# VARTM EPOXY HYBRID COMPOSITES USING ALUMINIUM, GLASS FIBER AND BASALT FIBER REINFORCEMENTS

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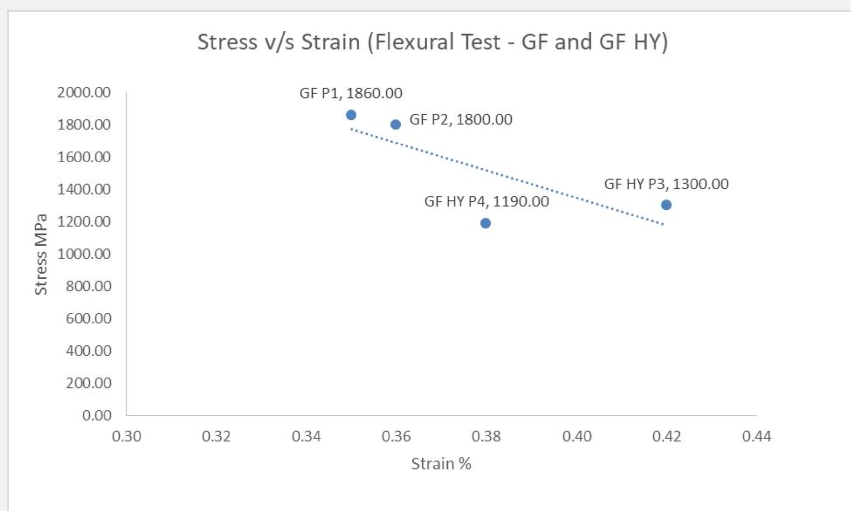
## Introduction:

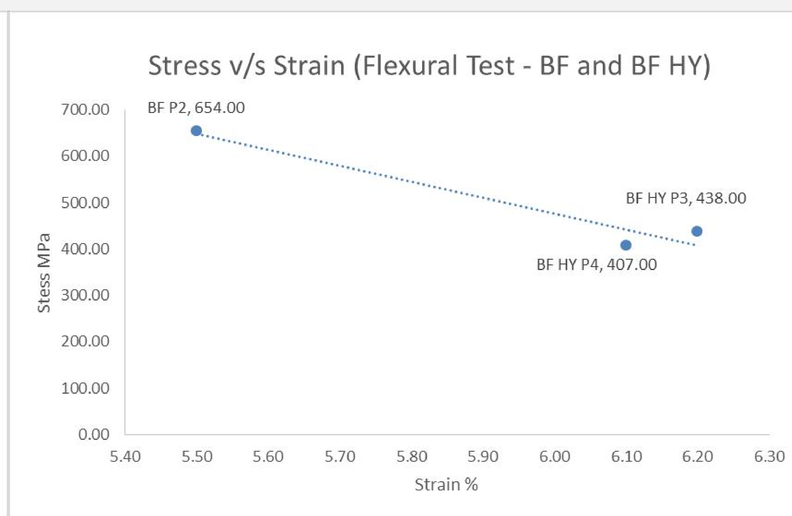
Liquid Composite Molding (LCM) process is one of the most successful Out of Autoclave (OoA) manufacturing methods making it cost effective for various applications. Vacuum Assisted Resin Transfer Molding (VARTM) method is a widely used LCM process and is a very cost-effective method for one-off or low scale manufacturing of complicated geometry and hybrid composites. There is significant demand for optimization of this process with respect to important manufacturing control parameters [1], due to the increasing demand of producing complicated profiles using new materials. Previous research [2-8] has shown that the addition of light metal structures as reinforcements for epoxy composites has considerable effect on the physical properties. The effect however, is yet to be investigated based on the manufacturing parameters, stacking and layup technique and the fiber reinforcement used. Investigation of hybrid epoxy composites [9-13] using basalt fibers has also been popular in the previous research because of the slightly better impact, tensile and lower wear rate of the basalt hybrid composites. Enhancement for one physical property had adverse effects on others in most of the cases so a trade-off is inevitable. Based on the desired application, the specific physical property is expected to enhance using hybrid combinations of different reinforcements including light metallic reinforcements.

