

Glass in Architecture

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Abstract: Glass, a hard, brittle building material generally transparent and translucent. It has been a fascinating material since it was first invented. It is hard to visualize architecture without glass. This is the oldest building material, now a vital appearance of buildings. But the question arises is that up to what extent the building should be glazed?

This paper concerns with the type of glasses with their use in building w.r.t surrounding, combination of different façade material with glass, so as to understand the smart use of in a building.

Keywords: Building material, visualize architecture, types, facade material

1. Introduction

Glass, one of the most versatile and oldest material in the building industry. It is hard, brittle material generally transparent and translucent, made by fusing sand, lime and cooling rapidly. Glass is most often used as a transparent glazing material in building envelope, including window panes, external walls, etc.

The demand on use of glass in building has been increasing frequently from last few decades. This ancient building material contributes to extraordinary appearance of building by combining with different materials such concrete, steel, metal, wood, stone and with many types of cladding material.

A. Properties of glass

Transparency: Transparency is an important property of glass which connects the vision of inside world with outside and vice-versa. It can be from one side or both the sides. One side transparency will act like a mirror. one can also alter its properties by adding some additives at its initial mixing stage.

Strength of glass: Strength of glass depends on modulus of rupture value of glass (ability to resist deformation under load). In general glass is a brittle material but by adding admixtures and laminates we can make it as more strong.

Workability of glass: It is capable of being work in many ways. It can be blown, drawn, or pressed to make clear, clean colorless, or stained glasses. It can also be welded by fusion method.

Transmittance: The visible fraction of light that passing through glass is the property of visible transmittance.

U value of Glass: The U-value is the measure of how much heat is transferred through the window. The lower the U-value the better the insulation properties of the glass– the better it is

at keeping the heat or cold out.

Recycle property: Glass is 100% recyclable. Culets are used as raw materials in glass manufacture, as aggregates in concrete construction, etc.

Greenhouse effect: Longer infra-red radiations from sun are unable to pass from glass. This leads to more heat and high temperature outside.

Solar heat gain coefficient: It is the fraction of incident solar radiation that actually enters a building through the entire window assembly as heat gain.

Energy efficiency and acoustic control: Double glazing or triple glazing are used nowadays not only to control room temperature but also to enhance the acoustic control.

2. Types of architectural glass and their use

A. Types of float glass

Float glass has perfectly flat, and brilliant surface also called as flat glass. It is produced by mixing all the ingredients of glass, heat them till molten state and then cooling the mixture.

1. **Clear glass:** Clear and transparent glass, usually greenish hue in color. This type of glass generally used in doors, windows, solar applications, shelves etc. Thickness- 3,5,6,12,19 in mm.
2. **Tinted glass:** Melted colorants are added to float glass for tinting and for solar radiation absorption properties. It saves energy, reduces heat penetration into the building, gives a striking visual effect. Thickness- 4mm to 12mm.



3. **Patterned/Textured glass:** This type of glass has pattern or texture on one of the faces, generally used for providing privacy to the interiors of house, windows and doors of bathroom even in house also. Thickness- 4mm, 6mm
Standard sheet size- 2160X1650mm



4. **Wired glass:** Wire mesh is set in the glass to protect from shattering and breaking out under stress. They are low cost fire resistant glass hence it is useful to protect against the effect of smoke and flame. It is generally used in roofs, skylights, fire resistant doors, windows etc.

Thickness- 6mm to 19mm
 Standard sheet size- 1370X1370mm



5. **Extra clear glass:** It is a colorless transparent glass which provides clear view without any distortion of color of object. Therefore it is used in aquariums, solar panels, art galleries, front façade of showrooms etc.

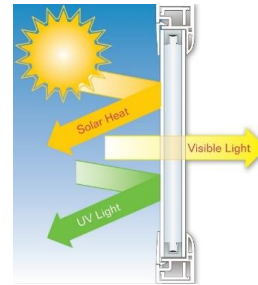
Thickness- 3mm to 19mm
 Standard sheet size – 3210X2250mm, 3210X2000mm

B. Types of high performance glass

High performance glass unit contains glass is separated by air, gas or vacuum to trap and reflect the rays coming through them. They act as a good insulator and also called as double glazed units.

1. **Solar control glass:** For tropical countries like India, this type of glass is very suitable as it transfers less amount of heat in buildings and also reduce the amount of air conditioning required. Therefore, it is used in skyscrapers as glass facades, conservatory roofs, air conditioned malls, showrooms etc.
2. **Low-E glass:** This type of glass has excellent thermal insulation properties. It allows only visible light to enter the room and thus gives protection from U.V. rays and infrared rays. In cold climates, they help us in maintaining the temperature of interior and provide energy efficient solution.
3. **Solar Control Low-E glass:** For facades, which are in direct contact of sunlight, only low-e glass cannot be used, as they will trap the heat inside, leading to overheating of interiors. In that case, solar control low-e glass will be used because it blocks solar radiations as well as provide thermal insulation. Best example-

Burj Khalifa, where this type of glass is used to decrease the air conditioning cost.



