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# FABRICATION & EXPERIMENTAL ANALYSIS OF HYBRID COMPOSITE MATERIAL (CARBON & E-GLASS)

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## ABSTRACT
Composite materials are considered to be designer materials because of their ease in tailor ability of properties, high specific strengths, high specific modulus, low densities, etc .based on the application. Presently they are playing a vital role in aerospace, defence, transport, sport applications, worldwide researchers are keenly interested in finding out their behavior in real life exposed to various environmental conditions, variety of loads etc. The key interest in the research is due to the variable properties of the same material, same compositions with respect to the manufacturing process undergone.

This paper deals the fabrication and experimentation deals with the know how the behavior and mechanical properties of E-glass epoxy composite and a hybrid composite made of E-glass and carbon fabric reinforcements and compared with the conventional materials.

**KEY WORDS**: Composites, composition, properties.

## INTRODUCTION
Composite materials are engineering materials made from two or more constituent materials that remain separate and distinct on a macroscopic level while forming a single component.

Further, though composite types are often distinguishable from one another, no clear determination can be really made.

## PROPERTIES OF MATRIX MATERIALS
Naturally fibers and whiskers are of little use unless they are bonded together to take form of structural element that can carry loads. The binder material is usually called a matrix. The purpose of the matrix is manifold support of fibers or whiskers, protection of the fibers or whiskers, stress transfer between broken fibers or whiskers, etc. Typically the matrix is of considerably lower density, stiffness, and strength than fibers or whiskers.

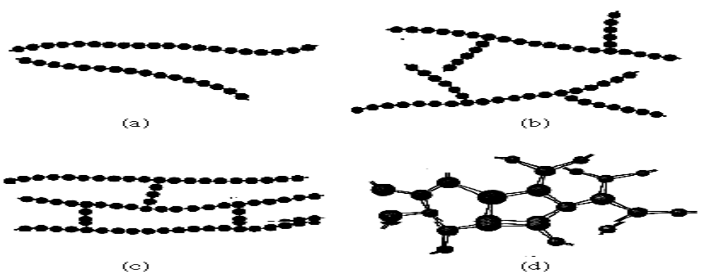


**Fig: a) linear b)branched c)cross linked d)network**

## TYPE OF MATRIX MATERIAL

- Metal Matrix Composites (MMC)
- Ceramic Matrix Composites (CMC)
- Polymer Matrix Composites (PMC)

## FABRICATION OF HYBRID COMPOSITE MATERIAL

## WET LAY-UP PROCESS

The wet lay-up technique, also called hand lay-up, is the simplest and most widely used manufacturing process. Basically, it involves manual placement of the dry reinforcements in the mold and subsequent application of the resin. Then, the wet composite is rolled using hand rollers to facilitate uniform resin distribution and removal of air pockets. This process is repeated until the desired thickness is reached. The layered structure is then cured. The emission of volatiles, such as styrene, is high as in any other open mold method. The hand lay-up process may be divided into four basic steps: mold preparation, gel coating, lay-up, and curing.

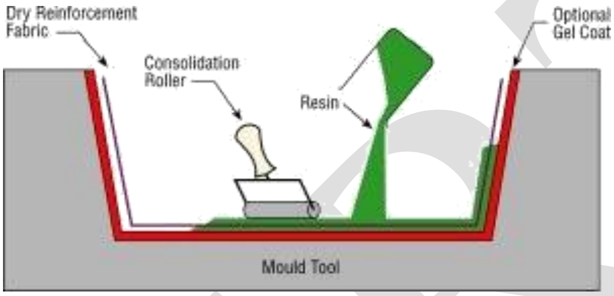


**Fig: Wet Lay-up Processes**

The mold preparation is one of the most critical steps in the lay-up process. The mold may be made of wood, plaster, plastics, composites, or metals depending on the number of parts, cure temperature, pressure, etc. Permanent molds, used for long runs, are made of metals. Molds made of composites are mostly used for low volume production since they do not respond well to repeated use. The mold may be male or female type, depending on which surface needs to be smooth. A coating of release agent is applied to the mold to facilitate the removal of the finished part.

