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MODELLING AND ANALYTICAL STUDY OF HYBRID COMPOSITE LAP JOINT

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ABSTRACT. *Composite materials are widely used in various fields, including aerospace structures, under water vehicles, automobiles and robot systems etc. Due to the high strength and they are widely used in the low weight constructions. Also used as a suitable alternative to metals. In many totally different applications and conjointly for connection varied composite elements along, they're mounted along exp loitation adhesives or mechanical fasteners.. Modeling of 3-D Models of joints such as riveted and hybrid was completed in ANSYS. Modeling and static analysis of 3D Models of joints such as bonded, riveted and hybrid were carried out and compared for three different composite materials. ANSYS FEA tool may be used for stress distribution characteristics of assorted configurations of double riveted single splice with 3 change of integrity ways specifically bonded, riveted and hybrid. The results are to be found in terms of total deformation, von mises stress, shear stress, and normal stress for stress distribution and strength analysis.*

Keywords: 3d modeling, finite element, ANSYS, FEA, hybrid, rivet, single lap joint.

1. **Introduction.** Nowadays the composite materials like plastics reinforced with carbon fibers (CFRP), glass fibers (GFRP), and aramid fibers (AFRP) are widely used in various industries such as automotive, chemical, electrical industry, aircraft and even in cryogenics. Due to its superior properties, composites are one among the materials used for repairing the present structures in numerous applications and conjointly for change of integrity composite elements along, victimization adhesives or mechanical fasteners today, a brand new technique known as hybrid joint is additionally being used wherever a mixture

of each adhesive and mechanical fasteners area unit used.

In the project, an attempt is created to research the strain distribution in 3D models of 3 configurations of double riveted single splice specifically bonded, riveted, hybrid. A major advantage of adhesive bonds with fastener may be designed and made in such a way that they can be stronger than the ultimate strength of many metals and it is broadly used in the aircrafts. Effect of composite materials like Carbon Fibre Reinforced Polymer (CFRP), E-glass Fibre, Glass Fibre Reinforced Polymer (GFRP), and Aramid Fibre Reinforced Polymer (AFRP) on stress concentration and deflection in the joints has to be analyzed.

1.1 **Methodology**

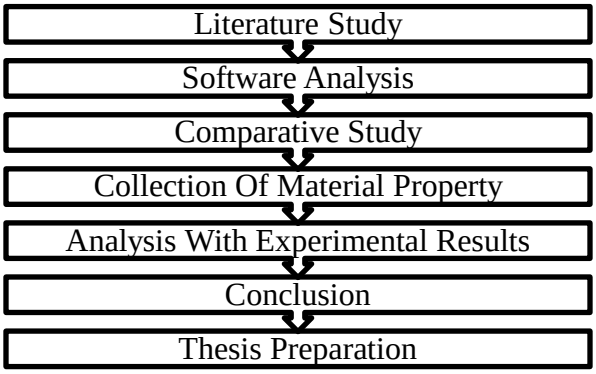

FIGURE 1 Methodology.

2. **Literature Survey.**

Ibrahim and Mahmod (2009) had concluded that the numerical solution could be adopted to study the ultimate shear strength of concrete beams reinforced with FRP laminates. They had also found that the numerical method adopted was a quick and effective way compared to full-scale experimental test.

Majeed (2012) had concluded that effective 3D modelling and non-linear analysis of steel fibre reinforced concrete deep beams are possible using ANSYS. The above studies had concluded that glass fibre sheet bonded with cement-based composites could be effectively used to strengthen the beam in shear at supports. It was also confirmed that ANSYS could be used to model retrofitted reinforced concrete beam members to study effectively the load– deflection behaviour, stress distribution, strain distribution and crack patterns. The results could be validated through wooden beams could be successfully retrofitted and enhanced in load carrying capacity. They were compared the effectiveness of carbon and glass fibre sheets and strips, for enhancing the properties of shear deficient beams damaged by sulphate attack. Experimental results were validated through an analytical model.

Mohamed Bak (2012) had studied the geometric parameters in the joint were varied and the stress distributions were compared to find the efficiency of the joint as their geometrical parameters were changed. That could be realized by profiling the adherent's layer thickness quadratically or linearly to reduce or eliminate the shear stress concentration at the ends. Joints with adherent's layer thickness of 0.21mm were compared employing a constant overlap length of 25.4mm and adhesive thickness of 0.4mm. It was found that as the number of layers decreases the value of maximum and minimum stress concentration in the joint decreases as the stress was distributed over large area. It was also found that as the number of layer decreases, the maximum stress location shifted from the adherent where the load was applied to the adhesive layer and then to the other adherent. Decreasing the adherent layer also increases the level of shear stress in the adhesive. The study had been performed to reveal the effect of various geometric parameters on the stress distribution of hybrid joint.