C. Types of processed glass

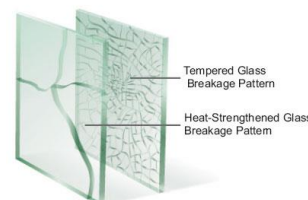
1. **Laminated glass:** They are made by applying a layer of polyvinyl butyl between 2 or more layers of glasses to hold together when shattered. They are sound proof; bullet proof therefore acts as good insulators. Because of these properties they are extremely used in automobiles, curtain walls, windows etc.



2. **Toughened/Tempered glass:** Toughened glass are very strong, when it breaks, it forms small granular chunks which causes less injury. They have low visibility therefore used for fire resistant doors, escalator side panels and viewing partition of airports, resorts etc.



3. **Heat Strengthened glass:** This type of glass is treated with heat to increase its durability for safety reasons. They are generally used in glazing system because of its less strength as compared to toughened glass and their breaking pattern which may cause injury.



4. *Reflective glass/Mirrors:* This type of glass imparts one-way mirror like appearance because of its metallic coating on it that cut off the solar heat. And also preventing visibility from outside thus preserving privacy. Primarily used for structural glazing façade.



5. *Ceramic Printed glass:* Ceramic glasses are very popular nowadays as it enhances the beauty facade or any space of a building with its high strength as compared to float glass. It is used for curtain walls, shower partitions or any other partitions, conference room etc.

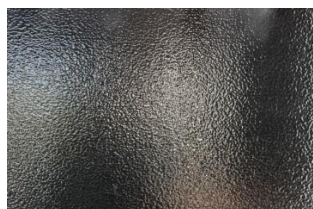


Ceramic printed glass used in facade

6. *Lacquered glass:* It is obtained by coating back surface of float glass, specially extra clear glass with lacquer. It has shiny and colored surface therefore it is used in wall cladding, glass partitions, kitchen glass backsplash. This is highly durable and resist U.V. rays thus does not fade during its lifetime.



7. *Frosted glass:* Frosted glass has translucent surface. It scatters the light passing through it. It is usually used in homes as it imparts decorative look.



3. Study about quality and quantity of glass needed in a building w.r.t. environment

The main focus in building is usually on saving energy, especially in the challenging time of increasing prices for energy and raw materials. If one looks at the expenditure of a building, around 15% of energy is spent on artificial lightning and around 35% is on cooling/air conditioning.

Therefore, Glass has become the easiest solution to all such problems. It supplies natural daylight in a building, protects from rain, water, cold, heat, fire. It provides not only psychological comfort but also acoustic environment. It's a good insulating material. Now-a-days, there are n. no. of high quality glasses are used which allow only visible light enter into a building rest u.v. rays, infrared rays get reflected from glass. Because of this all other materials have almost disappeared. Today Indian metros are full of high-rise fully glazed buildings. There is no doubt that they give hi-tech look to a building and also provide a good statement to a building even after years. But still a question arises is that 'IS IT SUSTAINABLE'?

Glass is 100% recyclable material. It provides many benefits to the environment like it helps in mitigating climate change, saves natural resources. Glass is more sustainable material as compared to concrete as it emits very less carbon footprint than concrete.

According to the criteria of GRIHA, LEED, sustainable materials are environmental responsible and resources efficient and resource efficient throughout its life-cycle and glass has all such properties.

Table 1
Leed-India Rating System

Rating	No. of Points Max. 69	No. of Points (2011) Max. 110
Leed Certified	26-32	40-49
Leed Certified Silver Level	33-38	50-59
Leed Certified Gold Level	39-51	60-79
Leed Certified Platinum Level	52-69	Above 80

Table 2
Important criteria and point allocation

S. No.	Criteria	Points
	Prerequisites	8
1.	Sustainable Sites	13
2.	Water Efficiency	6
3.	Energy And Atmosphere	17
4.	Material And Resources	13
5.	Indoor Environment Quality	15
6.	Innovation and Accredited Prof. Points	5
	Total	69

Best examples of fully glazed sustainable building which are approved by GRIHA, LEED.

A. Wipro Technologies, Noida, India



Gold rated LEED certified green building by IGBC in new construction category.

B. Suzlon One Earth, Pune, India



It has received LEED PLATINUM RATING in 2010

C. Infinity Benchmark, Kolkata, India



It has received LEED PLATINUM RATING

4. Conclusion

From the above examples, it is cleared that glass is a sustainable material. One should not directly jump to the conclusion; the question should be on longevity or the life-cycle.

Earlier, low quality glass were used in buildings even in window panes therefore they have less durability, but now, there are many high quality glasses are used in buildings, as

façade, roof, windows, skylights, walls etc. which have long durability and also ecofriendly. On the basis of study, it is concluded that glass is more extensively applied in building because of its versatile nature. It provides not only acoustic environment but also psychological comfort. Apart from esthetic criteria, one should know the optimum quality and quantity of glass used in buildings. According to ECBC 2007 INDIA, only 40% of glazing is allowed and 60% in some of the cases. There is great no. of glasses which we use today, suitable choice of glass type can improve the energy efficiency of the building and also given potential for future development in the

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