

“STRUCTURAL BEHAVIOR AND PERFORMANCE ON HIGH PERFORMANCE CONCRETE” (HPC)

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

by

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**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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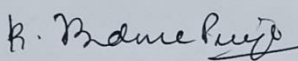
BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of A GANESH (40380001) who carried out the project entitled "**STRUCTURAL BEHAVIOR AND PERFORMANCE ON HIGH PERFORMANCE CONCRET (HPC)**" under my supervision from November 2021 to May 2022


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DECLARATION

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DATE: 11-5-2022

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ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully.

I am grateful to them. I convey my 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 for providing me necessary support and details at the right time during the progressive reviews.

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

I wish to express my 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.

ABSTRACT

High performance concrete (HPC) is that concrete meets special performance and uniformity requirements that cannot always achieved by conventional materials, normal mixing, placing and curing practices. Special performance requirements using conventional materials can be achieved only by adopting low W/C, which necessitates use of high cement content. But judicious choice of chemical and mineral admixture can reduce the cement content and this result in economical HPC. However the effect of a mineral admixture on the strength of concrete varies significantly with its properties and replacement levels. Mix proportioning method of normal concrete cannot adequately account for the large variations in the properties of ingredients. The paper presents a laboratory study on the influence of three mineral admixtures, silica fumes (SF), fly ash (FA), and hydrated lime and Conplast-SP430 on the properties of high performance concrete. The strength and durability properties are carried out for various mix designations and compared with normal conventional concrete. In present project work M40 grade considered and the fly ash (FA) at 45, 40 and 35% volume and silica fume(SF) at 5,10 and 15% volume and hydrated lime 5% of cement content are introduced into high performance concrete. Based on the results will find the increase of compressive strength than conventional and flexural beam has been tested and beam has low deflection and comparison between numerical and experimental has been done These results will show whether the HPC is suitable for structures subject to extreme load conditions.

Keywords: High performance concrete, fly ash, silica fume, hydrated lime, Conplast-SP430

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CHAPTER 1

INTRODUCTION

1.1 GENERAL

"High performance concrete" (HPC) is a general term that refers to any concrete that meets the standards established to overcome the limits of traditional concretes. This concrete has greatly greater environmental resilience much higher structural strength while maintaining suitable durability. Another description is any concrete that significantly reduces construction time to enable for the rapid installation or restoration of roads to trade without losing long-term serviceability. High performance concretes, independent of interpretation, have (W/C), flowability, early strength values, and, throughout many situations, high ultimate strengths. They are often more expensive up front, but should be less expensive over time. There is a scarcity of knowledge on the behaviour of high-performance concretes. They are suitable for pavement or bridge construction where strong salt or frost resistance is required often. As a result, it is becoming increasingly apparent that, in addition to strength, other equally significant factors such as durability, workability, and toughness must be considered.

High Performance Concrete (HPC) may be built to give highest efficiency attributes for a particular set of load, usage, and exposure conditions while also fulfilling cost, serviceability, and durability requirements. Except for careful design and manufacture, high performance concrete does not require any additional materials or equipment. High-performance concrete provides a number of advantages over standard-strength concrete, including better durability and reduced micro cracking.

1.2 HIGH PERFORMANCE CONCRETE

A concrete that fulfils particular performance and consistency standards that are not usually routinely met by utilising only conventional ingredients and standard mixing, putting, and curing techniques." Qualities such as effective compactness avoiding segment, lengthy mechanical properties, and early point toughness or life span under hostile environments may require improvements.

Concretes having multiple of these attributes are typically High Strength, while High Strength of concrete is not invariably Good Quality. Fig: 1.1

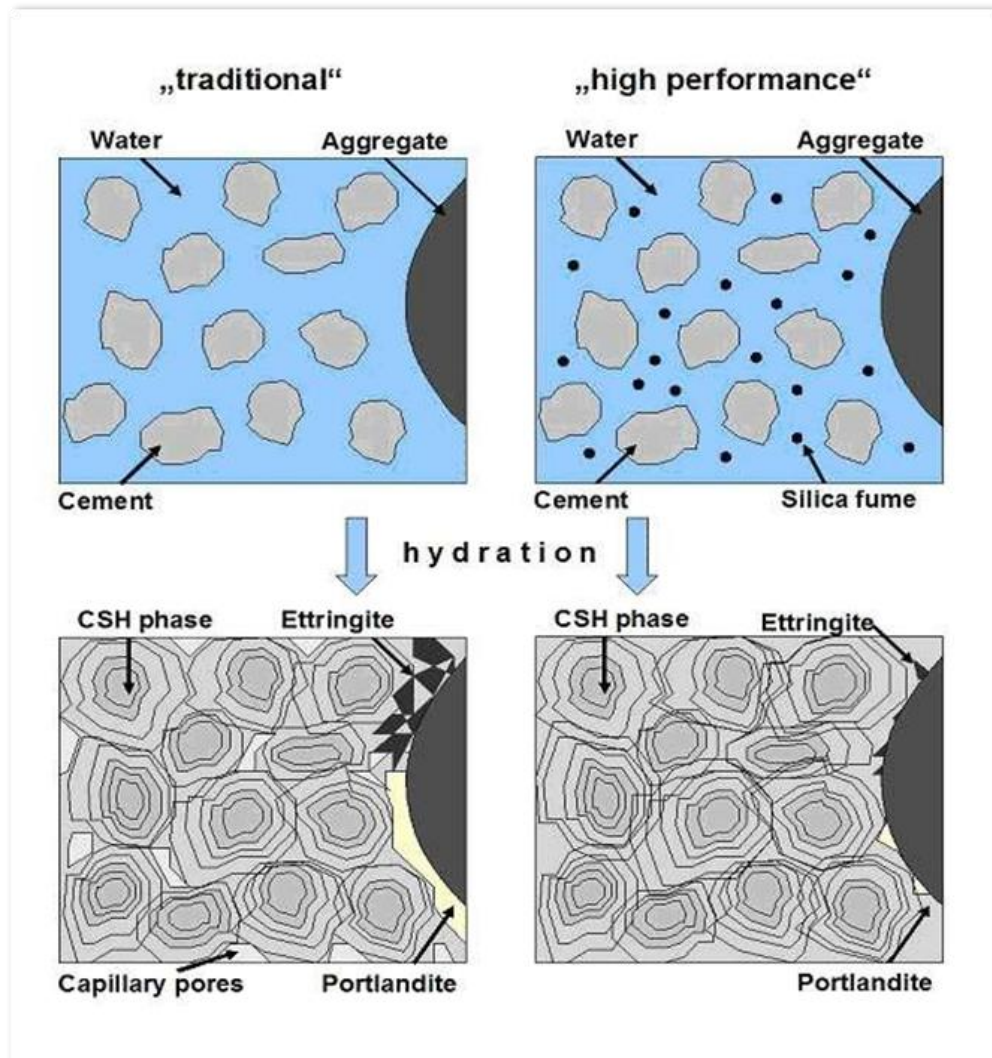


Fig: 1.1 structural arrangement of HPC

1.3 METHODS FOR ACHIEVING HIGH PERFORMANCE

The first technique is to reduce the capillary pore system to the point where no fluid flow can occur. This is extremely difficult to do, and so all concrete will contain some linked pores.

The second and more successful technique is to create reactive chemical binding sites that inhibit the transfer of hostile ions such as chlorides.

1.4 Advantages of high performance concrete:

1. These HPC are easy to install and consolidation without sacrificing strength.
2. It minimises structural member dimension and increasing usable space.
3. Because predictive can withstand larger loads, structural parts are modest in size.
4. The decreasing width of concrete slab and supports beams is an important component.
5. Reduced structural sections including such beams, columns, and slabs result in decreased self-weight and dead load, leading in considerable price reductions.
6. This was more structurally stable than traditional concrete.
7. It was also durable.
8. The formwork's area and value are reduced.
9. Shoring and strip time were reduced due to the high starting strength.
10. Tall structure development in densely populated areas will save.

1.5 Limitations of high performance concrete:

1. Extensive quality control is required since this form of concrete is commonly employed with in construction of skyscrapers.
2. Because of the usage of diverse admixtures & high-quality components, the cost is often expensive.
3. Particular components
4. Manufactured and positioned with care.
5. Concrete could be destroyed by extremely high temperatures.

1.6 Uses of High Performance Concrete:

Because of its extremely low permeability, High Performance Concrete may be utilised in extreme exposure situations when chlorides, sulphates, or other aggressive chemicals pose a threat to concrete. High Performance Concrete is primarily used to boost durability, which is an issue not only under extreme exposure conditions but also under regular settings, as carbon di oxide has always been present in the environment. This causes concrete carbonation, which

degrades the reinforcing and contributes to corrosion. Abrasion can occur when aggressive salts are present in the soil. Excellence Concrete can also be used to keep concrete from deteriorating. Concrete deterioration is caused mostly by alternating periods of quick soaking and protracted drying at regularly varying temperatures. Because High Performance Concrete has limited permeability, it assures that a structure exposed to such circumstances would last a long time.

1.7 Fly Ash

The incorporation of fly ash to concrete improves the properties of elastic concrete and the durability of the concrete mixture. The use of fly ash too is reasonably priced. If fly ash is included, the amount of Portland cement needed in concrete can be decreased. Fly ash has an alkaline pH due to the existence of carbonates and bicarbonates. Because of its high pH, fly ash is appropriate for usage in acidic situations, such as concrete subjected to industrial effluents. Because of its high pH, it is also suitable used in concrete that will be susceptible to marine settings like as that present on the ocean's beach. This decrease in Portland cement resulting in a more slip-resistant concrete that is also more moisture resistant and temperature. Portland cement which is less than 80% hydration has poorer moisture resistance, making it more prone to cracking and damage. Furthermore, fly ash has a better temperature resistance than Cementitious materials, producing concrete stronger and much more lasting. Because of its strong resistance to moisture and temperature, fly ash is an effective stuff for use in concrete.



Fig 1.2: Fly Ash

1.8 Silica Fume

Silica fume concrete doesn't really happen by chance. To attain desired concrete qualities, specifiers must make the choice to add it in concrete. The SFA or major admixture suppliers can help you specify silica-fume concrete for structural applications or enhanced durability. Silica fume for concrete is available in both wet and dry forms. It is often added during the manufacture of concrete at a concrete factory, as illustrated in the photo. Both central-mix and wet batch machines have successfully manufactured silica fume-concrete.



Fig 1.3: Silica Fume

1.9 Hydrated Lime

Hydrated lime (calcium hydroxide) is indeed a dry, transparent crystalline compound produced by slaking calcium oxide (quicklime) by water. Hydrated lime, also called as slack lime, constructors lime, or pickling lime, is used in the manufacture of binders, splints, cements, paints, solid rubber goods, petrochemicals, and tanneries.



