

“AN EXPERIMENTAL INVESTIGATION ON EFFECT OF VARIOUS CHEMICAL ADMIXTURES ON STRENGTH CHARACTERISTICS ON HSC USING M -SAND”

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

by

Praveen Kumar K (40380006)



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

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

Accredited with Grade “A” by NAAC

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May - 2022



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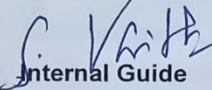


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DEPARTMENT OF CIVIL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of PRAVEEN KUMAR K (40380006) who carried out the project entitled "**AN EXPERIMENTAL INVESTIGATION ON EFFECT OF VARIOUS CHEMICAL ADMIXTURES ON STRENGTH CHARACTERISTICS ON HSC USING M-SAND**" under my supervision from November 2021 to May 2022


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DECLARATION

I Praveen Kumar K hereby declare that the Project Report entitled "**AN EXPERIMENTAL INVESTIGATION ON EFFECT OF VARIOUS CHEMICAL ADMIXTURES ON STRENGTH CHARACTERISTICS ON HSC USING M -SAND**)" done by me under the guidance of Mrs. S. Vanitha at **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY** is submitted in partial fulfilment of the requirements for the award of Master of Engineering degree in Structural Engineering.

Place: Chennai



SIGNATURE OF THE CANDIDATE

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ABSTRACT

Today's world is in need of some special concrete, which is able to solve all the functions of different concrete such as high strength, high permeability and high corrosion resistance. Also, we decided to improve these properties by adding different components such as manufactured sand, silica fume and chemical admixture. Super plasticizer is a type of water reducers; however, the difference between super plasticizer and water reducer is that super plasticizer will significantly reduce the water required for concrete mixing. In this experimental investigation, a brief review is presented on high strength concrete by using mineral and chemical admixtures.

We have collected all the details of these mineral admixtures from those reputed industries, and a brief introduction of all mineral admixtures is presented in this project work. We have designed high strength concrete. We have used this super plasticizer in order to achieve good workability under lower water-cement ratio for high strength concrete such as M60. We have also found out the percentage replacements of these mineral and chemical admixtures in order to achieve maximum strength. In High Performance Concrete, silica fume (SF) with extreme fineness and high amorphous silica content plays a very important role with physical (filler, lubrication) and pozzolanic effects. However, the limited available resource and the high cost constrain its application in modern construction industry, especially in developing countries. For these reasons, it gives a motivation for searching for other materials to substitute SF with similar functions. Experimental has been done. These results will show whether the HPC is suitable for structures subject to extreme load conditions.

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LIST OF SYMBOLS AND ABBREVIATIONS

L - Length of the specimen

b - Width of the specimen

d - Depth of the specimen

D- Diameter of specimen

R- Modulus of Rupture

P - Load at failure (N)

f_c - Compressive Strength

f_{sp} - Split tensile Strength

PPC- Portland Pozzolano cement

M Sand- Manufacture sand

SF- Silica Fume

SP- Superplasticizer

HPC- High Performance Concrete

CHAPTER 1

INTRODUCTION

1.1 GENERAL

Concrete has been one of the most commonly used building materials in the world. The development of concrete material may be marked and divided into several stages. The first is the traditional normal strength concrete (NSC). Usually, there are only four kinds of ingredients composed of the concrete, which are cement, water, fine aggregates and coarse aggregates. With the increasing development of civil engineering, such as high-rise buildings and long-span bridges, higher compressive strength concrete is needed. When the compressive strength of concrete is higher than 60 MPa, it is usually defined as high strength concrete (HSC). At the very beginning, the easiest way to reach high compressive strength was to reduce the water–cement ratio. Therefore, in HSC, the fifth ingredient, a water reducing agent or super plasticizer, is indispensable.

With the world-wide decline in the availability of construction sands along with the environmental pressures to reduce extraction of sand from rivers, the use of manufactured sand as a replacement is increasing. With the ban on sand mining implemented by different states, and with the increasing demand for river sand for construction works, many civil engineers have expressed the need to promote use of manufactured sand in the construction industry. As per reports, manufactured sand is widely used all around the world and technicians of major projects around the world insist on the compulsory use of manufactured sand because of its consistent gradation and zero impurity.

There is a double environmental benefit from using industrial by-products. Silica fume used in this study is a product obtained in the industries and also the production of Manufactured sand (M sand), which is very fine in nature. Laboratory investigations were carried out with designed mixes of M60 concrete. Detailed strength and durability related tests such as split tensile strength test and compressive strength test of cylinders, flexural strength test of prisms, etc.

In this experimental investigation, a brief review is presented on high strength concrete by using mineral and chemical admixtures. One of the main advantages of mineral admixtures in high strength concrete is reducing the cement content, which is not only economic and environmental benefits but also means reducing the rise in temperature

at the same time increasing the compressive strength and durability properties. Some of the mineral admixtures, namely silica fume. We have also used super plasticizer (chemical admixture) in this project work.

1.2 HIGH STRENGTH CONCRETE

HSC offers many advantages over conventional concrete. The high compressive strength can be advantageously used in compression members like columns and piles. Higher compressive strength of concrete results reduction in column size and increases available floor space. HSC can also be effectively used in structures such as domes, folded plates, shells and arches where large in-plane compressive stresses exist. The relatively higher compressive strength per unit volume, per unit weight will also reduce the overall dead load on foundation of a structure with HSC. Also, the inherent techniques of producing HSC generate a dense microstructure making ingress of deleterious chemicals from the environment into the concrete core difficult, thus enhancing the long-term durability and performance of the structure.

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

The main purpose of literature review is to give an idea about the research work conducted in the world. This forms the basis on which one can carry out the work and techniques that can be used for conducting experiments. The following literature review elaborates the research studies made on addition of fibre in concrete.

2.2 LITERATURE REVIEW

The Influence of Silica Fume Concentration on Capillary Porosity and Concrete Heat Conductivity (2020).

Authors : O. N. Kravtsova, A. M. Timofeev, N. I. Tappyrova and N. A. Protodyakonova
Journal: International Multi-Conference on Industrial Engineering and Modern Technologies.

The effect of the concentration of silica fume additive on the capillary porosity and thermal conductivity of concrete, depending on the age of concrete and the concentration of silica fume. It can be seen that with increasing age of concrete, the values of capillary porosity monotonously decrease, and by 28 days of hardening, the values of capillary porosity decrease by about 20%

Influence of cement stone structure with silica fume and superplasticizer admixtures on concrete strength and permeability (2019)

Authors : S.S. Kaprielov and A.V. Sheinfeld

Journal: Blended cements in construction - Structural Integrity Research Institute University of Sheffield. To learn the investigations of cement stone structure and strength, and strength, permeability and frost resistance of concrete with admixtures of silica fume that feature silicon dioxide and dispersivity. The impact of the samples on cement stone structure develops in an increase of gel porosity volume, a decrease of capillary porosity and an increase of strength. Thus, concrete strength increases and its permeability decreases. An increased dosage of superplasticizer is a beneficent factor to increase hydration degree and gel porosity, to decrease capillary porosity volume and consequently to increase strength.

Fine-grained fibre concretes modified by complexed nanoadditives (2018)

Authors : T.A. Nizina, A.N. Ponomarev, A.S. Balykov, N.A. Pankin

Journal: International Journal of Nanotechnology. The prospects of using the

fullerene-like nanoparticles and the combination of them with the analogous modifiers and different kinds of reinforcing fibres for the modification of the composite cement concrete are set out. The use of the complex modifiers based on the dispersed fibres and fullerene-like nanoparticles is proposed. The condensed silica foam, high active metakaolin and waterproof additive 'Penetron Admix' were tested as additives in these mixes also. According to the results of this experimental work, the optimal complexes, additives and dispersed fibres for the purpose of improving the characteristics of fine-grained fibre-reinforced concretes were selected.

Development of Construction Bricks Using Coconut Shell Powder as an aggregate Material (2019)

Authors : Pranav P. Data ,Vikas V. Shinde

Journal: Construction and Building Materials

Construction bricks are one of the most widely used construction material. In a developing country like India increasing industrialization and urbanization, requires huge amounts of natural resources. This means that large amount of soil is being used for brick production. Construction bricks having coconut shell powder (CSP) as aggregate material are developed. In this paper the process of making construction bricks with the use of coconut shell powder (CSP) as aggregate material. Further the mechanical properties of these bricks are to be tested and comparison with those of the conventional bricks will be done.

Discovery of innovative materials in structural system design: glass structures (2020)

Authors :Zeynep Yeşim İlerisoy, Burcu Buram Çolak

Journal: International Multi-Conference on Industrial Engineering and Modern Technologies

The use of glass as a structural element is a new subject that needs to be studied. 'Glass' has been a key word in the building industry with its unique feature of transparency throughout history. The most striking examples that have been applied up to now from the first use of glass as a structural material is presented in the tables. Despite the fact that the examples related to the subject are new, it still continues to develop in the field of construction and its examples are increasing day by day. This study was helpful to develop the design methods and to disseminate the practice of glass as a structural element.

Designing and Developing Innovative Structural Engineering Failure Experiment

Using Additive Manufacturing Technology 2019

Authors :Asma AlDarmaki, Alyazia AlShamsi, Waleed K Ahmed, Hamad Al Jassm

Journal: Advances in Science and Engineering Technology International Conferences (ASET)

Scientific advances and innovative technologies in Architecture, Engineering, Construction are key factors in this process, the tenets of which can help the countries move towards developing smarter, and more sustainable communities. Internet of Things (IoT), Blockchain, Machine Learning, Deep Learning, and Linked Data all provide immense opportunities for dealing with these challenges; more importantly perhaps, provide real tangible (evidenced-based) innovative solutions that until now, have never been possible before.

Study on preparation and properties of fly ash concrete with high sulfur and high-calcium fly 2020

Authors: Xiang-Ming Xie, Lei Guo

Journal: IEEE International Conference on Information Management and Engineering
Fly ash with high sulfur and calcium is abandon to mix into concrete and cement. In this paper, with the application of composite treatment-Fly ash and slag digestion and milling, Physical dilution method was adopt to solve the problem, too many free sulfur and calcium in fly ash, a new composite material was fabricated. This composite material has all the advantage of two raw materials, and discards the disadvantage of each one. This research has positive influence for the application of fly ash with high sulfur and calcium.

Sensitivity Analysis and Strength Prediction of Fly Ash — Based Geopolymer Concrete with Polyethylene Terephthalate using Artificial Neural Network 2018

Authors: Dante L. Silva; Kevin Lawrence M. de Jesus; Bernard S. Villaverde; Journal: IEEE 12th International Conference on Humanoid, Nanotechnology, Information Technology, Communication & Control, Environment, and Management Sustainability is considered as one of the most essential developmental models which is integrated in almost all industries and fields of specialization worldwide. In civil engineering, the use of resources that were used as substitution to the traditional materials could address the concerns of scarcity of construction material resources. Prediction model results presents a very satisfactory performance based on its difference to the actual values.

Study on Strength and Durability of Cellular Cement-Fly Ash Blocks 2019

Authors: K. Baskaran; J. R. U. C. Jayakody; M.A.R. Sandaruwan

Journal: 2019 Moratuwa Engineering Research Conference (MERCon)

Fly ash, which is a waste product collected during coal combustion, has become an issue to the environment and human, due to lack of proper disposal methods. The major barrier of fly ash not being used as a land filling material is its heavy metal composition. The usage of fly ash in concrete may also vary with the composition of unburned carbon in fly ash. Fly ash can be used in many applications as an additive in building materials such as bricks, blocks, concrete, road and embankment covers. Since fly ash is a by-product, it possesses a very low embodied energy, which in turn reduces the embodied energy of the product made out of fly ash to a considerably low value.

Investigating the Mechanical and Durability Performance of Cement Mortar Incorporated Modified Fly Ash and Ground Granulated Blast Furnace Slag as Cement Replacement Materials 2019

Authors: Ali Abdulhussein Shubbar; Dhiya Al-Jumeily; Ahmed J. Aljaaf;

Journal: 2019 Moratuwa Engineering Research Conference (MERCon)

The process of cement manufacturing produces a huge amount of carbon dioxide (CO₂). The utilization of alternative waste materials from various industrial processes as a partial substitution to cement is encouraged due to environmental and specific technical requirements. This strategy will have the potential to reduce cost of cement, conserve energy, and reduce waste volumes. The use of GGBS and MFA in the production of cement mortar and concrete can significantly help in reducing the CO₂ emissions of the cement industry and reduce the overall cost of cement.

CHAPTER 3

3.1 SCOPE AND OBJECTIVE

3.1.1 AIM:

1. To check the possibility of implementing super plasticizer for increasing the compressive strength and durability of concrete
2. To enhance the use of materials like Silplas super in concrete and study its strength characteristics
3. To analyze the characteristics of high strength concrete by using mineral and chemical admixture
4. To investigate the performance of high strength concrete by laboratory test compressive strength, split tensile strength and flexural strength test.

3.1.2 OBJECTIVE:

1. To develop high strength concrete by replacing natural sand into manufactured sand and adding mineral admixtures like silica fume
2. To examine the workability of manufactured sand and using two different admixtures in concrete such as Conplast SP 430 and Silplas super.

3.1.3 SCOPE OF THE STUDY:

To examine the high strength concrete mixture comprising the water, cement, fine and coarse aggregate with the dosages of super plasticizer. The compressive strength and workability characteristics were given more importance and a comparative study was carried out

3.2 MATERIALS AND METHODOLOGY

3.2.1 MATERIALS USED AND THEIR PHYSICAL PROPERTIES

3.2.1.1 Cement

Ordinary Portland cement Shankar 43 grade and Portland pozzolona cement super grade cement. Conforming to IS: 1489-1991 were used in concrete.

3.2.1.2 Manufacture sand

Manufactured sand made of crushed fine aggregate and also called as artificial sand. Silt in sand should not be more than 2%, for crushed sand. Manufactured sand can improve both compressive strength and flexural strength through better bond compared to river sand.



Fig 3.1 M Sand and River Sand

3.2.1.3 Water

Potable water was used for mixing and curing of concrete cubes.

3.2.1.4 Silica fume

The silica fume used in the experimentation was obtained from lakshmigraha enterprises puliakulam road, Coimbatore. Silica fume is a byproduct of ferrosilicon alloys. It has extreme fineness and high silica content (SiO_2 - 95 to 97%). Addition of silica fume reduces permeability of concrete.



Fig 3.2 Silica Fume

3.2.1.5 Conplast SP 430

The super plasticizer (conplast SP 430) used in the experimentation was obtained from Hi-tech concrete solutions.

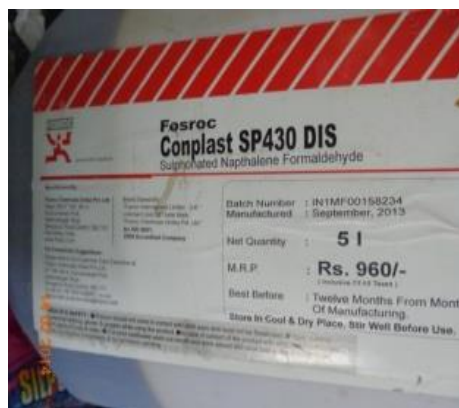


Fig 3.3 Conplast SP 430

3.2.1.6 Silplas super

The super plasticizer used in the experimentation was obtained from National repair and restoration co Ltd.

