Behavior of HSC using Polypropylene Fiber- an Experimental Study

Dissertation Report Submitted

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CERTIFICATE

Certified that this Dissertation report entitled **"Behavior of HSC using Polypropylene Fiber – An Experimental study"** submitted by **"Nidhi Sharma**, Registration No. **11305931**" student of Civil Engineering Department, Lovely Professional University, Phagwara, Punjab who carried out the dissertation work under my supervision.

This report has not been submitted to any other university or institution for the award of any degree.

This is to certify that the above statement made by the candidate is correct to best of my knowledge.

Signature

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CIVIL ENGINEERING	DISSERTATION GUIDE

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LIST OF GRAPHS

TERMINOLOGY

- FA – Fine Aggregates
- CA – Coarse Aggregates
- PP – Polypropylene
- HSC- High Strength Concrete
- FRC – Fiber Reinforced Concrete
- FAC – Fly Ash Concrete
- HPC – High Performance Concrete
- UHPS – Ultra High Performance Concrete
- SCC – Self Compacting/Consolidating Concrete
- CTM – Compression Testing Machine
- FTM – Flexural Testing Machine
- UTM – Universal Testing Machine
- BIS – Bureau of Indian Standards
- ASCE – American Society of Civil Engineering
- CFT – Circular steel concrete Filled Tubes
- PTCFT - Circular steel Post Tensioned concrete Filled Tubes
- FRCFT - Circular steel Fiber–Reinforced concrete Filled Tubes
- MOR – Moment Of Resistance
- IJAIEM - International Journal of Application or Innovation in Engineering & Management
- IJAFRSE - International Journal of Advance Foundation and Research in Science & Engineering
- OPC – Ordinary Portland Cement
- PPC – Pozzolana Portland Cement
- w/c – water cement ratio
- PFRC – Polypropylene Fiber Reinforced Concrete

ABSTRACT

In this present workexperimental investigation has been done to observe the change in behavior of High Strength Concrete (HSC) using PPF. In this paper, comparison of conventional concrete of grade M60 has been done with High Strength Concrete containing 3%, 4% & 5% of Polypropylene fibers replacing the cement content. Sikament, the superplasticizer 0.5% by weight of cement has been added to the concrete. The experimentation resulted in improved increase in compressive strength, split tensile strength and flexural strength. It has been observed that compressive strength increases by 5.35%, 6.2% & 7.9% at 3%, 4% and 5% respectively. It has been observed that split tensile strength increases by 18.08%, 24.3% & 37.3% at 3%, 4% and 5% respectively. It has been observed that flexural strength increases by 14.4%, 21.2% & 31.4% at 3%, 4% and 5% respectively. High Strength Concrete with 5% of Polypropylene Fiber content replacing the cement showed the optimum results.

CHAPTER 1

INTRODUCTION

1.1 HSC

Basically, concrete consists of Fine Aggregates (FA), Coarse Aggregates (CA) and Cement. High Strength concrete is used as various standards and for different common applications and also it is not limited to the strength factor.

The concrete whose strength ranges from 40 MPa to 100 MPa is known as High Strength Concrete (HSC). It can be used for both pre-casting and in-situ works. Various in-situ structures in which High Strength Concrete can be used are offshore structures, columns, long span bridge structures as well as highways, etc. Water cement ratio mostly used in HSC is 0.35. Super plasticizers such as metakaolin, sikament, silica fume are used to enhance the strength of the High Strength Concrete.

As per IS codes compressive strength greater than 40 MPa is High Strength Concrete.

HSC is the accessibility of better strength, high fluidity, better durability as well as permeability can cope up with the need of today's engineering structures for long span, tall rise buildings and heavy loads and even for bad weather conditions.

HSC (High Strength Concrete) can be compared to various concretes which are as under:-

- Fiber Reinforced Concrete (FRC)
- High performance Concrete (HPC)
- Ultra high performance concrete (UHPC)
- Self- Compacting Concrete (SCC)

FRC: Concrete consisting of fibrous content of various fibers such as steel, polypropylene etc is known as fiber reinforced concrete.

HPC: Concrete with high strength is the high performance concrete. In this type of concrete durability is the main factor considered. Also it consists of various other standards such as

a) Early age strength
b) Permeability
c) Density
d) Toughness
e) Hydrated heat
f) Stability
g) Durability
h) Strength
i) Endurance

UHPC: Concrete with high durability and strength ranging from 150 MPa to 250 MPa containing fibers such as steel fibers, polypropylene fibers, etc.

SCC: Concrete having increased workability due to high water cement ratio is known as Self compacting concrete or self-consolidating concrete.

High Strength Concrete (HSC) is an important factor for developing the concrete technology.

In this paper HSC comprises of Polypropylene fibers and 0.5% of sikament super plasticizers for improvement of the strength factor.

- For example: -Nuclear power plants situated at Kaiga in Karnataka examined and constructed with grade M60 of HSC by M/s L&T and RAPP situated in Rajasthan procedure and completed by M/s HCC, both in the year 1998. To get the desired strength silica fumes were used as super plasticizer.
- Fly-overs using M75 grade of high Strength concrete is in construction by M/s AFCONS situated at PUNE. Silica Fume and Fly ash are being used as supplementary binders in HSC to achieve the high strength. Only due to this reason slender piers and post tensioned segmental super structure became possible to be designed.
- Shear wall with more lateral stiffness can decrease the lateral displacements of the buildings. Therefore, it clearly proves that it can be widely used in modern technology for tall structures.

Advantages for High Strength Concrete:-

- Decreases the wall thickness of concrete shear wall
- Improves the room space
- Results in great economic and social advantages
- HSC can overcome the characteristics and constructional behavior of conventional concrete
- Provides better strength at early age
- Provides resistance to abrasion
- Better modulus of elasticity
- Highly strengthened and provides long life in bad weather conditions
- Also provides high resistance to chemical attack as well as frost
- HSC is very stable

This experimental study will represent the study of compressive strength, split tensile strength and flexural strength of M60 concrete by replacing the 3%, 4% and 5% of cement with Polypropylene Fibers. Tests will be conducted on concrete cubes and shall be studied for compressive strength, split tensile strength and flexural strength. Then these results were compared with the normal or conventional concrete.

Applications where High Strength Concrete (HSC) can be used are as under:

- Tunnels
- Bridges
- Tall Buildings
- Poles
- Parking Areas (Garages)
- Agricultural Applications

Materials to be used:

- Cement
- Fine Aggregates (FA)
- Coarse Aggregates (CA)
- Water
- Super-plasticizer
- Polypropylene fiber

Cement: Ordinary Portland cement of grade 53 confirming to IS code 8112-1989.

Fine Aggregates: Sand having bulk density 1754 kg/cum and fineness modulus 3.16. The specific gravity to be used 2.57.

Fine Aggregate Sieves

SI Units	US Units
4.75 mm	No. 4 (0.187 in.)
2.36 mm	No. 8 (0.0937 in.)
1.18 mm	No. 16 (0.0469 in.)
.600 mm	No. 30 (0.0234 in.)
.300 mm	No. 50 (0.0117 in.)
150 mm	No. 100 (.0059 in.)
.075 mm	No. 200 (.0029 in.)

Coarse Aggregate: The natural granite aggregates having fineness modulus of 7.18 and bulk density of 1618 kg/cum. The specific gravity of coarse aggregate is 2.67.

Polypropylene Fiber: The fiber or the plastic polymer which can be used for various purposes such as in industries, consumer goods, structural plastic etc.

1.2 DEMAND OF HSC

The mixture of the concrete that tends to attain the better strength as compared to the normal concrete is known as High Strength Concrete (HSC). **HSC (High Strength Concrete)** can be compared to various concretes which are as under:-

- Fiber Reinforced Concrete (FRC)
- High performance Concrete (HPC)
- Ultra high performance concrete (UHPC)
- Self- Compacting Concrete (SCC)
- Highly Durable Concrete along with resistance against water penetration
- Durable concrete containing high chloride penetration resistance

It is very high in demand due to its increased strength and performance which can be used for various applications which are as under: -

- Bridges
- Roads
- Metro Railways
- Dams
- Ports
- Thermal Power plants
- Nuclear power plants, etc.

