, barricade, grill or transoms.

A: FOUR SIDES FRAMED GLASS

In case of framed glass panels supported on four sides starting between the finished floor level and less than or equal to 750 mm as described in case 2 & case 3 given in Table A the maximum allowable area of the glass panel corresponding to thickness is as follows:

- Maximum area of normal or annealed glass less than or equal to 0.5 sqm,
- The maximum area of the safety glass with respect to its thickness shall be within the permissible maximum area as defined in the Table B below:

Table B : Maximum Permissible area of Safety Glass corresponding to thickness

Type of Glass	Nominal Thickness (mm)	Maximum allowable area (sqm)
Tempered Safety Glass	4	2
	5	3
	6	4
	8	6
	10	8
Laminated Safety Glass	12	10
	6	2
	8	3
	10	5
	12	7

(AS : 1288 - 2006)

In case of laminated glass the thickness of PVB is not accounted

- In case of glass panels supported on all four sides starting greater than or equal to 750 mm or a protection / transom / chair rail is in place permanently from the finished floor level as

given in Case 1, Table A, the thickness of annealed glass shall be within the permissible maximum area as defined in Table C below.

Table C : Maximum Permissible area of Annealed Glass corresponding to thickness in case of glass panes supported on all four sides

Type of Glass	Nominal Thickness (mm)	Maximum allowable area (sqm)
Annealed Glass	4	0.8
	5	1.2
	6	2.1
	8	3.2
	10	4.4
	12	6.3

(AS : 1288 - 2006)

B: TWO / THREE SIDES FRAMED GLASS

In case of glass panel supported on two / three sides starting greater than or equal to 750 mm or has a protection from the finished floor level as given in Case 1, Table A, then annealed glass can be used in following cases as mentioned in Table D else tempered or laminated glass shall be used.

Table D : Maximum Permissible area of Annealed Glass corresponding to thickness in case of glass panes supported on all four sides

Nominal Thickness (mm)	Maximum allowable height of glass (m)	Maximum allowable glass area (sqm)
6mm	< 1.2	0.9
8mm	> 1.2 to < 1.6	1.8
10mm	> 1.6 to < 2	2.7

(AS : 1288 - 2006)

B: FRAMELESS / NON-FRAMED GLASS

In case of frameless or non-framed glass panel toughened safety or laminated safety glass shall be used.

The thickness of safety glass and corresponding maximum permissible area is given in the following Table E:

Table E : Maximum Permissible area corresponding to thickness in case of frameless glass panel

Type of Glass	Nominal Thickness (mm)	Maximum allowable area (sqm)
Safety Glass	6	3.0
	8	4.5
	10	6.0
	12	7.5

(AS : 1288 - 2006)

In all above cases and in cases wherein the glass area exceeds 7.5 sqm. it is recommended to check and determine thickness of the glass using finite element analysis under wind load as per IS : 875 (Part 3) :1987 (Reaffirmed 1997) for external glazing.

C: POINT SUPPORTED GLASS

For point fixed system the glass area and glass thickness shall be determined by the specific strength analysis and type of point fixing hardware.

Note: If Insulating Glass Unit (IGU) is used in situations mentioned in this guide then any one of the following will apply:

- i) *If IGU is installed in areas subjected to human impact on either side then both the panes of the unit shall meet the requirements of this guide. The maximum area specified may be multiplied by 1.5 provided that each of the component glass of the unit otherwise complies with the relevant paras of this guideline.*
- ii) *In situations where access is restricted to one side of the unit, then only the accessible side should meet the requirements of this guide without the application of above- mentioned factor of 1.5.*

Annexure 3: Safety Glass Test Requirements

Relevant tests required for safety glasses are given in Table F below:

Table F

Test	Toughened Safety Glass	Laminated Safety Glass	Standard to be referred
Resistance to Shock Test	YES	-	IS : 2553 (Part 1)
Fragmentation Test	YES	-	
Warp Test	YES	-	
Boil Test	-	YES	
Fracture and Adhesion Test	-	YES	
Light Stability Test	-	YES	

In the above table 'YES' indicates test to be conducted.

Boil test for heat strengthened and toughened laminated glass can use laminates from ordinary annealed glass manufactured simultaneously.