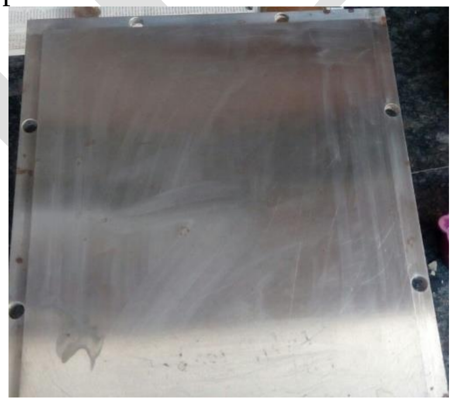

**Fig: (a) Mould Plate**

The release agents in common use are wax, polyvinyl alcohol, silicones, and release papers. The choice of the release agent depends on the type of material to be molded and the degree of luster desired on the finished product.

A gel coat is applied after the preparation of the mold to produce a good surface appearance of the part being molded. The coating is normally a polyester, mineral filled, pigmented, nonre in forced lamina. This resin lamina is applied to the mold before the reinforcements. Thus, the gel surface becomes the outer surface of the laminate when molding is complete. This surface forms a protective lamina through which the fibrous reinforcements do not penetrate and the product may require no subsequent finishing operations.

The final steps involve material preparation, fiber placement, and curing. The fiber is applied in the form of chopped strand mat, cloth, or woven roving. Premeasured resins and catalysts are mixed together thoroughly. The resin mixture is then applied to the fibers. Serrated hand rollers are used to compact the

material against the mold to ensure complete air removal. Curing is usually accomplished at room temperature and the final molded part is removed by pulling it from the mold.
The production rates and costs of the hand lay-up technique vary widely and depend on the fibers and matrix used size of the part to be manufactured, and the process used. The cost of tooling depends on the number of parts to be made because higher quality molds are needed for larger runs. A new mold is constructed for every new item. The cost of equipment depends on the production rate because of the need to set up several lines working at high speed for high production rates. The cost per part is minimized by choosing the appropriate mold construction and adjusting production rates to the available equipment. Finally, the cost per part is affected by the quality required because of the need for either semiskilled or skilled workers. Cost per unit weight may be up to $20/kg for high quality aircraft parts using glass fibers.

## MATERIALS USED

The material used for preparing hybrid composite material are:-

- Carbon Fabric
- E-glass Fabric

## CARBON FABRIC

Carbon fibers or carbon fabric (alternatively CF, graphite fiber or graphite fibre) are fibers about 5–10 micrometers in diameter and composed mostly of carbon atoms.

## PHYSICAL PROPERTIES OF CARBON FABRIC

It is a 8HSatin Woven Carbon Fabric

- Density ($g/cm^3$):- 1.8
- Filament Diameter (µm):- 7
- Tensile Strength (MPa):- 3450
- Elongation (%):- 1.5

## E-GLASS FABRIC

Over 90% of the fibers are used in reinforced plastics are glass fibers, as they are low cost, easy to produce and having high strength and stiffness with respect to the plastics with which they are reinforced.
Their low density, resistance to chemicals, insulation capacity are other bonus characteristics, although the one major disadvantage in glass is that it is prone to break when subjected to high tensile stress for a long time.
Loading period, temperature, moisture and some other factors also decides the tolerance levels of glass fibers and the disadvantage is further compounded by the fact that the brittleness of glass does not make room for prior warning before the catastrophic failure. But all this can be easily overlooked in view of the fact that the wide range of glass fiber variety lend themselves amicably to fabrication processes like matched die moulding, filament winding lay-up and so on. Glass fibers are available in the form of mats, tapes, cloth, continuous and chopped filaments, rovings and yarns.
Addition of chemicals to silica sand while making glass yields different types of glasses.

## PHYSICAL PROPERTIES OF E-GLASS FABRIC

It is a E-Glass Plain Weave Fabric

- Density ($g/cm^3$):- 2.62
- Filament Diameter (µm):- 7
- Tensile Strength (MPa):- 3100
- Elongation (%):- 4.8

## PREPARATION OF HYBRID COMPOSITE MATERIAL

Hand lay-up is the simplest process in the low end composite products, require low investment, higher operating skill, and versatile shapes of product that need single high quality surface finish.

