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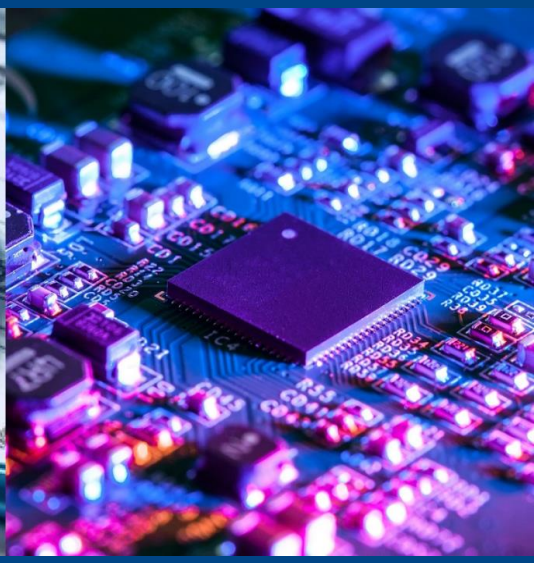

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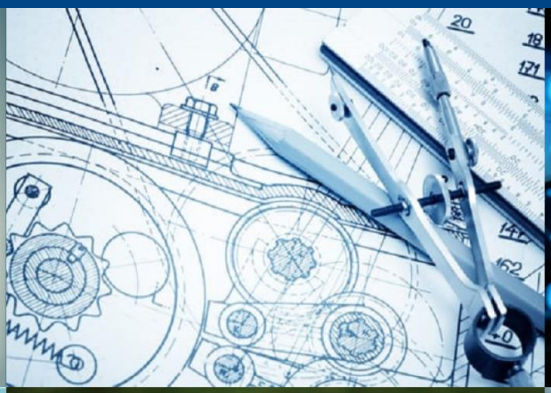

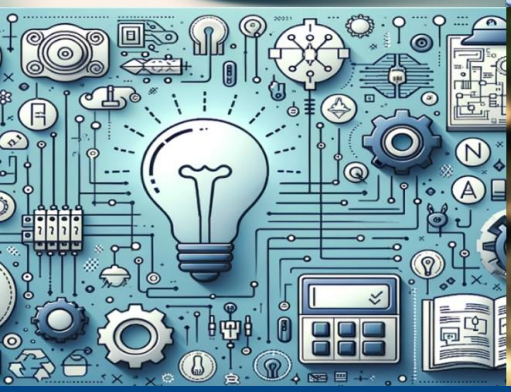

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Manufacturing of Light Weight Composite Armed Protection for Personal Body

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ABSTRACT: In modern defence applications, personal body armour plays a crucial role in protecting soldiers from ballistic threats. Traditionally, Kevlar fibre has been widely used due to its high strength and impact resistance. However, there is a continuous need for lighter yet equally strong materials to improve mobility and comfort without compromising safety. This project focuses on developing a lightweight composite armoured panel for personal body protection. The composite material is created by combining Kevlar fibre with an epoxy resin system (LY556) and a hardener (HY951). This combination enhances the mechanical properties of the armour, offering better impact absorption and durability while reducing weight. The manufacturing process follows conventional composite fabrication methods, ensuring cost-effectiveness and reliability. To evaluate the effectiveness of the developed armour, various tests were conducted to analyse its strength, impact resistance, and overall performance. The results indicate that the newly developed composite panel provides improved protection with a reduced weight compared to conventional Kevlar-based armour. This research contributes to the advancement of lightweight protective gear, making it a valuable innovation for defence applications.

KEYWORDS: Light Weight, Durable, Protective.

I. INTRODUCTION

The need for advanced personal protective equipment (PPE) has significantly increased due to the evolving nature of modern warfare and law enforcement challenges. Soldiers and security personnel require body armour that provides not only high-impact resistance but also enhanced mobility and comfort. Traditional body armour relies heavily on Kevlar fibre, a well-known ballistic-resistant material. However, there is a growing demand for improved armour systems that reduce weight while maintaining or enhancing protection levels.

This project aims to develop a “lightweight composite armoured panel” by incorporating “Kevlar fibre, epoxy resin (LY556), and hardener (HY951)”. The primary objective is to enhance the material’s strength, durability, and energy absorption capacity while minimizing overall weight. By reinforcing Kevlar with an epoxy matrix, the composite material exhibits better adhesion, increased toughness, and improved resistance against impact forces. This innovative combination can help address the limitations of traditional armour systems by offering a more efficient and ergonomic solution.

