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PARTIAL REPLACEMENT OF CEMENT WITH MARBLE DUST AND POLYPROPYLENE FIBER IN THE CONCRETE MIX

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ABSTRACT

Rate of the cement production every year over worldwide is around 3 billion tons. Cement is the binding material which is important for building sector. Emission of CO_2 due to cement industry is around 7% of worldwide. Concrete when used without reinforcement tends to be brittle in nature with very poor tensile strength and less strain capacity. During construction of concrete structures various hard circumstances get subjected on it which includes chemical attacks such as chloride, sulphate, and acid which in result gave a negative impact on the durability of structure. Polypropylene Fiber is a thermoplastic polymer which adds adhesive force due to its nature and hold the concrete mix together, reducing bleeding, shrinkage (both plastic and elastic), and cracks. Marble dust is also added to the mix in replacement of cement by 10%weight

and the fibers used in quantity of 0.5%to 2% and check result. The methodology, procedure of tests used according to the IS codes and the results are tabulated.

CHAPTER: 1

INTRODUCTION

1.1 General Introduction

Concrete is a mixture of aggregates such as coarse aggregate, fine aggregate and cement, sand. Other additive and admixtures may be present. It is the world's most essential building material, and humans have been utilizing it for a long time. Aggregate is the most important component after cement to employ in concrete. Cement is produced at a rate of over 3 billion tons per year. For the manufacture of concrete, the building sector relies on cement. Cement industry emissions account for around 7% of worldwide CO_2 emissions. To lower this emission, we must limit cement usage. It has become a competitive building material due to its properties like relative economy and high versatility which meets a wide range of needs in general. The demand for concrete in today's infrastructure expansion is gradually increasing.

Concrete without reinforcing is brittle in nature, which have very poor tensile strength and a limited strain capacity. Concrete constructions are subjected to a variety of harsh circumstances, including chemical attacks such as chloride, sulphate, and acid. These attacks have a negative impact on the concrete structures' durability. Corrosion, which is induced by chloride attack on hardened reinforced concrete, is the most significant effect. These chemicals seeped into concrete structures through fractures, corroding them and causing deterioration, which has an impact on the structure's durability.

From past time fibers are used to provide the flexural and tensile strength of concrete since ancient times, and some academics have also researched about the effect which occurs after using fiber on various characteristics of the concrete. Since the time, many types of fibers, like carbon, steel, glass and as well as polypropylene fiber have been employed in concrete. The addition of fiber to concrete affects its brittleness and ductility. These chemicals seeped into concrete structures through fractures, corroding them and causing deterioration, which has an impact on the structure's durability.

Polypropylene Fiber is a thermoplastic polymer that, because of its thermoplastic nature, adds to adhesive force and can hold the concrete mix together, reducing bleeding, shrinkage (both plastic and elastic), and cracks.

Fiber scattered in concrete forms a bridge across fissures, allowing for some ductility after cracking. Fiber reinforced concrete may endure significant stresses across a relatively high strain in the post-cracking condition if polypropylene fibers are used that are strong enough and form excellent connections with the material. Polypropylene fibers of various sorts can be used to strengthen concrete, reducing the formation of cracks.

Polypropylene fibers improve several qualities of concrete mixes, including tensile strength, flexural strength, toughness, and strength of the impact, and also define the failure modes. Polypropylene fiber is used because it binds the concrete mix together, slowing the settlement of coarse particles and reducing bleeding, which indirectly slows the rate of drying, resulting in less shrinkage. Polypropylene fibers resist fractures and offer strength as any other secondary reinforcement in hardened concrete. The fibers prevent cracks from propagating by holding the concrete together, preventing cracks from spreading wider or becoming longer. Polypropylene fibers, on the other hand, are effective near to where fractures begin at the aggregate paste interface because they are disseminated throughout the concrete.

This research investigates the effect of polypropylene fiber on concrete mix when replacement of cement is done with marble dust. And also, the comparison between different grades of concrete i.e., M25 & M30 to analyse a cost-effective parameter

The percentage of replacement of cement with marble dust has been kept constant that is 10% by weight and the proportion of Polypropylene fiber are varied in the percentage of 0%, 0.5%, 1.0%, 1.5% and 2.0%.

For this research marble dust used was obtained from Kishangarh Marble Industry, Kishangarh, Rajasthan having specific gravity 2.77gm/cc, Fineness 24.4% and PH of 8.89 and polypropylene fibers of aspect ratio 250 and specific gravity of 0.954 are used. And the tests are performed on the site CP signs Gandhinagar, Project by Alok Infracon Pvt Ltd. in GIDC Sez, Gandhinagar.

1.2 Objectives of Study

Partial replacement of cement with dust which is from marble and to add polypropylene fiber to increase the different strengths like compressive, tensile, flexural and workability etc. of the concrete.

- To reduce the cracks which are developed because of plastic shrinkage.
- To increase the different strengths of concrete using polypropylene fiber.
- To reduce the damage occurred by liquefying, subfreezing and fire in concrete.
- To decrease the failure of impact load and to provide proper resistance in concrete.
- To analyze the workability of fresh concrete.

1.3 Advantages and Disadvantages

1.3.1Advantages: PPF increases toughness and compressive strength when it has high elastic modulus and stiffness. Further, there are so many merits of using polypropylene fiber are:

- Increases fatigue, impact and resistance towards absorption.
- It increases tensile, flexural strength, increases ductility of concrete, also provide resistance towards the spreading of cracks and ability to resist load.

- Research is needed to establish the long-term Durability of Concrete containing polypropylene fiber.
- Concrete's microstructure qualities can be investigated.
- Adding chemical admixtures to boost the workability of polypropylene fiber concrete can be investigated further. PPF is chemically resistant, which improves the structure's overall function.
- The hydrophobic surface is resistant to balling because it is not influenced by cement paste.
- Because polypropylene fiber has no water requirement, there is no need to raise the water content of concrete.
- Because of its high elongation of 15 to 20%, PPF is a low modulus fiber that imparts increased energy absorption.
- PPF and marble dust boost the different characteristics like compressive, split tensile and flexural strength of concrete.
- PPF increases resistance to impact load, cracking, freezing, and thawing effects, among other things.
- Polypropylene fiber is a light-weight fiber that does not add to the structure's dead load and maintains structural components light and thin.

As PPF, The following are some of the benefits of using marble dust in concrete:

- Marble dust is a waste material that is used in concrete instead of cement in a small amount, lowering the cost of the concrete and making it more cost effective.
- By filling the spaces in concrete, marble dust improves its strength properties.

1.3.2 Disadvantages: Some of disadvantages of PPF and marble dust in concrete are as given below-

- Because PPF reinforced concrete is more expensive, it can't be used for everyday building.
- PPF has a negligible effect on the flexural strength of concrete hence it cannot be used to substitute structural steel reinforcement, which aids in the structure's moment resistance.
- PPF lowers the workability of concrete after a certain amount.
- Concrete with polypropylene fiber and marble dust necessitates careful planning, mixing, and placement, which necessitates additional skill.
- After a certain limit marble dust reduces the strength of concrete.

1.4 Selection of Topic

Following a review of the literature and studies on the current situation, it is obvious that the earth is experiencing an environmental catastrophe in terms of contamination of the soil, air, and water. Industrial wastage is dumped on dumping yards, rendering the land unsuitable for agricultural use. To help the environment, these waste items can be reduced, reused, or recycled. Some waste materials, such as marble dust and granite powder, can be utilized as a partial replacement for cement in concrete for construction purposes.

1.5 Scope

- In piles: Foundation piles, pre-stressed piles & piers.
- In road pavement of highways.
- Industrial flooring.
- Bridge decks, Panel face.
- Flotation units for walkways.
- Underwater pipe with heavyweight coatings.

1.6 Duration of Project

The duration of the project was about 14 weeks in which I was supposed to complete my project.

CHAPTER-2

LITERATURE REVIEW

A literature study is required to get knowledge of the area of research, the present state of the work, and how it will be resolved in the future. A thorough literature assessment provides a solid foundation for a worthwhile research work.

The first stage in beginning a research project is to identify the research's main problem and to narrow down the precise objectives that are required. Many studies and researches have been defined by experimenters to go along in order to get a specific conclusion on the research aims. In order to get at the conclusion of the problem's uniqueness and significance in a given region or subarea, a standard method will be followed in order to choose specific research objectives. The broader domain of the respective topic of research will be the first thing to be considered while conducting a literature review. Once the domain has been narrowed down to a single point of issue, the decision will be made.

It entails locating relevant articles from standard books, articles, case studies and research papers presented or published in different seminars, conferences, journals in the specific research area. Other than these scientific research articles, studying and analyzing the literature yields a well-condensed theory that is a little easier to comprehend. However, because it is not backed by adequate review by multiple academics working in the field, it does not provide a foundation for arriving at a conclusion of establishing research objectives. A research paper review is time-consuming task. Research necessitates prior understanding of the research field. Research papers are well-organized, concise, and exact in their explanations.

2.1 Historical Background

Addition of fiber in concrete is carried from a very long time. First reinforced concrete is invented in 1849 by Joseph Monier. In 1950 fiber reinforced concrete was became the field of interest. First paper on FRC was published in 1963 by Romualdi and Batson. Since steel, glass and polypropylene were used. Polypropylene fiber first used in 1965 for the construction of blast resistant buildings.

2.2 Literature Review Papers

[1] Rani and Priyanka (2017) conducted an experimental investigation employing polypropylene fiber to investigate the behavior of mechanical properties of self-compacting concrete, including compressive and flexural strength. There was also a comparison of polypropylene fibers and traditional fibers. According to the findings, the maximum amount of fiber in SCC was 0.75 percent to 1% of the total cement content per mix.

[2] Yeswanth et al., (2016) with the inclusion of fibers and fly ash, the effect of polypropylene fiber on concrete was tested. Different amounts of fiber (0%, 0.05 %, 0.1 %, 0.15 %, 0.2 %, 0.25 %, 0.30 %, 0.35 %, 0.40 %) were added to the volume of concrete, while different amounts of fly ash (0 percent, 10%, 20%, 30%, and 40%) were added to the volume of cement. The addition of PPF to concrete containing fly ash has been found to have a minor negative effect on the workability of the concrete; however the addition of PPF and fly ash increase the strength of hardened concrete. In comparison to other concrete composites without fiber and fly ash, there was also an increase in cracking resistance.

[3] Alsadey (2016) The effects of Polypropylene fiber use on the mechanical characteristics of cement mortar were researched and analyzed. An experiment was conducted on cement mortar reinforced with various amounts of polypropylene fiber, such as 0 %, 0.5 %, 1 %, and 1.5 %. On regular mortar and PPF reinforced mortar specimens, flow table tests and compressive strength at 28 days of curing were performed. The findings demonstrate that using PPF improves the qualities of concrete, hence the best PPF percentages have been considered**.**

[4] Pansuriya1 and Shinkar (2016) By adding polypropylene fibers to the mix at 0.5 %, 1 %, 1.5 %, 2 %, and 2.5 % by weight of cement added to the mix, the mechanical properties of M30 grade concrete can be investigated. A comparison of regular concrete to fiber reinforced concrete in terms of compressive, tensile, and flexural strengths has been carried out for the purposes of the analysis. In comparison to typical bituminous asphalts, cement is becoming a more appealing choice for base venture due to growing oil costs and a tighter monetary climate. India's Ministry of Road Transport and Highways has recognized that a modern civilization cannot function effectively without concrete roadways. Cement has a number of flaws, including poor tensile strength, a short fatigue life, and brittle failure, which results in a near-complete loss of loading capacity once failure occurs.

[5] Kumar (2016) The mechanical properties of Hybrid Fiber Reinforced Concrete were investigated (HFRC). HFRC is a composite mixture made up of any two fibers in ordinary concrete that provides benefits from each added fiber and demonstrates substantial reaction. Steel fibers and polypropylene fibers are employed in this experiment. Concrete of M30 grade can be prepared in this thesis. Steel and polypropylene fibers are introduced in 50 percent increments, with hybridization ranging from 0% to 1.5 percent. Specimens are cast and cured for 28 days before being tested in the lab for Compressive, Tensile, and Flexural tests. According to the findings, the strength parameter increases as the proportion of fiber grows, and a hybrid ratio of 1.5 percent produces the best results when compared to other hybrid ratios.

[6] Mohod (2015) The effects of adding various quantities of polypropylene fibers to high strength concrete for M30 and M40 mixes on compressive, tensile, and flexural strength under various curing conditions were explored. This entails determining the optimum Polypropylene fiber content for high strength gain in concrete by altering the polypropylene fiber content from 0% to 0.5 %, 1 %, 1.5 %, and 2 %. The mechanical characteristics of concrete were investigated on concrete specimens at various ages. In this study, half of the concrete specimens were left to cure naturally in the environment, while the other half was cured in a curing tank.

[7] Verma et al., (2015) The influence of polypropylene fibers ranging from 0.1% to 0.4 %, as well as 0.8 % steel fibers, on the stress-strain behavior of fibrous concrete is investigated. The results show that adding polypropylene fiber reduces the failure strain as the volume percent of polypropylene fiber increases. According to the research, polypropylene fibers with a larger percentage of polypropylene fiber have a better toughness.

[8] Khan et al., (2015) Investigate the mechanical performance of polypropylene fiber reinforced concrete (PFRC) under compression and split tensile loads in a comparative experimental investigation. Traditional concrete and PPF r/f concrete were tested for compressive strength and cylinder split tensile strength. Concrete mixes with the M25 and M30 grades and polypropylene monofilament macro-fibers with a length of 35 mm at volume fractions of 0.0 percent and 0.5 percent. The following percentages were employed in the study: 1.0 percent, 1.5 percent, 2.0 percent, 2.5 percent, and 3.0 percent. At a curing age of 28 days, all specimens were tested. This paper established and compared the relationship between cube compressive strength and cylinder split tensile strength for conventional and polypropylene fiber reinforced concrete. A considerable increase in compressive and tensile strength was found in this study for concrete mixes reinforced with polypropylene fibers. In compared to the others, the samples with additional polypropylene fibers of 1% and 1.5 percent produced better outcomes.