Annexure 4: Suggestions for Fire Safety

Building Envelope

A: BUILDINGS WITH CURTAIN GLAZING

In case of Buildings with curtain glazing, following may be provided:

- a) Glazing panels required for venting and emergency access from the exterior may be provided in form of openable panels. Alternatively, knock-out panels are to be provided with tempered glass to allow fracturing of the glass into small pieces,
- b) Knock-out panels are identified by a non-removable reflective dot (typically 5 cms in diameter) located in the lower corner of the glass to be visible from the ground by the fire fighters, and
- c) Space between the slab and façade/glazing mullion/spandrel to be provided with fire stops and fire rated GI backup panel to stop fire traveling from one floor to another.

B: BUILDING WITH EXTERNAL WINDOWS

It is recommended that each enclosed space in buildings, be it residential or non-residential, have an egress window large enough for a fire-fighter to climb in or a person to step out in an emergency.

C: PERIMETER PROTECTION

The space between the edge of the floor slab and the façade/glazing, mullion/spandrel to be provided with fire stops and fire rated galvanized steel back up panel or fire rated glass assembly to prevent fire from travelling across floors.

D: PROTECTION AGAINST FIRE LEAPING

A curtain wall by its very nature does not provide effective fire compartmentation and can allow fire to leap up across floors from outside. The following may be provided to mitigate the risk:

- a) The use of fire sprinklers mitigate fire leaping. Alternatively fire rated assemblies may be provided to prevent transfer of fire to other sections of the building, and
- b) In case of unprotected buildings, spandrels of minimum 0.9 m height to be provided with insulation or minimum 0.6 m deep projections along the external surface of building.

E: PROTECTION AGAINST FALLING GLASS

In case of a fire in the building, if not contained quickly, falling glass from affected floor on fire men and occupants escaping from the building or others can become a major cause of concern. Following may be considered in order to ensure human safety:

- a) Providing tempered/toughened glass is the best protection, and
- b) Providing laminated glass is also a solution.

Internal Fire Compartmentation

The glass proposed to be used for internal fire compartmentation should either be low radiation (Class EW) or insulated fire rated glass (Class EI) conforming to National Building Code of India 2005.

Annexure 5: Definitions

<i>Area</i>	: The area of a panel between sightlines after glazing, calculated using the sight size.
<i>Annealed Glass</i>	: Another term for “ordinary” glass, most commonly used for float glass.
<i>Aspect Ratio</i>	: The ratio of a longer side of panel to its shorter side.
<i>Balustrade</i>	: A low wall forming a parapet to a stair, ramp, balcony, raised level or a change in level.
<i>Back Putty</i>	: The portion of the putty remaining between the glass and the depth of the rebate after the glass has been pushed into position.
<i>Beads or Glazing Beads</i>	: A strip of wood, metal or other suitable material attached to the rebate to retain the glass.
<i>Bite</i>	: The width of silicone used to bond the fin or frame member to the edge of the glass panel.
<i>Bedding Putty</i>	: The compound placed in the rebate of the opening into which the glass is bedded.
<i>Bent Glass</i>	: Flat glass that has been shaped while into hot cylindrical or other curved shapes.
<i>Bevelling</i>	: The process of edge finishing flat glass to a bevel angle.
<i>Block (Setting Block)</i>	: A small piece of wood, lead or other suitable material used between the edges of the glass (generally the bottom edge only) to centralize the glass in the frame (frequently called a setting block).
<i>Building</i>	: A structure, constructed with any materials whatsoever for any purpose whether used for any habitation or not and includes - “Assembly building”, which means a building or part thereof where groups of people congregate or gather for amusement, recreations, social, religious, patriotic, civil, travel and similar purpose. “Assembly building” includes buildings of drama and cinema theatre, drive-in-theatres, assembly halls, city halls, town halls, auditoria, exhibition halls, museums, mangal karyalayas, skating rinks, gymnasia stadia, restaurants, eating or boarding houses, places of worship, dance halls, clubs, gymkhanas, road, air, sea or other public transportation stations and recreation piers.
<i>Business Building</i>	: Any building or part thereof used for transaction of business and / or keeping of accounts and record therefore offices, banks, professional establishments, court houses being classified as business buildings, if their principal function is transaction of business and / or keeping of books and records.
<i>Chair Rail</i>	: A fixed glazing bar, or rigid push bar, that provides protection from human impact.
<i>Clear Glass</i>	: Transparent glass.

