Building Materials and Composites
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Lecture - 14
Glass Wall and Glass Insulation

So, we are back with lecture 4, module 3. In this section, we will focus on the glass wall fixing and also the use of glass as an insulating material. So, we had looked into the various ways of fixing glass in the previous lecture. Prior to that, we had discussed the different types of glass. Earlier, in the beginning, we had studied the properties and manufacturing details of glass.

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By now, you are already exposed to the concept of glass walls (in the previous lecture) made of glass blocks fixed adjacent to one another. Now, we will discuss the binding agent between the glass blocks (like in brick masonry, we have mortar- sand, cement, water mix). After that, we will go to glass as an insulator.

We also have two more interesting things, which employ the use of glass fibers as reinforcements in gypsum and plastic.

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Let us start with the glass block, which we had already studied in lecture 3 (of Module 3), where we said that if you have two pieces of glass, which are moulded, brought, and fixed together, we get a glass block. That gives an obscure view on the other side, which implies that any object on the other side of the glass can be seen but cannot be accurately identified due to the hazy image formed owing to the semi-transparency.

Glass blocks provide an obscure, translucent view of the object. The fixing joints for glass blocks are visible and are different from the masonry work. That is why it is crucial to study this fixing detail. Glass blocks are usually utilized as a partition wall in between two spaces- a majorly internal application, and has much limited external application unlike that of the spider web joints in the glass façade.

This gives an elegant look, and at the same time, you will feel somewhat connected to the other side, even though you are not physically associated with the other side.

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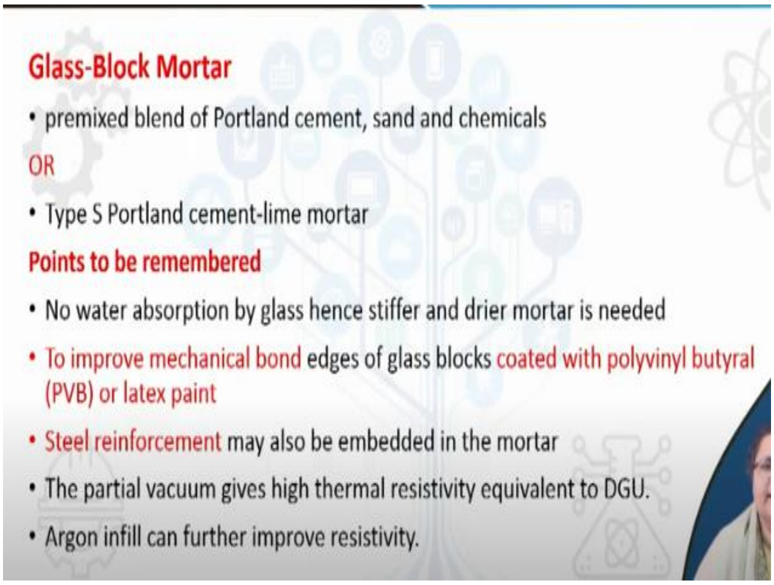

So, in the glass block system, the mortar is a premixed blend of Portland cement, fine sand, and chemicals, or it may be Type-S Portland cement-lime mortar. What is important here is that unlike brick masonry, here there is no absorber for the water component. Glass does not absorb water at all (zero absorption).

So, the water absorption being less, the mortar should be stiff, and to improve the mechanical bonding at the edges, it may be coated with polyvinyl butyral or PVB or even latex paints. Later in this course, we will have a detailed chapter on paints. For now, we will concentrate on improving the mechanical bondage between the glass wall and the adjacent wall by coating it with a PVB or latex paint.

Steel reinforcements may be pushed (embedded) in the mortar to make it more strong. You may recall that these glass blocks have partial vacuums inside them. So, these are almost equivalent to the double glazing units (DGUs). It is sealed when the two parts are joined together- it locks in the air and acts as a DGU.