[9] Sathya Prabha and Rajasekar (2015) Bottom ash has been utilized to substitute fine aggregate in concrete mixes, and Polypropylene fiber has also been used to improve the strength qualities of concrete. The concrete mix design is for M25 concrete grade. The mix is designed for different percentages of sand replacement by bottom ash with 0.5 % PPF by total weight of the Cube: 0%, 10%, 20%, and 30%, respectively. When the strength properties of concrete were compared to a control mix, it was discovered that a 30 percent bottom ash and 1.0 percent polypropylene fiber combination produced the best results. The results demonstrated that using bottom ash instead of fine aggregates had no effect on the strength of the beams.

[10] Dhillon et al., (2014) The influence of fly ash content on the characteristics of fly ash concrete was examined using steel and polypropylene fibers. By weight, 15 percent, 20 percent, and 25 percent fly ash have been used to replace cement. Steel and polypropylene fibers were used in 0.5 percent and 1.0 percent by volume, respectively. The effect of different percentages of steel and polypropylene fibers on the compressive strength, split tensile strength, and flexural strength of fly ash concrete was investigated. The compressive strength, split tensile strength, and flexural strength of concrete decrease as the proportion of fly ash component increases, although this decrease is offset by the usage of fibers in concrete. Steel fibers outperform polypropylene fibers in terms of performance. In addition, as the proportion of fiber content increases, so does the percentage increase in all strengths.

[11] Panda and Ray (2014) An experimental study was carried out to investigate the design technique and operations of polymer fiber reinforced concrete pavements. They provided a brief comparison of PFRC and traditional concrete pavement. They looked into how several types of recycled fibers, such as plastic waste, used tyres, carpet trash, and textile waste, can be used as fiber reinforcement. Over regular concrete, the polymer fiber enhances compressive strength by 12 to 16 % and flexural strength by 7 to 14%.

[12] Rai and Joshi (2014) carried out fiber reinforced concrete experimentation and application. They look into different types of fibers and how they might be used. They looked at how polypropylene fibers improved concrete qualities and found that compressive strength rose by roughly 16 percent. Polypropylene fibers have a 30 percent increase in flexural strength. They investigate the many sorts of fibers as well as the qualities of concrete. The addition of fiber improves the ductility of concrete. The workability and consistency of fresh concrete were tested using a slump test.

[13] Ramujee (2013) The strength qualities of Polypropylene fiber reinforced concrete were investigated. The compressive strength and splitting tensile strength of concrete with varied fiber quantities ranging from 0%, 0.5, 1%, 1.5, and 2.0 percent were investigated in this article. In comparison to the others, it was discovered that Polypropylene fibers with a concentration of 1.5 percent produced better outcomes.

[14] Parveen and Sharma (2013) The influence of polypropylene fibers ranging from 0.1 to 0.4 percent, as well as 0.8 percent steel fibers, on concrete behavior was examined. The concrete's qualities, such as compressive and tensile strength, were examined. According to the findings, adding polypropylene fiber has a minor impact on compressive strength, while increases in fiber content result in a large rise in tensile strength. There was a 47 percent improvement in split tensile strength and a 50 percent increase in flexural strength. The % volume fraction of fiber was shown to be the most important factor in determining ultimate load.

[15] Patel and Kulkarni (2013) The qualities of high-strength concrete with varying percentages of polypropylene fiber were investigated. The trials are being carried out to see how it affects compressive, tensile, flexural, shear, and plastic shrinkage cracking strength. Flexural, tensile, and shear strength all increased significantly. Varied proportions of Polypropylene fiber in the mix are utilized to create concrete of grade M40, and the optimum content of Polypropylene fiber is verified for different percentages like 0.5 %, 1.0 %, and 1.5 %. Concrete specimens were examined for mechanical properties of concrete such as cube compressive strength, split tensile strength, flexural strength, and other tests at various ages for the evaluation.

[16] Murahari and Rao (2013) The strength properties of concrete incorporating polypropylene fiber and class C fly ash in various quantities were examined. For all fly ash concrete mixes, different proportions of class C fly ash (30%, 40%, and 50%) were utilized in the concrete mix, with polypropylene fiber volume fractions of 0.15 %, 0.20 %, 0.25 %, and 0.30 %. At the age of 28 days, various tests were performed to determine compressive strength, split tensile strength, and flexural strength. This study investigated mixes with Fly ash containing polypropylene fiber in various volume fractions and varied water cement ratios. Each mixture was tested and assessed after 28 days to determine the most effective concrete mix.

[17] Kolli and Ramujee (2013) Analyze the polypropylene fiber reinforced concrete's strength qualities. For fiber reinforced concrete, a combination of high strength, stiffness, and thermal resistance polypropylene fibers is preferred. The compressive strength and splitting tensile strength of concrete samples created with different percentages of fibers ranging from 0 percent to 0.5 %, 1 % to 1.5 %, and 2.0 % were investigated in this study. In compared to the other fiber percentages, the samples with extra Polypropylene fibers of 1.5 % produced better outcomes.

[18] Patel et al., (2012) Compressive strength, flexural strength, split tensile strength, and shear strength of polypropylene fiber reinforced concrete are all evaluated. Fiber volume fractions ranging from 0% to 2% were employed in this study. When compared to plain concrete, there will be no substantial difference in compressive strength, but will be a large improvement in flexural, split tensile, and shear strength.

[19] Ahmed et.al, (2012) The effects of various quantities of polypropylene fiber on concrete parameters such as compressive, tensile, flexural, shear, and plastic shrinkage cracking were investigated. Flexural, tensile, and shear strength all increased significantly. However, there was no difference in compression strength. The addition of fibers in the 0.35% to 0.50 % range has been shown to minimize shrinkage cracking by 83% to 85 %.

[20] Pannirselvam et.al, (2009) the experimental strength characteristics of a fiber reinforced polymer reinforced beam was investigated. They discovered that fiber reinforced polymer can be used to strengthen constructions. The goal of their research is to figure out how strong reinforced concrete beams are in terms of structural behavior. They discovered that the deflection ductility values for beams increased when compared to the corresponding reference beams.

2.3 Strength and Weakness

This chapter would enlist the strengths and weaknesses of the various methods and algorithms used.

2.3.1. Strength:

- As compared to plain cement concrete beam, PFC has fewer width cracks.
- Cracks got ceased which improves ductile behavior of PFC after addition of polypropylene.
- The use of polypropylene fiber made the concrete corrosion free.
- A clear and detailed mechanism of chloride attack.
- PF effectively held the micro cracks in mass of the concrete.

2.3.2. Weakness:

- Construction cost increased when polypropylene fibers were used in concrete mix.
- Workability of concrete mix reduced with increase in quantity of PF fraction.
- To manage the workability of the fiber r/f concrete mix there will be addition of admixture which in result again increased the construction cost.
- Due to the stiffness of PF, some micro-defects i.e., void, honeycomb, etc. could form during the placement of polypropylene r/f concrete.
- The use of fiber in more quantity generates air cavity issue in concrete. @

2.4 Gaps in the Research Paper

- Polypropylene fiber provides more strength and ductility but its availability and cost is an issue, so it can't be used at every construction site.
- Further research is required as the diversity of composition was not included in past research.
- Waste materials like plastic bottles, rubber tires, waste paper, marble dust, kiln dust and other industrial wastes can be used in mix to make it eco-friendly.

- Limited research work is done on workability of fiber reinforced concrete this is the issue that needs more research.
- Durability of fibers is also a field that can be studied more.

2.5 Problem Statement

Fiber reinforcement can effectively improve the mechanical strength, durability, shrinkage, and toughness characteristics of concrete. The introduction of fiber in concrete increases the properties of concrete, i.e., compressive strength, flexural strength, impact strength and shrinkage properties and reduces the crack propagation. Chemical attacks on concrete are considered as the main cause of deterioration and corrosion in concrete structure. These chemical attacks effect durability of concrete. Hence the project title is selected as **"Partial replacement of cement with marble dust and Polypropylene fiber in concrete mix"**

CHAPTER-3

MATERIAL AND METHODOLOGY

3.1 Material Used

Selecting raw materials based on suitability and availability in the local market can result in a good and effective project/research. Various sorts of materials were employed in this project effort, which is listed below:

3.1.1 Cement

In 1824, an English mason named Joseph Aspdin invented cement. He named it Portland cement because it resembled a type of sandstone found in abundance in Portland in terms of color after setting. Cement is made by burning a mixture of calcareous and argillaceous minerals at a very high temperature. The proportions of the elements should be right and the mixture should be intimate. The approximate composition of essential Portland cement components is listed below.

Table-3.1: OPC Ingredient and Their Percentage

Ingredient OPC	Range of Percentage
CaO	60 – 67
SiO_2	17 – 25
Al_2O_3	3.0-8.0
Fe_2O_3	0.5-6.0
MgO	0.1-4.0

Ordinary Portland Cement (OPC) is made up of three separate activities.

- Mixing of raw materials
- Burning
- Grinding

When cement is mixed with water, it takes a while to become hard. This is referred to as cement settling. To manage the setting process of Portland cement, gypsum is used. It functions as a retarder, allowing cement to be combined with aggregates and put.

Grades of Cement

OPC cement is divided into three categories based on the strength of the cement after 28 days when tested according to IS 4031-1988.

- 33 Grade OPC (IS: 269-1998): After 28 days, the minimum compressive strength is 33 N/mm2.
- 43 Grade OPC (IS: 8112-2000): After 28 days, the minimum compressive strength is 43 N/mm2.
- 53 Grade OPC (IS: 12269-1999): After 28 days, the minimum compressive strength is 53 N/mm2.

Physical Properties of Cement

Physical parameters are often used to characterize Portland cements for quality control purposes. When you touch or rub good grade cement between your fingertips, it feels smooth. If it feels scratchy, it's because it's been contaminated with sand. Various laboratory tests are carried out to determine the quality of Ordinary Portland Cement. The standard OPC tests are listed below:

- Fineness
- Setting time
- Compressive strength
- Specific gravity
- Soundness

i. **Fineness**

Fineness or particle size of cement affects the rate of hydration; gain of strength and also on the rate of evolution of heat. Finer cement gets strength faster because it offers a larger surface area for hydration. Maximum number of particles in a sample of cement should have a size less than about 100 microns. Smallest particle may have size of about 1.5 microns. If the cement particles are coarser, hydration starts on the surface of the particles. So the coarser particles possibly will not be entirely hydrated. This causes low strength and low durability. For a fast development of strength, a high fineness is required.

ii. **Compressive strength**

One of the most essential characteristics of hardened cement is its compressive strength. That is why the strength of cement is always tested in a laboratory before it is utilized in field work. Because of the challenges of excessive shrinkage and subsequent cracking of neat cement, strength tests are not performed on fresh cement paste. Cement strength is determined indirectly by the proportions of cement-sand mortar. The cement's strength is tested over a variety of time periods:

- 1 day (for high early strength cement).
- 3 days, 7 days, 28 days and 90 days (for monitoring strength progress)

In most codes, 28-day strength is used as a control basis. The w/c ratio, cement-fine aggregate ratio, curing circumstances, specimen shape and size, fine aggregate type and grading, loading conditions, and age all influence cement strength.

iii. **Setting time**

The setting time of cement has been divided into two categories: initial setting time and final setting time. It's difficult to establish a clear line between these two seemingly unrelated divisions. The first setting time is defined as the period of time between when water is added to the cement and when the paste begins to lose its flexibility. The final setting time is the time between when water is introduced to the cement and when the paste has entirely lost its flexibility and is solid enough to withstand a specific amount of pressure. For mixing, transporting, installing, compacting, and finishing cement paste, mortar, or concrete, a particular amount of setting time is required. The fineness of the cement, the w/c ratio, the chemical content (particularly gypsum concentration), and the admixtures all affect the setting time of the cement. Setting tests are used to determine how a cement paste will set.

iv. **Soundness**

The ability to resist volume growth is defined as soundness. It is critical that the cement does not undergo any substantial volume changes after setting. When cement is utilized that is not sound, it will have a significant impact on the structure's durability. Excess lime, magnesia, or sulphates in the cement cause it to be unsound. Free lime (CaO) and magnesia (MgO) react slowly with water and expand significantly in volume, resulting in cracking, deformation, and crumbling. As a result, the amount of magnesia allowed in cement is limited to 6%. If the amount of gypsum added exceeds 3-5 percent, it may combine with C3A, but the surplus gypsum will remain free in the cement. This extra gypsum causes the cement paste to expand unnecessarily, causing the set to be disrupted.

v. **Specific gravity**

The weight of a material divided by the weight of the same volume of water at a given temperature is known as specific gravity. It's a number used to determine whether an item will sink or float in water. Every substance has a specific gravity. Typically, the value is in digits ranging from 0.1 to 100. The substance will float in water if the value is less than one. The material will sink if the value is greater than 1. When cement is put into water, it should sink rather than float to the surface.

Chemical Properties of Cement

The most common raw ingredients used in cement production are lime, silica, alumina and oxides of iron. At high temperatures in the kiln, these oxides combine with one another to generate more complex compounds. The varying compositions of lime oxides, silica, alumina, and iron are responsible for determining the various properties of cement.

To make cement with a specific compound composition, it's critical to keep a close eye on the oxide content of the raw materials.

When lime content is increased above a certain point, combination of it with other elements becomes difficult and free lime forms in the clinker, causing cement to become unsound. If the cement's silica content rises at the expense of alumina and ferric oxide, the cement will be difficult to fuse and produce clinker. High early strengths in cement are due to alumina and high ferric oxide content. Bogue's compounds C3S, C2S, C3A, and C4AF are also known as Alite, Belite, Celite, and Felite in the literature.

This study employed Ultra Tech Cement (OPC) grade 43, which had a specific gravity of 3.1645 and a fineness of 93 percent and was obtained from Ultratech cement plant, Bharuch.