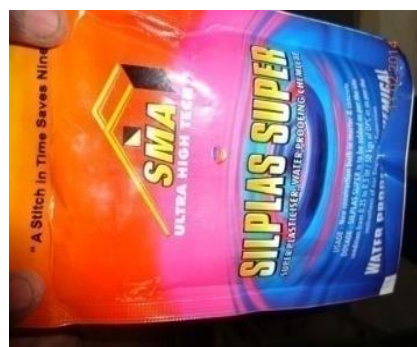
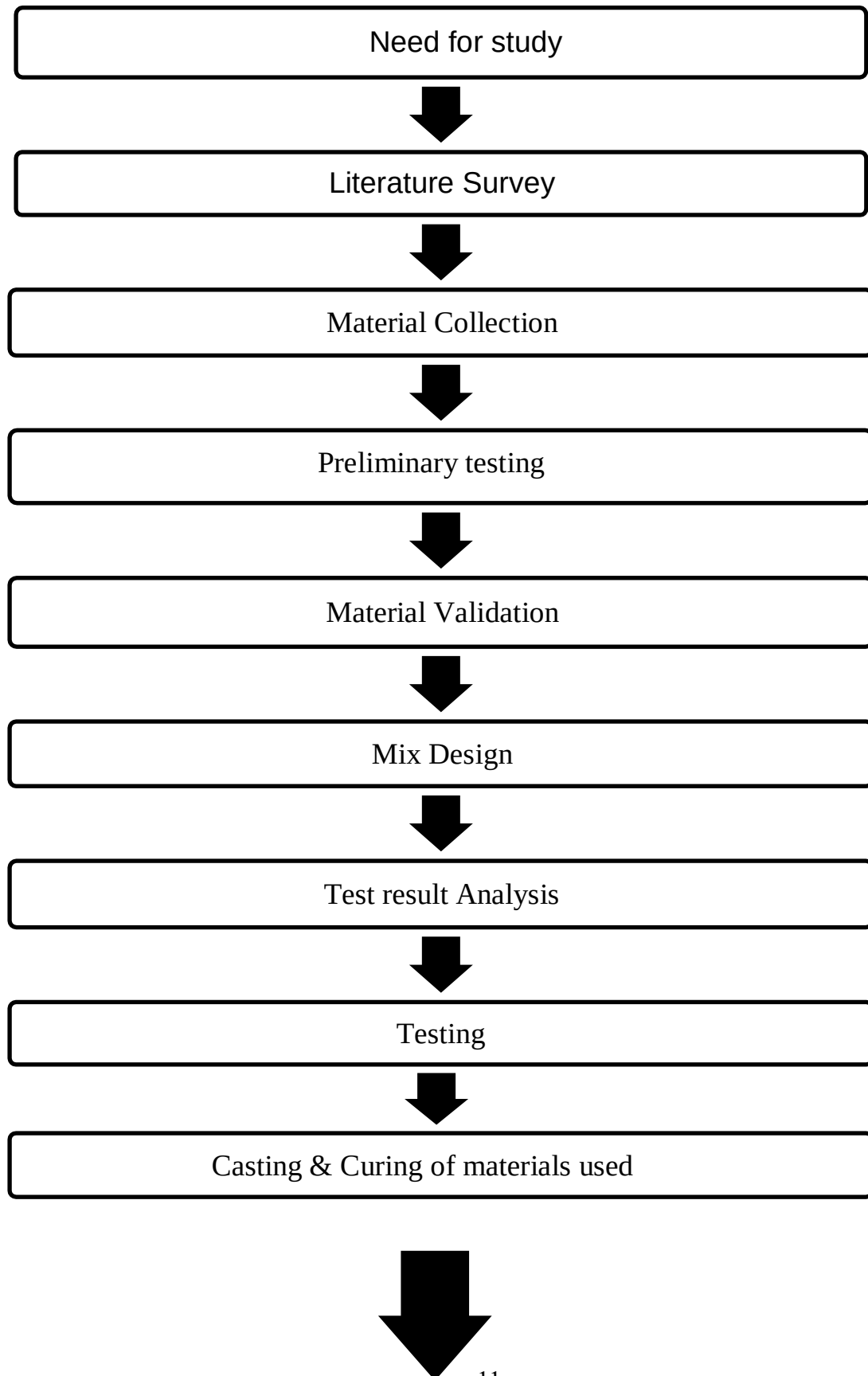


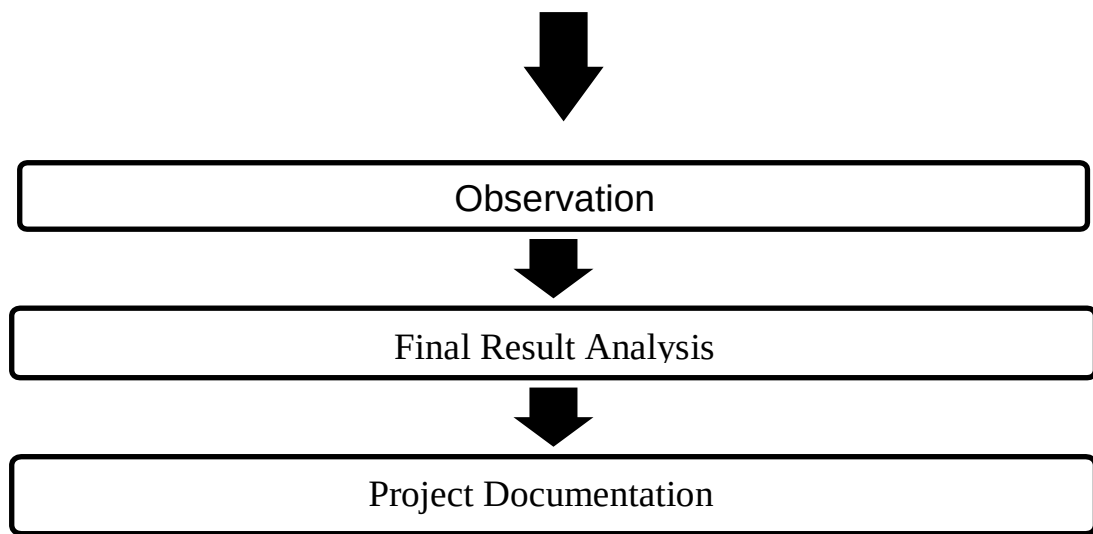
Fig 3.4 Silplas super

3.2.1.7 Coarse aggregate

Coarse aggregate of nominal size of 20mm & 12 mm is chosen and tests to determine the different physical properties as per IS 383-1970. Test results conform to the IS 383 (PART III) recommendations. The bulk density of coarse aggregate is 1691 kg/m³. Coarse aggregate 12 mm and 10 mm was used, which was manufactured from locally available rock.

3.3 METHODOLOGY





3.4 Preliminary test

- Specific Gravity of Cement = 3.15
- Specific Gravity of M- Sand = 2.51
- Specific Gravity of River sand = 2.61
- Specific Gravity of Coarse Aggregate = 2.85
- Specific Gravity of silica fume = 2.22
- Fineness Modulus of M- Sand = 4.16
- Fineness Modulus of River sand = 4.05

3.5 MIX DESIGN.

The initial mix proportions were calculated using mix design method of conventional concrete given by Indian Standard method. The common method of expressing the proportions of ingredients of a concrete mix is in the terms of parts or ratios of cement, fine and coarse aggregates. In the mixture proportioning of high strength concrete the quantities to be determined are air, water, cement, fine and coarse aggregate and the dosages of super plasticizer. The proportions are either by volume or by mass. The casted cubes are test for 7, 28, 56 days for control mixes.

3.5.1 Control mix proportions M60

Table 3.1

Trial number	Unit	Cement	Fine aggregate	Coarse aggregate (20 mm)	Coarse aggregate (12.5 mm)	Water	W/c ratio
1	volume kg/m ³	600	375	927	397	190	0.3

Table 3.2 For 3 samples and conplast sp 430 (MIX 1)

S.NO	% of SF	Quantity of cement in kg/m ³	Quantity of Fine aggregate in kg/m ³	Quantity of Coarse aggregate in kg/m ³	Water in litre	SUPER PLASTICIZER litre (2%)
1	5	606.7	600	999.6	191.6	12.77
2	7.5	590.7	598	994	191.6	12.77
3	10	574.7	596	989	191.6	12.77

Table 3.3 For 3 samples and conplast sp 430(MIX 2)

S.NO	% of SF	Quantity of cement in kg/m^3	Quantity of Fine aggregate in kg/m^3	Quantity of Coarse aggregate in kg/m^3	Water in litre	SUPER PLASTICIZER litre (1.5%)
1	5	606.7	603	1002	191.6	9.58
2	7.5	590.7	601	994.4	191.6	9.58
3	10	574.7	599	989.4	191.6	9.58

Table 3.4 For 3 samples and silplas super(MIX 3)

S.NO	% of SF	Quantity of cement in kg/m^3	Quantity of Fine aggregate in kg/m^3	Quantity of Coarse aggregate in kg/m^3	Water in litre	SUPER PLASTICIZER litre (2%)
1	5	606.7	600	996.6	191.6	12.77
2	7.5	590.7	598	994	191.6	12.77
3	10	574.7	596	989.4	191.6	12.77

Table 3.5 For 3 samples and silplas super(MIX 4)

S.NO	% of SF	Quantity of cement in kg/m ³	Quantity of Fine aggregate in kg/m ³	Quantity of Coarse aggregate in kg/m ³	Water in litre	SUPER PLASTICIZER litre (1.5%)
1	5	606.7	603	1002	191.6	9.58
2	7.5	590.7	601	994.4	191.6	9.58
3	10	574.7	599	989.4	191.6	9.58

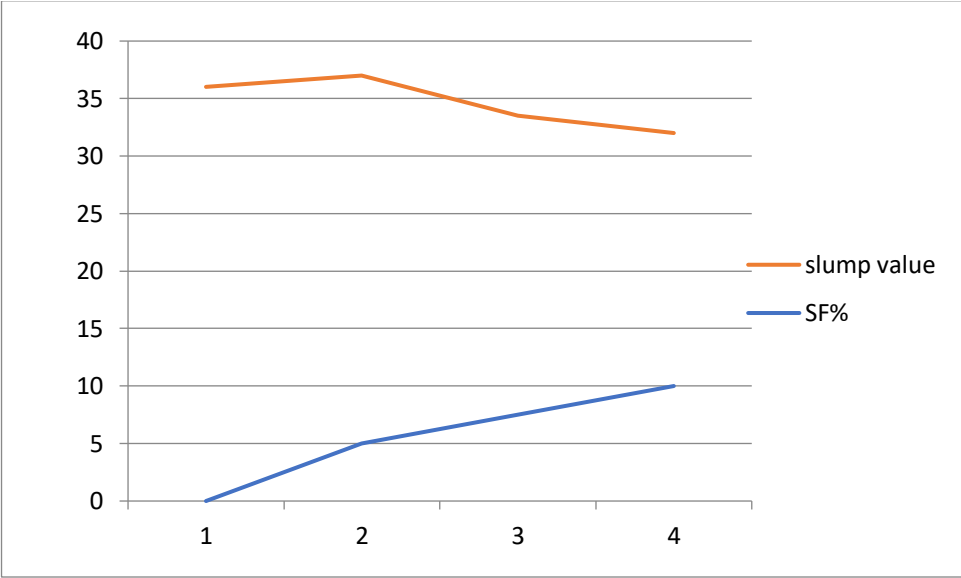
3.5.2 Workability Test Results

Table 3.6

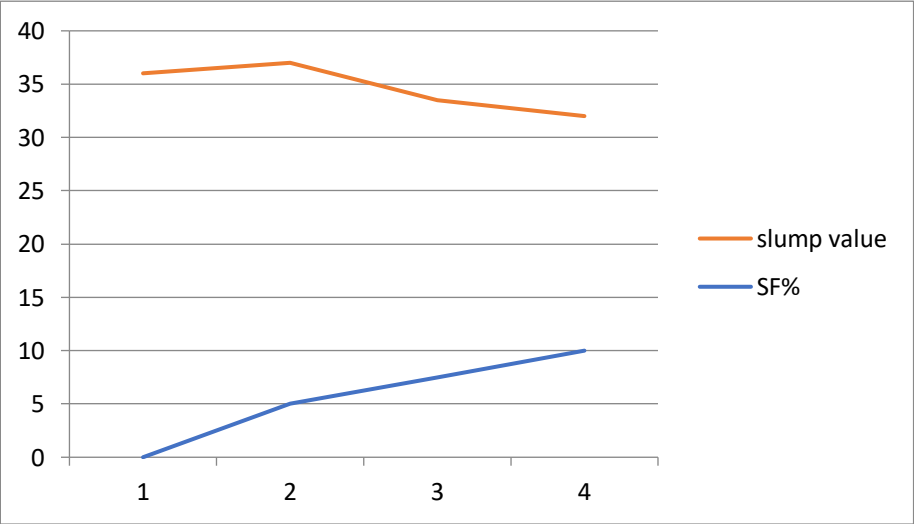
Super plasticiser	% of Mineral Admixture Replacement	Slump (mm)
Conplast SP 430	0 %	36
Conplast SP 430	5 % of silica fume	32
Conplast SP 430	7.5 % of silica fume	26
Conplast SP 430	10 % of silica fume	24
Silplas super	0 %	36
Silplas super	5 % of silica fume	32
Silplas super	7.5 % of silica fume	26

Silplas super	10 % of silica fume	22
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Graph 1: Conplast SP 430 (2%)



Graph 2: Silplas Super (2%)



3.6 TESTS CARRIED OUT

The Test comprised for strength behaviour

1. Cube compression test
2. Cylinder splitting tensile test
3. Flexural strength test

3.7 TEST PROCEDURE

3.7.1 Procedure for test on high strength concrete

3.7.1.1 Compression Test:

The compressive strength of concrete is one of the most important properties of concrete. Concrete specimens of 150 x 150 x 150 mm cubes were cast with different materials. After 48 hrs the specimens were demoulded and subjected to curing for 7, 28 and 56 days in curing. For each system triplicate specimens were cast. The cubes are tested in the compression-testing machine (1000 KN capacity). The ultimate load at which the cube fails was taken. The test set up is shown in Fig.