Sometimes, windows are also made of glass blocks. Further thermal resistivity may be achieved by adding argon as an infill. However, these blocks find most applications in colder countries that face subzero (around 0°C or below) exterior temperatures, whereas it is simultaneously important to maintain +23 to +26°C room temperature in the interior for human comfort. These glass-block windows are highly effective in such a climate.

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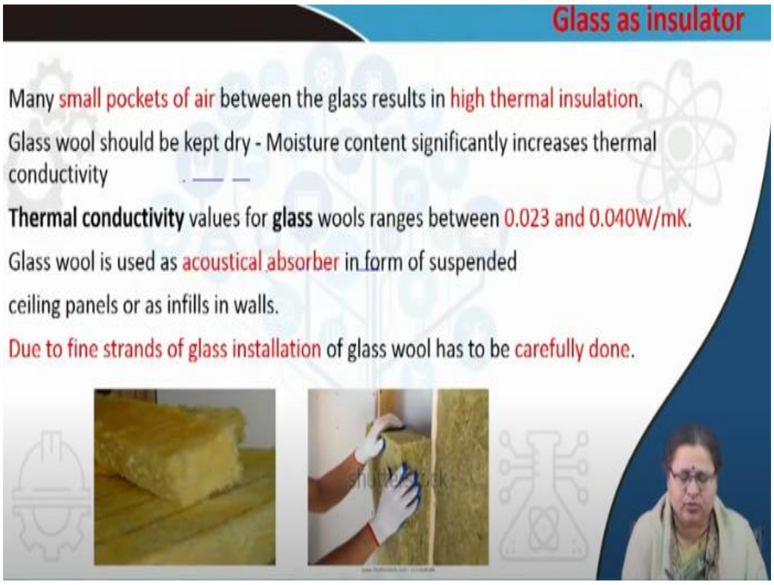

After knowing this glass wall fixing system, let us move to the glass wool, where glass works as an insulator. In the schematic diagram that some blue lines are coming out from a heated plate, and on top is some molten glass. There is a nozzle, which sprays air at a very high speed. The temperature at which the molten glass comes out from the furnace is around 1450°C

The thin strands (of the order of 4 to 15 µm in diameter) come out through a mesh. They are spun by a rotating head and are gradually cooled in contact with air. It finally reaches the gathering spool (a connecting spool). So, it is a diagrammatic representation of the entire process.

What you eventually get is very fine strands of glass. The glass was cast as sheets (in the earlier lecture), and now we see glass being transformed into wool-like fibers. They become glass-wool when they are arranged in a particular fashion, produced in rolls or in slabs (also called bats). These are non-combustible and recyclable like the other types of glass.

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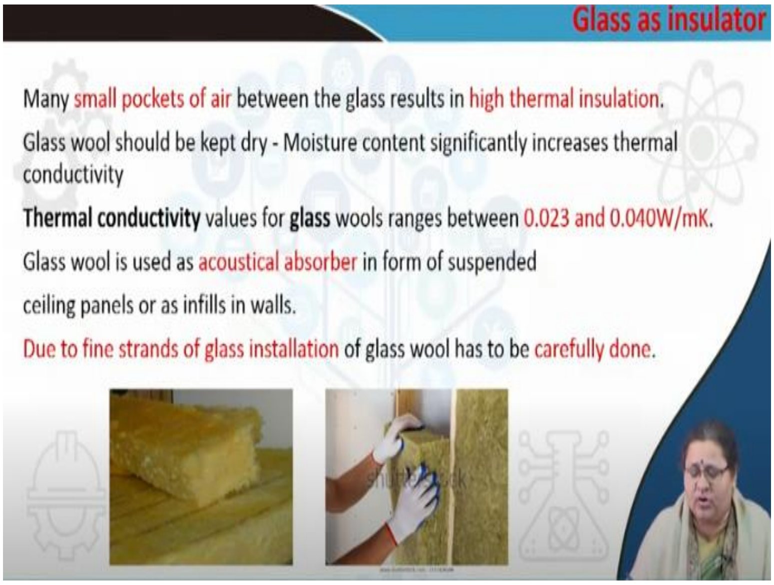

In this picture, you can see how the glass wool looks. Inside it, the entrapped air serves as the layer of insulation. Hence, it is crucial that the internal surface of glass wool is dry. If somehow moisture or water can seep inside, the thermal insulation property is lost. Glass wool also acts as an acoustic absorber.