3.1.2 Aggregates

Aggregates are inert or chemically inactive elements that give concrete its bulk proportion. Cement is used to hold the aggregates together. Fine and coarse aggregates are the two types of aggregates.

Fine aggregate is defined as material that passes through BIS test sieve no. 480. Finely crushed stone can be utilized as fine aggregate if natural river sand is not economically available. Coarse aggregate is the material that is retained on the BIS test sieve no. 480.Type of work describes the maximum size of coarse aggregate. The maximum size of coarse aggregate for thin slabs and walls should be one-third the thickness of the concrete section.

The aggregates used in cement concrete work should be firm, long-lasting, and free of contaminants. The aggregates should be free of clay lumps, organic and vegetable debris, fine dust, and other contaminants. The presence of all of this debris limits aggregate bonding and so diminishes concrete strength.

The aggregates may also be classified in the following two categories:

- Natural aggregates
- Artificial aggregates

i. **Natural Aggregates**

Natural aggregate is a broad phrase that refers to aggregate that can be extracted from either a natural deposit or as unconsolidated sediments. Gravel and sand are aggregates acquired from such deposits, whereas crushed stones are aggregates obtained from ledge rock, boulders, or cobble stone.

Thus the natural aggregates can be divided into the following three types:

- Crushed rock aggregates
- Gravel
- Sand

a. **Crushed Rock Aggregates**

Crushed rock aggregate is made by crushing rock particles into a size that is acceptable for use. The kind and type of rock from which the crushed rock aggregate is made will, without a doubt, influence its quality. According to their origin, rocks are divided into three categories: igneous rocks, sedimentary rocks, and metamorphic rocks.

Igneous rocks are generated by the cooling of magma, which is a molten rock substance. Plutonic rocks, hypabyssal rocks, and volcanic rocks are the three types of rocks. The presence of massive crystals makes plutonic variants brittle, and the primary types of rocks that fall into this category are granite, syenite, diorite, and others. The hypabyssal igneous rocks are medium grained and usually have an intergrown texture, making them excellent road stones. Porphyry, dolorite, pophyrite, and diabase are the most common forms of rocks in this group. The volcanic types of igneous rocks are fine-grained, with the primary verities being basalt and andesite. They are ideal for the construction of buildings.

Weathering products are deposited on top of pre-existing rocks to form sedimentary rocks. Calcareous, siliceous, and argillaceous are the three classifications. Calcium carbonate predominates in the calcareous variety, and the primary forms are limestone, dolomites, and chalk. Because of their high adhesion to cement and bituminous binder, limestone and dolomites are ideal. The chalk isn't suited for use in construction. The silica predominates in siliceous variety, and sandstones and quartzite are the most common forms of stone in this group. Sandstones are widely used as road stones in construction projects where they are locally available. The quartzite is quite hard, and while it adheres well to cement, it does not adhere well to bitumen. Clay predominates in the argillaceous variety, and the three primary forms are clay, shale, and mudstone. They're all bad stones to use in construction.

The metamorphic rocks are either igneous or sedimentary in origin, but they have been altered or metamorphosed into rocks with markedly different properties as a result of severe heat, pressure, or both. The hornfels that form as a result of thermal metamorphism are considered the best in terms of road construction.

b. **Gravel**

The term gravel refers to the coarse sediment formed when natural rock disintegrates due to weathering and is carried away by water and deposited on river banks. Gravel qualities are mostly determined by the properties of the fundamental rock elements, and hard forms of gravel are commonly found strewn along river side or over strata that had previously been under water. If used as soling or base course, larger forms of gravel, known as boulders, do not require specific testing.

c. **Sand**

Sand is the final residue of refractory mineral grains left behind by weathering action on rocks, and it often takes many cycles of deposition and weathering to attain its final form. The most important mineral in sand is quartz, which is resistant to most weathering processes.

ii. **Artificial Aggregates**

Blast furnace slag is likely to be the sole artificially prepared aggregate used in building which is a secondary product of the polypropylene manufacturing process. Slag can surely prove to be an outstanding aggregate of consistent quality provided it is carefully prepared under regulated conditions. Concrete constructed from blast furnace slag offers excellent fire resistance. Other artificial aggregates used in light weight concrete include foamed slag, expanded clay, fly ash aggregates, shale, and slate.

Characteristics of Aggregates

- Size
- Shape
- Texture
- Strength
- Specific gravity
- Water absorption

i. **Size**

Under a particular set of conditions, the greatest maximum size of aggregate practicable to handle should be used. Perhaps the largest size that could be used for concrete production is 80 mm using the biggest maximum size available will result in:

- ✓ Optimization of the cement content
- ✓ Optimization in water requirement
- ✓ Optimization of drying shrinkage

The nominal maximum size aggregate for severely reinforced concrete members should be limited to 5 mm less than the minimum clear gap between the main bars or 5 mm less than the minimum cover to the reinforcement, whichever is smaller. However, for reinforced concrete work, aggregates with a maximum size of 20 mm are normally deemed appropriate due to a variety of other practical concerns.

ii. **Shape**

The workability of concrete is influenced by the form of particles. Round aggregates are preferred to angular aggregates in terms of cement requirements for a given water/cement ratio. The higher strengths and sometimes greater durability of angular aggregate, on the other hand, are mitigated to some extent by the interlocking texture of the cured concrete and the higher bond characteristic between aggregate and cement paste. Flat particles in concrete aggregates will have a particularly negative impact on the workability of the concrete. The amount of cement required, as well as its strength and longevity. Excessively flaky aggregate produces inferior concrete in general.

iii. **Texture**

The feature of surface texture determines whether the particle surfaces are polished or dull, smooth or rough. The degree to which forces acting on the particle surface have smoothed or roughed the surface is determined by hardness, grain size, pore structure, rock structure, and the degree to which forces acting on the particle surface have smoothed or roughed the surface. Hard, dense, fine-grained materials have generally smooth fracture surfaces. In addition to physical and mechanical qualities, the adhesion between cement paste and aggregate is regulated by a number of complex elements have revealed by the laboratory investigations. Because contact area reduces as surface smoothness rises, a highly polished particle with the same volume will have less bonding area with the matrix than a rough particle with the same volume. A smooth particle, on the other hand, will require a thinner coating of paste to lubricate its interactions with other aggregate particles. As a result, tighter packing will be possible with equal workability, requiring less paste than rough particles. Experiments have also demonstrated that rough textured aggregates develop greater binding strength in tension than smooth textured aggregates.

iv. **Strength**

Concrete's qualities are principally determined by the quality of the cement paste, which is an aggregation of small bits of aggregate joined together by cementing substance. Regardless of the strength of the aggregate rock, if the paste's strength or the link between the paste and the aggregate is weak, a poor-quality concrete will result. However, if high-quality cement paste is used than the bond will become much strong with aggregates, and it will have the qualities of rock on the concrete strength. As a result, it is evident that strong concrete cannot be created from a weak rock or aggregate.

v. **Specific Gravity**

The specific gravity is important for concrete mix design calculations in concrete technology. The weight of each element converted into solid volume using its specific gravity, and a theoretical value of concrete per volume can be determined. The specific gravity of aggregate is necessary to compute the compacting factor with workability data. Specific gravity is also considered in case of light weight and heavy weight concrete. Average specific gravity ranges in between 2.6-2.8.

vi. **Water Absorption**

Some of the aggregates are absorbent and porous. The water/cement ratio, and hence the workability of concrete, will be affected by the porosity and absorption of aggregate. When concrete is subjected to freezing and thawing, as well as chemically hostile liquids, the porosity of the aggregate will have an impact on the concrete's endurance.

The weight gain of an oven dry sample when immersed in water for 24 hours is used to evaluate aggregate water absorption. Absorption of aggregate is defined as the percentage increase in aggregate weight over the weight of a dry sample. Aggregates in concrete absorb water, affecting the workability and final volume of the concrete. Rather than the 24 hour absorption of aggregate, the pace and volume of absorption within a time frame equivalent to the final set of the cement will only be a relevant element. It may be more practical to include the aggregates' absorption capacity, which will be even lower due to the closure of pores by cement particle coating, especially in rich mixes. Allowing for more water to be added to a concrete mix to compensate for water loss due to absorption requires a proper understanding of absorption over a specific time interval rather than calculating on the basis of 24 hours.

Aggregates are granular materials made up of crushed stone or gravel. Aggregate alone covers 60%to75 % of total concrete volume. For this study, coarsely crushed 20mm course aggregates with a specific gravity of 2.76 and water absorption of 0.5 percent were obtained from Jay Goga construction, Ahmadabad, (Gujarat).

3.1.3 Sand

Sand is a granular material made up of finely fragmented rock and mineral particles that occurs naturally. Sand composition varies greatly depending on local rock sources and circumstances, although silica (silicon dioxide, or sio2), usually in the form of quartz, is the most prevalent ingredient.

This study used natural river sand with a specific gravity of 2.66 and a water absorption of 1%, which was obtained from Jay Goga construction, Ahmadabad (Gujarat).

3.1.4 3.1.4 Polypropylene Fiber

Polypropylene is made from monomeric C_3H_6, a completely hydrocarbon compound. As mentioned below, the characteristic of polypropylene fibers is quite useful:

- The hydrophobic surface, which is not moistened by cement paste, prevents chopped fibers from balling up during mixing, as it does with other fibers.
- Polypropylene fibers have no water requirements.
- Because of the orientation, the film is weak in the lateral direction, allowing fibrillations to form. As a result, the cement matrix can penetrate the mesh structure between individual fibrils, forming a mechanical link between the matrix and the fiber..

PPF comes in a variety of forms, including fibrillated bundles, mono filaments, and microfilaments. The fibrillated PF are made by stretching a plastic film that is then cut into strips and sliced. The insertion of buttons to the ends of monofilament fibers improves the pull out load.

Polypropylene fibers are made from a synthetic resin made from propylene polymerization. Toughness, flexibility, light weight, and heat resistance are all advantages of polypropylene.

For this study, polypropylene fibers with an aspect ratio of 250 and a specific gravity of 0.954 were obtained through India Mart's online service.

3.1.5 Marble Dust

Marble is a metamorphic rock made up mostly of recrystallized carbonate minerals like calcite and dolomite. Marble can have foliation. Marble is a metamorphic rock formed when limestone is heated and compressed during metamorphism. It is largely made up of the mineral calcite (CaCO3), but it may also contain clay minerals, micas, quartz, pyrite, iron oxides, and graphite. Calcite in limestone recrystallized during metamorphism, resulting in a rock that is a mass of interconnecting calcite crystals. When dolostone is heated and compressed, a related rock called dolomitic marble is formed.

Marble polishing waste was collected from the industry. This study used marble powder from from Kishangarh Marble Industry, Kishangarh, Rajasthan which is supplied to Jay Goga construction; Ahmadabad (Gujarat) had a specific gravity of 2.77, fineness of 24.4 percent, water absorption of 1%, and a pH of 8.89.

3.2 Design of proposed work

The theoretical features of adding polypropylene fiber and using partial replacement of cement with marble dust in concrete were explored in the previous chapter. The details of the Mix-Design, cube, cylinder, and beam preparation, materials used, and tests done for the experiment of strength properties based performance analysis of modified polypropylene fiber concrete are discussed in this chapter.

3.3 Design Specification

The main goal of this project is to investigate the behavior of the specimen using the idea of Strength Properties-based Performance Analysis of Modified Polypropylene Fiber Concrete for Strength and Durability. The Mix-Design Proportion-Guidelines IS 10262: 2009 design methods were applied. The mix proportioning for a concrete of M30 grade using polypropylene fiber and granite dust as a partial replacement for cement is designed in the thesis according to the IS 10262: 2009 rules. Even the entire Mix-Design was completed in a controlled setting that allowed for the achievement of expected data and results. Some of the general data/details that are required for the initial stage of Mix-Design are listed below.

3.4 Data for Mix Proportioning

The following data is required for mix proportioning of a particular grade of concrete:

a. Grade designation
b. Maximum nominal size of aggregate
c. Type of cement
d. Minimum cement content
e. Workability
f. Maximum water-cement ratio
g. Maximum temperature of concrete at the time of placing
h. Table 4 and Table 5 of IS 456: 2000 for exposure conditions.
i. Method of transporting and placing
j. Maximum cement content
k. Type of aggregate

3.5 Experimental Procedure

Procedure followed in this experimentation is as follows:

3.5.1 Materials Selection and Finalization

Materials used in this experimentation with their specific qualities are as follows:

A. Cement

43 grade Ordinary Portland Cement (IS: 8112-2000) most widely used cement for general construction work. It provides minimum 28 days strength of 43 N/mm^2. It is used for construction of residential, commercial and industrial buildings, roads, bridges, flyovers, irrigation projects and other general civil construction works. It is also suitable for all types of applications RCC, plastering and masonry. Cement used in present experimentation is '43 Grade OPC Ultra Tech Cement'.

Fig. 3.1: Cement

B. Aggregates

Aggregates are a crucial component of the concrete mix. Aggregates acts as inert filler in the concrete mix. However, according to researches it is clear that aggregate has a significant impact on the characteristics of both types of concrete fresh and hardened concrete. When there is a change in grades, sizes, unit weight, and moisture content the performance of concrete mix will get affected.

a. Fine Aggregate

Fine aggregate with the appropriate qualities for experimental work, as well as sand that complied with grading Zone I of Table 4 of IS 383:1970 were obtained.

Specific gravity = 2.66

Fineness modulus = 2.74

Fig. 3.2: Fine Aggregate

b. Coarse Aggregate

The coarse aggregate used meets the requirements of IS 383: 1970. Coarse aggregates of various sizes can be mixed in particular proportions to produce an overall grading that conforms to Table 2 of IS 383:1970 for a given nominal maximum aggregate size.

As coarse aggregate, crushed gravel with a maximum size of 20 mm and a minimum size of 10 mm was employed. The combined aggregates' sieve analysis reveals that they meet the requirements of IS 383: 1970 for graded aggregates.

