

Strength Analysis on Silk Reinforced Fibre for Protective Body Armor

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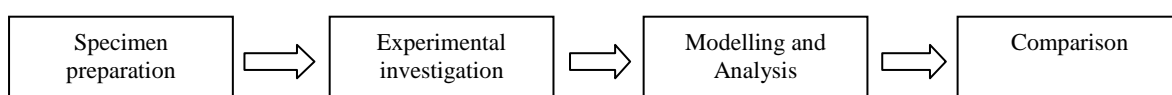
ABSTRACT: For the past two decades the warfare strategies and the weapons has been improvised a lot more than as expected. As the innovations in weapons have been doing in one side the other side has given importance to the self protection of people in the Warfield or in the same kind of atmosphere. One of the eminent roles of people's protection has been done by body armours. The latest trend of material using in the body armour is Kevlar. But there are certain problems associated with this material which is basically a synthetic fibre. The main problems associated with this are its heavy weight, high cost of production and the thermo physiological burden it causes to the bearer. So this paper aims to find a good replacement for Kevlar which overcomes the disadvantages. And compare its properties with Kevlar. Here materials used for making the composite are natural raw silk fibre and epoxy resin. The silk fibre is ecofriendly and biodegradable material.

KEYWORDS: Silk reinforced fibre, Composite, Kevlar, and ANSYS

I. INTRODUCTION

Synthetic (man-made) fibres are important reinforcement materials in modern composites for high performance applications primarily due to their high specific strength and high specific modulus. However, the environmental unfriendly production method of synthetic fibres is an area of concern [1]. Amid the growing global awareness and push for environmentally friendly products, the need to seek viable alternatives materials for synthetic fibres has been rising. As such, natural animal-based fibres are looked into as potential candidates. Modification of natural fibres to rival the mechanical performance of synthetic fibres has been looked into by many researches. Moreover, due to rising costs of energy, transportation, and raw materials, production costs of synthetic fibres have increased. To tackle this imminent problem, the development and use of "greener" natural alternatives is gaining momentum to replace synthetic fibres in composite fabrication. Currently, the Germans used a total of 30,000 tonnes of natural fibre reinforced polymers in their automotive industry in 2005 [7]. The use of natural fibres in composites is nothing new to human. Evidence of natural fibre reinforced composites could be found in pottery containing hemp fibre which dated back to as early as 10000BC [5]. This paper discusses about the development of a composite from natural silk fibre using epoxy resin as adhesive. And also includes comparison of the developed composite with the existing Kevlar. The composite has been made by proper mixing of materials and allowing the mix to undergo certain operations. For comparison and analysis ANSYS software [3] is used.

II. WORK PLAN



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Specimen preparation: The fabrication of silk composite is done by mainly three steps by using woven silk material and epoxy resin named Araldite AW 106 resin/Hardener HV 953IN. The process includes; Hand layup process, Preheating, Hot press. Hand layup process involves manual placement of dry fiber in the mould and succeeding application of resin matrix. Hand rollers are facilitate to get uniform resin distribution of the wet composite, to ensure better interaction between the reinforcement and the matrix and to achieve the required thickness. And the after product is then heated to 100°C, which is known as the preheating process. Hot pressing process is the process in which the simultaneous application of pressure and heat to consolidate fibre to full or nearly full density. The composite, is preheated at room temperature is placed in the punch, at room temperature and preheated to the hot pressing temperature. With the fibre composite in the punch, the composite must be heated to the hot pressing temperature. In Hot pressing fibre material are compressed at high temperature (100–130°C) between opposing punches. The material made from the hot pressing process is pressurized in the hot press for 3 days [2]. And applied a load of 100 KN.

Experimental investigation: Experimental investigation of mechanical properties of specimen is done by tensile test on universal testing machine . The obtained final results of silk fibre composite are,

- Ultimate strain = 5.24 mm
- Young’s modulus = 5997.36 MPa
- Poisson’s ratio = 0.275
- Ultimate stress = 567.33 MPa

