Development and FEA Analysis of FRP Butt Joint To Join Two Dissimilar Materials

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Abstract-*In order to join two dissimilar material in current industry field It is difficult to weld dissimilar materials so we have method to join these dissimilar materials. By using FRP material it is possible to join dissimilar material. FRP butt joint is formed between MS rod and AL rod and FEA analysis is done by using ANSYS R.14 for tensile loading condition and analysed the specimen for von-mises stresses and total strain developed in specimen. Specimen is tested for two different materials 1)CFRP .*

Keywords-FRP joint, butt-joint, CFRP,FEA analysis, Matrix material

I. INTRODUCTION

The joint connection at the ends of metallic tubes should ensure tight sealing and strength. In some cases, tube joints must also provide for rapid assembly and disassembly or a change in the direction of the line of tube. The most common types of joints used for general-purpose metal tubes are welded, flanged, threaded, and bell-and-spigot joints. Welding is a fabrication process that joins materials by causing a fusion of the parent material and the filler rod near the joint plane. After welding, a number of distinct regions can be identified in the weld area. The properties of the fusion zone depend primarily on the filler metal used, and its compatibility with the base materials. The fusion zone is surrounded by the heat-affected zone, the area that has its microstructure and properties altered by the weld. The metal in this area is often weaker than both the base material and the fusion zone, and is also where residual stresses are generated. Many distinct factors influence the strength of welds and the material around them, including the welding method, the amount and concentration of energy input, the weldability of the base material, filler material, and flux material, the design of the joint, etc.

An adhesive joint is another technique to join two parts. Here the main advantage is that the adherend of two dissimilar materials also can be joined easily. This method is also economical. However, the adhesive joints are poor in tension and, therefore the joints should be designed carefully so that the interface is subjected primarily to shear stresses. Also, these joints lose their strengths at elevated temperatures (>150°C or so), as the most adhesives are made of polymers which either disintegrate or get softened. Tying is also another method of joining; the failure occurs at the tow and the joint have knots, which are not aesthetic.

Objective of work is to form FRP butt joint between two dissimilar slender members such as AL and M.S and test this specimen for tensile loading condition Numerically with the use of ANSYS R.14

II. MATERIAL PROPERTIES

In this chapter, material properties of various materials employed in this study are presented. Materials used were adherends of aluminium and mild steel, fibers to make FRP patches and epoxy used in making FRP.

A) Tensile properties of adherends

One kind of joint are made in this study,

i) Butt joint between two circular tubes

For Butt joint between two circular tubes, an aluminium tube and a mild steel tube were used and for butt joint between two flat bars of rectangular cross section aluminium flat bars were used.

Aluminum Tube

Commercially available aluminum tube was used to form a butt-joint with a steel tube. The dimensions of aluminum tube are as follow:

Inner diameter of the aluminum tube = 22.2 mm
Outer diameter of the aluminum tube = 25.4 mm
Length of the aluminum tube = 175 mm

A bare aluminum tube was tested on a Universal Testing Machine (UTM). Figure 2.1 shows the stress vs. strain curve for aluminum adherend used in this study. The extensometer was taken out at about 21% strain and ultimate stress was found out by monitoring the load at which specimen fails. The properties were found as:

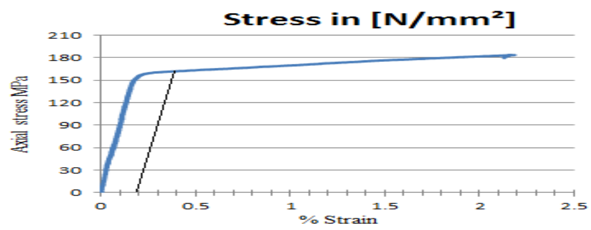


Figure 2.1 The stress vs. strain curve of aluminum adherent

Elastic modulus = 70 GPa,
Yield stress = 162.4 MPa,
Ultimate tensile strength = 183.5MP

Mild steel tube

For this study, commercially available mild steel tubes were purchased from the local market of Pune and were tested under tensile test.