Specific gravity = 2.746

Fineness Modulus = 6.9

Fig. 3.3: Coarse Aggregate

C. Water

Water is an important component of concrete because it plays an active role in the chemical reaction between cement and water. It aids in the formation of the cement gel that provides strength. Excessive amounts of unwanted organic or inorganic elements should be avoided in mixing water. Clean drinkable water was acquired for mixing and curing concrete in this project from GIDC, Gandhinagar.

Fig. 3.4: Water

D. Polypropylene Fiber

Polypropylene (PP) is a thermoplastic with a linear monomer C_nH_{2n} structure. It's made from propylene gas with the help of a catalyst like titanium chloride. PP is also a byproduct of the oil refining process.

Fig. 3.5: Polypropylene Fiber

In this project PPF used as described by manufacturer:

Name of Company: Dolphin Floats Pvt. Ltd, India (Product Name: NOKRACK)

The key actions of Nokrack are as follows:

- NOKRACK is a physical micro-reinforcement that does not react chemically; therefore it does not require any more water.
- Increases the ability of concrete to resist water (reduces permeability).
- Reduces the requirement for water proofing and pressure grouting.
- Reduces concrete shrinkage and plastic cracking.
- Ensures that the concrete is dense and sturdy.

Application of PP Fibers:

- Roof slabs, wet slabs, toilet floor slabs, bathrooms, utility areas & kitchens.

- Water retaining structures
- Effluent or sewage treatment tanks
- Warehouse flooring
- Rafts
- Basement waterproofing
- Concrete Tanks

Table No.3.2 Properties of Polypropylene Fibers

S.No.	PROPETIES	SPECIFICAION
1	Length	Multiples of 10/20 mm.
2	Construction	Combination of straight + fibrillated mesh fiber
3	Melting Point	165^{0} C
4	Absorption	Nil.
5	Acid Resistance	High.
6	Alkali Resistance	Completely resistant
7	Elongation	19%
8	Salt Resistance	High.
9	Thermal Conductivity	Low

E. Marble Dust

Marble dust is a waste material obtains from the quarrying and dressing of marble stone. In this project Makrana marble dust were used.

Fig. 3.6: Marble Dust

3.5.2 Mix Proportioning of M-25 &M-30 Concrete (Using polypropylene fiber and marble dust as Partial Replacement of Cement)

The mix proportions considered for each addition of polypropylene fiber by 0%, 0.5%, 1%, 1.5% & 2.0% volume of concrete and a fixed 20% replacement of cement with marble dust in M-25 & M-30 Grade Concrete shown in Annexure.

Quantity of marble dust: In this project we have replace the cement by marble dust in an adequate quantity by weight of cement. From the literature reviews it have been seen that the optimum strength of concrete got by replacing the cement 10% by weight of cement.

So, the quantity of marble dust = 425.73*10/100 = 42.72 kg/m^3

Now the quantity of cement decreases.

So the quantity of cement after replacement of cement by marble dust

= 425.73 – 42.72 = 383kg/m^3

Quantity of PPF: The quantity of polypropylene fiber varies at various percentages from 0.5% to 2.0% and the variation of PPF is by weight of cement and PPF have been added to concrete.

At 0.5 % = 0.5*383/100 = 1.915 kg/m^3

At 1.0% = 1.0*383/100 = 3.83 kg/m^3

At 1.5 % = 1.5*383/100 = 5.745 kg/m^3

At 2.0% = 2.0*383/100 = 7.66 kg/m^3

3.5.3 Preparation of Materials

Before starting the findings, all ingredients were brought to room temperature, preferably 27.3°C. On arrival at the site, the cement samples were completely mixed dry by transport mixing in order to guarantee the best possible blending and consistency in the material, with special attention paid to avoid the introduction of foreign matter. The cement was kept in airtight metal canisters in a dry location. Each batch had aggregate samples that were of the desired grading and had been air-dried. All of the materials must be collected in the proper quantity prior to mixing.

A. Weighing

Each batch's cement, aggregate, and water quantities were calculated by weight, with an accuracy of 0.1 percent of the overall batch weight. By weight of cement, marble dust and PPF were taken.

B. Mixing

Using a shovel, trowel, or other suitable equipment, the concrete batch was mixed on a water-tight, non-absorbent platform as follows: The cement and fine aggregate were combined dry until the color was consistent and the mixture was well blended. After that, the coarse aggregate was added and mixed with the cement and fine aggregate until the coarse aggregate was evenly distributed throughout the batch, and then the water was added and the entire batch was mixed until the concrete seemed to be homogeneous and had the appropriate consistency. Due to the addition of water growths while changing the consistency, the batch was abandoned and a new batch was prepared without halting the mixing process.

Fig. 3.7: Transit Mixture

3.5.4 Preparation of Specimen

A. Compressive strength: cube

The cube mould was instantly filled when the sample was evenly mixed. Any trapped air in the concrete would lower the cube's strength. As a result, the cubes were completely crushed. It was also taken care not to over compact the concrete, as this could have resulted in aggregate and cement paste segregation in the mix. It's also possible that it'll lower the final compressive strength. The cubes were 150x150x150 mm in size.

Fig 3.8 Cube Casting

B. Split tensile strength: Cylinder

The cylinder mould was immediately filled when the sample was mixed. Any trapped air in the concrete would lower the cylinder's strength. As a result, the cubes were completely crushed. It was also taken care not to over compact the concrete, as this could have resulted in aggregate and cement paste segregation in the mix. It may also weaken the final product. The cylinders were 150 mm (dia.) and 300 mm (dia.) in diameter (length).

Fig 3.9 Cylinder Casting

C. Flexure strength: Beam

The beam mould was instantly filled after the sample had been evenly mixed. Any trapped air in the concrete would lower the beam's strength. As a result, the cubes were completely crushed. It may also weaken the final product. The beams were 150x150x500 mm in size.

Fig. 3.10 Beam Casting

De-moulding & Curing of Concrete

After 24 hours, the test specimens were de-molded. For 24 hours and 12 hours after adding water to the dry components, test specimens were stored in a vibration-free environment with at least 90% relative humidity and at a temperature of 27^o 2^oC. After this time, the specimens were tagged and removed from the moulds, and unless the test was necessary within 24 hours, they were immediately submerged in clean fresh water and maintained there for 14 and 28 days, respectively, to cure before being tested. Every seven days, the water or solution in which the specimens were submerged was replaced, and the temperature was kept at 27^o $\pm 2\ ^oC$. The specimens were not allowed to dry out until they were ready to be used.

Fig. 3.11Demoulding of Specimens

3.6 Experimental Program:

3.6.1 Fineness Test

Take a sample in a dish and put it in the oven at a temperature of 100^0 – 110^0C. After drying take known amount of the sample and note down as W.

- Arrange the sieves in ascending order, starting with the largest sieve at the top. If using a mechanical shaker, place the ordered sieves in place, pour the sample into the top sieve, and close it with the sieve plate. The machine should then be turned on and the sieves should be shaken for at least 15 minutes.
- If shaking by hand, pour the sample into the top sieve and shut it, then shake it inwards and outwards, vertically and horizontally, holding the top two sieves.
- Record the sample weights maintained on each sieve after sifting. Then calculate the total weight retained. Finally, calculate the total percentage of each sieve that has been retained. We may calculate the fineness modulus by adding all of the cumulative percentage values and dividing by 100.

Table No.3.3 Fineness Modulus of Fine Sample

S.No.	Material	Sieve size	Fineness Modulus
1	Cement	90 micron sieve	93%
2	Sand	>4.75mm to 0.15mm	27.5%
3	Marble Dust	>4.75mm to 0.15mm	24.4%,

3.6.2 Specific Gravity Test

A. Fine Aggregates (Sand, Cement and Marble Dust)

- Dry the pycnometer and weigh it with its cap (W1)
- Take about 200gm to 300gm of oven dried soil passing through 4.75mm sieve into the pycnometer and weigh again (W2)
- Add water to cover the soil and screw on the cap.
- Shake the pycnometer well and connect it to the vaccum pump to remove entrapped air for about 10 to 20 minutes.
- After the air has been removed, fill the pycnometer with water and weigh it (W3).
- Clean the pycnometer by washing thoroughly.
- Fill the cleaned pycnometer completely with water up to its top with cap screw on.
- Weigh the pycnometer after drying it on the outside thoroughly (W4).

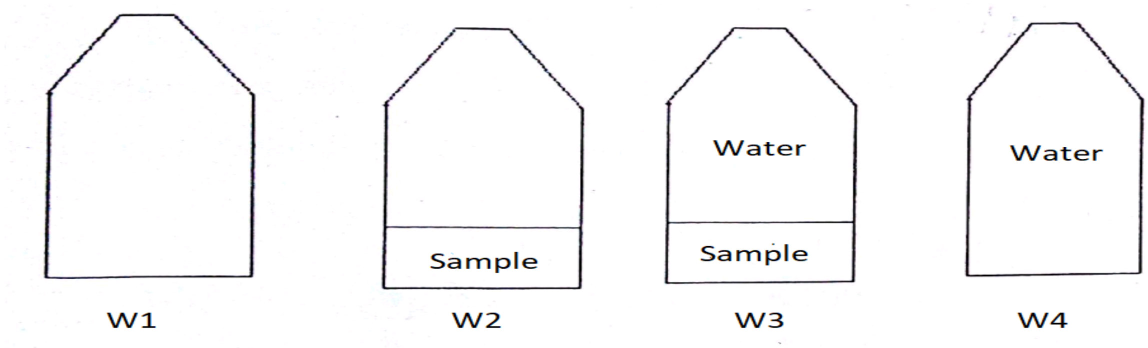

Fig 3.12 Pycnometer Apparatus

$$\text{Sp. Gravity(Gs)} = \frac{(W2 - W1)}{((W2 - W1) - (W3 - W4))}$$

B. Coarse Aggregates

- Approximately 2kg of aggregate is washed thoroughly to remove particles, drained, and then placed in the wire basket and immersed in distilled water at a temperature of 22 to 320C with a cover of at least 50 mm of water above the top of the basket.
- Immediately after the immersion the entrapped air is removed from the sample by lifting the basket containing it 25 mm above the base of the tank and allowing it to drop 25 times at the rate of about one drop per second. The basket and the aggregate should remain completely immersed in water for a period of 24±0.5 hours afterwards.
- The basket and sample are then weighed while suspended in water at 220 to 320 degrees Celsius. While suspended in water, the weight (W1) g is recorded.
- The aggregates are then transferred to the dry cloth once the sample and basket are taken out from the water and allowed it to drain for a few minutes.
- Return the empty basket to the tank, shook it 25 times, and the weights in water (W_2) g are calculated.
- The aggregates which are placed on the absorbent cloth will be completely dried and to check that the cloth can no longer absorb any more moisture.
- Then the aggregate is transferred to the second dry cloth spread in a single layer, covered and allowed to dry for at least 10 minutes until the aggregates are completely surface dry. 10 to 60 minutes drying may be needed. The surface dried aggregate is then weighed (W_3) g.
- The aggregate is placed in a shallow tray or pan and baked for 24 hours at 1100˚C in an oven. After that, it is taken out of the oven, chilled in an airtight container, and weighed (W_4) g
- $$\text{Sp. Gravity(Gs)} = \frac{(W4)}{(W3)-(W1-W2)}$$

Table No.3.4 Specific Gravity of Sample

S.No.	Material	Equipment	Reference Standard Liquid	W1g	W2g	W3g	W4g	G
1	Cement	Pycnometer	Kerosene (0.79)	622	942	1502	1310	3.1645
2	Sand		Water	622	1078	1783	1498	2.66
3	MD		Water	622	1238	1896	1506	2.77
4	Coarse Aggregates	Wire basket	Water	2000	697	1990	1896	2.76

3.6.3 Water Absorption Test :

- Take known amount of sample , oven dry it by maintaining 110^0C of temperature for 24 hours
- Now allow the sample to cool down at room temperature.
- After cooling weight the sample as W_A.
- Now emerge the sample in water for 24 hours at 23^0C.
- Remove the sample, pat it dry with cotton cloth and weight the sample as W_B
- Use below mention formula to calculate the amount of water absorb by the sample.

$$\text{Water Absorpation(WA)} = \frac{(\text{Wa} - \text{Wb})}{\text{Wb}} \text{X100}$$

Table No.3.5 Water Absorption

S.No	Material	W_ag	W_bg	W_A %
1	Corse Aggregate	1005.025	1000	0.5
2	Fine Aggregate	252.48	250	1
3	Marble Dust	504.92	500	1

3.6.4 pH Test

- Set the temperature control to 25°C and select the pH Mode.
- Using de-ionized water, rinse the electrode and dry it with a tissue.
- Place the electrode in a pH 7 buffer solution, wait for the display to stabilize, and then calibrate it with the adjusting knob before removing it from the buffer.
- Using a piece of tissue, blot dries the electrode with de-ionized water.
- Place the electrode in the pH 2 buffer solution, wait for the display to stabilize, and then calibrate it with the adjusting knob before removing it from the buffer.
- Using a piece of tissue, blots dry the electrode with de-ionized water.
- Take about 30g of sample.
- Dilute the sample in 70 ml of distilled water.
- Keep the solution undisturbed for 1 hour.
- Place the electrode in the solution allow the display to stabilize.
- Note the reading of pH for the sample

Table No.3.6 pH of Marble Dust

S.No	Material	Ph
1	Marble Dust	8.90

Fig 3.13 pH Meter

3.6.5 Test on Fresh Concrete :

3.6.5.1 Slump test (IS: 1199 – 1959)

This test is use for determining the consistency of concrete where the nominal maximum size of the aggregate does not exceed 38 mm.

Apparatus

a) Mould - The mould for the test specimen was in the form of the frustum of a cone having the following internal dimensions:

Bottom diameter: 20

Top diameter: 10

Height: 30

b) Tamping rod - The tamping rod was of polypropylene or other suitable material, 16 mm in diameter, 0.6 m long and rounded at one end.

The slump test is used to determine the consistency of a new batch of concrete before it sets. Slump is used to test the workability of freshly mixed concrete, and workability is defined as the ease with which concrete flows. It can also be used to detect a batch that has been poorly mixed. The workability of a concrete mix increases as the slump value rises.

