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EFFECT OF POROSITY ON THE MECHANICAL STRENGTH OF COMPOSITE MATERIALS

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Abstract- Fiber reinforced plastics are the combination of a reinforcement fiber in a thermoset polymer resin matrix, where the reinforcement has an aspect ratio that enables the transfer of loads between fibers, and the fibers are chemically bonded to the resin matrix.

FRP are used more and more for primary structures in Commercial ,industrial, aerospace and marine structures Mainly to reduce the weight and increases the strength. The strength of FRP reduce for various reason .among them presence of porosity is one of major factor. This paper describes the work performed by experimentally to analysis the effect of porosity on inter laminar shear strength(ILSS) properties of composite. The raw materials used in this study are epoxy resin with high strength carbon fibre & epoxy with glass fibre in the form of prepreg.

1. INTRODUCTION

Composite are materials created by combining dissimilar materials with a view to improve the properties or to create materials with desired properties. Composite material, due to their high specific thermal, stiffness and strength properties, have always been widely used for aircraft and spacecraft application and is deemed to be lighter than steel but ten times stronger than steel.

To guaranty the mechanical performance of the structure we need to avoid any defect in the composite part during the manufacturing process. For thin structures, quality procedure have been established in the past to define the maximum level of porosity content linked with the manufacturing effort which can be acceptable for required mechanical performance of the parts.

The previous established criteria need to be updated to maintain an acceptable compromise between mechanical properties drop due to defect, and acceptable manufacturing cost. One of the most important and current defect found in composite materials is the porosity. This paper describe the process of creation of porosity artificially and then the effect of porosity on the inter laminar shear strength(ILSS) . The ILSS test is conducted by universal testing machine(UTM) .

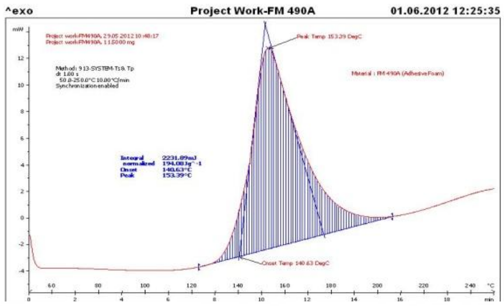
2. EXPERIMENTAL:

2.1 Raw Materials

The FRP composite matrix are epoxy and high strength carbon prepreg (G 939) and epoxy glass prepreg (Glass 7781) manufacture by M/s Les Avenieres, France and marketed by M/s Hexcel, USA .The thermal properties of prepreg are given in Table 1.the epoxy base adhesive Grade FM 490A manufacture and marketed by M/s Cytec engineering material, Arizona. The thermal properties of epoxy base adhesive are given Table 1.

Table 1 : Thermal Characterization Properties of Raw material

Sl. No	Raw material	Onset Temp(°C)	Peak Temp(°C)
1	Epoxy Carbon prepreg Grade G939	142.97	153.76
2	Epoxy glass prepreg Grade Glass 7781	144.04	155.08
3	Epoxy base Adhesive Grade FM 490A	140.63	153.39



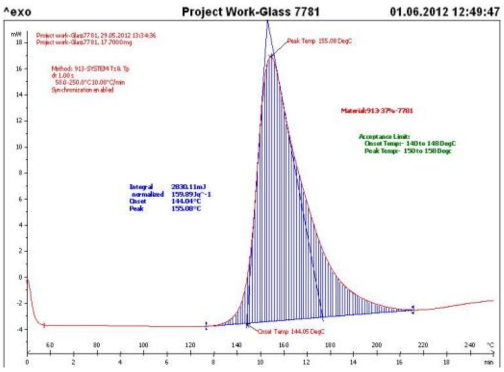


Fig.1. Epoxy base Adhesive Grade FM 490A Fig.2. Epoxy glass prepreg Grade Glass 7781

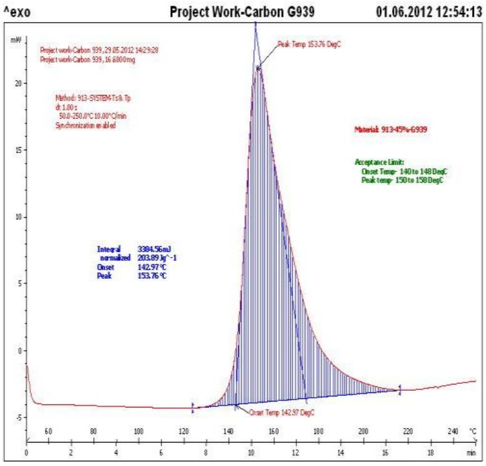


Fig.3. Epoxy Carbon prepreg Grade G939

2.2 Methods

Two Types of samples were prepared. In First, sample epoxy carbon prepreg Grade G 939 was used. in second sample glass epoxy prepreg grade glass7781.epoxy base adhesive FM 490A was used to create artificial porosity.

