

# EXPERIMENTAL INVESTIGATION ON STRAIN HARDENING POLYMER COMPOSITE

A.Joyson Albino<sup>1</sup>, K.S.Navaneethan<sup>2</sup>

<sup>1</sup> PG Student, Department of Civil Engineering, Kongu Engineering College, Tamilnadu, India

<sup>2</sup> Assistant Professor, Department of Civil Engineering, Kongu Engineering College, Tamilnadu, India

\*\*\*

**Abstract** - The examination is now being led by concerning the utilization of fiber strengthened covers for various applications. The scope of the work is to examine the hybridation of filaments with aramid, nylon and glass strands for utilization of strengthening. The mechanical properties, for example, impact, tensile and flexural strength of fiber strengthened composites in the frameworks of covers will discover. Creation of examples includes fiber material covered with holding material by epoxy gum, in which 3mm to 5mm thick overlays were prepared. Covers are created by hand layup system in a shape, cured under light weight for 2 hours, trailed by curing at room temperature for 2 days. Here, to decide the greatest quality of differing creations of aramid, nylon and glass filaments. These covers, mechanical properties will be inspected under the room temperature for deciding the central properties. Since the fiber have the non-linearity conduct, here we bring the cross breed fiber into the overlays that gives the strain hardening properties.

**Key Words:** Fiber, Epoxy, Aramid, Glass, Nylon, Hybrid, Strain Hardening, FRP

## 1. Introduction

The field of engineering investigating the solutions for avoiding the failures which the mankind comes across. In here to identify the principle causes for the failure along with the other causes which complement the principle causes along with their respective remedial measures and precautions to be taken prior to the failure. There is now, need to understand the various situations or conditions whose existence gave rise to such failures. This is very important to be done in order to reduce the consequences caused by such failures. The most ideal approach to handle these disappointments is to battle it by confronting them gravely recognizing the reasons for this and to decide the preventive measures to keep those disappointments from happening in future. The large classification of causes for failure can be done in two types called controllable and uncontrollable causes. Controllable causes are the causes which can be controls by taking legitimate preventive measures and through review among the development of the structure. Uncontrollable causes are those which are structures are in out of control and there are no preventive measures. Those controllable failures during the period of service can be rectified by the suitable repair or retrofitting technique. Retrofitting is the process of modifying the existing structures to make them more resistant to seismic activity, ground motion due to earthquakes and to provide

the additional structural stability. Many structures were planned without satisfactory documenting and support for seismic protection, in that view different research have been completed. Here, retrofitting used to reproduce the load carrying capacity and serviceability of structure for future consideration. Upgrading and repairing certain building to make it more resistant and also to be a better economic consideration and immediate solution for problems rather than replacement of building. Use of fibers could be beneficial in civil engineering structures. Fibers are normally using in concrete to govern cracking due to plastic shrinkage and drying shrinkage. They also reduce the permeability of concrete and reduce the bleeding of water. The materials are polymerized into a long, linear chemical that bond two adjacent carbon atoms. Different composition of chemical components will be used to produce different types of fibers. Synthetic fibers are having more durability by comparing natural fibers. Strain hardening is the process of making the material to harden after deformation and to increasing stress on a material. By applying load there are possibilities that material may fail before reaching the desired stress value. To examine the composite action of FRP laminates in different load levels. The use of fibers in composite materials will increase the strength of the structure. The composites can be increasing the structural performance.

## Materials

The furthestmost mutual form in which fiber reinforced composites are used in structural uses is named a polymer composite, which is made by stacking a number of tinny layers of fibers and matrix and merging them into the preferred thickness. Fiber placement in each layer as well as the stacking sequence of various layers in a polymer composite can be exact to make a wide range of physical and mechanical properties for the polymer composite laminates. Fiber Reinforced composite materials contain of fibers of high strength and modulus bonded to a matrix with separate interfaces between them. In general fibers are the standard load carrying members, while adjoining matrix keeps them in the preferred location and direction. It acts as a load transferal medium between them, and keeps them from the environmental damages due to high temperatures and moisture. Epoxy resin and hardener preparing with various types of fibers used by aramid, nylon and glass called fiber reinforced polymer composites (FRP), using on those fibers for hybridation called hybrid fiber reinforced polymer composite (HFRP).

## Properties

The primary reason for epoxy's popularity is its superb mechanical strength. It is nearly cheaper and faster than welding. Epoxy also has excellent resistance to chemicals. After setting time of epoxy resin, there is no worry of chemical reaction that will weaken the seal also it resists heat. That protection makes it perfect for gadgets and electrical frameworks and other mechanical applications. The individuals who utilize epoxy know about the great mechanical quality and low curing constriction. It also known the epoxy resin are well-balanced industrial materials and suited to broad range of applications. Engineers are faced with concerns about heat dissipation, electrical insulation, light weighting, vibration and reduction of corrosion. Epoxy is an adhesive formulation that meets all of those concerns. Its thermal and electrical properties, strength and durability are what epoxy is noted for. The properties along with the resistance to immersion and hostile chemical vapor are the reason, it's chosen by engineers. It has excellent gap filling properties. It also resistance to cold, radiation and steam.

Hardener is a substance mixed with paint or other protective covering to make the finish harder and more durable. It is a curing agent for epoxies or fiberglass. Material which does not enter into the reaction is known as catalytic hardener. Hardener is usually classed as a corrosive, and as an irritant when in contact with the skin or by inhalation.