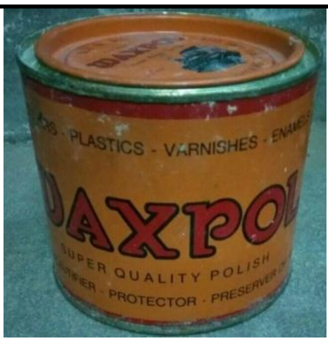


**Fig: 3.3(a) Waxpol Gel coating**

Hand lay-up is the process that starts with the application of gel coating onto a completely polished and waxed mould.

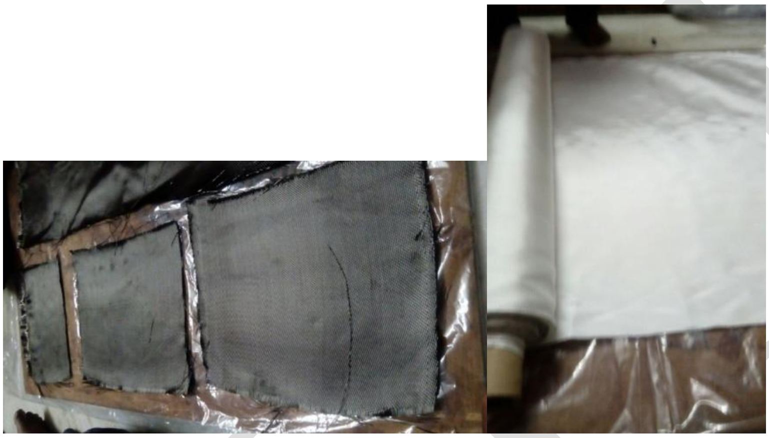

**Fig: 3.3(b) Carbon & E-glass Fabric**

A coat of laminating resin (resin that being mixed with hardener, or else your part will not cure) is then being applied by brush or roller. Follow by the first layer of Chopped strand mat, or if desire a surface tissue. Arrangement of the layers is two layers of carbon arranged bottom and other two layers are arranged at the top. The three layers of e-glass are placed at the center.

The laminating resin is then applied to the reinforcement so that all trap air can be force out using roller. Continue doing this for your next layer of fiberglass, until desired thickness is achieved.


**Fig: 3.3(c) Resin & Hardener**

Once finished, allow the resin to cure for 24 hours. You can feel the reaction taken place when your product is producing heat.

**Fig: (d) Final Hybrid Composite Specimen**

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Finally, remove your product from the mould (demould) and next step is trimming the product.

**FABRICATION DETAILS**

- Carbon Fabric :- 4 layers (340x390mm)
- E-Glass Fabric :- 3 layers (340x390mm)
- Resin :- 50gm (For each layer)
- Hardener :- 10gm (For each layer)

**EXPERIMENTATION:**

Here we are going to do the tensile test and compression test of the specimen by cutting into required ASTM standards. For each test three specimens to be tested. Tests are done on UTM machine.

**TENSILE TEST**

The tensile test specimen is prepared according to the ASTM D3039 standard. The dimensions, gauge length and

**Fig: 4.1 Tensile Test Specimens**

Cross-head speeds are chosen according to the ASTM D3039 standard. In tensile test the specimen is mounted in a machine and subjected it to the tension. The testing process involves placing the test specimen in the testing machine and applying tension to it until it fractures. The tensile force is recorded as a function of the increase in gauge length. During the application of tension, the elongation of the gauge section is recorded against the applied force.

Length:- 300mm
Width:- 25mm
Thickness:- 3mm

**COMPRESSION TEST**

The compression specimen is prepared as per the ASTM D3410 standard. In compression test the specimen is mounted in a machine jaws and subjected it to the compression. The compression process involves placing the test specimen in the testing machine and applying

**Fig: Compression Test Specimens**

Compress to it until it fractures. The compress force is recorded as a function of displacement. During the application of compression, the elongation of the gauge section is recorded against the applied force.

Length:- 125mm
Width:- 25mm
Thickness:- 3mm

## RESULTS AND CONCLUSION

The use of composite materials in the different fields is increasing day by day due to their improved properties. Engineers and Scientists are working together for number of years for finding the alternative solution for the high solution materials. In the present study carbon fabric is combined with e-glass fabric reinforced composite material and their effect on mechanical properties is evaluated and their properties are compared.