Fig 1.4: Hydrated Lime

1.10 Superplasticizer-Conplast-SP430

Conplast SP430 is a superplasticizing admixture made on polymers based on sulfonate naphthalene. It is administered as a black solution that dissolves quickly in water. Conplast SP430 diffuses particles inside the concrete mix, enabling the water content of the concrete to work more efficiently. The excessive levels of water efficiency feasible allow for significant gains in strength. Trials utilising the materials and circumstances that would be encountered in use should always be used to identify the best dose of Conplast SP430 to fulfil particular needs. This enables for the optimization of additive dose and mix design, as well as a thorough evaluation of the concrete mix. Based just on principal application of the product, the place to start for such studies is to utilise a dose inside the usual customary ranges.



Fig 1.5: Conplast-SP430

CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

Introducing the phenomena of high performance concrete in this business has had widespread consequences in enhancing the strength of concrete. The utilisation of fly ash, silica fume, and hydrated lime reduces costs, saves energy, produces arguably superior goods, and reduces environmental dangers.

The primary goal of a literature review is to provide information on prior research effort done both globally and nationally. This serves as the foundation for carrying out the task and procedures for performing experiments. The following study of the literature expands on the research investigations conducted with various elements of high performance concrete.

2.2 LITERATURE REVIEW

Nochaiya et al., (2015) the impact of adding silica fume into cementitious materials containing fly ash were studied. The test samples were constructed from various combinations of Cementitious, fly ash, and silica fume. The proportions of fly ash utilized were 5%, 10%, 20%, and 30%, respectively, whereas the proportions of mineral admixtures used were 2.5%, 5%, and 10%. The tests for natural aggregate, curing time, practicability, and hardness was carried out, and it has been revealed that increasing the silica fume level in conventional concrete reduced the liquid required for normal homogeneity while lowering the first setting time. The incorporation of silica fume into concrete with fly ash led to an overall increase in compressive strength. The flowability of fly ash concrete was reduced as silica fume was incorporated.

Wankhede et al., (2014) The impact of fly ash just on qualities of concrete were researched and determined that with 10% and 20% replacing of cement by fly ash, its compressive was enhanced, however with 30% substitution, the compressive was lowered. It was also discovered that as the amount of fly ash increased, so did the slump loss of concrete.

Patil et al., (2016) studies the compressive properties of concrete when cement is partially replaced with fly ash. By a 5% increase, the cement is replaced with fly ash between 5% to 25%. A rate of compressive strength growth in concrete with really no supplementation of cement with fly ash reaches a maximum at 60 days. Concrete containing 5% fly ash has the fastest rate of mechanical properties and durability until the age of 21 days, after which the rate slows. It has been discovered that a 10% fly ash additive provides the greatest strength after 90 days. Thus, the amount of strength growth is slower in concrete with partial substitution of cement replacement, but the needed maximum strength is eventually obtained.

Bargaheiser et al., (2017) the benefits of employing high-volume fly ash concrete to withstand corrosion damage in structures were discussed. The major causes of concrete corrosion are carbon dioxide and chloride permeating the concrete. The use of fly ash in concrete reduces carbon dioxide emissions, provides sustainability initiatives and a significantly longer life because of its infrastructure, slows the ingress of moisture, oxygen, chlorides, carbon dioxide, and combative chemicals into the concrete, and prevents damage in reinforced concrete structures.

Soni et al., (2014) At 80, 100, and 120 degrees Celsius, the compressive and elastic modulus of fly ash concrete was determined. The fly ash percentages employed were 30, 40, and 50% by weight of cement. The compressive, tensile strength, and elastic modulus of concrete with up to 30% cement replacement were found to be similar to those of cementitious materials without fly ash, however for concrete with much more than 30% cement replacement, these values were lower than either concrete with no cementitious material. The compressive strength of fly ash concrete dropped at 120 C as compared to room temperature.

Ghutke et al., (2014) identified the best cement replacement percentages with silica fume that may be utilised in Indian circumstances. The ideal replacement percentage is found to be between 10 and 15% since the compressive strength declines beyond 15%. Further analysis demonstrates that the workability of concrete declines as the amount of silica fume increases.

Amudhavalli et al., (2012) carried out a comprehensive experimental investigation on M35 concrete grade, partially substituting cement with silica fume by 0, 5, 10, 15, and 20%. When silica fume is added to concrete, the consistency of the cement rises. Flexural strength increased by up to 15% when cement was replaced with silica fume. The increase in fracture toughness was considerable up to 10% silica fume. The best flexural and compressive strength was reached by replacing 10-15% of the cement with silica.

Pradhan et al., (2013) Experiments were carried out to assess the compressive strength, compacting factor, and slump of concrete containing silica fume. When silica fume substituted 20% of the cement, the compressive strength was found to be optimal. When silica fume was added to concrete in various proportions, the titrated with a standard ranged between 0.82 to 0.88 and the slump value ranged from 20 to 50 mm. Better pore structures just at transition region of silica fume concrete are indeed the cause of improved concrete performance.

Shanmugapriya et al., (2013) Experiments were conducted out again on concrete with such a mean strength of 60Mpa, a water binder ratio of 0.32, and the CONPLAST SP 430. The optimal dose for best hardened concrete was determined to be 7.5 percent silica fume by weight. The compressive strength rose by 15%, the tensile strength improved by 20%, and the flexural strength improved by 23%.

Mohamed et al., (2017) Self-compacting concrete containing various amounts of fly ash, silica fume, as well as a mixture of fly ash and silica fume was tested. Slump and V-funnel tests were performed on cylinder specimens. Various approaches have been suggested for different specimens were used in the experiment. The maximum compressive strength was reached using concrete that included 15% fly ash and was cured in water for 28 days. Whenever fly ash and silica fume were combined in concrete, the best amounts were determined to be 10% fly ash & 10% silica fume.

The study conducted by Jensen et al., (2020) describes experimental and numerical investigations on high-performance concrete shrinkage (HPC). Carbonation shrinkage, in particular, can cause surface cracks in concrete, reducing its durability. To explore shrinkage, cylinders of eight HPC quality were

tested. Autogenously shrink, deformability, hydration, inner humidity levels, and strength were all studied in parallel. Previous studies in the topic have been summarised. Mechanisms of carbonation shrinkage are discussed through modelling connections to HPC composition and physical parameters. The results show that by adding silica fume, carbonation shrinkage may be prevented.

Konstantin et al., (2016) An experimental investigation was carried out to investigate the strength characteristics and rheological activity of a cement–silica fume–superplasticizer combination. According to the test results, an ideal superplasticizer-to-silica fume ratio (1:10) produces ultra-dense packing and excellent system fluidity. Experiment data is used to create high-performance concrete models. These models include formulas for calculating W/C for the needed compressive strength (up to 130 MPa) as well as the amount of cement paste for the appropriate slump (40–200 mm). Concrete slump is represented as a function of aggregate percentage as well as cement paste volume and fluidity for modelling purposes. This modelling methodology proposes a novel method for calculating the proportions of high-performance concrete mixes.

Zain et al., (2019) a research was conducted to explore the physical characteristics of newly mixed high performance concrete. Batch each batch, the physical properties and purity of fresh concrete were checked. Slumping, slump flow, V-funnel flow, air voids, temperature, and unit weight were all calculated for fresh high performance concrete. It was discovered that the features, notably the flow and air content, are interconnected. In term of V-funnel flow, the signal of workability was more obvious than in slump flow. This finding implies that the standard slump test is ineffective for assessing high performance concrete's durability and strength and permeability.

Nancy L Holland et al., (2014) the research Hydrated lime could be used in place of cement in concrete. There are two major difficulties with this sort of cement replacement, as there's always been: the increase in mechanical properties in terms of compressive strength, as well as the cost assessment of the alternatives. The first phase in this inquiry is to examine how well the compressive of a standard concrete mix varies when lime is used on cement. The results of this investigation show that the strength of cement decreases linearly as the relative

proportion of hydrated lime replacement increases. As the study advances, a cost benefit analysis will be addressed.

CHAPTER 3

SCOPE AND OBJECTIVE

AIM:

1. To determine the flexural behaviour of reinforced concrete beam using fly ash, silica fume and hydrated lime in high performance concrete.
2. To determine optimum mix ratio of cement replacement in concrete by adding it with suitable mineral admixture.

OBJECTIVE:

1. To enhance the use of materials like fly ash and silica fume in concrete and study its strength characteristics
2. To check the possibility of implementing hydrated lime and Conplast-SP430 for increasing the compressive strength and durability of concrete
3. To determine the properties of hardened concrete such as compressive strength, flexural strength and tensile strength
4. To compare field behavior and performance with these materials using finite element analysis and experimental analysis.

SCOPE OF THE STUDY:

In this study, the properties of fresh and hardened concrete of M40 grade by addition of cement replacement and admixture. The fly ash and silica fume will be the 50% of cement replacement in addition to the mineral admixture of fly ash and silica fume and hydrated lime and conplast sp-430 will be admixture materials will be incorporated in the present study and characteristic will be evaluated. In present work the fly ash of 45, 40 and 35%. Silica fume of 5, 10 and 15%. Admixture of hydrated lime of 5% of cement for the high performance concrete

CHAPTER 4

MATERIALS AND METHODOLOGY

4.1 MATERIALS:

4.1.1 Cement:

Cement has many features and characteristics that are determined by its chemical makeup. By varying the fineness of grind, oxide compositional cement has diverse qualities and types of cement. The use of additives, changes in chemical components and the utilization of various raw materials have culminated in the production of a diverse variety of cements. The cement utilised in the experiment is 43-grade ORDINARY PORTLAND CEMENT.

Table 4.1 Tests on cement

S.NO	PROPERTIES	VALUES
1.	specific gravity	3.15
2.	standard consistency	32%
3.	Setting time	
	(i) Initial setting time	345 minutes
	(ii) Final setting time	510 minutes
4.	Fineness	3%

4.1.2 Aggregates

Aggregates are necessary ingredients in the production of concrete. They give the concrete structure, help to reduce shrinkage, and have a financial influence. The fact that aggregates contribute for 70-80 percent of the overall weight of concrete does have an impact on the various characteristics and quality of concrete. Previously, aggregates were assumed to be unreactive materials; however it has subsequently been demonstrated

4.1.2.1 Coarse Aggregates

As coarse aggregate, crushed granite in sizes of 10mm and 20mm is employed. The current research makes use of locally available broken blue rock aggregate with sizes ranging from 20mm to 30mm, and the results of the different tests performed just on aggregate are listed below.

Table 4.2 Tests on Coarse aggregate

S.NO	PROPERTIES	VALUES
1.	Fineness modulus	7.12
2.	Specific gravity	2.85
3.	Water absorption	0.3%

4.1.2.2 Fine Aggregates

Fine aggregate that satisfies the requisite qualities for experiments conducted and adheres to zone according to IS: 383-1970 specifications.

It's bought from a local crusher. As fine aggregate, particles with dry density 2.54 that fulfil the standards are employed. The tests listed below are carried out in compliance with IS requirements.

Table 4.3 Tests on fine aggregate

S.NO	PROPERTIES	VALUES
1.	Specific gravity	2.54
2.	Fineness modulus	2.636
3.	Water absorption	2.62
4.	Bulk density	
	(i) Loose state	1537.96 Kg/m ³
	(ii) Rodded state	1778.609 Kg /m ³

4.1.3 Water

Clean drinkable water has been used for concrete mixing and curing. The water has indeed been tested and found to meet the specifications. Because its chemical composition is recognised and highly regulated, potable water is appropriate as a dilution process for cement concrete, ordinary concrete for road construction, and other purposes.

