



# Glass in Buildings



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# Glass in buildings

Glass is one of the most versatile and oldest materials in the building industry. Glass, a fascinating material, and usually quite viable in most places, glass has become useful material in architecture. Both classic and modern, its use in the construction industry has stood the test of time for over centuries now. The translucent and transparent nature of the material often accompanied every other material, be it cement, mud or steel in today's times. It has now moved heights, literally, with more and more skyscrapers in the world using it with steel as the prominent construction material.

In this edition of eMag we have focused on topics such as Glass facade, An overview of advantages and types, Importance Of Glass In Architecture Design, Different Types of Glass Used in Building Architecture, Solar glass for building architecture and Structural glazing systems in buildings. In today's time, glass has every quality desired of construction material, with experiments, all types of glasses like insulation glasses, fire-resistant, thermal control, etc. are now being used to make sure that the building can withstand any circumstantial environments.

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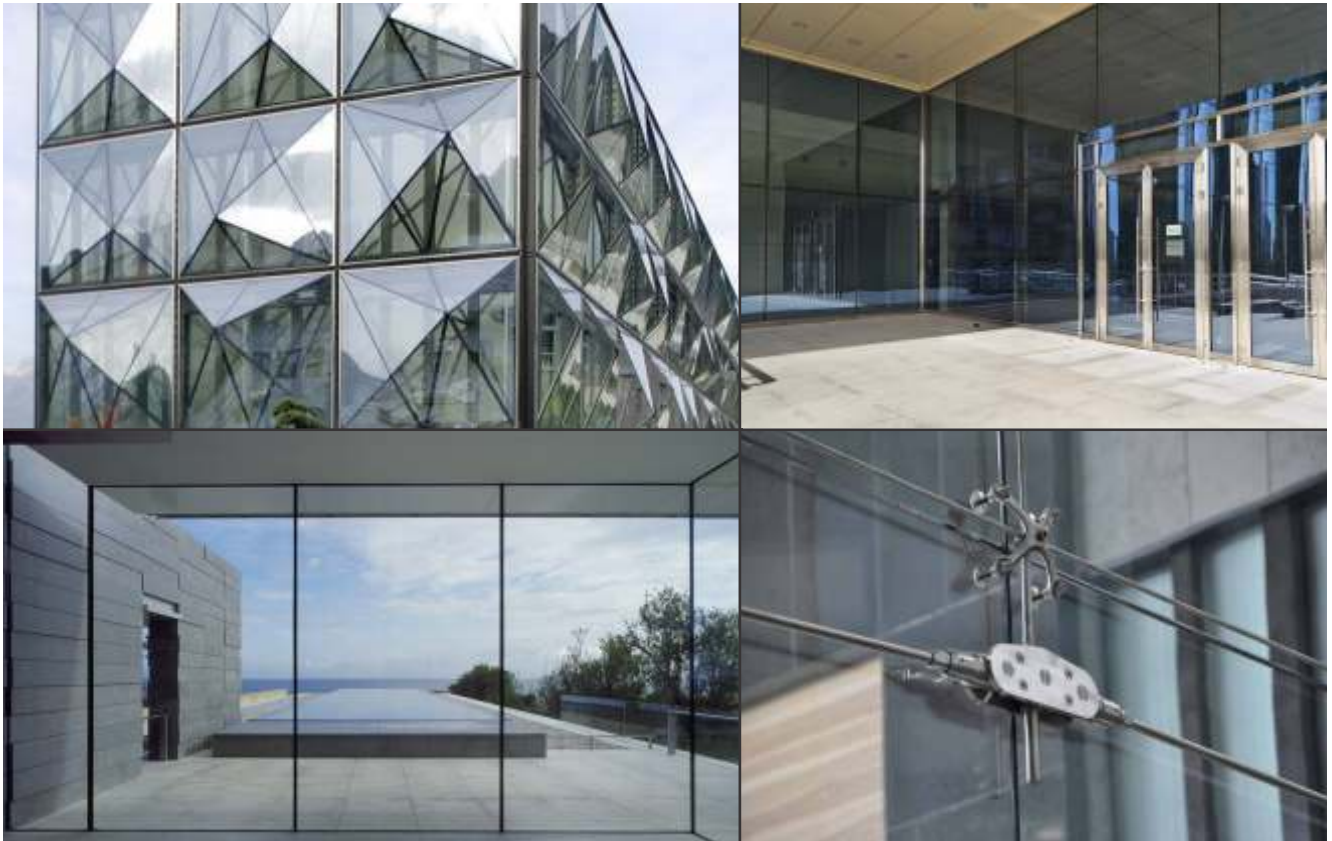
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# Glass Facade; An overview of advantages and types



**F**açade is a French origin word meaning the front face. The use of glass in the exterior facades provided more light and a good ambiance to the occupant of the building which gave rise to the increasing use of glass. Glass wrapping up the building exterior is called glass façade. In cities, whether residential or commercial, they tend to glamorize themselves by way of the owner's stylistic choices. One of the most preferred ways to instantly enhance the style quotient of a tall building is a glass façade. Apart from lending a contemporary yet open look to a modern-day building, it also offers

sound and heat insulation, making them a favourite choice. Modern building designs and constructions use an extensive amount of glass facades due to the simplicity of the materials and wide ranges of designs are possible due to the availability of various design options.