## TENSILE TEST RESULTS

The specimen size is 300x25x3mm.The different composite specimen samples are tested in the universal testing machine (UTM) and the samples are left to break till the ultimate tensile strength occurs. Load - displacement curve is plotted for the determination of ultimate tensile strength and elastic modulus. The sample graph generated directly from the machine for tensile test with respect to load and displacement of three Specimens for Hybrid composite material(Carbon & E-glass).

We have tested three specimen for each test and we have got different values for each specimen.

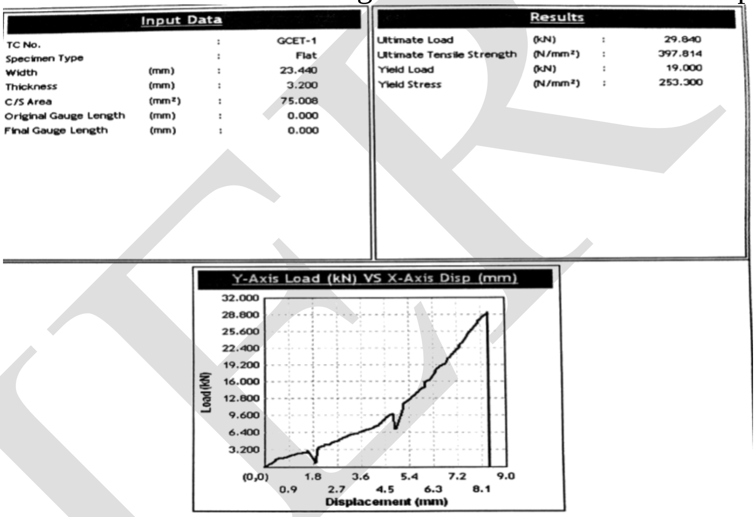


**Fig: (a) Tensile Test Specimen 1 Graph**

**Tensile test for specimen 1 we have got ultimate tensile strength is 397.814($N/mm^2$)**

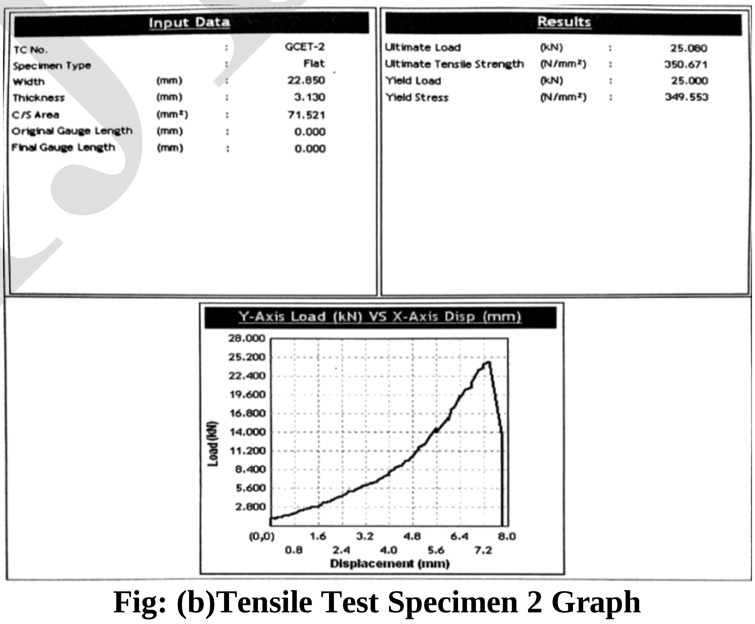


**Fig: (b)Tensile Test Specimen 2 Graph**

**Tensile test for specimen 2 we have got ultimate tensile strength is 350.671($N/mm^2$)**

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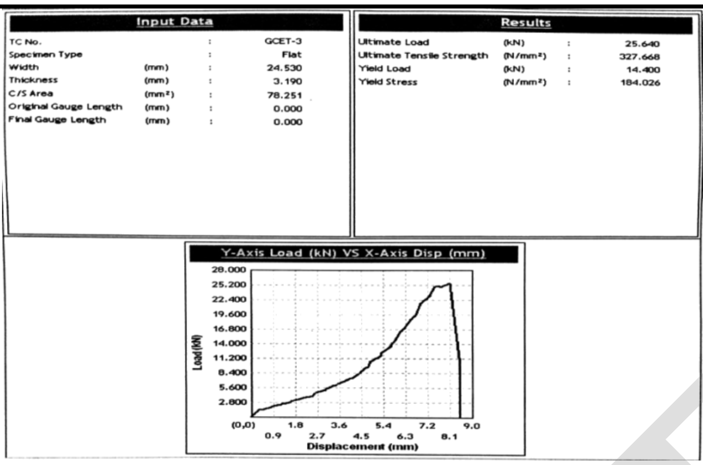