4.1.4 Fly Ash, Silica Fume and Hydrated Lime property

Table.4.4 Properties of Fly Ash, Silica Fume and Hydrated Lime

Property	Fly Ash	Silica Fume	Hydrated Lime
CaO %	1-40	0.1	-
SiO ₂ %	20-60	85-97	0.33
Al ₂ O ₃ %	5-35	0.1	0.45
Fe ₂ O ₃ %	4-40	0.6	0.08
SO ₃ %	0-10	-	-
MgO %	0-10	0.2	0.84
Surface area, m ² /kg	300-500	15000-30000	220-840
Specific gravity	2.38-2.65	2.22	2.25
Colour	Dark grey	White to light grey	White or off white

4.2 METHODOLOGY

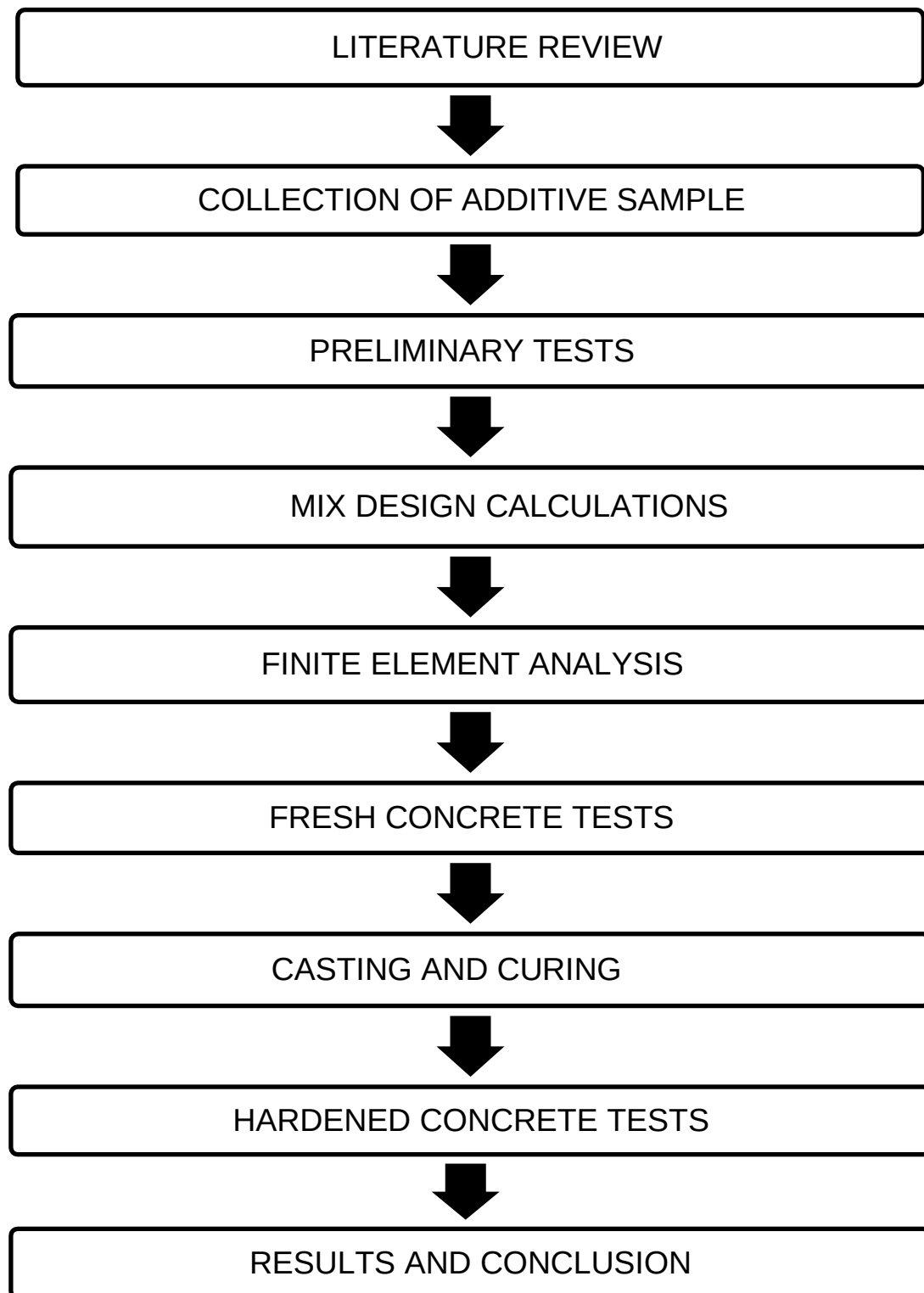


Fig 4.1: Methodology frame work for study

4.3 CONCRETE MIXDESIGN

4.3.1 Mixing Procedure:

To obtain accurate specimen test findings, consistent concrete mixing must be guaranteed. For standard concrete, coarse aggregate is measured for the needed quantity per concrete mixtures and placed into the mixer; subsequently, fully dry sand is measured and put into the mixture.

Cement is measured and properly distributed on the sand surface, ensuring consistent mixing. Dry mixing is performed, and then water is combined with the dry ingredients for a total of five minutes, or until a uniform colour of concrete is observed. The concrete is then put in moulds according to the technique.

Stipulation for Proportion:

1. Grade designation =M40
2. Type of cement = Ordinary Portland Cement 43grade
3. Max nominal size of the aggregate =20mm
4. Min Cement content = 450kg/cum
5. Max W/C ratio =0.45
6. Exposure condition =Moderate
7. Type of aggregate = Crushed angular
8. Aspect Ratio= $l/d = 25/0.5 = 50$

Target strength of mix proportion

$$f'_{ck} = f_{ck} + 1.65 s$$

Where,

f'_{ck} = Target average compressive strength at 28th day,

f_{ck} = Characteristic compressive strength at 28th day,

s = Standard deviation

From Table 1 of IS 10262:2009 standard deviation, $s = 5 \text{ N/mm}^2$

Therefore target strength = $40 + 1.65 \times 5 = 48.25 \text{ N/mm}^2$

4.3.2 Mix Calculation:

a) Vol. of concrete $=1\text{m}^3$

b) Vol. of cement $= [350/3015] \times [1/1000] = 0.111\text{m}^3$

c) Vol. of water $= [140/1] \times [1/1000] = 0.140\text{m}^3$

d) vol. of sp-430 $= [7/1.18] \times [1/1000] = 0.006\text{m}^3$

e) Vol. of all in aggregates (e) $= a - (b + c + d)$

$$= 1 - (0.111 + 0.140 + 0.006)$$

$$= 0.743\text{m}^3$$

f) Mass of coarse aggregates $= e \times \text{Vol. of CA} \times \text{sp.gravity of CA} \times 1000$

$$= 0.743 \times 0.56 \times 2.74 \times 1000$$

$$= 1140 \text{ kg}$$

g) Mass of fine aggregates $= e \times \text{Vol. of FA} \times \text{sp.gravity of FA} \times 1000$

$$= 0.743 \times 0.44 \times 2.74 \times 1000$$

$$= 896 \text{ kg}$$

S.NO	SPECIFICATION	VALUE
1	Cement	310 kg/m ³
2	Water	140 kg/m ³
3	Fine aggregates	896 kg/m ³
4	Coarse aggregates	1140 kg/m ³
5	Super plasticizer	6 kg/m ³
6	w/c ratio	0.4

Mix Proportion= 1: 2.5: 3.2

4.4 EXPERIMENTAL INVESTIGATION

Experiments were conducted on test specimens to examine the strength properties of HPC in various combinations. The experiment is carried out on HPC tested specimen to determine the mechanical and durability properties associated parameters of different mixtures, such as cube compressive, cylinder split tensile, and prism flexural.

Three samples were tested, and the mean for each combination is recorded for each test. All testing are carried out in accordance with Indian norms. The ideal percentage is determined based on the results of the cube and cylinder strength tests. The pre - cast concrete slabs are then casted. The panels are evaluated for compressive, tensile, and flexural strength after 7, 14, and 28 days of curing.

4.4.1 PREPARATION OF SPECIMEN

Concrete slump test The Slump Test (ASTM C 143M-00) is a laboratory experiment designed to measure the strength of the concrete. It carefully measures the properties of concrete in this sample. This test determines the quality of freshly produced concrete. The phrase "consistency" is strongly connected to the concept of "workability." It is a phrase used to describe the condition of new concrete. It relates to how easily the concrete flows. It's being used to determine the level of moisture. Concrete workability is primarily influenced by consistency, i.e. Wetter mixtures will be more usable than drier mixes, and however strength of concrete of same composition may vary. It is used to assess the uniformity of particular batches.

Concrete is made according to the mix design. Four consecutive layers of newly prepared concrete are poured in a neat slump cone. Before applying next layer, 25 tamping is applied to each layer. After the last layer has been tamped, excess concrete is struck off with a shovel from of the top of the mould. The cone is immediately removed by gently and carefully lowering it vertically. The settlement or sinking (slump) in the cone recorded as soon because it comes to a halt (i.e. the difference between both the elevation of the slump mold and the highest peak of the subsidised concrete cone.)

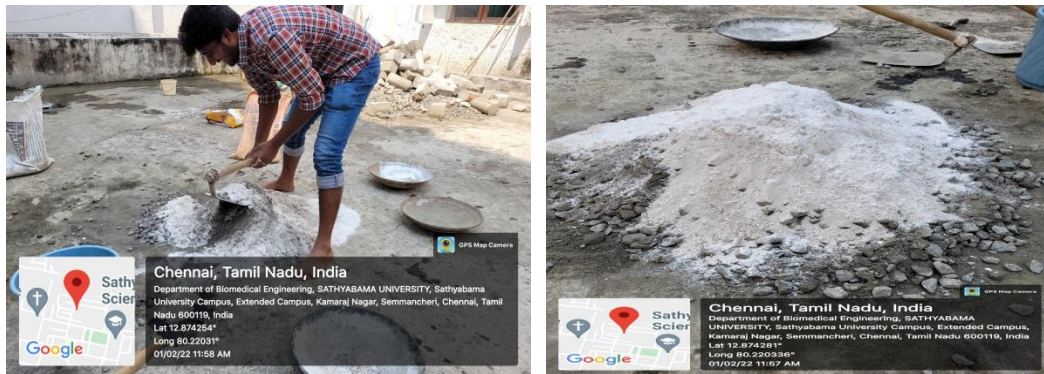


Fig.4.1. concrete preparation

4.4.1.1 CASTING:

CUBE:

The concrete cube specimens are casted by the consideration of following steps

1. Mould:

For conventional aggregate size of 38 mm, the cube Moulds of required dimension a 150 x 150 x 150 metre linear unit. Cube Moulds must be provided with a bottom plate and must conform to IS:10262-2009. 394 kg/m³ cement.

