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Corrosion and Stress Analysis of Sanwich Composites
A Comparitive Study

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Abstract:- Composite are new growth in material science industries mainly aircraft industries, material needed in low cost, less weight but should have high strength to increase the efficiency of aircrafts and also even in automobile industries. The solutions for above things are composite material only. This project gives the fabrication and investigation of mechanical properties of Carbon fibre with E-glass fibre and Chopped glass fibre reinforced with epoxy resin. In this process the fabrication is done by hand-layup method with random orientation of carbon, chopped glass and E-glass fibres. Further, Mechanical tests, such as Tensile test, Flexural test and corrosion test were performed on the sample, to study the mechanical properties of the composite. From the study it is observed that, Carbon fibre sandwich Composite is proved to be an effective composite with more corrosion resistant and also environment friendly, which can be used in the areas with greater exposure to sea water.

Keywords:- *Carbon Fibre Composite; Bending Test; Tensile Test; Corrosion;*

I. INTRODUCTION

A. Carbon Fibre

Carbon fibers or carbon fibres (alternatively CF, graphite fiber or graphite fibre) are fibers about 5–10 micrometres in diameter and composed mostly of carbon atoms. Carbon fibers have several advantages including high stiffness, high tensile strength, low weight, high chemical resistance, high temperature tolerance and low thermal expansion. These properties have made carbon fiber very popular in aerospace, civil engineering, military, and motorsports, along with other competition sports. However, they are relatively expensive when compared with similar fibers, such as glass fibers or plastic fibers.

Property	Value
Tensile Strength	3.62Gpa
Elastic modulus	288GPa
Elongation at break	3.15%
Density	1.74g/cm^3

Table 1:- Properties of carbon fibre

B. Stress Corossion Analysis of Carbon / Glass

With this background studies, we have started analysing the mechanical properties of Carbon – Glass laminates under wet corrosion environment. We have observed that the stiffness of the laminate is gradually degrading due to the continues application of load for a period of time.

II. FABRICATION PROCESS

A. Preparing composite laminates by hand lay-up method

➢ *Materials Required*

- Composite fibers
- Epoxy resin (Ly 556)
- Hardener (Hy 951)
- Mylar sheet Tools required
- Flatten surface
- Vernier caliper
- Scale
- Mixing container
- Roller
- Weight
- Sketch marker
- Electric cutter

➢ *Fabrication of Fiber Laminate (FML)*

- Fabrication of Carbon/Glass FL of 3mm thickness: - Carbon fiber, Glass fiber and Chopped glass fiber are cut into 7 sheets (3 Carbon, 2 Glass and 2 Chopped glass) of dimension 320mm × 320mm.
- The fibers are been weighted for calculating the resin composition. The total weight of fiber is 245gms the resin and hardener are mixed in the composition of 10:1 ratio.
- The Carbon FRP has been laminated by hand lay-up method. The fibers are arranged in a specific combination and dried for two days under room temp. (C-E glass-Chopped Glass- C-E glass-Chopped Glass-C) The laminate is let to cure for two days, plates have been fabricated.
- The laminate is Cut under waterjet method as per ASTM D638-03(tensile testing) and ASTM D790(flexural testing) standards.

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III. RESULTS AND DISCUSSIONS

A. Flextural Testing

The Specimen is cut as per ASTM standards (ASTM D790). 3-point bending is performed to determine the ultimate stress of the fabricated laminate. Computarized graph after the test are mentioned below.