<i>Combustible Material</i>	: The material which when burnt adds heat to a fire when tested for combustibility in accordance with the IS 3808-1979: Method of Test for non-combustibility of building materials and National Building Code of India - 2005.
<i>Corridor</i>	: It means a common passage or circulation space including a common hall.
<i>Critical Locations</i>	: Parts of a building most likely to be subjected to accidental human impact.
<i>Curtain Wall</i>	: Non load bearing structure / partition of glass attached in a frame.
<i>Distance Piece</i>	: A small piece of wood, lead or other suitable material used to locate the glass between the bead and the back of the rebate, and prevent lateral movement.
<i>Door</i>	: A hinged, sliding or otherwise supported openable barrier providing entrance to and exit from a building, corridor or room. Doors may be framed or unframed.
<i>Double Glazing</i>	: Glazing that incorporates two panels, separated with an air space, for the purpose of sound insulation or thermal insulation or both.
<i>Edge Polished</i>	: Usually applied to flat glass, the edges of which have been polished after cutting.
<i>Edging</i>	: Grinding the edge of flat glass, to a desired shape or size.
<i>Exposed Edge</i>	: A glass edge that is not covered.
<i>External Wall</i>	: An outer wall of a building not being a party wall even though adjoining a wall of another building and also means a wall abutting on an interior open space of any building.
<i>Facade</i>	: Front or face of the building.
<i>Faceted Glazing</i>	: Flat panes of glass installed vertically at an angle to each other, to form a faceted curve.
<i>Fin</i>	: A piece of glass positioned and fastened to provide lateral support.
<i>Fire Resistance</i>	: It means the time during which a fire resistant material i.e. material having a certain degree of fire resistance, fulfills its function of contributing to the fire safety of a building when subjected to prescribed conditions of heat and load or restraint. The fire resistance test of structures shall be done in accordance with IS 3809-1979 Fire Resistance Test of Structures.
<i>Fire Resistant Glass</i>	: Ability of glass to prevent the passage of flame, hot gases, smoke and provide radiation control and/or insulation. The fire rating criteria of any building element is determined as per the following: <i>Integrity</i> : Prevention of passage of flames, hot gases and smoke from the fire side to the non fire side (denoted by the letter E).

Radiation Control: The radiation performance category defined at a qualifying maximum total heat flux of 15 Kw/Sqm. Values are determined based on measurements at standard distance of 1.0 metre from the glazed element till the end of standard fire test time period. This criterion can be achieved by the use of fully insulating fire resistant glass or by using integrity only glass types with additional radiation reducing property. Providing integrity along with keeping the radiated heat through the building element below 15 Kw/Sqm when measured at a distance of 1.0 metre from the building element (denoted by the letters EW).

Insulation: Providing Integrity along with keeping the average temperatures as measured by all the thermocouples on the non fire side below 140°C from the initial temperature considering that no thermocouple records a temperature more than 180°C from the ambient temperature at any point of time during the test (denoted by the letters EI).

- Fire Separation*** : It means the distance in metre measured from any other building on the site or from another site or from the opposite side of a street or other public space to the building.
- Flat Glass*** : A general term covering sheet glass, float glass and various forms of rolled and plate glass.
- Float Glass*** : A form of flat glass produced by reheating the continuous ribbon of glass whilst it floats over a bath of molten metal.
- Frame*** : A structure manufactured from timber, metal, glass or other durable material or combinations of materials such as glass fins and structural sealant, supporting the full length of a glazed panel edge.
- Frameless Glazing*** : See unframed glazing.
- Front Putty*** : The compound forming a triangular fillet between the surface of the glass and the front edge of the rebate.
- Fully Framed Glazing*** : Panels that have all edges framed.
- Glass*** : An inorganic, non-metallic material produced by the complete fusion of raw materials at high temperatures, into a homogeneous liquid, which is then cooled to a rigid, condition essentially without crystallization.
- Glazing*** : The securing of glass in prepared openings in windows, door panels, partitions and the like.
- Guarding*** : Glass used to prevent people falling wherever there is a change in floor level by means of a permanent barrier.
- Heat Soaking*** : Heat Soaking is done on toughened glass by reheating to a temperature of 290°C and keeping it at this temperature for eight hours and cooling it gradually. The glass can break spontaneously and without provocation due to possible impurity of Nickel Sulphide in basic glass used for tempering. This risk of spontaneous breakage can be minimised by heat soaking process by forcing such glasses to break in the factory itself.

