Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 13 Issue 06, June - 2024

Analysis of Glass as Modern Material

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Abstract
Glass is a material that is great structurally known to man. Architects love glass because it does not obstruct a view or visually interrupt a room Architects love glass because it does not obstruct a view or visually interrupt a room. Structural engineers should love it because when theoretically compared to steel, it can carry two times the tension load Also, because glass is the most recycled material in the world, the supply is plentiful and non-detrimental to the environment . However, theory and practice are two different things. While glass would win in a theoretical competition for the best building material, it would fail in a practical contest. Both social and physical limitations must be overcome before glass can gain widespread acceptance as a structural material. In India glass is now gaining widespread acceptance in recent times.This paper explains types of glass its,manufacture and use in history as well as its properties.

***Keywords*: glass manufacture ,properties types of glass process,innovative glass structures**

INTRODUCTION

Glass is a modern material known to man. In recent times glass is accepted as a modern building material in India.Research on glass as a material is motivated by a wide range of factors and applications.It is a versatile and unique material with properties that make it of significant interest to scientists engineers and researchers . Some key motivations for researching glass as a material include

Material Science advancement: Understanding the physical and chemical and mechanical properties of glass allows for the development of new formulations with improved strength transparency and durability.

Float Glass

Made from sodium silicate and calcium silicate, float glass is also known as soda-lime glass. The “float” name refers to the method used to produce it, where the molten glass is floated onto a bed of molten tin. This gives us a flat, clear, distortion-free glass.
Float glass can be cut utilizing a glass cutter without a need for special equipment. It’s available in thickness ranging from 2mm to 20mm, with a weight ranging from 6 to 36 kg/m².
The applications of float glass include fixed and opening windows above waist height, shop fronts, as well as public places.

Innovation in technology: Glass is used in electronic devices sensors and other electronic applications
Energy Efficiency: Research into smart glass technologies focuses on developing energy efficient solutions for building and vehicles .Smart glass can adjust its transparency to control light and heat, reducing the need for artificial lighting and heating.

Environmental sustainability: Research on glass recycling methods contributes to sustainable practices reducing the environmental impact of glass production and waste.

Innovative structures: Research in architectural applications explores new possibilities for glass in building design such as ultra thin and curved glass to create visually stunning and structurally efficient structures.
According to Mayank Kumar in his paper Types of glass and its engineering properties for use in construction there are several types of glass which are described below.

Sheet Glass

Sheet glass is manufactured by having molten glass pass through rollers to produce a nearly flat finish. However, the action of the rollers does leave the resulting sheets with some degree of distortion.
Sheet glass can be cut via a glass cutter – no special equipment is needed. It’s usually available in a range of standard sizes.
Due to the relatively low cost of float glass and its lack of distortion, sheet glass is mainly used in glazing greenhouses and the like, where the visual distortion isn’t an issue as opposed to domestic windows etc.

Laminated Glass

As the name suggests, laminated glass consists of layers of ordinary glass bonded by a transparent, flexible material. Think of it as a sandwich made up of two or more sheets of glass.
Laminated glass can also be made using other types of glass (such as float, wired, or toughened), where they keep their original breaking attributes. Laminated glass is also UV and soundproof, which explains its use in the construction of bridges and aquariums. It’s even the best choice for making glass canopies as it can reduce harmful rays.
At WA Special Projects we commonly use SGP for our totally frameless balustrading and fully frameless pool fencing such as out channel fixed range. SGP is a laminated glass consisting of 2 sheets of toughened glass and a laminate in the middle. This is typically 6mm toughened/2.28mm laminate/6mm toughened.

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Shatterproof Glass

Shatterproof glass is just what it sounds like, a type of glass that's resistant to shattering. In other words, it doesn't break into sharp pieces in the event of destruction.

Manufacturing shatterproof glass involves the addition of a plastic polyvinyl butyral resin to prevent it from forming sharp pieces. It's commonly used in windows, floors, and skylights.

Energy-efficient Glass

This type of glass is produced by glazing float glass with a special thin coating on one side. This coating allows solar energy to pass through in one direction while minimizing the transfer of thermal energy in the other direction.

Extra-clean / Self-cleaning Glass

Extra-clean or self-cleaning glass is both photocatalytic and hydrophobic. These two unique properties make it stain-proof, resulting in attractive appearance and easy maintenance.