The thermal conductivity value of glass wool is of the order of 0.023 to 0.04 W/mK. This can be used for acoustic absorbers, too, in the form of infills in walls or ceilings. The workmen who install the glass wool must have their hands covered with gloves. In the image here, you see that the person is wearing eye goggles and a mask to cover his nose and mouth.

This is because glass wool contains thin strands that may easily cause various internal injuries (of the respiratory tract and oral cavity) if inhaled. This is a significant disadvantage of glass wool. Otherwise, it is an excellent material for being used as a thermal or acoustic (sound) insulator.

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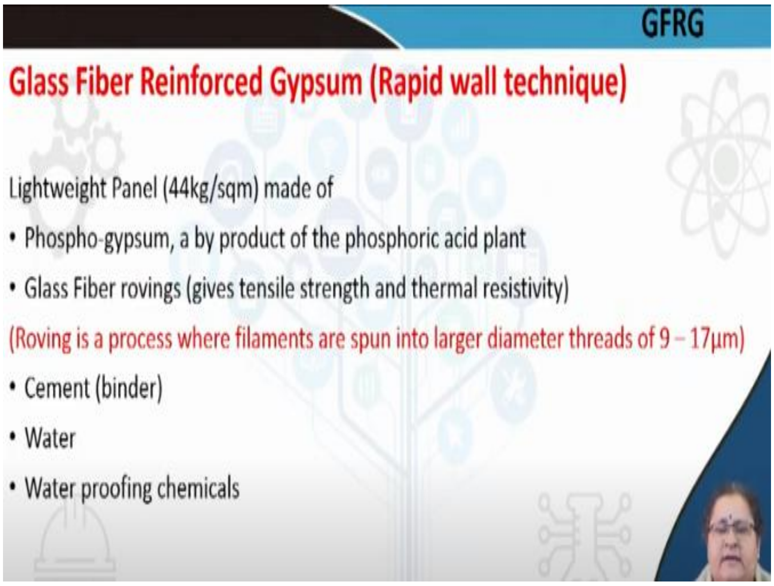

Other than using glass fibers in bat or wool form or as thermal/ acoustic absorbers, we may use them as a reinforcing material in gypsum to produce Glass Fiber Reinforced Gypsum (GFRG). But in this case, the diameter of the thread must be higher (around 9- 17 µm). The process where filaments are spun in larger diameters of threads is termed as 'roving'.

You can actually insert these rovings in gypsum, and they will still remain lightweight. Lightweight panels weigh around 44 kg/m² and are made from phospho-gypsum as the major constituent and also glass fiber rovings. Cement acts as a binder (for attachment between the constituents). You also need some water and waterproofing chemicals.

