# Fabrication of Glass Fiber Helmet

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**Abstract:** Fiberglass Industry over the years has been regarded as a versatile reinforcement material in imparting structural stability and strength to various components in a wide variety of markets such as Automobile, Aeronautics, and Wind Turbine etc. A high percentage of fiber glass produced in the world is used for reinforcement of plastics The main products marketed by the fiber glass plants are Mats, Roving's, Woven Roving's, Yarns etc. An attempt has been made to fabricate a fiberglass reinforced plastic helmet using an Industrial helmet as the mold. The Industrial helmet is essentially made up of Polyethylene thermoplastic. The construction of the fiberglass helmet is done using the fiberglass hand lay-up operation. Emphasis is laid in constructing the helmet with superior structural strength and stability over the polyethylene thermoplastic while also ensuring that the weight is kept as low as possible comparison with the polyethylene plastic helmet and also ensuring that the product is economical.

**Keywords:** Fiberglass, fabricate, helmet, polyethylene thermoplastic

## 1. Introduction

One of composites' main advantages is how their components - glass fiber and resin matrix - complement each other. While thin glass fibers are quite strong, they are also susceptible to damage. Certain plastics are relatively weak, yet extremely versatile and tough. Combining these two components together, however, results in a material that is more useful than either is separately. With the right fiber, resin and manufacturing process, designers today can tailor composites to meet final product requirements that could not be met by using other materials. The key factors to consider are fiber, resin and filler. Glass-reinforced composites gain their strength from thin glass fibers set within their resin matrix. These strong, stiff fibers carry the load while the resin matrix spreads the load imposed on the composite. A wide variety of properties can be achieved by selecting the proper glass type, filament diameter, sizing chemistry and fiber forms (e.g., roving, fabric, etc.).

As temperatures increase, glass fibers lose tensile strength. C-glass performs poorly in high-temperature applications and should not be used for them. While E-glass and S-type glass lose about 50% of their tensile strength at 1000º F, their strength at high temperatures is still considered good. Another temperature-related property to consider is the coefficient of thermal expansion (CTE). Fibers with a high CTE expand more as temperatures increase. S-type glass has a much lower CTE than either E-glass or C-glass. Having a similar CTE in both the fiber and resin prevents problems due to different thermal expansion rates.

Matrix resins bind glass-reinforcing fibers together, protecting them from impact and the environment. Glass fiber properties such as strength dominate in continuously reinforced composites. When glass is used as a discontinuous reinforcement, resin properties dominate and are enhanced by the glass.

Polymer matrix resins fall into two categories: thermoset and thermoplastic. The difference is in their chemistry. Thermoset resin is chemically comprised of molecular chains that crosslink during the cure reaction (set off by heat, catalyst, or both) and "set" into a final rigid form. Molecular chains in thermoplastic resin are processed at higher temperatures and remain "plastic," or capable of being reheated and reshaped. While the tradeoffs between thermosets and thermoplastics have been debated extensively, engineers will find that material suppliers will tailor matrix resin formulations best for their application.

## 2. Industrial Plastic Helmet

High-density polyethylene (HDPE) or polyethylene high-density (PEHD) is a polyethylene thermoplastic made from petroleum. Known for its large strength to density ratio, HDPE is commonly used in the production of plastic bottles, corrosion-resistant piping, geo membranes, and plastic lumber. HDPE is commonly recycled, and has the number "2" as its recycling symbol. In 2007, the global HDPE market reached a volume of more than 30 million tons.

### 2.1. Properties

HDPE is known for its large strength to density ratio. The density of high-density polyethylene can range from 0.93 to 0.97 g/cm$^3$. Although the density of HDPE is only marginally higher than that of low-density polyethylene, HDPE has little branching, giving it stronger intermolecular forces and tensile strength than LDPE. The difference in strength exceeds the difference in density, giving HDPE a higher specific strength. It is also harder and more opaque and can withstand somewhat higher temperatures (120 °C/ 248 °F for short periods, 110 °C /230 °F continuously). High-density polyethylene, unlike polypropylene, cannot withstand normally required autoclaving conditions. The lack of branching is ensured by an appropriate choice of catalyst (e.g., Ziegler-Natta catalysts) and reaction conditions.