The Curtain Wall is designed to resist and handle all the imposed loads on it as well as keep air and water from penetrating the building. The loads imposed on the curtain wall are transferred to the building structure through a structural interface that attaches the mullions to the building. The curtain wall is designed for both Dead

Load and Wind Load.

## Advantages of Glass Facades

- The materials used in glass facades are extremely strong and durable. They're designed to resist major weather elements, including high winds, rain etc.
- A unique transparent material that allows light to pass through it so that the objects behind the glass are visible clearly.
- Has a smooth glossy surface, so it is dustproof and can be cleaned efficiently. Unlike other materials, it is easy to maintain.
- Available in a wide range of colours, and when we combine

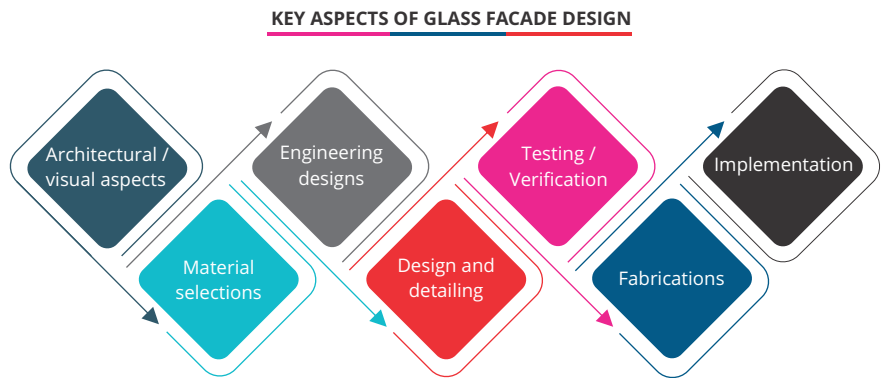
the glass sheet in laminated or insulated units, it changes in colour and appearance.

- Glass is UV stable since it is not affected by ultraviolet radiation and hence cracks, discoloration or disintegration will not occur.
- Glass is an excellent insulator and does not readily conduct electricity,
- Glass is corrosion resistant, and only under certain conditions, the glass is chemically attacked.
- It can withstand the effects of the wind, rain, or the sun and can retain its appearance and integrity in most of the given conditions.
- It can transmit 75%-80% of the natural light in both the directions, something which no other substitute does.
- It can be made translucent or molded in different shapes, it can offer a lot of flexibility to the architect in terms of usage in the building.
- Glass does not rust so it is better than iron and does not succumb to its surrounding environmental conditions.
- Reduces weight on the foundation of the building and makes the building lighter as compared to walls.
- In addition to all of the functional benefits of a glass facade, one of the biggest advantages is how it looks.

### Different types of glass facades

#### Curtain Wall Facades

Non-load bearing curtain-like structures are attached to the floor of the building in which the façade is to be incorporated. Such facades have to support only their weight and not the dead load weight imposed by the building. Connections exist between the curtain wall and the building's col-



umns and floors so that the weight of the wind can be transferred from the façade.



#### Storefront Wall Curtain Facades

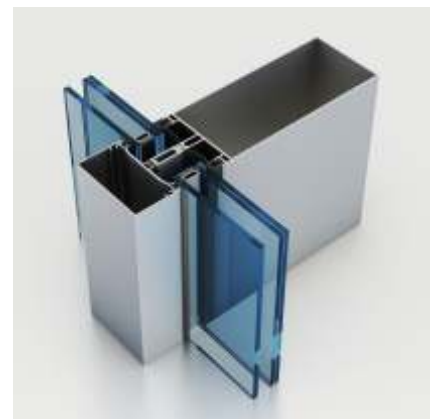
Non-load bearing façade type designed primarily for ground floors. It spans between the ground and the roof of the building above it and offers optimal thermal and sound insulation when constructed using specialised glasses. It is a cost-effective option and can be customised.



#### Framing Facades

##### Stick system

Built from long vertical extrusions or support mullions that are attached to the building's structure. Typically,



shorter horizontal extrusions span between the vertical mullions, creating a rectangular frame that binds the glass on all four sides.

##### Unitized Curtain Wall

Composed of large units that are pre-assembled and glazed in the factory before shipping to the building site for installation. With unitized curtain walls forming the core component of the external envelope of the building, thermal efficiency, sound transmission and fire safety become the key performance criteria of the system.

Semi Unitized curtain wall - A type of structural glazing where the primary structural framing components are erected individually as an erector set. In this set, the vertical mullions are attached first to the floor slabs and the horizontals are attached to the vertical mullions to resemble a grid.



### Frameless Facades

Frameless Glazing systems are more commonplace in modern-day architectural glazing. As a system, frameless



glazing offers huge potential within architectural glazing design. Frameless Glazing is an excellent way of maximising the level of natural daylight transmitted through a structure, whilst mitigating the effect on both the glass structures' internal and external aesthetics.

### Tension system

These facades use high tensile cables or stainless steel rods to impose loads of the facade on the main structure.



This decreases the amount of solid structural elements visible on the project, therefore increasing the transparency of the facade. The two main types in the industry are tension rod facades and cable net walls.

### Conclusion

Recent advancement in tints and coatings have now ensured that glass has exceptional performance not only aesthetically and functionally. Architects, developers and users can impart transparency, vibrancy and vitality to a building facade the way glass does. Combine this with its unparalleled durability and it being practically maintenance-free throughout its lifetime and glass will remain the topmost material choice when designing a facade, and arguably rightly so.