Fig 3.14 Slump Test

Procedure:

- Clean the inside of the mould and coat it with oil.
- Place the mould on a flat, non-porous horizontal base plate.
- Fill the mould in four about equal levels with the prepared concrete mix.
- Tamp each layer with 25 strokes of the rounded end of the tamping rod across the cross section of the mould in a regular way. Tamping should permeate the underlying layer for the subsequent layers.
- Remove any extra concrete and use a trowel to smooth the surface.
- Remove any mortar or water that has gotten between the mould and the base plate.

- The droop is the difference between the height of the mould and the height of the specimen being assessed.
- Raise the mould from the concrete in a vertical direction as soon as possible.
- The discrepancy between the height of the mould and the height point of the specimen being evaluated is the slump..

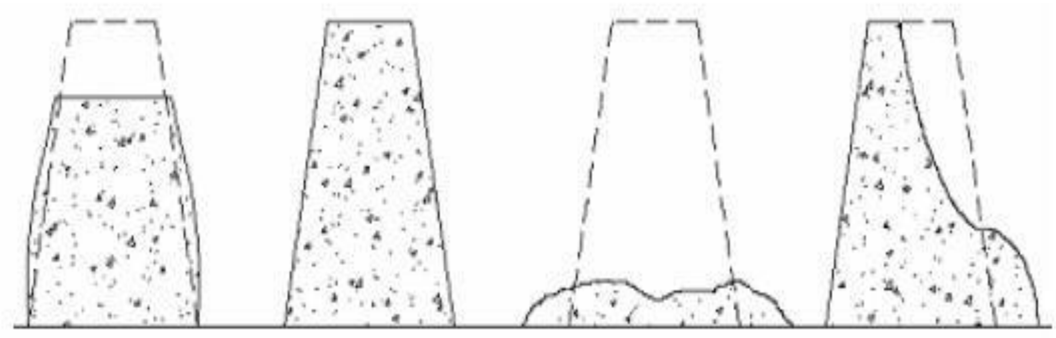

Fig 3.15 Slump Parameter

Note- The value of slump of concrete mix is mention in result section for every percentage of replacement of polypropylene fibers and marble dust powder.

3.6.6. Test on Harden Concrete

3.6.6.1 Compressive Strength of Concrete: (As per IS: 516-1959)

Testing Machine: The testing machine that was employed was a manual Compressive Testing Machine having a maximum loading capacity of 2000 kN. The machine's lowest count was 10 kN. Two polypropylene bearing platens with toughened faces were used in the testing equipment. Both platens' bearing faces were the same size as, if not larger than, the nominal size of the specimen to which the load was applied. The bearing surface of the platens should not deviate from a plane by more than 0.01 mm at any point when fresh; hence an allowed variation limit of 0.02 mm was maintained. The movable component of the spherically seated compression platen was held in place by the spherical seat, while the bearing face could rotate freely and tilt in any direction thanks to little bangles.

Procedure:

- After the stipulated curing time has passed, remove the specimen from the water and wipe away any excess water from the surface.
- Take a measurement of the specimen's size.
- Clean the testing machine's bearing surface.

- Place the specimen in the machine in such a way that the load is applied to the cube casts opposite sides.
- Align the specimen in the centre of the machine's base plate.
- Rotate the moveable section slightly by hand until it reaches the specimen's top surface.
- Apply the weight gradually, without shock, and at a rate of 140 kg/cm2/minute until the specimen breaks.
- Make a note of the maximum load and any unexpected characteristics in the type of failure.

Fig. 3.16 Compressive Strength Testing Machine

Calculation:

Because the Compressive Testing Machine was manual, the specimen's measured compressive strength was computed by dividing the greatest force applied to the specimen during the test by the cross-sectional area, and the number we needed was in N/mm^2. A formula can be used to calculate compressive strength:

$$f = P/A$$

Here, f = compressive strength

P = Maximum load applied

A = Cross sectional area of specimen

Fig. 3.17 Compressive Strength Testing

3.6.6.2 Split Tensile Strength of Concrete Specimen: (As per IS: 5816-1999)

Testing Machine: The testing machine that was employed was a manual Universal Testing Machine having a maximum loading capacity of 1000 KN. The machine's lowest count was 10 KN. Two polypropylene bearing platens with toughened faces were used in the testing equipment. One of the platens had a ball sitting in the shape of a section of a sphere, with the platen in the middle being a plain stiff bearing block. The bearing surface of the platens should not deviate from a plane by more than 0.01 mm at any point when fresh, hence an allowed variation limit of 0.02 mm was maintained.

Procedure:

- After the allotted curing period, remove the wet specimen from the water.
- Using a damp cloth, wipe the water off the specimen's surface.
- To guarantee that the two ends of the specimen are on the same axial plane, draw diametrical lines on them.
- Take note of the specimen's weight and size. Set the compression testing machine to the desired range of compression.
- Placing the specimen on the lower plate is a good idea.
- Align the specimen so that the vertical lines on the ends are centered over the bottom plate.
- To touch the specimen, lower the upper plate.
- Apply the load at a rate of roughly 14-21kg/cm^2/minute continuously without shock (which equates to a total load of 9900kg/minute to 14850kg/minute)
- Record the maximum load and note any unusual features in the type of failure.

Fig. 3.18 Split Tensile Strength Test machine

Calculation:

The specimen's recorded splitting tensile strength, f, was estimated to the nearest 0.05 N/mm^2 using the formula below:

f= 2P/πDL17

Here,

f = Split tensile strength of specimen

P = Maximum load applied to the specimen

D = Cross sectional dimension of the specimen

L = Length of the specimen

Note: Split tensile strength of concrete varies from 1/8 to 1/12 of the cube compressive strength.

Fig. 3.19 Split Tensile Strength Testing of Cylinder

3.6.6.3 Flexural Strength Test of Concrete Specimen: (As per IS: 516-1959)

Flexural test machine: The specimen was to be supported on the bed of the testing machine by two 38 mm diameter polypropylene rollers, which were mounted so that the distance from centre to centre was 60 cm for 15.0 cm specimens and 40 cm for 10.0 cm specimens. Two comparable rollers positioned at the third places of the supporting span, spaced at 20 or 13.3 cm centre to centre, applied the load. The force was evenly distributed between the two loading rollers, and all rollers were positioned in such a way that the load was applied axially with no torsional stresses or constraints on the specimen.

Procedure:

- After the allotted curing period, remove the wet specimen from the water.
- The test should be performed on the specimen as soon as it is removed from the curing state to avoid surface drying, which reduces flexural strength.
- Clean the supporting and loading rollers' bearing surfaces.
- Position the specimen so that the distance between the outer rollers (i.e. span) is 3d and the distance between the inner rollers is d.
- The inner rollers must be evenly positioned between the outer rollers, resulting in a systematic system.
- To touch the specimen, lower the upper plate.
- For the 10.0 cm specimens, the load must be applied at a rate of 180 kg/min.
- Record the maximum load and note any unusual features in the type of failure.

Note- The test should be conducted in on specimen immediately curing period so as to prevent surface from drying which decline flexural strength.

Fig. 3.20 Flexure Strength Testing Machine

Calculation:

The Flexural Strength or modulus of rupture (**f_b**) is given by (for 2 point loading)

f_b = pl/bd2

Here,

b = width of specimen (cm)

d = failure point depth (cm)

l = supported length (cm)

p = max. Load (N)

Note: flexural strength, in general fall in the range of 9 to 12% of arrived compressive strength.

Flexural strength = 0.7 * square root of compressive strength

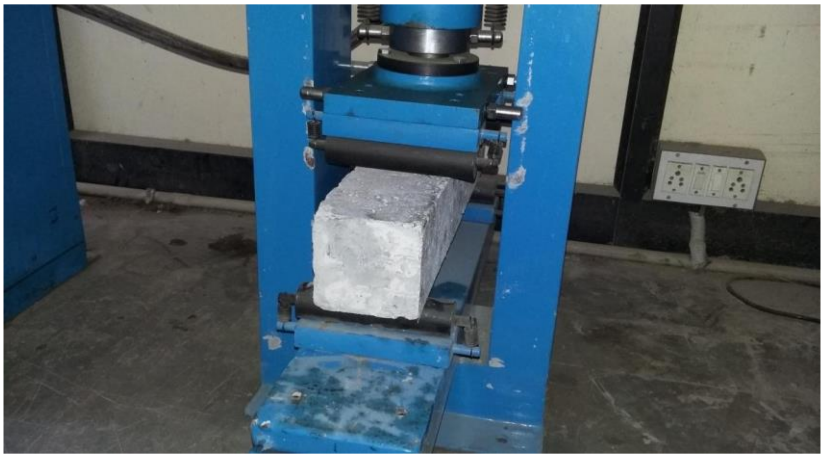

Fig. 3.21 Flexure Testing of beam

3.6.6.4 Test for Durability of Concrete by its Resistance against Acid Attack and Alkali Attack:

The test to determine the durability of concrete is done by checking its resistance against acid attack and alkali attack.

Durability of concrete is important factor which signifies it's withstand capacity in adverse exposure conditions. The one of basic factor of concrete, which makes it durable in exposure condition, is its sustainability in acidic medium and alkaline medium. When concrete is subjected to expose in acidic medium, like sulpuric acid attack then as reaction with cement hydrated paste in concrete, the calcium sulphate formed can proceed to react with calcium aluminate phase in cement to form calcium sulpho-aluminate, which on crystallization can cause expansion and disruption of concrete.

When concrete is subjected to alkaline medium, like sodium sulphate attack then the reaction takes place between the products of hydration of cement i.e. $Ca(OH)_2$ and sulphate solution. The calcium aluminate hydrate can react with sulphate salt from outside. The product of reaction is calcium sulpho-aluminate, forming within the framework of hydrated cement paste. Therefore, the test to find the resistance against acid and alkali attack is important in terms of durability of concrete.

Determination of Durability of Concrete made with different Mix Combinations comparative to the Designed Strength of Standard Concrete i.e. Controlled Concrete of Grade M 25 and M30 at 90 days

Durability of concrete tested in terms of its resistance against acid and alkali attack, made of different mix combinations using alternate materials are mentioned below –

Resistance against Acid Attack:

For the acid attack test, a 150 x 150 x 150 mm concrete cube was produced with varied percentages of diverse combinations. The test specimens were casted and cured in the mould for 24 hours, after which they were all demoulded and maintained in the curing tank for 7 days. After 7 days, all specimens were weighed and immersed in a 5 percent sulphuric acid (H2SO4) solution for 28 days to maintain a steady weight. The acid media had a pH value of 0.3. The pH level was monitored on a regular basis and kept at 0.3. The specimens were removed out of the acid solution after 28 days and cleaned in running water before being stored in the environment for two days to maintain a steady weight. After that, the specimens were weighed, the weight loss was recorded, and the percentage loss of weight was computed.

Resistance against Alkali Attack:

For the alkaline attack test, a 150 x 150 x 150 mm concrete cube was produced with varied percentages of diverse combinations. The specimens were cast and cured in the mould for 24 hours, then demoulded and maintained in the curing tank for another 7 days. After 7 days, all specimens were weighed and immersed in a 5 percent sodium sulphate (Na_2SO_4) solution for 28 days to maintain a steady weight. The alkaline media had a pH value of 12.0. The pH level was measured on a regular basis and kept at 12.0. The specimens were removed out of the alkaline solution after 28 days and cleaned with running water before being maintained in the environment for two days to maintain a steady weight. After that, the specimens were weighed, the weight loss was recorded, and the percentage loss of weight was computed.

Chapter 4

RESULT AND DISCUSSION

4.1 Workability of Concrete

4.1.1 Slump Test

Table No. 4.1 Slump for Control mix of M25 & M30 Grade

S. No.	Control Mix	Slump (mm)
1	M25	75
2	M30	90

Table No. 4.2 Slump with 10% MDP and Polypropylene Fiber

S. No.	Polypropylene Fiber %	Slump (mm)	
		M25	M30
1	0.0	70	80
2	0.5	68	78
3	1.0	64	75
4	1.5	61	72
5	2.0	59	70

Table no.4.2 shows slump comparison for different fiber content % It has been noticed that when the amount of polypropylene fiber in concrete grows, the slump of the concrete reduces, and hence the workability diminishes. As a result, concrete with 0% fiber has the best workability, whereas concrete with 2.0% fiber has the worst.

4.2. Compressive Strength Test

Concrete's compressive strength is its most important attribute. Cubes with dimensions of 150x150x150 mm were cast and tested on compression testing equipment for compressive strength.