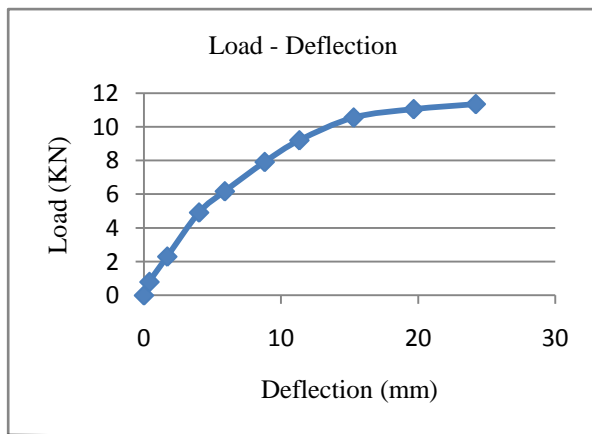


Fig 1: Load – Deflection

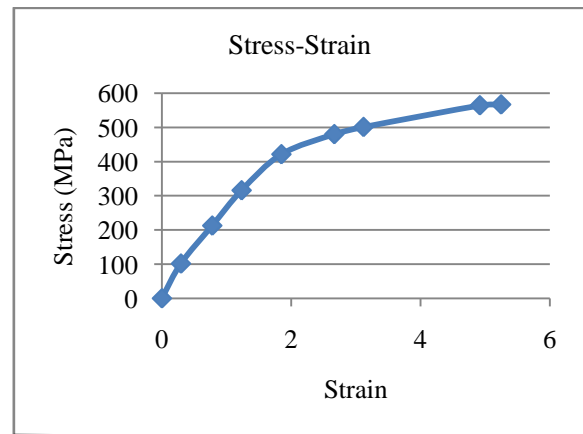


Fig 2: Stress – Strain

Figure 1 and 2 represents the graphic representation of obtained data from tensile testing in universal testing machine. Figure 1 is the representation of loads and corresponding deflections. Whereas figure 2 is the stresses and strains at particular points.

III. ANALYSIS

A model of composite and Kevlar has been made using solid works software for the purpose of analysis. The model is then exported to ANSYS software. Analysis has done in the aspect that a bullet with velocity of 250m/s is allowed to hot on the composite and Kevlar individually. And the total stress and deformation in both cases has compared using the ANSYS software the experimental outcomes are the inputs for the composite analysis. Kevlar data has obtained from journal.

