Design and Analysis of Composite Bolt

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Abstract - *Composites are combination of materials that provide characteristics which cannot be achieved by single material system. This is achieved by cohesion of the materials made by actually combining two or more compatible materials, different in characteristics, composition and sometimes its form can also be different. The field of composite is to make material which can fulfill all criteria for manufacturing and use by making it low cost, easy availability, ecofriendly and also that it can fulfill all the criteria of its ease of manufacturing and usage. Glass Fiber has already been utilized in many useful applications such as light weight pultruded bars, an insulating material, panel boards, switchgears, etc. It has characterization of high strength to weight ratio. Against this back ground the present project work is carried out with an objective to use glass fiber, as a reinforcement material in epoxy based polymer. This fiber sheets can be layered in the epoxy matrix. Usual hand lay-up technique can be adopted for manufacturing the composite bolt.*

Key Words: Composite, Bolt, Glass fiber, Hand lay-up, Low cost.

1.INTRODUCTION

Composite materials have been used by men since ancient age and yarn is probably one of the greatest developments of mankind which enabled him to survive any climate area and to explore the surface of the earth hence flexible fabrics made of cotton, flax and jute were excellent compared to animal skins. Age after age use of the composite materials increased continuously in the form of straw reinforced walls, composite bows and cross bows, chariots made of the combination of layers of wood, bones and horns.

In today's modern age low cost manufacturing material with good mechanical properties to meet the requirements of growing population and which can also be renewable resource to meet the requirement easily anywhere in the world. Composite materials with glass fiber have attracted attentions of many researchers worldwide because of their low cost and ease of manufacturing. Now a days polymer composite materials has extensive use in engineering applications due to their excellent chemical physical and properties. They also find applications in fields where high resistance to wear, abrasion and erosion is required (mining, automobile, domestic equipment, aerospace, marine, sports etc.). These composites are light in weight and are having greater strength. So considering these fiber composites, here comes the possibility of attaching two or more sheets of fibre reinforced plate with metal sheets or itself and this could be done with the help of bolts. Fasteners are used in many fields specifically in technical fields which have high demands in chemical, electrical and thermal industries. Fasteners are also possible outcomes of glass fibre reinforced epoxy or polyester resin systems with special additives and special structure. It could be much lighter, non-conductive in electrical application and no temperature effect on such FRP composite bolts for higher temperature application. It could also be used in marine and chemical industries where the atmosphere can easily corrode metallic objects.

2. LITERATURE REVIEW

Turvey and Cerutti [1] worked on flexural behavior of pultruded glass fibre reinforced polymer composite with bolted joints. Here two to three pultruded glass fiber reinforced polymer laminates were bolted. It concluded that deformation increased with number of splice plate increased from two to six .Also torque increased from 3Nm to 30 Nm for the same number of increase in splice plates But at the same time the major axis transverse stiffness increased. Hence, it was seen that the transverse stiffness increases almost linearly as bolt torque increases.

Kanitkar et.al [2] investigates that the composite materials are inert to most atmospheric effects. The composite of Kevlar and glass fiber is treated with flexural test. It concluded that the content of glass fiber increases flexural strength decreases the volume fraction of glass fiber to Kevlar must be kept at 16% to 24 % range respectively to have optimum results.

Rao and Reddy [3] investigation the toughness of glass fiber /epoxy composites can be increased to avoid the inter ply cracking, inter laminar delamination & fiber cracking. Here the material behaves more like a ductile material as fiber content increases. Also the crack propagation decreases with increase of fracture toughness. The best combination of glass fiber & resin (binder) is 50:50 ratios.

Bajracharya et al[4] presents composite materials made from mixed plastic solid waste (PSW) containing, low-density polyethylene, polypropylene and short glass fibres (10 to30% by weight). The effects UV radiation and moisture ingression were the main parameters considered. The adhesion of glass fibre could be affected by higher temperature. Furthermore, the specimen's exposure to moisture results in the swelling and weakening the interfacial bonding. Besides, the addition of glass fibre reduces the surface degradation of composites under UV and moisture ingression resulting in higher matrix properties. A reduction in the tensile properties was observed for all the specimens under elevated temperatures. The strength retention after 4000 h of exposure of the G-0 specimen is 96%, while for G-10, G-20, G-30 is 104%, 108% and 105%, respectively. With the addition of glass fibre, the moisture absorption was reduced due to the reduction of matrix and the tendency of glass fibre to bind them.

Bandaru et al [5] experimented in this paper comparison of the mechanical properties of 5 composite laminates with different percentage of their contents. The combination of Kevlar and basalt yarn was tested and it showed better tensile and compressive behavior compared to their normal composites. These properties can be useful in applications like armors and aerospace structures.

Shaaria et al [6] concluded that the impact behavior of Kevlar /Glass fiber hybrid composite is checked by drop weight impact test .the result showed that the Kevlar fiber to glass fiber improved the load carrying capability, energy absorption capacity and damage was reduced in small percentage. Damage area of glass fiber is more as compared to Kevlar fiber composite. And hybridization of Kevlar and glass fiber reduces the damage slightly.

