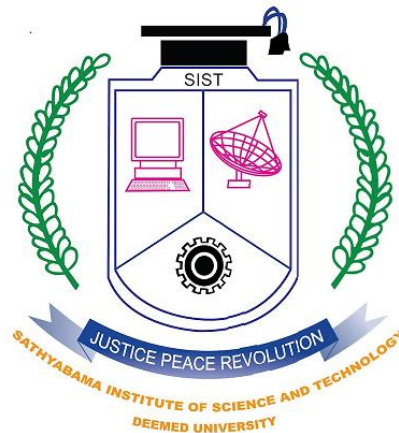


FLEXURAL BEHAVIOUR OF BASALT AND STEEL FIBRE REINFORCEMENT USING GFRP BAR

Submitted in partial fulfilment of the requirements of the award of
Master of Engineering Degree in Structural Engineering

By

DINESH CHANDRAN B (REGNO:41380005)



**DEPARTMENT OF CIVIL ENGINEERING
SCHOOL OF BUILDING AND ENVIRONMENT**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

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MAY 2023



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DEPARTMENT OF CIVIL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafied work of **DINESH CHANDRAN (41380005)** who carried out the project entitled "**FLEXURAL BEHAVIOUR OF BASALT AND STEEL FIBRE REINFORCEMENT USING GFRP BARS**" under my supervision from December 2022 to May 2023.

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Submitted for the Viva voce Examination held on 05/05/2023

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DECLARATION

I **DINESH CHANDRAN B (41380005)** here by declare that the Project Report entitled “**FLEXURAL BEHAVIOUR OF BASALT FIBRE REINFORCEMENT USING GFRP BARS**” done by me under the guidance of **Dr. R. Packialakshmi M.E, Ph.D** at **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY** is submitted in partial fulfillment of the requirements for the award of Master of Engineering Degree in Structural Engineering.

DATE: 05-05-2023

PLACE: Chennai



SIGNATURE OF THE CANDIDATE

ACKNOWLEDGEMENT

We are pleased to acknowledge our sincere thanks to Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

We convey our thanks to **Dr. Devyani Gangopadhyay, B.Arch., M.T.P., Ph.D.**, Dean, School of Building and Environment and **Dr. S. Packialakshmi, M.E., Ph.D.**, and **Dr. R. Padmapriya, M.E., Ph.D.**, Head of the Department, Dept. of Civil Engineering for providing us necessary support and details at the right time during the progressive reviews.

We would like to express our sincere and deep sense of gratitude to our Project Guide **Dr. S. Packialakshmi M.E., Ph.D.**, for her valuable guidance, suggestions and constant encouragement paved way for the successful completion of our project work.

We wish to express our thanks to all Teaching and Non-teaching staff members of the Department of Civil Engineering who were helpful in many ways for the completion of the project.

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CHAPTER 1

INTRODUCTION

Basalt fiber are Produced from basalt rocks by melting them and converting the melt in to fibers and it is igneous origin. It is the raw material to produce of fibers is made in natural condition. It is continuous fiber are used for the production of reinforced and composite products. It is used for the production of thermal insulation material

Steel fiber is a metal reinforcement. Steel fiber for reinforcing concrete is defined as short, discrete lengths of steel fibers with an aspect ratio (ratio of length to diameter) from about 20 to 100, with different cross-sections, and that are sufficiently small to be randomly dispersed in an unhardened concrete mixture using the usual mixing procedures.

GFRP was used as a alternative material to the steel bars. It is lightweight, corrosion superior tensile strength, high mechanical performance. GFRP rebar is non- Conductivity to electricity and heat making it an ideal choice for facilities like power Generation plants and scientific installations. Taking into account the long - term benefits of GFRP rebar, it is a cost-effective products as compared with epoxy coated.

1.1 OBJECTIVES:

- To study the Flexural Strength, Toughness, Impact Resistance, Abrasion Resistance and Ductility.
- To Select the suitable fibre for developing Fiber Reinforced Concrete concrete
- To Determine the Strength Characteristics of the Fiber by using GFRP Bar.
- To evaluate the strength characteristics using experimental approach

- To compare the Analytical results and Experimental Results.

1.2 SCOPE OF STUDY

- Low cost, high performance fibers offer the potential to solve the largest problem in the cement and concrete industry, cracking and structural failure of concrete.
- Because of the higher performance and lower potential cost predicted for basalt fibers.

1.3 NEED FOR RESEARCH

- The research is aimed to utilize the hybrid fibers and GFRP bars for M40 grade concrete for investigating improved strength characteristics
- Determine strength characteristics of FRC using basalt and steel fibres
- Determine the mechanical properties of the FRC beam with GFRP bars
- To find the optimum percentage of hybrid fibers for achieving greater strength.

CHAPTER 2

LITERATURE REVIEW

2.1 LITERATURE REVIEW

Hamid Behbahani (2011) Concrete is one of the world most widely used construction material. However, Since the early 1800's. it has been known that concrete is weak in tension. Weak tensile Strength combined with brittle behaviour result in sudden tensile failure without warning. This is obviously not desirable for any construction material.

Jimmy Susetyo, Paul Gauvreau & Frank J. Vecchio(2011)Study on the Addition of Steel Fiber to Concrete has been found to significant increase the post-Cracking toughness and Ductility of the concrete, even when the amount of fiber added is low. Increase in tensile strength have also been observed, although a high volume percentage of fiber are required to obtain.

ZY Sun, y Yang & Gwu (2012) Experimental Studies Investigation the Flexural behaviour of six concrete beams were conducted with various reinforcements including ordinary steel fiber reinforced ploymer composite bars pure fiber reinforced polymer bars.

Jordon R.Deluce and Frank J. Vecchio(2013)Study on the addition of steel fiber has a significant effect on the tensile stress strain softening behaviour , albeit with significant greater toughness and energy absorption capacity than a plain concrete of the capacity than a plain concrete of the same strength.

Andreea Serbescu et al. (2013) Study on the tensile strength of the tested BFRP bars ranged from 972 to 1,481 MPa while the elastic modulus varied from 34 to 47 GPa. Among all parameters examined, temperature was found to be the most important factor affecting the degradation process. The lowest strength retention of 69% was observed for bars exposed to pH9 solution at 60°C for 5,000 h; An increase in the pH levels from 7 to 13 induced 8% additional loss in strength. Despite some strength deterioration, the elastic modulus of the tested bars increased by an average of 6.5%.

Yamini Roja (2014) Study on the corrosion is a crucial problem in steel reinforcement which deteriorates the material when it reacts with the environment. Glass Fibre Reinforced Plastic (GFRP) rebar emerged as a promising alternative to traditional steel reinforcement with excellent results in terms of corrosion resistance. Its advantages include high longitudinal strength and tensile strength, resistance to corrosion and chemical attack, light weight and electromagnetic neutrality

Douglas Tomlinson and Amir Fam(2015) Study on the Ultimate capacities of the beams are directly related to flexural reinforcement ratio regardless of failure mode, whether flexural or shear. On the other hand, load-deflection responses within the service loads range were not noticeably affected by shear reinforcement type. 2. In beams without stirrups, the load at which major diagonal shear cracking occurred increased as BFRP flexural reinforcement ratio ρ increased. The load then dropped by various amounts inversely proportional to ρ , before it increased again to ultimate shear failure levels exceeding shear cracking load by percentages also inversely proportional to ρ .

Ahmad Altalmas et al (2015) Study on the Conditioning of pullout specimens in aqueous solutions had negligible effect on the trend of the bond stress–strain curves. Sand coated bars showed higher bond strength and higher adhesion to concrete than ribbed bars regardless of the fiber type. This finding was observed

for both unconditioned and conditioned specimens. Swelling of the bar at early stages of exposure enhanced its adhesion to concrete

Tomasz Blaszczyńska, Marta Przybylska-Faleka (2015) Study on Fiber - Reinforced Concrete is the Concrete with addition of short fibers targeting the improvement of the property of this material. Its durability is basically connected with the long-term dynamic loading. The main characteristic in the case are the critical Stresses. The object of this article is steel fiber-reinforced Concrete.

Gang Wu et al(2016) study on a novel technique for strengthening RC beams using a newly developed reinforcement, SBFCP, which is composed of steel wires and BFRP and combines the advantages of both materials. The main parameters used in this study were the volumetric ratio of steel wires in SBFCPs, composite plate type, and type of anchorage mechanisms.

Ahmed El Refai et al(2016) Study on the pullout test results on BFRP and GFRP bars showed similar trends of the bond-slip curves for both types of bars, with an ascending concrete strengths are used. Experimental tests on other types of commercially available BFRP bars with various properties and surface deformations are recommended for future studies. Bond durability data of BFRP bars are also needed to investigate the bond performance of the bars when exposed to various service environments.