Chromatic Glass

Used in ICUs and meeting rooms, chromatic glass can control the transparent efficiency to protect the interior from daylight. This type of glass may be electrochromic (has electric lamination), thermos-chromatic (has heat-sensitive lamination), or photochromic (has light-sensitive lamination).

Patterned Glass

Patterned glass is flat glass that's been rolled onto one side during production. It's available in many coloured tints and patterns, each with a distortion number from 1 to 5 (1 is very little distortion and 5 is a high degree of diffusion).

Patterned glass is used for decoration purposes, with or without added privacy.

Tinted Glass

Tinted glass is simply coloured glass. A certain type of ion is added to the normal glass mix to produce coloured glass, where the colour doesn't affect other properties of the glass. For example, iron oxide gives green and sulphur gives blue.

Toughened Glass

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Smashed tempered glass

Toughened glass, also called safety or tempered glass, is used extensively throughout the industry for its ability to resist breaking. If it does break, it does so into many small 'safer' pieces as opposed to large shards (like float glass) Toughened glass is typically used in home interiors such as kitchen splashbacks (for its heat resistance), and shower screens,glass balustrade and swimming pool fencing.

It can also be used in laminated panels for extra safety precautions.

Wired Glass

Wired glass has a wire mesh in the middle of its glass structure. The purpose of the wire is to hold the glass together in the event of cracking or breaking, however, it doesn't stop the glass from forming sharp pieces when broken.

Available as clear or obscured, wired glass is commonly used in more industrial areas or structures such as garages.

Glass Blocks

Otherwise called glass bricks, glass blocks are made from two halves pressed and annealed during the melting process of glass. The applications for glass blocks include walls and skylights, providing a pleasant aesthetic appearance when light passes through.

Glass Wool

Used as an insulating filler, glass wool is made out of glass fibres. It's also fire-resistant.

Insulated Glazed Units

Also referred to as double-glazed glass, an insulated glazed unit consists of two or three layers separated by air or vacuum. This air or vacuum acts as a good thermal insulator, so this glass doesn't allow heat to pass through it.

Mirrors

These are typically made from float glass of 4mm to 6mm thickness with one side silvered.

Properties of glass

According to for use in Construction. (al.)

Glass has 5 engineering properties:

- Transparency: this is the primary property of glass that allows us to see through it. Glass can be transparent from both sides or from one side only (the other side acts like a mirror).
- Workability and Recycle Property: glass has superior workability as it can be moulded into countless shapes or blown during melting. Also, any type of glass can be 100% recyclable and used as a raw material in construction.
- Strength: the strength of glass is determined by its modulus of rupture value. Glass is usually brittle but we can make it stronger by adding admixtures and laminates.
- Transmittance: this is the visible fraction of light passing through the glass.
- U value: this represents how much heat transferred through the glass. Insulated glass units should have a low U value.

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Manufacture of glass

According to Mali Meado in his paper titled Glass manufacturing process the manufacture of glass is in four phases: (1) preparation of raw material, (2) melting in a furnace, (3) forming and (4) finishing. Glass is primarily made from silica, which is obtained from sand. Other materials such as soda ash, limestone, and feldspar ...

The batched raw materials pass from a mixing silo to a five-chambered furnace where they become molten. Temperatures in the furnace reach upto 1600°C. The molten glass is then "floated" onto a bath of molten tin at a temperature of about 1000°C. It forms a “ribbon” which is normally between 5 and 6 mm.

The components of glass, whatever they may be, are combined in a furnace where they will be “melted” together. The temperatures that must be reached for this phase are dependant upon the individual components of the glass, but they range from 2400ºF to 2900ºF. The use of the term “melting” can be misunderstood when referring to glassmaking. While all components begin in a solid form, not all of them immediately turn into a liquid during the initial heating process. Instead, what happens is at the escalated temperatures the raw materials react and create new compounds. This process is a necessary step on the way to the high temperature fusion that creates molten glass. Once the glass is molten, chemical reactions continue to occur during the refining stage. The refining phase is very important because this is when all the gasses present in the mix are released through bubbles. This stage takes place at temperatures ranging from 2700ºF to 2900ºF. Failure to eliminate all the gas prevents the glass from becoming a homogeneous solution resulting in a weakened final product. The best way to eliminate bubbles is to melt the glass as rapidly as possible. This allows the bubbles to escape by their own buoyancy

