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Analysis of Serial Pinned Joints in Composite Materials

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ABSTRACT

Pin jointed structures are more regularly used because they are simple to design, relatively inexpensive to make, easy to construct, and easy to modify. A pin joint is a solid cylinder-shaped device, similar to a bolt, which is used to connect objects at the joint area. The pin can only transmit a force and has no ability to resist rotation. They can be 'fixed' structures such as frames, or they can be structures that move, more normally referred to as mechanisms.
In practice pin jointed structures often use bolts which are tightened and therefore they can resist rotation to a certain extent. This type of joint connection allows each object to rotate at the point of joint connection. Most mechanical devices that require bending or opening typically use a pin joint. These joints can be welded solid or allow movement between the two connected objects.
In this thesis, analysis is done on the E Glass and S2 Glass epoxy composite plate with two serial holes by varying distance from the free edge of the plate to the diameter of the first hole and width of the specimen to the diameter of the holes and also and the distance between center of two holes-to-hole diameter. Structural and Fatigue analysis are done using Cosmos.

KEYWORDS: *Cosmos, Fatigue, PRO-E,Structural Analysis, Pin joints.*

I. INTRODUCTION

1.1 Mechanical joints

A mechanical joint is a part of a machine which is used to connect another mechanical part or mechanism. Mechanical joints may be temporary or permanent.

1. Knuckle joint
2. Turnbuckle
3. Pin joint
4. Cotter joint
5. Bolted joint
6. Screw joint
7. Welded joint

2.2 About pinned joints

In mechanical engineering, there are multiple methods for fastening objects together. A pin joint is a solid cylinder-shaped device, similar to a bolt, which is used to connect objects at the joint area. This type of joint connection allows each object to rotate at the point of joint connection. Most mechanical devices that require bending or opening typically use a pin joint.

II. OVER VIEW OF COSMOS WORKS

Cosmos works is a useful software for design analysis in mechanical engineering. That's an introduction for you who would like to learn more about COSMOS Works. COSMOS Works is a design analysis automation application fully integrated with Solid Works.
This software uses the Finite Element Method (FEM) to simulate the working conditions of your designs and predict their behavior. FEM requires the solution of large systems of equations. Powered by fast solvers, COSMOS Works makes it possible for designers to quickly check the integrity of their designs and search for the optimum solution.

III. ANALYSIS OF PINNED JOINT

3.1 Original model

3.1.1 S2 glass fiber Structural analysis

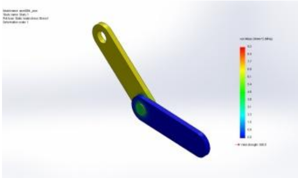
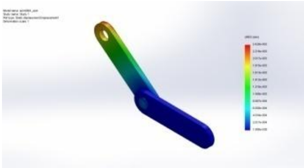
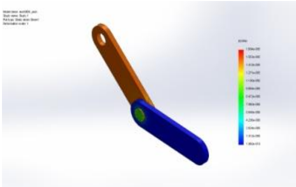




Fig1:Study 1-stress –stress1 **Fig2: Study 1-Displacement –displacement1** **Fig3:Study 1- strain strain 1**

3.1.2 Fatigue analysis

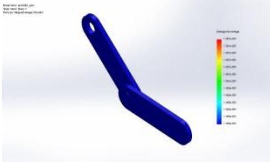


Fig4 :Study2-results-results1 **Fig5:Study 2-results-results2** **Fig 6: Study 2 –results-results3**

3.2E glass epoxy

3.2.1Structural analysis

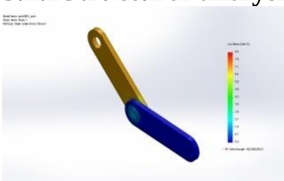
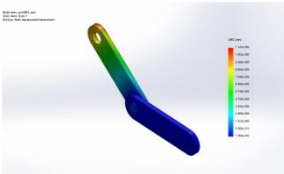
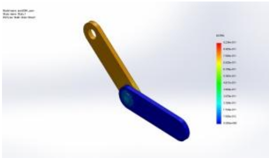




Fig7: Study 1 – stress – stress1 **Fig8: Study 1 displacement – displacement1** **Fig9: Study 1-strain –strain 1**