Hayder Alaa Hasan, M. Neaz Sheikh, Muhammad N.S. Hadi (2017) study on the results of an experimental investigation on high strength concrete (HSC) and steel fibre high strength concrete (SFHSC) circular column specimens reinforced longitudinally and transversely with Glass Fibre-Reinforced Polymer (GFRP) bars and helices, respectively.

Benard Isojeh, Maria El-Zeghayar, and Frank J. Vecchio(2017) Study on the dynamic nature of loading while in service, these structures are susceptible to fatigue failure resulting from reinforcement fracture, crushing of concrete struts

coupled with irreversible compressive strain accumulation, or excessive opening of concrete cracks.

Fareed Elgabas et al (2017) Study on the flexural behavior of concrete beams reinforced with ribbed BFRP bars is presented herein. A total of eight concrete beams measuring 3,100 mm long × 200 mm wide × 300 mm deep were constructed and tested up to failure. Six beams were reinforced with 8-, 12-, and 16-mm BFRP bars with ribbed surfaces, and two reference beams were reinforced with 10M and 15M steel bars. The beams were tested under four-point bending over a clear span of 2,700 mm until failure. Based on the test results and the discussions presented herein.

Junzaho et al (2019) Study on BFRP- reinforced concrete beams were tested under fatigue loading after different elevated temperature treatments, and the influence factors of elevated temperature, holding time, fatigue load level and FRP bar type were considered. Finally, the deflection and fatigue life of beams were predicted using existing models.

Eric Hughes et al(2020) conducted to determine the feasibility of using externally bonded BFRP fabrics to strengthen RC beams. Five full-size specimens were tested. The following conclusions have been drawn from this research, and while the results are similar to previous studies, the conclusions may be limited to this study. Externally bonded BFRP is a feasible alternative to other FRP fabrics when flexurally strengthening RC beams.

Lam Thanh Quang Khai(2021) study on steel fiber concrete beams, there are many design parameter that affecting stress- strain state, cracks formation and cracks development in beam changes of these design parameter will effect bearing Capacity,Displacement and Cracks in Beam

Saber Fallah-Valukolaee , S.K. Hashemi, Mahdi Nematzadeh (2022)Study on steel rebars with glass fiber reinforced polymer (GFRP) rebars in concrete

beams can lead to the production of lightweight and durable structural members. Meanwhile, layering concrete beams and using different volume fractions of steel fibers in the layers can be a proper method for improving structural performance and reducing construction costs of fiber reinforced-concrete beams.

Chuanchuan Li , Haitang Zhu b, Guoqiang Niu , Shengzhao Cheng Zhiqiang Gu , Lin Yang (2022) Study on steel fiber reinforced concrete (SFRC) beams reinforced with BFRP bars were tested under four-point bending. The main test parameters included steel fiber volume ratio, SFRC layer thickness, and BFRP reinforcement ratio.

2.1 SUMMARY OF LITERATURE REVIEW:

- It is demonstrated that optimal design of high-performance concrete with hybrid SF and BF can be carried out using adapted mathematical experiments planning methods. The main novelty of the research is verifying the effect of adding hybrid fiber reinforcement for improving the homogeneity of fine-grained fiber reinforced concrete mixtures and preventing their segregation.
- It yields higher values of hardened concrete strength. The study presents a methodology for the design of HFRC compositions based on the adapted mathematical experiments planning method. Study about the strength and different proportions of concrete design principles through the Literature and Study about the Mix Ratio
- The obtained experimental results demonstrate the possibility of improving the structure and the properties of HFRC using BF. More detailed research was carried out to study the influence of water–cement ratio, cement content, SF and BF

CHAPTER 3

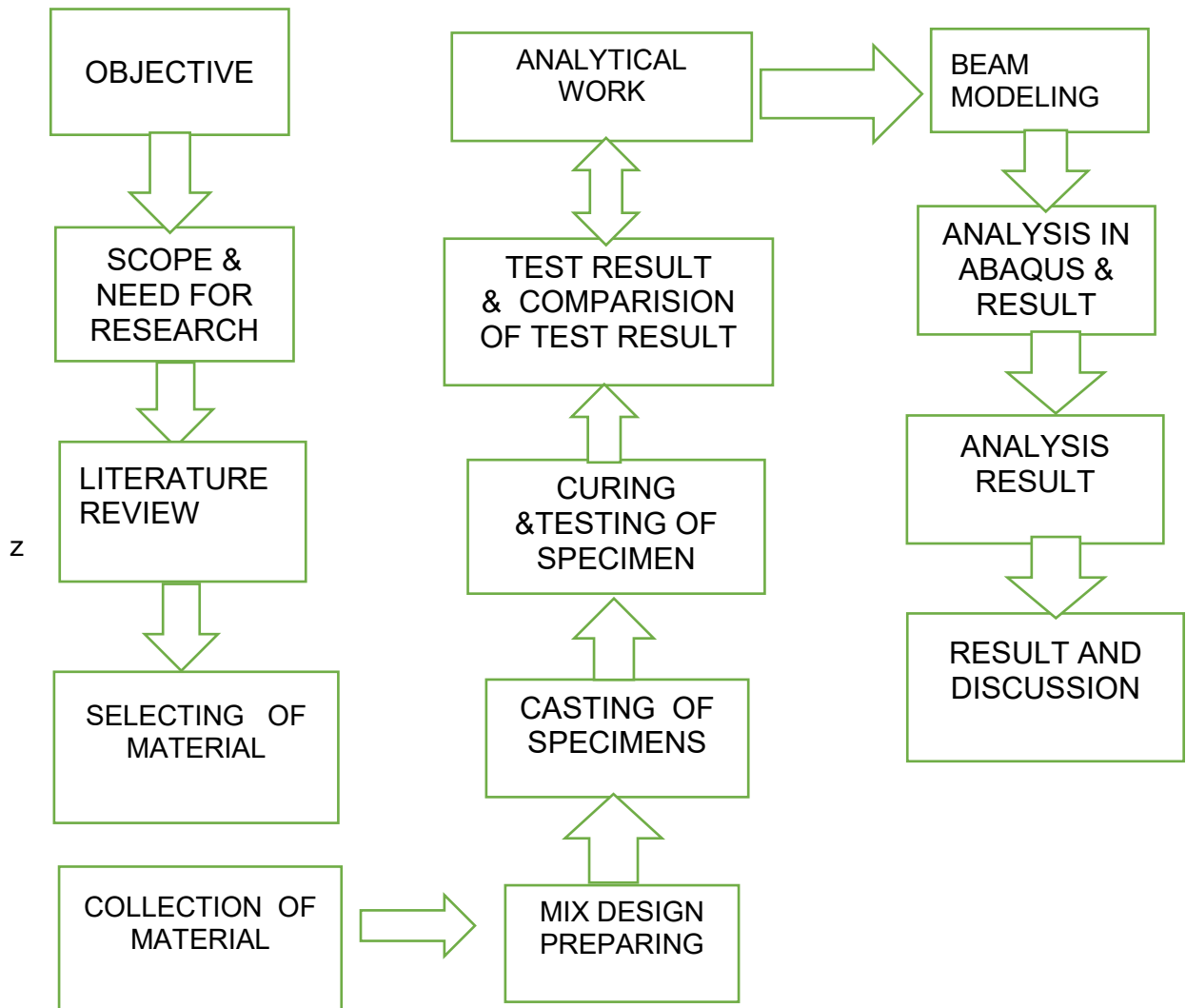
METHODOLOGY

3.1 GENERAL :

To determine the step by step Procedure of the work in this Project are Done. To Explain the Step to be Follow the work are to be Finishing through the Process.

3.2 METHODOLOGY

FLOW CHART



CHAPTER 4

MATERIALS AND METHODOLOGY

4.1 MATERIALS

4.1.1 Cement:

Ordinary Portland cement of 53 grade conforming to IS: 8112 has been used in the present investigation. This the most common cement used in general concrete construction.

4.1.2 Fine Aggregate:

Fine aggregates are essentially any natural sand particles won from the land through the mining process. Fine aggregates consist of natural sand or any crushed stone particles that are $\frac{1}{4}$ " or smaller. This product is often referred to as $\frac{1}{4}$ " minus as it refers to the size, or grading, of this particular aggregate

4.1.3 Coarse Aggregate:

Coarse aggregates are any particles greater than 0.19 inch, but generally range between $\frac{3}{8}$ and 1.5 inches in diameter. Gravels constitute the majority of coarse aggregate used in concrete with crushed stone making up most of the remainder.

4.1.4 Water:

Potable water is used for mixing and curing of concrete as per IS 456-2005.

