EXPERIMENTAL STUDY ON SANDWICH PANEL USING SISAL AND BASALT FIBER

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ABSTRACT:-*In present era sandwich Panels represent the achievements of construction technology. A sandwich panel is any structure made up of three layers, a low-density core, and a thin skin-layer bonded to each side. These panels are more durable than traditional building materials and they are lighter in weight. These panels are commonly used in structures due to their superior strength and stiffness and they can also be used when a combination of high structural rigidity and low weight is required. In this paper the flexural behaviour was studied. The size of sandwich panel consider in this paper was 1200mmX200mmX50mm which is chosen according to the codal provision of D 3043-000 "Standard Test Methods for Structural Panels in Flexure". In order to achieve light weight sandwich panel without compromising strength and stiffness, light weight fibers like sisal fiber and basalt fibers were used. The percentage of sisal fiber taken are 2%,2.5%,3% and 2%,2.6%,3.2% of basalt fiber are taken. The Optimum percentage of sisal fiber and basalt fiber were taken from the test results such as compression test, split-tension, which is used for casting sandwich panel by using Sisal fiber and basalt fibers as skin, core of the panel. Then the flexural strength of the sandwich panel were studied using two point loading condition. The experimental result is compared with analytical work using ANSYSWORKBENCH 19.2 version software. The Test result show that flexural strength of sandwich panel shows increased value compared to Analytical Work.*

KEYWORD: Sisal fiber, Basalt fiber, Sandwich panel.

1. INTRODUCTION

A sandwich panel is any structure made up of three layers a low density core and a thin skin layer bounded to each side. sandwich panel construction techniques have experienced considerable development in 40 years, previously sandwich panel were considered as the product suitable only for functional construction and industrial building however their good insulation characteristic, their versatility, quality, appealing visual appearance have resulted in a growing and wide spread use of the panel across a huge variety of building. Sandwich panel are used in application where a combination of high structural rigidity and low weight is required. Sandwich panel are used as storage buildings, partition and fire resistant compartment wall. sandwich panel has an advantage such as they are mobility and efficiency, long working life, construction lightness, low thermal conductivity.

1.1. Sisal Fiber

Sisal fiber is a natural fiber and eco friendly material. These fibers are used to due to the advantage that they are more durable, biodegradable, water resistant, abrasion resistant. Sisal fiber are obtained from sisal plant by extraction process. In earlier stage sisal fiber was widely used in ropes, papers. The use of sisal fiber in non-woven textile is also a prime significance as sisal is an environmental friendly agent to replace asbestos and fiber glass in composite material. This had to lead to increased employment of sisal fiber in automobile industry. Sisal are commonly used in shipping industries for mooring small craft, lashing and handling cargo. It is used in auto mobile industry with fiber glass in composite material. It is also surprisingly used as the fiber core of steel wire cables of elevators, being used for lubrication and flexural properties. Sisal fiber are not recommended for smooth wall finish and for wet areas.

1.2. Basalt Fiber

Basalt fiber is a material made from extremely fine fibers of basalt, which is composed of the minerals plagioclase, pyroxene, and olivine. It is similar to fiber glass, but having better physical and mechanical properties than that of fiber glass and they are significantly cheaper than carbon fiber. They are used as a fire proof textile in the aerospace and automobile industries and can also be used as a composite to produce products such as camera tripods. Basalt fiber has mechanical properties such as high tensile strength and they have low manufacturing cost compared to glass fiber. The recycling process of basalt fiber is more efficient than glass fiber and therefore basalt fibers are environmentally friendly. The advantage of using basalt fiber is that they do not require any special technologies or equipments. Basalt fiber shows 15-20% high tensile strength, they have better thermal resistance and chemical resistance.

2. MATERIALS USED

A. Cement: Cement is a material ,generally in powder form, that can be made into paste usually by addition of water. Care has been taken to see that the procurement made from a single batch and is stored in airtight containers to prevent it is being affected by atmospheric, monsoon moisture and humidity. The cement used in all mixture was commercially available ordinary Portland cement (OPC) of 53 grade confirmed to IS: 12269-1987.The specific gravity of cement is 3.15.

B. Fine Aggregate: Locally available Natural River sand of size below 4.75 mm conforming to Zone II of IS 383-1970 is used as fine aggregate. Specific gravity of fine aggregate is 2.606.

C. Sisal Fiber: Sisal fiber is a species of Agava. It is botanically known as Agave sisalana. The material is chosen to improve the various strength properties of the structure and have better quality structure. The sisal fiber is shown in fig 1.