The dimensions of steel tube are as follow:
Inner diameter of steel tube = 22.2 mm
Outer diameter of steel tube = 25.4 mm
Length of steel tube = 175 mm

Figure shows the stress vs. strain curve of steel adhered used in this study. The extensometer was taken out at about 43% strain; the ultimate tensile stress was determined by monitoring the load at which the specimen fails. The properties of the steel tube were: modulus = 211.2 GPa, yield stress = 321.4 MPa, and ultimate tensile strength = 349.1MPa

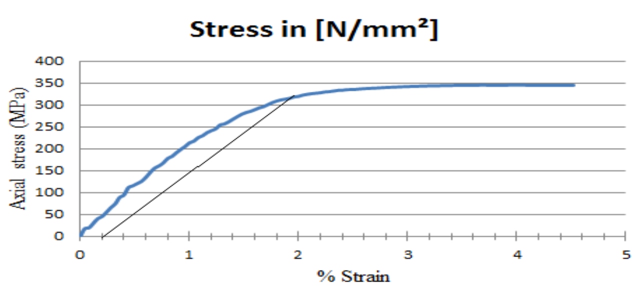


Figure 2 Stress vs strain for the mild steel tube

B) Properties of reinforcement

Two types of reinforcement was used in this study for specimen preparationCarbon fiber reinforced polymer (CFRP) of 160 gsm where gsm is gram per square meter (gm/m2)Linear orthotropic material properties were assigned for unidirectional (UD) CFRP patches. The elastic constants of the UD patches were obtained using the rule of mixture and Halpin-Tsai relations from properties of constituent materials, carbon fibers and epoxy.

The properties of the UD carbon fiber as obtained from the supplier, Hindoostan technical Fabrics Ltd, were as follows:

Fiber modulus, Ef= 231 GPa
Poisson's ratio, vf = 0.2,
Density, ρ=1860 kg/m3

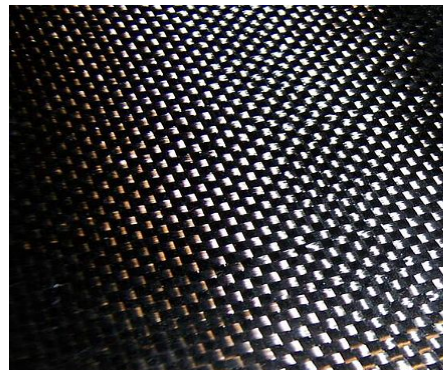


Figure UD CFRP

C) Properties of Matrix Material

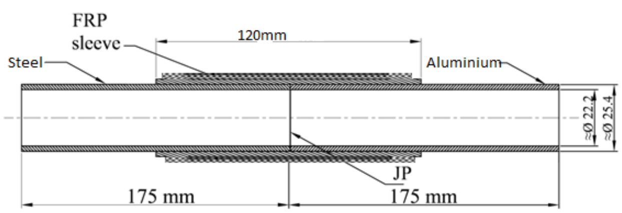
The role of a matrix in fiber-reinforced composites are: (i) to bond the fibers, (ii) to transfer stresses between the fibers, (iii) to provide a barrier against an adverse environment, such as chemicals and moisture, and (iv) to protect the surface of the fibers from mechanical degradation (e.g. by abrasion). However, the matrix plays a minor role as long as its load carrying capacity is concerned to its much smaller modulus compared to that of carbon fiber. The selection of a matrix has major influence on the compressive, interlaminar shear as well as in-plane shear properties of the composite material.