<i>Heat Strengthened Glass</i>	: Glass which has been heated past its softening point and chilled rapidly to increase its strength and make it thermally safe, but which breaks like annealed glass.
<i>Heat Strengthened Laminated Safety Glass</i>	: Laminated Safety Glass utilizing two or more panels of heat-strengthened glass in the make up.
<i>High Activity Area</i>	: Where multiple human activity takes place.
<i>High Risk Area</i>	: Area prone to human injury.
<i>Infill Balustrades</i>	: Balustrades in which the supported glass resists an infill pressure and / or point load applied to the glass panel.
<i>Insulating Glass Unit</i>	: The standard configuration for residential and commercial windows consisting of a (IGU) sealed unit of two panes of glass separated by a metal spacer.
<i>Internal Partition</i>	: An interior dividing wall or such portion of an interior dividing wall that is not a door, side panel, shopfront or atrium wall.
<i>Laminated Glass</i>	: A composite material consisting of two or more sheets of glass permanently bonded together by a plastic interlayer material.
<i>Laminated Safety Glass</i>	: Laminated glass that satisfies the requirements for a safety glazing material according to this guide.
<i>Maximum Thickness</i>	: The thickness of a panel of glass at the maximum thickness tolerance.
<i>Manifestation</i>	: Any technique for enhancing a person's awareness of the presence of transparent glazed areas.
<i>Minimum Thickness</i>	: The thickness of a panel of glass at the minimum thickness tolerance.
<i>Mirror</i>	: A piece of glass silvered on one side, with a protective paint coating.
<i>Monolithic Glass</i>	: A single sheet of flat glass which could be either annealed, toughened or heat strengthened.
<i>Nominal Thickness</i>	: A numeric designation used for reference purposes that indicates the approximate thickness of glass.
<i>Non-combustible</i>	: It means not liable to burn to add heat to a fire when tested for combustibility in accordance with the IS:3808-1979, Method of Test for non-combustibility of building materials.
<i>Non-residential Buildings</i>	: Buildings other than those defined above such as hotels, hostels, motels, shops, offices, schools, public assembly buildings, and factories and those parts of the residential buildings common to a group of dwellings such as common circulation areas in blocks of two or more flats.
<i>Pane</i>	: Single piece of glass cut to size for glazing.

<i>Panel</i>	: An assembly containing one or more panes.
<i>Parapet</i>	: It means a low wall or railing built along the edge of the roof or a floor.
<i>Partition</i>	: It means an interior non-load bearing divider, one storey in height or part.
<i>Partly Framed Glazing</i>	: Panels that have one or more edges unframed.
<i>Patterned Glass</i>	: Rolled glass having a distinct pattern on one or both surfaces.
<i>Rebate</i>	: The part of a surround; the cross section of which forms an angle into which the edge of the glass is received.
<i>Reflective Coated Glass</i>	: Glass with metallic or metallic oxide coating applied onto or into the glass surface to provide reduction of solar radiant energy, conductive heat energy and visible light transmission.
<i>Residential Buildings</i>	: Buildings and such portions of buildings used as separate dwelling houses and flats, but not incorporating common circulation areas in blocks of two or more flats.
<i>Residual Protection</i>	: It is the protection provided to avoid the impact of human being to glass. It is provided on the side of glass where there are chances of Human impact. It can be achieved by providing a sill structure or a grill inside.
<i>Safety Organic-coated</i>	: A glazing material consisting of a piece of glass coated and permanently bonded on one or both sides with a continuous polymeric coating, sheet or film, which meets the test requirements of the safety glazing standards.
<i>Shower doors, Shower screens and Bath enclosures</i>	: The panels, doors or windows enclosing or partially enclosing a shower or bath.
<i>Side Panel</i>	: A panel (operable or inoperable) located adjacent to a doorway. It may or may not be in the same plane as the doorway.
<i>Skylight</i>	: A fenestration surface having a slope of less than 60° from the horizontal plane. Other fenestration, even if mounted on roof of a building is considered as vertical fenestration.
<i>Sloped Overhead Glazing</i>	: Glazing that is inclined at less than 75 degrees to the horizontal and located, wholly or partially, directly above an area that may be used by people.
<i>Span</i>	: The dimension between supports. For panels supported on all four edges, it corresponds to the smaller of the sight size dimensions.
<i>Spandrel</i>	: That portion of the exterior wall of a multistory commercial building that covers the area below the sill of the vision glass installation.
<i>Tempered or Toughened Glass</i>	: When float glass panels are heated and then cooled rapidly in a controlled environment.