S.Venkateswarlu and K.Rajasekhar (2013) had analysed a model on composite material with different joints. Hybrid (bonded/bolted) composite single-lap joints and its load transfer analysis in hybrid joints was complicated because of differences among alternate load path stiffness in hybrid composite single-lap joints including the effects of bolt hole contact and non-linear behavior of material. The effect of relevant joint design parameters on the load transferred by the bolt had been investigated through a finite element parameter study. Analysis of adhesively secured double lap joint in laminated FRP composites subjected to longitudinal loading this investigation deals with the static analysis of adhesively secured double lap joint in laminated FRP composites mistreatment the three-dimensional theory of elasticity primarily based finite element method. Shear stresses at the interfaces of the adhered and adhesive were calculated for different adhesive thicknesses. A piezoelectric mechanism bonded to the middle of the composite panel was wont to offer controlled vibration input. Optimization of the rivet joints of the CFRP material and aluminium alloy the sculptural static tensile strength test meted out for the plates from CFRP and from the 6061 aluminum alloy joined with the steel rivet. A simulation was meted out with associate degree ideas software package using the FEM.

T. Subramani and A. Arul (2014) had investigated the Ritz method for the approximate solution of problems in the mechanics of deformable solids. It includes an approximation of energy purposeful by the familiar functions with unknown coefficients. Minimization of functional in relation to each unknown leads to the system of equations from which the unknown coefficients might be determined. One from the most restrictions within the Ritz methodology is that functions used ought to satisfy to the boundary conditions of the problem. In 1943 Courant significantly redoubled prospects of the Ritz methodology. They had conducted experimental test on CFRP with aluminium alloy to find the strength and stress distribution with different composite materials.

Hsu Hnin Wai , Dr. Ehab Hamed (2014) Adhesive bonding was a process of joining materials by placing an adhesive bond between two surfaces called adherent. The

advantages of lap-joint embody its light-weight, low cost, easy application and improved mechanical performance. However, there were ongoing studies on better prediction of stress distribution and failure criterion for long term safety of the structure. The purpose of the analysis was underneathstand to know the stress distribution of lap joints under applied force created with steel and composite so as to supply a basis for predicting their debonding failure load. To proceed with experimental creep analysis of the debonding failure, it absolutely was vital to verify the potential of the analysis technique through examination the simulation outcome with studies conducted antecedently. Through the understanding, the research would continue to non-linear stress distribution. Conclusion1) ANSYS was capable of predicting the stresses distribution in the lap-joint 2) This could be further used to understand the non-linear adhesive failure of lap-joints made with different materials.

Ahire and Prof. Kachave (2017) had investigated on the different joint type. Failure of components occurs due to lots of reasons such as stress concentration excessive deflection or combination of joints. By the appliance varied assorted joining techniques attempt to determine stress concentration at specific location and strength of joint so the acceptable configuration might be chosen for various applications. Modeling, manufacturing (bonded, riveted, hybrid joint) and static analysis of 3D models would carried out using FEA software. The results would be interpreted in terms of Von Mises Stress. Various joints like Bonded, Riveted, and Hybrid joint were prepared and tensile test would carried out to evaluate results to identify their load bearing capacity. The carbon fibre plate joints were stronger, in all three cases riveted, bonded, and hybrid cases. Riveted joints were failed at very less loads, whereas hybrid joints were healthier comparatively, also it depends on the hardener used and time taken for hardening.

Prof. K.H. Munde et al (2017) had examined the feasibility and reliability of hybrid joint system dependent on design of the joints and their type. Adhesive and Bolt joint technology was demanding research area now days. To reduce the weight of structures and enhance the load bearing capacity of joint with respect to the traditional joint composite joints could be used. Traditional joints such as weld, spot, rivet, etc. were used for connecting various Automotive, Aerospace, etc. parts. To enhance strength of already existing joints without changing existing design can be achieved by use of Industrial adhesives. So instead of only using adhesively bonded joint it could become advantageous to use hybrid joint. In this thesis, modeling of both joints are done i.e. bolted joint without adhesive and bolted joint with adhesive by using CAD software and analyzing it for induced structural stresses and deformation in CAE software. Furthermore it could also test experimentally for the tensile load and results were correlated with analysis results and evaluated the stress analysis of the both joints by using FEA. In post processing step, Reaction force was calculated and compared both the results and found that reaction force on hybrid joint was more.

3. **Conclusions and Future Work**

3.1 Work Done:

1. The literature has been carried out in behavior of different joints with different composite materials.
2. Based on literature survey the proposed aim of investigation has been identified along with the other experimental parameters.

3.2 Work To Be Done:

1. To modeling the hybrid composite with rivets as mechanical fasteners and adhesive bonding in ANSYS Workbench.
2. To modeling the hybrid composite joints namely, single lap joint of mild steel plates.
3. To study the effect of providing thin layer of composite materials such as CFRP, GFRP and Aramid fibers in single lap joint under tensile load.
4. To compare deflections and stresses of the joints using the above mentioned composite materials.
5. To analyze with experimental results.

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