## Turkey's Rize applies to certify 'largest tea glass building'

The people of northern Turkey's Rize will soon have a new landmark and its builders say, once completed, it will be the world's largest building in the shape of a tea glass.

Rize Commerce Exchange, which is constructing the 30-meter-high (98.43 feet) building in Turkey's tea capital, applied to the Guinness World Records to get this unique, seven-story building formally listed.

Currently named the "Tea Market," the building will serve to promote this Black Sea province's most famous export. Overlooking a tea garden, the glass building embodies the favorite vessel for tea consumption of the Turkish public: a "slim-waisted" glass.

"This is a symbol of pride for us," the exchange's Chair Mehmet Erdoğan told Demirören News Agency (DHA).

Workers are currently putting the final touches on the building, which is ex-

pected to open next year. Built on an area of 9,500 square meters, the new landmark will give visitors access to anything and everything related to tea and the local culture.

In the marketplace spread over several floors, visitors will be able to sample every type of tea produced in Rize. It will also host shops selling local copperware and textiles, restaurants serving local cuisine and replicas of the province's natural and historic wonders.

The building will also house a tea history museum, a cinema screening documentaries on tea and a viewing terrace on the top floor.

Erdoğan said the building will contribute to Rize's tourism. "We will host Guinness representatives later this year. They will make their final decision next spring," he said.

"This is our new symbol and will definitely promote Rize better. I believe no



one will leave without taking a selfie here," he said. Indeed, locals and visitors already crowd the street in front of the towering "glass" for a photo opportunity.

"Paris has its Eiffel Tower and we have the tea glass now," Salih Can Keskin, one of them, said. "Looks like this tea has been overbrewed, too strong," quipped Naciye Arkan Horoz, another local admiring the building as she pointed to the dark-tinted glass on the upper floors. "But still, it is beautiful," she added.

# Importance Of Glass In Architecture Design

**G**lass is a magical material which has so many different properties and uses, that it has presented Architects with many new possibilities and designs. In their quest for transparency and safety, Architects often use reinforced, toughened and laminated glasses.

## Advantages of Glass

- Can absorb, refract or transmit light. It adds beauty to a building when used in transparent or translucent applications. Glass transmits up to 80% of available natural daylight.
- The use of natural light can lower electricity bills, brighten the rooms of a building, and can also boost the mood of the occupants.
- Resistant to weather and can hold up to the effects of the wind, rain, or the sun.
- Rust is resistant and does not degrade because of the effects of chemical and environmental conditions.
- Recyclable and it does not degrade during the recycling process, and it can be recycled again and again without loss of quality or purity.
- Unaffected by noise, air, water. Sealed glass panes transmit very little sound, and hence can be a good sound insulator.
- Glass has a smooth, glossy surface so it is dust proof and can be easily cleaned.

## Glass in contemporary architecture

Glass is also a more resistant and

dimensionally stable building material, odor-neutral, hygienic and easy to maintain. That is why it is used in windows, on facades and as roofs. In buildings, transparent sliding elements, such as in kitchens and bathrooms, or transparent partitions in large office rooms are made of this material. Glass is also used in architecture for elevators or balcony railings.

Glass has various uses that makes it a fascinating material, special importance in architecture.

## Glass window pane

A glass pane is built into the frames of your window to create a spotless view, eliminate air flow and insulate your home.

Panes of glass vary in shape and size from one window to the next. Some panes of glass might have films on them to provide better insulation, which is known as Low-E glass. Other panes of glass will vary in thickness, depending on the quality of the window. As windows age, the glass panes become thinner and more vulnerable to the elements.



## Glass curtain wall

A curtain wall is an outer covering of a building in which the outer walls are non-structural, utilized only to keep the weather out and the occupants in. Since the curtain wall is non-structural, it can be made of lightweight materials, such as glass, thereby potentially reducing construction costs. An additional advantage of glass is that natural light can penetrate deeper within the building. The curtain wall façade does not carry any structural load from the building other than its own dead load weight.



## Glass roofing material

Glass roofs are hugely effective at transforming the interior aesthetic of a property, and present some of the most versatile and impactful glazing solutions. It's a bit misleading, however, to simply refer to 'glass roofs' as though they were a single product or entity - there are many different types, styles,



and designs, and there are all sorts of things you'll need to consider when choosing one. Depending on your property and your requirements, different types of glass roof will be most appropriate.



### Glass partitions

Glass partition walls are ideal for creating comfortable and practical office working environments. When you allow natural light to flow into a given space, it changes how shapes, colors, patterns, textures and people interact. Glass partition walls are also one of the simplest ways to update an office or commercial space. These glazing systems sys-

tems are gaining in popularity over traditional drywall installations. Interior designers and architects both appreciate these glass wall systems for their scalability and translucent properties.

### Glass doors

One of the most common types of home and business glass outside of traditional windows is glass doors. Safe for interior and exterior use, modern-day glass doors are made of tempered glass, energy-efficient and come in a variety of styles. Glass doors can be customized to fit your space and personal design aesthetic. From opaque shower or etched closet doors to clear French doors that lead into a dining room or living space, Doors can be made with large panes set in a frame, like those used for sliding doors and storm doors, or they can be made of materials like hardwood, metal or composite, with smaller windows inset within the door.

### Conclusion

Glass acts as an unique architecture material that is utilized mainly due to its special features and advantages. With proper planning, architects and engineers can design a beautiful structure.