## Research Objectives:

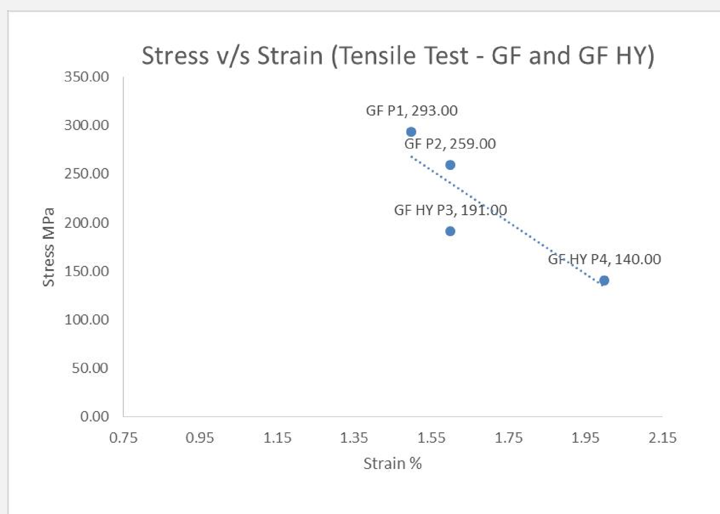
Epoxy composites were manufactured via the VARTM process, using Aluminium alloy metal mesh with glass fiber and basalt fiber reinforcements. Different orientations and stacking of fibers and aluminium alloy metal mesh, based on previous research, were used to fabricate the panels. The study was carried out in two parts: flat geometry panels manufactured using a glass mold (Part A); and curved L-Angled geometry panels manufactured using a 3D printed mold (Part B). The manufactured panels were subjected to visual inspection and non-destructive testing (NDT) using ultrasound. Differential Scanning Calorimetry (DSC) measurements were carried out to determine the post curing of the matrix. Mechanical tests (tensile, flexural, and impact) of the manufactured panels were also conducted according to ISO standards to compare the hybrid and fiber composites physically.




Glass Fiber




Bassalt Fiber

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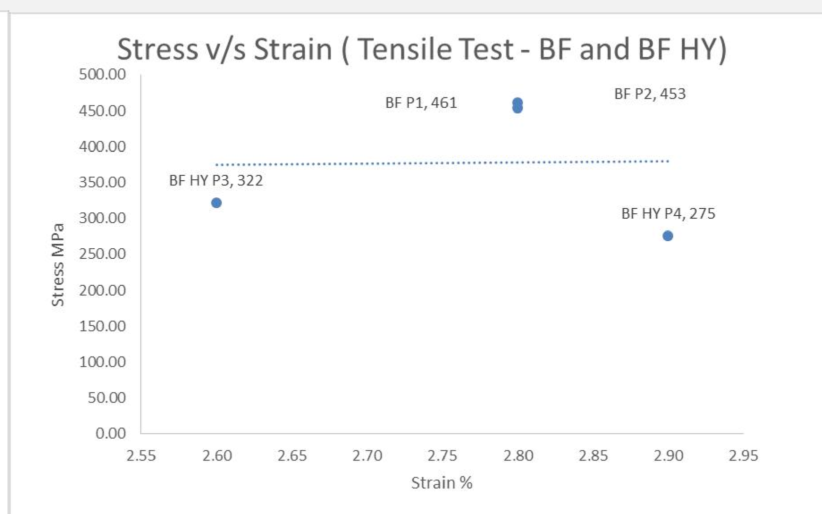