2. Tamping

According to IS: 10262-2009, the tamping rod must be 160.5 mm in diameter, 6002 mm length, with a curved operating end, and constructed of mild steel.

3. Casting Process

The cubic Mould sides must be taken, cleaned carefully, and so all bolts should be tightened entirely. After that, apply a small layer of oil on all Mould's faces. It is necessary for the cubic aspect faces to be parallel. After merging concrete specimens, the cubic should be solid as quickly as feasible. The concrete specimen must be put into cube molds at a depth of 5 cm. When introducing each scoop of concrete, press the scoop along the top of the Mould as that of the concrete pours from it, ensuring an actual procedure of the concrete within the Mould. Every stratum must be manually compressed.

4. Compaction

Every layer of concrete filled into the Mould must be compressed with no more than 35 tool strokes. The strokes must penetrate the underlying layer, and the bottom layer must be rodded to its depth. Anywhere the tool leaves spaces, all borders of the Mould must be approached to close the voids.

CYLINDER:

Concrete material qualities may only be effectively examined if test samples are produced and cured in accordance with standards. Concrete cylinders are commonly used to test the compressive and strength of the concrete.

1. Mould:

Metal cylinder 150 x 300 mm Moulds have been used in the field to cast concrete specimens were tested. They should be set on a smooth, sturdy, flat surface for filling.

2. Tamping :

If 150mm diameter Moulds are utilised, they should be filled in three equal layers and rodded twenty-five rounds with a sixteen millimetre diameter x 450 - 600-millimeter length hemispheric pointed steel rod.

3. Casting :

The strokes must be dispersed evenly over the cross-sectional area of the Mould. The bottom layer must be rodded all the way to the bottom. The rod must penetrate approximately 25 mm through into substratum for each higher layer. If the rod leaves spaces, to seal the voids, scratch the surface of the Mould. Before applying the Ext layers.

PRISM:

According to standards Concrete prism are casted to evaluate the flexural. The casting and testing procedure to be followed as Indian standard code IS 10262-2009.

1. Prism Mould:

The usual dimensions of the metal mould will be 100 x 100 x 500. The tamping bar must be a steel bar that weighs 2kg, is 40 cm long, and has a ramming face that is 25 mm square. The test sample must be created as soon as possible following mixed and in such a manner that complete compacted of concrete is achieved with no segmentation or excess sapling.

2. Casting Process:

The compaction must be dispersed consistently over the Mould's section, and the bottom layer must be occurring through natural throughout its depth. The rod should reach about 25 mm into substratum for each above layer. If the rod leaves spaces, tap the sides of the Mould to fill the voids prior applying the next layer of material.

RC BEAM:

According to standards Concrete beam are casted to evaluate the flexural. The casting and testing procedure to be followed as Indian standard code IS 10262-2009.

1. Beam Mould:

The mould is constructed of wood and is 230 x 230 x 1500. The tamping bar must be a steel bar that weighs 2kg, is 40 cm long, and has a ramming face that is 25 mm square. The test specimen must be created as soon as possible after mixed in such a manner that complete compact of concrete is achieved with no segmentation or excess laitance.

2. Casting Process:

The compaction must be dispersed consistently over the Mould's portion. The bottom layer must be rodded all the way to the bottom. The rod should reach about 25 mm further into substratum for each above layer. If the rod leaves spaces, tap the edges of the Mould to fill the voids before applying the very next layers.

3. Reinforcement details:

Main reinforcement = 2 number of 12mm dia bars

Stirrups = 8 mm dia bars @ 150mm c/c

Specimen dimension: 230mmx230mmx1500mm

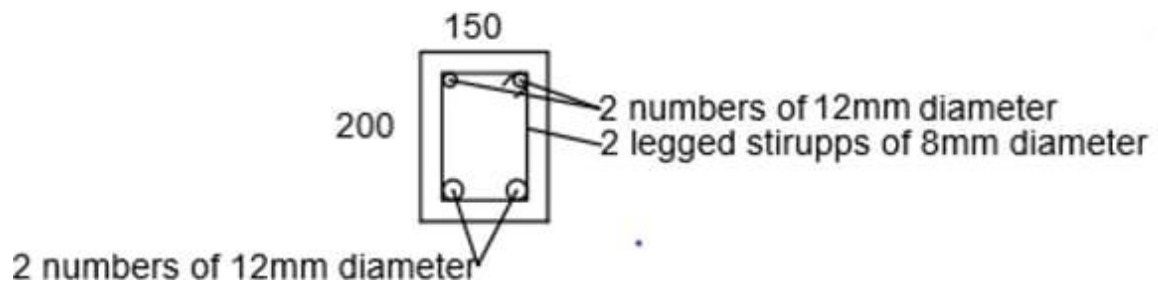
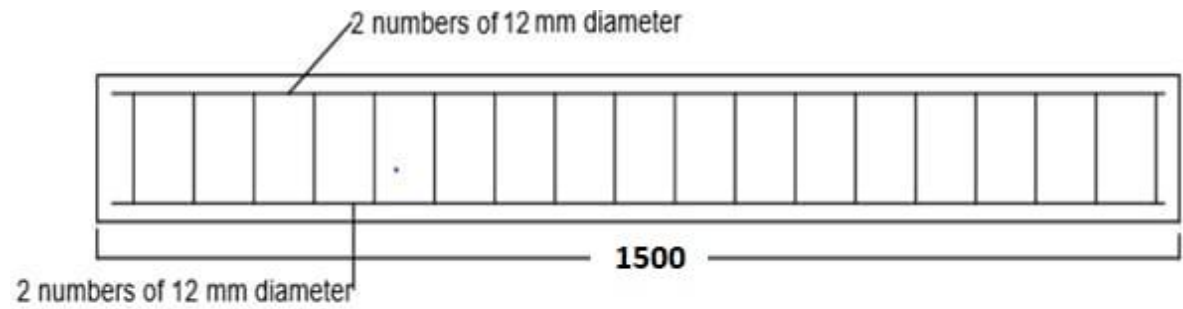




Fig.4.2. RC Beam Casting

4.4.1.2 DEMOULDING AND CURING:

DEMOULDING:

Concrete test specimens should be removed from the mould within sixteen and twenty-four hours after they are formed. If the concrete has not reached a sufficient strength to modify the demoulding without injuring the specimens at this point in time, the demoulding should always be delayed for a further twenty-four hours. After extracting the concrete samples from the Mould, disassemble the Mould completely. Be careful not to damage the specimens since any breaking might affect the all-strength values. When demoulding, use a weather-proof wax or toner to identify each concrete specimen with such a clear identity on the top or bottom. When demoulding, the Mould should be carefully cleaned. Make certain that no oil or debris collects in between flange faces; otherwise, the two parts will not fit together properly, resulting in discharge thru the joint Assistant in nursing an irregularly formed.

CURING:

Curing is essential for the growth of concrete strength and durability. Curing concrete is a way of preventing moisture loss during bonding and maintaining the concrete intact within the appropriate temperature range. Curing hardened concrete may increase its strength while lowering its Preambles. Curing also assists in the avoidance of heat and polymeric fractures, both of which would have a detrimental impact on building longevity. Curing includes keeping the concrete moist or wet until the concrete's association is established and strength is achieved. After the first setting period of concrete, the biological cycle of concrete should commence immediately. As per IS 456 – 2000 concrete shouldn't be cured but seven days for standard Portland Cement, and it should be a minimum of ten days for concrete with mineral admixtures or integrated cement are used. just in case of atmospheric condition and extremely dry temperature conditions, the natural process shouldn't be but ten Days for OPC and fourteen days for concrete with integrated cement & mineral admixtures.

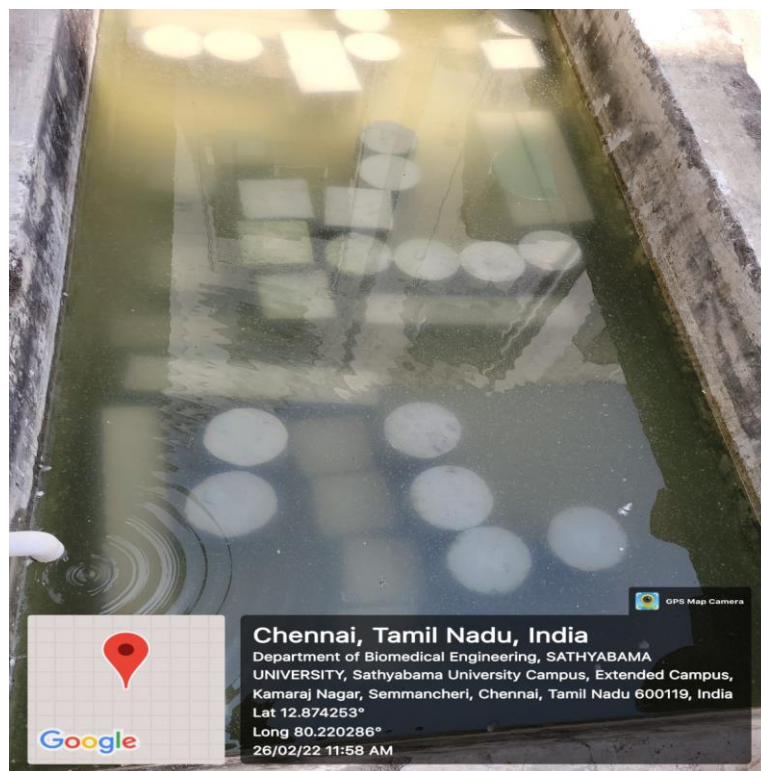


Fig.4.3. Curing

4.4.2 CUBE COMPRESSIVE STRENGTH TEST:

The cubic compressive strength testing is conducted on cube specimens 150mm x 150mm x 150mm in size. After wiping away the surface wetness, all specimens are examined in surface dry state. Three similar specimens are tested using a compression testing equipment at the ages of 7, 14, and 28 days for each mix combination. Loading was kept up until the specimen failed. The ultimate load is determined by the reading at the moment of reversal.. The test setup is shown in fig. 4.4



Fig. 4.4 Compressive strength test

4.4.3 CYLINDER SPLIT TENSILE STRENGTH TEST

This is a test used to assess the tensile strength of cylindrical samples in an indirect manner. The concrete cylinder sample of size 150mm diameter and 300mm length is tested for splitting tensile strength at the age of 28 days using universal testing equipment. The stress is gradually applied until the specimen splits, as well as the readings are recorded. The test setup is show in fig. 4.5. $f = \frac{2P}{\pi dl}$