<i>Tinted Glass</i>	: Normal float glass to which colorants are added during manufacturing process to achieve tinting and solar radiation absorption properties.
<i>Transom</i>	: Horizontal bar of wood, aluminium or stone etc. across a window, door or partition.
<i>Toughened Laminated Safety Glass</i>	: Laminated safety glass utilizing two panels of toughened safety glass in the make up.
<i>Unframed Glazing</i>	: Panels without framed edges.
<i>Wardrobe Doors</i>	: Doors that provide access to built in storage areas, excluding those fitted to pieces of furniture that are not built into the building.
<i>Wind Load</i>	: Load on glass because of the speed and direction of wind.
<i>Window</i>	: It means an opening other than a door, to the outside of a building which provides all or part of the required natural light, ventilation.
<i>Window Sill</i>	: Solid wall (brick or concrete wall) starting from the finished floor level to the base of first window or structural member consisting of a continuous horizontal metal/ wooden forming the lowest member of a framework or supporting structure.

Annexure 6: References

- IS : 2553 (Part 1) - 1990 - Safety Glass - Specification.
- IS : 2835 - 1987 - Specification for Flat Transparent Sheet Glass (third revision).
- IS : 875 (Part 3) Reaffirmed 1997 - Codes for the Wind Loads.
- IS : 3548 - 1988 (Reaffirmed 2009) - Code of Practice for Glazing in Buildings.
- IS : 10439 - 1983 - Code of Practice for Patent Glazing.
- IS : 7760 - 1985 - Specification for steel glass-front cabinet.
- IS : 3808 - 1979 - Method of Test for non-combustibility of building materials.
- IS : 3809 - 1979 - Fire resistance test of structures.
- IS : 14900 – 2000 (Reaffirmed 2005) - Transparent float glass - Specifications.
- National Building Code of India 2005.
- 16 CFR Ch II (1-1-04 Edition) - Part 1201 - Safety Standards for architectural glazing materials.
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- AS : 1288 - 2006 - Glass in Buildings - Selection and Installation.
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- BS : 6262 - Part 4 - 1994 - Code of Practice for Glazing for Buildings - Safety related to Human Impact.
- BS : 6262 - Part 6 - 1997 - Code of Practice for Glazing for Buildings: Special Applications.
- BS : 952 - For nominal thickness of glass.
- BS : 8000 - Part 7 - 1990 - Workmanship on Building Sites - Code of Practice for Glazing.
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- BS : 8213 - Part 4 - 1990 - Windows, Doors and Rooflights: Code of Practice for the Installation of Replacement Windows and Doorsets in Dwellings.
- BS EN : 12600 - 2002 - Glass in buildings - Pendulum tests - Impact test method and classification for flat glass.
- BS : 7499 - 1991 - Specification for inclusion of glass in the construction of furniture, other than tables or trolleys, including cabinets, shelving systems and wall hung or free standing mirrors.
- BS : 7376 - 1990 - Specification for inclusion of glass in the construction of tables or trolleys.
- BS EN : 1727 - 1998 - Domestic furniture, storage furniture, safety requirements and test methods
- BS EN : 1153 - 1996 - Kitchen furniture, safety requirements and test methods for built-in and free standing kitchen cabinets and work tops.
- EN 13501 - 2 Classifications of Fire Resistant glass.
- JIS R 3206 : 1997 - Tempered Glass.
- JIS R 3205 : 1998 - Laminated Glass.
- DIN 52 337 : Methods of testing flat glass for use in buildings - pendulum impact tests.
- Glass Association of North America Installation Guide.
- Guidelines for Use of Glass in Buildings, by Dr. N.K. Garg, Professor, Faculty of Architecture, MIT, MAHE, Manipal & Former Head, H & P Division, Central Building Research Institute (CBRI), Roorkee, India.

LIST OF STEERING COMMITTEE MEMBERS

A Steering Committee on “Guidelines on use of Glass in Buildings - Part A : Human Safety” was constituted to ensure the integrity of the process and the acceptance of the recommendations of the committee by the industry. Four meetings of Steering Committee, two in Delhi, and one each in Mumbai and Bangalore were organized. Apart from the discussion of the draft in Steering Committee meetings, it was widely circulated amongst the Architects, Engineers and Professionals to solicit comments and views to ensure preparation of documents useful acceptable and adoptable to the industry.