High Strength concrete consists of various cementing materials which are as under:-

- Fly Ash
- Silica Fume/ Ground Granulated Blast Furnace Slag
- Super Plasticizer

CHAPTER 2

SCOPE OF THE STUDY

For both sub structures and super structures of bridges High Strength concrete can be used. Guidelines can be provided for producing the mix design of the high Strength concrete (HSC). In the present work percentage of polypropylene fibers has been varied. To study the strength properties of M60 concrete. This study can be extended to:

- Variation in Fiber content to study the change in behavior of M60.
- Keeping the same variations in fibers the effect of different w/c ratio can be studied.
- The experiments can be done for change in durability.
- The study can be extended on effects of curing at different temperatures.
- The present study can be extended to study change in properties of concrete with addition of natural or synthetic fibers in addition to polypropylene fibers.
- We can aim to extend the present study to higher grades of concrete.

CHAPTER 3

OBJECTIVES OF THE STUDY

The objectives of the present investigation done was to develop a convenient mix for design procedure, especially for High strength concrete (HSC) by varying the percentage of cement replaced by polypropylene (PP) fibers (3%, 4% & 5%) at a constant content of polypropylene (PP) fiber, based on BIS codes which has provided the methods of mix design procedure as well as the literature reviews available for High Strength Concrete (HSC). Also it was investigated for M60 grade using the maximum 20mm size of coarse aggregates to increase the strength, workability as well as the mechanical properties of the mixes designed and also it was investigated to find the optimum cement content replaced by Polypropylene (PP) fibers.

In the present examination/investigation emphasis is laid to study the behavior of the high strength concrete along with its constituent materials while replacing the cement content by Polypropylene (PP) fibers with change in percentage of fiber content making it more economical. The change in slump to be studied. Various tests have been proposed to study the change in strength properties. Compressive strength, tensile strength and flexural strength tests need to be conducted on specimens as per the table included. The results are to be analysed for variation in strength as compared to the concrete without fibers.

CHAPTER 4

LITERATURE REVIEW

4.1

Ph.D Chen Bing, Wu Zhen and Ph.D Liu Ning in 2012 [1] aimed to develop the structural foamed concrete by using silica fume, fly ash and polypropylene fibers. The study presents the use of fly ash for fully replacing sand to produce foamed concrete. Fine silica fume and PP fibers were used to improve the properties of foamed concrete. Lightweight foamed concretes with a wide range of concrete densities (800-1000 kg/cum) were studied mainly for compressive strength, split tensile strength and drying shrinkage. The results indicate that foamed concrete with a density of 800-1500 kg/cum and compressive strength of 10-50 MPa can be made by using silica fume and polypropylene fibers. Fine silica fume and PP fiber greatly improved the compressive strength of foamed concrete. In addition, PP fiber significantly improved the split tensile strength and drying shrinkage resistance.

4.2

V.R.Rathi Miss Sweety.P. Jain in 2007 [2] investigated to design the concrete design mix of grade M40 which comprises of polypropylene fibres, steel fibres, combination of Polypropylene fibres & fly ash, combination of steel fibres and fine aggregates with the percentage of 0.6%, 0.9%, 1.5% and 1.8% used to replace the weight of the cement. Different mixes tests were also conducted to check the strengths.

Resulted in high ductility to structural members imparted by high performance concrete also resulted in the improvement of cracks.

4.3

Y. Deng, S.M.ASCE; C. Y. Tuan, Ph.D., P.E., F.ASCE; and Y. Xiao, Ph.D., P.E., M.ASCE in 2012 [3] explained that nine simply supported circular steel concrete-filled tubes (CFTs), two circular steel posttensioned concrete-filled tubes (PTCFTs), and one circular steel fibre–reinforced concrete-filled tube (FRCFT) have been tested in an instrumented drop-weight impact facility. The weight and the height of the drop-weight were varied to cause failure in some test specimens. The failure modes and local damages in those specimens have been investigated extensively. Failure in the steel tubes was commonly tensile facture or rupture along the circumference. Concrete core in the impact area commonly crushed under compression and cracked under tension. The use of prestressing strands and steel fibres significantly restrained the concrete tension cracks in the PTCFT and FRCFT specimens, respectively. The experimental results are analysed in the context of principles of energy and momentum conservation.

4.4

Dr. Atul Desai and A.L. Ardeshana represented in 2012 [4], the study of durability as well as mechanical properties of Fiber Reinforced Concrete (FRC). This paper also includes the data that supports that fiber reinforced concrete is an ideal material to reach the targets. Firstly without fibers 15 cubes were casted and after that cubes containing 0.15 %, 0.20%, 0.25%, 0.30%, 0.35%, 0.40% of polypropylene fiber (PP Fiber) were casted replacing the cement content in the concrete and were tested for compression.

High strength concrete has received quite encouraging results by using Polypropylene fibers (PP) in high strength concrete (HSC). FRC containing 0.30% showed optimum results as per the experimental work.

4.5

Peng Zhang, Ph.D.[1]; Qingfu Li[2]; and Hua Wei, Ph.D.[3] in 2010 [5] explained that with low modulus of elasticity, high strength, excellent ductility and low price polypropylene fibre is often used in cement-based materials to improve the toughness and anti-cracking performance of the matrix composite. The aim of this study was to investigate the flexural properties of cement-stabilized macadam reinforced with polypropylene fibre. Four different fibre volume fractions (0.04, 0.06, 0.08 and 1.0%) and four different cement contents (4, 5, 6 and 7%) were used. Besides, a series of tests without mixing fibres were also carried out. By means of four-point loading method, the flexural strength and flexural modulus of elasticity of elasticity of cement-stabilized macadam were measured. The results indicate that polypropylene fibre can increase the flexural strength and decrease the flexural modulus of elasticity of cement-stabilized macadam. The flexural strength and flexural elastic modulus are increasing with the increase in specimen curing period. When the fibre volume fraction is not beyond 0.1%, the flexural strength is gradually increasing and flexural modulus of elasticity is gradually decreasing with the increase in fibre volume fraction. Besides, with the increase in cement content, there is a tendency to increase both in the flexural strength and flexural elastic modulus. Furthermore, polypropylene fibre appears to be highly effective in improving the non-deformability of cement-stabilized macadam.

4.6

Mahendra Prasad and Grover Rakesh in 2011 [6] examined to investigate the flexural strength as well as workability of HSC containing Silica Fume & PP fibres. Content of silica fume used was 0%, 5%, 10% and 15% by weight of volume and content of PP fibre was 0%, 0.20%, 0.40% and 0.60% by volume of concrete.

HSC containing 10% of silica fume and 0.40% of polypropylene fibres showed the optimum results.

4.7

Renu Mathur, Pankaj Goel and Rakesh Kumar in 1978 [7] represented the study of various properties like compressive strength, settlement, abrasion resistance and drying shrinkage of discrete Polypropylene fibers containing the fiber content as 0.05%, 0.10% and 0.15% replacing the cement content.The paper presents the investigation on the relative uses, characteristics and polypropylene fibers (PP) and also the comprehensive review on its different aspects. For attaining manufacture and strength of polypropylene fibers emphasis were laid on various issues.

Using polypropylene concrete has resulted in the achievement of high mechanical strength, high stiffness and better durability and not only this achievement of optimum utilization of materials was done. Improvement in abrasion resistance was observed, reduced settlement & drying shrinkage without affecting the compressive strength.

4.8

Dr. Atul Deasi and Priti Patel in 2013 [8] experimented to study different proportions of high strength concrete (HSC) as well asto study the features of PP fibers as reinforcement from the research work which the researchers has already carried out. FRC with Polypropylene Fiber content ranging from 0% to 2% were checked for compression, flexure and split tension as well as various other properties are ductility, low tensile failure, brittle failure and energy absorption. . Various other properties of high strength concrete (HSC) such as tensile strength, durability, shrinkage, impact, fatigue, resistance to erosion and serviceability of concrete was checked out. High durability and alkali resistance was achieved by the use of Polypropylene fiber in high strength concrete. There was no such change in compressive strength but included the great and significant changes in flexural and split tensile strength.