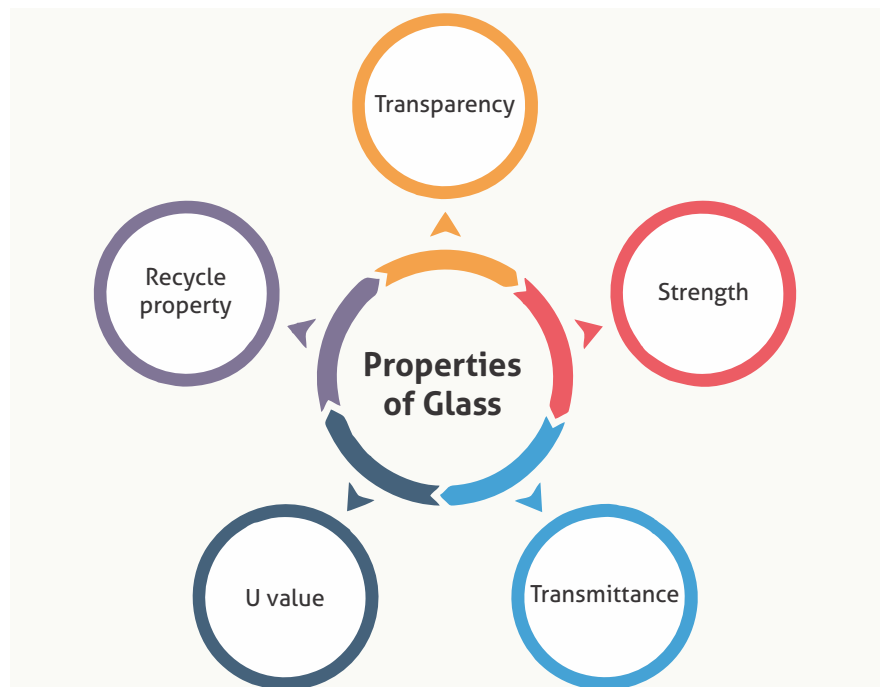


## Different Types of Glass Used in Building Architecture

**G**lass is a hard substance that may be transparent or translucent and brittle. It is manufactured by a fusion process. In this process sand is fused with lime, soda and some other admixtures and then cooled rapidly. Glass is used for architectural purposes in engineering. There are different types of glass used each of them are discussed below.

### Sheet or Flat Glass

Flat glass, sheet glass or plate glass is a type of glass that is initially produced in plane form. It is commonly used for windows, glass doors, transparent walls, and windshields. For modern architectural and automotive applications, the flat glass is sometimes bent after the production of the plane sheet. It is commonly used for windows, glass doors, transparent walls, and windcreens. For modern architectural and automotive applications, the flat glass is some-



times bent after the production of the plane sheet.

**Laminated Glass**

Laminated glass is constructed of two plies of glass that are bonded together with interlayers to form a permanent bond. The interlayers work to support and hold the glass to create a strong, uniformed layer even when broken. Laminated glass comes in varying thicknesses and can be created using different glass combinations or coatings to provide different qualities, such as low emissions or increased insulation. Laminated glass is used when there is a possibility of human impact or where the glass could fall if shattered, and for architectural applications. Skylight glazing and automobile windshields typically use laminated glass. In geographical areas requiring hurri-

cane-resistant construction, laminated glass is often used in exterior storefronts, curtain walls, and windows.

**Shatterproof glass**

Shatterproof glass is laminated glass; two or more sheets of glass bound together with an invisible interlayer of polyvinyl or resin, though other compounds are sometimes used. The interlayers of shatterproof glass help to reduce sound transmission; your home will be significantly quieter. UV rays are also reduced by this type of glass, keeping the sun from fading fabrics and furniture.

**Energy-efficient Glass**

Energy-efficient Glass is manufactured by glazing float glass with a special thin coating

on one side. Energy-efficient glazing incorporates low-emissivity coated glass to prevent heat from escaping through the windows. This makes the windows highly thermally insulating hence improving the energy efficiency of your building.

**Wired Glass**

Wired glass is being used for decades now and it prevents the glass from shattering in case of emergencies. The glass is reinforced with wire mesh during manufacture, which makes it durable, fire-resistant when compared to float glass. It is also known as Georgian wired glass and wire mesh works as a reinforcement. In case due to some higher impact activity the glass breaks, it is held by the wire in position. This lessens the chances of anyone around getting hurt. The wire mesh glass is available in diamond grids and square grids.