The role of Steering Committee was to:

1. Guide and support the secretariat in its functioning
2. Assist and advise and if possible share responsibility in background research, analysis, preparation of draft report
3. Review and confirm the draft report
4. Assist and advise on wider feedback to the draft report.
5. Review and confirm the final report

Below is the list of the members of the Steering Committee:

1. Mr. Abhijit Ray, Architect, The Indian Institute of Architects, Delhi
2. Mr. A. B. Bhalerao, Director, Garware Polyester Ltd., Aurangabad
3. Mr. Ajay Patwardhan, GLS Business Manager - India/ASEAN, EI Dupont India Pvt. Ltd., Gurgaon
4. Mr. A. K. Jain, Commissioner Planning, Delhi Development Authority (DDA), Delhi
5. Mr. A. K. Singhal, Chief Engineer, Public Works Department (PWD) - Delhi, Delhi
6. Mr. Alok Taparia, AGM Marketing, HNG Float Glass Ltd., Delhi
7. Mr. Amit Malhotra, Managing Director, McCoy Silicones Ltd., Delhi
8. Mr. Anand Jain, Project Manager, Saint Gobain Ltd., Chennai
9. Mr. Anuj Munot, Director, Kalpataru Properties Private Limited, Mumbai
10. Mr. Aprameya Kar, Architect, Unitech Ltd., Gurgaon
11. Mr. Arun Sharma, Managing Director, Trosifol India Private Limited, Delhi
12. Mr. Ashok B Lal, Architect, TVB School Of Habitat Studies, Delhi
13. Mr. Ashok Kumar, Architect Scientist - Housing & Planning, Central Building Research Institute, Roorkee
14. Mr. Ashok Menon, Division Head - Construction Market Center, 3M India Ltd., Bangalore
15. Mr. Ashok Shintre, Chief Engineer (DP), Municipal Corporation of Greater Mumbai, Mumbai
16. Mr. Balbir Verma, Architect, Balbir & Associates, Delhi
17. Mr. B.L Moolchandani, Chief Engineer 1st, Rajasthan Housing Board, Jaipur
18. Mr. Deepak Malik, Executive Director, ABC Group, Bangalore
19. Mr. Deependra Prashad, Architect, Secretary, International Network for Traditional Building, Architecture & Urbanism (INTBAU), Delhi
20. Mr. Dhananjay Dhake, Architect, Construction Catalysers Pvt. Ltd., Pune
21. Mr. Feroz Kachwala, Director, FG Glass, Mumbai
22. Dr. Gerard Savineau, Architectural Applications Manager, Safflex Interlayers, France
23. Mr. G. P. Savlani, Resident Director, Confederation of Real Estate Developers Associations of India, Delhi
24. Mr. Ingawale V. D., Executive Engineer, Building Proposal Department of M.C.G.M., Municipal Corporation of Greater Mumbai, Mumbai
25. Mr. Jatinder Wasan, MD, Sky Frames, Delhi
26. Mr. K. Nagaraj, Architect, CPG Corporation, Bangalore
27. Mr. K.K. Mutreja, Engineer-in-Chief (Retd.), New Delhi Municipal Council (NDMC), Delhi
28. Mr. K.K. Trivedi, Secretary General, All India Flat Glass Manufacturers Association (AIFGMA), Delhi
29. Mr. Kiran A. Kadam, Retd Chief Fire Officer, Mumbai Fire Brigade, Mumbai
30. Mr. Kunwar Narayan, Chief Operating Officer, AIS Glass Solutions Ltd., Delhi
31. Dr. Leon Jacob, Jacob and Associates Pty. Ltd., Australia
32. Mr. L. Mahesh, AGM -Planning, Skyline Builders, Cochin
33. Mr. L. Venkatesh, Architect, C.R Narayanan Rao Architects and Engineers, Chennai
34. Mr. Manjunatha Prasad, GM (Projects), Brigade Gateway, Bangalore
35. Mr. Mayank K. Tilak, Superintending Engineer (TAS)/CSQ., Central Public Works Department (CPWD), Delhi
36. Ms. Meeta Zaveri, Director, Gras Impex Pvt. Ltd., Mumbai
37. Mr. Nalin Sharma, Architect (Ex), Airports Authority of India (AAI), Delhi
38. Mr. Naren Kumar, Manager - Institutional Sales, Saint Gobain Ltd., Chennai
39. Mr. Naveen Keswani, Managing Director, Aluplex India Pvt. Ltd., Mumbai
40. Mr. N. Gopinath, National Sales Manager, 3M India Ltd., Bangalore
41. Mr. N. G. Rao, National Head, Gujarat Guardian Ltd., Delhi
42. Mr. Nilabh Nagar, Architect, Architect Hafeez Contractors, Mumbai
43. Mr. Nimish Patel, Architect, Abhikram, Ahmedabad
44. Mr. Paresch Misra, HOD - Architectural Division, Gujarat Guardian Ltd., Delhi
45. Mr. P. Ganesh, Executive Director and Chief Executive Officer, Glass & Glazing Systems (P) Ltd., Kerala
46. Ms. Pallabi Chandra Sarkar, Director Planning, Archimedes India Consultants Pvt. Ltd., New Delhi
47. Mr. Phil Murray, Technical Services Manager, CP Films - Middle East, Africa, India
48. Mr. Phillip Davies, Architectural Director, Asia Pacific, Dupont Australia, China
49. Mr. Prashant Yadav, Architect, SP Fabricators Pvt. Ltd., Bangalore
50. Mr. Raj Kapoor, Architect, Department of Architecture, Public Works Department (B&R), Haryana
51. Mr. R. K. Gandhi, Chief Engineer, Public Works Department (B&R), Haryana