Table 4.3 Compressive Strength of M25 grade

Polypropylene Fiber %	Compressive Strength(N/mm^2)		
	7 Days	14 Days	28 Days
0.0	16.09	21.46	26.82
0.5	17.95	23.78	29.93
1.0	20.52	26.94	33.64
1.5	21.24	27.85	34.82
2.0	18.17	22.24	27.70

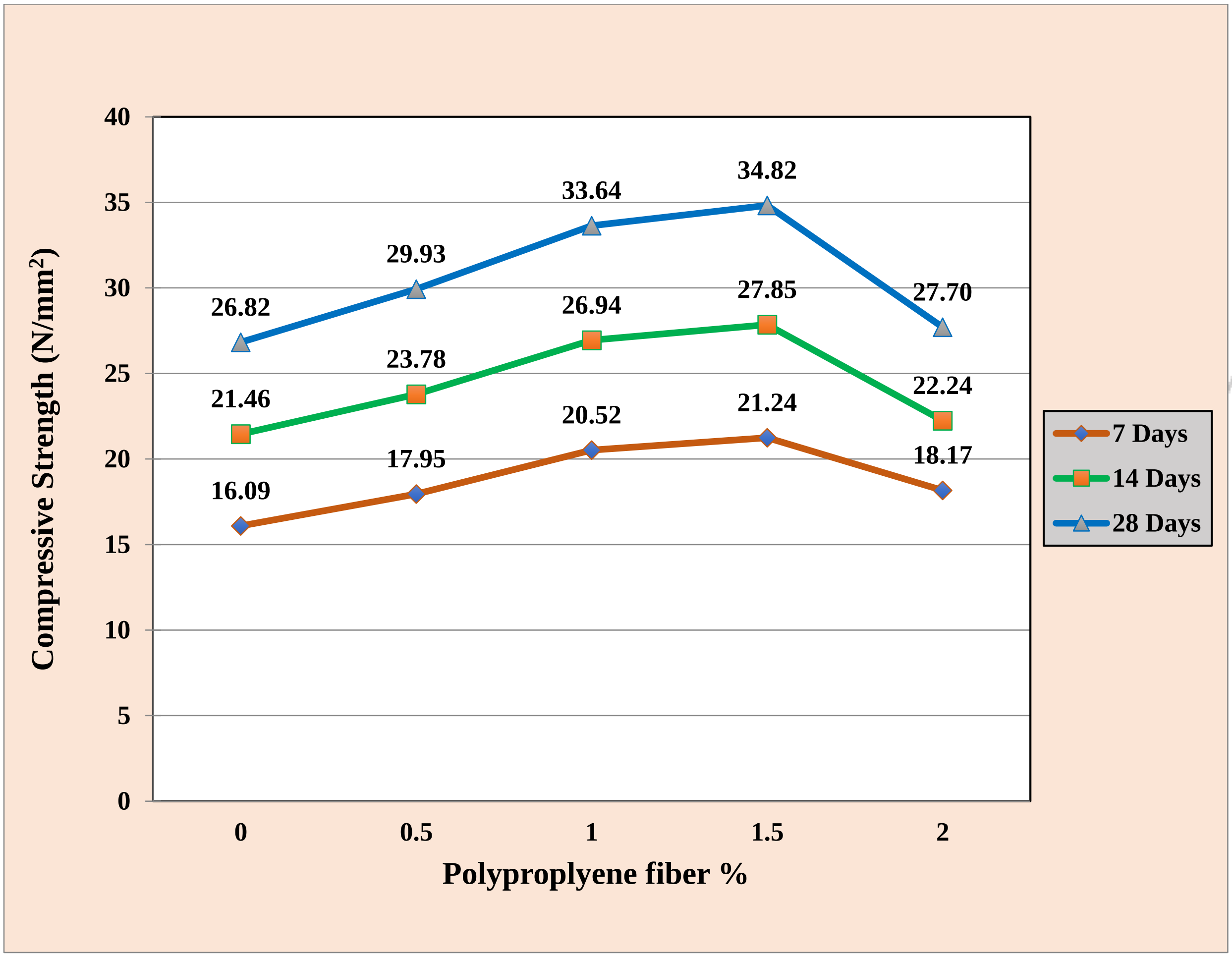

Fig 4.1 Comparative Compressive Strength of M25 Grade

Figure 4.1 shows that for 7, 14, and 28 days of curing, the minimal compressive strength was produced at 0% addition of polypropylene fiber, whereas the optimal compressive strength was obtained at 1.5 percent addition of polypropylene fiber. The ideal percentage increase in concrete compressive strength was found to be 29.82 percent after 28 days of curing.

Table 4.4 Compressive strength of M30 grade

Polypropylene Fiber %	**Compressive Strength(N/mm^2)**		
	7 Days	**14 Days**	**28 Days**
0.0	19.60	26.50	32.67
0.5	20.41	26.12	33.47
1.0	21.50	28.46	35.84
1.5	22.80	29.47	36.79
2.0	21.71	28.76	35.60

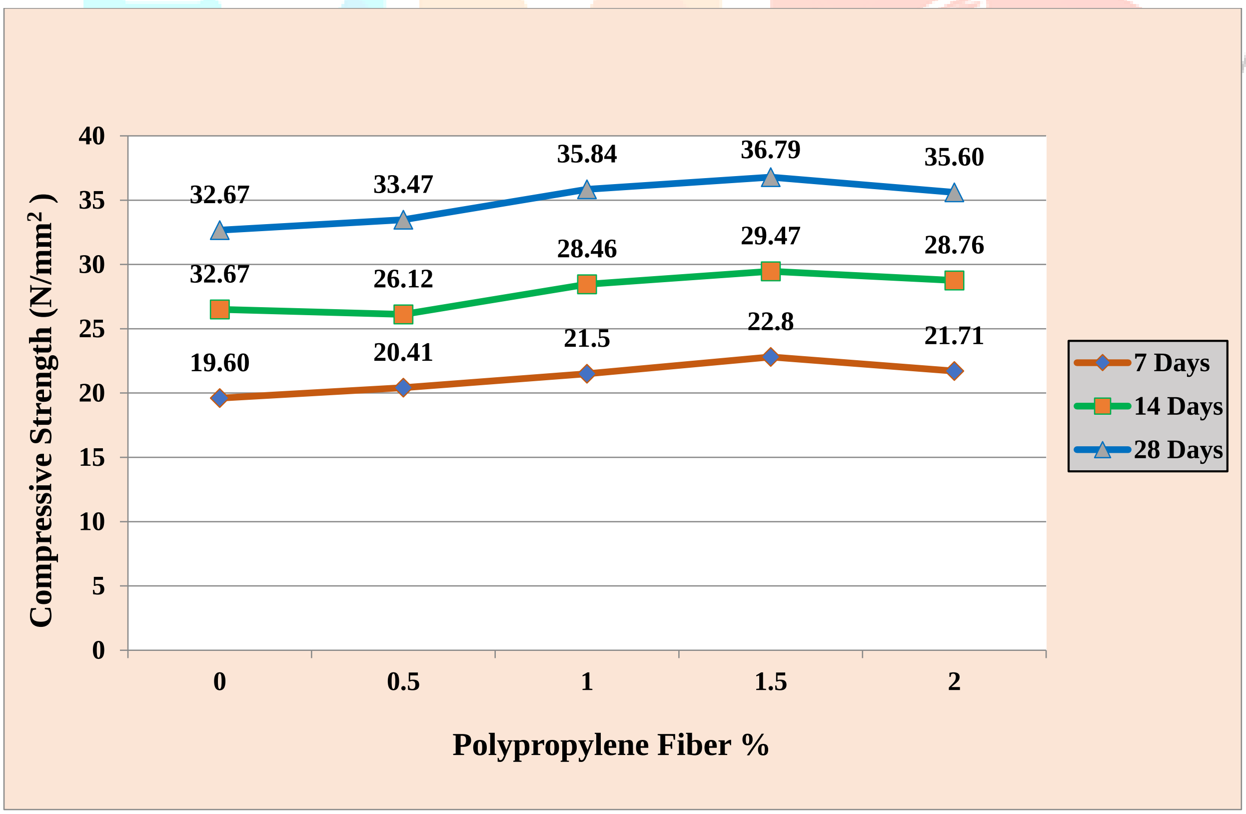

Fig 4.2 Comparative Compressive Strength of M30 Grade

Figure 4.2 shows that for both 14 and 28 day curing periods, the minimal compressive strength was obtained at 0% addition of polypropylene fiber, while the optimal compressive strength was obtained at 1.5 percent addition of polypropylene fiber. It was also discovered that the ideal percentage increase in concrete compressive strength was 12.61 percent after 28 days of curing.

4.3 Split Tensile Strength of Concrete

Because concrete is weak in tension, tensile strength testing of cylinder specimens is essential. On universal testing equipment, cylinders with dimensions of 150mm in diameter and 300mm in length were cast and tested for split tensile strength.

Table 4.5 Splitting Tensile Strength of M25 grade

Polypropylene Fiber %	**Splitting Tensile Strength(N/mm^2)**		
	7 Days	**14 Days**	**28 Days**
0.0	1.38	1.79	2.24
0.5	1.49	1.94	2.41
1.0	1.66	2.18	2.73
1.5	2.02	2.58	3.26
2.0	1.39	1.77	2.27

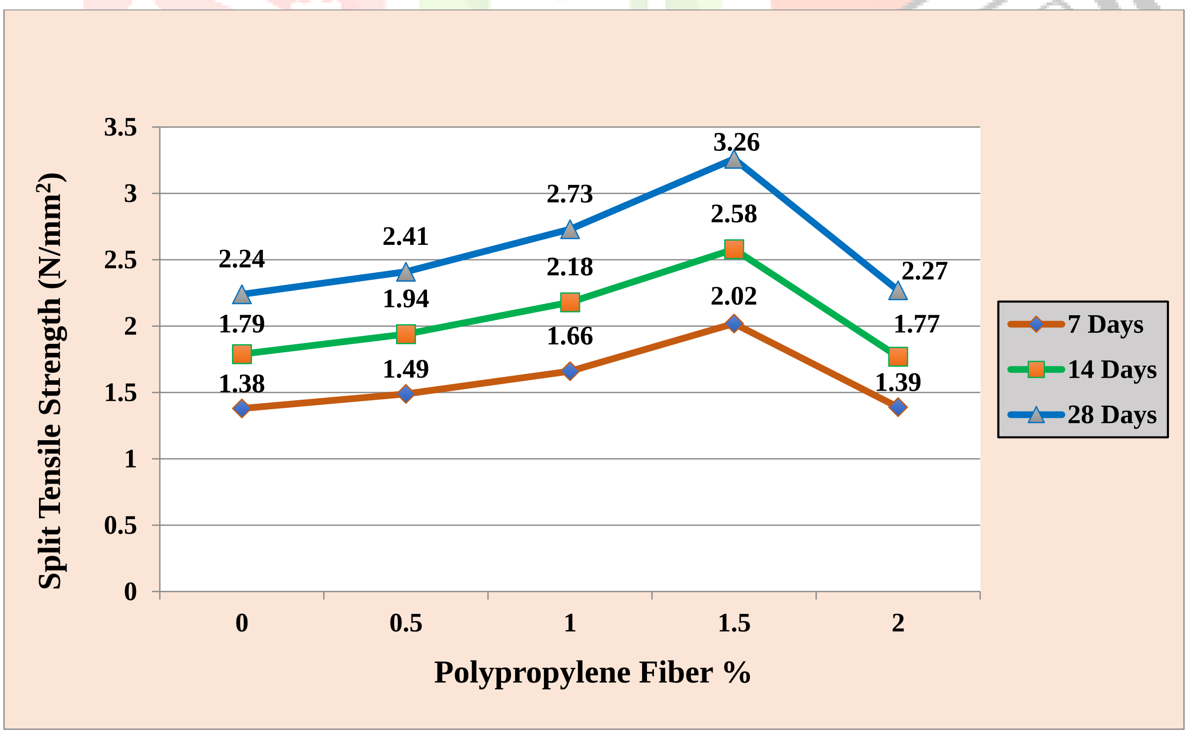

Fig 4.3 Comparative Splitting Tensile Strength of M25 Grade

Figure 4.3 shows that the least split tensile strength was obtained at 0% polypropylene fiber addition, whereas the optimum split tensile strength was obtained at 1.5 percent polypropylene fiber addition during 14 and 28 days curing of cubes.

The ideal percentage increase in split tensile strength of concrete was found to be 45.53 percent after 28 days of curing.

Table 4.6 Splitting Tensile Strength of M30 grade

Polypropylene Fiber %	**Splitting Tensile Strength(N/mm^2)**		
	7 Days	**14 Days**	**28 Days**
0.0	1.99	2.97	3.33
0.5	2.42	3.33	3.97
1.0	2.51	3.48	4.12
1.5	2.22	3.29	3.64
2.0	2.04	3.06	3.41

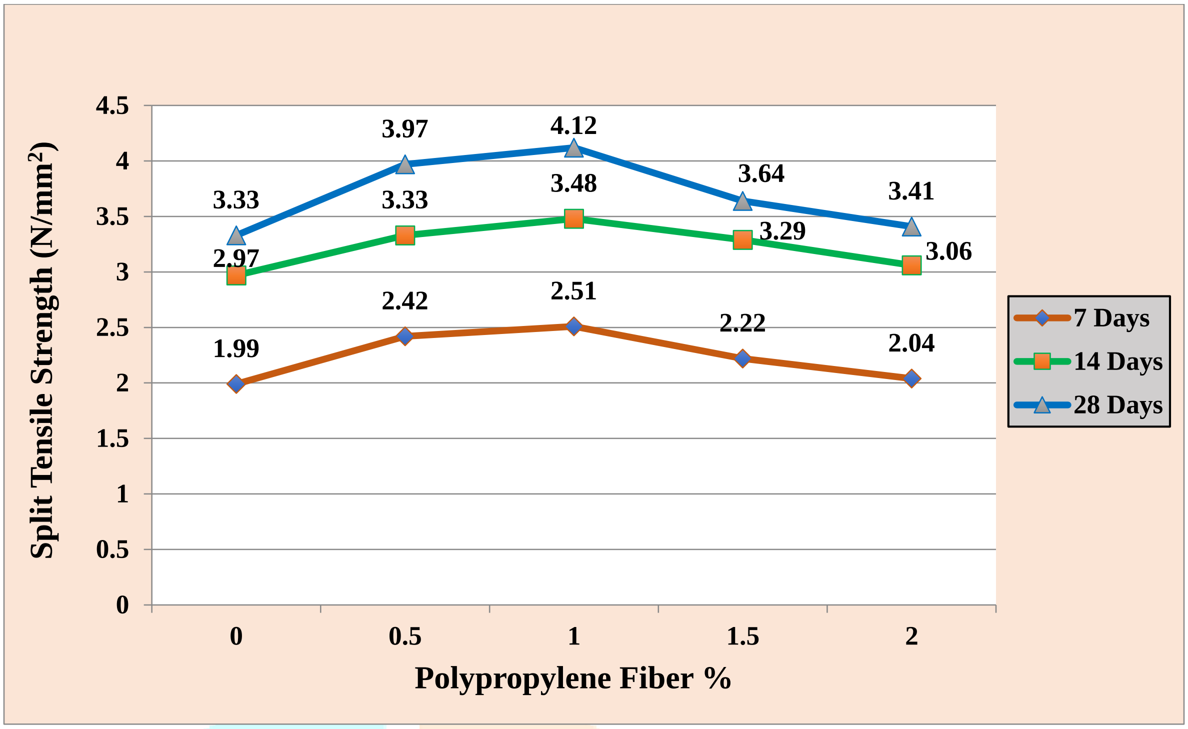

Fig 4.4 Comparative Splitting Tensile Strength of M30 Grade

Figure 4.4 shows that during 14 and 28 days of curing, the minimal split tensile strength was obtained with a 0% addition of polypropylene fiber, while the optimum split tensile strength was obtained with a 1.0 percent addition of polypropylene fiber.