Compressive strength was calculated using the following formula.

$$f_{ck} \text{ (N/ mm}^2\text{)} = \frac{\text{Ultimate load (KN)}}{\text{Area of the specimen (mm}^2\text{)}}$$



Fig 3.5



Fig 3.6 Cubes and Cylinders for test

3.7.1.2 Split tensile test:

Concrete cylinders of size 150 mm diameters and 300 mm height were casted. During casting, the cylinders were mechanically vibrated using a table vibrator. After 48hrs, the specimens were removed from the mould and subjected to curing for 7, 28 and 56 days. After the specified curing period was over, the concrete cylinders were subjected to split tensile test by using universal testing machine. Tests were carried out on triplicate specimens and average split tensile strength values were recorded

$$f_{sp} = \frac{2P}{\pi dl} (\text{N/mm}^2)$$

Where,

P=load at failure (N)

d=diameter of specimen (mm)

l=length of specimen (mm)



Fig 3.7 Split tensile test set up

3.7.1.3 Flexural strength:

Toughness is defined as the amount of energy required to break a material (area under the load deformation curve). The test specimen of size 100x100x1200 mm beam is subjected to two point loading. The load is applied to the specimen gradually until the specimen fails. The deflection is noted at the centre point of the specimen. The crack will appear when the specimen fails. Crack width is measured at the top, middle and bottom of the specimen using the crack width detector. The monotonic load was applied by using screw jack and to record the load precisely, proving ring was used. The beam was gradually loaded by increasing the load level in each cycle such as 2, 4, 6, 8, 10 KN, etc. up to the maximum load of that cycle. At the end of each cycle the load was gradually increased and deflections during were noted. The beam was loaded up to failure and the values of load at first crack and ultimate failure stage and crack pattern were noted. The crack were marked by different colors show clearly the failure patterns of beam. As the load was increased in each cycle, the observed deflection was greater than in earlier cycle.



Fig 3.8 & Fig 3.9

Beams prepared for flexural strength



Fig 3.10 Flexure test setup

**Model Calculations for
Flexural Strength:**

Ultimate Moment $= WL/6$

Flexural Strength $= M/Z$

Ductility Index $= \Delta u \Delta y$

Energy Index $= \text{Area up to } \Delta u / \text{Area up to } \Delta y$

Total Energy Absorption Capacity $= \text{Area up to } \Delta u$



Fig 3.11 Crack formation

CHAPTER 4

4.1 RESULTS AND DISCUSSION

4.1.1 Control specimen for cube and cylinder:

Table shows the compressive and tensile strength results for 7, 28 and 56 days of curing. From the table it is observed.

Table 4.1 Control specimen: Conplast SP 430 (2%)

Cube ID	Compressive strength N/mm ²		
	7 days	28 days	56 days
River sand	33.33	55.11	60.22
Manufacture sand	36.88	58.66	61.45

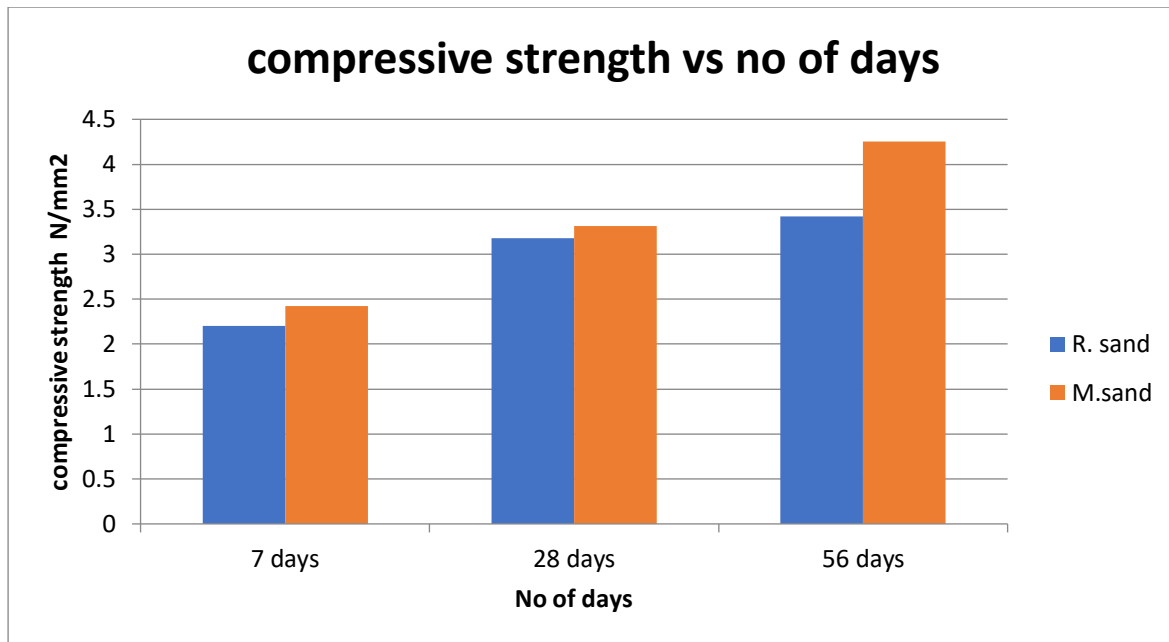


Fig 4.1

When compared to river sand and manufacture sand chart shows higher compressive strength in M.sand sand when compared to river sand at 56 days. From the results it is concluded that, river sand has shown lesser compressive strength in manufacture sand which may be due to fine particle and gives better workability in conplast SP 430.

Table 4.2

Cube ID	Split tensile N/mm ²		
	7 days	28 days	56 days
River sand	2.2	3.18	3.42
Manufacture sand	2.42	3.31	4.25

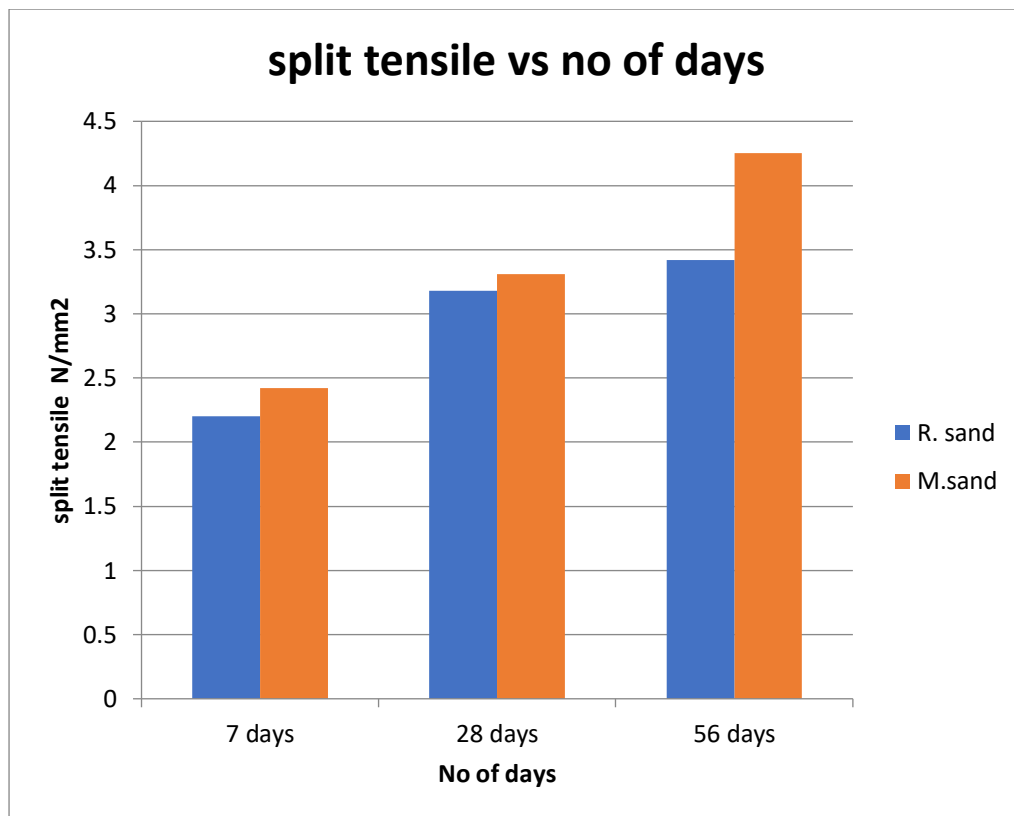


Fig 4.2

When compared to river sand and manufacture sand chart shows higher tensile strength in M.sand sand when compared to river sand at 56 days. From the results it is concluded that, river sand have shown lesser compressive strength in manufacture sand which may be due to fine particle and gives better workability in conplast SP 430.

Table 4.3 Control specimen : silplas super(2%)

Cube ID	Compressive strength N/mm ²		
	7 days	28 days	56 days
River sand	31.02	54.51	62.31

Manufacture sand	32.68	56.69	63.42
------------------	-------	-------	-------

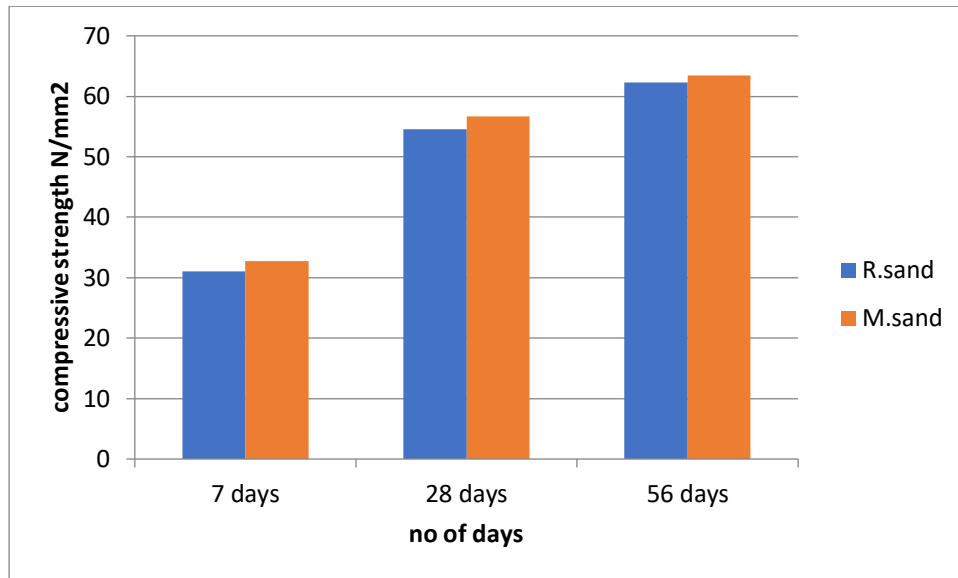


Fig 4.3

When compared to river sand and manufacture sand chart shows higher compressive strength in river sand when compared to manufacture sand. From the results it is concluded that, same compressive and tensile strength compared to conplast sp 430 but mix is more workable than silplas super.

Table 4.4

Cube ID	Split tensile N/mm ²		
	7 days	28 days	56 days
River sand	2.17	2.98	3.12
Manufacture sand	2.02	2.68	2.99

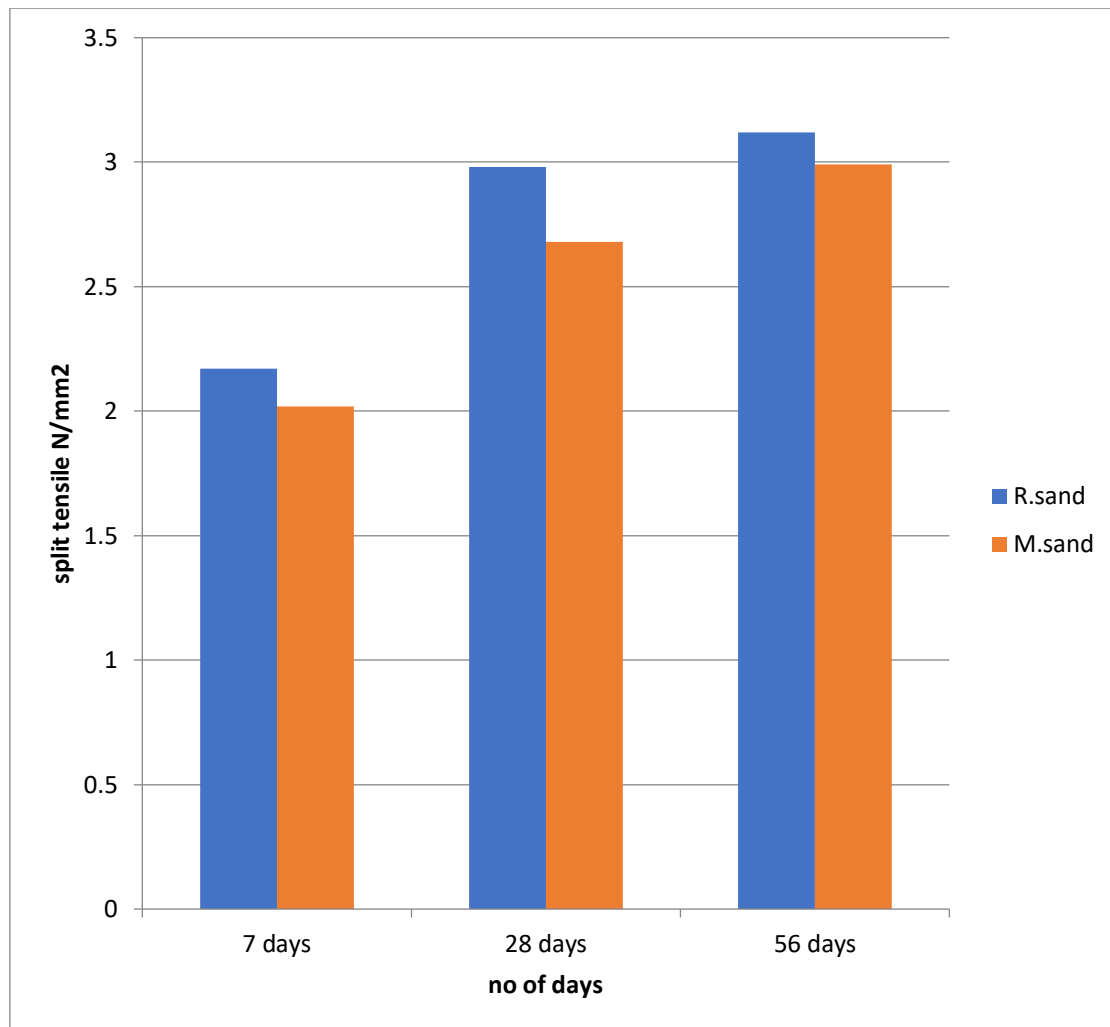


Fig 4.4

When compared to river sand and manufacture sand chart shows higher tensile strength in river sand when compared to manufacture sand. From the results it is concluded that, same compressive and tensile strength compared to conplast sp 430 but mix is more workable than silplas super.

