

Stress Distribution and Deformation of Adhesive Bonded Laminated Composite Shaft

M.K.Patil¹, N.S.Dharashivkar², P.J.Patil³

PG Student, Department of Mechanical Engineering, TKIT Warnanagar, Maharashtra, India¹

Assistant Professor, Department of Mechanical Engineering, TKIT Warnanagar, Maharashtra, India²

PG Coordinator, Department of Mechanical Engineering, TKIT Warnanagar, Maharashtra, India³

ABSTRACT: In this work an experimental study about stress distribution and deformation of adhesive bonded laminated composite shaft had been carried out. After experimentation, the single lap adhesive joint had the better torque transmission capacity among the different tubular joints. As compared between lap joint and scarf joint, the scarf does not improve the torque carrying capacity of joint of shaft. When increase in the length of adhesive joint, decreases in the torque carrying capacity of shaft. While changing in adhesive thickness, changes in torque carrying capacity of shaft. At 0.5 adhesive material thicknesses the torque carrying capacity of composite adhesive shaft is maximum. The weight of the composite shaft is less as compared with metallic shaft hence weight of the shaft is reduced.

KEYWORDS: Adhesive, Composite, Deformation, Distribution, Laminated, Stress.

I. INTRODUCTION

Continuous fibre reinforced composite materials have been used in aircraft structures and space structures because of their high specific strength (strength/density). In recent years, they have been used in robot arms and high speed rotational drive shafts because of their high specific modulus (modulus/density) and high material damping capacity. The high specific modulus and high material damping not only increase the natural frequencies of the structures which are composed of composite materials, but also dissipate quickly vibrations which are induced in motion. Since the whole structure cannot be made with composite materials due to either manufacturing difficulty or high cost, joining of composite materials to metal or other composite materials is frequently required. There are two kinds of joints: mechanical and adhesively bonded. Mechanical joints, which use bolts or rivets as fastening element, require holes in composite adherents. The holes in the composite are usually made by drilling or boring, which induces a damaged area in composite adherents. Moreover, the stress concentration at the holes of anisotropic composite materials can be larger than that of isotropic materials. Therefore, the mechanical joint usually becomes the weakest area in the composite structure. Adhesively bonded joints use an adhesive interlayer between the adherents. The adhesively bonded joints can distribute the load over a larger area than the mechanical joints, require no holes, add very little weight to the structure, and have superior fatigue resistance. Also, the adhesive acts as a damping layer which absorbs vibration and noise induced in structures. However, the adhesively bonded joints require careful surface preparation of the adherents and are difficult to be disassembled for inspection and repair. Also, they are affected by service environments such as temperature and humidity, and their performance is dependent somewhat upon the labour skills in the joining operation.

II. PROBLEM STATEMENT

Since the structural efficiency of a composite structure is established, with very few exceptions, by its joints, not by its basic structure, the joint design of the composite material has become an important research area. Here are two kinds of joints: mechanical and bonded. Mechanical joints are created by fastening the substrates with bolts or rivets. Bonded joints use an adhesive interlayer between the adherents. Since the adhesive bonded joints can distribute the load over a

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larger area than the mechanical joints, require no holes, add very little weight to the structure and have superior fatigue resistance, in this work, the adhesive-bonded lap joints were chosen for the torque transmission joint.

III. OBJECTIVES

- The torque capacity of the tubular adhesive joints under torque is to be determining by Analytical and experimental method.
- To calculate shear strength of adhesive bonded joint.
- To see the effect on shear strength of joint by changing the thickness of adhesive bond and the length of adhesive bond.

IV. EXPERIMENTATION



Fig-1.Composite shaft before machining



Fig-2.Composite shaft after machining

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Fig-3. Experimental set up for torque testing

V. RESULTS AND DISCUSSION

Torque Carrying Capacity of Different Adhesive Joints

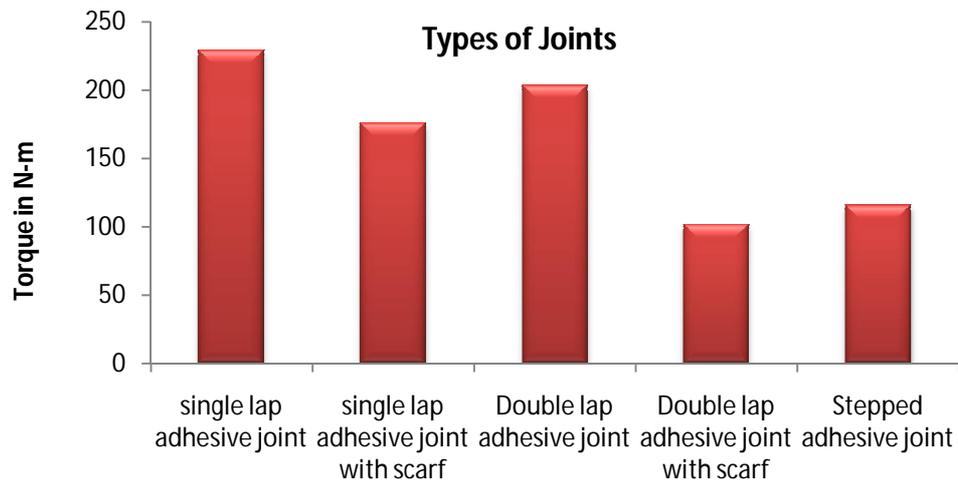


Fig-4. Torsional Strength of Different Adhesive Joints

From above figure it is observed that single lap adhesive joint has maximum torque carrying capacity among the all types of joint. With small difference double lap joint also has great torque carrying capacity among this all joint.