3.2.2 Fatigue analysis

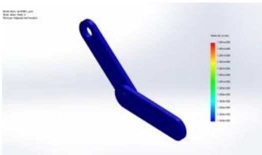
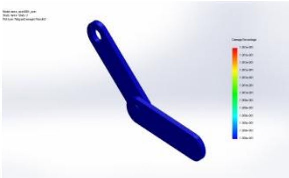




Fig10: Study 2- results –results 1 **Fig11: Study 2 – results –results** **Fig12: Study 2-results – results3**

3.3Changing hole distance

3.3.1 S_2 Glass structural analysis

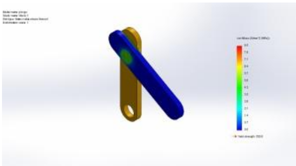
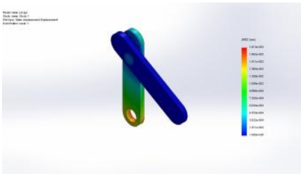
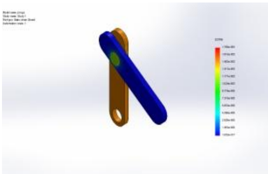




Fig13: Study 1- stress –stress1 **Fig14: Study 1-Displacement – displacement 1** **Fig15: Study 1-Strain –strain 1**

3.3.2 Fatigue analysis

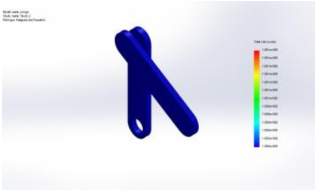




Fig16: Study 2-Results- results1 Fig17: Study 2 –Results –result Fig18: STUDY 2 –Results –results 3

3.4E GLASS

3.3.1 Structural analysis

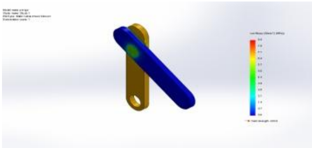
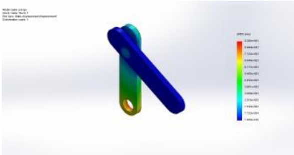
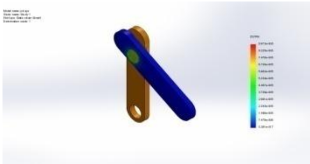




Fig19: Study 1-Stress-Stress1 Fig20: Study 1-Displacement-Displacement1 Fig21 : Study 1-Strain-Strain1

3.3.2 Fatigue analysis

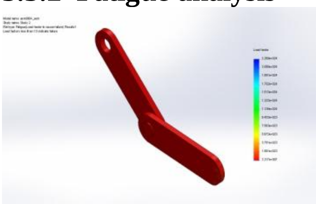
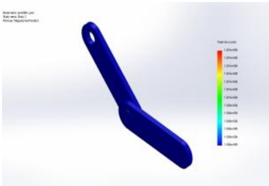




Fig22: Study 2-Results-Results1 Fig23: Study 2-Results-Results2 Fig24: Study 2-Results-Results3

3.5 Changing link position

3.5.1 S2 glass fatigue analysis

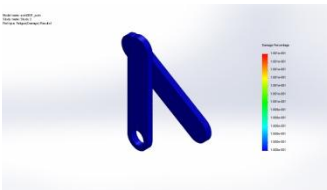
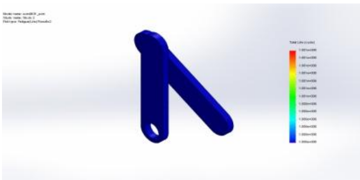
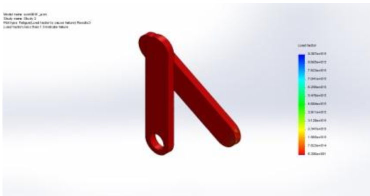




Fig25: Study 2-Results-Results1 Fig26: Study 2-Results-Results Fig27: Study 2-Results-Results3