Cube ID	% of Silica fume	Compressive strength N/mm ²		Split tensile N/mm ²	
		7 days	28 days	7 days	28 days
1	5	37.22	60.52	3.03	4.85
2	7.5	36.35	56.56	2.33	4.17
3	10	30.57	55.59	2.30	4.31

Table 4.5

4.2 Test result for compressive strength and split tensile test (Conplast SP 430 2%)

Compressive strength result for (Conplast SP 430 2%)

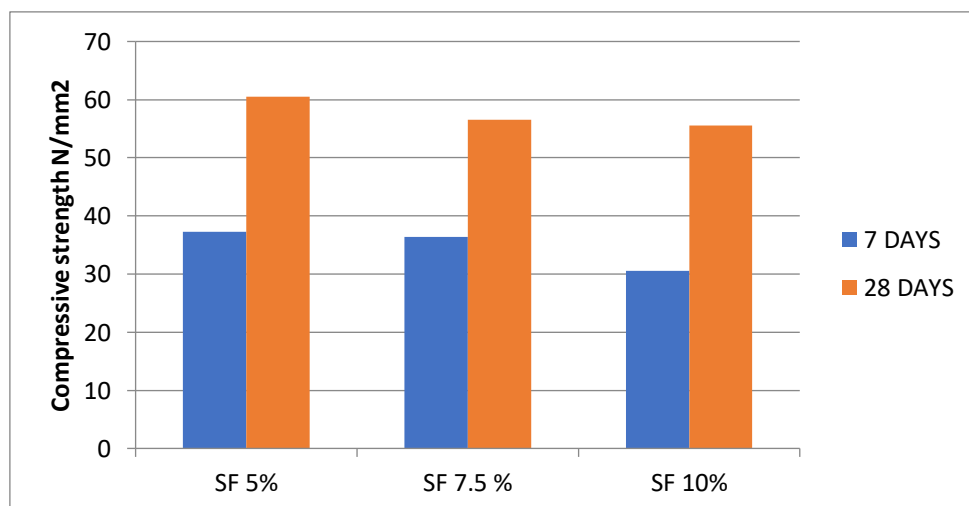


Fig 4.5

When compared two different super plasticizer chart shows good performance and better workability in conplast sp 430 admixtures compressive strength in 5% replacement of silica fume which is better compared to the other proportion. In silplas super the mix of the concrete is dry compared to conplast sp 430 with 2%.

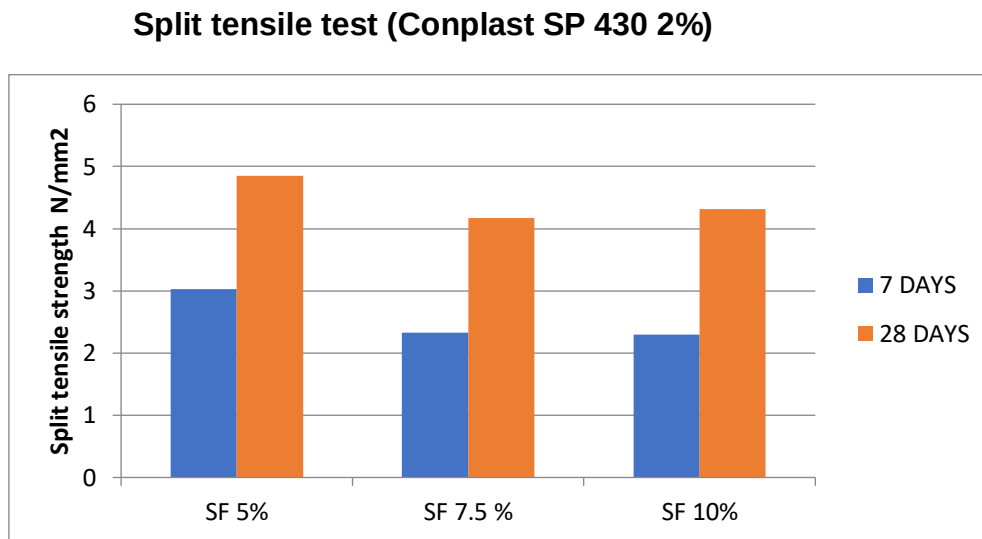


Fig 4.6

When compared two different super plasticizer chart shows good performance and better workability in conplast sp 430 admixtures tensile strength in 5% replacement of silica fume which is better compared to the other proportion. In silplas super the mix of the concrete is dry compared to conplast sp 430 with 2%.

Table 4.6

Cube ID	% of Silica fume	Compressive strength N/mm ²		Split tensile N/mm ²	
		7 days	28 days	7 days	28 days
1	5	35.50	59.55	3.24	5.40
2	7.5	34.22	56.80	2.90	4.84
3	10	32.00	53.77	2.58	4.30

4.3 Test result for compressive strength and split tensile test (Conplast SP 430 1.5 %)

Compressive strength result for (Conplast SP 430 1.5%)

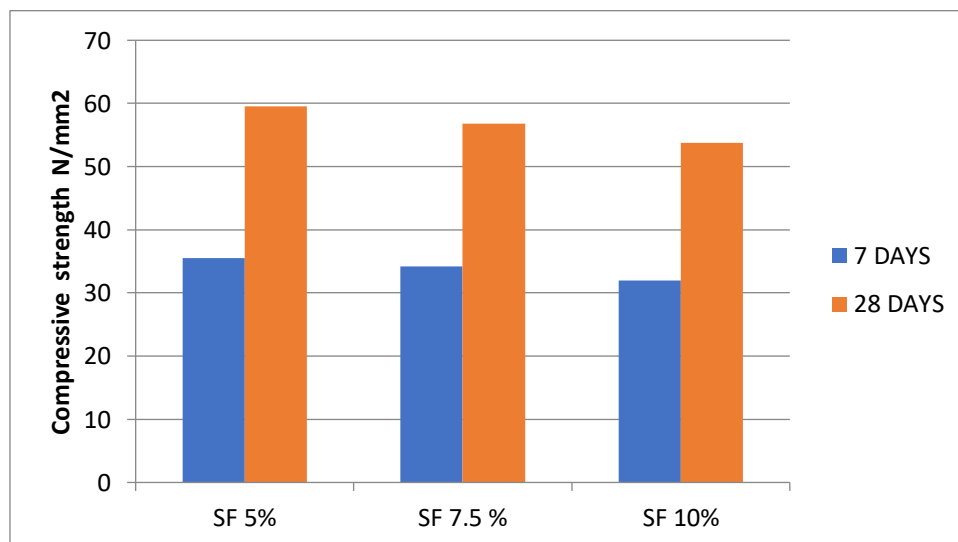


Fig 4.7

When compared two different super plasticizer chart shows good performance and better workability in conplast sp 430 admixtures reaches compressive strength in 5% replacement of silica fume which is better compared to the other proportion. In silplas super the mix of the concrete is dry compared to conplast sp 430 with 1.5%.

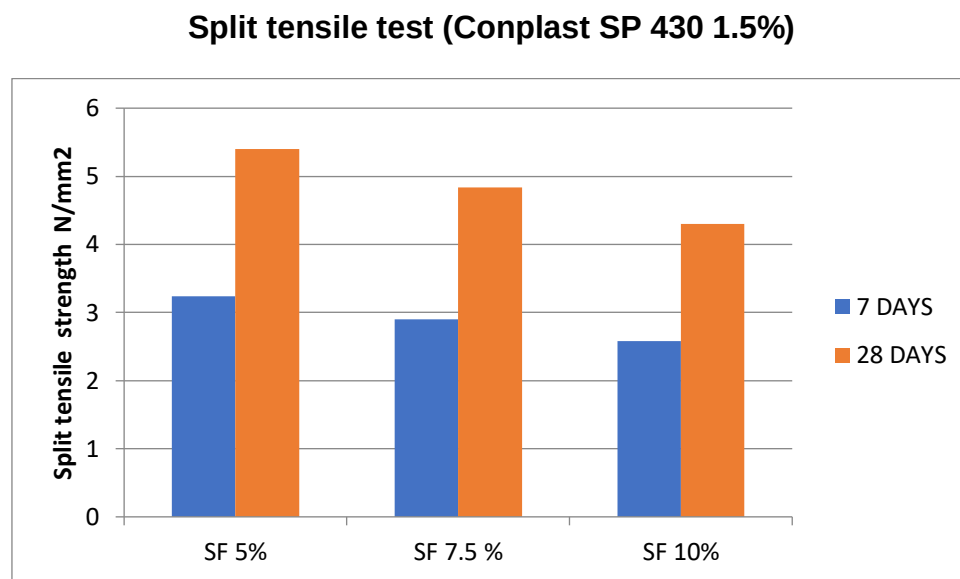


Fig 4.8

When compared two different super plasticizer chart shows good performance and better workability in conplast sp 430 admixtures better tensile strength in 5% replacement of silica fume which is better compared to the other proportion. In silplas super the mix of the concrete is dry compared to conplast sp 430 with 1.5%.

4.4 Test result for compressive strength and split tensile test (Silplas super 2%)

Compressive strength result for (Silplas super 2%)

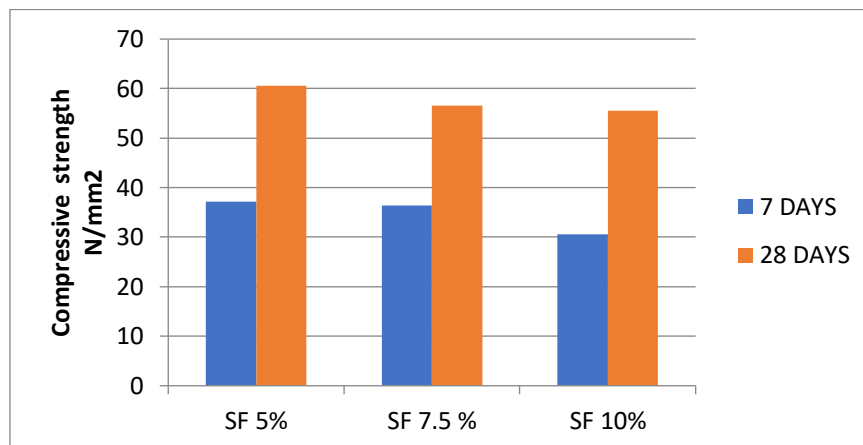


Fig 4.9

Table 4.7

Cube ID	% of Silica fume	Compressive strength N/mm ²		Split tensile N/mm ²	
		7 days	28 days	7 days	28 days
1	5	37.22	60.52	3.03	4.85
2	7.5	36.35	56.56	2.33	4.17
3	10	30.57	55.59	2.30	4.31

When compared two different super plasticizer chart shows good performance admixtures reaches compressive strength in 5% replacement of silica fume which is

better compared to the other proportion. In silplas super the mix of the concrete is dry compared to Silplas super 2%

Split tensile test (Silplas super 2%)

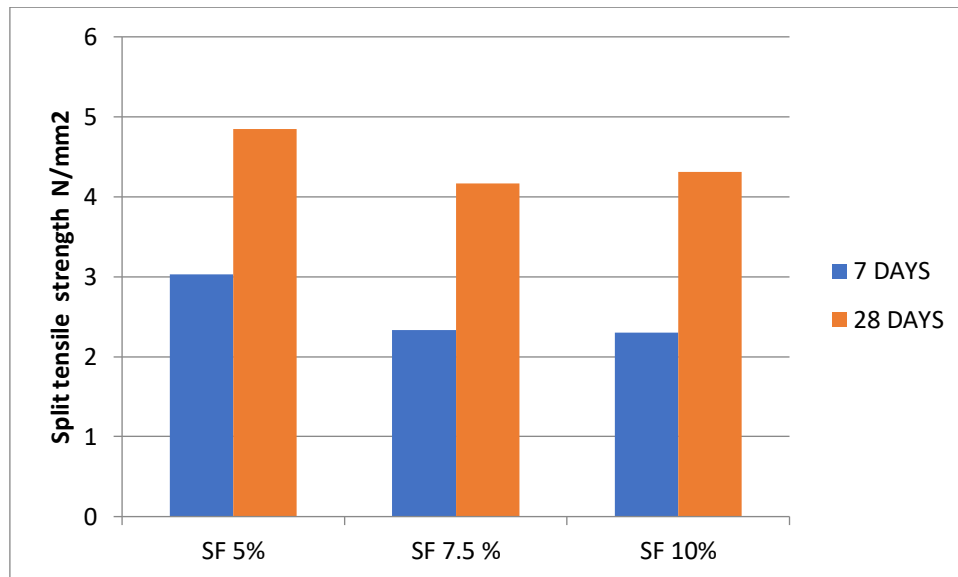


Fig 4.10

When compared two different super plasticizer chart shows good performance admixtures reaches tensile strength in 5% replacement of silica fume which is better compared to the other proportion. In silplas super the mix of the concrete is dry compared to Silplas super 2%

4.5 Test result for compressive strength and split tensile test (Silplas super 1.5 %)

Cube ID	% of Silica fume	Compressive strength N/mm ²		Split tensile N/mm ²	
		7 days	28 days	7 days	28 days
1	5	32.53	58.31	3.04	4.25
2	7.5	32.29	56.82	1.92	3.42
3	10	31.30	51.47	1.74	3.15

Table 4.8

Compressive strength result for (Silplas super 1.5%)

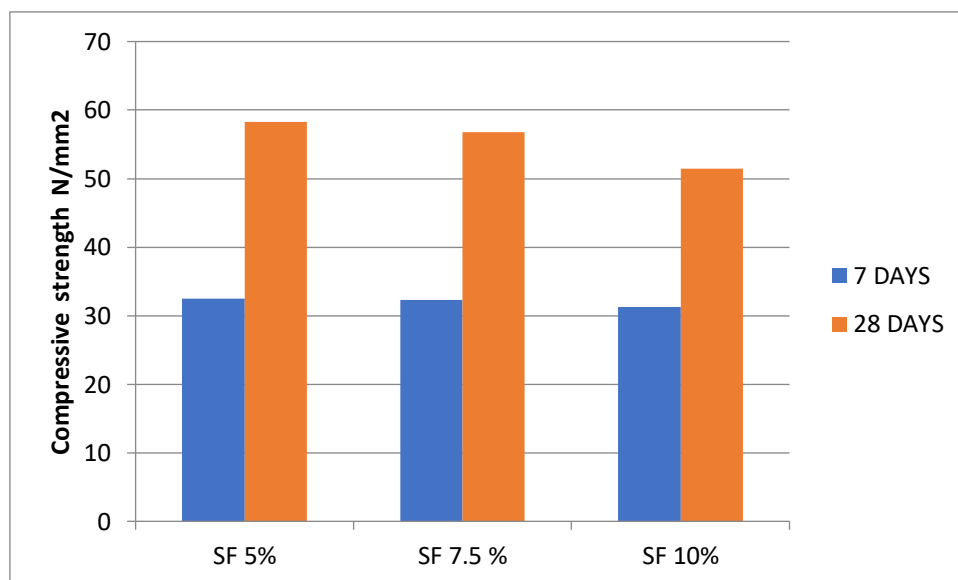


Fig 4.11

When compared two different super plasticizer chart shows good performance admixtures reaches compressive strength in 5% replacement of silica fume which is better compared to the other proportion. In silplas super the mix of the concrete is dry compared to Silplas super 1.5%

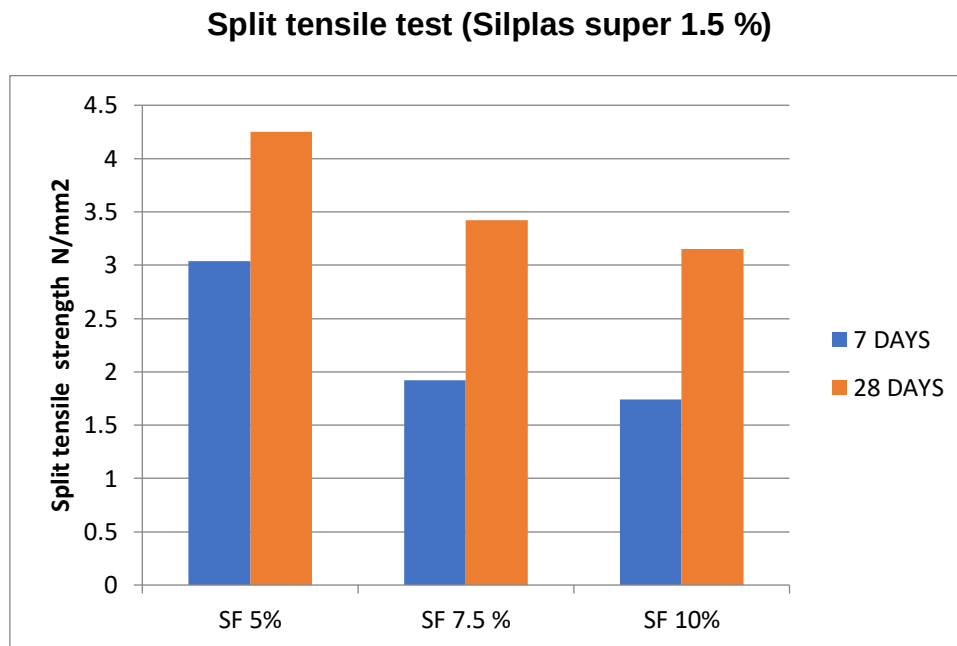


Fig 4.12

When compared two different super plasticizer chart shows good performance admixtures reaches tensile strength in 5% replacement of silica fume which is better compared to the other proportion. In silplas super the mix of the concrete is dry compared to Silplas super 1.5 %

4.6 NUMERICAL ANALYSIS

4.6.1 GENERAL

Ansys offers structural analysis software solutions that enable engineers of all levels and backgrounds to solve complex structural engineering problems faster and more efficiently. With our suite of tools, engineers can perform finite element analyses (FEA), customize and automate solutions for structural mechanics challenges and analyze multiple design scenarios. By using our software early in the design cycle,

businesses can save costs, reduce the number of design cycles and bring products to market faster.