4.1.5 Steel fibres

Steel fibres – essentially short lengths of specialised steel wire with 'hooked' ends – are added to concrete used in tunnelling applications to provide much-needed strength, resistance to cracking when concrete dries, and importantly the possibility to use less concrete than would otherwise be necessary.

4.1.6 Basalt fibre

Basalt fibers are produced from basalt rocks by melting them and converting the melt into fibers. Basalts are rocks of igneous origin. The main energy consumption for the preparation of basalt raw materials to produce of fibers is made in natural conditions.

4.1.7 GFRP Bars

GFRP (Glass Fibre Reinforced Polymer) rebar, commonly referred to as Fibreglass reinforcement, is a high tensile strength alternative to steel reinforcement. GFRP is made by weaving high quality glass fibres into a fabric before being impregnated with polymers and formed into a round bar.

4.2 TESTS ON CEMENT

4.2.1 Fineness test on cement

Collect a sample of cement and rub with your hands. The Fineness test sample should be free of lumps. Take 100 gm of cement sample and note its weight as W1. Drop 100 gm of cement in 90 μ m sieve and close it with the lid. Now, shake the sieve with your hands by agitating the sieve in planetary and linear movements for 15 minutes in all direction or by Sieve shaking machine. After that take weight the retained residual cement which left on the 90 μ m sieve as W2. The standard cement should have fineness less than 10 % as per IS Recommendations.

4.2.2 Initial Setting Time :

Place the test block confined in the mould and resting on the non-porous plate, under the rod bearing the needle. Lower the needle gently until it comes in contact with the surface of test block and quick release, allowing it to penetrate into the test block. In the beginning the needle completely pierces the test block. Repeat this procedure i.e. quickly releasing the needle after every 2 minutes till the needle fails to pierce the

block for about 5 mm measured from the bottom of the mould. Note this time (T_2). Initial setting time= T_2-T_1



Fig 4.1 Vicant Apparatus

4.2.3 Final Setting Time

For determining the final setting time, replace the needle of the Vicat's apparatus by the needle with an annular attachment. The cement is considered finally set when upon applying the final setting needle gently to the surface of the test block; the needle makes an impression thereon, while the attachment fails to do so. Record this time (T_3). Final setting time= T_3-T_1

4.2.4 Specific gravity of cement

The specific gravity test procedure contains only four steps. The Flask should be free from the liquid that means it should be fully dry. Weigh the empty flask. Which is W_1 . Next, fill the cement on the bottle up to half of the flask around 50gm and weigh with its stopper. And it is W_2 . Add Kerosene to the cement up to the top of the bottle. Mix well to remove the air bubbles in it. Weigh the flask with cement and kerosene. And it is W_3 . Empty the flask. Fill the bottle with kerosene up to the top and weigh the flask for counting W_4 .



Fig 4.2 Specific Gravity

4.3 TEST FOR FOR FINE AGGREGATE

4.3.1 Grain size distribution test

Weight a dry soil sample which should be at least 500gr. Record the weight of the sieves and the pan that will be utilized during the analysis. Each sieve should be thoroughly cleaned up before the test. Assemble the sieves in ascending order, placing those with the larger openings on top.



Fig 4.3 Grain Size Instrument

Therefore, the No. 4 sieve should be on top and the No. 200 sieve on the bottom of the stack. Place the soil sample into the top sieve and place a cap/lid over it. Place the stack in a mechanical shaker and shake for 10 minutes. Remove the sieve stack from the shaker and measure the weight of each sieve and that of the pan placed at the bottom of the stack.

4.3.2 Specific gravity test

In this test is used to determine the specific gravity and moisture content of fine aggregate. The Pycnometer is cleaned with dry find the mass of the Pycnometer, brass cap. Take about 200gm to 400gm of oven dried soil and put it in the Pycnometer find the mass of the Pycnometer plus soil etc.



Fig4.4 Pycnometer Apparatus

Fill the Pycnometer to half of the height with distilled water and mix it thoroughly with glass rod. Add more water and shake it. Replace the screw top and the Pycnometer flush with hole in conical cap. Dry the Pycnometer from outside find the mass. Empty Pycnometer Clean it thoroughly and fill it with distilled water to the hole of the conical cap and find the mass.

4.3.3 Water Absorption test

The water absorption test is used to determine the percentage of water

absorption capacity of fine aggregate. In this test take a weight of 200 gm of fine aggregate. The Sample was tested for 24 hrs in full of water. After 24hrs the sample was taken from water and weighs it. Now find out the percentage of water content of Fine aggregate.

4.4 TEST FOR COARSE AGGREGATE

4.4.1 Impact test

Sieve the material through 12.5mm and 10.0 mm IS sieves. The aggregates passing through 12.5 mm sieve comprises the test material. Then, just 1/3 rd depth of measuring cylinder is filled by aggregate by pouring. Compact the material by giving 25 gentle blows with the rounded end of the tamping rod in the cylinder. Two more layers are added in a similar manner, to make cylinder full. Strike off the surplus aggregates. Determine the net weight of the aggregates to the nearest gram (W1).

Bring the impact machine to rest without wedging or packing upon the level plate, block or floor, so that it is rigid and hammer guide columns are vertical. 25 gentle strokes with tamping rod are used to compact the test sample by fixing the cup firmly in position on the base of the machine with placing the whole of the test sample in it.

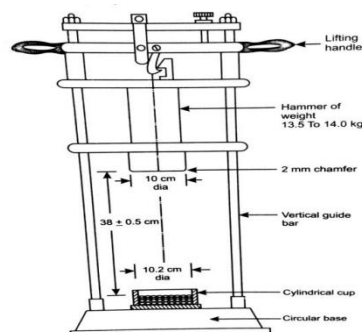


Fig 4.5 Impact Test Apparatus

4.4.2 Specific gravity test

In this test is used to determine the specific gravity and moisture content of coarse aggregate. The Pycnometer is cleaned with dry find the mass of the Pycnometer, brass cap. Take about 200gm to 400gm of oven dried soil and put it in the Pycnometer find the mass of the Pycnometer plus coarse aggregate etc. Fill the Pycnometer to half of the height with distilled water and mix it thoroughly with glass rod. Add more water and shake it. Replace the screw top and the Pycnometer flush with hole in conical cap. Dry the Pycnometer from outside find the mass. Empty Pycnometer Clean it thoroughly and fill it with distilled water to the hole of the conical cap and find the mass.

4.4.3 Sieve Analysis test

Sieves shall be cleaned and arranged in sequence in descending order. Pan shall at the lowermost end and Lid on top. Take around 3 kg of sample and dry it in an oven at a temp of 100-110⁰ C.

The dried sample shall be then weighed (5 kg preferably) and sieved successively on sieves starting with 40mm and then through 4.75mm (For 20 mm down an aggregate size) and through 2.36 mm (For 12.5/10 mm down an aggregate size). Each sieve shall be shaken at least for two minutes on a clean tray until no more trace passes. The motion shall be varied like back and forth, left to right, circular clockwise and anti-clockwise and with frequent jarring. Material shall not be forced through the mesh. But for coarser than 20mm particles, placing is permitted (passing particles through sieve opening manually).

4.4.4 Parameters

After a beam is modeled in CAD software the analysis part is carried over in the ABAQUS software and find out which combination is optimum

among the four combinations. ABAQUS a general-purpose, finite-element modeling package for numerically solving a wide variety of mechanical problems. These problems include static/dynamic, structural analysis, heat transfer, and fluid problems, as well as acoustic and electromagnetic problems.

4.5 MIX DESIGN

4.5.1 Mix Proportion

Fig 4.1 Mix Proportion

S.No	Sample	Cement	Fine Aggregate	Coarse Aggregate	Water
1	0	432Kg/m ³	732Kg/m ³	1246Kg/m ³	197Kg/m ³
2	0.3%	432Kg/m ³	732Kg/m ³	1060Kg/m ³	197Kg/m ³
3	0.7% & 0.5%	432Kg/m ³	732Kg/m ³	1005Kg/m ³	197Kg/m ³
4	0.5% & 0.7%	432Kg/m ³	732Kg/m ³	947Kg/m ³	197Kg/m ³

4.6 CASTING AND CURING

It is understood that casting is the process of creating a solid object from a liquid or semi-liquid material by pouring it into a mold or a form and allowing it to harden. In the context of concrete, casting refers to the process of creating a solid, three-dimensional object or shape from a mixture of cement, water, aggregates, and additives.

4.6.1 Form work preparation:

A form or mold is prepared based on the required size and shape of the concrete element. The form can be made of various materials, such as wood, steel, or plastic.