Change in Adhesive Length of Single Lap Joint Shaft

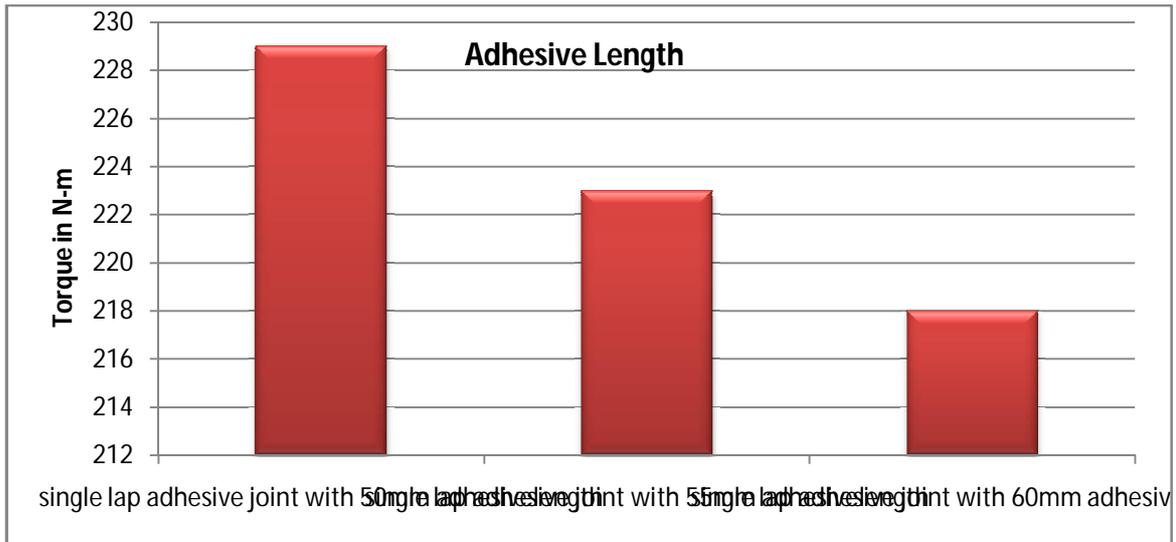


Fig-5.Change in Adhesive Length of Single Lap Joint Shaft

When the length of adhesive joint is changed in small amount, it is observed that the length of adhesive joint effect on torque carrying capacity, it is observed that the torque carrying capacity continuously decreases with increase in length.

Change in Adhesive Thickness of Single Lap Joint Shaft

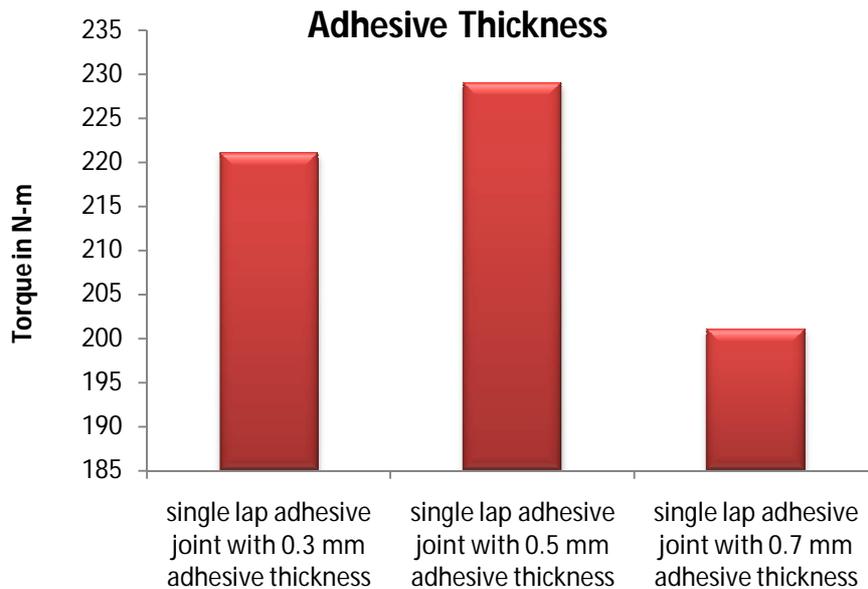


Fig-6.Change in Adhesive Thickness of Single Lap Joint Shaft

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With the small amount of change in adhesive thickness, considerable effect on torque carrying capacity of joint and every adhesive joint has an optimum adhesive thickness.

VI. CONCLUSION

- The single lap adhesive joint had the better torque transmission capacity among the different tubular joints.
- As compared between lap joint and scarf joint, the scarf does not improve the torque carrying capacity of joint of shaft.
- When increase in the length of adhesive joint, decreases in the torque carrying capacity of shaft.
- While changing in adhesive thickness, changes in torque carrying capacity of shaft. At 0.5 adhesive material thicknesses the torque carrying capacity of composite adhesive shaft is maximum.
- The weight of the composite shaft is less as compared with metallic shaft hence weight of the shaft is reduced.

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