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52. Mr. R. Raj Dilip, Sr. Architect, Natraj and Venkat, Chennai
 53. Mr. R. Subramanian, Director (Operations), Sejal Architectural Glass Ltd., Mumbai
 54. Mr. Sandeep Chowdhry, Managing Partner, Al Karma, Delhi
 55. Mr. Sandeep Gaiwal, Assistant Engineer, Building Proposal Department of M.C.G.M., Municipal Corporation of Greater Mumbai, Mumbai
 56. Mr. Sandeep Kashyap, Executive Director, GlasNovations, New Delhi
 57. Mr. Sanjeev Oberoi, Institutional Glass Group, Delhi
 58. Mr. S. Balakrishna, Additional Chief City Planner, Greater Hyderabad Municipal Corporation, Hyderabad
 59. Mr. S.C. Bhatia, ADG, Architecture (Retd.), Central Public Works Department (CPWD), Delhi
 60. Mr. S. C. Marwah, VP, Indo Alusys Industries Ltd., Delhi
 61. Mr. Sharanjit Singh, Managing Director, GSC Toughened Glass Pvt. Ltd., Greater Noida
 62. Mr. Sthaladipti Saha, Deputy Design Head, Larsen & Toubro Limited | ECC Division, Gurgaon
 63. Mr. Srinivas Sapher, Sales Manager, Gujarat Guardian Limited, Delhi
 64. Prof. Subir Saha, School of Planning and Architecture, New Delhi
 65. Mr. Sudhir Kumar, Addl. Chief Executive Officer, Greater Noida Industrial Development Authority, Uttar Pradesh
 66. Mr. Suhel, Managing Director, FG Glass, Mumbai
 67. Mr. Syed Muzaffir Hussain, Director House Numbering Cell and Chief City Planner, Greater Hyderabad Municipal Corporation, Hyderabad
 68. Mr. Tarun Motta, Secretary, Practising Engineers, Architects and Town Planner Association, Mumbai
 69. Mr. V. B. Sud, Business Manager, Solutia Chemicals India Pvt. Ltd., Delhi
 70. Mr. V. D. Deewan, Chief Architect, Delhi Development Authority (DDA), Delhi
 71. Mr. Vijay Dahiya, Architect, Morphogenesis Architect Studio, Delhi
 72. Mr. Vivek Dubey, Marketing Head, Gold Plus Toughened Glass Limited, Delhi
 73. Mr. V. K. Rustogi, General Manager - RE, National Buildings Construction Corporation Ltd. (NBCC), Delhi
 74. Mr. Vinod Tandon, Secretary, Glass Processors Forum, Delhi
 75. Mr. Vivek Sabherwal, Architect, Interior India, Delhi
 76. Mr. Yogesh Dutt, Director, Impact Safety Glass Works Private Limited, Bangalore
 5. Mr. Gaurav Tyagi, Director, Shiv Shakti Float Glass Pvt. Ltd., Bangalore
 6. Mr. Giriappa, Proprietor, Giriappa and Associates, Bangalore
 7. Mr. G. Naga Varma, AGM - Marketing, HNG Glass Containers Ltd. Mumbai
 8. Mr. Jaubilant C., Architect, Saint Gobain Glass, Bangalore
 9. Mr. Javed Anwar, Managing Director, Milestone, Bangalore
 10. Mr. K R. Singh, Branch Manager, GSC Toughened Glass Private Limited, Bangalore
 11. Mr. Madan Lal, Director, Mahaveer Safety Glass, Chennai
 12. Ms. Manisha Thakur, Sr. Engineer - Projects, Oberoi Constructions, Mumbai
 13. Mr. Manoj Chandel, Area Sales Manager, Garware Polyster Limited, Delhi
 14. Mr. Motta Tarun, Joint Secretary, Practising Engineers and Architecture Town Planner Association (PEATA), Mumbai
 15. Mr. Nanda Kumar, Commercial Department, S.P. Fabricators, Mumbai
 16. Mr. Nainish B Sanghani, EI Dupont India Pvt. Ltd., Gurgaon
 17. Mr. Neeraj Mathur, Regional Manager, FG Glass, Mumbai
 18. Mr. Pankaj Keswani, Managing Director, Alufit, Bangalore
 19. Mr. Pradeep Ramesh, Engineer, A. N. Prakash and Consultants, Mumbai
 20. Mr. Praveen, EDM (South), S. P. Fabricators, Mumbai
 21. Mr. Prem, Sr. Vice President, Zak Trade Fairs and Exhibition, Mumbai
 22. Mr. Raj Gopal, Architect, Sundaram Architects, Bangalore
 23. Mr. Ravindra Mudugu, Assistant Manager - Projects, Oberoi Constructions, Mumbai
 24. Mr. Satya Kiran, Sr. Architect, Archimedes India Consultants Pvt. Ltd., New Delhi
 25. Ms. Sheetal Jain, Sales Manager, Sun Control Systems, Delhi
 26. Mr. Sourabh Mathur, Sr. Manager, Business Operations, Sky Frames, Delhi
 27. Mr. Srinivasan Desikachari, Architect, CREDAI, Bangalore
 28. Mr. Susanta, Engineer, Natraj and Venkat, Bangalore
 29. Mr. Sushil Padwal, Officer Purchase, Kalpataru Properties Private Limited, Mumbai
 30. Mr. T. Ravindran, Director, Instruct, Bangalore
 31. Mr. Uttaran B. Ray, Director and Architect, Impact Safety Design
 32. Mr. Vasim Sayed, Manager North, S. P. Fabricators, Mumbai
 33. Mr. Vijay G., Assistant Technical Manager, 3M India Limited, Bangalore
 34. Mr. Vineet Gupta, Territory Head, Gujarat Guardian Limited, Bangalore
 35. Mr. Vivek Kulkarni, Assistant Manager - Projects, Oberoi Constructions, Mumbai