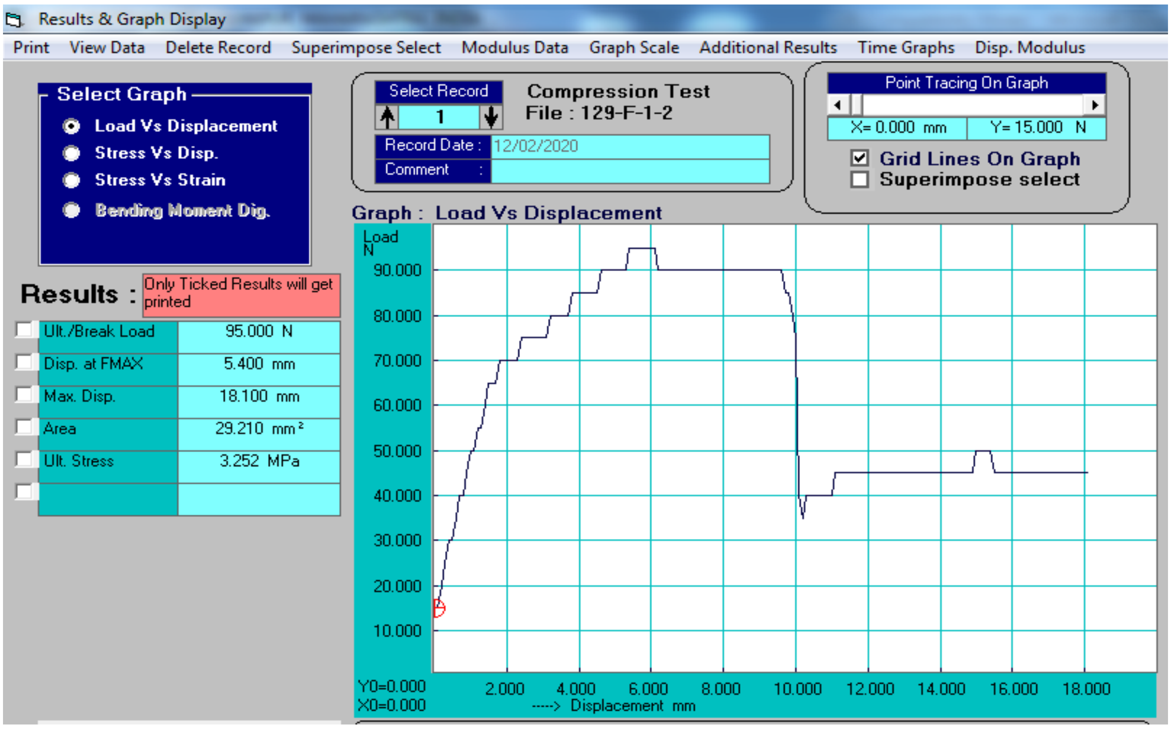

Fig 2:- Bending test for carbon-glass (specimen 1)

The Ultimate load applied on the specimen 1 is 95N and area of the specimen is 29.210mm^2. The load which is subjected to specimen is uniformly varying load. The rate of applying load is very gradually increased and ultimate stress is 3.252MPa.

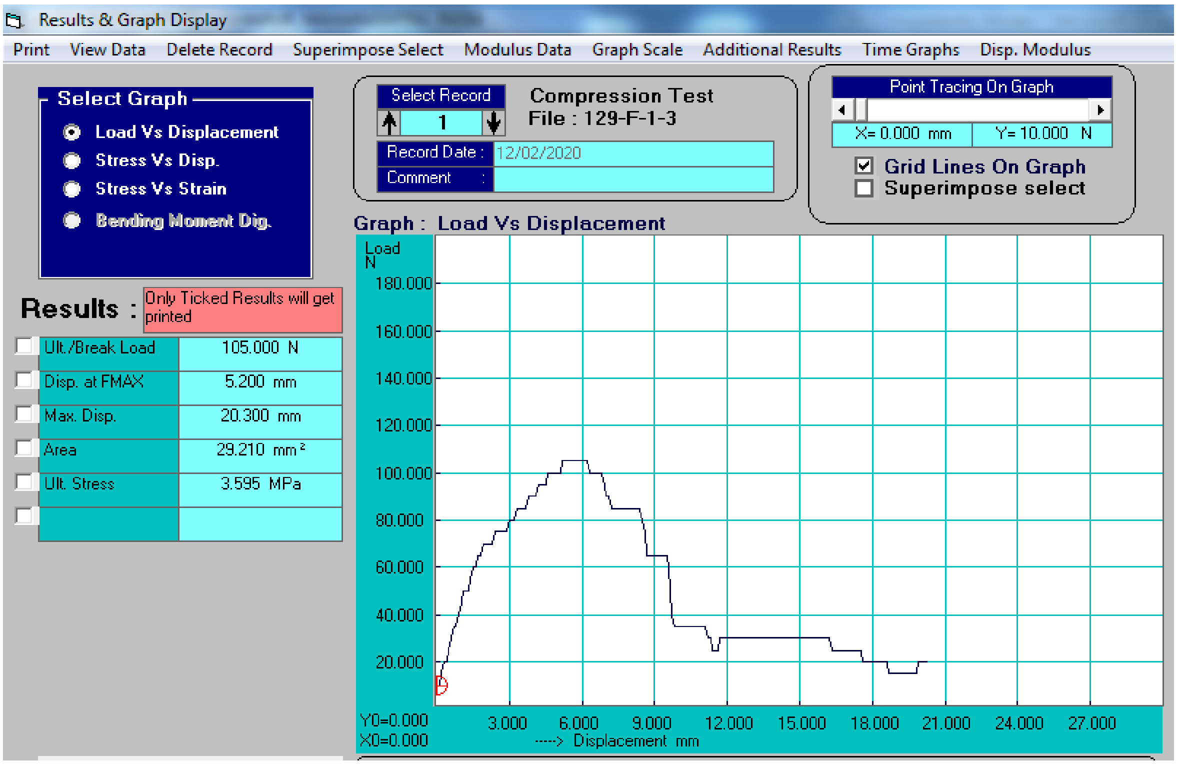

Fig 3:- Bending test for carbon-Glass (specimen 2)

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The Ultimate load applied on the specimen 2 is 105N and area of the specimen is 29.210mm^2. The load which is subjected to specimen is uniformly varying load. The rate of applying load is very gradually increased and ultimate stress is 3.595MPa.