4.9

K. Murahari, Rama Mohan Rao in 2014 [9] investigated about the strength properties of the concrete consisting of polypropylene fibre (PP) containing different proportions. Various mixes were made which consisted of 30%, 40% and 50% of silica fumes and 08%, 0.9% & 1% of polypropylene fibres. Flexural strength to be calculated till the age of 28 days. Each series will be tested and designed as per the IS codes.

Resulted in the improvement of various concrete features like split tensile strength, fatigue properties, shrinkage, and impact, resistance to erosion and concrete's serviceability.

4.10

Venkatesh Kodur, F.ASCE; and Wasim in 2011 Khaliq [10] gave the knowledge of high temperature thermal properties is critical for evaluating the fire response of concrete structures. This paper presents the effect of temperature on the thermal properties of different types of high-strength concrete (HSC). Specific heat, thermal conductivity, and thermal expansion are measured for three concrete types, namely, HSC, self-consolidating concrete (SCC), and fly ash concrete (FAC), in the temperature range from 20–800°C. The effect of steel, polypropylene, and hybrid fibers on thermal properties of HSC and SCC is also investigated. Results from experiments show that SCC possesses higher thermal conductivity, specific heat, and thermal expansion than HSC and FAC in the 20–800°C temperature range. Data generated from tests is utilized to develop simplified relationships for expressing different thermal properties as a function of temperature. The proposed thermal property relationships can be used as input data for evaluating the response of concrete structures under fire conditions.

4.11

Kolli Ramuje in 2013 [11] represented the study of strength properties of PFRC containing 0%, 0.5%, 1%, 1.5% and 2% of polypropylene fibers.

Samples containing 1.5% of polypropylene fibres showed the optimum results as compared to the others.

4.12

Peter Donkor; Esther Obonyo; Fabio Matta; and Ece Erdogmus in 2014 [12] explained that earthen masonry generally is brittle, weak, and poor in damage resilience. There is historical evidence that natural fibers, such as straw and horsehair, have been used to reinforce earthen masonry to prevent desiccation cracks and improve tensile strength. However, fibers also have been known to affect mechanical properties negatively, such as with compressive strength (an important quality control parameter for load-bearing masonry) by creating voids and lowering density. This paper reports on findings of a study directed at investigating the feasibility of avoiding such problems in compressed and stabilized earth blocks through optimizing the fiber length when using soil from Newberry, FL. Standard polypropylene fibers were selected for the study. The two lengths of fibers studied were 54 mm and 27 mm. The test results showed a general improvement in compressive strength of the fiber reinforced matrices compared to the unreinforced ones. Although an improvement in modulus of rupture (MOR) was observed for matrices reinforced with 54 mm fibers, results varied for the other fiber-reinforced matrices. An improvement in post-initial crack behavior was observed for all fiber-reinforced matrices compared to the unreinforced ones. The 54 mm fibers yielded the best results based on the influence on MOR, compressive strength, and deformability compared with the other matrices.

4.13

Journal of Engineering Research and Studies on 09,08,1998 [13] targeted to improve the engineering as well as the durability features of the conventional concrete by the use of fly ash and will be experimentally tested. Mix designs for various grades of concrete such as M25, M30, M35 and M40 grades were tested by adding 50%, 55% and 60% on the concrete by replacing cement content.

The results for compressive strength for 3 days, 7 days, 28 days and 56 days for all grades concrete mentioned above without meeting the code requirement. Compressive strength was increased from 12% to 15% using polyester fibres.

Proved much efficient for constructing earthquake resistant structures.

4.14

International Journal for Scientific Research & Development Vol. On 2, 06, 2014 [14] investigated to test the effect on high strength concrete using steel fibers and polypropylene fibers (PP). Various tests such as compression test, slump flow test, tensile strength test and flexural test were conducted to check the behavior and features of high strength concrete.

Investigation has resulted in the placement and compaction of concrete under its own weight. Also, various economic and technical advantages have been provided.

4.15

International Science Index on 09,11,2010 [15] experimented that PP fibre of 0.2-0.5% and 0.5-3% were added to replace the cement content with an elevated temperature 300 to 900 ^{0}C.Specimens were tested after air cooling to examine the thermal as well as the physical properties of the concrete. Binder ration of aggregates were taken as 2.0.

Resulted in resistance to cracks and spallings.

4.16

International Journal of Application or Innovation in Engineering & Management (IJAIEM). 2, April, 2013 [16] investigated the addition of metal fibres to the high strength concrete and its effect on mechanical properties of the high strength concrete.

Steel fibres resulted in the resistance to the cracking as well as the openings created by the optimum loadings. Also it prevents the concrete spalling and the crack propagation. Moreover it also improved the ductility.

4.17

Ramandeep Kaur, Shruti Sharma and Gurbir Dhillon in 2014 [17] investigated the concrete containing 15%, 20% and 25% fly ash replacing the Cement content and steel and PP fibre using 0.5% and 1.0% by volume. Variation of percentages of compression, flexural and tension has been studied in this paper.

Fly ash increment resulted in decrease in the compressive strength, flexural strength and split tensile strength that was then compensated by using the fibres.

4.18

Arkan Radi Ali Civil Department, Babil Technical Institute, Babil, IRAQ in 2013 [18] experimented potential of polypropylene fibres on mechanical properties of the concrete structures. 1% and 2% of PP fibres were added to HSC of M45 grade reducing the slump of 20% and 28% respectively and was compared to the normal concrete and was tested for compressive strength.

Increased compressive strength wasas follows:

(After 7 days, 13.1 % and 19%)

(After 28 days, 8.5% and 14.3%)

(After 90days, 12.25% and 17.2%) respectively.

Increase in Flexural strength was as follows:

(After 7 days, 11.1 % and 18.3%)

(After 28 days, 13% and 24%)

(After 90days, 13.8% and 20.7%) respectively.

Increase in Split Tensile strength was as follows:

(After 7 days, 7 % and 11.6%)

(After 28 days, 12.5% and 17.8%)

(After 90days, 19% and 22.4%) respectively.

4.19

International Journal of Advance Foundation and Research in Science & Engineering (IJAFRSE) 5, October 2014 [19] showed for high strength concrete that when exposed to higher raised temperatures with respect to use mix materials of concrete, Polypropylene fibres (PP) as well as fire characteristics.

Resulted that concrete strength properties remained unchanged even at extreme temperature exposure.

4.20

ARPN Journal of Engineering and Applied Sciences on 3, October, 1998 [20] investigated study cubes of size 100mm*150mm*150mm grade concrete had casted of high strength concrete with the addition of 0.03%, 0.06% and 0.1% of glass fiber for 90 days, 180 days, 365 days and 720 days.

Glass fibers added to high strength concrete resulted in better strength and improved durability as well as workability providing resistance to alkali development.

4.21

Gurunaathan, Seenivasan, and Thirugnanam in 2014 [21] had experimented the strength of concrete cubes and cylinders cast using M40 grade concrete and reinforced with recron3s, polypropylene fibers and mineral admixtures have been presented. Also, hybrid fibers with recron3s and polypropylene have been used in concrete matrix to study its impact on strength and durability properties. The recron3s, polypropylene and hybrid [polypropylene and recron3s] fibers of various proportions i.e., 1% of recron3s fiber, 1% of polypropylene fiber (Boasee fiber) and 1% of hybrid fibers each of 0.5% by volume of cement with admixtures of 1% by weight of cement have been used in concrete mixes. The result obtained has been analyzed and compared with the control specimen (0% fiber). It clearly shows the compressive strength values for M40 grade without and with fibers.

CHAPTER 5

EQUIPMENT, EXPERIMENTAL STUDIES, AND MATERIALS

5.1 MATERIAL SELECTION

Based on the following properties materials should be checked:

1. Required rheological properties as well as the strength.
2. Examination of better endurance.
3. At every stage, quality and quantity of concrete should carefully be checked.

The main constituents of High Strength Concrete are

- **Cement**
- **Aggregates**
    1. **Fine aggregates (10mm)**
    2. **Coarse aggregates (20mm)**
- **Water**
- **Super-plasticizer (Sikament NH 2002)**

5.2 CEMENT

Calcination of lime and clay resulting in the formation of a powdered substance which is then mixed with water to prepare mortar or concrete by mixing it with sand, gravel and water. Cement is a grey colored powdered substance that acts as a binder. It is a substance that has the tendency to bind the materials together and tends concrete to set and harden.