4.6.2 Reinforcement placement:

In some cases, reinforcement such as steel bars or mesh is placed inside the formwork to provide additional strength to the concrete element.

4.6.3 Concrete mixing :

The concrete mixture is prepared by mixing cement, water, aggregates, and additives in the correct proportions. The mixing can be done manually or by using a concrete mixer.

4.6.4 Curing

The concrete is left to cure and harden for a specified period of time, typically 28 days. During this time, the concrete gains strength and durability.

4.6.5 Demoulding

Once the concrete has hardened, the formwork is removed, and the concrete element is released.

It is understood that proper execution of the casting process is essential for the safety and durability of concrete structures. The casting process is a critical step in the production of concrete elements, as it ensures that the final product is of the desired shape, size, and strength.

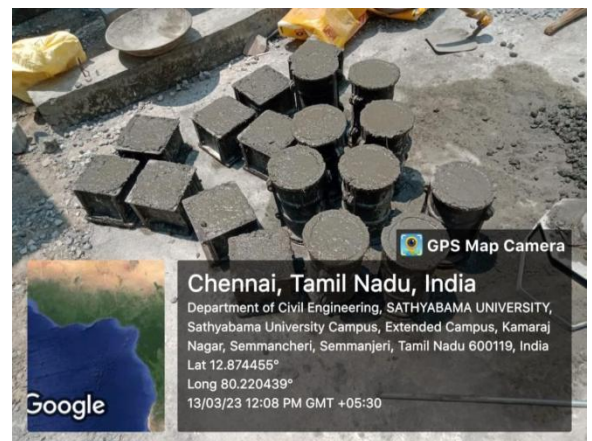
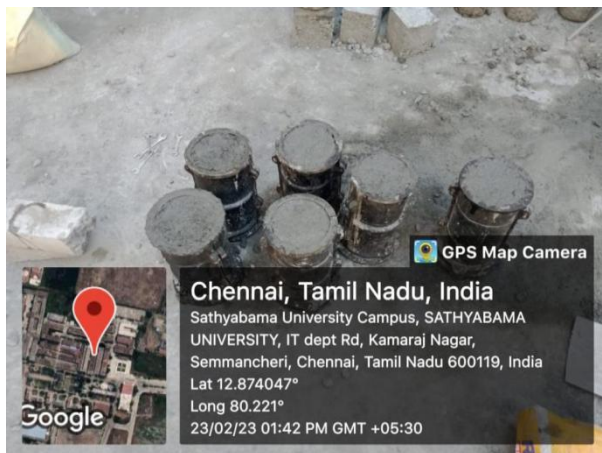


Fig 4.6 Cube & Cylinder Casting Process

4.7 TEST ON FRESH CONCRETE

4.7.1 Slump cone test

The slump cone test on concrete is to find out the work-ability which is a property of fresh concrete. Work-ability is the property of fresh concrete which means it is easy to place and workable concrete is the concrete which shall be placed and compacted with ease and without any segregation. Work ability is capacity working without any extra labor and strength loss. The concrete strength depends upon the water percentage. Water percentage and slump are taken from this slump test. It is the vertical height of the fresh concrete compared to its mould height.

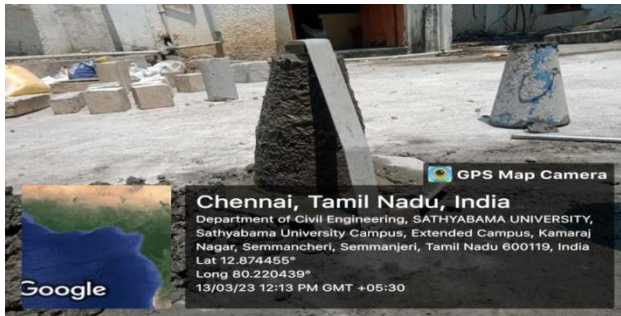


Fig 4.7 Slump cone test

The workability is determined by using the slump cone test in fresh concrete. The code book IS: 1199-1959 is required

- Slump cone
- Tamping rod
- Metallic sheet

Procedure

- The mould is cleaned thoroughly and the inner surface should be free from moisture and the attached old concrete is cleared before the test is started.

- The mould is placed on a smooth and clean surface and compacted for every layer.
- Each layer is tamped 25 times using the tamping rod which distributes the equal strokes. The remaining concrete is cleared using the trowel to level.
- The mould is removed in a vertical direction from the concrete by raising the mould slowly and with care.
- The fresh concrete is allowed to subside. This form of concrete is termed a slump.
- The height between the top of the slump cone and the top of the deformed concrete is measured and noted. The height difference in mm is known as the slump of the fresh concrete.
- The slump of the fresh concrete indicates the concrete characteristics with the slump value. If the fresh concrete slumps evenly then it is called a true slump. If one-half of the fresh concrete slides down then it is called a collapsed slump. In a shear slump, the variation in height between the top of the mould and the average value of the slump is measured as the slump value.
- we can see the slump value of fresh concrete with 0, 0.3%, 0.7% & 0.5% and 0.5 & 0.7% of coarse aggregates

Table 4.2 Slump Cone test

Conventional & Mix Proportional	Slump Value
0	60
0.3%	50
0.7% & 0.5%	45
0.5% & 0.7%	64

4.8 TEST ON HARD CONCRETE

4.8.1 Compressive strength test

The Compression strength is carried out for cubes at 7 days and at 28 days. The compressive strength of the concrete cube and Cylinder test provides an idea about all the characteristics of the concrete. Compressive strength of concrete depends on many factors such as water-cement ratio, cement strength, quality of concrete material, quality control during the production of concrete, etc. For cube test two types of specimens either cubes of 15cm X 15cm X 15cm or 10cm X 10cm x 10cm depending upon the size of aggregate are used.



Fig 4.8 Compressive strength test

For most of the works cubical molds of size 15cm x 15cm x 15cm are commonly used. This concrete is poured in the mold and appropriately tempered so as not to have any voids. After 24 hours, molds are removed, and test specimens are put in water for curing. The top surface of these specimen should be made even and smooth. This is done by placing cement paste and spreading smoothly on the whole area of the specimen.

These specimens are tested by compression testing machine after seven days curing, 14 days & 28 days curing. Load should be applied

gradually at the rate of 140 kg/cm² per minute till the Specimens Cracks. Load at the failure divided by area of specimen gives the compressive strength of concrete.

After being removed from the mould, the cubes were weighed before being stored for curing. The cubes were weighed once more after 28 days of drying. Table 4.6 displays the Average Cube Specimen Weight Before and After Curing for both conventional and lightweight concrete and table 4.7 displays the dry density of conventional and lightweight concrete.

Table 4.3 the Average Weight of Cube Specimen before and after Curing For both Conventional and Mix Proportional

Conventional & Mix Proportional %	Weight of Before Curing	Weight of After Curing	Average
0	8.16kg	8.17kg	8.15kg
0.3%	8.12kg	8.06kg	8.10kg
0.7% & 0.5%	8.36kg	8.15kg	8.20kg
0.5% & 0.7%	8.45kg	8.35kg	8.15kg

4.8.2 Split Tensile strength test

The tensile strength of concrete is the important properties which affect the extent and size of cracking in structures. Moreover, the concrete is very weak in tension due to its brittle nature. Hence, it is not expected to resist the direct tension. So, concrete develops cracks when tensile forces exceed its tensile strength. Therefore, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack. Furthermore, splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. Initially, take the wet specimen from water after 7, 28 of curing. Then, wipe out water from the surface of specimen.



Fig 4.9 Split Tensile Machine

Set the compression testing machine for the required range. Place plywood strip on the lower plate and place the specimen. Align the specimen so that the lines marked on the ends are vertical and centered over the bottom plate. Place the other plywood strip above the specimen.

Bring down the upper plate so that it just touch the plywood strip. Apply the load continuously without shock at a rate within the range 0.7 to 1.4 MPa/min (1.2 to 2.4 MPa/min based on IS 5816 1999). Finally, note down the breaking load(P).

