IJISET - International Journal of Innovative Science, Engineering & Technology,
ISSN (Online) 2348 – 7968
www.ijiset.com

Evaluation of The Tensile And Impact Strength Of Glass And Basalt Composite

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Abstract

Technical Textiles has found an unprecedented use in our daily life. When considering automobiles, these products have found a variety of applications. Usage of Technical Textiles in the automobile manufacture has resulted in reduction in weight and cost. One such use is the bumper. Currently Polyurethane is moulded to form car bumpers. This study involves usage of Glass and Basalt composite fabrics. The composite was formed using resin method. Two core sample using 5 fabrics sandwiched to form composite were used for the study. The studies involved examination of Tensile, Impact and Flexural strength. From the impact test, it was seen that, the composite material which contain the combination (3B/2G) shows the maximum Impact strength than specimen of 2G/3B Basalt and Glass fabricated hybrid composites. Based on the Tensile test, the tensile strength exhibited the stacking sequence of 3B/2G is the higher than 2G/3B.

Keywords: Basalt, Glass, Car bumpers, Epoxy resin

1. Introduction

Technical Textiles has found an unprecedented use in our daily life. When considering automobiles, these products have found a variety of applications. Usage of Technical Textiles in the automobile manufacture has resulted in reduction in weight and cost. One such use is the bumper. These bumpers are believed to produce initial safety to the vehicles during impact. Bumper systems in earlier years tended to be comprised mostly of steel, adding weight and its concomitant increased fuel use, as well as resulting in price increases, to post-standard cars. The steel bumpers were replaced by polymeric substitutes. Currently, Polyurethane is moulded into the required shape and used as bumpers. The main objective of the study is to find a suitable alternative using woven fabrics made of glass and basalt composites.

2. Literature review

Glass

Fibreglass or Glass fiber reinforcements are popular artificial reinforcing materials which are used in the composite industries. The commercial development of the good-quality fibreglass materials during the 1940s was a key technology which is still being used in the composite industries. The properties of the different fibre-reinforced cement materials are based on the composite structures. Hence, for analysing these composites and predicting their performance in different conditions, one has to characterise their internal structural composition. In the recent past, many studies were carried out for investigating the GFRC. The materials being used in the construction sector are constantly evolving. There is a continuous demand for resistant, high-strength and light-weight concrete materials. This has led to the development and application of fibreglass as a reinforcement material (either as mortar or paste). The strength properties of the concrete material are their most important characteristic, as they are directly related to the microstructure of the hydrated cement and concrete materials. The strength properties are also dependent on other concrete properties like stress, elasticity, strain etc. During the last two decades, a lot of research has been conducted with regards to the application of fibreglass in concrete.

Basalt

Basalt fiber is obtained after extrusion from basalt-based molten igneous volcanic rock, which is found in flowing lava. Park and Jang introduced fibers of polyethylene (PE) along with carbon fibers within an epoxy matrix to fabricate a hybrid laminated composite material. In their experiment, they chose PE fibers because of the high elongation at break followed by its high specific-strength and stiffness. Based on their observations, it was concluded that the superior mechanical properties of the hybrid-based composite depends strongly upon the position of the reinforcing fiber. So, whenever the CF was placed at the peripheral (outermost) layer, the composite delivered a high degree of flexural strength. Based on the above observations, strong, lightweight, durable and economically viable fibers are currently required for fabricating the hybrid composites. Presently, several organic and inorganic fibers are available in the market, but many of them either lack structural strength or durability, or are extremely costly for use in moderate loadings. Basalt fiber is the material of choice presently and is an inorganic fiber with extremely good modulus, high strength, improved strain to failure, high temperature resistance, excellent stability, good chemical resistance, and it is easy to process, non-toxic, natural, eco-friendly and inexpensive

Basalt is fine-grained, extrusive, igneous rock composed of plagioclase, feldspar, pyroxene and magnetite, with or without olivine and containing not more than 53 wt% SiO_2 and less than 5 wt% total alkalis. Many types of basalt contain phenocrysts of olivine, clinopyroxene (augite) and plagioclase feldspar. Basalt is divided into two main types, alkali basalt and tholeiites. They have a similar concentration of SiO_2, but alkali basalts have higher content of NA_2O and K_2O than tholeiites. The plutonic equivalent of basalt is gabbro.

Properties of epoxy resin

Excellent chemical resistance, particularly to alkaline environments..
Outstanding adhesion to a variety of substrates.
Very high tensile, compressive, and flexural strengths.
Low shrinkage on cure
Excellent electrical insulation properties and retention thereof on aging or exposure to difficult environments.
Remarkable resistance to corrosion.
A high degree of resistance to physical abuse.
Ability to cure over a wide range of temperatures.

3. Materials and methods

Fabrics:

- Basalt fabric
- Glass fabric

Resins:

- Epoxy resin
- Hardener

The composites were made from E-glass fibre, basalt fibre and commercially available ARALDITE (L-12) along with hardener K-6. Glass fabric and basalt fabric composite as reinforcement have improved stiffness, strength, thermal conductivity, wear resistance, fatigue resistance, reduced thermal expansion and dimensional stability. Basalt Fiber is an environmentally friendly high performance fiber, it is an ideal low cost fiber, Basalt fabric and glass fabric are layered as per the determined number, this product have chemical resistant, high strength, high modulus, wide range of work temperature, magnetic wave passable, similar coefficient of thermal expansion

Properties of Glass fabric	
GSM	360 gsm
Density	2.58gm/cc
Tensile strength	3450 mpa
Elastic modulus	80 gpa
Properties of Basalt fabric	
GSM	360 gsm
orientation	Plain- woven fabric
Density	2.65 gm/cc
Elastic modulus	90-110 gpa

Hand Lay Up Followed Heating:

The ratio of epoxy resin and hardener mixed is around 100:10. Glass and basalt fabric of required length is cut to 20*20 cm, The woven mat stacking one above other and the mixture of resin spreaded over the fabrics by using hand lay-up, The Basalt fabrics and Glass fabrics are arranged with possible different stacking sequences,3G /2B, 3B/2G, these samples are selected for testing and then the compositions are subjected to harden at a temperature of 800c in the hot air oven. The details of various compositions of the composite are given below in the table.