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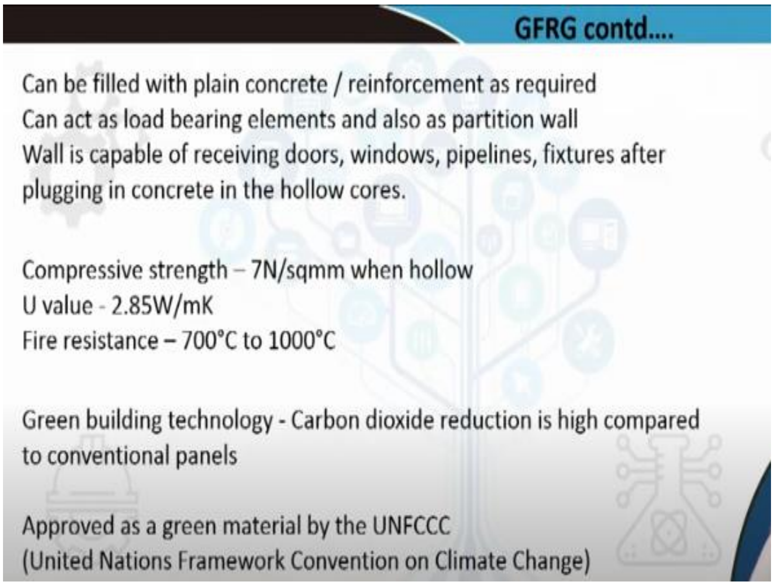

Let us discuss the various characteristics of GFRG. You can get continuous sheets of 12m (width) × 3 m (height) × 125 mm (thickness), having gaps (hollow). Here, in this image, you see a section, and this glass acts as a reinforcement. GFRG is hard, tough, and can withstand impact forces. Within these hollow spaces, you may plug in reinforcement or plain cement concrete, if necessary, to impart more rigidity to the panel.

Otherwise, you may use GFRG sheets as a partition wall within a building system. The hollows spaces also allow passage of pipelines when installed. More than the applications of GFRG, we are more interested in the glass strands, which imparts a compressive strength of 7 N/mm² when hollow. Its U-value is 2.85 W/mK, and it has a fire-resistance up to a temperature of 1000°C.

GFRG comes under green building technology. It reduces a lot of carbon dioxide when compared to conventional panels. The product has also been approved by the United Nations' agency.

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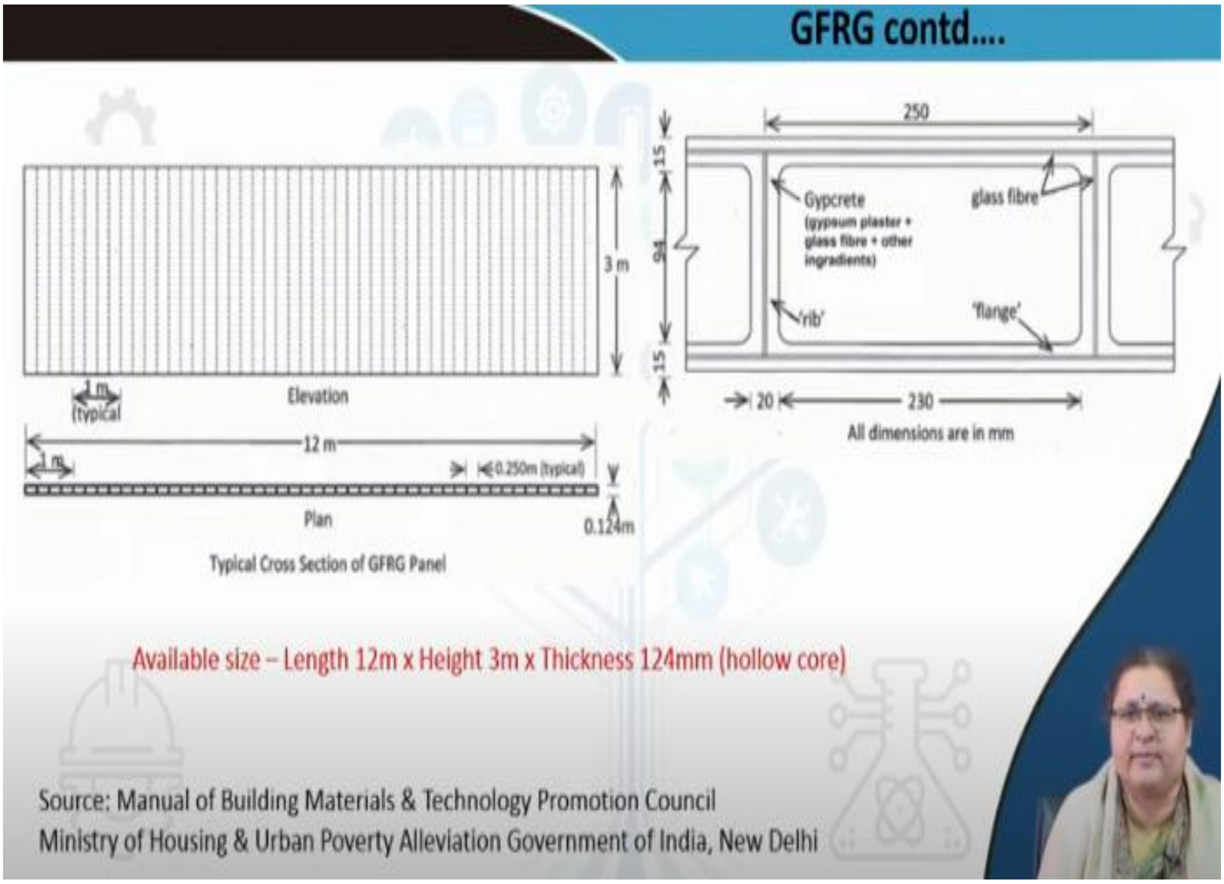