4.8.3 Flexural Behaviour of RC Beam

All four beams were tested under a Four-point bending configuration so that the length of both the pure bending span and the shear span is 1400 mm. The vertical load was applied under displacement control at a rate of 1 mm/min until obvious concrete crushing and spalling were observed at the top surface of the beams. Three linear variable differential transformers (LVDTs) were installed in the pure bending span to measure the deflections at the mid-span of the beam and the loading points. For the strengthened beams. the LVDT arrangement for each beam was designed based on the configuration of the strengthened scheme. The test should be conducted on the specimen immediately after taken out of the curing condition so as to prevent surface drying which decline

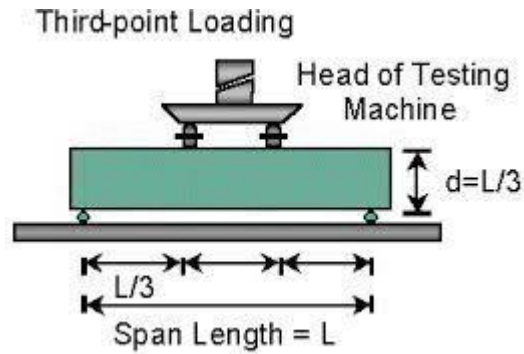


Fig 4.10 Flexural strength test

flexural strength. Place the specimen on the loading points. The beam lifting through the beam before to set the dial gauge below the left, right & Center the loading system in relation to the applied force. Bring the block applying force in contact with the beam surface at the loading points. Applying the load on the beam surface through the each rotation to calculate the each reading ultimate load.

Employing 0.10 mm and 0.38 mm leaf-type feeler gauges, specify whether any space between the specimen and the load-applying or support blocks is greater or less than each of the gauges over a length of 25 mm or more.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 EXPERIMENTAL TEST RESULTS

In the Following section we are going to discuss about the two fibers of different ratio are 0.3%, 0.5%, 0.7% by adding of these fibers to find the strength of the cube, cylinder and beam of the load acting section.

5.1.1 Compressive strength test results

DAYS	Mix 1	Mix 2	Mix 3	Mix 4
7days	17.9	19.78	20.22	19.48
14days	28.51	25.56	27.85	30.59
28days	40.56	39.68	38.89	42.5

5.1.2 Split Tensile strength test results

DAYS	Mix 1	Mix 2	Mix 3	Mix 4
7days	2.97	2.68	2.99	3.15
14days	3.27	3.80	4.14	30.59
28days	5.20	5.82	5.18	6.43

5.1.3 Modulus of Elasticity test

The Young's modulus is a parameter that measures the degree of stiffness of concrete material when it is subjected to compressive or tensile stress. It is defined as the ratio of stress, which is the amount of force per unit area, to strain, which is the degree of deformation per unit length in the elastic region of the

stress- strain curve. Various factors, such as the type and strength of the concrete, its age and curing conditions, and the method of testing used to determine the value, can cause variations in the Young's modulus

Table 5.4 the stress and strain values of M40 grade conventional concrete

Loads (KN)	Stress (N/mm²)	Change in Length (mm)	Strain	Young's Modulus (MPa)
25	1.414	0.041	3.68×10^{-5}	28712
50	2.829	0.028	3.28×10^{-5}	28675
75	4.244	0.016	9.38×10^{-4}	26854
100	5.658	0.024	2.48×10^{-4}	27458
125	7.073	0.025	1.68×10^{-4}	28463
150	8.488	0.023	1.78×10^{-4}	25674

Table 5.5 the stress and strain values of M40 grade

the stress and strain values of M40 grade with 0.3% of Fibers

Loads (KN)	Stress (N/mm²)	Change in Length (mm)	Strain	Young's Modulus (MPa)
25	1.414	0.038	2.68×10^{-5}	29742
50	2.829	0.026	9.28×10^{-5}	24645
75	4.244	0.018	1.38×10^{-4}	28864
100	5.658	0.022	2.28×10^{-4}	23498

125	7.073	0.023	1.08×10^{-4}	25413
150	8.488	0.020	1.58×10^{-4}	22604

Table 5.4 the stress and strain values of M40 grade
the stress and strain values of M40 grade with 0.7 & 0.5% of Fibers

Loads (KN)	Stress (N/mm²)	Change in Length (mm)	Strain	Young's Modulus (MPa)
25	1.414	0.038	2.38×10^{-5}	28752
50	2.829	0.028	9.88×10^{-5}	22625
75	4.244	0.020	1.18×10^{-4}	21874
100	5.658	0.025	2.08×10^{-4}	26458
125	7.073	0.030	1.98×10^{-4}	21493
150	8.488	0.077	1.28×10^{-4}	26614

Table 5.7 the stress and strain values of M40 grade with 0.5 & 0.7% of Fibers

Loads (KN)	Stress (N/mm²)	Change in Length (mm)	Strain	Young's Modulus (MPa)
25	1.414	0.040	1.68×10^{-5}	25772
50	2.829	0.029	9.88×10^{-5}	27635
75	4.244	0.019	1.08×10^{-4}	21814
100	5.658	0.034	2.08×10^{-4}	27458
125	7.073	0.015	2.38×10^{-4}	23423
150	8.488	0.084	1.28×10^{-4}	26654

Results

Young's Modulus of Conventional concrete

specimen = 26854Mpa

Young's Modulus of - 0.3% specimen= 23498Mpa

Young's Modulus of - 0.7% & 0.5% specimen= 21493Mpa

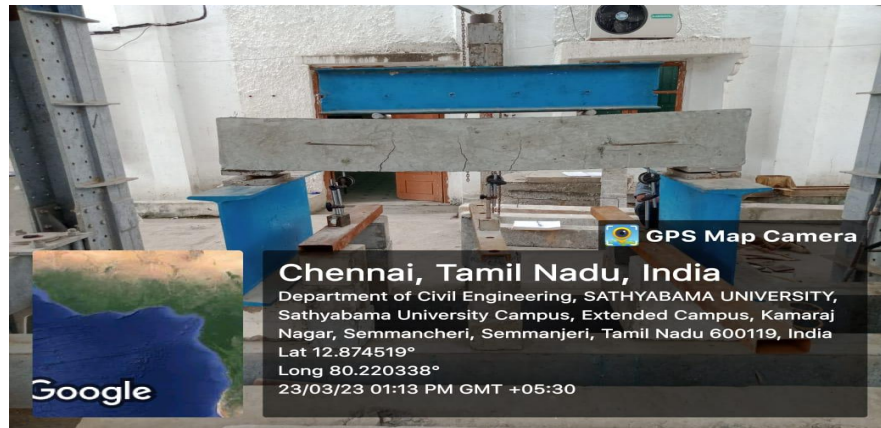
Young's Modulus of - 0.5% & 0.7% specimen = 21814 Mpa

5.1.4 Beam Load Vs deflection test

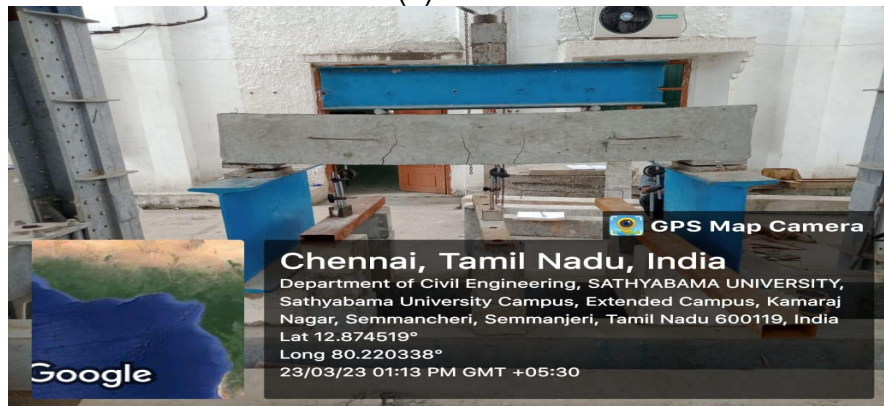
All four beams were tested under a Four-point bending configuration so that the length of both the pure bending span and the shear span is 1400 mm. The vertical load was applied under displacement control at a rate of 1 mm/min until obvious concrete crushing and spalling were observed at the top surface of the beams. Three linear variable differential transformers (LVDTs) were installed in the pure bending span to measure the deflections at the midspan of the beam and the loading points. For the strengthened beams, the LVDT arrangement for each beam was designed based on the configuration of the strengthened scheme.