Romans used the word "opus caementicium" which means modern concrete that has been formed by crushed rocks along with burnt lime which acts as binder. And this substance was later named as cement.

Depending upon the presence of water in cement, it can be characterized as:

- Hydraulic
- Non-hydraulic

Non-Hydraulic Cement

Hydraulic cement is the one which sets under dry conditions i.e. it does not sets under wet conditions and then it reacts with carbon dioxide (CO_2) which is present in the air. Even after setting it is affected by aggressive chemical attacks.

Hydraulic Cement

It is formed by replacing cement content in the mix so formed by the activated Aluminum Silicates (Al_2 SO_3), pozzolanas such as fly ash etc. The chemical reaction so formed results in the formation of hydrates which are insoluble in water. About 40% of Portland cement is constituted by Pozzolanas.

It is a strong building material which is used in the formation of mortar for masonry works.

- Cement acts as binder which when mixed to the other constituents of the concrete get sets, hardens and binds all the materials together.

- It is made of crushed rocks with added burnt lime which acts as a binder. After that volcanic ash as well as pulverized brick supplements are also added to make cement more strengthened. This makes the cement, a hydraulic binder.

- A fine mineral powder that is prepared with various methods and then mixed with water which then gets transformed into the paste which is used for binding material is known as Cement.

- Cement after hardening easily gets submerged into the water

- It is very economical and used for high quality construction material worldwide.

- In market two types of cements available are:

    1. OPC (Grade 43 & Grade 53)
    2. PPC
- It can bear temperature of about 1500 ^{0} C.

- Cement is a very basic requirement for all construction works whether for bad environmental conditions or for corrosive conditions

- Cement is prepared in a clinker at a temperature of 1450 degree Celsius grinding together both limestone and clay.

There are various types of cement prepared as per European standards are as under:

a) Portland cement and Portland compound cement:

Examples: - Industrial buildings

Commercial buildings

Residential buildings

b) Blast furnace slag cement and Slag cement:

Examples: - Underground Works

Sea related Projects

c) Pozzolan cement:

Examples: - Hydraulic Structures

d) Prompt natural cement:

Examples: - Under water structures

Restoration and decoration of heritage structures

Ecological structures

The cement was used in this project is Ordinary Portland Cement grade 53.

5.2.1 Tests in Field

For the inspection at site, below are the steps which needs to be followed are as under-

- **a)** When the cement bags will be opened there should be no lumps formation inside the bag of cement.
- **b)** When the hand is put inside the bag it should be checked that there should be no hidden lumps inside the cement.
- **c)** When touched and rubbed between the fingers cool essence/ sensation of cement should be felt on our hands.
- **d)** Cement so rubbed in between the fingers should be very smooth in nature.
- **e)** Another test to check cement is it should be put in bucket full of water and then it should float on water for some instant before sinking into the water.

5.2.2 Tests in Laboratory

Field tests proves that the cement we are going to use is not bad but it can only be used for fulfilling small scale constructional works.

For large scale construction works and for better results cement needs to be tested in laboratory and then it can also be used for important works.

Steps to conduct laboratory tests are as under:

Following are the tests that are necessary to be conducted on cement in laboratory-

5.2.2.1 Fineness Test-

Procedure:

- 10g of cement was weighed and placed on sieve.
- Sieve was agitated and swirled in planetary as well as linear movements till all the finer materials passes through the sieve.
- Residue was weighed and its mass was expressed as percentage R1 of the quantity which was first placed on the sieve.
- Clean the sieve gently.
- Whole procedure was repeated to get the values of R2 and R3 and the mean value R was calculated.

Result:

R1 = 89.6 microns

R2 = 90.1 microns

R3 = 90.3 microns

R = (R1+R2+R3)/3 = 90 microns.

For fineness testing size particle was 90 microns and passed through the sieve no. 9.

5.2.2.2 Setting Time Test-

Procedure:

- Cement paste was prepared by mixing the cement with 0.85 times the water required to prepare the paste of standard consistency.
- Stop-watch was started from the moment when he water was added to the cement.
- Then the paste was filled in the Vicat mould.

a) Initial setting time:

Block was placed under the rod consisting of the needle. Needle was lowered gently for making it to touch the surface of paste and released quickly in order to allow it to penetrate the test block. Procedure was repeated until the needle fails to pierce the test block. The time elapsed between the water added to cement and failure of needle for piercing is initial setting time.
Initial Setting Time (IST)-129 minutes.

b) Final Setting Time:

Needle was replaced by an annular attachment. Cement was considered as finally set when needle left an impression on the block. The time elapsed between the water added to cement and needle making an impression on the block is known as final setting time.
Final Setting Time (FST)-320 minutes

Hardness of cement mixture increases with the time.

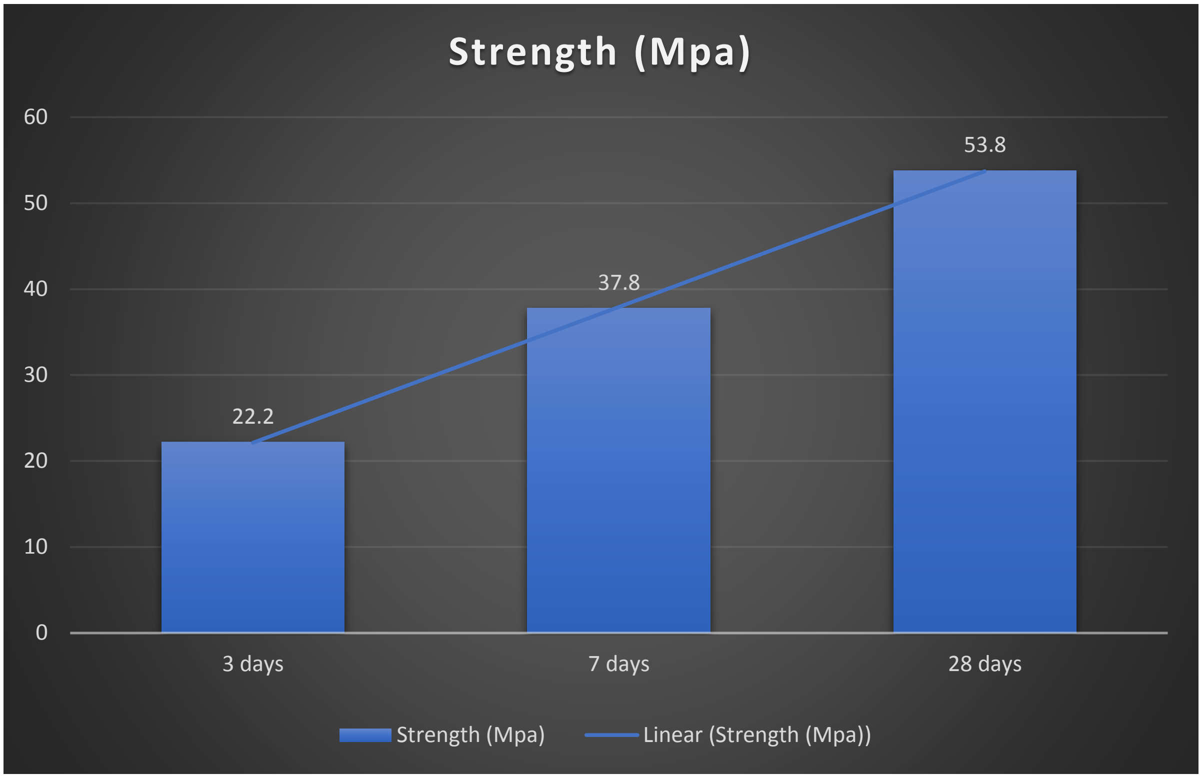
5.2.2.3 Compressive Strength Test-

Procedure:

- Mortar cubes were prepared as per the proportion given in IS codes.
- Then the cubes were taken out of the mould after 24 hours and then they were placed in the curing pond for 3, 7 & 28 days respectively.
- After 3, 7 &28 days respectively they were taken out and dried with a dry cloth.
- Then they were placed in the compression testing machine and load was applied uniformly.
- Unit of the strength in which it is measured is MPa/ N/mm^2.

