DEVELOPMENT OF ROAD BARRIER USING GLASS FIBRE COMPOSITE

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ABSTRACT

In recent times, advanced materials such as composites are being extensively tested across various geotextile applications, and their use has expanded into road safety systems like barriers. A composite road divider/barrier has been developed with the ability to efficiently absorb impact energy, thereby lowering the severity of injuries during accidents.

Textile waste materials are utilized as the primary base in the fabrication of the composite barrier, along with reinforcements and fillers such as glass fiber, coir pith, crushed stones, and marble waste. The current focus of roadside safety barrier development is on the efficient use of natural and recycled resources. This objective can be achieved through improved design approaches, selection of suitable materials, and effective manufacturing techniques.

The composite barrier is fabricated using the hand lay-up technique with E-glass/epoxy bidirectional laminates. In this process, the required thickness is obtained by successively applying layers of fiberglass and liquid resin. A Charpy impact test was conducted to evaluate the impact resistance of the barrier surface, and the impact strength was found to be 38 Nm.

When compared to conventional concrete barriers, the composite barrier exhibits a 64% higher factor of safety and is approximately 75% more economical. Additionally, the use of composite materials resulted in a weight reduction of about 53.8% without compromising the structural strength.

Key words: *Glass fiber, Composite barriers, Light Weight, Tensile and compressive strength, Impact strength*

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1. INTRODUCTION

Currently, the number of road accidents and related fatalities is steadily increasing due to unsafe road conditions. Although safety measures such as helmets and seat belts have been introduced by transportation systems, they mainly protect individuals rather than improving roadside safety. Conventional road dividers and barrier posts made of concrete are extremely hard and rigid, offering very little flexibility and poor energy absorption, much like stone. A divider is essentially a structure used to separate lanes of traffic, helping to prevent collisions and ensure smooth movement of vehicles.

Median barriers are specifically designed to stop vehicles from crossing into the opposite lane and causing head-on collisions. Despite the presence of personal safety measures, accident rates continue to rise due to the limitations of existing roadside infrastructure. At present, three common types of road dividers are used: metal, plastic, and concrete. Each of these materials has its own drawbacks. During severe impacts, all three can lead to serious injuries. Plastic barriers tend to break easily and degrade under prolonged exposure to sunlight. Metal barriers are prone to damage due to environmental factors such as heat and moisture.

Concrete barriers, on the other hand, are extremely rigid and have a hard surface, which can cause severe head injuries and other health issues when they come into direct contact with the human body during accidents. Reports indicate that accidents involving crash barriers contribute to nearly a 32% increase in fatality rates each year. To address these issues, a composite road barrier/divider has been developed. This barrier is designed to effectively absorb impact energy, thereby reducing the severity of injuries. Like conventional crash barriers, it functions to guide and restrain vehicles that go off track.

The proposed composite barrier offers advantages such as lower cost, reduced weight, and efficient use of natural and waste materials. These factors are becoming increasingly important in the design of safer roadside systems in the current scenario. Achieving improved safety performance is possible through enhanced design concepts, selection of appropriate materials, and the adoption of efficient manufacturing processes.

2. PROBLEM IDENTIFICATION AND INDUSTRIAL RELEVANCE

In current roadways system, the main problems occurring due to conventional concrete road barriers are:

- Heavy barriers cause high damage during accidents
- Unable to move them freely to change lane structure
- High cost of manufacturing
- Intensive material consumption
- No sludge management

3. OBJECTIVES OF THE STUDY

The main objectives of the research are:

- To design and develop the glass fiber composite road barrier.
- To test the impact and compressive strength of composite road barrier
- Compare the existing steel barrier and glass fiber composite road barrier

LITERATURE REVIEW

Previous research has highlighted the growing use of fiber-reinforced composites in transportation and infrastructure applications due to their high strength-to-weight ratio and superior energy absorption characteristics. Studies indicate that glass fiber reinforced polymer (GFRP) composites exhibit excellent mechanical properties, corrosion resistance, and durability, making them suitable for structural and safety applications such as road barriers. Researchers have also reported that the inclusion of fillers like natural fibers, mineral aggregates, and industrial waste materials can further enhance the impact resistance and sustainability of composite structures.

Investigations on impact behavior reveal that GFRP composites possess better energy dissipation capacity compared to conventional materials like steel and concrete, thereby reducing the severity of injuries during collisions. In addition, fabrication techniques such as hand lay-up and compression molding have been widely studied for producing cost-effective composite barriers with consistent quality. Literature also emphasizes that the use of epoxy resins improves bonding strength and structural integrity, while proper fiber orientation contributes to enhanced load-bearing performance.

However, limited studies are available on the development and optimization of glass fiber-based composite road barriers incorporating waste materials, highlighting the need for further research in this area to achieve safer, lightweight, and sustainable roadside systems.

4. MATERIALS USED

The materials used in the composite product are:

- Glass Fiber
- Epoxy Resin
- CRD (Crushed Rock Dust)
- MSP (Marble Sludge Powder)
- Cement
- Iron rod

Its composition in the prototype includes:

- MSP - 20%
- CRD - 15%
- Cement - 15%
- Composite - 15%
- Steel rods - 10%

5. METHODOLOGY

5.1. Collection of Raw Materials

Raw materials such as glass fiber, epoxy resin, hardener, and fillers like coir pith or marble sludge are collected. Each material is carefully selected based on required mechanical properties, availability, durability, and cost effectiveness for composite barrier fabrication, ensuring uniform quality, improved performance, and sustainability in the final composite structure.

5.2. Formation of Mold

A suitable mold is prepared according to the required dimensions and shape of the road barrier. The mold surface is thoroughly cleaned and coated with a release agent to prevent sticking, ensuring easy removal of the composite after curing while maintaining proper geometry, smooth surface finish, and dimensional accuracy of the final product.

5.3. Hand Lay-Up Method

In the hand lay-up process, layers of glass fiber are carefully placed in the mold and coated uniformly with epoxy resin mixture. This process is repeated layer by layer to achieve the required thickness, followed by proper curing under controlled environmental conditions to ensure strong bonding, enhanced strength, and long-term durability of the composite barrier.

5.4. Testing of Composite Barrier

The fabricated composite barrier is tested for mechanical performance and reliability. Compressive strength is evaluated using a Universal Testing Machine, while impact resistance is measured using a Charpy Impact Tester to determine its ability to absorb sudden loads, resist failure, and perform effectively under real-time impact and loading conditions.

6. RESULT AND DISCUSSION

The results indicate that the glass fibre–reinforced composite barrier performs better than conventional materials in terms of mechanical strength and safety performance. It exhibited good compressive strength and an impact strength of 38 Nm, demonstrating its ability to effectively absorb impact energy and reduce injury severity during collisions. Furthermore, the barrier achieved significant reductions in both weight and cost compared to traditional concrete barriers. These improvements make it a safer, more economical, and efficient solution for modern road safety applications.

7. CONCLUSION

The development of a glass fibre–reinforced composite road barrier demonstrates a promising alternative to conventional concrete and plastic barriers in terms of safety, cost, and performance. The use of composite materials along with textile and industrial waste not only enhances impact energy absorption but also promotes sustainable resource utilization. Fabrication through the hand lay-up process proved to be simple and effective in achieving the desired structural properties. Experimental results, including compressive and impact strength tests, confirm that the composite barrier provides improved durability and reduced injury risk during collisions. Additionally, significant weight reduction and lower production cost make it suitable for large-scale implementation. Overall, this study highlights the potential of composite barriers in creating safer and more efficient roadside infrastructure.

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