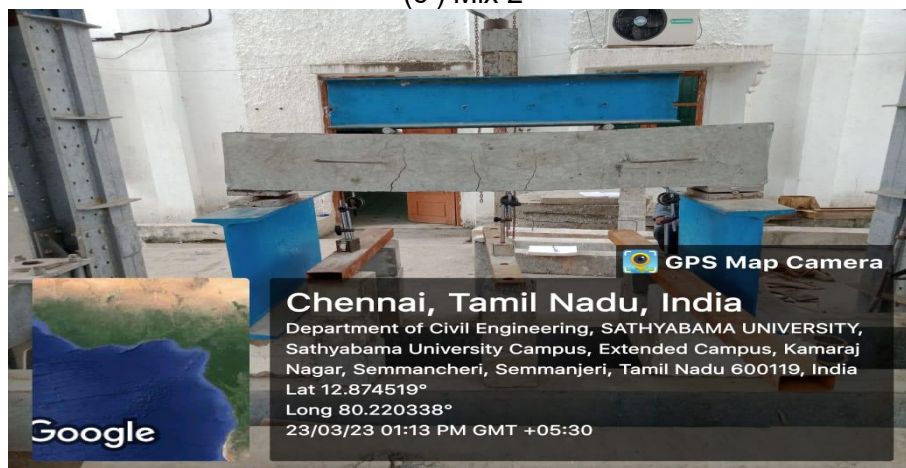
(a) Conventional Beam



(b) Mix 1



(c) Mix 2



(d) Mix 3

Fig 5.1 Beam crack pattern

Table 5.9 Conventional mix

S.No	Loads (KN)	Displacement (mm)
1	10	0.64
2	20	0.97
3	30	1.36
4	40	1.67
5	50	1.95
6	60	2.23
7	70	2.75
8	80	2.84
9	90	2.95
10	100	3.00

Table 6.0 MIX 1(0.3% of Basalt & Steel Fiber)

S.No	Loads (KN)	Displacement (mm)
1	10	0.46
2	20	0.58
3	30	0.74
4	40	0.84
5	50	0.97
6	60	1.56
7	70	1.63
8	80	0.46
9	90	0.58

10	100	0.74
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Table 6.1 Mix 2 (0.7% of Basalt & 0.5%Steel Fiber)

S.No	Loads (KN)	Displacement (mm)
1	10	0.53
2	20	0.62
3	30	0.75
4	40	0.92
5	50	1.34
6	60	1.46
7	70	1.68
8	80	1.79
9	90	2.65
10	100	2.73

Table 6.2 Mix 3 (0.5% of Basalt & 0.7%Steel Fiber)

S.No	Loads (KN)	Displacement (mm)
1	10	0.70
2	20	1.08
3	30	1.40
4	40	1.70
5	50	2.28
6	60	2.80
7	70	2.85
8	80	0.70

9	90	1.08
10	100	1.40

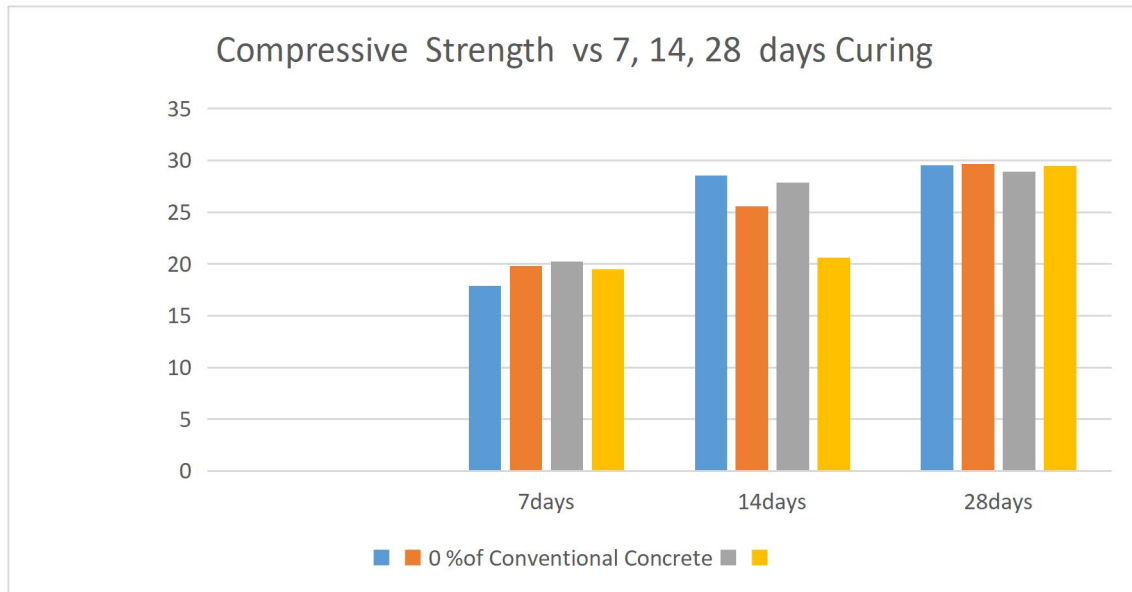


Fig 5.1 graphical representation of compressive strength test

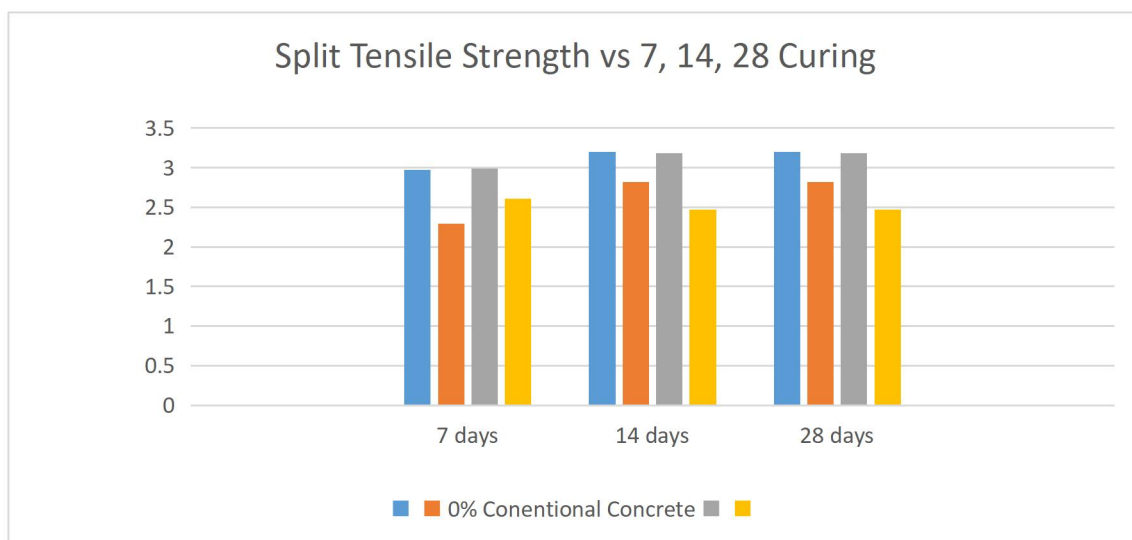


Fig 5.2 graphical representation of split tensile strength test

5.2 ANALYTICAL RESULTS

5.2.1 Finite Element Analysis

Finite Element Analysis (FEA) is a numerical method used to solve complex Engineering problems that involve Structural Mechanics, Heat Transfer, Fluid Dynamics & other Physical Phenomena. It is Extensively Utilized in the Design And Analysis of Structural in Various Industries, Including aerospace, Civil Engineering.

5.2.2 Abaqus

Abaqus is a popular Commercial Finite Element Analysis Software Developed by Dassault System. It is Extensively Utilized in the Simulation and analysis of various Physical Phenomena, including Structural Mechanics, Heat Transfer, Fluid Dynamics and Electromagnetics.

Abaqus Provide a Powerful Platform For the building and Simulating Complex Modulus using various elements, material, loading condition. It Has a user friendly interface that allows user to create, edit, and mesh models, Define Boundary Condition and Material Properties, run Simulation.

Some of the Features and Capabilities of Abaqus Include

- Nonlinear analysis : Abaqus can simulate complex nonlinear behaviour such as large deformation, material plasticity, contact and Damage.
- Multi physics analysis : Abaqus can simulate the interaction between different physical Phenomena such as thermal - structural, fluid-structural, and electromagnetic- thermal.
- High- performance Computing: Abaqus can take advantage of parallel Computing to speed up simulations and handle large-scale models.
- Customization: Abaqus provide a scripting Language (Python) that allows users to automate tasks Customize the user interface and extend

The Software Functionality.