Let us talk about the appearance of a GFRG panel. In this cross-section, you can see hollow portions. Each hollow part is 250 mm in width and has a rib to strengthen the panel. At every 0.25 m (250 mm), there is a rib, which strengthens the wall. These ribs and the ends (flanges) are composed of glass rovings mixed with the gypsum.

GFRG is an enlisted material by the Central Public Works Department. It is mentioned in the specifications and has been promoted by the Building Materials and Technology Promotion Council (BMTPC) as well. You may find all details regarding GFRG in the BMTPC manual. We will discuss more of this product when we go into prefabricated items.

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Another product of glass is the Glass Fiber Reinforced Plastic (GFRP) which is made with thermosetting plastic (details will be mentioned later). Glass fibers rovings are used as reinforcement. Resins are the binders here and you can also use additives, coloring agents etc. An image of a GFRP panel is shown. The fibers may be aligned in several ways.

In the first image (aligned fiber panel), the glass fibers are aligned, all in one particular direction. These are having a unidirectional reinforced strength. You may also have woven fibers in such a way that where the strength is in both directions. You may bend it in either transverse or longitudinal directions, because it is ultimately going into plastic. In this unidirectionally aligned fiber, you may see the a pattern of waviness (or corrugation). This corrugation is always in the direction of the glass fibers, but not in the opposite direction.

But with the woven fiber panel, you may have the corrugation in any direction. You may use GFRP panels as glass fiber reinforced plastic sheets. In the case of a random fiber panel, you can see the glass rovings are randomly spread in various directions. All these panels are lightweight, translucent, heat resistant, strong building material and may be used as roofing (sheet) for temporary structures, such as bicycle shade roofs.

So, we do not stop exploring glass. You have seen many applications in your daily life (as window panes, glass doors, washroom louvers, etc.) in our homes, schools, colleges, offices, etc. Obviously, those constitute the major part of the possible applications, but usages of glass are still being explored by researchers across various domains.

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Thus, glass has versatile uses and we are often seeing newer applications. In modern times, glass is being increasingly used as insulation materials, structural components, external glazing material, cladding materials- other than the conventional windows and the delicate-looking fenestrations on the facades.

Glass may undergo special transformations; one such example is in solar-powered glass and in switchable glass (E-glass), where you mechanically alter the translucency value and control the entry of solar energy inside the building. These are modern applications coming under the purview of intelligent building systems. With these, I conclude the fourth lecture of this module on glass.

In the last lecture of this module, we will discuss the ceramic and vitrified tiles which have a glass coating; thus, their properties are related to glass. That will be the concluding topic for this module. Thank you.