4.6.2 ANSYS WORKBENCH

The Ansys Workbench platform **lets you integrate data across engineering simulations to create more accurate models more efficiently**. Ansys Workbench makes it easier to make more informed design choices by coordinating all your simulation data in one place. Easily manage data across all your Ansys products.

Properties of Outline Row 3: Concrete			
	A	B	C
1	Property	Value	Unit
2	 Material Field Variables	 Table	
3	 Density	2420	kg m ⁻³ ▼
4	  Isotropic Secant Coefficient of Thermal Expansion		
6	  Isotropic Elasticity		
7	Derive from	Young's Modulus and P... ▼	
8	Young's Modulus	38600	MPa ▼
9	Poisson's Ratio	0.18	
10	Bulk Modulus	2.0104E+10	Pa
11	Shear Modulus	1.6356E+10	Pa
12	 Tensile Yield Strength	0	Pa ▼
13	 Compressive Yield Strength	0	Pa ▼
14	 Tensile Ultimate Strength	5E+06	Pa ▼
15	 Compressive Ultimate Strength	4.1E+07	Pa ▼

Fig 4.13 Concrete Material properties

Properties of Outline Row 4: Structural Steel			
	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7850	kg m ⁻³ ▼
4	Isotropic Secant Coefficient of Thermal Expansion		
6	Isotropic Elasticity		
7	Derive from	Young's Modulus and P... ▼	
8	Young's Modulus	2E+05	MPa ▼
9	Poisson's Ratio	0.3	
10	Bulk Modulus	1.6667E+11	Pa
11	Shear Modulus	7.6923E+10	Pa
12	Alternating Stress Mean Stress	Tabular	
16	Strain-Life Parameters		
24	Tensile Yield Strength	2.5E+08	Pa ▼
25	Compressive Yield Strength	2.5E+08	Pa ▼
26	Tensile Ultimate Strength	4.6E+08	Pa ▼
27	Compressive Ultimate Strength	0	Pa ▼

Fig 4.14 Structural Steel Material properties

4.7 Flexural strength of RC beam

4.7.1 TEST RESULTS OF CONTROL SPECIMEN

The experimental result for the control beam RC are tabled

SL.NO	LOAD IN KN	CENTERAL DEFLECTION IN MM
1	0	0
2	1.5	0.34
3	3	0.59
4	4.5	1.24
5	6	1.93

6	7.5	2.58
7	9	3.32
8	10.5	4.01
9	12	4.70
10	13.5	5.45
11	15	6.23
12	16.5	7.75
13	18	9.77
14	19.5	11.28
15	21	12.88
16	22.5	15.42
17	24	17.92

Table 4.9

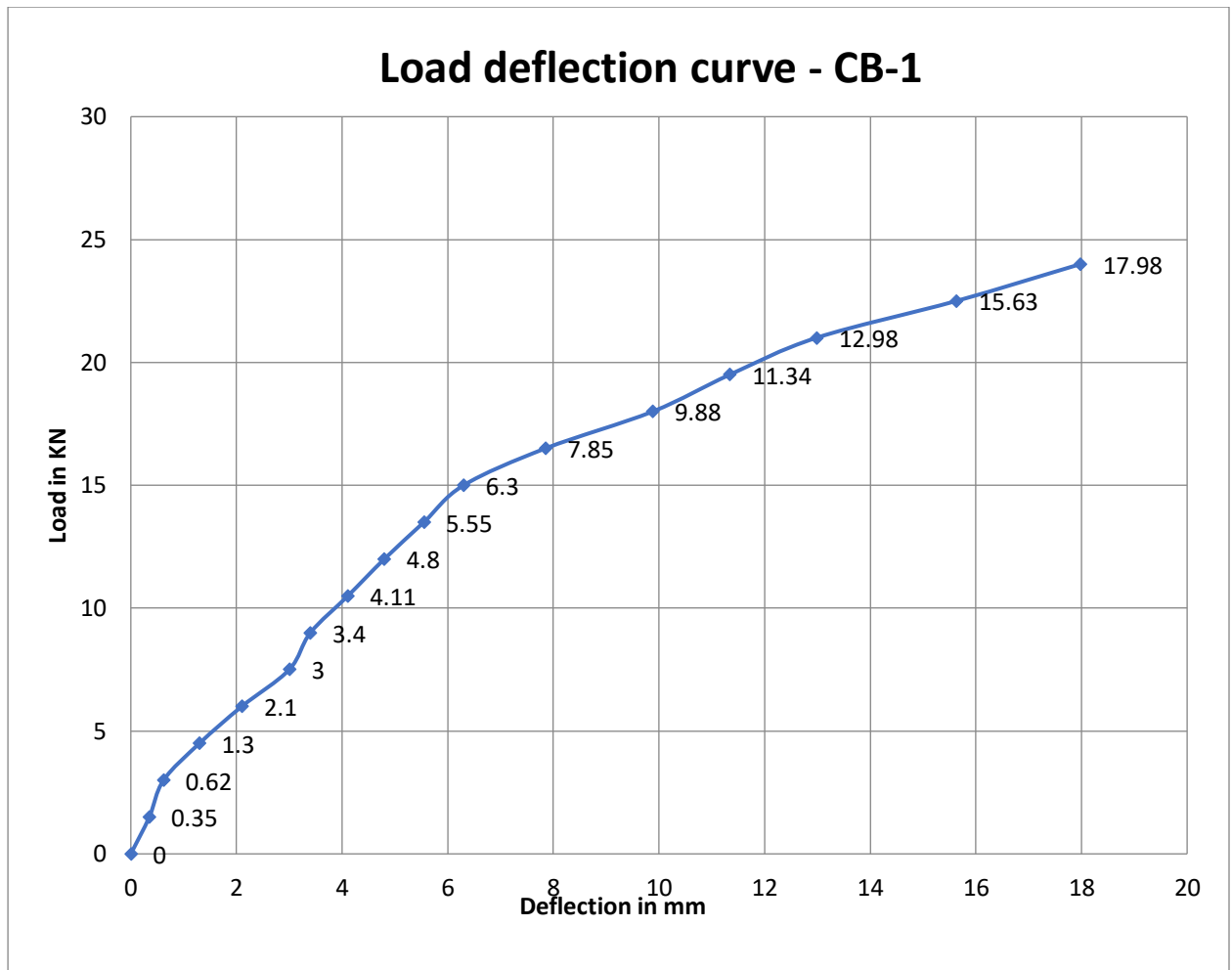


Fig 4.15

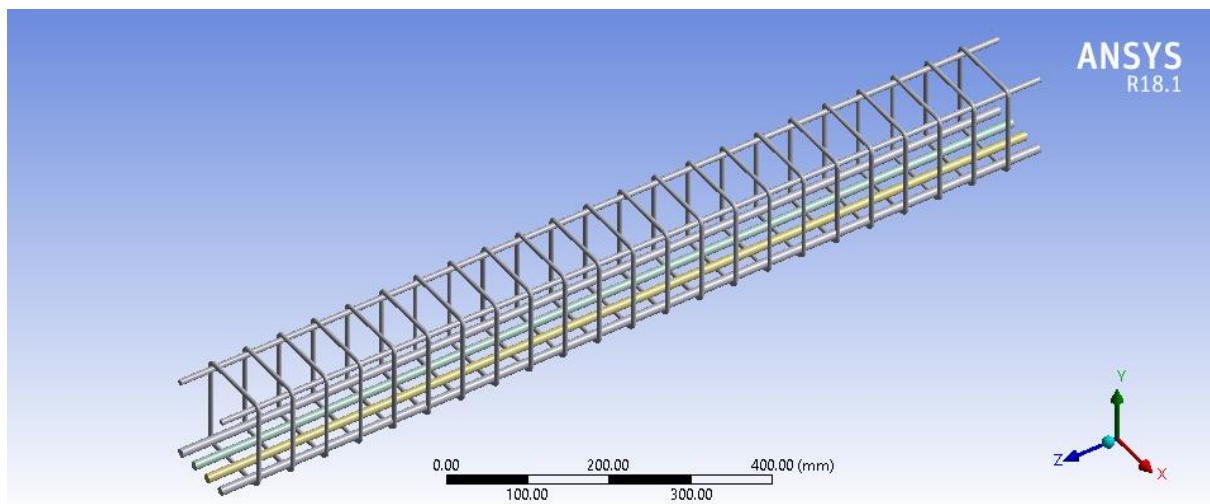


Fig 4.16 Reinforcement Diagram

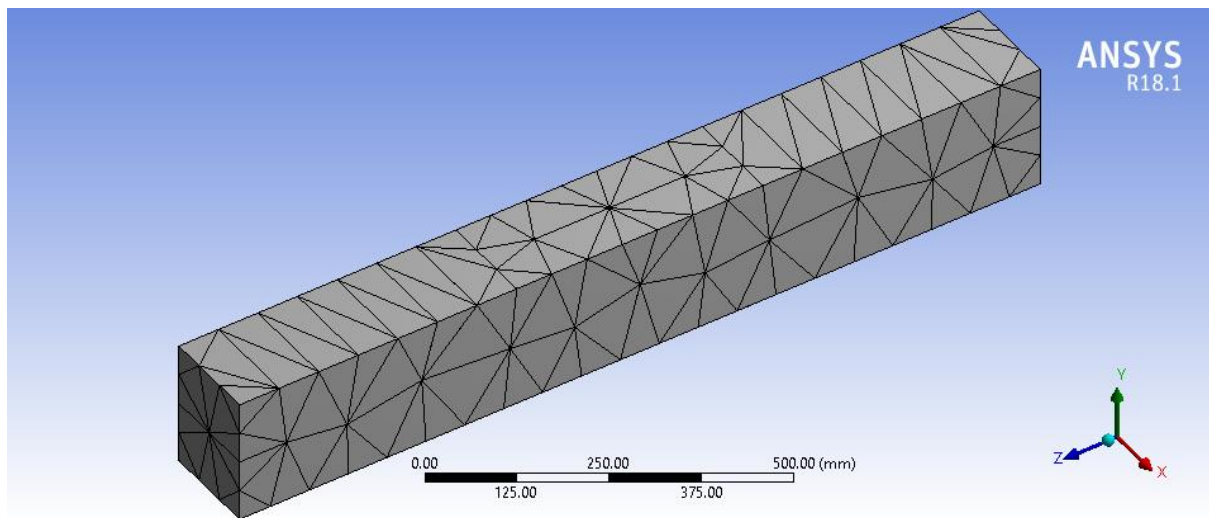


Fig 4.17 Meshing Diagram

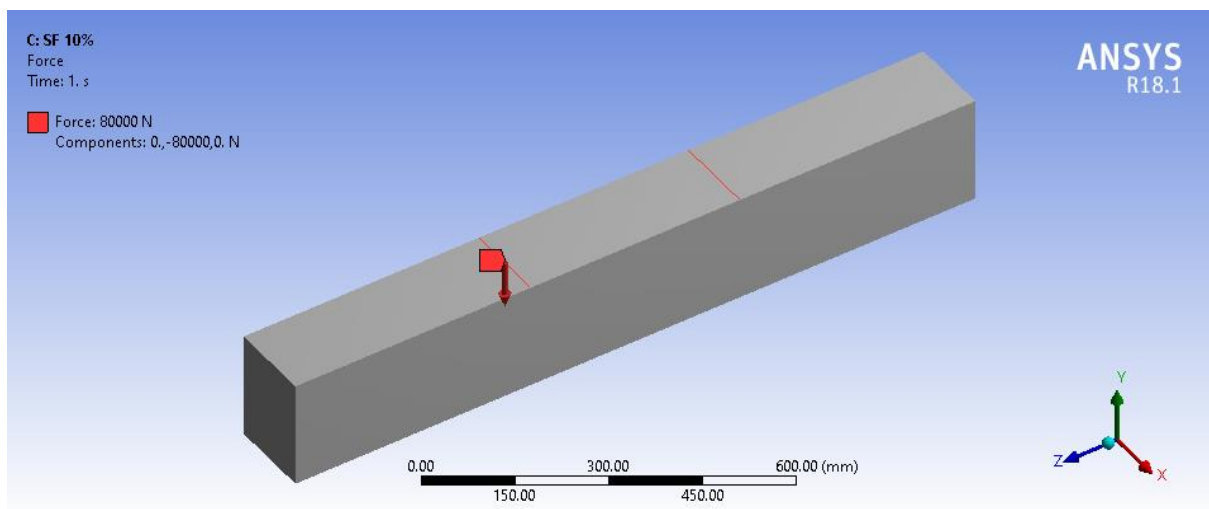


Fig 4.18 Loading Diagram

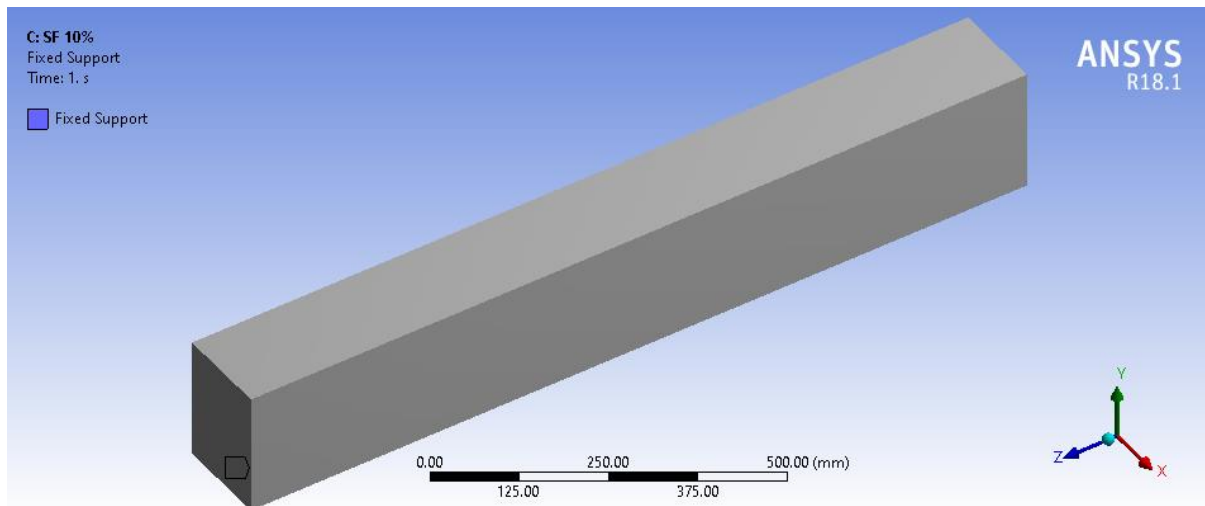


Fig 4.19 Support assign diagram

4.7.2. EXPERIMENTAL RESULTS OF RC BEAM

SL.NO	TEST RESULTS	VALUES
1	Initial crack load	9 KN
2	Ultimate load	24 KN
3	Ultimate Moment	4 KNM
4	Flexural Strength	16 N/MM ²
5	Initial stiffness	2.73 KN/MM
6	Ductility index	2.32
7	Energy index	3.5
8	Total energy absorption capacity	168 KNMM

Table 4.10

For the control specimen of M60 grade concrete the initial crack was identified during the cycle at the load 9KN on RC specimen. As the load was increased, further cracks were developed and widened. The ultimate load carrying capacity of the conventional beam RC was 24KN.