S.NO	FABRIC	RESIN	LAYER	TEMPERATURE	TIME
1	Basalt: glass	Epoxy	3:2	80oC	45 mins
2	Basalt : glass	Epoxy	2:3	80oC	45 mins

Parameters Of Fabrication

4. Testing

Tensile strength:

Mechanical testing plays an important role in evaluating fundamental properties of engineering materials as well as in developing new materials and in controlling the quality of materials for use in design and construction. If a material is to be used as part of an engineering structure that will be subjected to a load, it is important to know that the material is strong enough and rigid enough to withstand the loads that it will experience in service. As a result engineers have developed a number of experimental techniques for mechanical testing of engineering materials subjected to tension, compression, bending or torsion loading. The most common type of test used to measure the mechanical properties of a material is the Tensile Test. Tensile test is widely used to provide a basic design information on the strength of materials and is an acceptance test for the specification of materials. The major parameters that describe the stress-strain curve obtained during the tension test are the tensile strength (UTS), yield strength or yield point (σy), elastic modulus (E), percent elongation (ΔL%) and the reduction in area (RA%). Toughness, Resilience, Poisson's ratio (ν) can also be found by the use of this testing technique.

Sample preparation

The specimen is prepared according to the ASTM D638 standard. The testing is carried out in tensile testing machine with displacement velocity at 2 mm/min. The gauge length for testing specimen is 80 mm. Initially the breadth and width of specimen is observed and the area of cross section is the output calculated. Two specimens are tested for each fibre resin composition ratio.

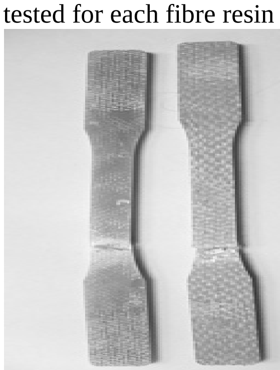

Figure 1: Tensile test specimen

Impact strength:

The impact strength of the hybrid composites is carried out with charpy impact tester.

Sample Preparation

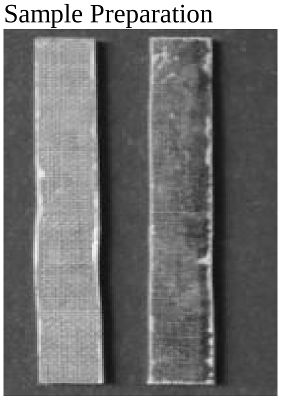

Figure 2: Tensile test specimen

The standard charpy impact test specimen consist of a bar of metal, or other material, 55x10x10mm having a notch machined across one of the larger dimensions.

v-notch: 2mm deep, with 45° angle and 0.25mm radius along the base

u-notch and keyhole notch: 5mm deep notch with 1mm radius at base of notch

5. Results and discussion

Tensile strength

S S no	Fabric	Ultimate load in KN	Ultimate stress N/mm2	% of Elongation
1	3B/2G	15.640	186	5.00%
2	3G/2B	15.980	178	4.9%

The 3G/2B fabric displays better load but considering elongation 3B/2G displays a slightly better %. As a whole there is only negligible difference between the samples

Impact strength

S.no	Specimen area		Hammer impact energy
1	17.63*3.57	62.9391mm2	286 joules
2	18.04*3.52	63.5008 mm2	290 joules
3	16.68*3.40	56.712 mm2	288 joules
4	17.02*3.69	62.8638 mm2	299 joules
5	15.83*3.80	60.154 mm2	292 joules
Average		Average	61.22194 mm2

IMPACT STRENGTH OF 3B/2G

S.no	Specimen area		Hammer impact energy
1	18.95*3.06	57.987mm2	286joules
2	21.33*36	71.6688mm2	292joules
3	18.13*3.74	67.8062mm2	292joules
4	19.07*2.70	51.327mm2	292joules
5	19.99*3.06	61.1694mm2	290joules
Average		61.99168mm2	292joules

IMPACT STRENGTH OF 2B/3G

Impact strength of pure Glass fiber composite was 3.5% greater than pure Basalt fiber composites. The impact strength of (3B/2G) and (2B/3G) has been compared and the (3B/2G) combination was found to be greater. It was seen that the incorporation of Basalt and Glass fibers in has considerable effect in the impact properties. It is the indication of the better interfacial bonding between the basalt and glass fiber. There is no significant variation between 3B/2G and 2B/3G. There is a considerable effect on the hybridization of the composites. This is because of damage arrested by the high strength synthetic fibers.

6. Conclusion

From the impact test, it was seen that, the composite material which contain the combination (3B/2G) shows the maximum Impact strength than specimen of 2G/3B Basalt and Glass fabricated hybrid composites. Based on the Tensile test, the tensile strength exhibited the stacking sequence of 3B/2G is the higher than 2G/3B.

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