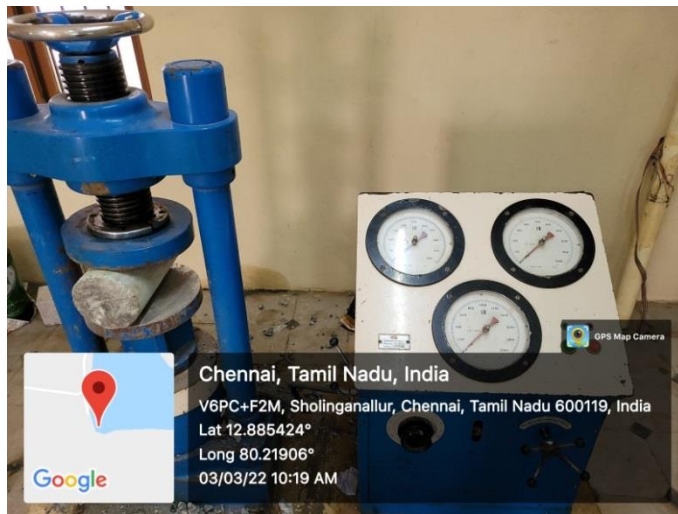


Fig. 4.5 Split tensile strength test

4.4.4 FLEXURAL STRENGTH TEST:

The prisms were examined for flexure to assess their lateral load resistance. As demonstrated in. The prism (100mm x 100mm x 500mm) was horizontally mounted and examined for flexural strength using third point loading. The initial failure site was studied and discovered to be inside the centre third of all prisms. The stress on failure is calculated using the third point loading. Fig. 4.6

$$R = \frac{Pl}{bd^2}$$

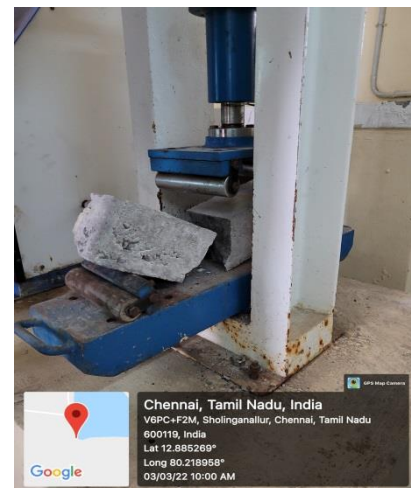


Fig.4.6 Flexural Strength Test

4.4.5 MATERIAL DESIGNATION:

Table 4.5 Material Designation

Fly Ash (%)	Silica fume (%)	Specimen Designation
0%	0%	CONV
45%	5%	FY45SF5
40%	10%	FY40SF10
35%	15%	FY35SF15

4.4.6 RC Beam Test:

A beam with an effective span of 1500 mm are tested under two-point loading by using hydraulic jack with the distance between the loading points as 570 mm after 28 days of curing using wet gunny bags at ambient temperature. LVDT is fixed to measure mid-span deflection.



Fig.4.7. Experimental set up for beam

4.5 NUMERICAL ANALYSIS

4.5.1 GENERAL

Today, the Finite Element Method (FEM) is regarded as a well-established and practical technique again for computer solution of complex problems in a variety of engineering fields, including structural engineering, mechatronics, nuclear engineering, bioengineering, hydrodynamics, heat conduction, geomechanics, and so on. FEM, on the other hand, may be viewed as a powerful instrument for approximating the solutions of difference calculus describing various physical processes.

In many industrial applications, this effective design tool has substantially enhanced both the grade of engineering systems and the method of the design process. The FEM's widespread applicability makes it a strong and universal instrument for a wide range of challenges. As a result, a number of digital software packages have indeed been developed to solve a range of structural problems.

4.5.2 ANSYS WORKBENCH

The Ansys environment is a user-friendly finite element model tool that works in tandem Design Simulation. The ANSYS Workbench software environment allows you to perform structural, thermal, and electromagnetic evaluations. The course emphasizes geometry development and optimization, as well as connecting working frameworks, establishing the finite - element, resolving, and reviewing outcomes. The class will cover how to utilize the code as well as fundamental finite element simulation ideas and results interpretation.

For engineers, ANSYS is a general-purpose program that is used to model interactions in many fields such as physics, structure, vibrating, fluid dynamics, heat transport, and electromagnetic.

ANSYS could accept CAD data and also create geometry using its "pre-processing" capabilities. Similarly, the finite element analysis (a.k.a. mesh) necessary for computing is created in the same pre-processor. After specifying loadings and conducting analysis, the results may be evaluated numerically and graphically.

ANSYS's contact algorithms, time-based loading features, and non - linear material models enable it to perform advanced engineering studies rapidly, safely, and effectively.

Ansys is a platform that combines simulation technologies with parametric CAD tools to provide unparalleled automation and performance. The strength of Ansys is derived from FEA solver algorithms that have been refined throughout time. Furthermore, the goal of Ansys is to verify and improve the product in a virtual environment.

4.5.3 ANSYS MODEL

The analysis focuses on

1. Engineering data
2. Fixing up the geometry of beam in design model
3. Setting up the finite element model
4. Providing the support and loading conditions
5. Checking for equivalent stress, strain and deformation

4.5.3.1 ENGINEERING DATA

The materials are to be assigned for the creating model. Here selecting the materials which are used in modelling like steel, concrete. The grade of concrete used in this modelling is M40 Compressive strength value. And grade of steel is FE415. For reinforcement details.

	A	B	C	D	E
1	Contents of Engineering Data			Source	Description
2	Material				
3	Concrete				
4	Structural Steel				Fatigue Data at zero mean stress comes from 1998 ASME BPV Code, Section 8, Div 2, Table 5-110.1
*	Click here to add a new material				

Properties of Outline Row 3: Concrete				
	A	B	C	D
1	Property	Value	Unit	
2	Material Field Variables	Table		
3	Density	2500	kg m ⁻³	
4	Isotropic Secant Coefficient of Thermal Expansion			
6	Isotropic Elasticity			
7	Derive from	Young's Modulus and Pois...		
8	Young's Modulus	31623	MPa	
9	Poisson's Ratio	0.18		
10	Bulk Modulus	1.647E+10	Pa	
11	Shear Modulus	1.3399E+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 4.8 ANSYS Material Property

4.5.3.2 GEOMETRY CREATION

After assigning the material in engineering data, the model is created by providing the proper dimensions of the beam, diameter of bars. Separate model is to be created for all the materials like concrete, steel and it should be assigned for the respective model.

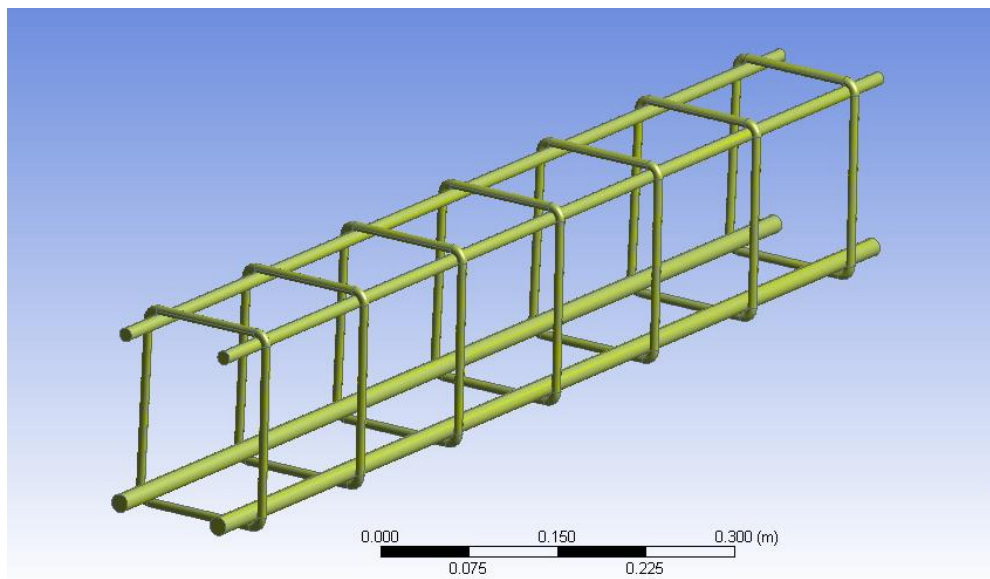


Fig 4.9 geometry of beam in design model

4.5.3.3 SETTING UP THE FINITE ELEMENT MODEL

After you've finished designing the geometry, move on to the modelling step and assign all of the material attributes. Then we will construct a mesh that will aid us in fixing the issues using the finite element approach and obtaining correct results

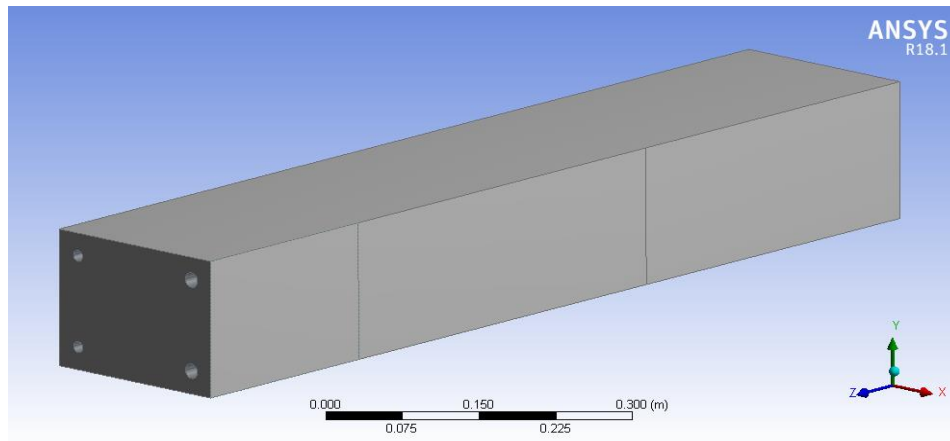


Fig 4.10 mechanical model

4.5.3.4 PROVIDING THE SUPPORT AND LOADING CONDITION

The RC beam was subjected to a two-point load. Following the application of load, the equation is validated for the needed results, and the model's failure mode is obtained.

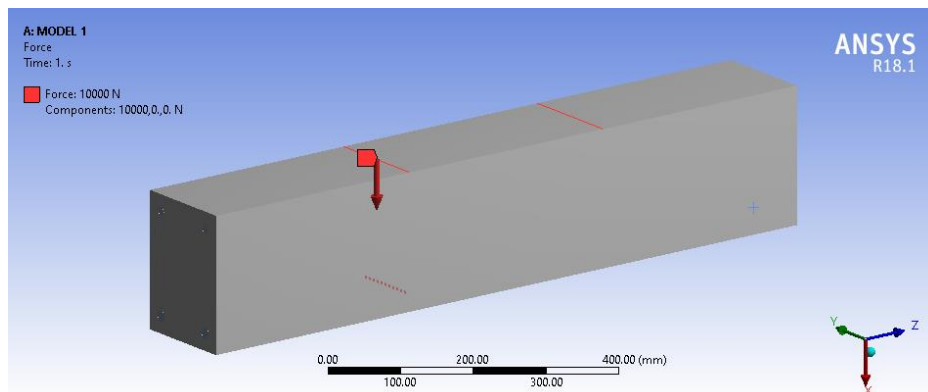


Fig4.11 loading condition

CHAPTER-5

RESULT AND DISCUSSION

This chapter presents test results and discusses the development of compressive strength, tensile strength, and flexural strength of high performance concrete at different percentages and curing times.