## Aramid Fiber

It is a class of warmth safe and solid engineered filaments. They are ordinarily utilized as a part of aviation and military applications, for body protection texture composites, tires, marine cordage. Aramid filaments were first presented in business application in mid-1960's. The limit of para aramid generation was evaluated at 41000 tons for every year in 2002 and expands every year by 5-10%. In from 2007 the collection generation limit of around 55000 tons for every year.

## Glass Fiber

It is a material involving continuous to a great degree fine filaments of glass. Glass strands are substantially less expensive and fundamentally less fragile when utilized as a part of composites. Glass fibers are used as a reinforcing agent for many polymer products. It is used to form a very strong and relatively light weight fiber reinforced polymer (FRP) composite material. Uses of glass fiber include mats and fabrics for thermal insulation, sound insulation and electrical insulation. Manufacturing of glass fiber insulation can used recycled glass contains up to 40% of recycled glass. It is cheaper and more flexible than aramid fiber. It is stronger than many metals by weight also can be molded into complex shapes. The glass fibers used for insulation, for made the structure to be strong.

## Nylon Fiber

It is the fiber which have longest history among synthetic fibers. Nylon was the first commercially successful synthetic thermoplastic polymer. The nylon stocking will be reprocessed and made into parachute for army fliers. Nylon pitches are generally utilized as a part of vehicle industry particularly in the motor compartment likewise it utilized as a segment of nourishment bundling, where an oxygen obstruction is required.

## Development of FRC and HFRC Laminates

It manages the manufacture stages used to acquire the composite material. The means associated with Hand-Lay-Up strategy for advancement of fiber fortified composite is same for the manufactured filaments. There are eight states of FRP overlays are utilized here in like manner aramid, nylon and glass with various grams per square meter for FRC and HFRC covers. By setting up a form in 150mm X 200mm X 15mm putting with overhead projector sheet and remover for simple to evacuate and dealing with the overlay shows in fig 1.1. Planning of epoxy framework by 1:10 proportion connected at base layer of form. For FRC overlays applying single fiber tangle with shape measurement and furthermore for HFRC covers utilizing diverse fiber mats with form measurement used to submerged by epoxy gum. Again applying epoxy network up to the level secured with overhead projector sheet and curing at room temperature for two days. The testing of FRC and HFRC laminates are done with the help of ASTM standards, before testing the laminates shown in figure 1.2



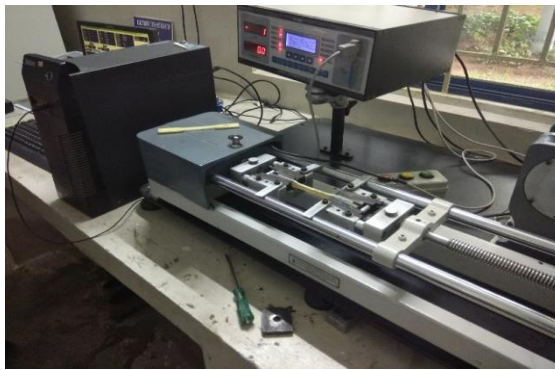
Fig 1.1 Polymer composite



Fig 1.2 ASTM standard laminates

**Testing**

The tensile, flexural and impact strength of polymer composite was tested by using the Strain controlled UTM based on ASTM standards shown in figure. The size of 165mm X 19mm X 13mm for tensile, 50mm X 13mm for impact and 50mm X 13mm flexure (as per ASTM standard size).



**Fig 1.3 Tensile test**

The outcomes were depicted aramid fiber is great in quality however not great in prolongation. For this situation Nylon strands gives a decent outcome in stretching yet not all that well in quality.



**Fig 1.4 Impact test**



**Fig 1.5 Flexural test**

By the blend of aramid and nylon HFRP composite not give a normal outcome as a result of holding issues. So by getting ready glass filaments like 200 and 400 GSM overlays with aramid and nylon textures give a superior come about by looking at different composites. The main concept of Strain hardening is the process of making the material to harden after deformation and to increasing stress on a material.

**Table 1.1 Test results of HFRP laminates**

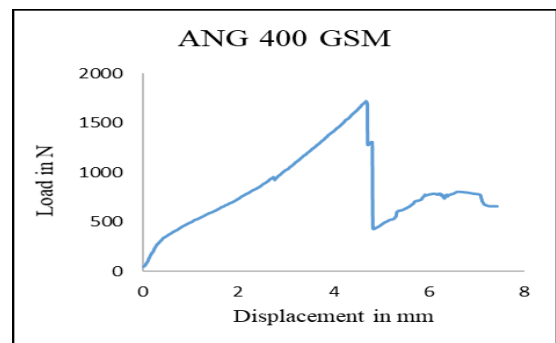
Description	Aramid and Nylon	ANG 200 GSM	ANG 400 GSM
Yield force (N)	392.28	1686.8	1677
Yield elongation (mm)	4.87	5.44	4.58
Break force (N)	843.4	1735.84	1716.23
Flexural at yield (N/mm <sup>2</sup> )	24.57	32.53	21.57
Flexural strength at break (N/mm <sup>2</sup> )	29.195	34.085	23.353
Impact load (Joule)	0.552	1.622	2.642



**Fig 1.6 Tested Laminates**

In here ANG 200 and 400 GSM HFRC laminates gives a worthy results and also, even if it had a failure at the time of load carrying the strength is quickly reduced but after at some point level it has gain as shown in the figure

Therefore, in this ANG composites gives a good result in strain hardening. The tested laminates are shown in fig 1.6 also the difference between load and deflection of HFRC laminates shown in figure 1.7.



**Fig 1.7 Graphical Result for ANG laminate**