List of special invitees to steering committee meetings

During four Steering Committee meetings organized two in Delhi, and one each in Mumbai and Bangalore, following professionals participated as special invitees:

1. Mr. A. C. Kadir Velu, Consulting Engineer, Bangalore
2. Mr. Ajit Chnadrashekar, Manager - Institutional Sales, Saint Gobain Glass, Bangalore
3. Mr. Bharat Gawde, Officer Purchase, Kalpataru Properties Private Limited, Mumbai
4. Mr. Brijesh Kumar, Sr. Manager, Design, Staralubuild Pvt Ltd, Gurgaon

LIST OF EXPERT COMMITTEE MEMBERS

1. **Sh. P. B. Vijay** **Chairman**
Former Director General, Central PWD
2. **Sh. D. S. Sachdev**
Director General, Central PWD
3. **Sh. Mayank K. Tilak**
S.E.(TAS), Central PWD
4. **Sh. P. Krishnan**
Former Director General, Central PWD
5. **Sh. B. S. Duggal**
Former Director General, Central PWD
6. **Sh. P. S. Chadha**
Former Additional Director General, Central PWD
Consultant, Indian Buildings Congress
7. **Sh. Balbir Verma**
Former President, Indian Institute of Architecture
8. **Sh. Subhash Kapoor**
Former Additional Director General, Central PWD
Consulting Engineers Association of India
9. **Sh. Subhash Mehrotra**
Consulting Engineers Association of India
10. **Sh. Deepak Gahlawt, Architect**
Convener,
Confederation of Construction Products & Services
11. **Sh. K. K. Mutreja**
Former E-in-C, NDMC & Additional Director General, Central PWD
Adviser, CCPS
12. **Sh. Shashi Kant**
Former Dy. Adviser, Planning Commission
Adviser, CCPS
13. **Sh. Sharanjit Singh**
Managing Director
GSC Toughened Glass Pvt Ltd
14. **Sh. Kunwar Narayan**
Chief Operation Officer
AIS Glass Solutions Ltd
15. **Sh. Anand Jain**
Head - Design & Commercial
Structural Glass Solution
Saint Gobain Glass India Ltd.



Confederation of Construction Products and Services

S1&S2, 2nd Floor, Abhishek Tower, D-II, Alaknanda Commercial Complex,
New Delhi - 110019

Tel: +91-11-26023615, TeleFax: +91-11-26021709

Email: ccps@ccpsindia.com

Website: www.ccpsindia.com

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