5.1 Slump Cone Test Result

Table 5.1 Slump Value

Specimen	Slump Result
CONV	100mm
FA45SF5	60mm
FA40SF10	75mm
FA35SF15	90mm

5.2 Experimental Results:

5.2.1 Compressive strength

This method may be used to develop a method for assessing the concrete strength samples. When test specimens are withdrawn from the water while still wet, they must be tested as shown. The specimens were also kept moist by covering them with damp burlap. In the region of the unit in interface with the compression plates, the material properties of the test machine must be cleaned and dried with soft sand or other debris away from of the test specimen surface. In the instance of the cubic, 12 samples are loaded into the machine such that the force is applied to the forgings' opposing faces, rather than the top and bottom face images.

The test piece's axis must be precisely aligned with the pressure environment of the circular disc. The packing must not be employed between the edges of the sample group and, as a result, the test machine's steel plate. To load the specimen equally, the maximum load must be set at 5.2 KN/s for 15 cubic centimetres.

The load must be delivered without shock and gradually raised until the test piece's resistance to the growing load was overcome and no further weight can be maintained. The maximum force applied to the sample should then be documented, as well as the look of a concrete and any odd failure patterns.

The basic criteria for structural design are compressive strength. The development of strength in HPC reinforced concrete was evaluated at 7, 14, and 28 days. Compressive strength varies with cement ratio as compared to standard concrete. The outcomes among all concrete samples reveal that compressive improves as the age of setting increases.

Table 5.2: 7th Day Compressive Strength

% OF CEMENT CONTENT	COMPRESSIVE STRENGTH in N/mm²
CONV	34.26
FA45SF5	42.65
FA40SF10	39.32
FA35SF15	35.46

Table 5.3: 14th Day Compressive Strength

% OF CEMENT CONTENT	COMPRESSIVE STRENGTH in N/mm²
CONV	41.53
FA45SF5	48.96
FA40SF10	45.84
FA35SF15	41.67

Table 5.4: 28th Day Compressive Strength

% OF CEMENT CONTENT	COMPRESSIVE STRENGTH in N/mm²
CONV	48.12
FA45SF5	55.48
FA40SF10	51.67
FA35SF15	47.56

Table 5.5: 7,14&28 Day Compressive Strength

%OF CEMENT CONTENT	7 Days N/mm²	14 Days N/mm²	28 Days N/mm²
CONV	34.26	41.53	48.12
FA45SF5	42.65	48.96	55.48
FA40SF10	39.32	45.84	51.67
FA35SF15	35.46	41.67	47.56

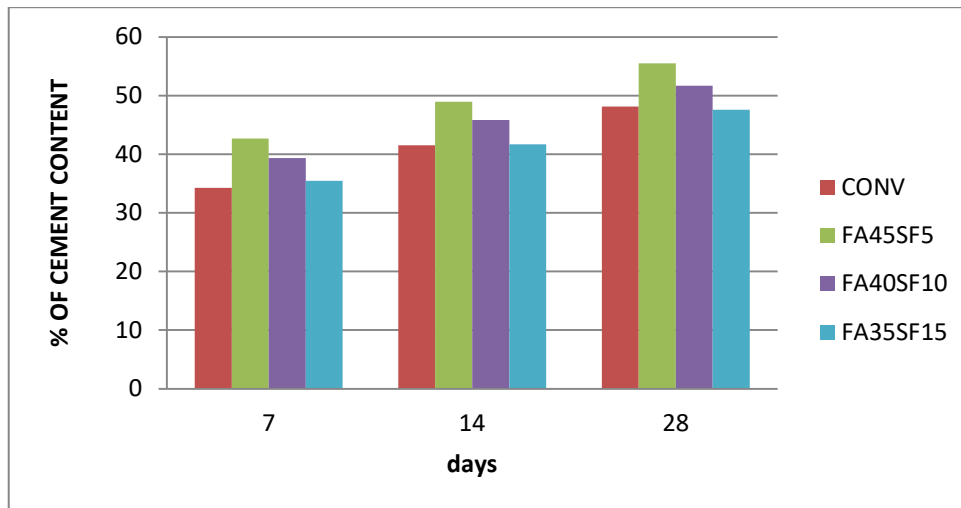


Fig5.1: Comparison of compressive strength

Fly ash does improve the statically compressive, with gains ranging from basically nil to perhaps percent. Silica fume's effect on compressive strength is negligible. However, the fly ash significantly improves the material's post-cracking ductile, or energy absorption.

5.2.2 Split Tensile Strength

This process applies to the development of a testing method to determine the fraction strength of the concrete specimens. When the specimen is received dry, it must be submerged in water for twenty-four hours before testing. Unless otherwise specified for a specific laboratory investigation, samples should be analysed immediately after being removed from water even while wet. Fresh water and dust must be eliminated from the specimen, as well as any fins from any square-sized areas covered with packing tape.

Any acceptable process and equipment should be used to draw marked diameters at the end of the test section to confirm that both lie in same axial plane. When the specimen is placed in the tester, the support portions of the analyzer and the packaging are examined.

Positioning - Place one of the laminated strips in the center of both the bottom shelf. The specimen must be put on the laminate and oriented such that the lines designated either at extremity of the template square are parallel and in the center of the lamination. The second laminate strip should be put straight on the cylinder, centered on the lines specified at the cylinder's ends. Aggregation should be segregated to ensure the requirements listed below.

- The lines indicated on the extremities of the sample square measure vertical, and the extension of the plane of the two lines indicated on the ends of the molecule crosses the platens in the center.

- The supplemental bearing bar or plate, if employed, and the sample square measure immediately at a lower position the spherical bearing block's center of push.

Load Rate - The load must be introduced without shock and continually expanded at a rate that provides a tension force with between 14 and 21 kg/cm²/min till the specimen's strength under load becomes unsatisfactory and no bigger loads can be maintained. This load rate is 1.62 kN/s to 2.43 kN/s for 15 cylinders with diameters of 39 cm and lengths of 30 cm. After that, the greatest load applied to a test item must be recorded. It is important to take notice of the look of the concrete as well as any unexpected alternatives inside the design of even damage.

Tensile strength was tested for wet drying concrete specimens at 7, 14, and 28 days of age.

According to the graphs, the tensile strength of cement reinforced concrete rises at all hardening ages when compared to conventional concrete. This rise may be due to a large decrease in the capillaries permeability of the adhesives substrate but also excellent distribution of the cement grains in the mixture, which increases bond strength and leads to a substantial increase in strength. When separating, pull.

Table 5.6: 7th Day Split Tensile Strength

% OF CEMENT CONTENT	TENSILE STRENGTH in N/mm²
CONV	3.41
FA45SF5	4.05
FA40SF10	3.81
FA35SF15	3.36

Table 5.7: 14th Day Split Tensile Strength

% OF CEMENT CONTENT	TENSILE STRENGTH in N/mm²
CONV	3.89
FA45SF5	5.02
FA40SF10	4.35
FA35SF15	3.96

Table 5.8: 28th Day Split Tensile Strength

% OF CEMENT CONTEN T	TENSILE STRENGTH in N/mm²
CONV	4.34
FA45SF5	6.32
FA40SF10	5.62
FA35SF15	4.55

Table 5.9: 7, 14&28 Day Split Tensile Strength

%OF CEMENT CONTENT	7 Days N/mm²	14 Days N/mm²	28 Days N/mm²
CONV	3.41	3.89	4.34
FA45SF5	4.05	5.02	6.32
FA40SF10	3.81	4.35	5.62
FA35SF15	3.36	3.96	4.55

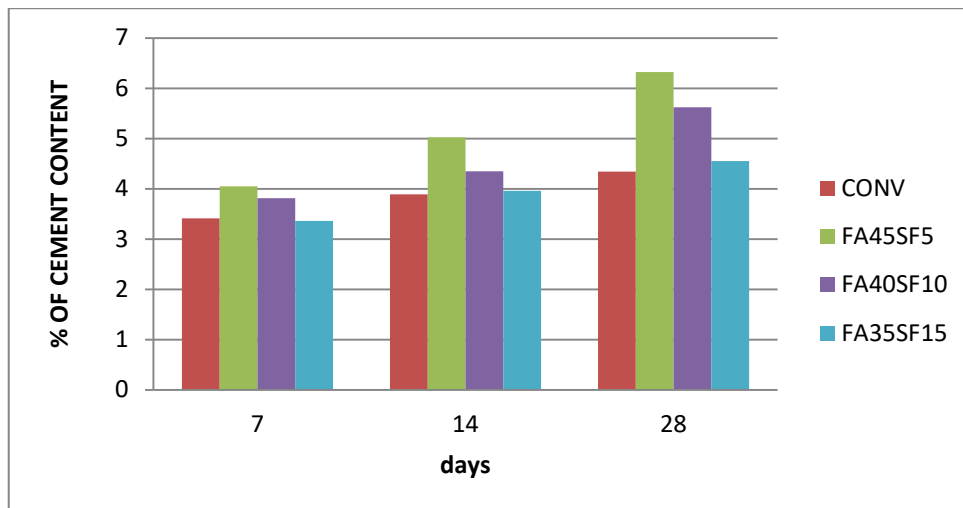


Fig5.2: Comparison of Split Tensile Strength

Nevertheless, for more or less uniformly dispersed fly ash and silica fume, the strength gain varies from as low as no increase in certain cases to about a percent increase, with several studies finding intermediate values. HPC splitting-tension test yields comparable results. However, just like compression, fly ash causes huge rise in the post-cracking characteristics or toughness of composites.

5.2.3 Flexural Strength

The compression strength of concrete and tension both in directions are shown to be strongly connected; however the relation is not of proportional relationship. The total concrete strength determines the combination of two strengths. In other words, higher compressive value concretes have higher tensile strength; nonetheless, the ratio of split tensile increase is increasing in a linear fashion.

