FATIGUE BEHAVIOR OF GLASS FIBER REINFORCED PLASTIC LAMINATES WITH DRILLED HOLE

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Summary The Polymer Matrix Composites are increasingly being used in structural applications owing to their superior mechanical properties. The in-service performance of these materials requires them to perform under a variety of loading environments. Although a lot of research work has been done towards the mechanical characterization of PMCs, a lot remains to be done in special cases such as characterization of Glass Fiber Reinforced Plastics (GFRP) laminates with drilled hole. It is established that drilling in laminates causes damage around the drilled hole and the damage influences the mechanical behavior of GFRP laminates. The present investigation aims at studying the fatigue behavior of GFRP laminates with drilled holes.

1. INTRODUCTION

The polymer matrix composites (PMCs) are widely used in automotive, sports equipment, and structural applications, for their exceptional properties such as high strength to weight ratio, flexibility in design, parts consolidation, dimensional stability, and corrosion resistance. As the demand for PMCs composites increase, there is a need to develop high quality cost effective manufacturing techniques for these materials. The manufacturing of the PMCs composites can be classified as primary and secondary manufacturing. The separately manufactured parts by primary manufacturing (hand layup, filament winding, and compression molding) are there-by assembled to get the final composite product. The most common method of assembling composite structure is by the use of mechanical fasteners; which requires drilling to facilitate bolting of parts to other structural components. Machining thus becomes imperative to ascertain the structural integrity of complex composite products. Although a number of approaches have been used for making holes in composite laminates, conventional drilling till date is the most widely acceptable and frequently practiced machining operation for hole making. Drilling induced damage is an important research challenge. Various approaches have been proposed to minimize drilling induced damage such as optimization of the operating variables (feed rate and cutting speed), optimization of the tool point geometry, and unconventional methods of hole making. Although a number of approaches have been proposed to minimize the drilling induced damage, but still development of damage around the drilled hole results in parts rejection or impairs the long
term performance of the composite structures with drilled holes. Fatigue tests are used for determining mechanical behavior of FRP laminates subjected to cycling loading. The laminates were drilled using different operating conditions such as the cutting speed, the feed rate, and the drill point geometry. The spindle speed was 1120, 1800, and 2800 rpm and the feed rate was 0.12, 0.19, and 0.3 mm/rev. The diameter of drill bits taken was 4 mm. Figure 1 shows different types of drill point geometries used. The experimentally failed specimen with a drilled hole under cyclic loading conditions is shown in figure 2.

![Figure 1 Drill point geometries](image1.png)

![Figure 2 Failed GFRP laminate](image2.png)

2. CONCLUSIONS

The tension-tension fatigue behavior of GFRP laminates with drilled holes has been studied with different operating conditions (cutting speed, feed rate, drill point geometry). It has been found that the failure starts around the drilled hole and propagated along the width. The failure starts with the cracking sound, indicating the failure of the brittle matrix. The damage zone expands by the debonding of the fiber and the matrix at the interface. Thereafter, the failure of the fibers takes place. The experimental results established hereby are helpful to designers involved in designing structures which incorporate laminates with drilled holes.

REFERENCES