**Stained glass**

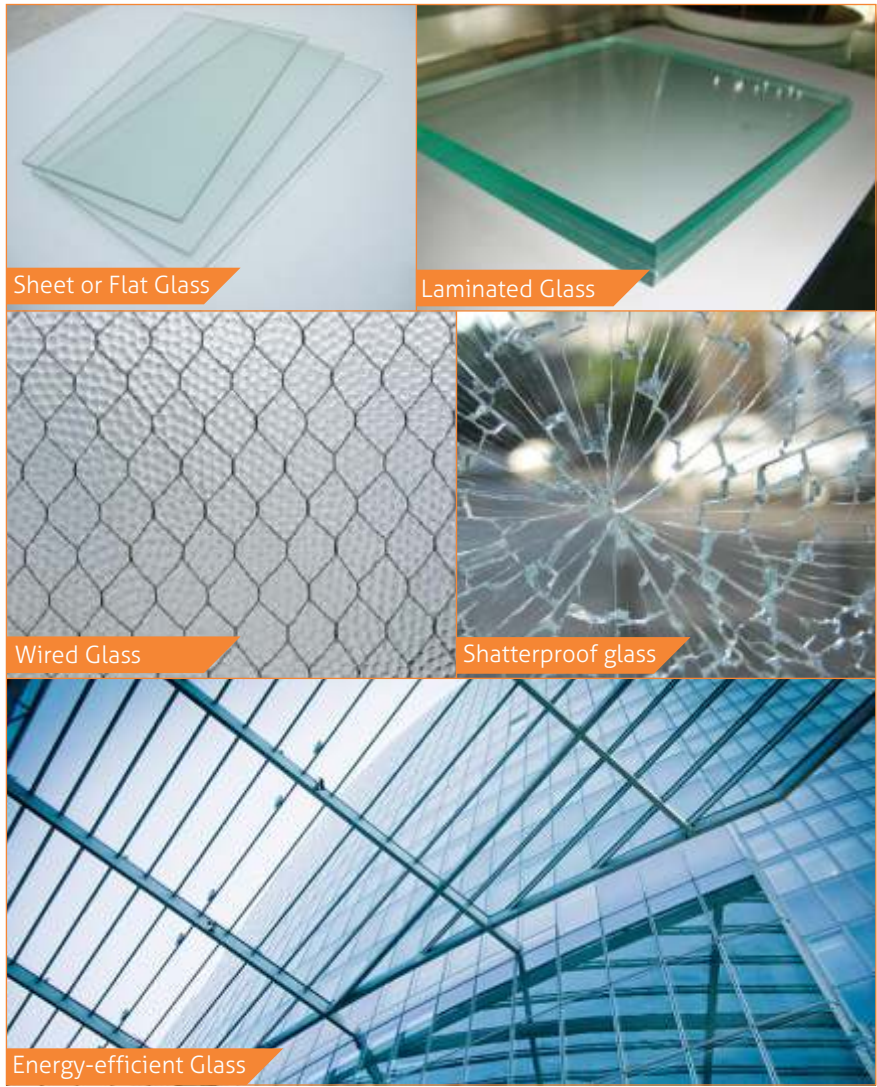
Stained glass refers to coloured glass as a material and works created from it. Throughout its thousand-year history, the term has been applied almost exclusively to the windows of churches and other significant religious buildings. Although traditionally made in flat panels and used as windows, the creations of modern stained glass artists also include three-dimensional structures and sculpture.

**Toughened Glass**

Toughened glass is physically as well as thermally solid, and research shows that it can withstand surface compression of at least 10,000lbs per square inch, which is why toughened glass is considered to be safety glass. They are also known to be four to five times stronger than annealed glass and three times stronger than heat-strengthened glass. As these glasses are robust, they reduce the risk of damage if they come in contact with a calamity or disaster. Toughened glass is manufactured when regular glass is exposed to extreme heat and then cooled rapidly. Due to this excessive heating and cooling process, the chemical composition of the glass goes through an alteration making it more resilient.

**Chromatic Glass**

Chromatic glass can control the transparent efficiency of glass and protects the interior from daylight. The chromatic glass may be photochromic which has light-sensitive lam-





Stained glass

Float glass

Toughened Glass

Heat-strengthened glass

Chromatic Glass

Self-cleaning Glass

ination, thermos-chromatic which has heat-sensitive lamination and electrochromic.

### Self-cleaning Glass

Self-cleaning glass is a specific type of glass with a surface that keeps itself free of dirt and grime. The field of self-cleaning coatings on glass is divided into two categories: hydrophobic and hydrophilic. These two types of coating both clean themselves through the action of water, the former by rolling droplets and the latter by sheeting water that carries away dirt. Hydrophilic coatings based on titania (titanium dioxide), however, have an additional property: they can chemically break down absorbed dirt in sunlight.

### Float glass

Float glass is a sheet of glass made by floating molten glass on a bed of molten metal, typically tin, although lead and other various low-melting-point alloys were used in the past. This method gives the sheet uniform thickness and very flat surfaces. Modern windows are made from float glass. Most float glass is soda-lime glass, although relatively minor quantities of specialty borosilicate and flat panel display glass are also produced using the float glass process. Float glass is essentially a super smooth, distortion-free glass which is used for designing other glass items such as laminated glass, heat-toughened glass, and so on. With a natural greenish hue and translucent nature, it is capable of transmitting the incident light.

### Heat-strengthened glass

Heat-strengthened glass is similar to tempered glass except that the cooling is done at a much slower pace. Annealed glass is heated to approximately 650-700°C, but the cooling process is slower than that for tempered glass. Heat-strengthened glass is about twice as strong as annealed glass of the same size and thickness. Heat-strengthened glass is a semi-tempered glass that retains the normal properties of ordinary float glass.

### Conclusion

Given above are different types of glass that could be used for building architecture. Glass is used as a transparent glazing element in the building envelope. This includes windows in external walls and internal partitions.



# Solar Glass for Buildings

**S**olar glass or solar control glass is a specially coated glass that is designed to reduce the amount of heat entering the building. This glass reflects and absorbs the sun's rays and helps control the glare. Solar glass only allows a small amount of heat to pass when compared to normal glass. It has many applications in the construction industry. Roof, windows, skylights, facades- solar glass can be used in several ways in a building. Whether it's a commercial building like business centres, shopping malls or residential property,

solar glass can be used for either of them. It can also be used for both external and internal purposes.