4.7.3 TEST RESULTS OF SILICA FUME 5 % WITH CONPLAST SP 430:

The following results are tabulated are as follows

SL.NO	LOAD IN KN	CENTERAL DEFLECTION IN MM
1	0	0
2	1.5	0.35
3	3	0.62
4	4.5	1.30
5	6	2.10
6	7.5	3.00
7	9	3.40
8	10.5	4.11
9	12	4.80
10	13.5	5.55
11	15	6.30
12	16.5	7.85
13	18	9.88
14	19.5	11.34
15	21	12.98

16	22.5	15.63
17	24	17.98

Table 4.11

4.8 Load Vs Deflection

Load in KN	SF – 5%	SF – 7.5%	SF – 10%
10	0.041705	0.040791	0.04266
20	0.083409	0.081583	0.08532
30	0.12511	0.12237	0.12798
40	0.16682	0.16317	0.17064
50	0.20852	0.20396	0.2133
60	0.25023	0.24475	0.25596
70	0.29193	0.28554	0.29862
80	0.33364	0.32633	0.34128

Table 4.12

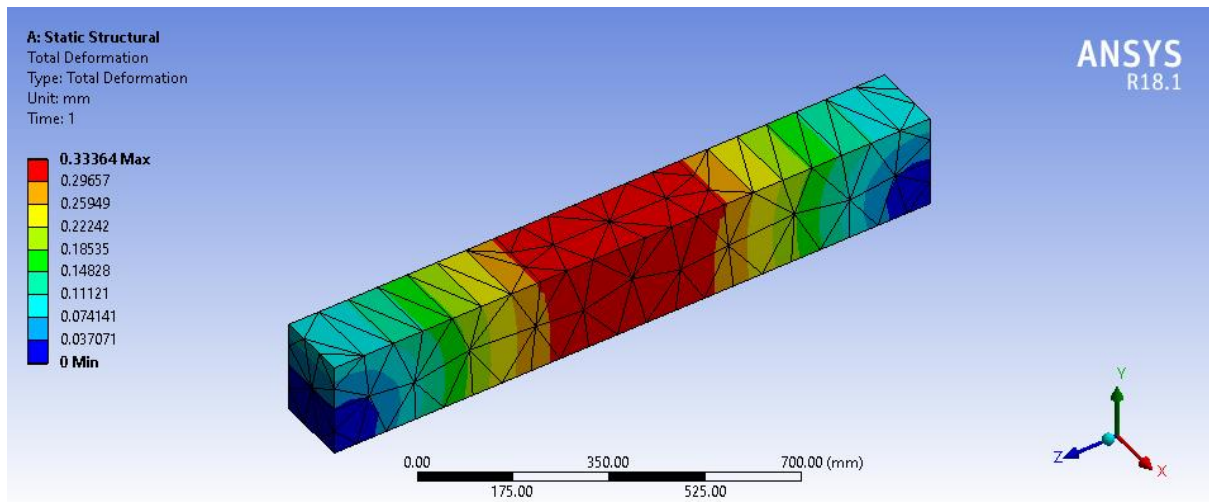


Fig 4.20 Model 1 – Deflection at 80KN

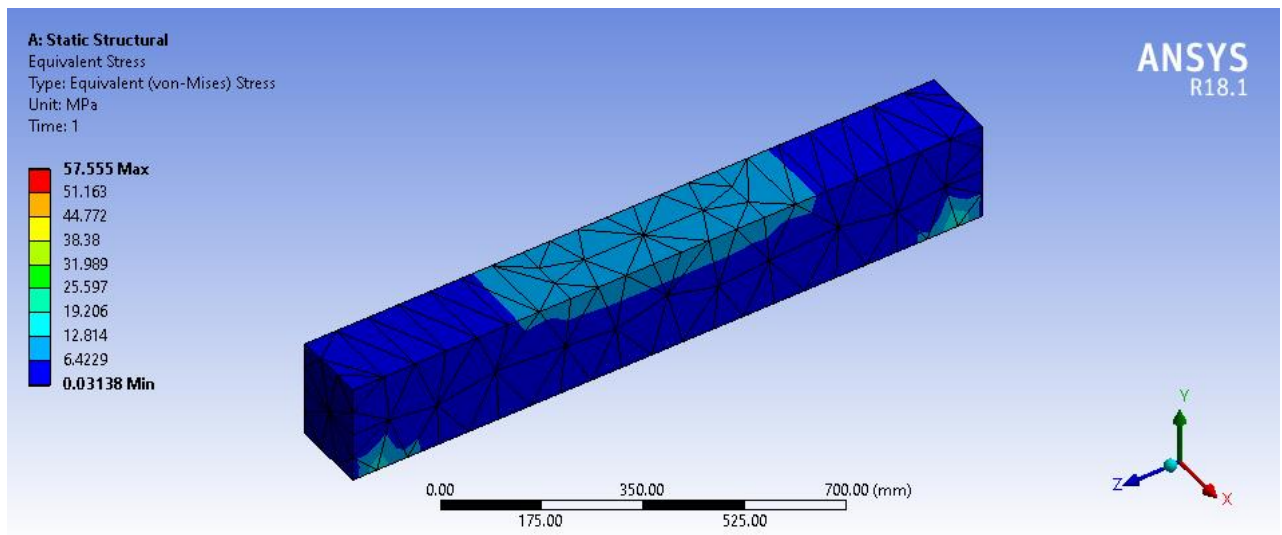


Fig 4.21 Model 1 – Stress at 80KN

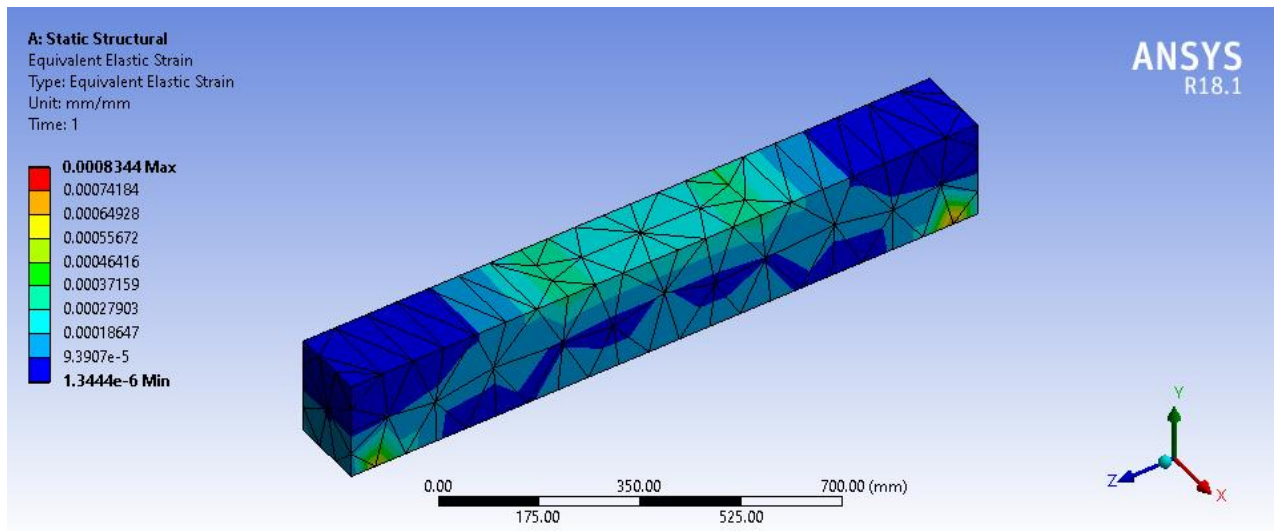