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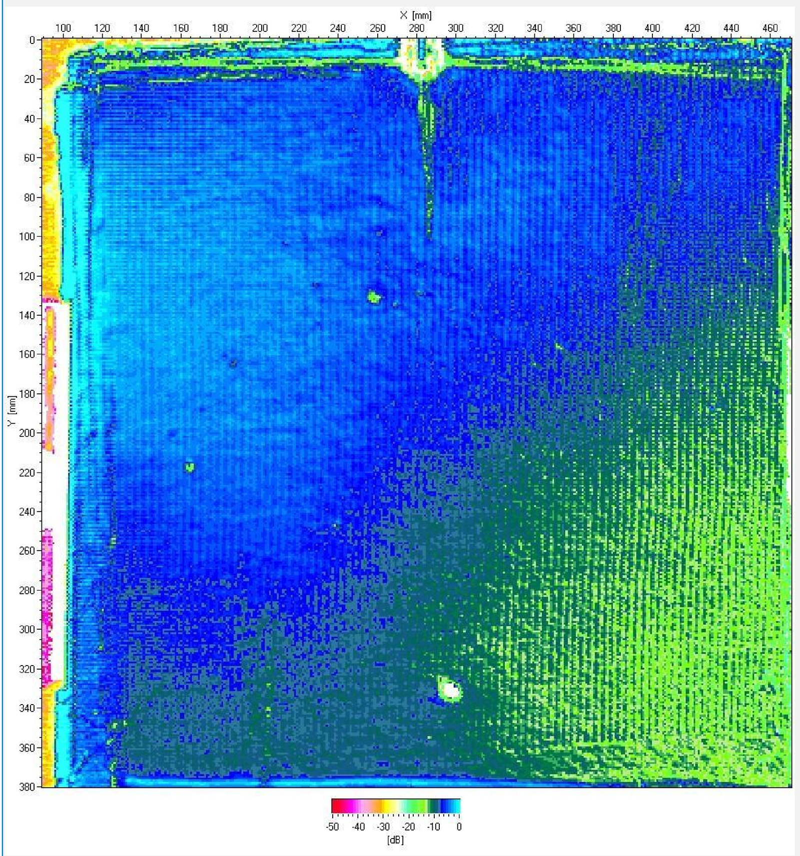

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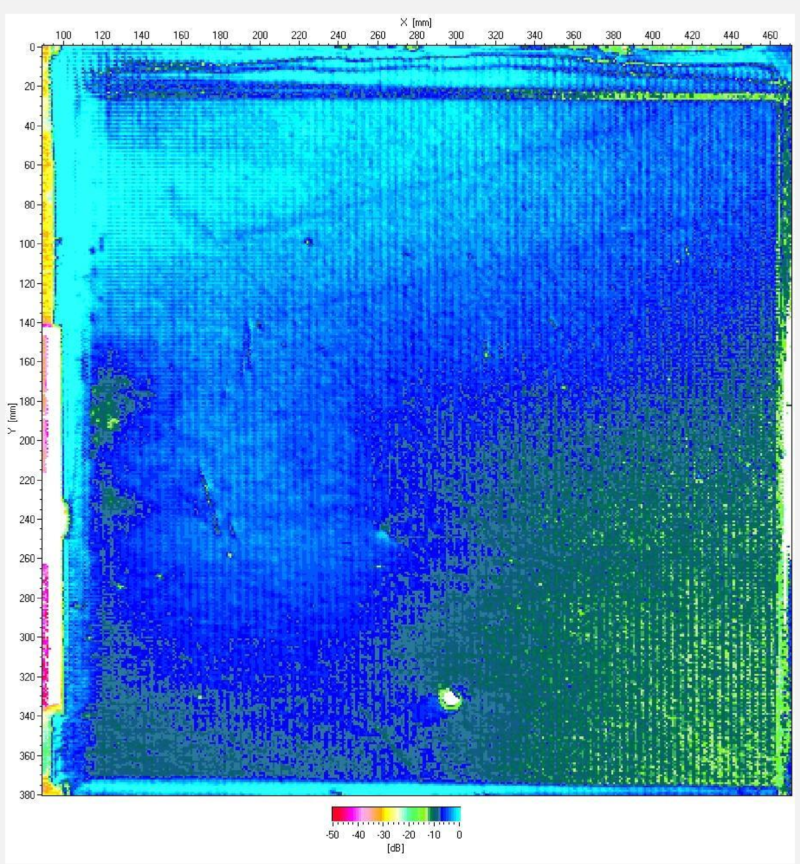
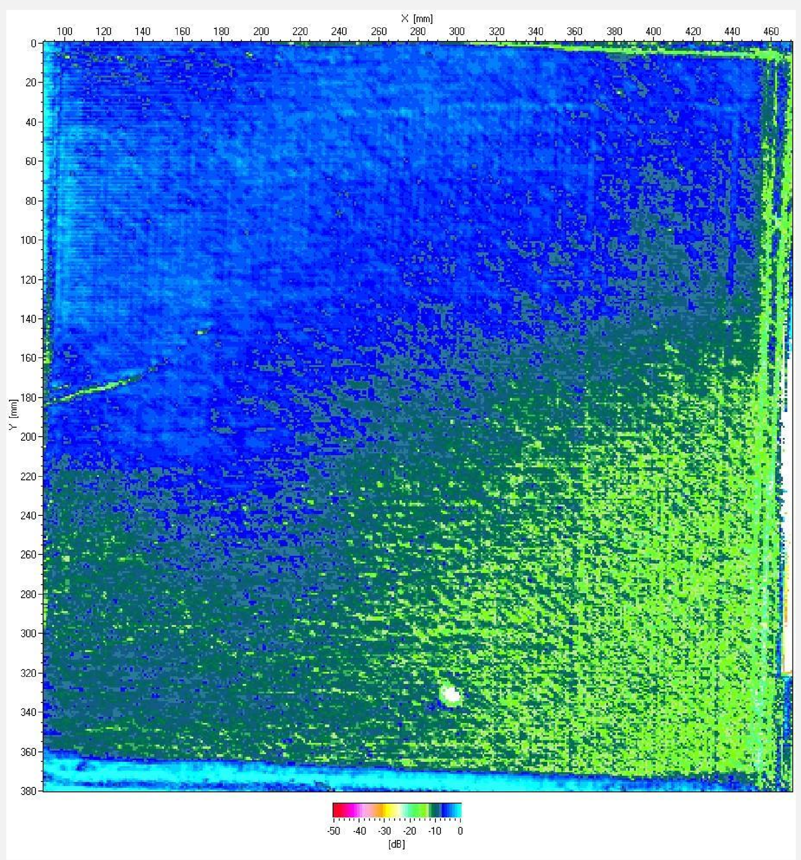


