Improving Sheet Molding Composites

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Background

SMC is ready to mold fiber reinforced thermoset polymer primarily used in compression molding. This is manufactured by dispersing long strands (usually >1") chopped fibers in random orientation, commonly glass fibers (GF) and carbon fibers (CF) on thermoset resin (Typically polyester, vinyl ester, and epoxy). SMC's are used as an alternative for metals and thermoplastics. The goal for the creation of SMC is to reduce the weight and enhance the mechanical properties of a given component.

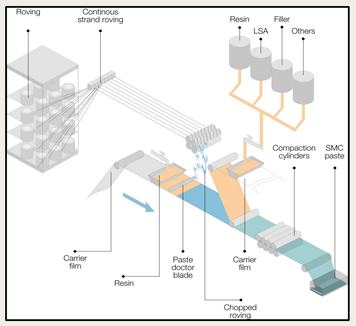


Figure 1: SMC Process of Fiber and Resin Layers conveyed along to create SMC [1]

Figure 2: SMC Molded Wheel Chasey [1]

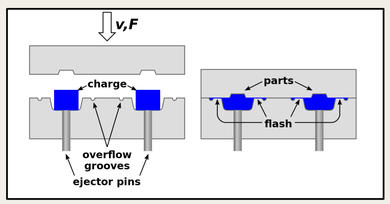


Figure 3: Compression Molding Process with SMC Resin Flow [1]

Most importantly, the SMC line is divided into three parts, resin, cutting chamber and compaction systems. The fibers are sandwiched between resins and rolled in S-pattern compaction unit for better wettability of fibers. The SMC charge is then compressed into the desired shape.

Research Need

As SMC has been used for some time, improvements have been looked to make it a more economical option, quicker to produce and to get Isotropic properties. Development in this field could change the way modern amenities are created, and improve already developed fields. The determination of the fibers with resin with an addition to additives such as fillers, thickener, and catalyst has been a continuous research process.

Research Objectives

1. **To find the best combination of resin and fiber for SMC compression molded parts**
2. **Optimize the processing parameters of SMC for better properties and economical material.**

Creating SMC Plates

The processed SMC mat are cut into small sections 4.5×4.5 inches. Two or more layers(depending upon how thick plate is required) of lamina's are placed at one particular direction in 6×6 inches tool and compressed it for 150 seconds at 180° C.

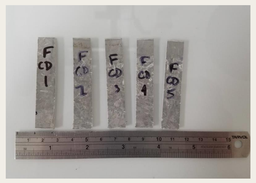


Figure 4: SMC Plate and Samples cut for testing (Flexural as Pictured)

Once the plate is fabricated (Figure 3: Left), along(with reference to conveyor side) side is marked. Samples are taken from the plates according to ASTM standards (Figure 3: Right).

Testing SMC Plates

Preliminary technique, such as Scanning Electron Microscopy (SEM) of the plate to check the porosity and wettability of the fibers. Mechanical characterization such as Flexural test and Inter laminar shear strength (ILSS) are

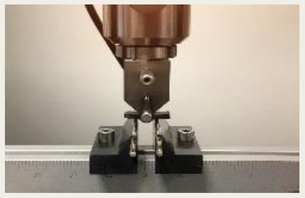


Figure 5: Test Resources 3-point Bending Test Set-up for Flexure and ILSS Test.

tests using ASTM standards D790 and D2344 respectively in Test resources frame located at FCMF, UTK.

Results and Conclusion

The SMC plates containing Fiber Glass and Polyester were tested, showing promising results for this combination of SMC compression molding materials.

Figure 6: Tested Samples

Figure 6 shows the flexural strength of Across and Along side of SMC which are 175.9 and 148.3 MPa respectively. There was an increase of 27% in across side compared to along.

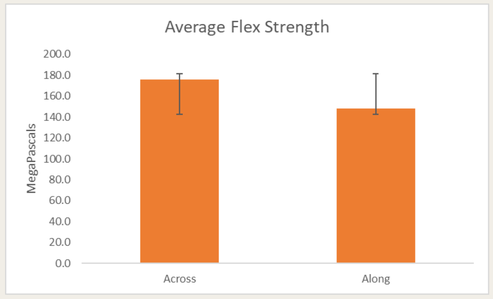
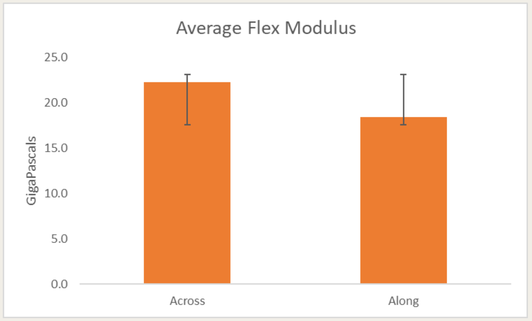


Figure 7: Flexural strength of Along and Across direction

The flexural modulus of across and along side, 22.3 and 18.3 GPa respectively shown in figure 7. It was about 55% increase in Modulus of Across side compared to along. Figure 8 shows the inter laminar shear strength of across and along side which are 13 and 9.7 MPa

Figure 8: Flexural Modulus of Across and Along direction



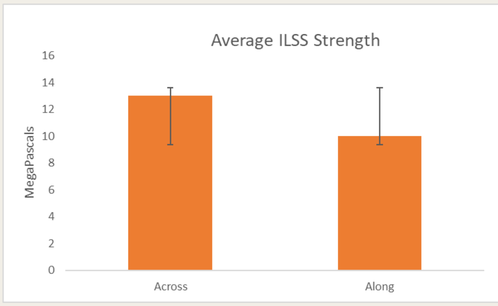


Figure 9: Inter Laminar shear strength of Across and along direction

Respectively. It was an increase in 34% in the across side compared to along. Considering the data the more number of fibers are oriented in across direction compared to along.

Future Testing

The Polyester-Fiber Glass SMC shows promising results, but further testing's need to be carried out to justify the orientation of fibers. Processing parameters can be changed to get better results.

Another and very important variation is the post curing process. The plates we tested were post cured at room Temperature for 3 days, but Polyester is best left in their mold at 40 C° for 3 hours and then left in an oven at 25 C° [3].

Sources: [1] "SMC and BMC Hot Press." *Poliya*, 12 Mar. 2014, www.poliya.com/en/smc-and-bmc-hot-press [2] Crow. "IMPACT TESTING AND DUCTILE-BRITTLE TRANSITION." *Impact Strength*, 2015, polymerdatabase.com/polymer%20physics/ImpactTest.html. [3] Cripps, David. "Gelation and Curing of Thermoset Resins." *NetComposites*, NetComposites, 12 Aug. 2005, netcomposites.com/guide-tools/guide/resin-systems/gelation-and-curing/.