Fig 4.22 Model 1 – Strain at 80KN

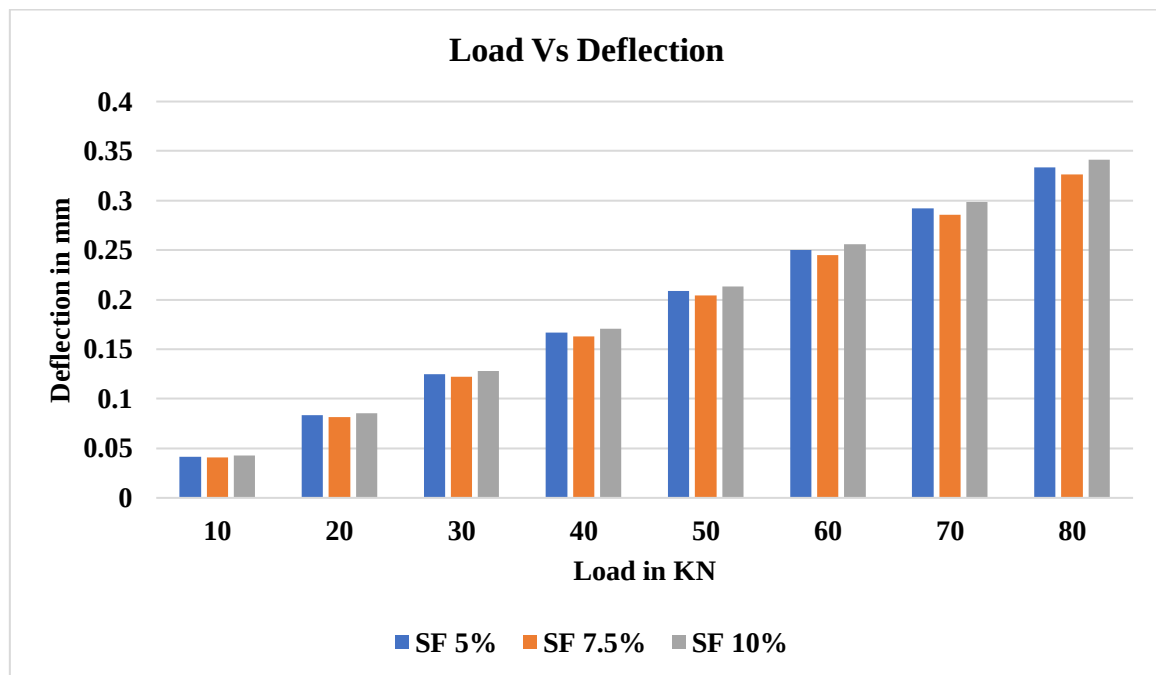


Fig 4.23

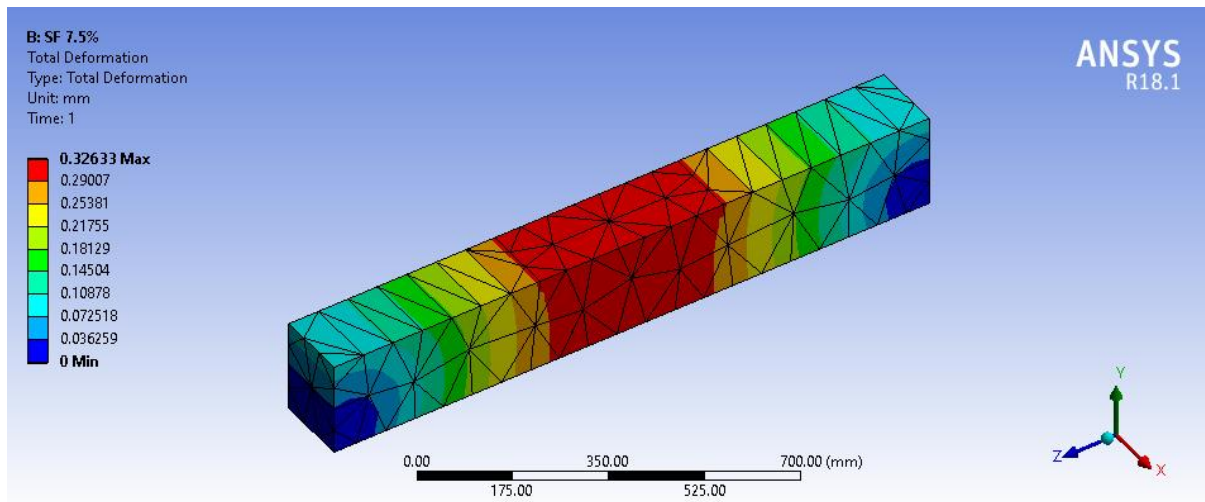


Fig 4.24

Model 2 – Deflection at 80KN

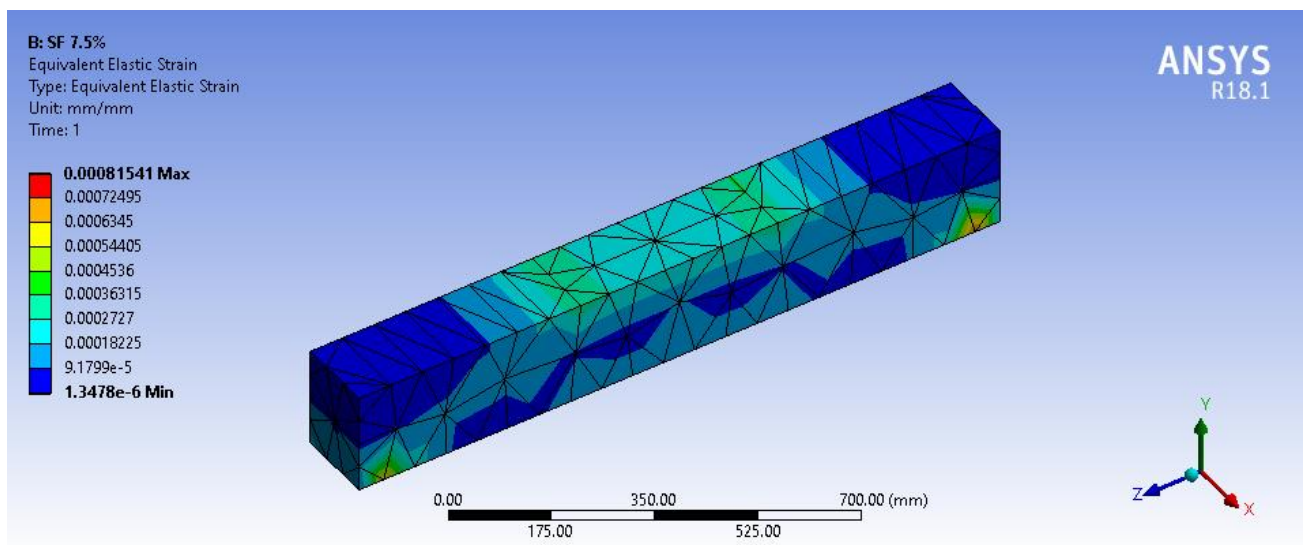


Fig 4.25

Model 2 – Strain at 80KN

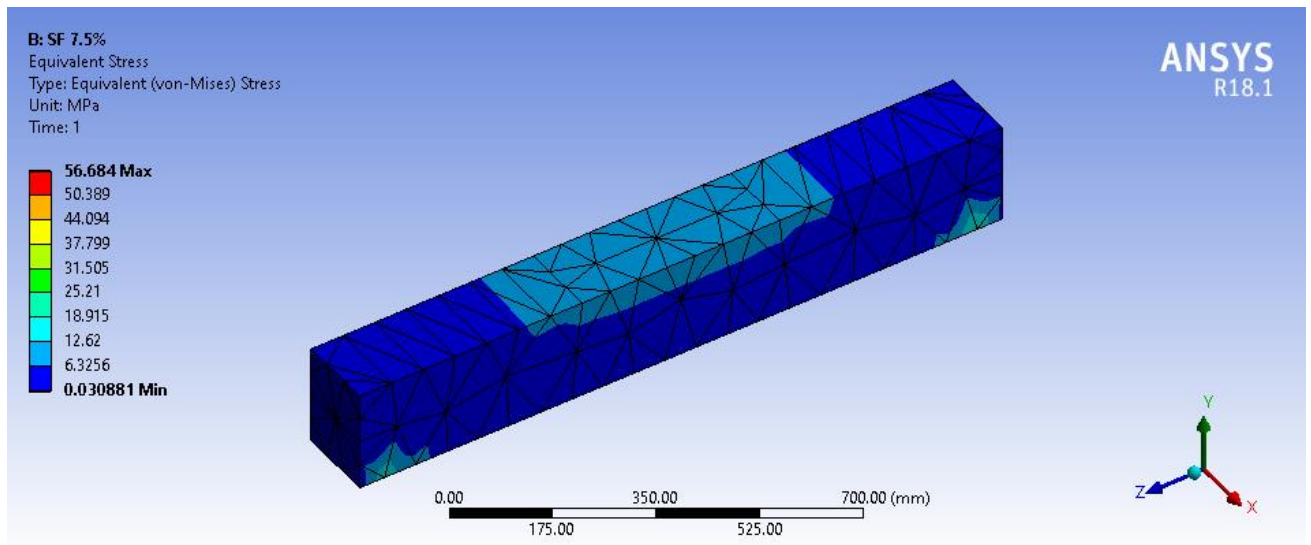


Fig 4.26

Model 2 – Stress at 80KN

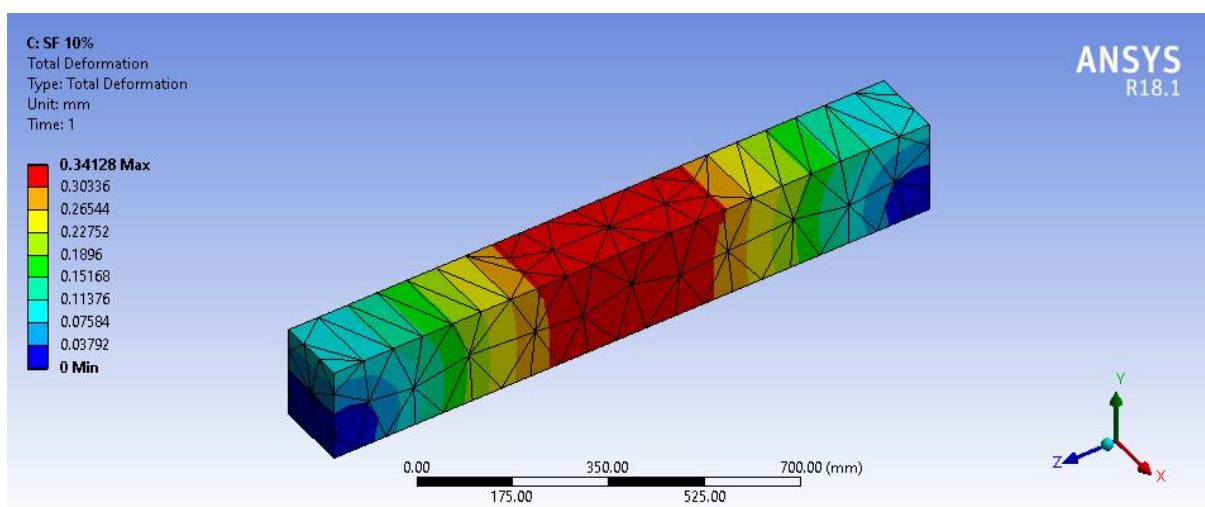


Fig 4.27

Model 3 – Deflection at 80KN

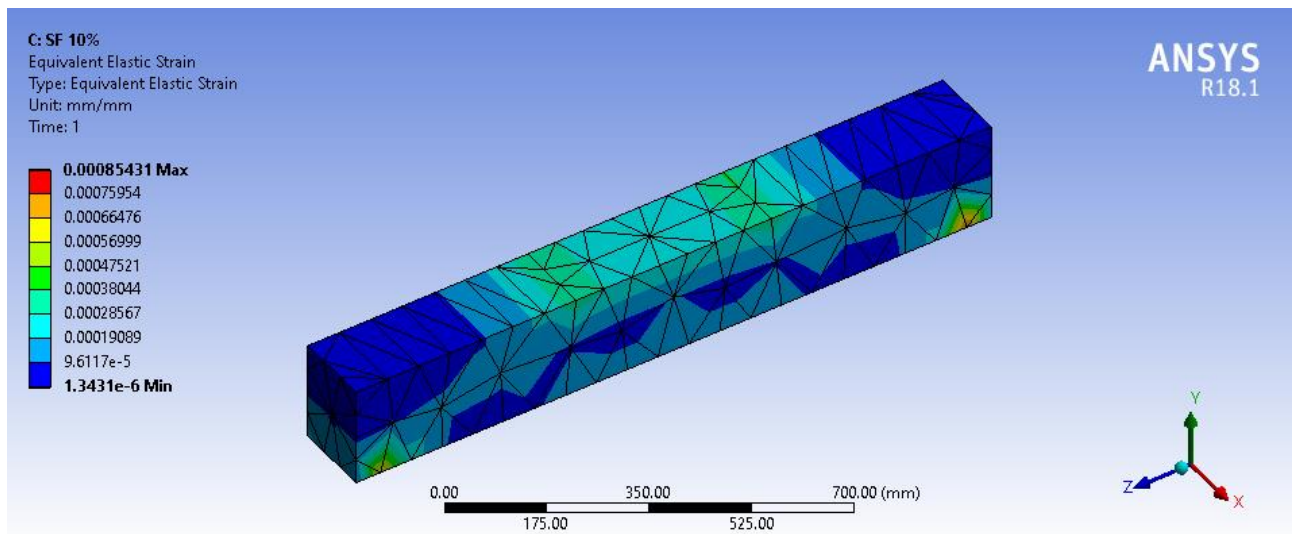


Fig 4.28

Model 3 – Strain at 80KN

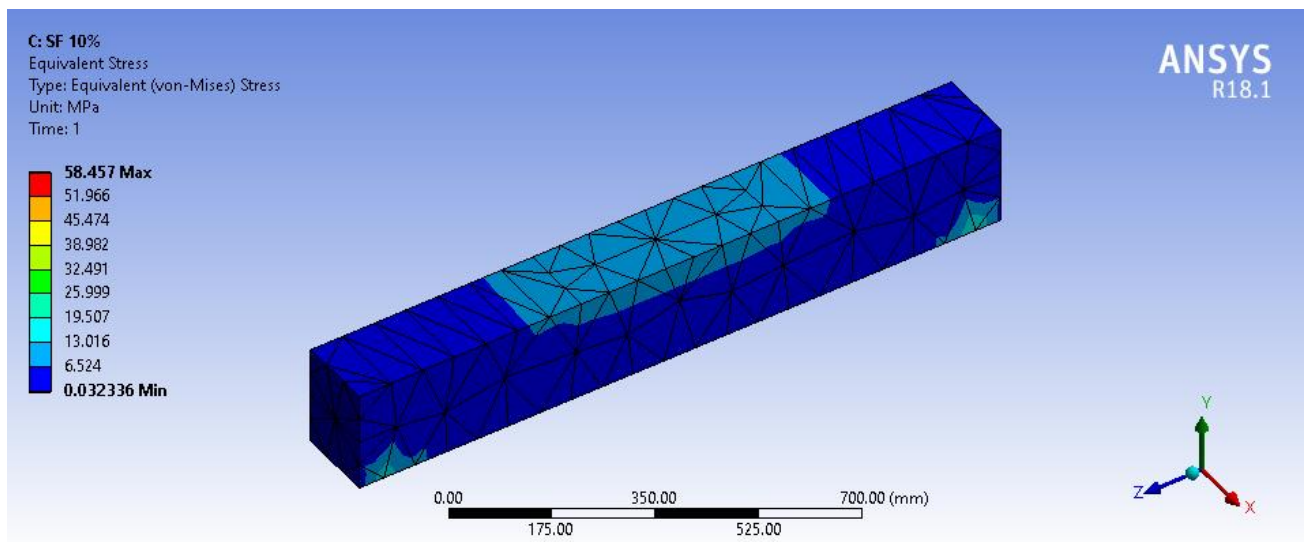


Fig 4.29

Model 3 – Stress at 80KN

4.9 Load Vs Stress

Load in KN	SF – 5%	SF – 7.5%	SF – 10%
10	7.1944	7.0855	7.3072
20	14.389	14.171	14.614
30	21.583	21.256	21.922
40	28.777	28.342	29.229
50	35.972	35.427	36.536
60	43.166	42.513	43.843
70	50.36	49.598	51.15
80	57.555	56.684	58.457