Modern solar glass is perfect for architectural projects where aesthetic matters and can be integrated in projects as diverse as solar carports or facades. They even come equipped with leading monocrystalline technology and can be seamlessly integrated.

## Types of solar glass

Solar glass incorporates transparent semi-

conductor-based photovoltaic-or solar-cells by sandwiching them between two sheets of glass. Buildings with a substantial number of photovoltaic panels could potentially produce some of their own sustainable energy, reducing not only their energy costs, but also their carbon footprint. In climate zones, where too much glass in a building would create a heat issue, this reduced transparency could also save on air conditioning costs. For projects in which more light is desired, fabricators are rising to the occasion with variations, like slitted glass, that has gaps between the solar cells to allow for

greater light penetration. It comes with double or triple glazing, and in a variety of different colors, gradients, and patterns. They are available in two different types;

*Thin-film modules* - can be designed into the fabric of a building and can perform in conditions/locations where crystalline silicon panels cannot.

*PV glass* - comes with varying levels of opacity. It can be up to 50% transparent – much more than traditional PV. They can be used for instance in balconies, skylights or in facades. Thin film panels work in non-optimal conditions, in lower light and higher temperatures.

**Advantages of Solar Glass for Buildings**

**Energy-Efficient**



By selecting solar glass, you can reduce the amount of heat entering the interiors. This can improve energy utilisation and decrease the operating cost of cooling systems, thereby reducing your electricity bills. Since the amount of natural light entering the indoors is not affected due to solar control coating, your property's interior will not only remain cooler during the summer months, but it will also be brighter and airier. This will lessen your need for artificial lighting and will further reduce energy bills while making your property an energy-efficient zone.

**Sustainable**

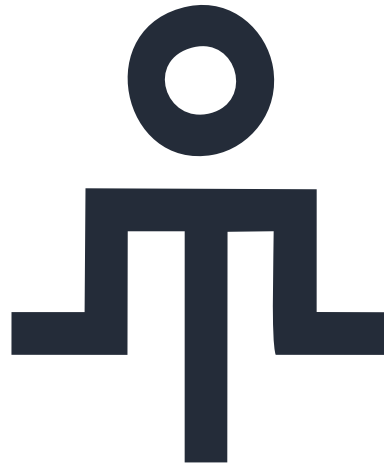
As solar control glass acts as green glass, it can be used to enhance sustainability by creating sustainable structures. Sustainability, energy-efficiency, and reduction of carbon footprint lies at the core of solar glass and hence incorporat-



ing it in the construction of buildings is an environment-conscious decision.

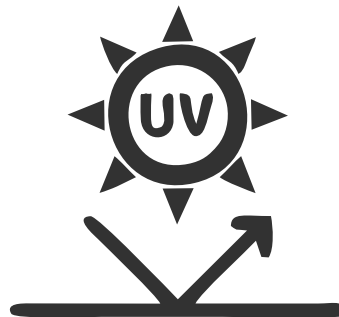
**Multi-faceted Uses**

Can be easily paired with other types of glass to achieve multi-functional glazing as per your requirements. Whether you want noise reduction, thermal insulation or you desire to enhance the safety and security quotient.



**Protects from Harmful UV RAYS**

Reflective glass's high performance metal oxide coating protects you from harmful



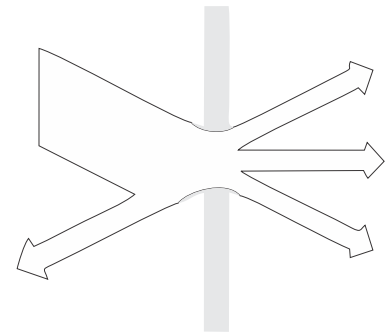
**WHY SOLAR GLASS?**



UV rays giving you an extra cover to maintain natural glow and smoothness.

**Optimum Light Transmission**

The high performance metal oxide coating on the glass allows higher light transmission providing you natural lighting, saving you money on artificial lighting costs during the day.



**Conclusion**

Solar glass is being used in new and existing buildings, including office blocks in Canary Wharf. Organic polymer photovoltaics could conceivably replace all windows/glass in new builds, once it is transparent. It will always be ever so slightly tinted but not pixelated like its predecessors. Solar glass derive clean, pure energy from the sun. Installing solar panels on your home helps combat greenhouse gas emissions and reduces our collective dependence on fossil fuel.



## Structural glazing system in buildings

**S**tructural glazing systems are types of curtain wall systems consisting of glass that is bonded or anchored back to a structure without the use of continuously gasketed aluminum pressure plates or caps. The glass can be monolithic, laminated, dual-glazed or even triple-glazed insulating glass units (IGUs). The back-up structure may use horizontal and/or vertical aluminum mullions or be a glass mullion, steel blade, cable or stainless steel rod. Structurally glazed systems create a greater transparency than traditional captured systems.

There are many benefits to using structural glass within a building, it can offer a greater coherence and connection

between the natural world and our buildings, while still protecting us from the elements. It allows sunlight to flood a home without any attendant annoyances that have previously hampered glass structures.

### Advantages of structural glazing

Structural glazing can offer a greater coherence and connection between the natural world and our buildings, while still protecting us from the elements. It allows sunlight to flood a home without any attendant annoyances that have previously hampered glass structures, such as overheating and the subsequent loss of heat at night. In fact, advances in technology mean that insulation is actually one of

the great advantages of using structural glass.