The ideal percentage increase in split tensile strength of concrete was found to be 23.72 percent after 28 days of curing.

4.4 Flexural Strength of Concrete

The tensile strength of concrete is measured in several ways, one of which is flexural strength. It is the ability of an unreinforced concrete beam or slab to withstand bending failure. For the flexural strength test, 150x150x500 mm beams were cast and tested on a flexural testing equipment.

Table 4.7 Flexural Strength of M25 grade

Polypropylene Fiber %	**Flexural Strength (N/mm^2)**	
	7 Days	**28 Days**
0.0	1.58	2.6
0.5	1.76	2.9

1.0	2.01	3.3
1.5	2.07	3.4
2.0	1.67	2.7

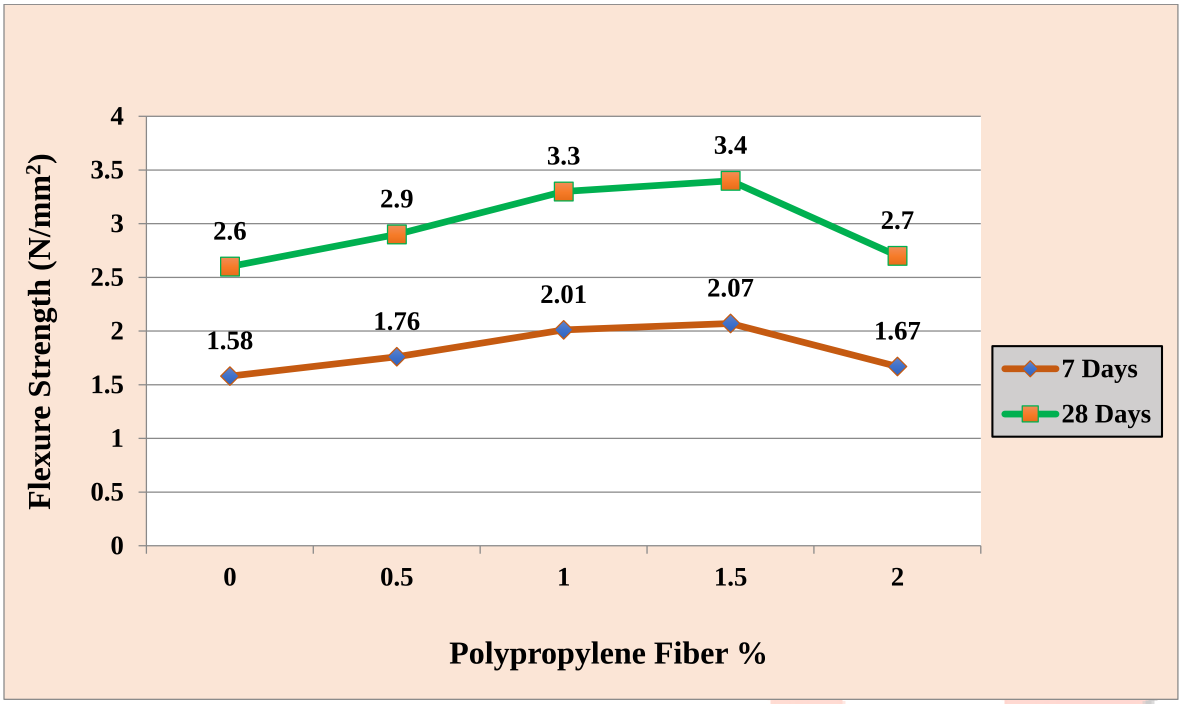

Fig 4.5 Comparative Flexural Strength of M25 Grade

Figure 4.4 shows that during 14 and 28 days of curing, the least flexural strength was obtained at 0% addition of polypropylene fiber, while the maximum flexural strength was obtained at 1.5 percent addition of polypropylene fiber.

At 28 days of curing, the optimum percentage increase in flexural strength of concrete was found to be 30.76 percent.

Table 4.8 Flexural Strength of M30 grade

Polypropylene Fiber %	**Flexural Strength (N/mm^2)**	
	7 Days	**28 Days**
0.0	1.64	2.70
0.5	1.81`	2.97
1.0	2.06	3.38
1.5	1.98	3.26
2.0	1.93	3.12

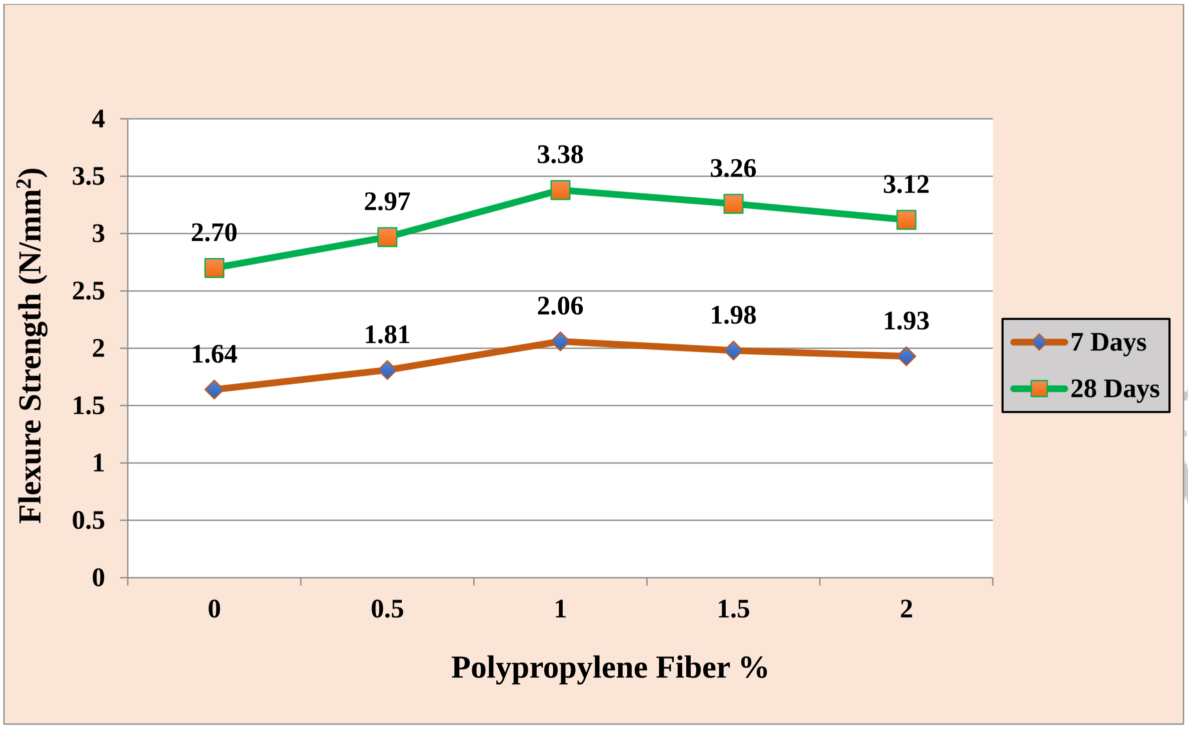

Fig 4.6 Comparative Flexural Strength of M30 Grade

Figure 4.4 shows that at 14 and 28 days of curing, the least flexural strength was obtained at 0% addition of polypropylene fiber, while the maximum flexural strength was obtained at 1.0 percent addition of polypropylene fiber.

At 28 days of curing, the optimum percentage increase in flexural strength of concrete was found to be 25.18 percent.

4.5 Durability of concrete

A. For M25

i) Observation Table and Calculations : (Resistance against Acid Attack)

Table 4.9 Resistance against Acid Attack of M25 grade

S. No.	Mix Combination Designation	Dry weight of cube specimen (W1) in kg	Weight of cube specimen after immersed in solution (W2) in kg	Percent weight loss in kg $\frac{W1-W2}{W1}X\ 100 = \%$
1	MD 10%	8.178	8.102	0.92
2	MD 10% +0.5%PF	8.150	8.072	0.95
3	MD 10% + 1% PF	8.060	7.973	1.07
4	MD 10%+1.5% PF	7.998	7.886	1.40
5	MD 10%+ 2% PF	7.970	7.832	1.73

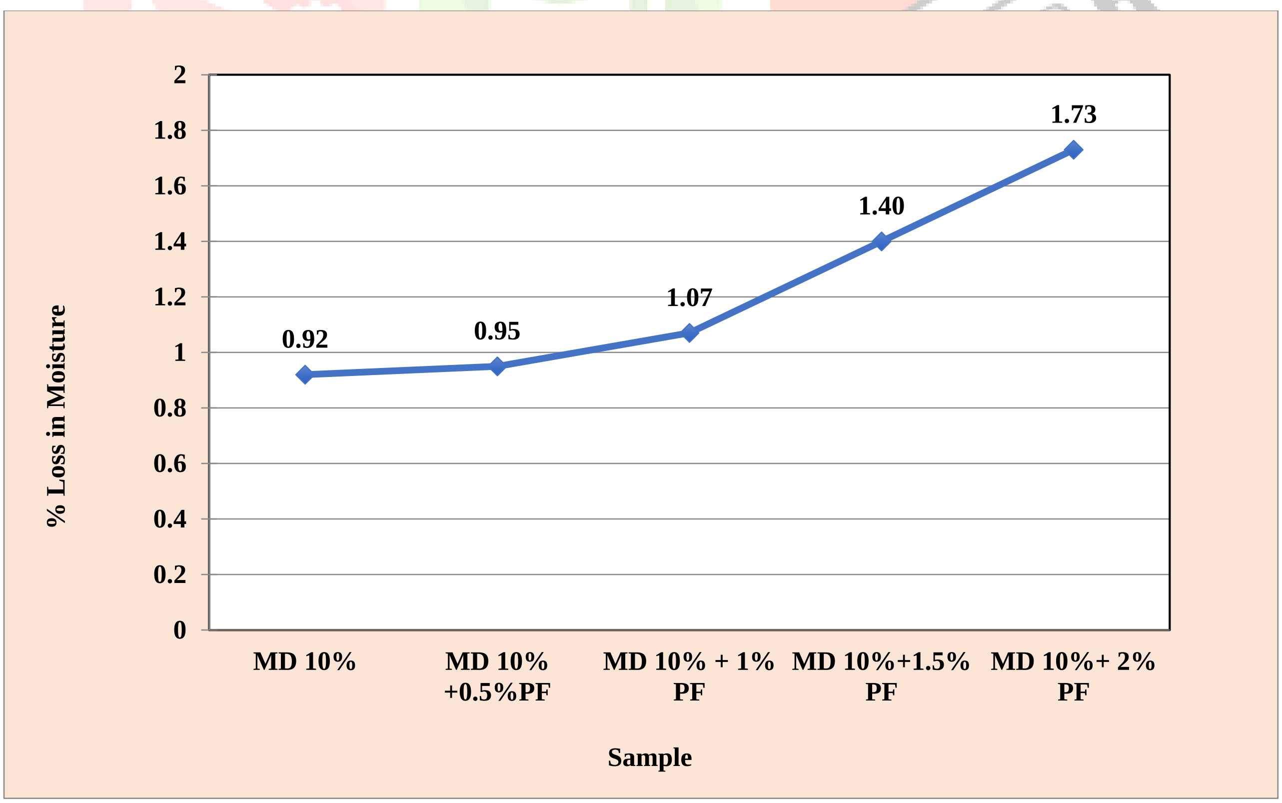

Fig 4.7 Comparative analysis of loss in moisture of M25 Grade

ii) Observation Table and Calculations : (Resistance against Alkali Attack)

Table 4.9 Resistance against Alkali Attack of M25 grade

S. No.	**Mix Combination Designation**	**Dry weight of Cube Specimen (W1) in kg**	**Weight of Cube Specimen after Immersed in Solution (W2) in kg**	**Percent Weight Loss in kg** $\frac{W1-W2}{W1}$ X 100 = %
1	MD 10%	8.168	8.146	0.26
2	MD 10% +0.5%PF	8.154	8.128	0.31
3	MD 10% + 1% PF	8.056	8.024	0.39
4	MD 10%+1.5% PF	7.982	7.945	0.46
5	MD 10%+ 2% PF	7.975	7.934	0.51