Table 5.10: 7th Day Flexural Strength

% OF CEMENT CONTENT	Flexural Strength in N/mm²
CONV	6.28
FA45SF5	7.52
FA40SF10	7.05
FA35SF15	6.11

Table 5.11: 14th Day Flexural Strength

% OF CEMENT CONTENT	Flexural Strength in N/mm²
CONV	7.26
FA45SF5	8.74
FA40SF10	7.66
FA35SF15	7.14

Table 5.12: 28th Day Flexural Strength

% OF CEMENT CONTENT	Flexural Strength in N/mm²
CONV	8.55
FA45SF5	9.45
FA40SF10	8.18
FA35SF15	7.73

Table 5.13: 7,14 &28 days Flexural Strength

%OF CEMENT CONTENT	7 Days N/mm²	14 Days N/mm²	28 Days N/mm²
CONV	6.28	7.26	8.55
FA45SF5	7.52	8.74	9.45
FA40SF10	7.05	7.66	8.18
FA35SF15	6.11	7.14	7.73

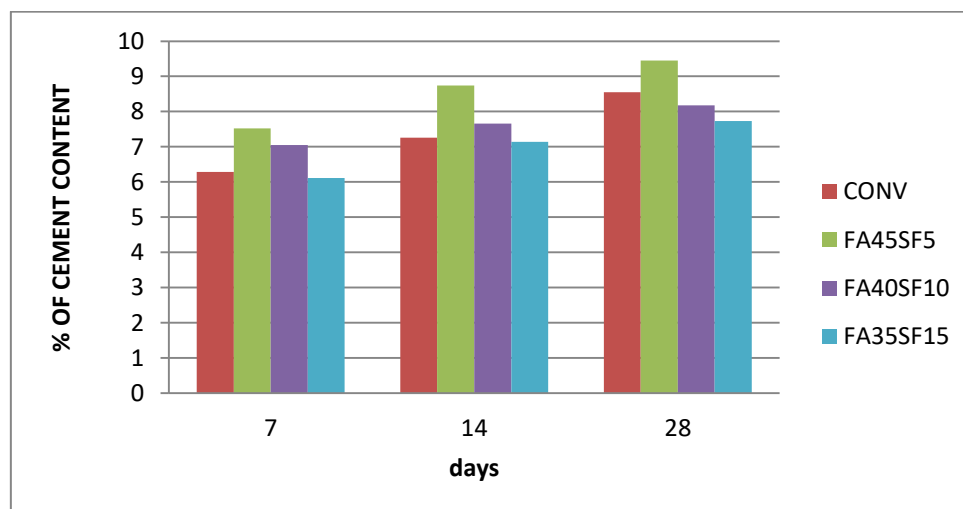


Fig 5.3: Comparison of Day Flexural Strength

Fly ash has been shown to have a substantially bigger aggregate influence on the flexural of HPC than on the compressive or tensile strength, and rises of more than percent observed. The rise in flexural is notably sensitive to not just the FA45SF5 content, but also the area ratio of the HPC, having greater aspect ratio resulting in bigger strength increases. Fly Ash with superior bond properties has higher toughness ratings than smooth for all empirical measurements of toughness.

Table 5.14: Percentage Increase in Strength over conventional mix

Sl. No	Properties	Gain Over Normal Concrete
1.	Compressive Strength	15.29%
2.	Split Tensile Strength	45.62%
3.	Flexural Strength	10.52%

5.2.4 RC Beam Test Result:

The beam was subjected to two-point loading after 28 days of curing. Three LVDTs were placed below the two-point loading supports and mid-point. For every 10 kN, three deflection values were noted. The first crack load for the FA45SF5 beam was 50 kN and the initial crack load for the Conventional beam was observed to be 40 kN.

Specimen details:

Main reinforcement = 3 number of 12mm dia bars

Stirrups = 8 mm dia bars @ 150mm c/c

Specimen dimension= 150mmx200mmx1000mm

Table 5.15 load and deflection values (experimental)

S.NO	Load(KN)	CONV	FA45SF5
1	10	56	70
2	20	73	96
3	30	113	140
4	40	147	166
5	50	170	189

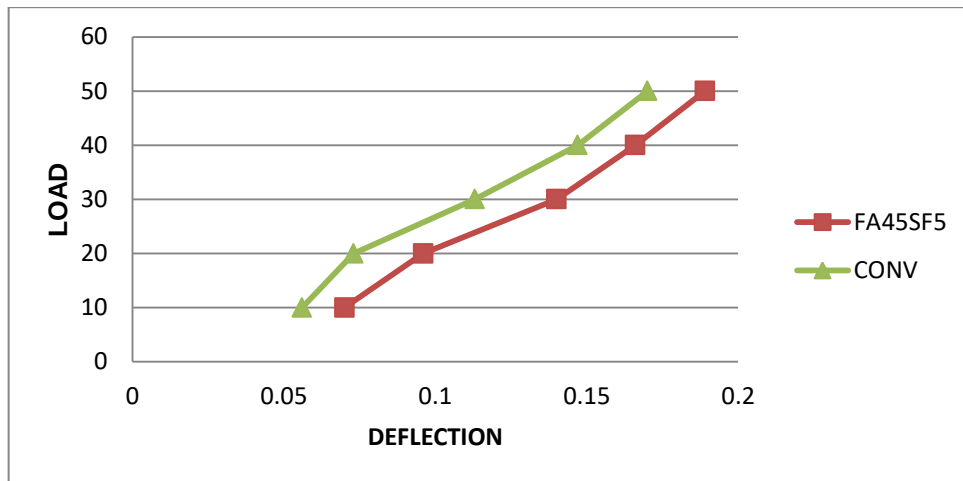


Fig 5.4 load and deflection behaviour (experimental)

5.3 Numerical Result:

1.3.1 Conventional beam:

The numerical analysis is conducted for the Conventional beam. The stress contour of conventional RC beam is shown in Fig.5.5.

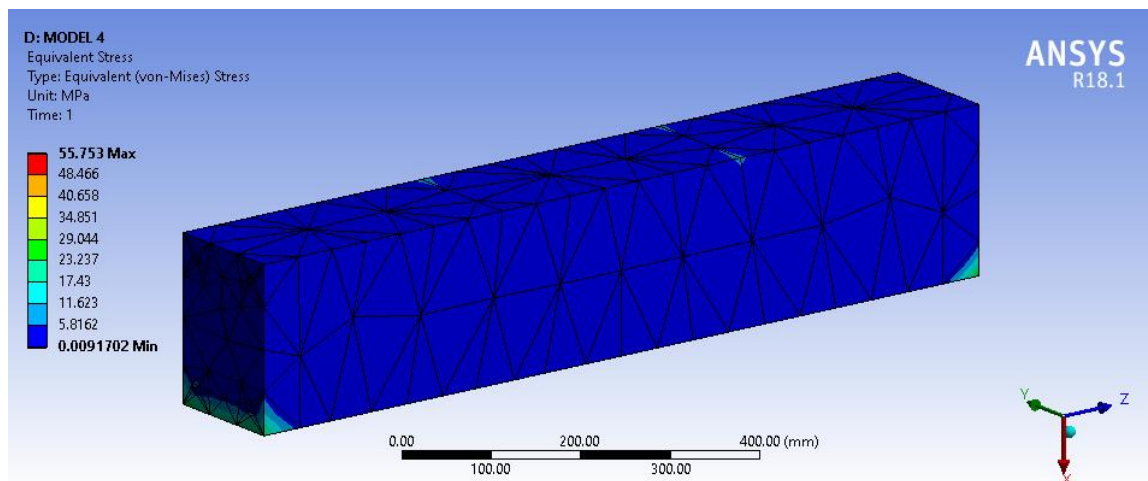


Fig 5.5 Stress Contour for RC Beam

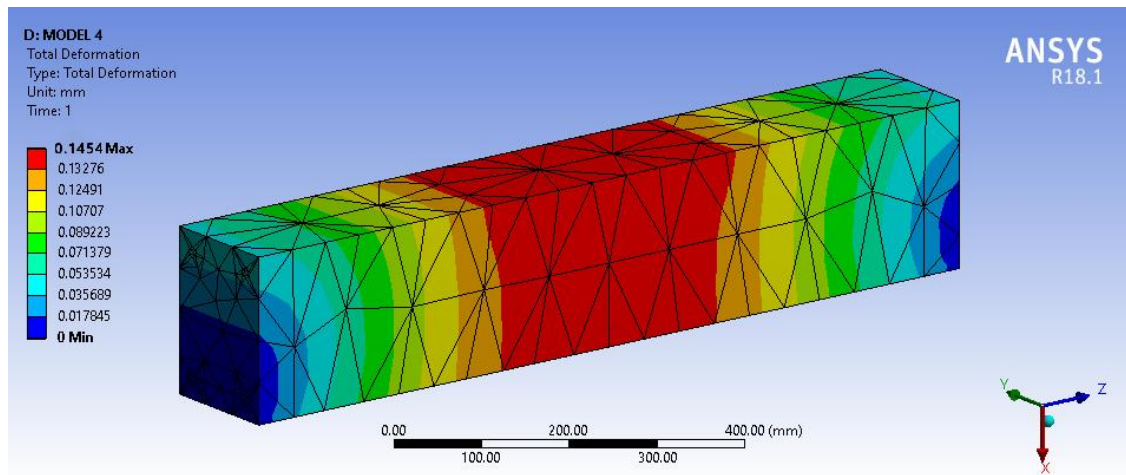


Fig 5.6 Deformation for RC Beam

1.3.2 FA45SF5:

The numerical analysis is conducted for the FA45SF5. The stress contours of FA45SF5 RC beam are shown in Fig.5.7.