To melt glass, either a pot furnace or a tank furnace can be utilized. Because the heating process takes longer, typically the only time that a pot furnace is used is for optical glass or crystal-glass. A pot furnace contains three to twelve pots made of a refractory material. The pots must be made of refractory material so that they can withstand the high temperatures created in the furnace. The main purpose of the pots is to retain the molten glass. The furnace that the pots are placed into is responsible for producing the heat required to melt the glass. The pots are preheated at a slow rate in a special furnace called a pot arch. Once the pots reach a temperature above 1000°C, the pots are transferred to another furnace that is operating near the required glass-melting temperature. The pots are preheated to prevent cracking that could occur if pots were placed directly into a furnace and heated quickly (Maloney 74). In the case of most structural glass, such as in windows, a tank furnace is employed. A tank furnace is one in which the walls serve to retain the heat as well as hold the molten glass. Tanks can range in capacity from five tons up to 1000 tons. Most tank furnaces used today are a continuous tank. They are continuous because as glass is being drawn from one end, components are added to the batch at the other end. This provides a constant output of glass, which is ideal for manufacturing purposes (Maloney 77). No matter which type of furnace is used, it is important that the interior of the melting tank be specially designed to prevent corrosion. Molten glass is very caustic so the usable life of a normal continuous tank furnace is limited to three or possibly four years

Tempered glass is prepared by heating the glass to a very high temperature, near the set melting point, and then rapidly cooling the surface. Because the center cools more slowly, it creates a dense internal structure, while the surface is less dense. Also, the outer surfaces will prevent the inner area from shrinking completely. This puts the surface in compression and the center area in tension. Fracture mechanics explains that when glass fails, it is most commonly caused by a small crack or nick in the surface that is propagated by tensile stresses. With tempered glass, the tension zone is on the interior and therefore has no effect on the surface cracks which are in compression. Introducing compression stresses onto the surface of a glass element is good because that means the member can hold more tension before failure since the initial compression must be overcome first. In addition to carrying an increased tensile load, toughened glass can also withstand larger impact loads

Laminating is another method of making glass stronger. The process makes two or more panels of glass into a single member by using an intermediate layer of another material. The most common interlayers include polyvinylbutyral foil (PVB or vinal), Urethane, and cast-inplace resin (Innovative Online). A few of the benefits of laminated glass are that it is not only stronger, but it also fails in a more ductile way. Standard glass gives no warning signs of failure, but with a laminated piece there is a noticeable amount of warning before failure

METHODS

This paper tries to do a literature survey of material available on glass its manufacture process its uses its types its uses and its properties in order to understand use of glass as a material.

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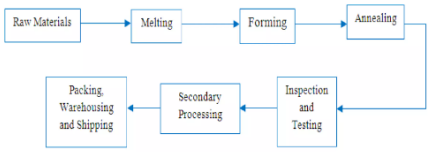

DISCUSSION ON USES OF GLASS

According to Glass in structural applications by Marcin glass has always been found in nature, but the first glass created by humans can be dated to about 4,000 years ago, when craftsmen working in Mesopotamia, the land between the Tigris and Euphrates Rivers, discovered the art of mixing sand, soda, and lime to make glass.Thereafter it was used in the Gothic period when stained glass windows were made . Architectural glass, however, was introduced also in the Romanesque period of the 11th century, when transparent and translucent glass was used for window coverings that allowed for the introduction of light, or even for interior liturgical partitions.

The earliest method for creating glass windows was called the crown glass technique. In this case, a round piece of hot blown glass was cut away from the pipe and then spun around rapidly until it flattened out like a thin pancake. The piece would then be cut entirely off its pipe and shaped into smaller pieces that would fit into iron frames. This type of glass reveals a characteristic bull's-eye at the center point, where it remained attached to the pipe while being spun. Later, more sophisticated cutting of the crown glass resulted in a diamond-shaped piece, which reduced the distortion created by the varying thickness of the crown glass and allowed for a more intricate pattern of fenestration. Only in the 19th century was this process finally replaced by a less expensive process of creating sheet glass, which allowed for larger individual windowpanes. This type of glass still has subtle variations in thickness that are apparent in older buildings today, where one can see the effect of rippling on the glass. Float glass, used today for windowpanes, is a process invented in the 1950s and 1960s by the manufacturer Sir Alastair Pilkington of Pilkington Glass in England. Float glass provides the smoothest surface, is the least expensive flat glass to produce, and is used in architectural construction across the world.