Result:

- In 3 days, strength of the cement was around 22.2 MPa for Ordinary Portland Cement of Grade 53.
- In 7 days, strength of the cement was around 37.8 MPa for Ordinary Portland Cement of Grade 53.
- In 28 days, strength of the cement was around 53.8MPa for Ordinary Portland Cement of Grade 53.



5.2.2.4 Soundness Test-

Equipment required are:

- Le-Chatelier apparatus.
- Water bath (100^{o}C)
- Calliper (30 cm)
- Measuring cylinder
- Balance (100g)
- Glass sheet

Procedure:

- Paste was prepared of standard consistency 0.78P.
- Le-chatelier mould was oiled and was placed on lightly oiled glass sheet. And then the mould was filled with the paste prepared.
- Mould was covered with other glass sheet which was also oiled.
- Whole assembly was submerged into the water of temperature approx. 27^{o}C and was kept there for 24 hours.
- Whole assembly was taken out from the water bath and distance separating the indicator points to the nearest 0.55mm was measured.

Result:

Soundness/ expansion of cement = 8.5mm
Even after setting, there should be no change in the Volume of theConcrete mix.

Properties of Cement:

Property	Values	Values as per IS:8112-1989
Specific Gravity	3.14	3.10-3.15
Consistency	31.50%	30-35
Initial Setting Time	129 minutes	30 minutes minimum
Final Setting Time	320 minutes	600 minutes maximum
Compressive Strength	53.8 N/mm2	53 N/mm2 minimum
Soundness	8.5mm	10mm
Fineness	90 microns	90 microns

Stack of cement

5.3 AGGREGATES

Aggregates which are used for the preparation of concrete are the natural deposits of sand and gravel. In some areas where the aggregates are difficult to obtain there the larger rocks are crushed to produce the aggregates for preparing concrete and those areas are known as crushers.They have improper shapes and sizes.

There are basically two types of aggregates which are used are as under:

- FA (fine aggregates)
  Size is less than 4.75 micrometer
- CA (Coarse aggregates)
  Size is greater than 4.75 micrometer

Types of Aggregates which are required for cement formation are as under:

FINE AGGREGATE

The material that can pass through sieve no. 4 and its most part is retained on sieve no. 200 is known as fine aggregate.

The aggregate which is used in concrete whose size is less than 4.75micrometers are the fine aggregates.Can be denoted as FA.

COARSE AGGREGATE

The materials that will be retained on sieve no. 4 due to its larger size are known as Coarse Aggregates

Two types of coarse aggregates used are as under:

- 10mm
- 20mm

The aggregate which is used in concrete whose size is more than 4.75micrometers are the coarse aggregates.

5.3.1 Tests conducted

5.3.1.1 Sieve analysis

The mechanical device that is used for the purpose of separating the samples of various sizes uses equipment known as sieve. Sieves were first assembled in the decreasing size order and placed correctly as per the sizes on the pan.

Then the sample was poured into the sieve stacker.

Sieve stack in which sample was poured   shaker of the sieve

Sample loaded in the sieve shaker was then tested for its size analysis.

The resultant sizes then decided whether the aggregates are the coarse aggregates or the fine aggregates.

The aggregates which passed through sieves smaller than 4.75 mm were Fine aggregates.

The aggregates which passed through sieves whose variations ranges from 4.75mm to 20 mm or above were Coarse aggregates.

5.3.1.2 Fine Aggregate Specific Gravity

The test which was used to determine specific gravity of fine aggregate by examining the weightof given volume of aggregate/ weight of an equal volume of water is known as fine aggregate specific gravity test.

FA specific gravity sample &pycnometer

Sample conditions for FA specific gravity are as under:

a) Oven-dry.
b) Saturated surface dry.
c) Submerged in water.

Specific Gravity of Fine Aggregate = 2.7

5.3.1.3 Coarse Aggregate Specific Gravity

The test which is used to determine specific gravity of coarse aggregate by examining the weight of given volume of aggregate/ weight of an equal volume of water is known as coarse aggregate specific gravity test.

Sample

Sample conditions for FA specific gravity are as under:

a) Oven-dry.
b) Saturated surface dry.
c) Submerged in water.

Specific Gravity of Coarse Aggregate = 2.6

5.3.1.4 Water Absorption Test

Procedure:

1. For removing finer particles as well as dust, sample was thoroughly washed, then drained and then was placed in the perforated basket.
2. Sample was then immersed in distilled water whose temperature variation from 22 to 32 degree Celsius.

3. Due to immersion, the air entrapped was then removed by lifting the basket& making it to drop 25 times in 25 sec.
4. Basket containing sample was then allowed to remain immersed for about 24 hours.
5. Basket along with sample was then taken out of the water and water was allowed to drain out of the sample.
6. Sample was dried with the dry cloth and was removed after no moisture remained in it.
7. Then the aggregate was spread on second cloth and were exposed to atmospheric temperature till the sample seems to be fully dry. (Sample Weight-A).
8. The sample was then oven dried at the temperature ranging from 100^0C to 110^0C cooled and weighted as B.
9. Water absorption = ((A-B)/B)*100%.

S.no.	Sample	Reading 1	Reading 2	Reading 3
1	Weight of surface dried sample, A	2409	2380	2491
2	Weight of oven-dried sample, B	2404	2375	2486
3	Water Absorption	0.208%	0.210%	0.201%
Average Results		**0.206%**		

Properties of Fine Aggregates:

Property	Values	As per IS:2386-3(1963)
Specific Gravity	2.7	2.57

Bulk Density	1757 kg/cum	1754 kg/cum
Fineness Modulus	3.1	3.16
Water Absorption	1.20%	3% maximum

Properties of Coarse Aggregates:

Property	Values	As per IS:2386-3(1963)
Specific Gravity	2.6	2.67
Bulk Density	1680 kg/cum	1618 kg/cum
Fineness Modulus	7.04	7.18
Water Absorption	0.206%	3% maximum

5.4 WATER

The constituent which plays a very important role in concrete mix is known as water.

There are various principal uses of water that when mixed into the concrete makes the mix workable, serviceable, durable and hydrated.

Not only has this water provided the binding strength to the cement.

Binding ratio of water is 0.25.

Thumb rule- If water is good for drinking purpose, it can be used for making concrete.

Ordinary Potable water can be used for preparing mix design of High Strength Concrete.

The quantity and quality of water has much effect on the strength, workability of mortar and cement concrete in construction work.

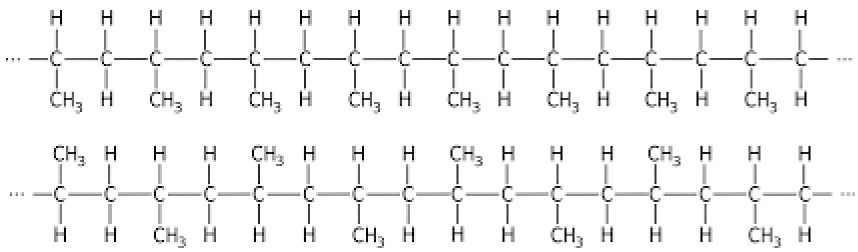
Water is the basic material required in concrete which is also used for mixing and curing.

Also, it makes the water free from harmful features like alkalis, basics, acids, oils, salt, sugar, organic and inorganic materials, vegetable growth and other substances that can cause deterioration to bricks, stones, concrete or steel.

5.5 POLYPROPYLENE

The short strands with very fine monofilament which is added to the concrete during the batching is known as polypropylene fibers. It controls the shrinkage and thermal cracking. Not only have this fibers when added to the concrete reduced the slump in the concrete. It increases the flexural strength of the concrete making the structure more earthquake/ seismic resistant.

- The fiber or the plastic polymer which have the chemical formula as C_3H_6 Polypropylene.
- Polypropylene can be used for the fulfilment of various purposes such as in industries, consumer goods, structural plastic as well as fiber.



- PP fibers can also be used for adding dyes as well as for carpeting which requires to be rubbed and are durable, for example, swimming pools, and miniature golf courses.
- Polypropylene fibers to be used for this study are very different from nylon. It is very often used for rugged carpeting because of the reason that it does not soak up water which makes it ideal for it is very often use. It can constantly be subjected to moisture.
- The synthetic resin which are built up by the process of polymerization of propylene which produces a fibrous material known as Polypropylene. It is flexible and light-weight.
- Polymerization of polypropylene with ethylene tends to make a material named as elastic-propylene copolymer.