- Intergration : Abaqus can be integrated with other software tools such as CAD Software, Optimization Software, Data Analysis Software

5.2.3 Properties

The Definition of the Characteristics of the material and section being utilized as a vital stage in the finite element modeling procedure. For instance, Established the parameter of the section entitles providing the section thickness And other patient material properties required for the analysis in the case of a Composite beam Built of Concrete

Table 5.14 Properties of Material

Property	Percentage %			
	0%	0.3%	0.5%	0.7%
Compressive Strength at 28 days	35.47Mpa	27.6Mpa	31.6Mpa	30.43Mpa
Young's Modulus	30.04Gpa	25.40Gpa	28.67Gpa	26.53Gpa
Poison Ratio	0.177	0.12	0.15	0.14

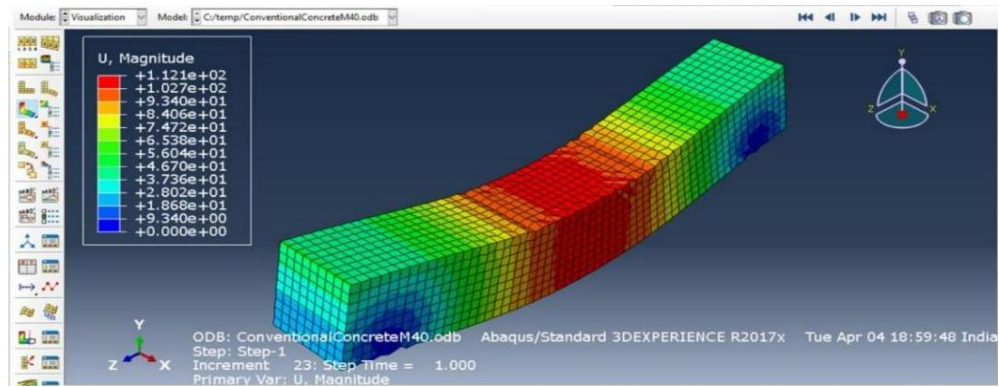
5.2.4 Analytical Results

Abaqus/CAE, or "Complete Abaqus Environment" (a backronym with a root in Computer-Aided Engineering). It is a software application used for both the modeling and analysis of mechanical components and assemblies (pre-processing) and visualizing the finite element analysis result.

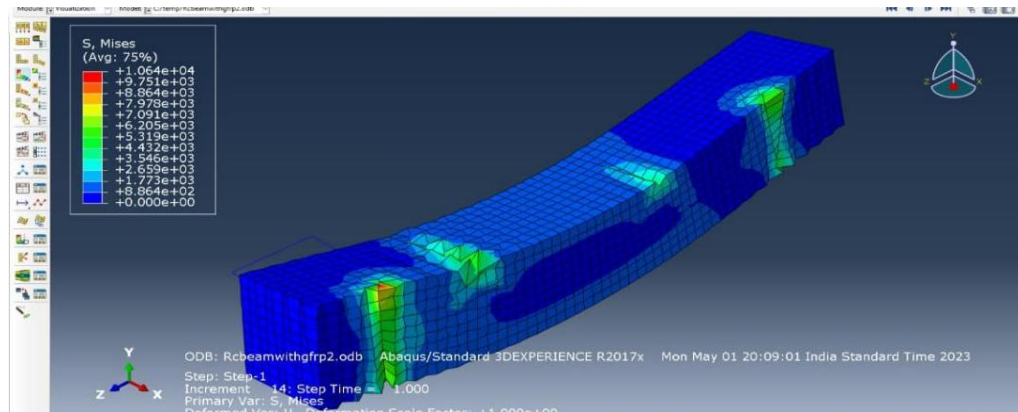
Table5.15 Tabulation for Analytical work

S.No	Loads (Kg)	Displacement (mm)			
		CC	MX 1	MX 2	MX 3
1	10	0.24	0.24	0.18	0.21
2	20	0.38	0.34	0.38	0.13

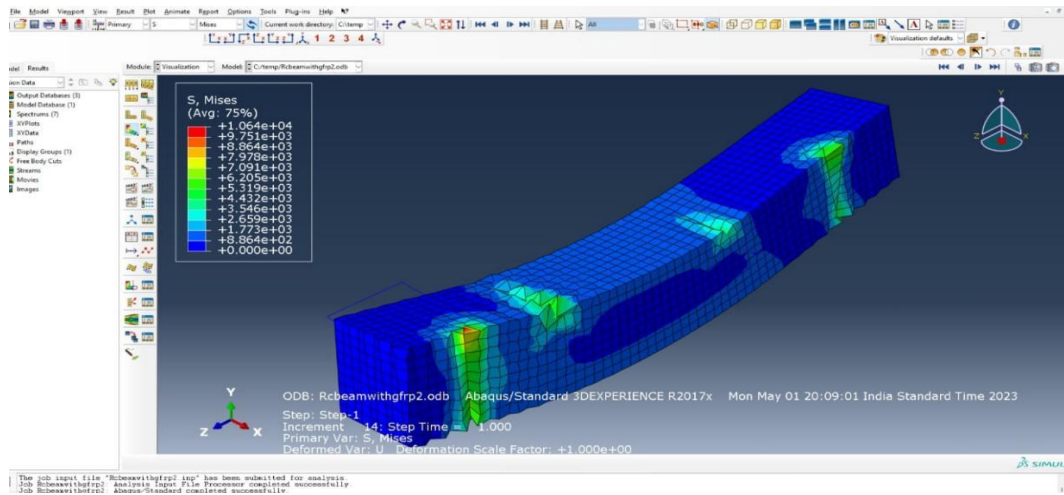
3	30	0.56	0.62	0.55	0.58
4	40	0.82	0.80	0.17	0.83
5	50	1.07	1.08	1.02	1.07
6	60	1.38	1.35	1.31	1.38
7	70	1.81	1.73	1.70	1.68
8	80	2.16	2.22	2.18	2.14
9	90	2.57	2.37	2.28	2.37
10	100	2.80	2.72	2.50	2.69



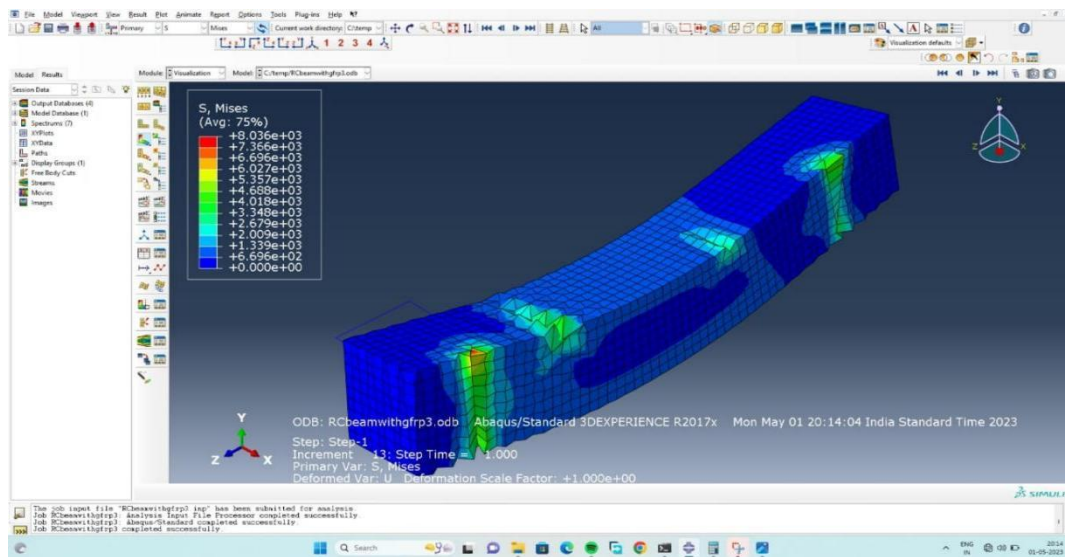
Conventional beam



MIX 1 (0.3% of Basalt & Steel Fiber)



Mix 2 (0.7%of Basalt & 0.5% Steel Fiber)



Mix 3 (0.5%of Basalt & 0.7% Steel Fiber)

Fig 5.3 Analytical model of beam

5.3 Comparison of Experimental and Analytical Results

- The flexural test is conducted in compliance with the standards outlined in IS 516-1999. Beams with a length of 1500mm, breadth of 230mm, and depth of 230mm are placed at two points of a hydraulic jack.
- Four-point loading is carried out, and the top two points are subjected to weight distribution. As a result, cracks start to appear on the beam's surface.
- Both experimental and analytical tests have their advantages and disadvantages, and the choice between them depends on factors such as the available resources, the level of accuracy required, and the specific requirements of the project. It is often useful to combine both types of tests to obtain a more comprehensive understanding of the behavior of the reinforced beam