Glass Fiber Hybrid



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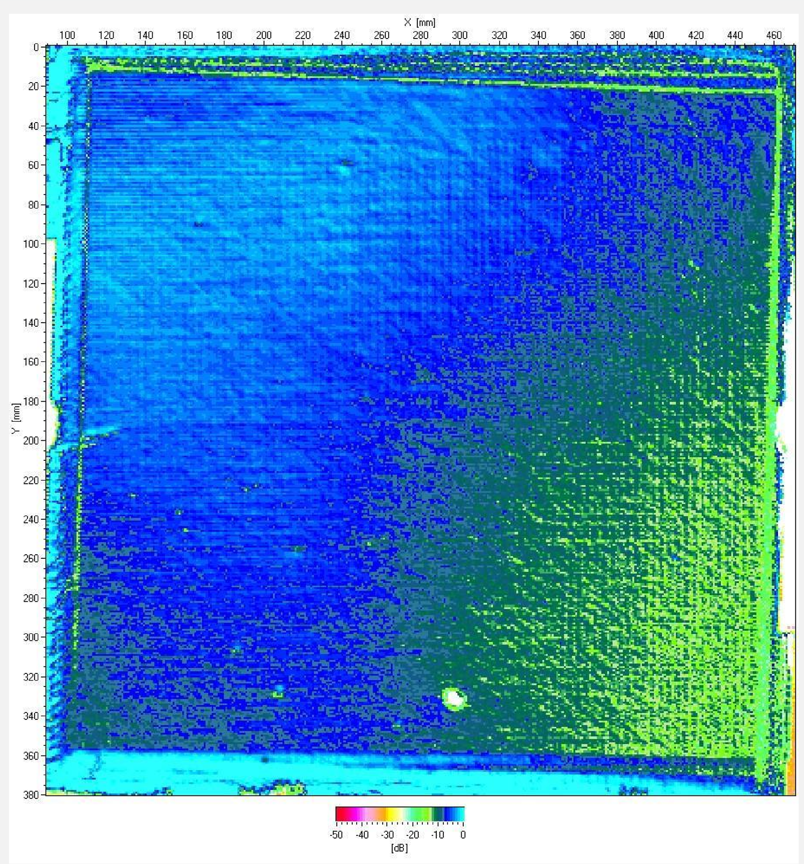
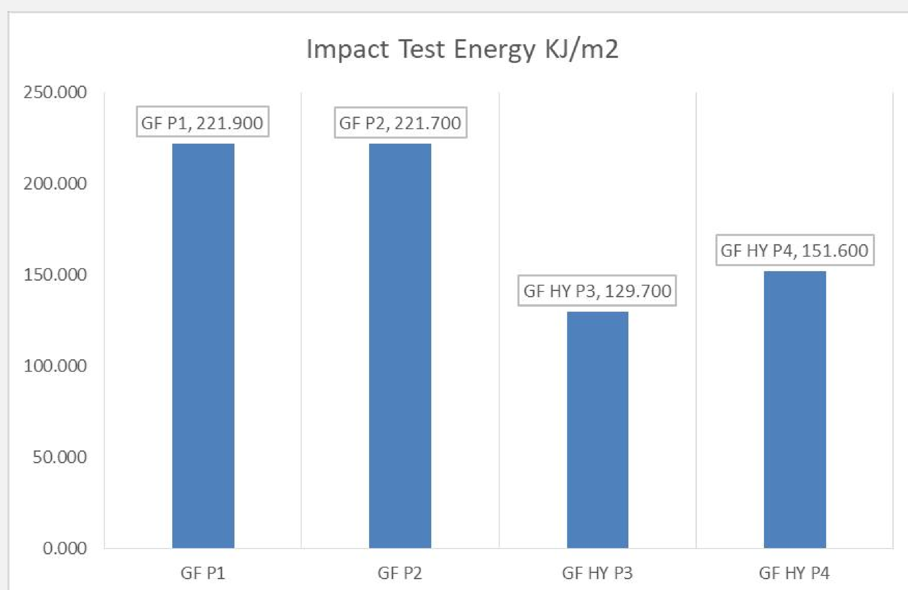
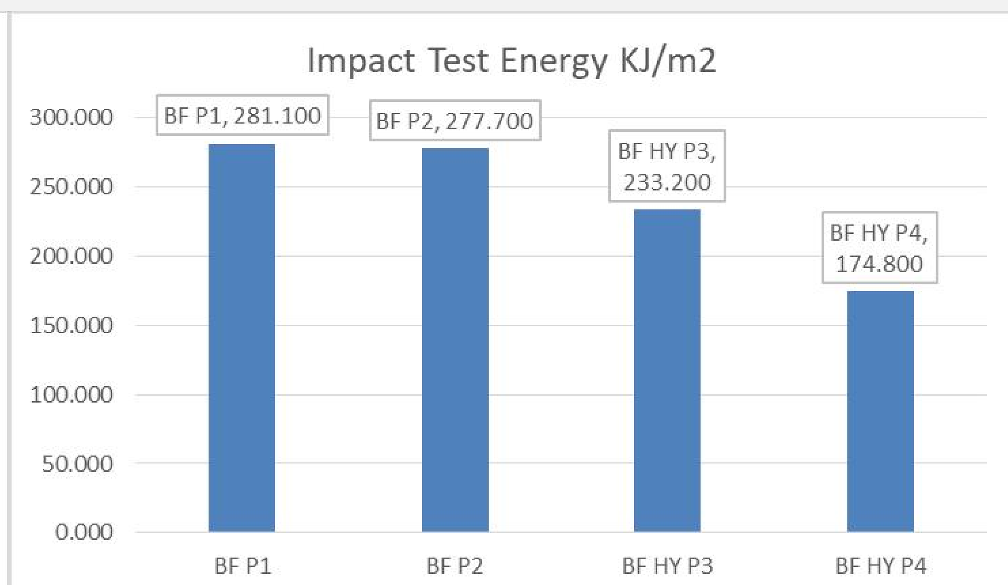


Bassalt Fiber Hybrid




Glass Fiber




Bassalt Fiber

## Conclusion:

1. The results from mechanical testing between hybrid and non-hybrid composites, where compared
2. Hybridization, results in lower stress and modulus.
3. As the elongation beyond the elastic region is more for the hybridised samples, the inexpensive fibres with hybrid make composite damage tolerant, when compared to high modulus and more expensive fibres.
4. This configuration is well suited for applications, where strength and stiffness of the composite structure, can be compromised for a more complicated geometry.

## Future Work:

1. A cumulative analysis of the results from Part A and B can be derived to comment better on the results of the hybrid configuration using metal substrate.
2. Based on literature, it is currently understood that the geometry plays a role in mechanical strength which is to be determined along the course of this work.
3. Further, to improve the mechanical properties, composite mechanics approach can be used and finite element modelling and analysis can also be carried out.
4. Main focus should be laid down on improvement of ultimate strength of the hybrid composite.

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