**Fig: 5.1(c) Tensile Test Specimen 3 Graph**

**Tensile test for specimen 3 we have got ultimate tensile strength is 327.668($N/mm^2$).**

## COMPRESSION TEST RESULTS

The specimen size for compression test is 125x25x3mm.The sample graph generated directly from the machine for compression test with respect to load and displacement for hybrid composite material(carbon and e-glass). We have tested three specimens for each test and we have got different values for each specimen.

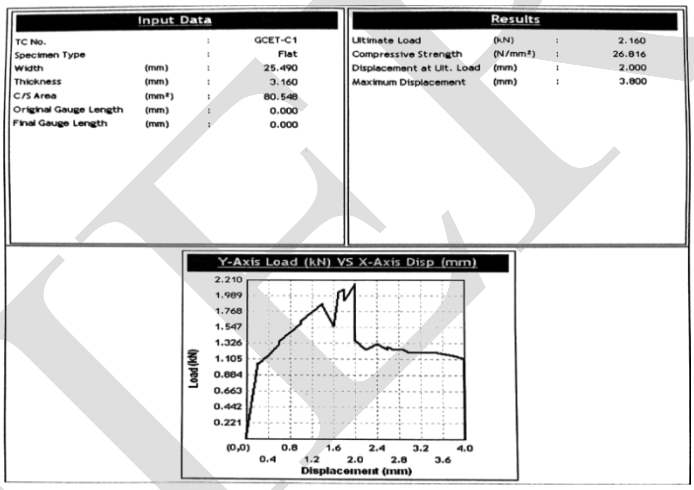


**Fig: (a) Compression Test Specimen 1 Graph**

**Compression test for specimen 1 we have got compression strength is 26.816($N/mm^2$).**

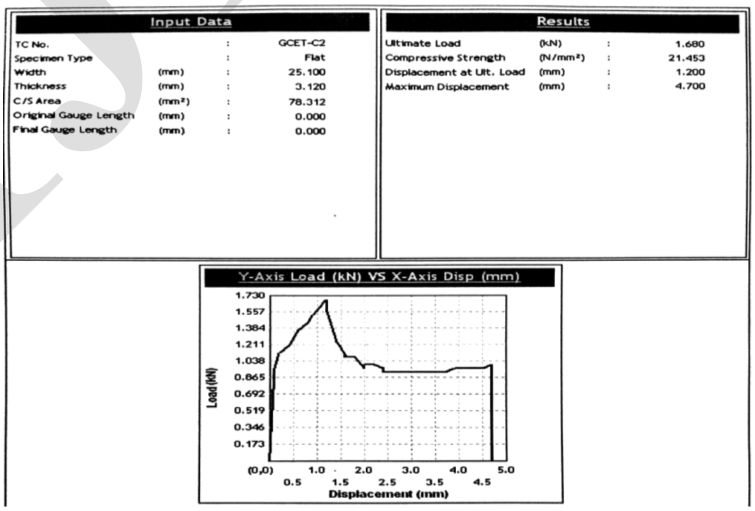


**Fig: (b) Compression Test Specimen 2 Graph**

**Compression test for specimen 2 we have got compression strength is 21.453($N/mm^2$).**

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**Input Data**

| | | | |
|---|---|---|---|
| TC No. | | : | GCET-C3 |
| Specimen Type | | : | Flat |
| Width | (mm) | : | 24.920 |
| Thickness | (mm) | : | 3.130 |
| C/S Area | ($mm^2$) | : | 78.000 |
| Original Gauge Length | (mm) | : | 0.000 |
| Final Gauge Length | (mm) | : | 0.000 |

