Recovery and re-use of glass fibers for composite reinforcements

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The fiber glass waste generated from composite Industries is difficult to dispose as they are hazardous to environment and are even found to be carcinogenic. Fiber glass recovered from the waste was collected and reused as reinforcement. Three boards of baggase with varied composition of glass fibers were prepared using urea formaldehyde resin as binder. The boards obtained were tested for strength and thermal property. The use of recovered glass fiber is extended to high strength cement applications wherein the glass fibers were reinforced with cement mortar and tested for compressive strength. The optimum percentage of glass fibers, to achieve maximum strength, in cement mortar was determined through this experiment.

Key words: Baggase, Cement mortar, Compression, Fiber glass, Thermal conductivity, Urea formaldehyde.

Introduction
Fiberglass is a fiber reinforced polymer of a plastic matrix reinforced with fine fibers of glass, it is called glass-fiber reinforced plastic (GFRP) or glass-reinforced plastic (GRP). Fiberglass is a robust, lightweight, and extremely strong material. Compared to metals its strength and weight are favorable. A single structural glass fiber is stiff and strong in compression and tension. Fiberglass combines its light weight with an inherent strength to provide a weather resistant finish, with a variety of surface textures. In 1930s, extensive research was carried to develop fiber reinforced plastic for commercial use. Common uses of fiberglass include water tanks, boats, automobiles, helmets, roofing, pipes, cladding and in defence organization to carry ammunitions. Glass wool fibers are a human carcinogen. Studies of fiberglass factory workers show significant increases in lung cancer. Fiberglass will irritate the eyes, skin and the respiratory system. Across the Globe 2, 00,000 tons of fiber glass waste is generated annually. In India more than 500 Glass fiber composite manufacturing units generate 80 kg per day of waste. Deformed pieces of waste fiber glass were obtained from a Hitein Bushings Pvt. Ltd., Pune.

Materials and methods
Waste composite fiber glass was collected from the industry (Hitein Bushings Pvt. Ltd., Pune) and brought to the laboratory. The composite contains 60% fiber glass and remaining 40% resin. Gas welding torch was used to produce high intensity flame of temperature 450 – 550° C to remove the resin which melts at around 350° C. The fiber glass strands have a very high melting point above 1200° C and thus remain unaffected. The carbon deposit left on the fiber surface was removed by keeping glass fiber strands in a muffle furnace at 650° C temperature. Later the carbon was oxidized to carbon di-oxide resulting in white fiber glass. The recovered fiber glass strands was cut into 3 cm length before they are used. Baggase was collected from a local sugar industry, sun dried for 24 hrs and stored in air tight container.

Glass fiber blended baggase board
The dried baggase was further manually screened to remove the pith and waste matter associated with it. Baggase was uniformly mixed with urea formaldehyde resin (20% by total mass) in a tumbling mixture to ensure optimum mixing. The glued mixture was taken on a flat metal container and glass fibers were blended manually in 5, 10, 15% respectively. The mixture was taken into a standard frame of size 4’ X 2’ which holds up to 5.2 kg weight. The mixture was released from the frame and was subjected to compression in a hydraulic pressing machine at a temperature of 150 °C and pressure of 120 Kg/cm². The boards were subjected to hydraulic compression for a time period of 20 minutes. The boards obtained were cured at ambient conditions.

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for a period of 24 hrs. Finally the boards were cut into definite sizes in a milling cutter.

**Glass Fiber Reinforced Cement (GFRC)**

Glass-fiber reinforced concrete (GFRC) is a material composed of cement, sand, water and admixtures, in which short length glass fibers are dispersed \(^2\). Cement (53 Grade) and sand in the ratio of 1:3, were taken in a flat metallic container. The fiber glass in varied proportion of 2, 4, 6, 8 and 10% were blended with the cement-sand mixture in separate containers. Calculated amount of water (approximately 250 ml) was gradually added to the cement-sand-fiber glass mixture. The entire mixture in the container was mixed manually \(^5\). The mass from every proportion was taken in a standard mould \((7.06 \text{ cm}^3)\) to obtain cubic blocks of mortar. The mixture was allowed to cure at ambient conditions for 24 hrs. The cubes were dismantled from the mould and kept under water for a period of 7 days. The cubes were sun dried and further taken for Compression Test.

**Results and discussion**

Fig. 1 illustrates that thermal conductivity of a board decreases with increase in fiber glass composition in a bagasse board because loosely added glass fiber provides thermal insulation in a board. Lowest thermal conductivity was observed for 15% glass fiber composition. Figure 2 shows increase in tensile strength and compression strength with respect to glass fiber composition which is due to increased elasticity of glass fiber. Figure 2 shows compression strength of a board did not increase much. It was observed from Fig. 3, that the strength of the mortar blocks increased for 2 and 4% glass fibers. Cement, when reinforced with glass fiber, produces precast elements much thinner typically 10 mm than would be possible with traditional steel-reinforced concrete \(^3\).

**Conclusion**

Thermal conductivity of bagasse board is reduced by 9% with 15% fiber glass, so bagasse boards fused with fiber glass can be a potential replacement to conventional polystyrene boards used for AC room insulation. GFRC can be used for complex building designs and can be used for high strength applications like flyovers, Dams. For 4% composition there was substantial increase in strength (25-47%) of concrete. Thus we can conclude that 4% composition of glass fiber is the optimum blending composition in glass fiber reinforced cement.

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