3. SAMPLE WITH EPOXY CARBON PREPREG

Six layer of epoxy carbon prepreg (G939) was laid as per prepreg layup scheme 45°/90°/45°/90°/45°/90° (Fig.1).Then small pieces of epoxy base adhesive are placed on it(Fig .2). Again five layer of epoxy carbon prepreg was laid(Fig.3). Then vacuum bag was done and was Cured in an auto calve at 100˚-150˚C.

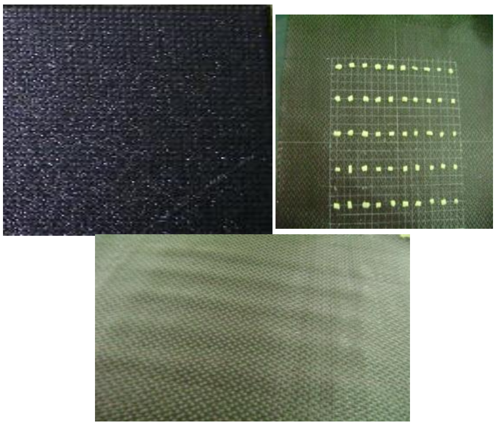


Fig.1. carbon prepreg Fig.2. carbon prepreg with FM 490A Fig .3. laminate comp

Four layer of epoxy Glass prepreg (Glass 7781) was laid as per prepreg layup scheme **0˚/90˚/0˚/90˚(Fig.4).** Then small pieces of epoxy base adhesive are placed on it (Fig5). again four layer of epoxy carbon prepreg was laid(Fig.6).then vaccum bag was done and cured at100˚- 150˚C.

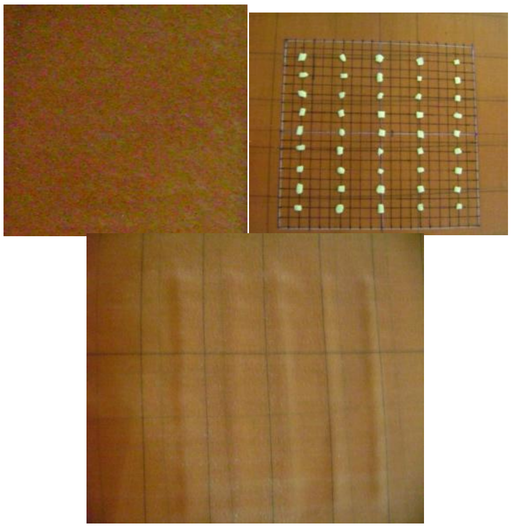


Fig .4. glass prepreg laminate Fig.5. glass prepreg with Fm 490A Fig.6.laminate comp.

4. RESULT AND DISCUSSION:

Both the sample were c-scan (Fig.7 & Fig.8)as a result voids positions were located .inter laminar shear strength (ILSS) tested for all sample .

Table -2. ILSS of carbon laminate:

Sl No	SAMPLE	ILSS (MPa)
1	**Good sample (without porosity)**	391.311
2	**Bad sample (with porosity)**	291.669

Table -3. ILSS of Glass laminate

Sl No	SAMPLE	ILSS (MPa)
1	**Good sample (without porosity)**	351.803
2	**Bad sample (with porosity)**	280.801

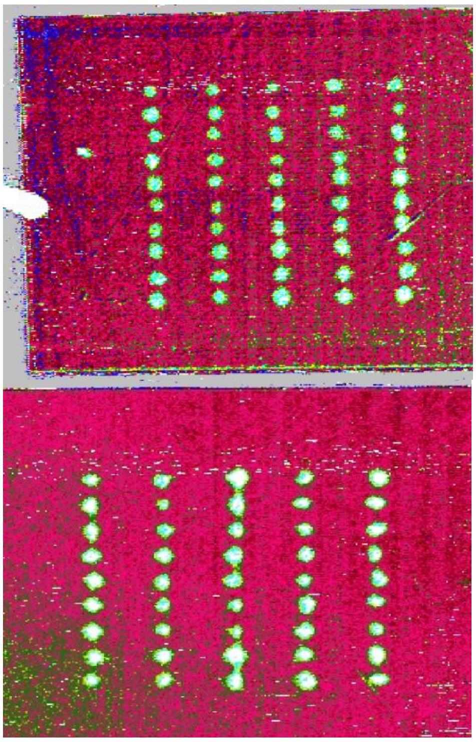


Fig.7 .C-scan of carbon laminate
Fig.8. C- Scan of glass laminate.

5. CONCLUSION:

After carrying out the tests, we have concluded that the permissible acceptance range of voids should be within 3.4%. This range enables the composite part manufacturer to reduce the total production and quality control costs. Fewer tests are required, less time is consumed and more precise properties are gained with this procedure.

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