The manufacturing process follows conventional composite fabrication techniques, ensuring a balance between cost-effectiveness and structural integrity. Various mechanical and ballistic tests were conducted to evaluate parameters such as “impact resistance, tensile strength, and flexibility”. The results demonstrate that this newly developed composite armour can offer improved protective capabilities without compromising mobility.

This research contributes to the field of “defence and security” by introducing a “lightweight, high-performance armour solution”. The findings could be beneficial not only for military applications but also for law enforcement agencies and personal security personnel who require advanced protective gear. As the demand for enhanced body armour continues to grow, the integration of composite materials offers a promising avenue for future innovations in the field.

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II. FABRICATION AND ANALYSIS

The fabrication of Kevlar-epoxy composite armour follows a structured process to achieve high strength, durability, and lightweight performance. Initially, Kevlar fibre is selected* for its excellent impact resistance, while epoxy resin (LY556) and hardener (HY951) are used to enhance bonding strength and overall structural integrity. A Mold is prepared based on the desired armour shape, and multiple Kevlar layers are arranged in various orientations to improve multi-directional protection. The epoxy resin mixture is applied uniformly to each layer to ensure full impregnation. To eliminate air bubbles and create a dense composite structure, the laminate is compressed using a hydraulic press or vacuum bagging technique. The composite then undergoes a controlled curing process for 24–48 hours, allowing the epoxy to harden completely. Once cured, the material is cut, smoothened, and quality-checked to ensure flawless protection.

To validate its effectiveness, the composite undergoes extensive mechanical and ballistic testing. Tensile, compression, and flexural strength tests determine the armour's load-bearing capability, while ballistic impact tests assess its ability to absorb high-speed projectile energy. Environmental resistance testing, including moisture, UV, and thermal stability assessments, ensures its durability in extreme conditions. Weight and comfort analysis further confirm that the armour remains lightweight without compromising protection, making it superior to traditional Kevlar vests.

In addition to its performance benefits, the Kevlar-epoxy composite is also cost-effective and scalable. Unlike expensive ceramic plates, this material is affordable and easier to manufacture using existing fabrication techniques. Its customizable protection levels make it suitable for military, law enforcement, and civilian applications, while its resistance to wear and environmental degradation extends its service life. With its balance of affordability, protection, and durability, this project represents an innovative step forward in personal body armour technology.

III. PROPOSED METHODOLOGY

The methodology for this project follows a systematic approach to designing, fabricating, and evaluating a lightweight composite armoured panel using Kevlar fibre, epoxy resin (LY556), and hardener (HY951). The process ensures that the final product achieves high impact resistance, mechanical strength, and reduced weight, making it suitable for personal body protection. The first step involves a literature review and material selection, where an in-depth study of existing body armour materials and their properties is conducted. The benefits and limitations of Kevlar fibre and epoxy composites in armour applications are analysed, and suitable materials are selected based on strength, durability, and lightweight characteristics. Next, the design and specifications of the composite armour panel are defined, including its dimensions, thickness, and layering structure to achieve optimal impact resistance. An appropriate *fibre to-resin ratio is chosen for improved mechanical performance.

The fabrication process begins with material preparation, where Kevlar fibre sheets are cut to the required size, and the epoxy resin and hardener are mixed in precise proportions. The hand layup metho is used for composite layup, where Kevlar layers are placed in a Mold, resin is applied uniformly, and the process is repeated to build the composite structure. The panel is then cured at room temperature for 24 hours, with optional heat curing or compression moulding for enhanced strength. After curing, the panel undergoes finishing and trimming, where excess material is removed, and surface treatments are applied to improve durability.

Once fabricated, the composite undergoes mechanical and ballistic testing to evaluate its tensile strength, impact resistance, flexural strength, and hardness. The performance is compared to traditional Kevlar-only armour to measure improvements. Data analysis and optimization follow, where test results are reviewed to determine efficiency, weight reduction, and impact resistance. The fabrication process and material composition are further refined for better performance finally, the conclusion and future recommendations summarize the key findings and evaluate the success of the composite armour. Potential improvements and future research directions in lightweight ballistic protection are suggested. By following this structured methodology, the project ensures the successful development, testing, and evaluation of an innovative, lightweight, and impact-resistant composite body armour panel.