Fig 1 Sisal Fiber

D. Basalt Fiber : Basalt fiber is a material made from extremely fine fibers of basalt, which is composed of the minerals plagioclase of the pyroxene and olivine. It increases 15-20% tensile strength.It has lower manufacturing cost than glass fibers and recycling of basalt fibers is much more efficient than glass fibers and its environmentally friendly. The basalt fiber is shown in the fig 2

Fig 2 Basalt Fiber

3. CASTING OF SANDWICH PANEL

The size of the panel (1200X200X50mm) is chosen according to the codal provision D 3043-000 Standard Test Methods for Structural Panels in Flexure. Usually the sandwich panel is made up of three layers (Skin, Core, Skin).In this the panel thickness is split into three layers of 10mm(Skin),30mm(Core),10mm (Skin).The skin layer of the panel is made up of sisal fiber mixed along with the cement-mortar for 10mm thick ,the core layer of the panel is made up of basalt fiber mixed along with the cement-mortar for 30mm thick and again the skin layer of the panel is made up of sisal fiber mixed along with the cement-mortar for 10mm thick. The optimum percentage of sisal fiber and basalt fiber were used for casting the panel which is taken from the test result of compressive test and split-tensile test and then 28 days curing is done after that the panel is loaded for two point loading condition by using universal testing machine (UTM).

4. EXPERIMENTAL WORK

4.1 *Compressive Strength*

The compressive strength for a mortar cube of size 70.6X70.6X70.6mm was conducted in Universal Testing machine as per IS516:1964.Then the specimen was placed in machine and the axis of the specimen was carefully aligned at the centre of the loading frame. The load was applied at a constant rate until the specimens fails and the maximum load is recorded. From the test result average value of compressive strength for sisal fiber is 12.11N/mm^2,7.030N/mm^2 at 7 days and 28 days for 2.5 % inclusion of sisal fiber and the average value of compressive strength for basalt fiber is 10.09N/mm^2,6.892N/mm^2 at 7 days and 28 days for 3.2%inclusion of basalt fiber. The test result are shown in table no 1,2

Compressive strength = P/A

P- Load(KN).

A- Area of the specimen(mm^2).

Table No 1 Compressive Strength of Sisal fiber @28 Days

Sisal Fiber %	Average Compressive Strength(Mpa)
S_2	3.22
$S_{2.5}$	7.03
S_3	5.76

Table No 2 Compressive Strength of Basalt fiber @28Days

Basalt Fiber %	Average Compressive Strength(Mpa)
B_2	6.37

$B_{2.6}$	6.89
$B_{3.2}$	6.82

4.2.Split tensile strength

The Split tensile strength for mortar cylinder of size 100mmX150mm was conducted in Universal Testing Machine (UTM) as per IS516:1964.The Specimen was kept horizontally between the loading surfaces of a universal testing machine and the load was applied at a constant rate until the specimen fails and maximum load applied was recorded. The average value of split tensile strength for sisal fiber is was applied at a constant rate until the specimen fails and the maximum load applied was recorded. The average value of split tensile strength for sisal fiber is 3.3N/mm^2,2.95N/mm^2 at 7 days and 28 days for 2.5 % inclusion of sisal fiber and the average value of split tensile strength for basalt fiber is 3.37N/mm^2,2.42 N/mm^2 at 7 days and 28 days for 3.2%inclusion of basalt fiber. The test result are shown in table no 3,4

Split-tensile strength = 2P/ΠDL

P-Load(KN).

D- Diameter of the specimen(mm).

L – height of the specimen.

Table no 3 Split-Tensile strength of Sisal fiber @ 28 Days

Sisal Fiber %	Average Split-tensile Strength (Mpa)
S_2	2.32
$S_{2.5}$	2.95
S_3	2.01

Table No 4 Split-Tensile strength of Basalt fiber @ 28 Days

Basalt Fiber %	Average Split-tensile Strength (Mpa)
B_2	2.14
$B_{2.6}$	2.25
$B_{3.2}$	2.42

4.3. Flexure test

The Flexural strength test was performed according to IS516-1959.The test specimen (sandwich panel) of size 1200mmX200mmX50mm.The casting of the panel is done by taking average value of compressive and split-tension test result from that 2.5%sisal fiber and 3.2% basalt fiber were used for casting of sandwich panel, after that 28 days of curing at room temperature is done. It is then tested under two point loading condition under Universal Testing Machine(UTM).The average value of flexure strength is 12.72N/mm^2.The flexure strength of the sandwich panel is obtained by using the formula given below.