Various applications where fiber reinforced high strength concrete can be used are as under:

- Hydropower Structures
- Spillways
- Tail Race tunnel
- Head Race tunnel
- Diversion tunnels
- Precast roofs
- Airfields
- Hydraulic Structures
- Pavements
- Heavy duty pavements

Polypropylene fiber which is short-cut strands of very fine denier monofilament is added to the concrete during batching. Thousands of individual fibers are then equally dispersed throughout the concrete during the mixing process creating a matrix-like structure.

Advantages for which PFRHSC is very high in demand are as follows: -

- Better endurance
- High fluidity
- Better strength
- Highly impermeable in nature
- Leads to developing trend in advancement of modern concrete technology
- Poor deformability and high seismic resistance

Properties of Polypropylene Fibres

Properties	**Tested Values**
Aspect Ratio	50
Length of PP fibers	12mm
Diameter of Fibers	0.05mm
Tensile Strength	335 Mpa
Density	0.91 kg/cum
Modulus of Elasticity	3.72 Gpa

5.6 CONCRETE TESTING

Slump cone test

Types of slump:

Collapse slump

Slump collapses completely due to the too wet mix.

Shear slump

Top portion slips away or shears off.

True slump

- True slump is mostly used in different tests.
- Neither collapses nor shears off.
- Stands vertically.

Principle of slump cone test is to measure:

- Properties of fresh concrete.
- Consistency/Stiffness.
- Workability/Fluidity.
- Under the action of gravity, behavior of inverted and compacted concrete.

Apparatus Required:

- Slump Cone
- Measurement Scale
- Tamping steel rod

Procedure:

- The mould of slump test is a frustum cone with height 300mm, base diameter 200 mm and upper diameter 100mm.
- Take a smooth surface and place the base of the cone on it.
- In three layers concrete was filled in the container and each layer was tamped 25 times with the tamping rod of diameter of 16mm.
- Mould must be held firmly so that it does not move during pouring the concrete.
- After complete filling of the cone upper portion was levelled with concrete.
- Very carefully and slowly the container was taken out in vertical direction, the unsupported concrete so slumped is called as slump.
- The decrement in the height of the concrete as compared to the mould was measured with the measurement scale which came out as nearest 5mm.

CHAPTER 6

EXPERIMENTAL WORK

In this respective approach, various tests has been done which are listed and described below:

1. **CASTING**
2. **CURING**
3. **TESTING**

6.1 CASTING

- Cubes of M60 High Strength concrete with Polypropylene fibers and without polypropylene fibers were casted with dimensions 150mm*150mm*150mm.

COMPOSITION OF CUBES

PP Fiber content	Composition	No. of Cubes

(%)	w/c ratio	Cement (kg)	FA(kg)	CA(kg)	Sikament	
0%	0.35	1.18	2.91	3.6	0.024	3
3%	0.35	1.1446	2.91	3.6	0.024	3
4%	0.35	1.1328	2.91	3.6	0.024	3
5%	0.35	1.121	2.91	3.6	0.024	3

COMPOSITION OF CYLINDERS

PP Fiber content (%)	Composition					No. of Cylinders
	w/c ratio	Cement (kg)	FA(kg)	CA(kg)	Sikament	
0%	0.35	1.85	4.57	5.64	0.0371	3
3%	0.35	1.7945	4.57	5.64	0.0371	3
4%	0.35	1.776	4.57	5.64	0.0371	3
5%	0.35	1.7575	4.57	5.64	0.0371	3

COMPOSITION OF BEAMS

PP Fiber content (%)	Composition					No. of Beams
	w/c ratio	Cement (kg)	FA(kg)	CA(kg)	Sikament	
0%	0.35	1.75	4.315	5.33	0.035	3
3%	0.35	1.695	4.315	5.33	0.035	3
4%	0.35	1.68	4.315	5.33	0.035	3
5%	0.35	1.6625	4.315	5.33	0.035	3

- Cylinders of M60 High Strength concrete with Polypropylene fibers and without polypropylene fibers were casted with dimensions as 150mm diameter and 300mm height. Base plate width is 1 mm and internal diameter is within 0.2mm of the mould.

- Beam of M60 High Strength concrete with Polypropylene fibers and without polypropylene fibers were casted with dimensions as 150mm height, 150mm width and 500mm length.

6.2 CURING

Cubes were cured immediately after de-moulding and were placed in curing tank or mist room.

6.3 TESTING

Cubes after curing were gone through the following tests:

- Compressive Strength Test.
- Split Tensile Strength Test.
- Flexural Strength Test

CHAPTER 7

RESEARCH METHODOLOGY

In this project, the polypropylene fiber were added to High Strength concrete by replacing some percentage (3%, 4%, and 5%) of cement content. For the purpose, amount of material required was first calculated and then the materials were tested which were used so as to get the required strength. Tests were also conducted to check the workability, strength, etc. of the Polypropylene fiber. The study of the present investigation was done to develop a convenient mix for design procedure, especially for High Strength concrete(HSC) by varying the percentage of cement replaced by polypropylene (PP) fibers (3%, 4%, 5%) at a constant content of polypropylene (PP) fiber, based on BIS codes which has provided the methods of mix design procedure as well as the literature reviews available for High Strength concrete (HSC).

For the above procedure for preparing High Strength concrete (HSC) was investigated for M60 grade using the maximum 20mm size of coarse aggregates to increase the durability, workability as well as the mechanical properties of the mixes designed and also it was investigated to find the optimum cement content to be replaced by Polypropylene (PP) fibers.

In the present examination/investigation emphasis was laid to study the behavior of the High Strength concrete along with its constituent materials while replacing the cement content by Polypropylene (PP) fibers making it more economical.

Cement of grade 53 ordinary Portland cement was used.

Following were the tests that will be experimented out for the completion of the study for comparing the normal/conventional concrete of grade M60 with the Fiber reinforced concrete of grade M60 containing Polypropylene Fibers : -

1. **Compressive strength test**
2. **Tensile strength test**
3. **Flexural strength test**

7.1 COMPRESSIVE STRENGTH TEST

Equipment required:Cube moulds of cast iron, tamping steel rod, curing tank and compression testing machine

Procedure:

- Design mix procedure as per BIS codes was prepared.
- Measured the required quantities of the materials for preparing the cubes of High Strength concrete of Grade M60.
- Mortar cubes were prepared as per the proportion given in IS codes.
- Then the cubes were taken out of the mould after 24 hours and then they were placed in the curing tank for 7, 14 & 28 days respectively.
- After 7, 14 & 28 days respectively they were taken out and dried with a dry cloth.
- Then they were placed in the compression testing machine (CTM) and load was applied uniformly.
- Unit of the strength in which it is measured is MPa/ N/mm^2.

7.2 SPLIT TENSILE STRENGTH TEST

Equipment required:

- Cylindrical moulds of cast iron

- Tamping steel rod
- Curing tank
- Tensile Testing Machine

Procedure:

- Design mix procedure as per BIS codes was prepared.
- Measured the required quantities of the materials for preparing the cubes of High Strength concrete of Grade M60.
- Mortar cylinders were prepared as per the proportion given in IS codes.
- Then the cylinders were taken out of the mould after 24 hours and then they were placed in the curing tank for 7, 14 & 28 days respectively.
- After 7, 14& 28 days respectively they were taken out and dried with a dry cloth.
- Then they were placed in the Tensile testing machine and load was applied uniformly.
- Unit of the strength in which it is measured is MPa/ N/mm^2.

7.3 FLEXURAL STRENGTH TEST

Equipment required:

- Beam moulds of cast iron

- Tamping steel rod
- Curing tank
- Flexural Testing Machine (FTM)

Procedure:

- Design mix procedure as per BIS codes was prepared.
- Measured the required quantities of the materials for preparing the cubes of High Strength concrete of Grade M60.
- Mortar beams were prepared as per the proportion given in IS codes.
- Then the beams were taken out of the mould after 24 hours and then they were placed in the curing tank for 7, 14 & 28 days respectively.
- After 7, 14 & 28 days respectively they were taken out and dried with a dry cloth.
- Then they were placed in the Flexural testing machine and load was applied uniformly.
- Unit of the strength in which it is measured is MPa/ N/mm^2.