LOAD VS DEFLECTION

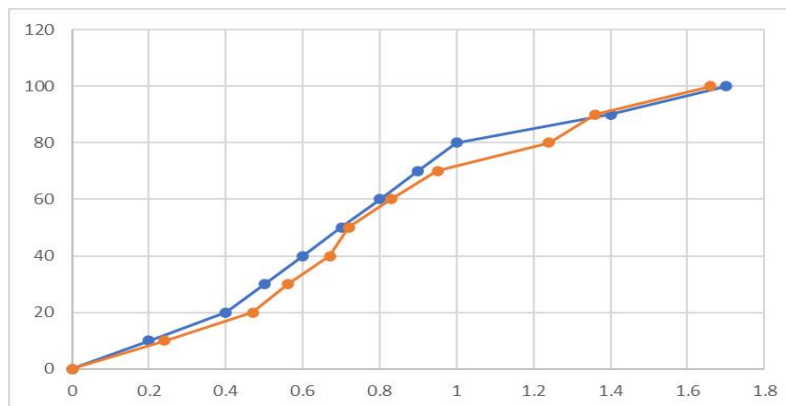


Fig 5.4 Experimental & analytical graph of conventional beam

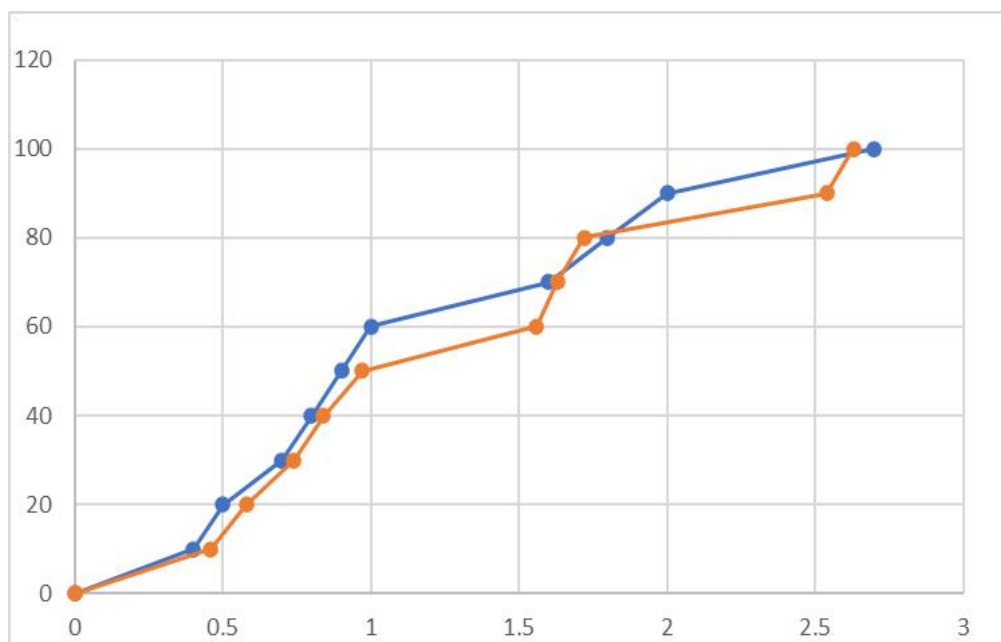


Fig 5.5 Experimental and analytical graph of Mix 1

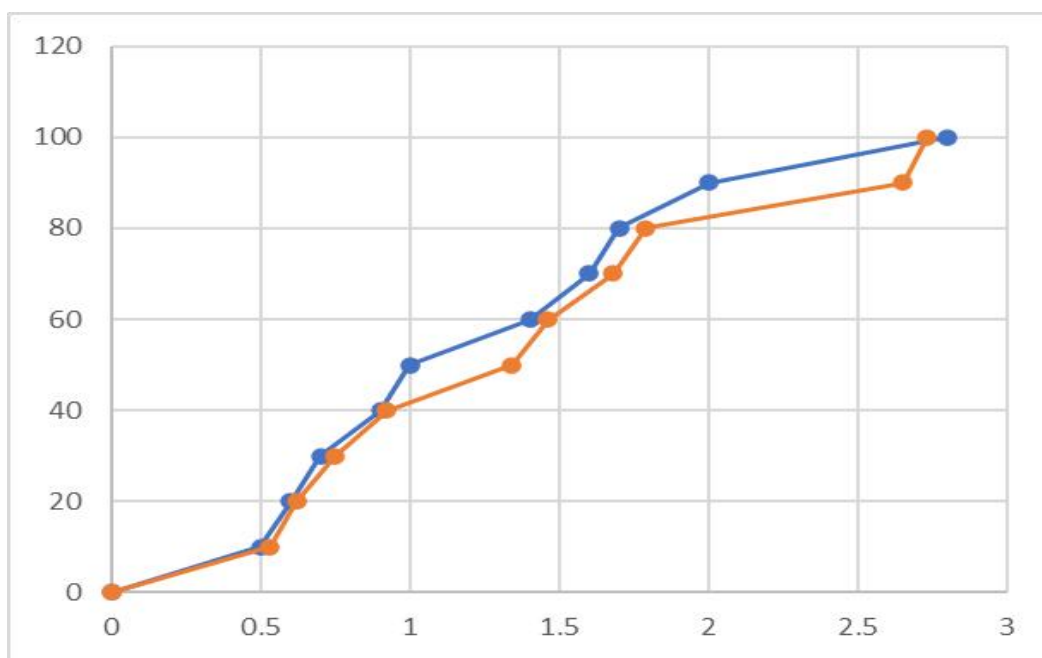


Fig 5.6 Experimental and analytical graph of Mix 2

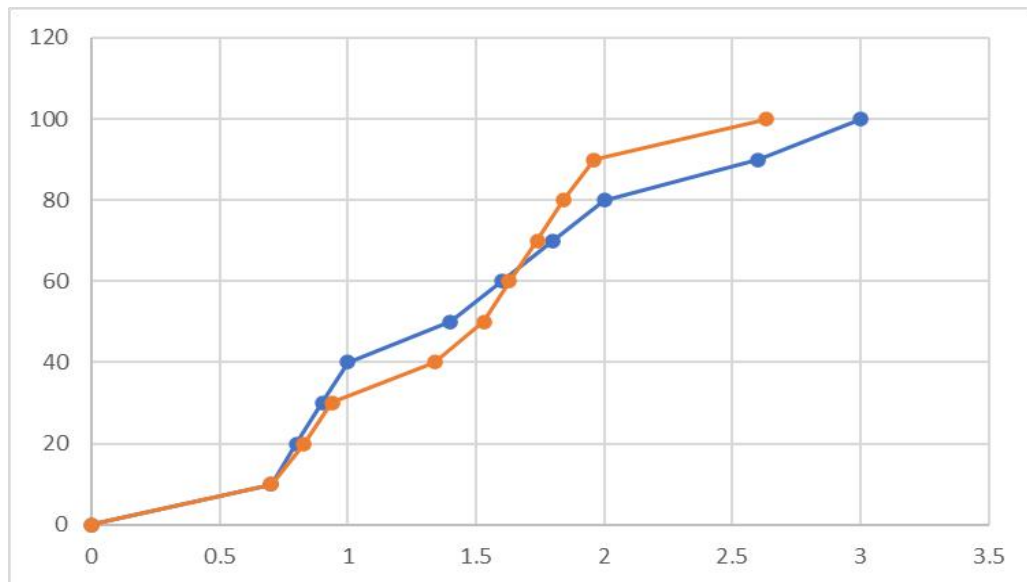


Fig 5.7 Experimental and analytical graph of Mix3

CHAPTER 6

CONCLUSION

6.1 SUMMARY

- Bars fabricated from Glass fiber-reinforced polymers (GFRP) are a new material used as an alternative to steel bars in reinforced concrete to overcome corrosion problems especially in harsh and aggressive environments.
- Glass fibers also have high tensile strength and enhanced durability, in addition to moderate cost. This research investigates experimentally the flexural behavior of GFRP reinforced beams compared to steel RC beams. In the experimental program, six concrete beams reinforced by BFRP bars, BFRP bars and dispersed steel fibers and steel bars are tested in four-point bending until failure. fiber reinforced polymer (FRP) bar reinforced structures employed glass FRP (GFRP) bars. The results of tests, which were conducted on the Basalt FRP (BFRP) bar reinforced concrete beams, are reported in this article. The beams reinforced with conventional steel rods were tested as control specimens. Nearly equal crack spacing and number of cracks were noted in both types of beams, at all stages of loading.

6.2 CONCLUSION

Project have been done with the refer of the journals of the book published through the Author and this Journal is used to refer for our Project and we have to find the strength which caring the load acting on the members are Cube, Cylinder and Beam.

I am using Basalt and Steel fibers and to find their properties of these fibers and to find ratio of working through our project and we have to refer the journal which is used suitable for our project.

To find the scope & objectives of this project and we can find the Strength with the help of curing of time period is 7days, 14days, 28days of curing time interval.

To Search the Literature to scope, objective, Properties. To find the young's Modulus & Poison Ratio by these test. Tests to be Followed are Compression , Split Tensile of cube & cylinder for beam have to the Flexural Strength Test.

This test to find the beam how much of load is caring through and to find the the Deflection.To find the Analytical and Experiments Analyzing software of ABQUAS Software was used for beam design of Software.

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