Joseph Paxton's Crystal Palace, built for the 1851 London Exhibition, established a technological as well as a philosophical interest in creating a glass house. In 1938, Walter Gropius used thick glass blocks to create an entire exterior wall for his own house built in the Bauhaus style in Lincoln, Massachusetts, and in 1946 Ludwig Mies van der Rohe used a large single pane of glass to cover the façade of the Farnsworth House near Plano, Illinois. Philip Johnson took this idea to its conclusion with the construction of his own house made almost entirely of glass. His so-called "Glass House," built in New Canaan, Connecticut, in 1949, is often considered one of the most beautiful but least functional houses in the world. Free from constraints of a clientele, function, or money, Johnson created an exceptional home of glass walls set into a concrete frame and with concrete flooring. All the interior rooms flow together, and no interior walls touch the glass exterior. The bathroom is enclosed in a brick cylinder in the center of the small rectangular house, while the rest of the home enjoys privacy from its rural setting.

By the mid-20th century, large glass windows had become common in domestic architecture. The Ranch style house, for example, is characterized by both the use of larger glass windows and glasspaned sliding doors. These larger sheets of movable glass then necessitated the development of laminated and tempered glass to prevent their shearing into jagged strips if broken. Instead, this shattered glass holds together in a spider-web pattern. More varieties of chemically strengthened glass continue to be produced today to allow for further architectural possibilities, including not only the use of glass curtain walls on skyscrapers, but also load-bearing glass walls that are more energy efficient and soundproof.

CONCLUSION

Glass can have endless possibilities in structural applications. It is very advantageous from an architectural standpoint because it is transparent and causes very minimal visual interruption. Although, just because glass possesses these properties does not mean that it is ideal in all instances that require transparency. For example, many aquariums all over the world use polyacrylic or polycarbonate panes. Even though glass is stronger and more durable than these acrylics, it is also much more expensive and challenging to supply in the shapes required There are many challenges to overcome before glass becomes widely accepted by designers, contractors, and code officials. Even though glass members rarely fail, the perception that glass is brittle, sharp and dangerous keeps people from pursuing structural uses of it. Also, when glass fails it does so suddenly without any sign of warning, preventing even experienced designers from taking the chance. What most people fail to realize is that glass is considerably stronger than steel when carefully produced. If the glass industry could agree to work together and fund research on structural glass applications, and would create an industry wide standard for structural design, it could provide the backing needed to move this wondrous art form into mainstream construction in the United States. No other structural material can provide the transparency, strength, and beauty that is provided in the architectural use of glass.Innovations in detailing can improve the use of glass.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 13 Issue 06, June - 2024

REFERENCES

During the preparation of this work the author(s) used [NAME TOOL / SERVICE] in order to [REASON]. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

[1] Glass manufacturing Process,Mali Meado
[2] Laufs, W., & Luible, A. (2003). Introduction on use of glass in modern buildings (No. REP_WORK). EPFL, Laboratoire de la construction métallique ICOM.
[3] Kozłowski, M., Malewski, A., Akmadžić, V., & Vrdoljak, A. (2019). Glass in Structural Applications. e-Zbornik, elektronički zbornik radova Građevinskog fakulteta, 9(18), 44-52.
[4] Central glass and ceramic research institute Kolkata www.cgri.res.in
[5] A paper review on glass processing EGAON; Muhammad Kashif Shaikh Ghaffar, STC,SERT,SHEGAON; Nandkishor S Kale, STC,SERT,SHEGAON; Dinesh M Ugle, STC,SERT,SHEGAON,IJRSD
[6] Glass material and their advanced applications, R Rajamakrishna,JakrapongKaewkhao
[7] Rajaramakrishna, R., & Kaewkhao, J. (2019). Glass material and their advanced applications. KnE Social Sciences, 3(18), 796–807. https://doi.org/10.18502/kss.v3i18.476 Physics of glass manufacturing process,H.Rawson,Physics in Technology,Volume 5 Number 2,1974
[8] Gupta, M., Yadav, S., Kasar, A. A., & Khan, M. U. (2022). An overview of engineering properties and durability of glass fibre reinforced mixed plastic waste composite. Materials Today: Proceedings, 60, 760-764.
[9] The complete book on glass technology , NPCS Board of Consultants and engineers,Asia Pacific Business Press
[10]www.consol.co.za/business/whyglass/glass manufacturing process
[11]Optimising the glass manufacturing process McCloskey, L. & Burgoon, D.. (2006). Optimising the glass manufacturing process. 29. 20-21.