B. Tensile Stress

The Specimen is cut as per ASTM standards (ASTM D638-03). Tensile test on UTM is performed to determine the maximum strain of the fabricated laminate. Computarized graph after the test are mentioned below.

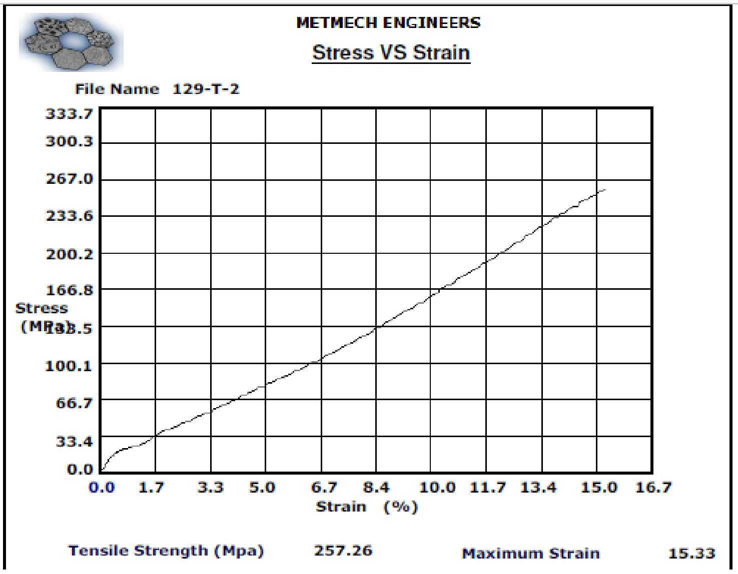

Fig 4:- Tensile test for Carbon-Glass (Specimen 1)

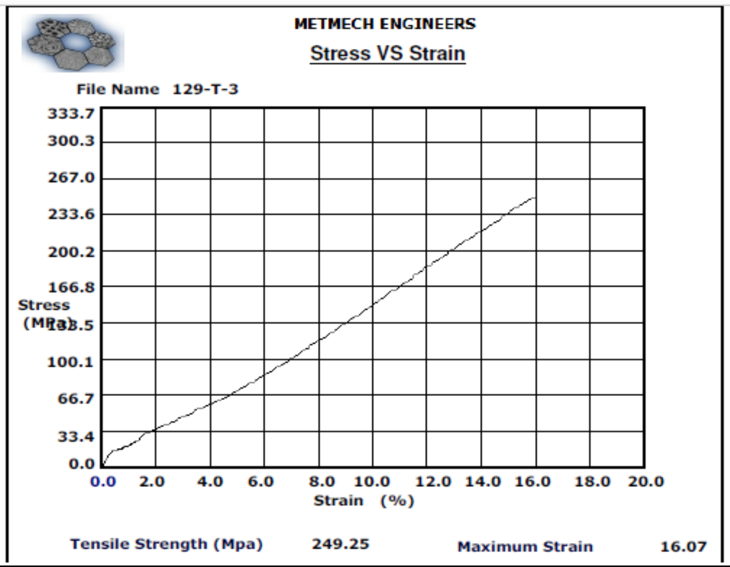

Fig 5: Tensile test of Carbon-Glass (Specimen 2)

C. Corrosion Test

➢ *Stress Corrosion (Bending Test)*

- The Bending test are carried out on the specimens prepared as per ASTM standards. The test is done under 3-Point bending.
- Preparation of specimen according to ASTM standards for bending and tensile tests using water jet cutting.
- The frame used to do bending test was designed by us.
- The deflection of the specimen is measured by means of strain gauges at midpoint positions.
- The displacement and the bending strength are measured.
- The specimen prepared for conducting the bending test is presented in Figure. The experiments are carried out at a temperature of around 25 °C with 50% humidity.