Table 4.13

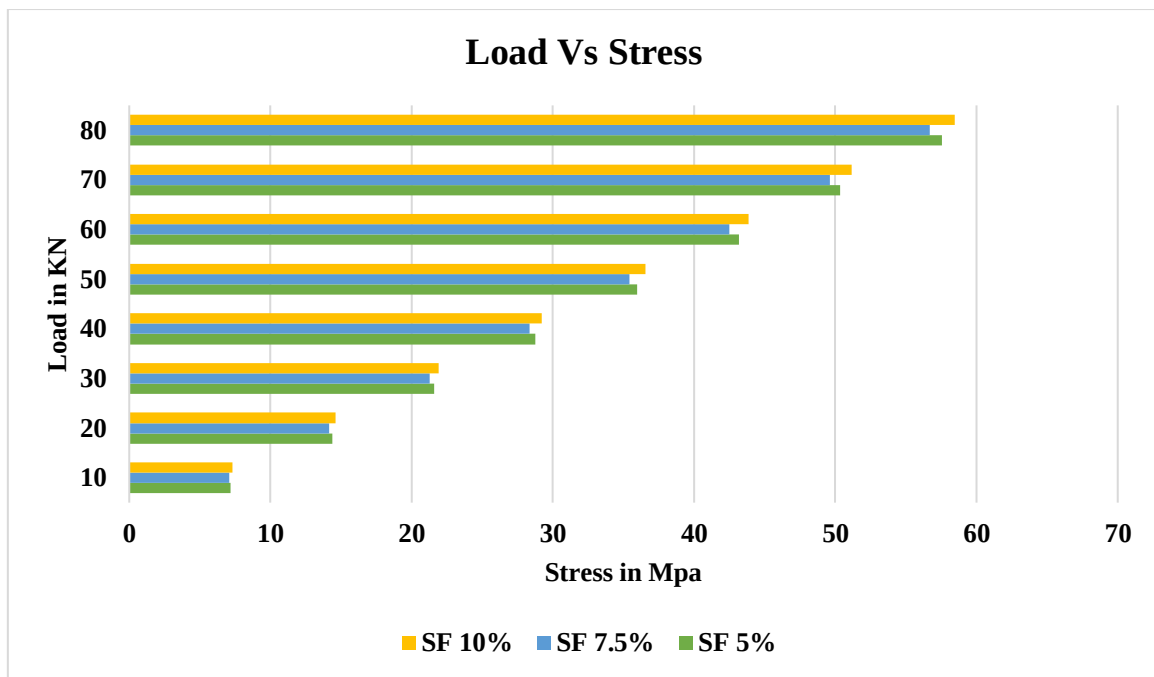


Fig 4.30

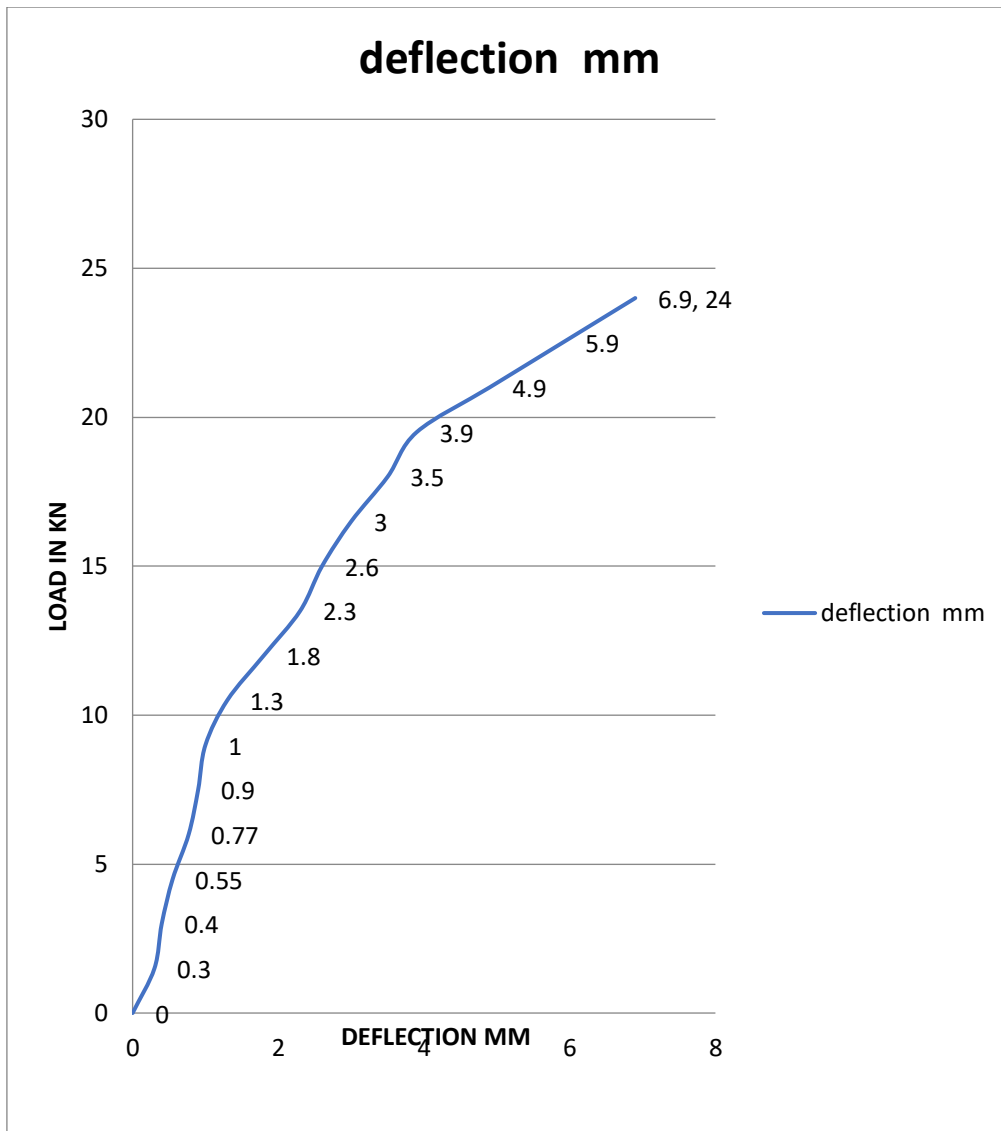


Fig 4.31

For the 5% silica fume of M60 grade concrete the initial crack was identified during the cycle at the load 9kN on RC specimen. As the load was increased, further cracks were developed and widened. The ultimate load carrying capacity of the conventional beam RC was 24kN.

SL.NO	TEST RESULTS	VALUES
1	Initial crack load	9 KN
2	Ultimate load	24 KN
3	Initial stiffness	2.65 KN/MM
4	Ductility index	5.45
5	Energy index	5.45
6	Total energy absorption capacity	168 KNMM

Table 4.14

4.9.1 TEST RESULTS OF SILICA FUME 7.5 % WITH CONPLAST SP 430:

The following results are tabulated are as follows

SL.NO	LOAD IN KN	CENTERAL DEFLECTION IN MM
1	0	0
2	1.5	0.6
3	3	0.9
4	4.5	1.40
5	6	1.80
6	7.5	2.60
7	9	3.40
8	10.5	4.20

9	12	4.80
10	13.5	5.60
11	15	6.20
12	16.5	7.80
13	18	9.60
14	19.5	11.20
15	21	12.60
16	22.5	15.40
17	24	18.40
18	25.5	20.20

Table 4.15

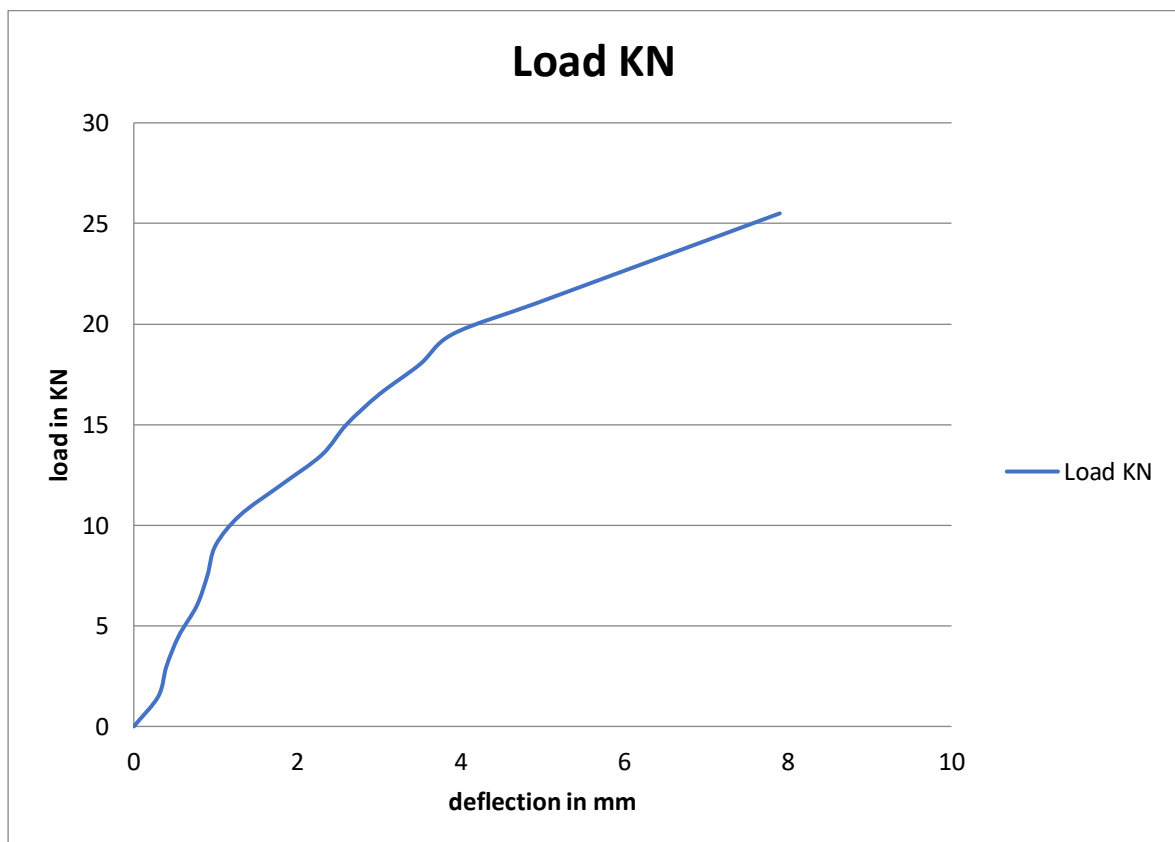


Fig 4.32

For the 7.5% silica fume of M60 grade concrete the initial crack was identified during the cycle at the load 10.5 KN on RC specimen. As the load was increased, further cracks were developed and widened. The ultimate load carrying capacity of the conventional beam RC was 25.5 KN.

SL.NO	TEST RESULTS	VALUES
1	Initial crack load	10.5 KN
2	Ultimate load	25.5 KN
3	Initial stiffness	2.14 KN/MM
4	Ductility index	4.92
5	Energy index	4.92
6	Total energy absorption capacity	192 KNMM

Table 4.16

4.9.2 TEST RESULTS OF SILICA FUME 10 % WITH CONPLAST SP 430:

The following results are tabulated are as follows

SL.NO	LOAD IN KN	CENTERAL DEFLECTION IN MM
1	0	0
2	1.5	0.3
3	3	0.4
4	4.5	0.55
5	6	0.77
6	7.5	0.90
7	9	1.00
8	10.5	1.30
9	12	1.80
10	13.5	2.30
11	15	2.60
12	16.5	3.00
13	18	3.50
14	19.5	3.90
15	21	4.40
16	22.5	5.90

17	24	6.90
18	25.5	7.90
19	27.0	8.80

Table 4.17

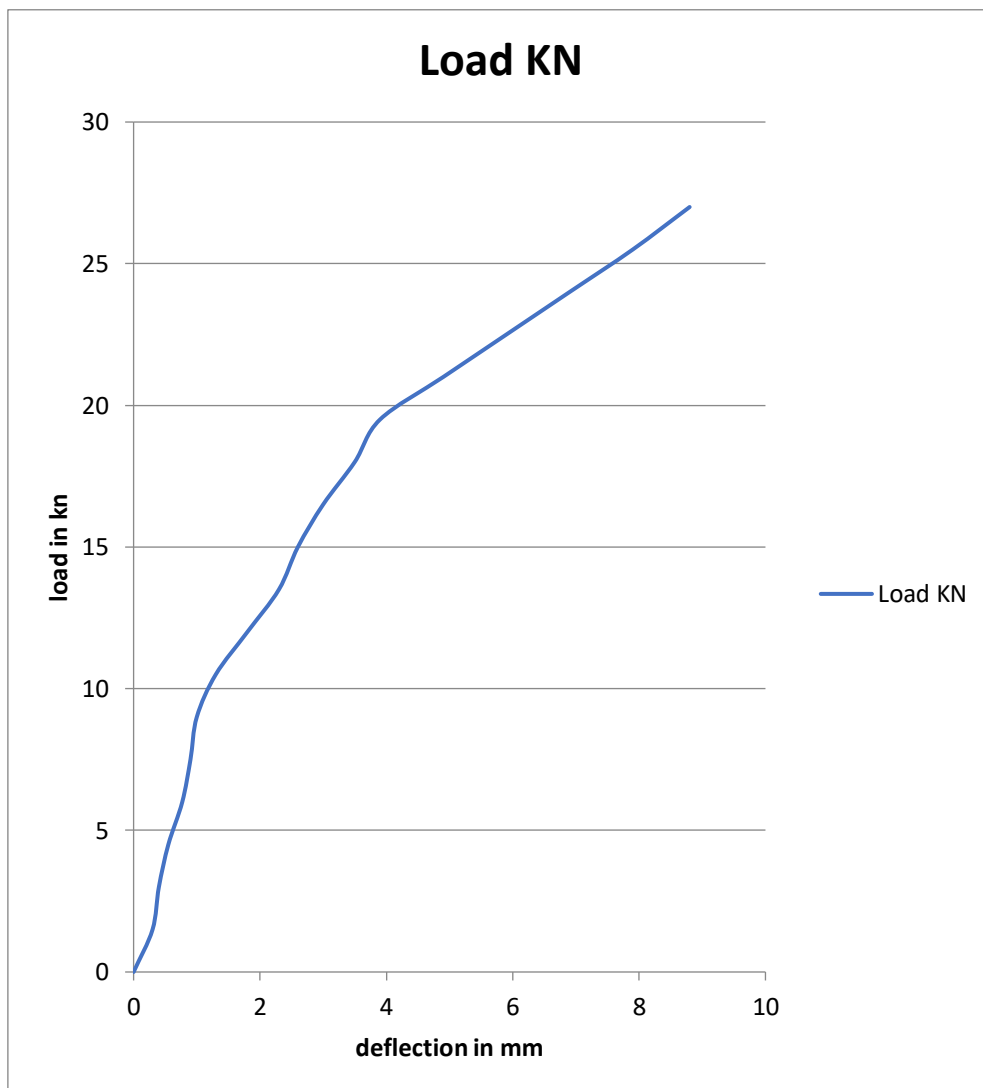


Fig 4.33

For the 10% silica fume of M60 grade concrete the initial crack was identified during the cycle at the load 12 KN on RC specimen. As the load was increased, further cracks were developed and widened. The ultimate load carrying capacity of the conventional beam RC was 27 KN.

SL.NO	TEST RESULTS	VALUES
1	Initial crack load	12 KN
2	Ultimate load	27KN
3	Initial stiffness	7.5 KN/MM
4	Ductility index	5.65
5	Energy index	5.65
6	Total energy absorption capacity	169.5 KNMM

Table 4.18

CHAPTER 5

CONCLUSION

1. When compared to river sand and manufacture sand in the control specimen chart shows designed compressive and tensile strength in M.sand of about 54.51 N/mm^2 and 2.98 N/mm^2 sand when compared to river sand. From the results it is concluded that, river sand have shown lesser compressive strength in manufacture sand which may be due to fine particle and gives better workability in conplast SP 430.

2. When compared to river sand and manufacture sand chart shows higher compressive and tensile strength in river sand when compared to manufacture sand. From the results it is concluded that, same compressive and tensile strength compared to conplast sp 430 but mix is more workable than silplas super.

3. Finally In silplas super the mix of the concrete is dry compared to conplast sp 430. Designed compressive strength achieved in 5% replacement of silica fume in 28 days.

4. For the control specimen of M60 grade concrete the initial crack was identified during the cycle at the load 9KN on RC specimen. As the load was increased, further cracks were developed and widened. The ultimate load carrying capacity of the conventional beam RC was 24KN.

5. For the 5% silica fume of M60 grade concrete the initial crack was identified during the cycle at the load 9KN on RC specimen. As the load was increased, further cracks were developed and widened. The ultimate load carrying capacity of the conventional beam RC was 24KN.

6. For the 7.5% silica fume of M60 grade concrete the initial crack was identified during the cycle at the load 10.5 KN on RC specimen. As the load was increased, further cracks were developed and widened. The ultimate load carrying capacity of the conventional beam RC was 25.5 KN.

7. For the 10% silica fume of M60 grade concrete the initial crack was identified during the cycle at the load 12 KN on RC specimen. As the load was increased,

further cracks were developed and widened. The ultimate load carrying capacity of the conventional beam RC was 27 KN.

8. More water absorption takes place in M. sand compare to R. sand. According to the preliminary test the finess modulus river sand is higher.

9. Due to two different chemical admixtures such as conplast sp 430 and silplas super added with 1.5% and 2% it results better mix in 2% conplast sp 430.

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APPENDIX A

Concrete grade M 60 for control mix proportions

Specific Gravity of Cement	= 3.15
Specific Gravity of M- Sand	= 2.51
Specific Gravity of River sand	= 2.61
Specific Gravity of Coarse Aggregate	= 2.85
Specific Gravity of silica fume	= 2.22
Fineness Modulus of M- Sand	= 4.16
Fineness Modulus of River sand	= 4.05
Water absorption of Fine aggregate	= 1%

1. Target strength for mix proportioning:

$$F_{ck} = f_{ck} + 1.65 s$$

$$= 60 + 1.65 * 7.8$$

$$= 72.87 \text{ N/mm}^2$$

2. Selection of W/c ratio:

Maximum water content = 180 litre (for 25 to 50 mm slump)

3. Calculation of cement content :

$$W/c \text{ ratio} = 0.3$$

$$\text{Cement content} = 180/0.3$$

$$= 600 \text{ kg/m}^3$$

4. Mix calculations:

Entrapped air as 2%

Volume of concrete = 0.98 m^3

Volume of Cement = 600 kg/m^3

Volume of water = 180 litre

Volume of Fine aggregate = 375 kg

Volume of coarse aggregate for 20 mm = 927 kg

Volume of coarse aggregate for 12.5 mm= 397 kg

Trial number	Unit	Cement	Fine aggregate	Coarse aggregate (20 mm)	Coarse aggregate (12.5 mm)	Water	W/c ratio
1	volume kg/m^3	600	375	927	397	190	0.3