CHAPTER 8
PLANNED WORK WITH TIMELINES

S.No.	Timeline	Activity	Description

1	15 Jan to 25 Jan	Material Testing	Materials were tested for soundness, strength, consistency, hydration, stiffness, specific gravity, etc.
2	30-Jan	Casting of cubes	9 cubes with fiber content and 3 cubes without fiber content were casted of dimensions 150mm*150mm*150mm.
3	31-Jan	Casting of cylinders & Curing of cubes	9 cylinders with fiber content and 3 cylinders without fiber content were casted of dimensions 150mm diameter and 300mm height. Also cubes were demoulded and were put into the curing tank.
4	1-Feb	Casting of Beams & curing of Cylinders	9 beams with fiber content and 3 beams without fiber content were casted of dimensions 150mm*150mm*500mm. Also cylinders were demoulded and were put into the curing tank.
5	2-Feb	Curing of Beams	Beams were demoulded and were put into the curing tank
6	6-Feb	Testing of cubes	7 days testing of cubes was done.
7	7-Feb	Testing of cylinders	7 days testing of cylinders was done.
8	8-Feb	Testing of beams	7 days testing of beams was done.
9	13-Feb	Testing of cubes	14 days testing of cubes was done.
10	14-Feb	Testing of cylinders	14 days testing of cylinders was done.
11	15-Feb	Testing of beams	14 days testing of beams was done.
12	27-Feb	Testing of cubes	28 days testing of cubes was done.
13	28-Feb	Testing of cylinders	28 days testing of cylinders was done.
14	1-Mar	Testing of beams	28 days testing of beams was done.

CHAPTER 9

ANALYSED OUTCOMES

High Strength concrete (HSC) characteristics were examined for particular applications and environmental conditions. Some of the properties included are as under:

- Better strength
- Increased early strength
- Increased modulus of elasticity
- High resistance to abrasion
- Increased endurance and larger life in bad weather conditions.
- Decreased permeability as well as diffusion
- Chemical attack resistant
- High in frost resistance
- Resistance to toughness as well as impact
- Stability of volume
- Placing ease
- Resistant to bacterial growth

CHAPTER 10

RESULTS AND DISCUSSIONS

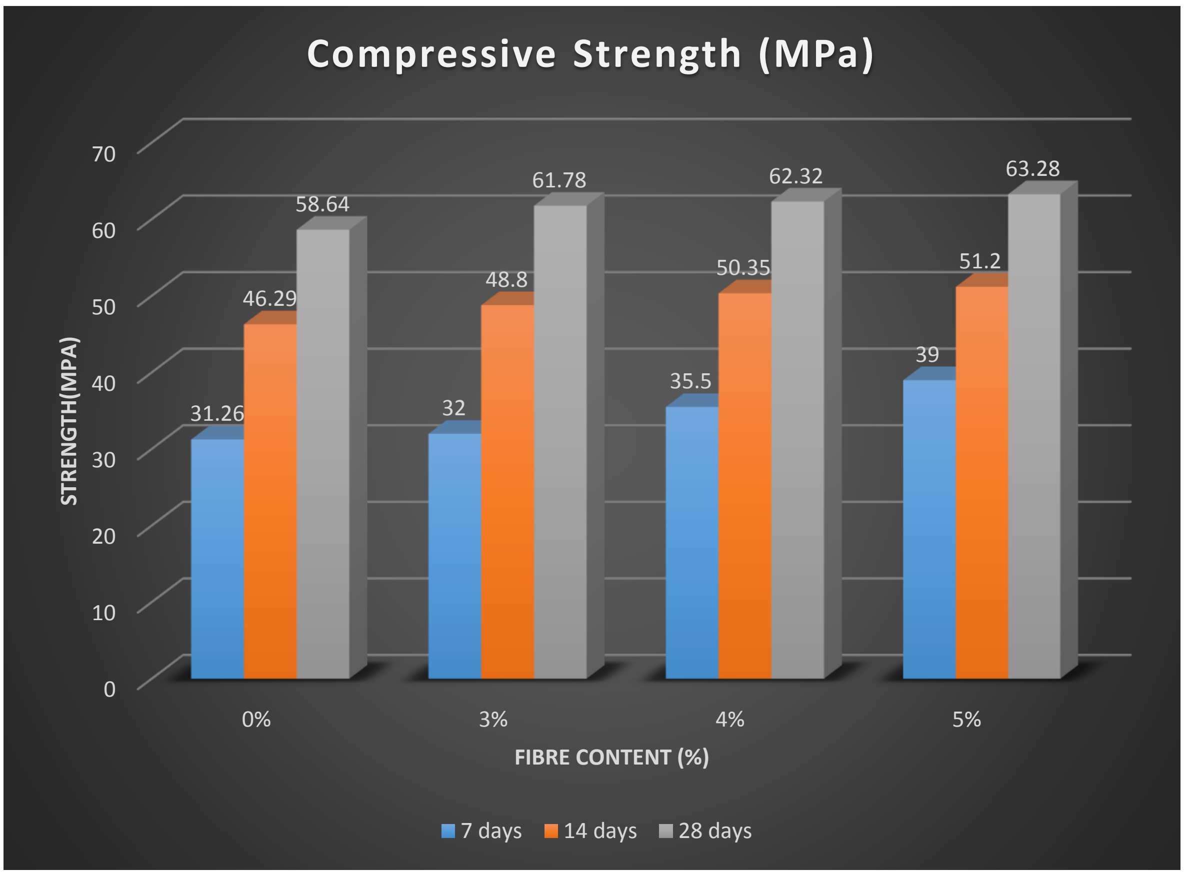
From the above discussions, it had been examined that fibre used in concrete increased the compressive strength, tensile strength as well as the flexural strength of the concrete. Also it had been concluded that the percentages of Polypropylene (PP) fibre content 3%, 4%, 5% for all 7 days, 14 days and 28 days testing. For yielding an economical result and for the reduction in the slump fibre at the rate of 5% should be added because it had shown the optimum results.

Reduction in slump will be there if the fibre content will be increased, generally beyond 5% addition of the fibrous content.

10.1 COMPRESSIVE STRENGTH TEST

Number of days	HSC (without Fiber content)	HSC (with Fiber content)		
		3%	4%	5%
7	31.26	32	35.5	39
14	46.29	48.8	50.35	51.2
28	58.64	61.78	62.32	63.28

Graph:

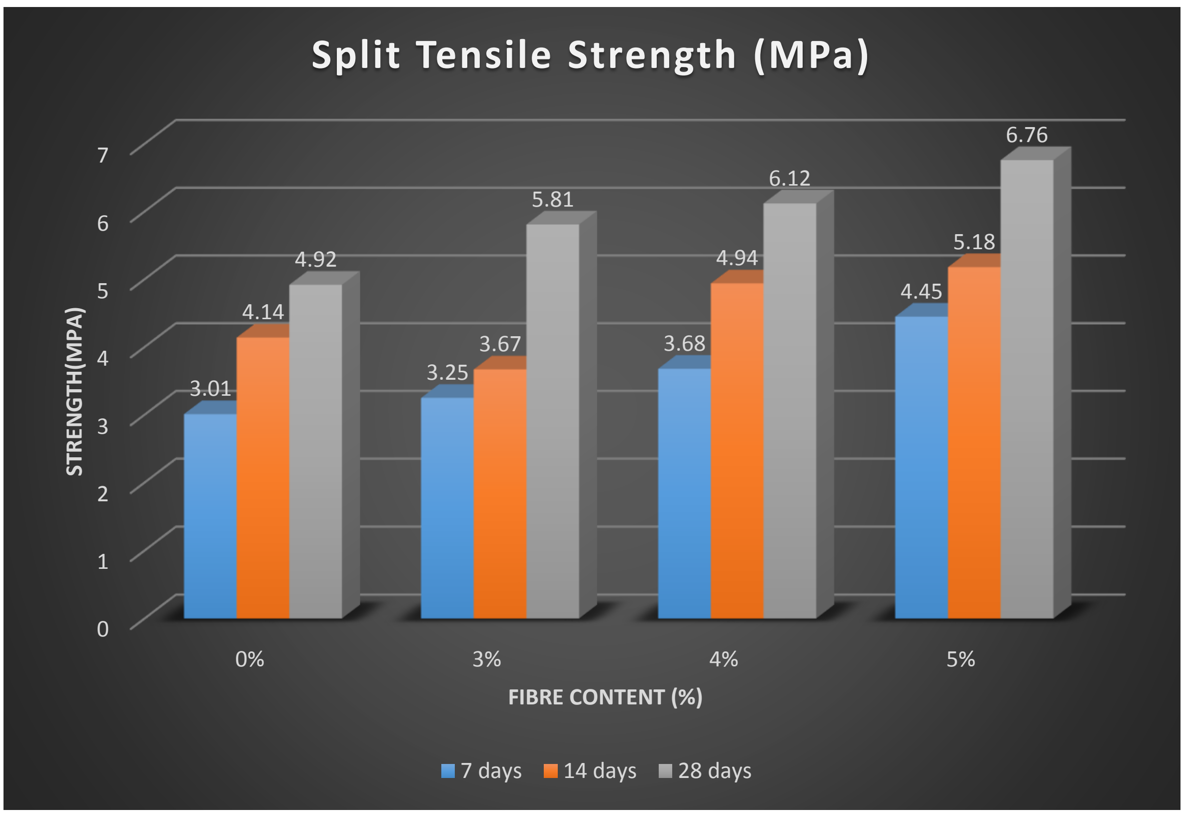


It has been observed that compressive strength increases by 5.35%, 6.2% & 7.9% at 3%, 4% and 5% respectively.

10.2 SPLIT TENSILE STRENGTH TEST

Number of days	HSC (without Fiber content)	HSC (with fiber content)		
		3%	4%	5%
7	3.01	3.25	3.68	4.45
14	4.14	3.67	4.94	5.18
28	4.92	5.81	6.12	6.76

Graph:

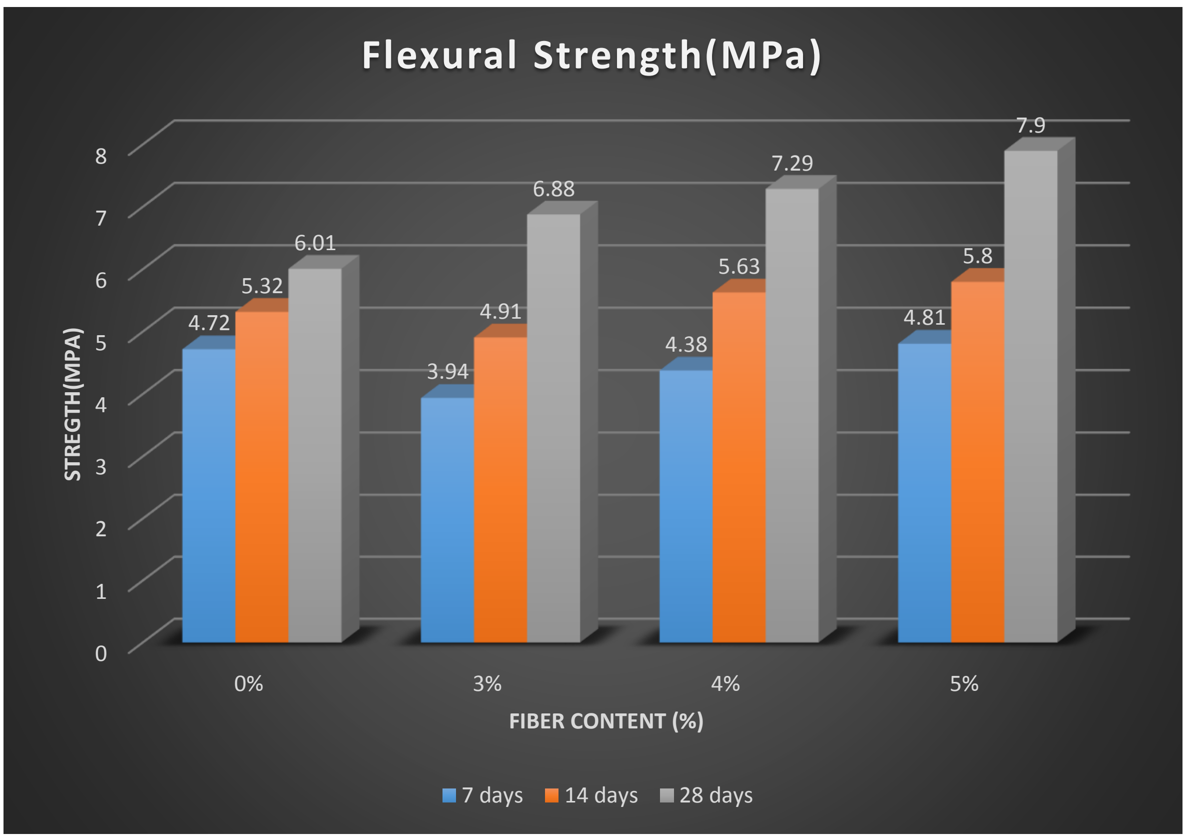


It has been observed that split tensile strength increases by 18.08%, 24.3% & 37.3% at 3%, 4% and 5% respectively.

10.3 FLEXURAL STRENGTH TEST

Number of days	HSC (without fiber content)	HSC (with fiber content)		
		3%	4%	5%
7	4.72	3.94	4.38	4.81
14	5.32	4.91	5.63	5.8
28	6.01	6.88	7.29	7.9

Graph:



It has been observed that flexural strength increases by 14.4%, 21.2% & 31.4% at 3%, 4% and 5% respectively.

CHAPTER 11

SUMMARY

Application of Polypropylene Fibers booststhe strengthof concrete. Basically, concrete consists of Fine aggregates (FA), Coarse aggregates (CA) and cement. High Strength concrete is used as various standards and for different common applications and also it is not limited to the strength factor. Some processes where High Strength concrete can be used are as under:

- Placement
- Compaction in the absence of segregation
- Strength at early age
- Permeability, etc.

This experimental study presented the study of compressive strength, split tensile strength and flexural strength of M60 concrete by replacing the 3%, 4%, and 5% of cement with Polypropylene fiber. Tests were conducted on concrete specimen and were studied for compressive strength, split tensile strength and flexural strength. Then these results were compared with the normal/conventional concrete.

For the above procedure for preparing High Strength concrete (HSC) were investigated for M60 grade using the maximum 20mm size of coarse aggregates to increase the strength, workability as well as the mechanical properties of the mixes designed and also was investigated to find the optimum cement content replaced by Polypropylene (PP) fibers.

In the present examination/investigation emphasis was laid to study the behavior of the High Strength concrete along with its constituent materials while replacing the cement content by Polypropylene (PP) fibers making it more economical.

In this paper, experimentation was based on the polypropylene (PP) fiber, which was used to replace the cement content of M60 grade concrete, where strength, workability was not affected.

CHAPTER 12

CONCLUSIONS

Based on the Experimental Investigations, the following conclusions were drawn which are as under.

(1) Increase in the reduction of the slump was obtained by adding the fibrous content (Polypropylene) to the concrete, especially beyond 5% of addition.

(2) It was concluded that compressive strength, the tensile strength and flexural strength increased proportionately when the volume ratios of polypropylene (PP) fibre with respect to the mix design increasing the strength.

(3) When mix with fibres and without fibres were compared, the compressive strength and the tensile strength test in case of mix with fibres increased.

(4) As compared to the other samples of this study, samples containing 5% of fibre content had shown the optimum results.

(5) Strength properties for the given loadings and conditions along with the need of cost, service life as well as durability for maximum optimization High Strength concrete (HSC) was prepared.

(6) The applications of concrete will necessitate the use of High Strength concrete adding new generation chemical admixtures based on super-plasticizers and available mineral admixtures.

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DECLARATION

I hereby declare that the dissertation proposal entitled,submitted for the M-Tech Degree is entirely my original work and all ideas and references have been duly acknowledged. It does not contain any work for the award of any other degree or diploma.

Dated:

Investigator

RegistrationNo. 11305931