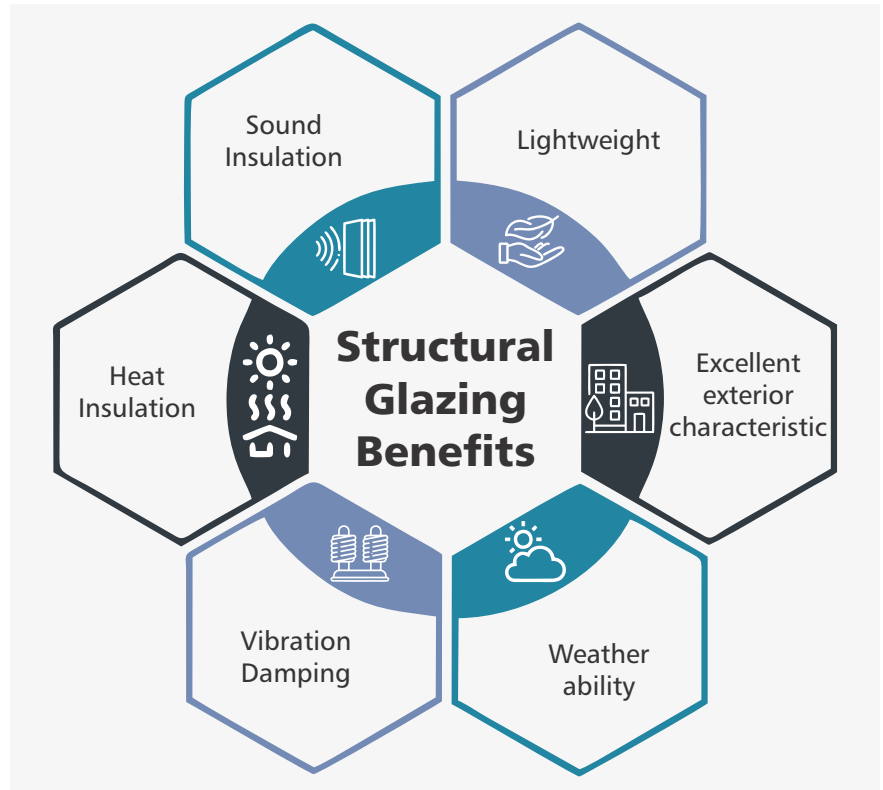
- In structural glazing the two materials predominantly used are glass and aluminium, which neither corrode nor decay when comparing other conventional building material like wood, iron, steel etc.
- Light penetrates the structurally glazed building through the glass facades and hence their employment translates to reduced energy bills.
- The processed glass used in the structural glazing system also insulates the building from heat and sound.
- Fulfills the architectural view for the external decoration and

beauty.

- Using glass in the interior of the building saves the space inside the building.
- Glass cladding in building fulfills the functional requirement of lighting heat retention and energy saving.
- Glass is an excellent material for thermal insulation, waterproofing, and energy conservation.
- The glass is a bad conductor of heat, hence it saves energy in air conducting of the building.
- Toughened glass can have a good interior design with the use of glass in the transparent staircase, colored shelves, ceiling etc.
- Provides excellent sound insulation
- An easy-to-clean surface.
- Gives protection for the load-bearing structure.

#### Type of structural glazing systems

- Unitized Curtain Wall - factory manufactured finished panels, transported to site and erected to the building façade with fixings and brackets. The wall system uses pre-fabrication methods and produces highest level of quality with less works.
- Stick Built Structural Glazing System - assembled from similar components to that of a captured sys-



tem, with the exception of an exterior aluminum pressure plate and cap with gaskets to hold the glass in place.

- Semi Unitized factory finished, transported to site and erected to building façade with fixings and brackets. Involves considerable work at the site.

- Stick Glazing - frames are machined at the factory and brought to the site as knockdown conditions. Glass panels are installed to frames with pressure plates and gaskets.
- Frameless system - transparent façade with less frames or structural members. Used in large spaces, airports, lobbies etc.
- Point supported glass systems - can be custom engineered to fit any opening. From the exterior, they have silicone sealants between the joints.

#### Conclusion

Structural glazing is used with the most impact on large, commercial buildings, but has many other applications, including glass entrance-ways, skylights, canopies, and glass elevator enclosures. These are streamlined curtain walls of glass that are attached using silicone bonding, or anchored by means of rods, cables, glass fins or other unobtrusive ways.



## Peter Pichler completes angular concrete-and-glass villa in Italian vineyard



The folded form of this villa, designed by Peter Pichler Architecture for the owners of a vineyard in South Tyrol, is intended to merge with the existing landscape and form a shield around its central courtyard.

The Milan-based studio won an invited competition in 2018 to design the property, which replaced an existing structure within the Kastelaz vineyard in the Termeno district in Italy.

The estate's owners wanted to build a contemporary home on the elevated site, which enjoys spectacular views of the surrounding Alpine landscape.

The design of the house responds to its setting, nestled among trees and vines and looking along the valley towards Lake Caldaro.

"The geometry of the villa evolves from local site conditions," the studio said. "It creates a flowing and harmonious transition with the landscape and is barely noticeable from the nearby village."

The angular structure appears to emerge from the earth of the hilltop, with its sloping walls connecting seamlessly with the roof.