In this study Epoxy, a thermosetting resin, was used as matrix material. One of the most versatile properties of epoxy resin is its ability to transform readily from the liquid state to a hard solid with only small shrinkage. Epoxy is not tough, it is brittle but the composite becomes tough due to interface which absorbs energy during failure. This hardening is accomplished by the addition of a chemically active reagent known as curing agent or hardener. The epoxy resin employed was Dobeckot 520F (100 parts by weight) with hardener Beck 758 (9 parts by weight) which cured the resin at room temperature. Figure 2.5 shows the epoxy resin and hardener. The mixture of the epoxy and the hardener has processing time of 25-30 minutes and it gets fully cured in 24 hours at the room temperature

D) Specimen Preparation

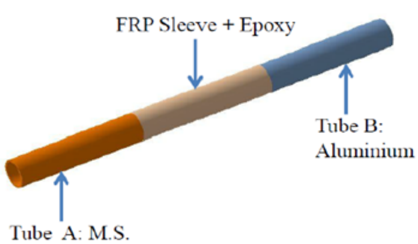
specimen preparation and tensile testing of specimens numerically for Butt joint between two circular tubes.

A CFRP butt joint was formed between aluminium adherend and steel adherend by wetting the reinforcement sheet of CFRP in epoxy and bonding them on the surface of specimen. The basic geometry of the specimen is shown in Figure 3.1. The sleeve was prepared during the curing of epoxy through a vacuum bagging.

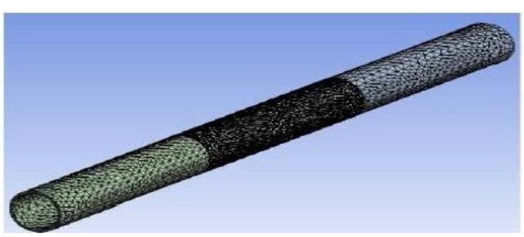


III. FEA ANALYSIS OF SPECIMEN

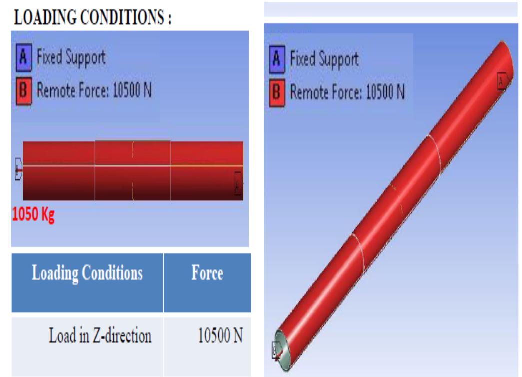
i) Preparation of model in ANSYS R.14



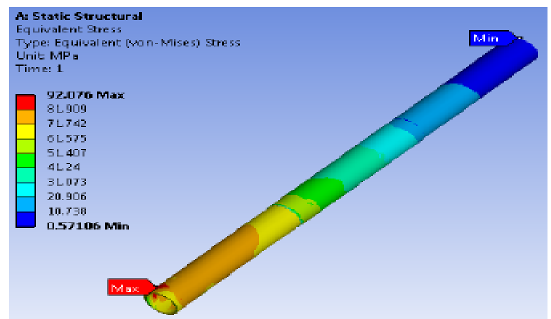
ii) Meshing done by using ANSYS R.14



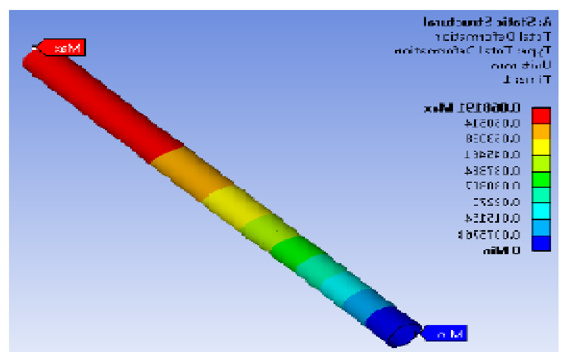
iii) Load is applied in Z direction in longitudinal direction with value of 10500N



iv) Von mises stress developed



Maximum stresses developed in specimen are 92 MPA



Total strain developed in specimen is o.0605mm

IV. CONCLUSION

Maximum amount of stress developed in specimen is lesser than yield value of both of the parent materials so specimen is safe to use. According to FEA analysis the max stress.

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