Channabasavaraju et al [7] work shown in this paper was to evaluate tensile and flexural properties of graphite, glass and Kevlar reinforced composites. Here Kevlar fiber show greater strength compared to glass fiber and graphite reinforced laminate. Also increase in the thickness of composite increases tensile and flexural properties.

Bencomo-Cisneros et al [8] concludes in this paper characterization of Kevlar fiber with the help of tensile test and nano-indentation. The intrinsic behavior was also characterize under quasi static loading. The result revealed that elastic modulus of fiber cross section is lower than that obtained in longitudinal direction.

Mahato et al[9] work carried out in this paper was the short term exposure of thermal-shock conditioning on mechanical properties of glass/epoxy composites. The ultimate tensile strength as well as strain to failure was found to increase with increase in loading rates at room temperature. The ultimate tensile strength of thermal shock directly proportional to loading rate .the tensile modulus of thermal shock conditioned specimen exhibit more modulus value than at room temperature. Also the strain to failure of glass fiber composite is increasing as loading rate increases.

Rajat Kapoor et al [10] experimental work of Kevlar fiber reinforced with polypropylene composites under high strain rate compression. Dynamic stress strain relations taken to reveal the mechanical properties at high strain rates. The peak stress increases by 3 times and toughness by 10 times. Also the strain at peak stress increased by as much as two times.

Tanwer [11] carried out experiment on unidirectional and bidirectional glass fiber reinforced epoxy resin based polymer composite. Where unidirectional oriented glass fiber reinforced composite have large values of all properties compared to bidirectional glass fiber composite. Also the glass fiber alignment has more compressive strength compared to tensile strength.

Table -1: Material composition

Sr. No.	**Material for composition**	**specification**	**Mix ratio by weight**
1	Epoxy Resin	Araldite-AW-106	1 litre
2	Hardener	HV-953	0.8 litre
3	Glass Fiber	E-Glass(E300) 2.5 gm/cm^3	75 gm/sample

Table -2: Physical properties

Specimen	**Yield Force (KN)**	**Ultimate Force (KN)**	**Tensile Strength (MPa)**	**Elongation (mm)**
Uni-directional	2.125	3.375	16.87	0.75
Bi-directional	1.425	1.615	8.07	0.25

Table -3: Glass fiber strength

Specimen	Ultimate Force (KN)	Compressive Strength (MPa)
Uni-directional	10.4	52
Bi-directional	2.8	14

Sanborn and Weerasooriya [12] shows that the mechanical properties of Kevlar are relevant to impact when crimping, weaving or finishing process require weaving the Kevlar yarn into fabric. The strength of this fiber is measured at wide range of strain rates compared with fibers from unwoven yarn .it was seen that the woven fiber was 20% weaker than the woven Kevlar fiber. Here, it was seen that failure strength and stiffness of fiber are affected at all strain rates by the methods used to process fiber into a hydrophobic fabric.

Valença et al[13] paper informed regarding the evaluation of mechanical behavior of epoxy composite reinforced with Kevlar plain fabric and glass–Kevlar hybrid fabric. The result discussed here of Kevlar / glass fiber hybrid composite for mechanical properties through tensile test, bending and impact test. The hybrid composite showed better result with respect to specific mechanical strength as well as bending and impact energy. Hence, it concluded as the hybrid of Kevlar and glass fiber transferred the highest values of mechanical strength and specific stiffness, which can become new alternative for use of structural laminate composite in industrial market.

Singh and Samanta[14] reviewed paper for extensively high strength to mass ratio of Kevlar fiber. It shows that Kevlar and its composites possessed very high ratio of tensile to compression strength due to its highly anisotropic nature of Kevlar fiber .also to improve the compressive strength of Kevlar composites it can be treated and hybridized with other synthetic fiber. The hybridization not only increased compressive strength but also resulted in better flexural, modulus and thermal properties of Kevlar composite. Also, it reduced the cost of Kevlar composite.

Deju Zhu et al [15] investigates the stress strain response in warp and fillsdirection. Poisson's ration and in-plane shear response of Kevlar fabric. The experimental results shows that the fabric exhibits the orthogonal and non-linear behavior in tension and can damage 20% before complete failure. Also the Poisson's ratio found is non-linear. Also function of strain and dependent on preloading. It increases with strain quickly at the beginning and decreases gradually until the fabric fails. Generally the Poisson's ratio varies from 0.35 to 0.75. Similarly shear also has been seen non- linear and not dependent of specimen size.

3. SUMMARY

This review reveals that Glass fibers and Kevlar are having excellent properties like high strength, flexibility, stiffness and resistance to chemical harm. It may be in the form of yarn, woven clothing etc. The mechanical, tribological, thermal, water absorption and vibrational properties of various glass fiber reinforced polymer composites were tested . Ultimate tensile strength and flexural strength of the fiber glass polyester composite increased with increase in the fiber glass of fiber weight fractions. The Young's modulus of elasticity of the composite increased with the fiber glass The damping properties of GRP were improved by increasing the GF content in composite . we can conclude that Glass fiber and Kevlar can be used for manufacturing of mechanical components as metal components are not able to sustain in corrosive environment like marine industry, chemical factories, textile industries, etc. also composite material are non-corrosive. Also glass fibre and Kevlar is having greater strength to weight ratio which can replace the bolts in static loading condition for storage tanks in chemical industry.

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