$f_y = WL/BD^2$

W-Failure Load,

L-Effective Length.

B-Breadth.

D-Depth.

Table No 5 Test Result of Sandwich panel

Fiber	Flexure stress (Mpa)
Conventional mortar	6.72
SBS 1	9.84
SBS 2	15.6

5. ANALYTICAL WORK

The analytical work is done in order to study the flexural behavior of sandwich panel and the result

obtained from the analytical work is compared with the experimental result. The analytical work is done by ANSYS WORK BENCH Software 19.2 version.

Step I: Properties of the fiber assigned for sandwich panel

Click on Engineering property and create data to assign the fiber properties for the sandwich panel. The following are the fiber properties assigned for sandwich panel.

For Sisal Fiber

- Density of sisal fiber - 2250Kg/m^3.
- Young's Modulus - 2.2E^{+10}.
- Poisson's Ratio - 0.23.

For Basalt Fiber

- Density of sisal fiber - 2350Kg/m^3.
- Young's Modulus - 4.5E^{+10}.
- Poisson's Ratio - 0.2.

Step II : Element Used

The element used for sandwich panel is SOLID186.Solid 186 is used as they have higher order 3D 20 node solid element which exhibits the quadratic displacement behavior. They have three degrees of freedom per node translations in the nodal x, y, z directions. These elements supports plasticity, creep, stress, large deflection and strain capabilities. These elements are well suited for irregular meshes and they have any spatial orientation. Due to this Solid186 element was used.

Step III: Simulation of sandwich panel

The Geometry of the sandwich panel was created by clicking rectangle sketching in that the dimension of the panel is given and the thickness of the sandwich panel is given by clicking extrude.

Dimension of the sandwich panel

- Length = 900mm.
- Breadth = 200mm.
- Thickness= 50mm.(skin,core,skin)
  - Skin -10mm.
  - Core -30mm.
  - Skin -10mm

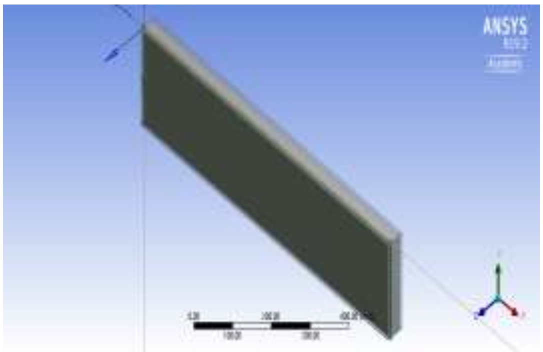

Fig 3 simulation of sandwich panel

Loading condition

The loading condition used for the sandwich panel is two point loading. The two point loading condition is chosen because it shows pure bending. The total span of the sandwich panel is split into three parts using face split and then the loading is given at the splitted edges.

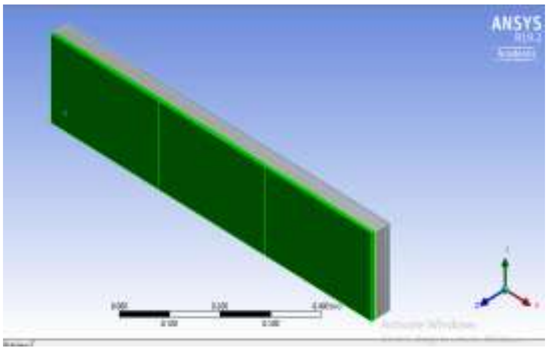

Fig 4 Face Split of the Sandwich Panel

Step IV : Modeling of the sandwich panel

In modeling of panel the skin and core are assigned for the sandwich panel and then meshing of sandwich panel is done by giving 25mm mesh size and on click generate mesh. After meshing click on static structural to assign support condition for the sandwich panel and then force are applied on the sandwich panel.