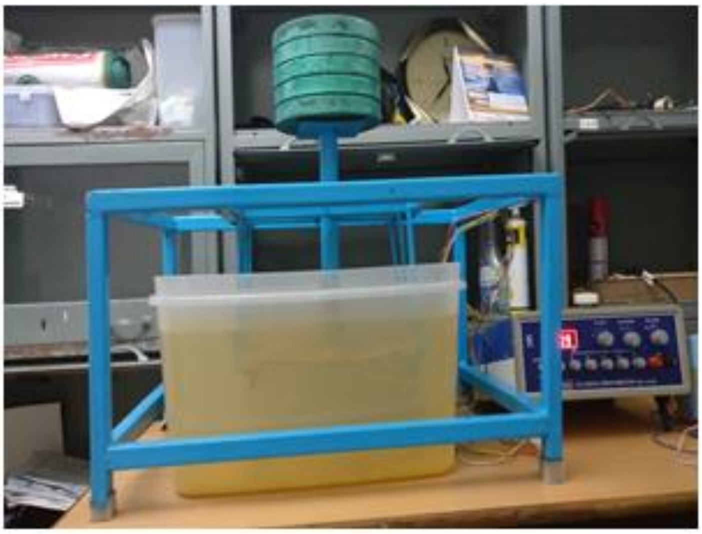

Fig 8:- Stress corrosion setup (Bending test)

Days	**1**	**5**	**10**	**15**	**20**	**25**	**30**
Carbon-glass	49	316	940	1107	1115	1121	1103
Carbon	168	571	593	780	794	798	780
Carbon-glass	40	581	825	1230	1310	1332	1180
Carbon	47	390	485	590	614	632	560
Carbon-glass	200	398	922	1146	1162	1176	1150

Table 2:- Stress Corrosion (Bending) Readings for 1-30 Days Observation

Days	**35**	**40**	**45**	**50**	**55**	**60**	**65**
Carbon-glass	1099	1093	1083	1051	1042	1027	1003
Carbon	771	767	752	721	709	689	667
Carbon-glass	1171	1163	1152	1140	1123	1115	1099
Carbon	552	545	529	503	488	471	454
Carbon-glass	1142	1136	1123	1119	1109	1095	1079

Table 3:- Stress Corrosion (Bending) Readings for 31-65 Days Observation

➢ *Stress Corrosion (Tensile Test)*

- The Tensile test were carried on the specimens prepared as per the ASTM standards.
- One end of the specimen of the specimen is fixed to the frame and in the other end weight of 25kg is attached to specimen and allow to hang.
- The entire setup is placed in a tub and filled with salt water. The experiment is carried out at a temperature of 25ºC.

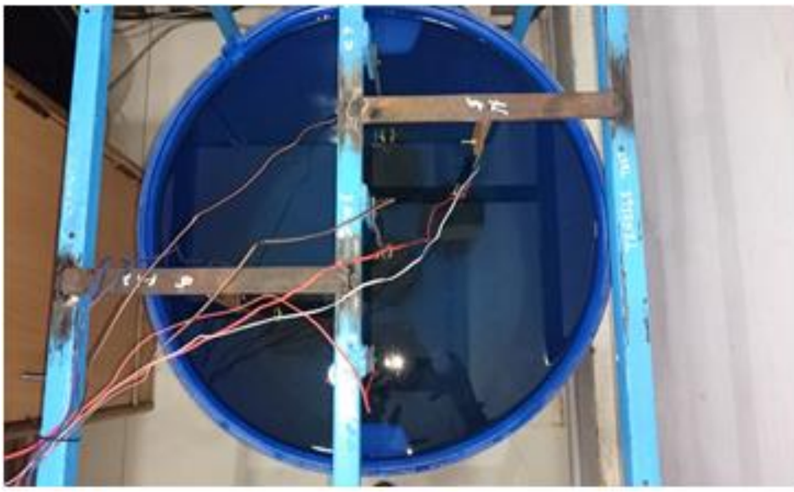

Fig 9:- Stress Corrosion setup (Tensile testing)

Day	1	5	10	15	20	25	30
Carbon-glass	-3	55	79	117	129	152	197
Carbon	-10	54	105	114	142	184	207
Carbon-glass	-12	88	115	129	142	174	198
Carbon	-7	47	98	127	142	183	208
Carbon-glass	-8	65	109	138	149	172	202

Table 4:- Stress Corrosion (Tensile) Readings for 1-30 Days Observation

Days	35	40	45	50	55	60
Carbon-glass	208	221	254	275	291	307
Carbon	219	231	253	284	298	311
Carbon-glass	211	229	246	271	284	305
Carbon	219	237	261	278	304	314
Carbon-glass	216	229	256	279	291	315

Table 5:- Stress Corrosion (Tensile) Readings for 31-60 Days Observation

IV. CONCLUSION

The composite provide excellent hardness with very less density, which shows that the material is comparatively light weighted. The excellent hardness of the material is a remarkable characteristic of the composite, with such a low density. Furthermore, the tensile strength of the material shows that the composite cannot hold large amount of load, but can be used in the areas of higher vibrations with lesser load. Therefore, the composite shows excellent Mechanical properties. However, there are several modifications, which can be done to improve the elastic property of the material. But the composite can be used in the areas like ceiling of airplane, doors, cabins, etc. and can reduce the cost of the airplane.

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