**Results**

| | | | |
|---|---|---|---|
| Ultimate Load | (kN) | : | 1.840 |
| Compressive Strength | ($N/mm^2$) | : | 23.590 |
| Displacement at Ult. Load | (mm) | : | 1.500 |
| Maximum Displacement | (mm) | : | 3.500 |

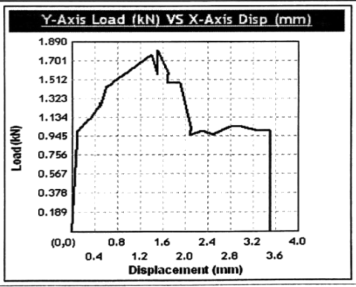


**Fig: (c) Compression Test Specimen 3 Graph**

**Compression test for specimen 3 we have got compression strength is 23.590($N/mm^2$).**

## CONCLUSION

In this project an attempt is made to find the tensile and compressive strength of Hybrid composite material (Carbon & E Glass).

We fabricated Hybrid composite material (Carbon & E Glass) by using Wet Layup method and conducted tensile test and Compression test on UTM and obtained Tensile strength is 397.81Mpa and compression strength is 26.81 Mpa.

We absorbed that the low carbon steel having Designation ASTM no 1010 & 1020 and UNS no: 10100,10200 [C(wt%):0.10, Mn(wt%):0.45] is used for manufacturing of Automobile panels, nails, wires and some structural applications also has Tensile strength of 320 & 380 MPa.

So Tensile strength of Hybrid composite material (Carbon & E Glass) is higher than the low carbon steel named ASTM no 1010 & 1020. Hence Hybrid composite material (Carbon & E-Glass) may be suggested for manufacturing of Automobile panels, nails, wires and some structural applications to increase the strength and durability.

On the basis of previous research work it is identified that the Tensile strength of the hybrid composite material (Carbon & E Glass) is lower than the carbon fiber composite material.

The compressive strength of the hybrid material is much less than the tensile strength.

## REFERENCES

I. Barbero,E. J. 1998. *'Introduction to Composite Materials Design', Taylor & Francis, Philadelphia*

II. Rafael Celeghini Santiago ,Ricardo Lessa Azevedo , Antônio F. Ávila , Marcílio Alves, George C. Jacob, J. Michael Starbuck, John F. Fellers, Srdan Simunovic, Raymond G. Boeman '*Mechanical characterization of glass/epoxy composite material with nanoclays' Received 4 November 2003; accepted 16 March 2004, DOI 10.1002/app.20901, Published online in Wiley InterScience (www.interscience.wiley.com).*

III. Keshavamurthy Y C , Dr. Nanjundaradhya N V ,Dr. Ramesh S Sharma, Dr. R S Kulkarni , *'Investigation of Tensile Properties of Fiber Reinforced Angle Ply laminated composites', International Journal of Emerging Technology and Advanced Engineering Website: www.ijetae.com (ISSN 2250-2459, Volume 2, Issue 4, April 2012), p 700-703*

IV. Daniel Gay, Suong V. Hoa and Stephen W. Tsai, '*Composite materials design and applications', © 2003 by CRC Press LLC*



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V. Donald F. Adams, Leif A. Carlsson, and R. Byron Pipes, "Experimental Characterization of Advanced Composite Materials," CRC Press

VI. ASTM D3039. 1995. '*Standard Test Method for Tensile Properties of Polymer MatrixComposite Materials'. Annual Book of ASTM Standards, American Society for Testing and Materials, Philadelphia.14 (2): 99-109*

VII. Yang G. C, Zeng H. M, Jian, N. B and Li, J. J. *Properties of banana/ glass fiber reinforced PVC hybrid composites. Plastics Industry, 1: (1996), pp 79-81.*

VIII. Chawla K. K. *Composite Materials: Science and Engineering: Springer, 1998*

IX. Barbero, E. J., *Web resource, www.mae.wvu.edu/barbero/icmd/*

X. *Advanced Moldmaking and Plug Construction. Fiber Glast Development Co. Brookville, OH. Web resource, http://www.fiberglast.com*

XI. *Composites Manufacturing Series DVD Package. Society of Manufacturing Engineers (SME), Dearborn, MI. Web resource, http://www.sme.org*

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