## 3. Manufacturing Process

1. The mould is first selected in order to give shape and dimension to the product. The mould chosen for this project was the plastic industrial helmet itself.

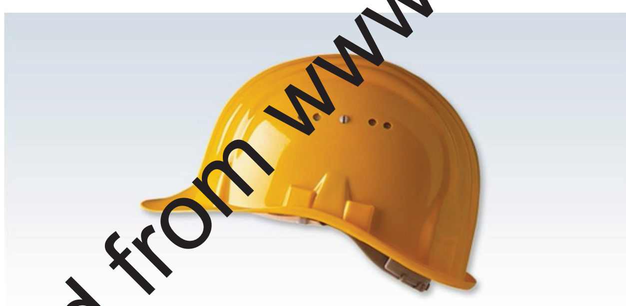

Figure 1. Industrial Helmet

2. The fiber glass cloth is cut into pieces which help in fabrication process.

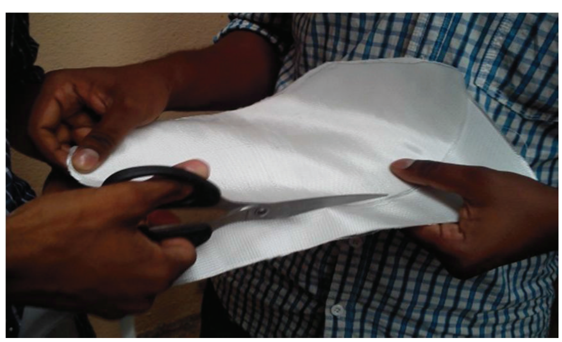

Figure2. Cutting the Glass Fiber Cloth To Get the Desired Shape

3. The mold is thoroughly coated with releasing agent. This releasing agent helps the component to get detached from the mould easily. Wax is used as a releasing agent for the manufacturing of helmet.

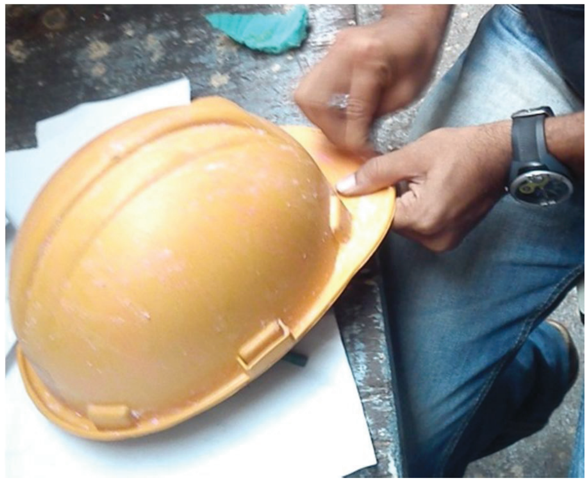

Figure 3. Applying Wax on the Mould

4. The mould which is coated with the wax is kept idle for almost 20 minutes.

5. Mix Epoxy and hardener in the ratio of 2:1 and stir it thoroughly.

6. Apply this compound to the waxed helmet mould and wait for 20 minutes so that the fibre glass cloth can stick well onto the surface of the helmet.

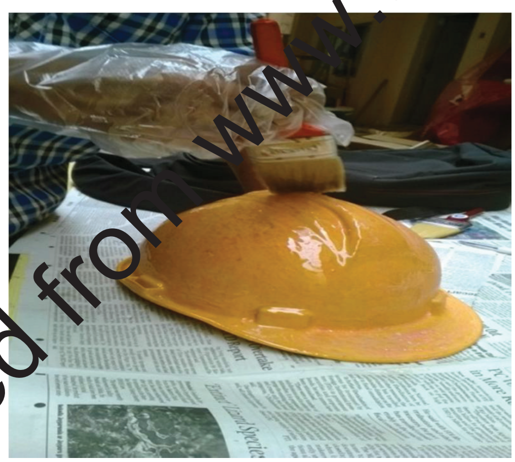

Figure4. Applying the Mixture On To the Mould

7. Place the fiber glass cut piece clothes onto the helmet.

8. It is then kept for drying. A drier can be used to make the process faster.

9. Apply another layer of Epoxy hardener mixture onto the first layer and wait for 30minutes.

10. Continue this process till four layer of glass fiber is been kept on the mould.

11. Apply one more layer of Epoxy hardener layer on the fourth layer to give a smooth finish to the helmet.

12.Allow the layers to get dried for 12 hours.