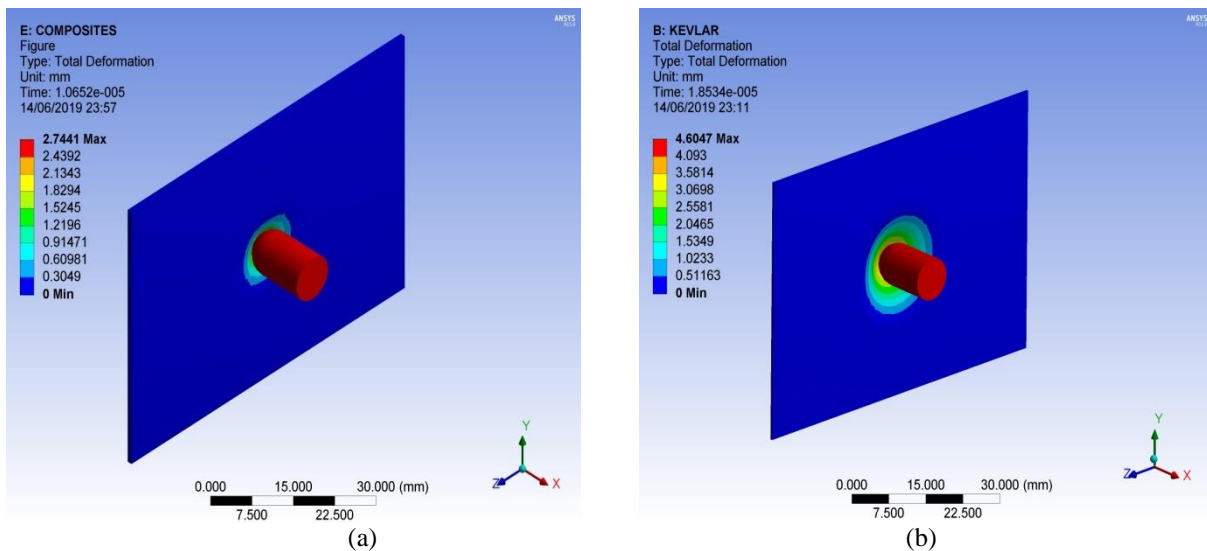


Fig 3: Total deformation (a) composite, (b) Kevlar

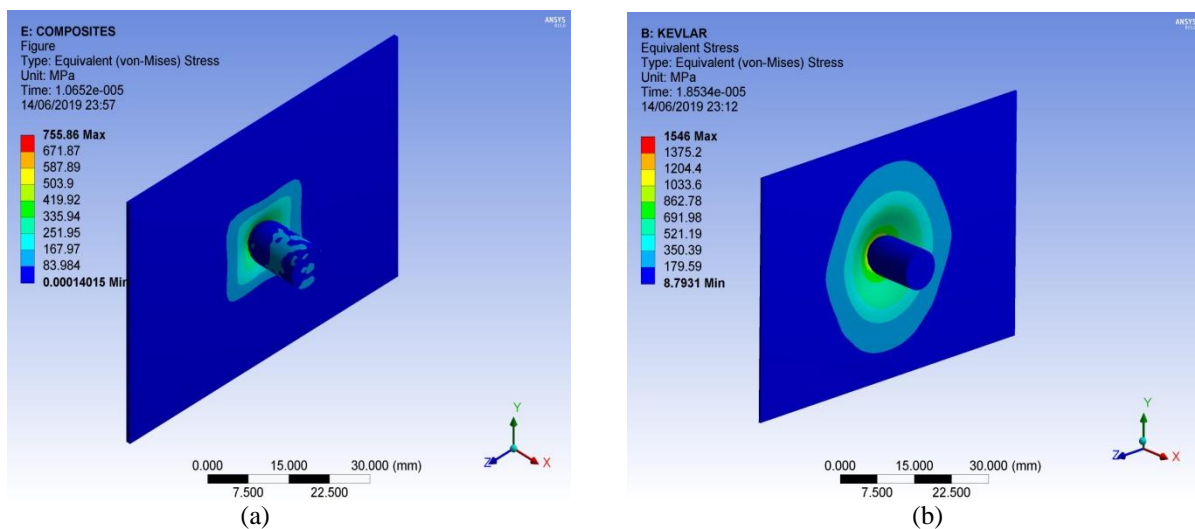


Fig 4: Equivalent (von-mises) stress (a) Composite, (b) Kevlar

Figure 3 and 4 are the outcomes of the ansys analysis. In which figure 3 represents the total deformation on both composite and Kevlar. The maximum deformation on composite when a bullet of 250m/s is struck is 2.7441mm where as on Kevlar the same is 4.6047mm. Figure 4 represents equivalent (von-mises) stress on both composite and Kevlar. In the condition same as above maximum stress of composite obtained is 755.56MPa and of Kevlar is 1546MPa.

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IV. ANALYSIS RESULTS

Material	Thickness (mm)	Total deformation (mm)	Stress (MPa)
Silk fibre composite	1	2.74	755.56
Kevlar	1	4.60	1546

Table 1: Comparison

The table 1 above is the basic comparison of results obtained after the ansys analysis in both cases of silk fibre composite and Kevlar. The thickness taken for ansys analysis for both composite and Kevlar is 1 mm. When a bullet with a velocity of 250m/s is allowed to strike on both silk fibre composite and Kevlar of 1 mm thickness it is found that the total deformation and stress developed is higher as almost twice for Kevlar than silk fibre composite.

V. CONCLUSION

This paper focuses on development of a composite whose core component is natural silk fibre which could replace the current material used in protective body armours that is Kevlar. And check its compatibility by comparing the properties of newly developed composite with the properties of Kevlar. While doing the same on ANSYS software it is saw that the mechanical properties like total deformation and stress developed of Kevlar is almost twice as high as the developed silk fibre composite. And the natural silk fibre composite possesses more advantages over Kevlar. One of the main advantage over Kevlar is that it is eco friendly and bio degradable. So it is concluded that Kevlar could be replaced with the newly developed composite of natural silk fibre in protective body armour in warfare.

REFERENCES

- [1] Youssef K Hamidi, M Akif Yalcinkaya (2018) "Manufacturing Silk/Epoxy Composite Laminates: Challenges and Opportunities"
- [2] Darshil U. Shah*, David Porter, Fritz Vollrath (2014) "Can silk become an effective reinforcing fibre? A property comparison with flax and glass reinforced composites" Composites Science and Technology, Oxford Silk Group, Dept. of Zoology, University of Oxford.
- [3] Puran Singh, Vikas Malik (2013). "Analysis of composite materials used in bullet proof vests using fem technique" International Journal of Scientific & Engineering Research, Volume 4, Issue 5
- [4] K.M. Kelvin Loh, C.K. Willy Tan (2011) "Natural Silkworm Silk-Epoxy Resin Composite for High Performance Application"
- [5] M. Grujcic, A. Hariharan, B. Pandurangan, C.-F. Yen (2011) "Fiber-Level Modeling of Dynamic Strength of Kevlar_KM2 Ballistic Fabric" Journal of Materials Engineering and Performance, Volume 21, Issue 7
- [6] M. De Araújo (2011) "Natural and man-made fibres: Physical and mechanical properties" University of Minho, Portugal
- [7] Xiao-Xia Xiaa, Zhi-Gang Qiana, Chang Seok Kib, Young Hwan Parkb, David L. Kaplanc, and Sang Yup Lee (2011). "Native-sized recombinant spider silk protein produced in metabolically engineered Escherichia coli results in a strong fibre"
- [8] Cork C R, Foster P W (2007) "Ballistic performance of narrow fabrics" International Journal of Impact Engineering, Volume 34, Issue 3
- [9] J. perez Rigueiro, C. Viney, J Llorca, M. Elices, "Silkworm silk as an engineering material", Journal of Applied Polymer Science, Volume 70
- [10] K. Murugesh Babu (2006) "Silk from silkworms and spiders as high-performance fibers" Bapuji Institute of Engineering and Technology, Davangere, Karnataka, India.