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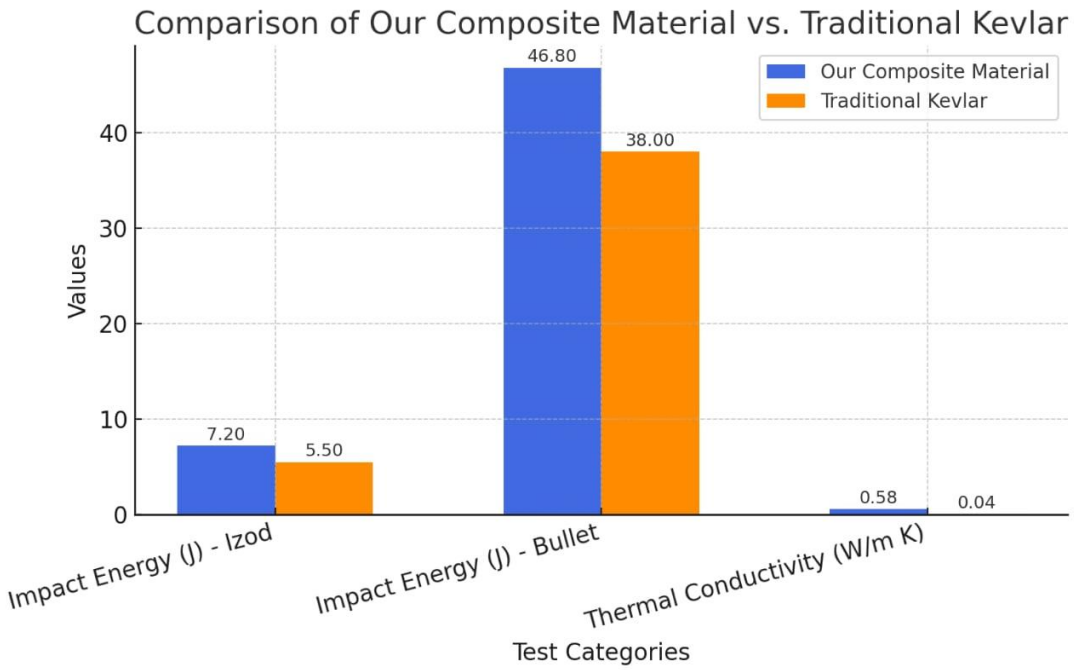
IV.COMPARISION

The comparison between the traditional Kevlar method and the composite material method highlights significant improvements in impact resistance, thermal conductivity, and overall performance. Traditional Kevlar, while offering good ballistic protection, has limitations in terms of impact absorption and thermal resistance. In contrast, the composite material, which integrates Kevlar fibre, epoxy resin (LY556), and hardener (HY951), demonstrates superior mechanical strength, enhanced impact resistance, and improved durability.

In impact tests, the composite material exhibits higher energy absorption, with impact energy values of 7.2 J (Izod) and 46.8 J (Bullet), compared to 5.5 J and 38 J for traditional Kevlar. This indicates better resistance to sudden forces and projectiles. Additionally, the thermal conductivity of the composite material (0.58 W/m K) is significantly higher than that of traditional Kevlar (0.04 W/m K), making it more effective in dissipating heat. These improvements suggest that the composite material is a more efficient and advanced alternative for body armour applications, offering both lightweight protection and enhanced durability. Overall, the study confirms that the composite method outperforms traditional Kevlar in strength, impact resistance, and thermal properties, making it a superior choice for protective gear.

V. RESULT AND DISCUSSION



In This Fig, The graph compares the impact energy and thermal conductivity of our composite material versus traditional Kevlar. It shows that our composite material has higher impact resistance in both Izod and bullet impact tests while having slightly higher thermal conductivity.

VI. CONCLUSION

Based on the test results and comparative analysis, it is evident that the composite material offers superior mechanical properties compared to traditional Kevlar. The impact resistance of the composite material is significantly higher, as seen in both * Izod and bullet impact tests, demonstrating its ability to absorb greater energy under dynamic loading conditions. Additionally, the thermal conductivity of the composite material is notably higher, suggesting improved heat dissipation, which is beneficial for high-performance applications such as body armour and protective gear Overall, the study confirms that the Kevlar-based composite material provides enhanced durability, improved impact resistance, and better thermal management, making it a more effective and advanced alternative to conventional Kevlar for protective applications.

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