The horseshoe-shaped plan wraps around an internal courtyard that is protected from the winds funneling up the valley from Lake Garda to the south.

The building's external surfaces evoke the tone and texture of the chalk-stone retaining walls found throughout the surrounding vineyards.

Source: [www.dezeen.com](http://www.dezeen.com)

## Efficiency Lab for Architecture designs Telluride Glass House



Efficiency Lab for Architecture is a Brooklyn-based US studio, which this year completed the construction of a luxurious mansion on the steep walls of Telluride Box Canyon in Colorado. The house is surrounded by Aspen trees – namely the *Populus tremula* – and has the distinction of having been built in just a few weeks. However, to be able to create the luxurious residence, characterised by simple, minimal features and set in a geographically and geologically difficult environment like that of the canyon, it was necessary to invest five long years in the design phase. As Aybars Asci, the president and founder of Efficiency Lab explains in relation to the philosophy with which the project was developed: "I came up with the idea of creating something breathtaking in just a few weeks, but it took years of careful refinements to bring the vision to life, while the general concept was quite simple, the project was a reminder that sometimes complexity is the path to achieving such levels of simplicity".

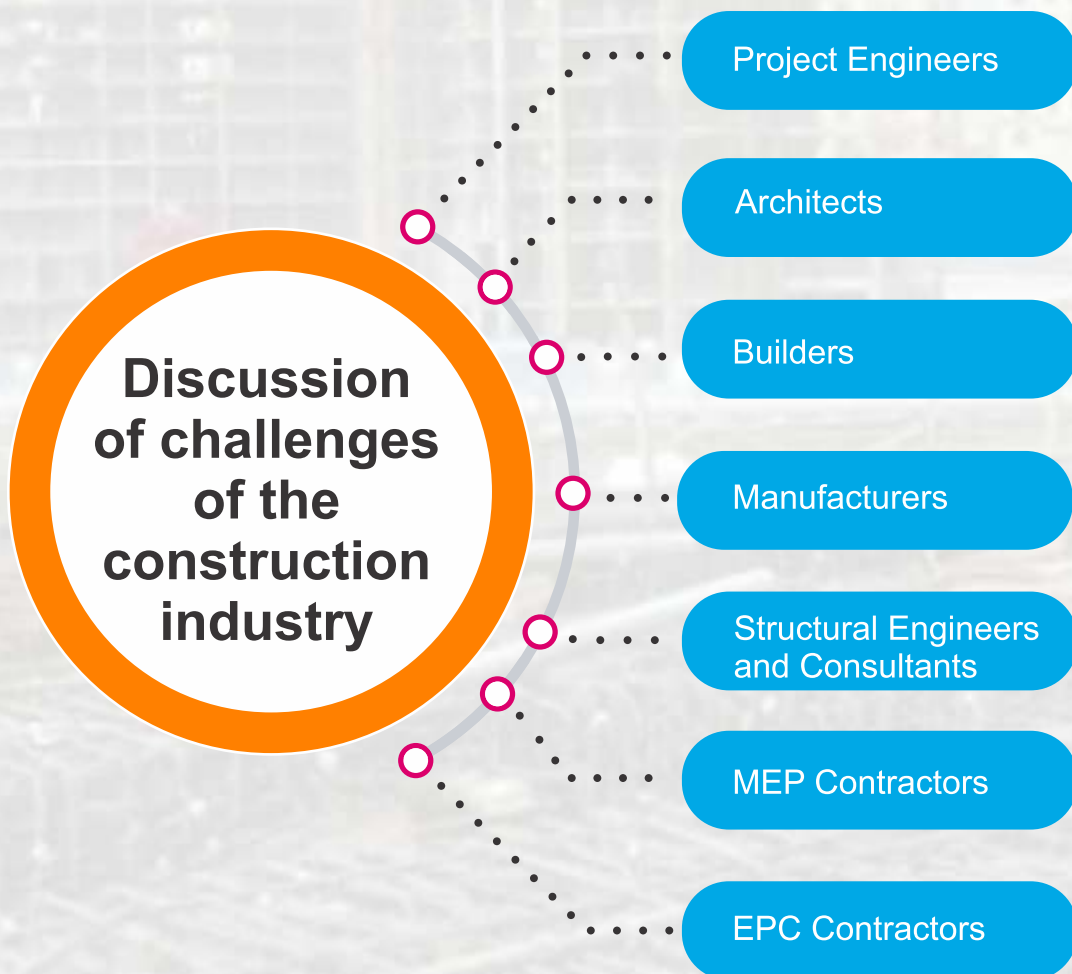
Structurally, the house is configured as a series of three single-height square-plan volumes placed one above the other, following and carefully optimising the offset of the contour curves. As the architects describe in a press release: "Each 45' × 45' glass box is positioned in a moment of suspension, providing a horizontal approach to the vertical terrain". The Telluride House is characterised not only by its unique shape, but also by the fact that each exposed side of the three volumes is covered in glass, thus opening up wide panoramic views of the Colorado landscape for its inhabitants. In a lot that covers nearly 1.5 hectares, Efficiency Lab has in fact obtained almost 650 square metres of floor area.

Source: [www.floorature.com](http://www.floorature.com)



## *What is the huss about eMagazine*

eMagazine is a digital medium for interaction among the various personnel among the construction industry namely, Manufacturers, Business to Business users and the Civil Engineering professionals.



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