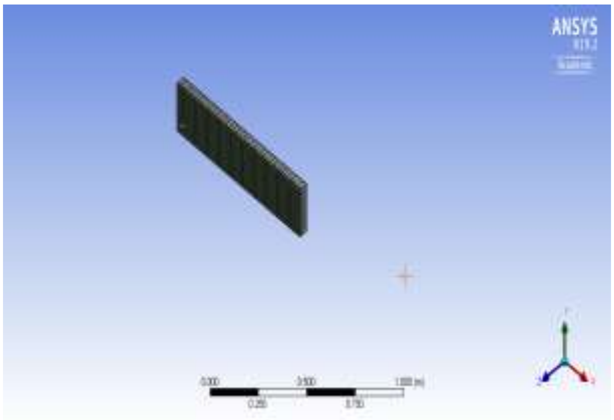

Fig 5 Meshing of Sandwich Panel

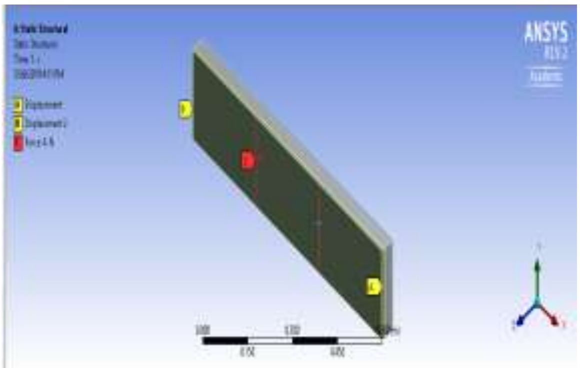

Fig 6 Support and Force applied on Sandwich Panel

Step V: Solution

After support and force are assigned on sandwich panel click on solution and insert the following

- Click deformation -Total.
- Click deformation- Total-Direction.
- Click sliding distance.
- Click contact tool.
- Click frictional stress.

The following are inserted.

Step VI : Solve

Click on Static structural and click on solve then click ok.

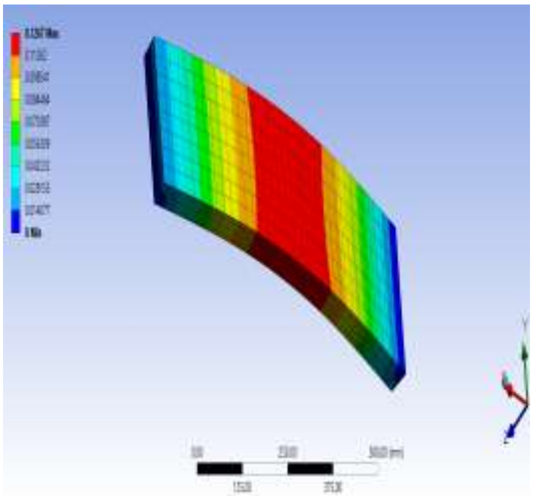

Fig 7 Deformation of the Panel

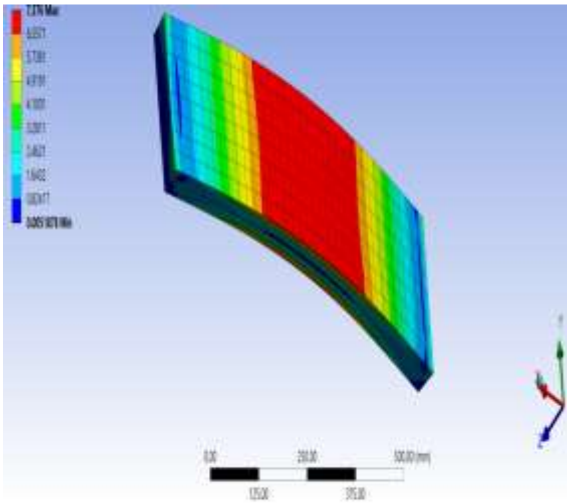

Fig 8 Stress Diagram of Sandwich Panel

Thus the stress and deformation shape of the Sisal-Basalt-Sisal fiber Sandwich Panel is obtained by using ANSYS WORKBENCH Software version 19.2

6. CONCLUSION

In order to find the optimum value and to study the flexural behavior of sandwich panel various test such as compression test, split tensile test were conducted. The optimum values of both the fibers were obtained from the compressive strength and split tensile strength results. The compressive strength of the mortar cubes decrease due to the aging of the fiber reduces the bonding capacity between them. The tensile strength increases as the fibre content increases. The optimum value of sisal fiber was found to be 2.5% from compression and tensile strength result and for basalt fiber it was found to be 3.6% from compression and tensile strength result. From the experimental result the flexural behavior of the sandwich panel using sisal fiber and basalt fiber was obtained by taking optimum value of 2.5% of volume of panel of sisal fiber which is mixed along with the cement mortar and 3.2% of volume of panel of basalt fiber which is mixed along with the cement mortar were used for casting the sandwich panel. The experimental behavior of sandwich panel is compared with the analytical work using ANSYS WORK BENCH Software 19.2 version It is found that the experimental results show higher value compared to analytical. From the above discussion, it can be concluded that the sandwich panel with fiber have high tensile strength, compression strength, flexure strength and reduced self weight.

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