3.5.2 E glass fatigue analysis

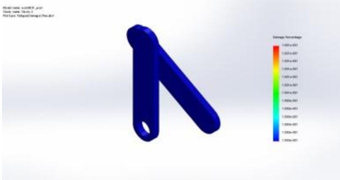
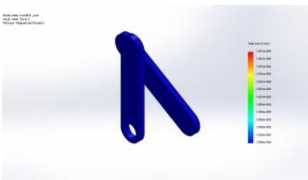
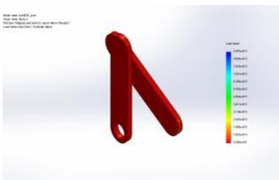
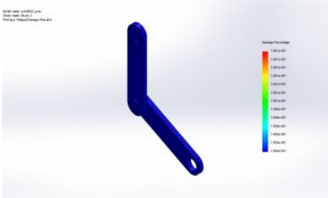




Fig28: Study 2-Results-Results1 Fig29: Study 2-Results-Results2 Fig30 :Study 2-Results-Results

3.6 Changing fixed area

3.6.1 S2 glass fatigue analysis



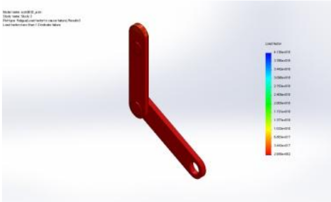


Fig31:Study 2-Results-Results1 **Fig32:Study 2-Results-Results2** **Fig33: Study 2-Results-**
Results3

3.6.2 Fatigue analysis

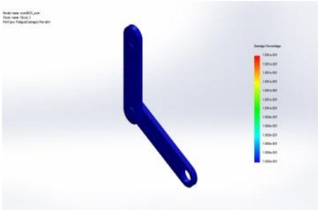


Fig34: Study 2-Results-Results1 **Fig35: Study 2-Results-Results2** **Fig36: Study 2-Results-**
Results3

IV. RESULTS TABLE

4.1 Original model

Static	Stress (N/mm^2)	Displacement (mm)	Strain
S2 Glass	9.2	2.420e-003	1.694e-006
E Glass	8.5	1.147e-008	9.234e-011

Table no.1 Static results

Fatigue	Damage	Load factor	Life
S2 Glass	1.001e-001	2.771e+019	1.001e+006
E Glass	1.001e-001	2.269e+024	1.001e+006

Table no.2 Fatigue results

4.2 Changing hole distance

Static	Stress (N/mm^2)	Displacement (mm)	Strain
S2 Glass	8.5	1.813e-003	1.756e-006
E Glass	8.5	9.266e-003	8.973e-006

Table no.3 Static results

Fatigue	Damage	Load factor	Life
S2 Glass	1.001e-001	1.049e+017	1.001e+006
E Glass	1.001e+001	2.055e+016	1.001e+006

Table no.4 Fatigue results

4.3 Changing link

Static	Stress (N/mm^2)	Displacement (mm)	Strain
S2 Glass	8.8	4.113e-004	1.619e-006
E Glass	8.7	8.962e-003	8.960e-006

Table no.5 Static results

Fatigue	Damage	Load factor	Life
S2 Glass	1.001e-001	3.442e+017	1.001e+006
E Glass	1.001e-001	9.387e+015	1.001e+006

Table no.6 Fatigue results

4.4 Changing fixed area

Static	Stress (N/mm^2)	Displacement (mm)	Strain
S2 Glass	9.6	2.200e-003	1.810e-006
E Glass	9.6	1.124e-002	9.251e-006

Table no.7 Static results

Table no.8 Fatigue results

Fatigue	Damage	Load factor	Life
S2 Glass	1.001e-001	4.130e+018	1.001e+006
E Glass	1.001e-001	1.642e+018	1.001e+006

V. CONCLUSIONS

In this thesis, analysis is done on the E Glass and S2 Glass epoxy composite pinned joints with two serial holes by varying distance from the free edge of the plate to the diameter of the first hole and width of the specimen to the diameter of the holes and also and the distance between center of two holes-to-hole diameter. Structural and Fatigue analysis are done using Cosmos.

By observing the structural analysis results, the stress and displacement values are less than their respective strength values. So using composite materials is safe for serial pinned joints. By observing fatigue analysis results, damage factor is very less for both materials, life is about $1e^6$ cycles.

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