13. When the layers becomes hard in the shape of the helmet detach the layer from the mould by gently heating the mould.

Figure 5. Fiber Glass Helmet after Removing From the Mould

14. Cut the unwanted glass fibre layer and a smooth finishing is given to the product.

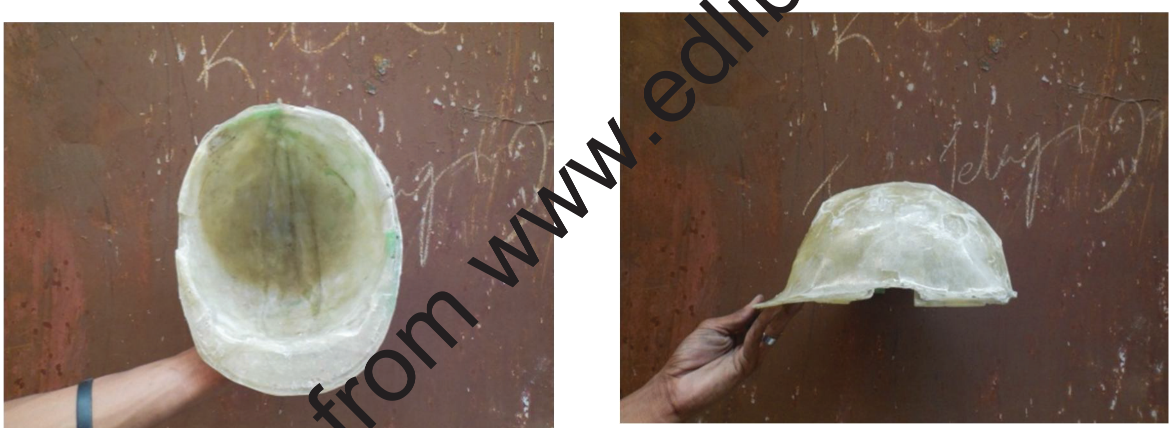

Figure 6. Final Product after the Finishing



## 4. Test Results

Table 1. Plastic Helmet test results

| Tensile Test | Hardness Test | Flexural Test |
|---|---|---|
| 31.37 $N/mm^2$ | 65 | 63 $N/mm^2$ |

Table 2. Glass Fiber Helmet test results.

| Tensile Test | Hardness Test | Flexural Test |
|---|---|---|
| 49.815 $N/mm^2$ | 69 | 80.29 $N/mm^2$ |

Table 3. Cost analysis.

| Material | Amount | Cost | Total |
|---|---|---|---|
| Fiber Glass | $1m^2$ | 240 per meter | 240 |
| Epoxy Resin | 600ml | 350 per liter | 210 |
| Hardener | 300 ml | 350 per liter | 105 |
| Wax | 5 nos | 5 | 25 |
| **Total** | | | 580 |

The price for a single unit helmet was Rs.200 while the cost for making glassfibre helmet costs Rs.580. The cost of making glassfibre helmet was more than the Plastic helmet that was produced by mass production. This was mainly because the materials used for making the glass fibre helmet was purchased in retail price. The cost of production could be further reduced to a large extent when the materials are bought in large amount and in wholesale.

## 5. Conclusion

The fiberglass cloth was chosen keeping in mind various parameters concerning the weight and cost of the fiberglass reinforced glass helmet and also ensuring that the mechanical properties were not compromised. The various parameters considered include weight, the weave pattern, strand direction and the cost effectiveness. The Hand Lay-up process was chosen to fabricate the Fiber Reinforced Glass Helmet while a HDPE Industrial Safety helmet was chosen to be the open mould. Four layered glass specimens were tested for tensile strength, hardness and flexural strength and have been compared alongside the standard mechanical properties of a HDPE Industrial helmet. While the FRP emerged as a clear winner over the HDPE Industrial helmet with respect to the structural properties, the study has also widened the areas of research for improvement in design and in its economy. A research on the fiber glass market both domestically and internationally has been studied and also on the future of the Fiber Glass Industry.

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