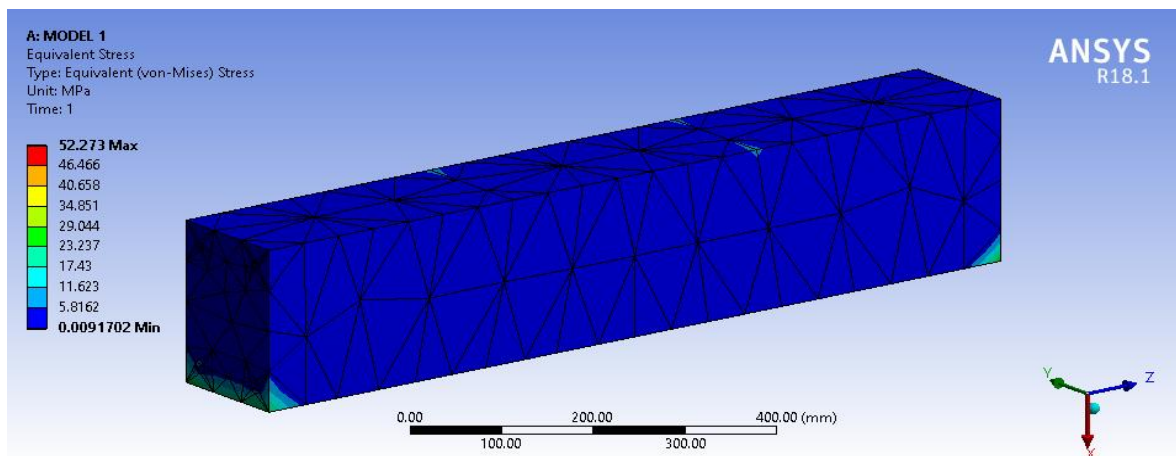


Fig 5.7 Stress Contour for FA45SF5 Beam

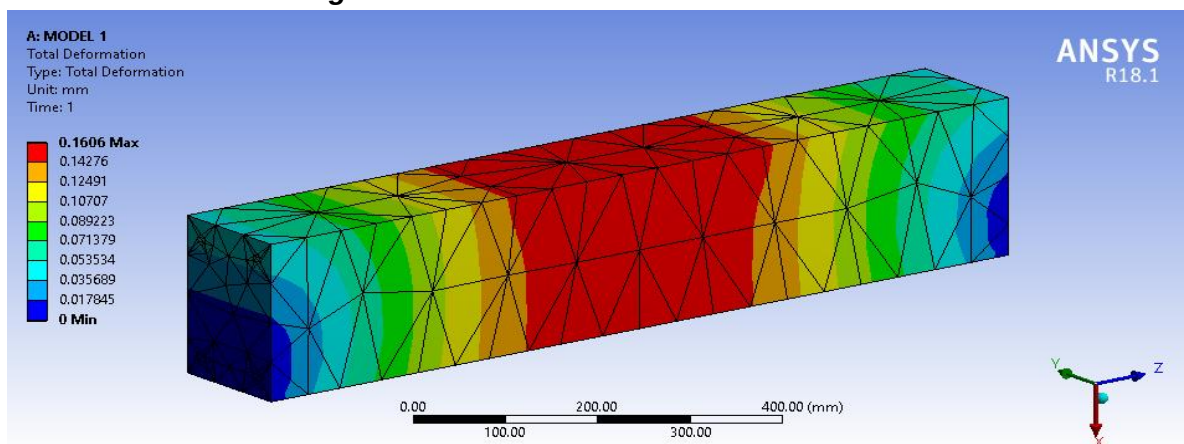
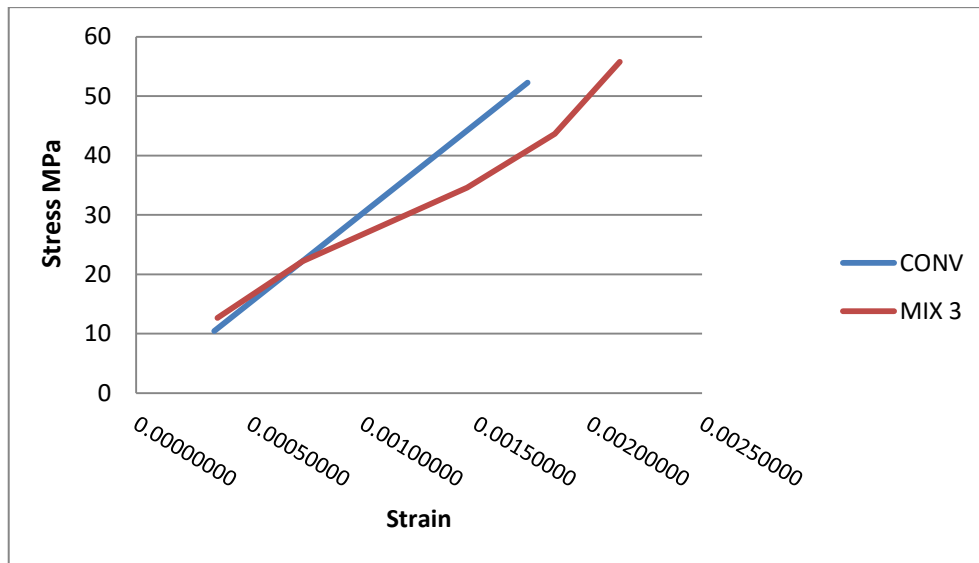


Fig 5.8 Deformation for FA45SF5 Beam

Table 5.16 load and deflection value (analytical)

SN. No	Specimen Designation	Ultimate Load (KN)	Deflection (mm)
1	Conventional Beam	50	0.145
2	FA45SF5	50	0.160

**Fig 5.9 stress vs strain curve**

The evolved solution done using the FEA method and this is the results for stress and strain in that the gradually increase of strain after 20KN of load is shown in Fig 5.9.

Table 5.17 load vs deflection curve (analytical)

S.NO	LOAD	CONV	FA45SF5
1	10	0.026	0.032
2	20	0.041	0.064
3	30	0.082	0.096
4	40	0.107	0.128
5	50	0.145	0.16

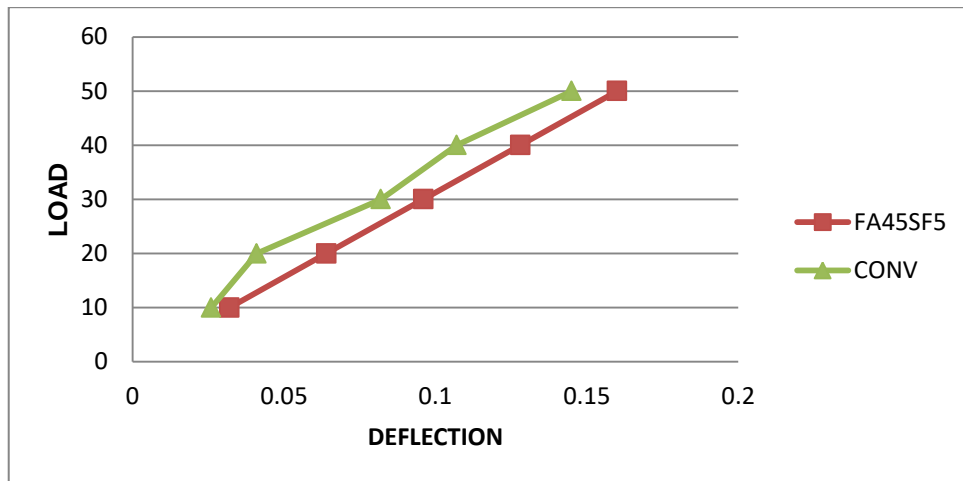


Fig 5.10 load vs deflection curve (analytical)

The stress vs strain curve and load vs deflection curve for analytical study is plotted in below fig 5.9 and 5.10. This curve is plotted by the results obtained in ansys software. And it is compared with experiment results.

1.4 COMPARISON OF EXPERIMENTAL RESULTS WITH ANALYTICAL RESULTS:

We could see that almost the experimental value of conventional beam values are almost same for both analytical and experiment procedures. But whereas we see the FA45SF5 it shows some slight variations in analytical value. The experiment value is higher than the analytical value. So the experimental procedure shows us that it can used to achieve high strength with minimum increase of whole weight of the concrete.

Table 5.18 comparison of conventional beam experimental with analytical results

S.NO	LOAD	CONV/E	CONV/A
1	10	0.056	0.026
2	20	0.073	0.041
3	30	0.113	0.082
4	40	0.147	0.107
5	50	0.17	0.145

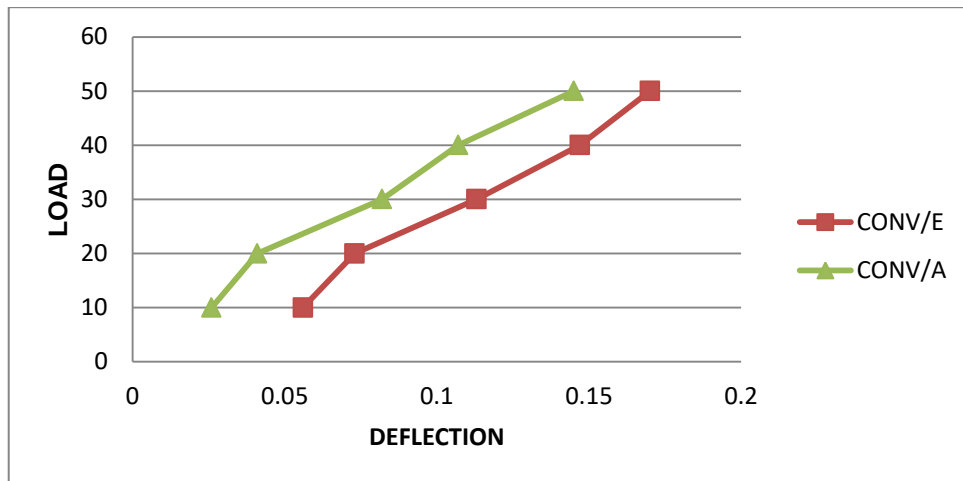


Fig 5.11 comparison of conventional beam experimental with analytical results

Table 5.19 comparison of FA45SF5 beam experimental results with analytical results

S.NO	LOAD	FA45SF5/E	FA45SF5/A
1	10	0.07	0.032
2	20	0.096	0.064
3	30	0.14	0.096
4	40	0.166	0.128
5	50	0.189	0.160

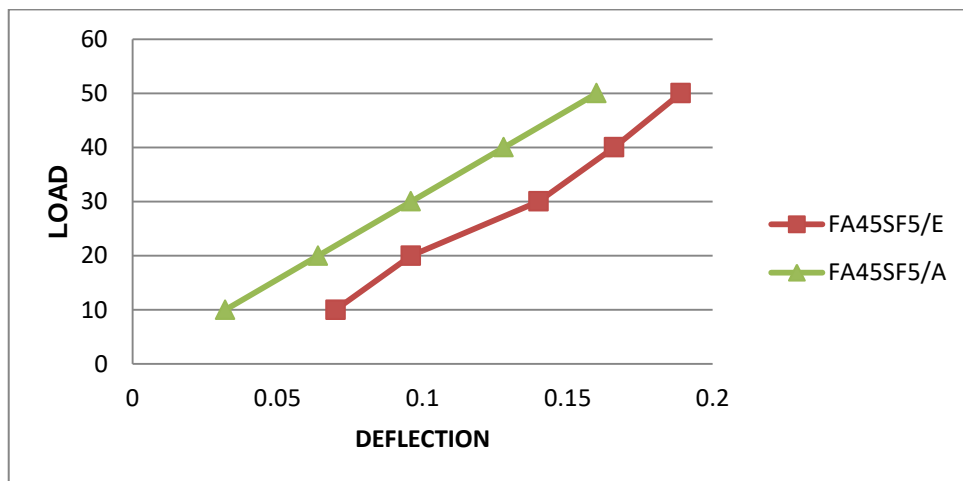


Fig5.12 comparison of FA45SF5 beam experimental results with analytical results

CHAPTER-6 CONCLUSION

Fly ash improves the compressive, tensile, and flexural strength of concrete. It also improves resistance to alkali aggregation reactions, reduces moisture, oxygen, chloride, carbon dioxide, and hostile chemicals, and inhibits corrosion. The primary drawbacks of utilizing fly ash include a slower rate of strength improvement, greater air entrainment, and increasing slump loss.

The use of silica fume increases the strength of concrete by 10–15 percent while also providing excellent early strength. Other benefits of using silica fume include a decreased water-cement mix, resistance to frost action, and a chemical impact. However, silica fume decreases the workability and enhances the uniformity of high performance concrete.

The use of hydrated lime promotes the effectiveness of mechanical strengths in HPC concrete, particularly early mechanical strength. The mechanical strengths of HPC concrete grow initially, then fall, and reach their maximum value when the hydrated lime level is 5%.

The impact of fly ash accumulation on the compressive strength has increasing by 15.29% with optimal mix of FA45SF5 when compared with nominal mix. Further, in other mixes, increase in silica fume content significantly affects the strength characteristics. The increase in fly ash showed an increase in compressive, strength than normal mix. The results of the splitting tensile strength tests show that, there is an increase in strength by increasing fly ash. It was found that highest splitting tensile strength was achieved by FA45SF5, which was found about 6.32 N/mm² compared with other mix. The load carrying capacity is increased to 10.52 % compared with the conventional specimen. Based on the experimental test result there is an improvement in flexural strength of the FA45SF5 mix is higher at age of 7,14 & 28 days respectively compared to all other mixes.

The beams were analyzed using 2-point load test and flexural cracks have been observed. From the study it shows that use of FA45SF5 showed an improvement in both the ways and also increase the flexural capacity of the beam and it helps to increase stiffness under service loads. It also helps to reduce the deflection in both ways. Comparison of FA45SF5 beam experimental results with

analytical results has not the major variations on the beam that deflects after 30kn in the mix

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