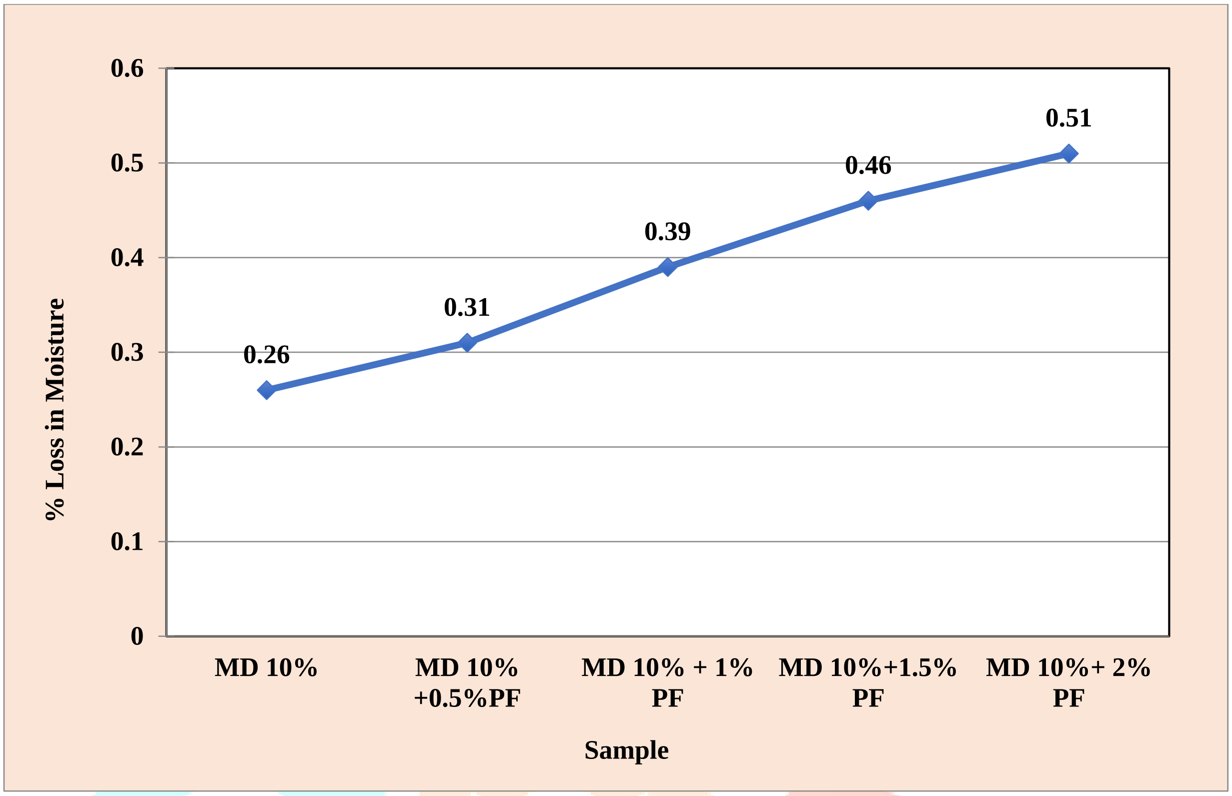

Fig 4.8 Comparative analysis of loss in moisture of M25 Grade

From figure 4.7 and 4.8 following observations were made:

a) The percent loss of weight of cube specimens for resistance against acid attack :

- For MD 10% at 28 days **-0.92 %**
- For MD 10% and PF 0.5% to 2.0%at 28 days found increasing **- 0.95 to 1.73 %**

b) The percent loss of weight of cube specimens for resistance against alkali attack :

- For MD 10% at 28 days - **0.26%**
- For MD 10% and PF 0.5% to 2.0%at 28 days found increasing**- 0.31 to 0.51 %**

B. FOR M30

j) Observation Table and Calculations : (Resistance against Acid Attack)

Table 4.10 Resistance against Acid Attack of M25 grade

S. No.	Mix Combination Designation	Dry weight of cube specimen (W1) in kg	Weight of cube specimen after immersed in solution (W2) in kg	Percent weight loss in kg $\frac{W1-W2}{W1}$ X 100 = %
1	MD 10%	8.468	8.386	0.96
2	MD 10% +0.5%PF	8.419	8.327	1.09
3	MD 10% + 1% PF	8.376	8.273	1.22
4	MD 10%+1.5% PF	8.230	8.102	1.55
5	MD 10%+ 2% PF	8.167	8.012	1.89

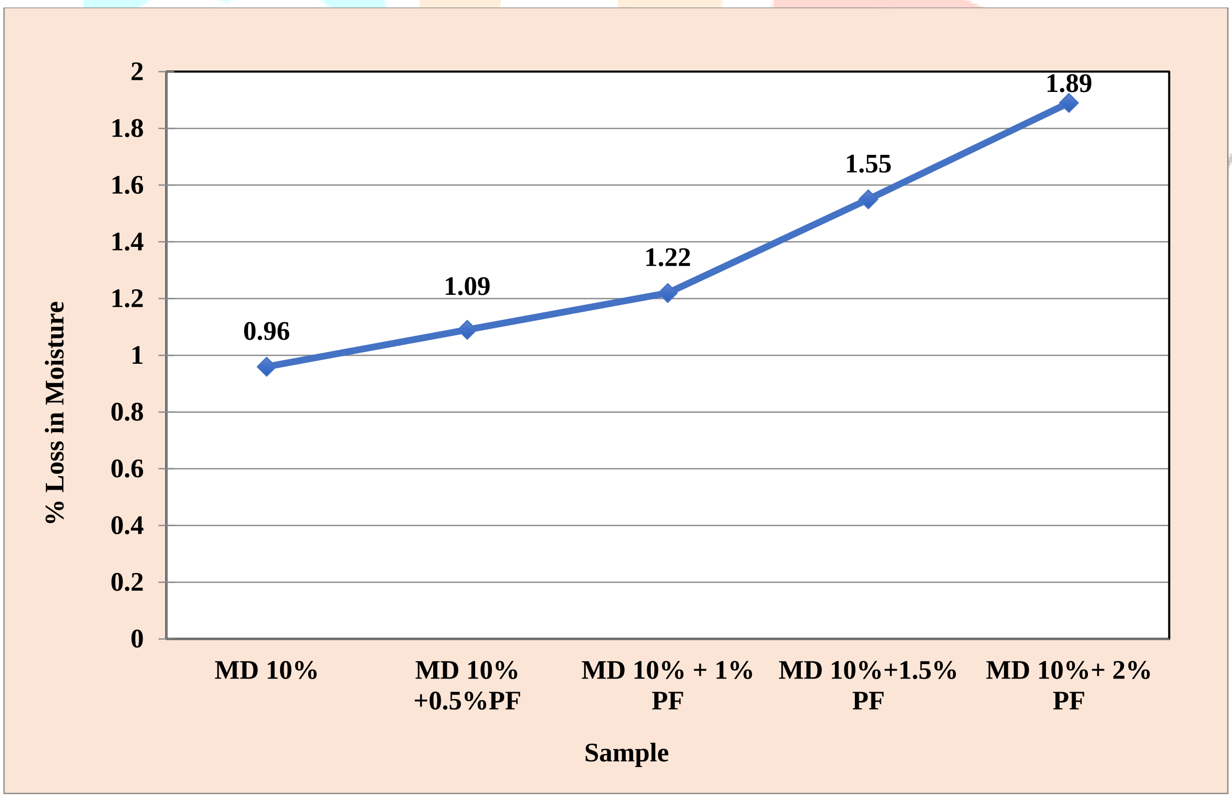

Fig 4.9 Comparative analysis of loss in moisture of M30 Grade

iii) Observation Table and Calculations : (Resistance against Alkali Attack)

Table 4.11 Resistance against Alkali Attack of M25 grade

S. No.	**Mix Combination Designation**	**Dry weight of Cube Specimen (W1) in kg**	**Weight of Cube Specimen after Immersed in Solution (W2) in kg**	**Percent Weight Loss in kg** $\frac{W1-W2}{W1}$ X 100 = %
1	MD 10%	8.468	8.436	0.37
2	MD 10% +0.5%PF	8.419	8.378	0.48
3	MD 10% + 1% PF	8.376	8.329	0.56
4	MD 10%+1.5% PF	8.230	8.175	0.67
5	MD 10%+ 2% PF	8.167	8.104	0.77

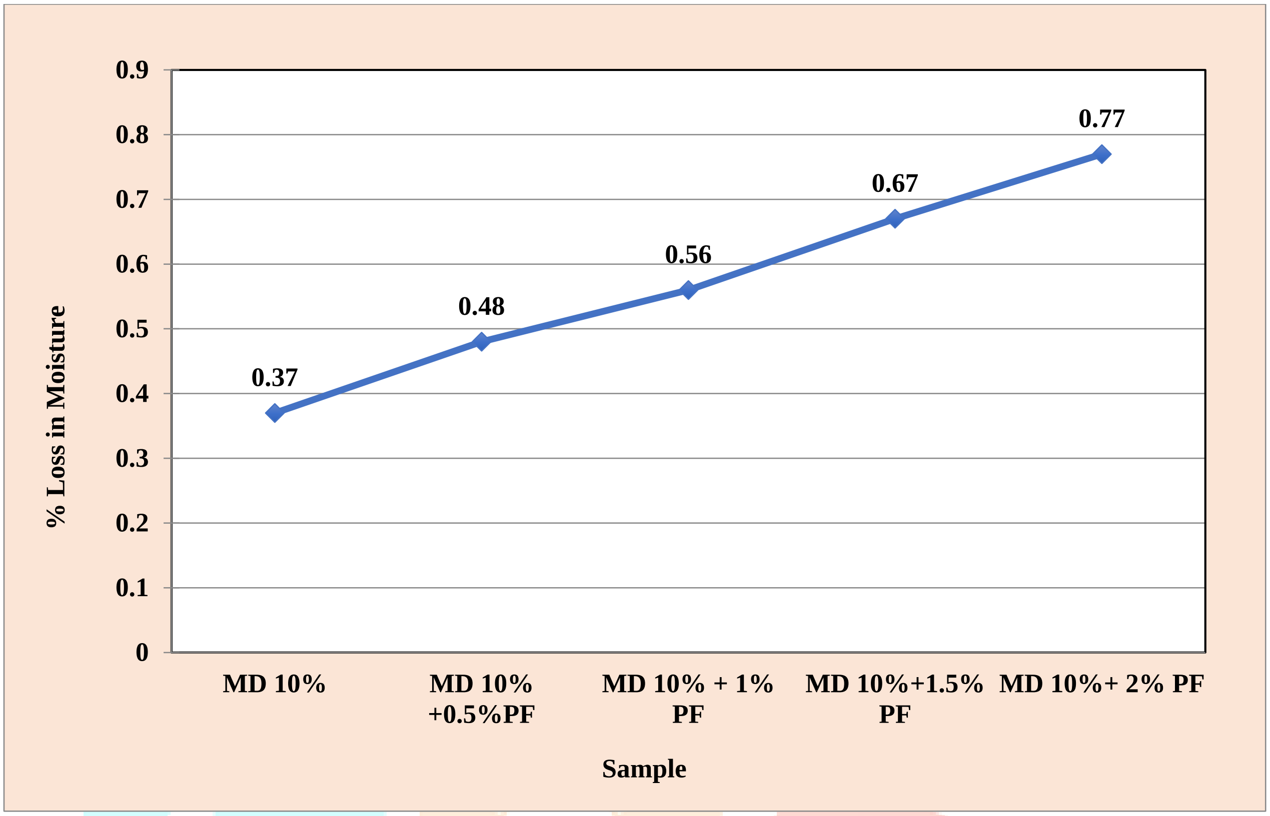

Fig 4.10 Comparative analysis of loss in moisture of M30 Grade

From figure 4.9 and 4.10 following observations were made:

a) The percent loss of weight of cube specimens for resistance against acid attack :

- For MD 10% at 28 days **-96%**
- For MD 10% and PF 0.5% to 2.0%at 28 days found increasing - 1**.09 to 1.89 %**

b) The percent loss of weight of cube specimens for resistance against alkali attack :

- For MD 10% at 28 days - **0.37%**
- For MD 10% and PF 0.5% to 2.0%at 28 days found increasing**- 0.48 to 0.77%**

CHAPTER 5

CONCLUSION

In order to study and discover current problems and scope of work in the area of strength properties based analysis of modified polypropylene fiber concrete, a review of 22 research publications was conducted.

Following the review, three difficulties based on an experimental method were discovered in the literatures. To develop the issue statement and purpose, a thorough review of the literature was conducted, focusing on common results of research works, strengths and weaknesses, and gaps.

5.1 General Experimentation Result

In the thesis work these Experimental Scenarios were considered during experimentation.

- Perform compressive strength, split tensile strength, and flexural strength tests on concrete of grade M25 and M30 containing varying percentages (0, 0.5, 1.0, 1.5, and 2.0 percent) of Polypropylene Fiber and 10% Marble Dust.
- To assess the durability of concrete in terms of percentage moisture loss for both M25 and M30.

Results: In this experiment, the water-cement ratio of 0.45 is used in the Mix-Design of M25 and M-30 grade concrete (reference IS 10262: 2009). A percentage of polypropylene fiber (0% to 2%) is added to concrete, coupled with marble dust, which was used to partially replace cement by 10%. A total of 60 Polypropylene fiber Reinforced Concrete prototypes were cast with extreme precision and cured for 7, 14, and 28 days. Slump tests on fresh concrete were undertaken during the concreting/casting of cubes to verify workability with the aforesaid proportion (percent) addition of polypropylene fiber, i.e. (0 % to 2 %). Following the completion of the concrete's maturation time, On all specimens with appropriate casting dates, compressive strength tests, split tensile tests, flexural strength tests, and durability tests were performed. The following observations were made based on the findings of the study in relation to the above-mentioned tests.

A. FOR M25

1. Compressive Strength:

After 1.5 percent of PPF compressive strength drops for both 14 days and 28 days cube strength, the compressive strength grew as the percentage (percent) of polypropylene fiber (0 percent to 1.5 percent) increased.

The ideal percentage increase in concrete compressive strength was found to be 29.82 percent after 28 days of curing.

2. Split Tensile Strength:

At 14 and 28 days of curing, the least split tensile strength was obtained with 0% polypropylene fiber addition, while the maximum split tensile strength was obtained with 1.5 percent polypropylene fiber addition.

The ideal percentage increase in split tensile strength of concrete was found to be 45.53 percent after 28 days of curing.

3. **Flexure Strength:**

At 14 and 28 days of curing, it was shown that the flexural strength of concrete increased gradually with the addition of polypropylene fiber, with the lowest flexural strength obtained at 0% and the highest flexural strength acquired at 1.5 percent addition of polypropylene fiber.

The ideal percentage increase in flexural strength of concrete was found to be 30.76 percent after 28 days of curing.

4. **Durability:**

It was concluded that the percent loss of weight of cube specimens for resistance against acid attack was found to be -

- For MD 10% at 28 days - **0.92 %**
- For MD 10% and PF 0.5% to 2.0% at 28 days found increasing - **0.95 to 1.73 %**

The results revealed that the percent loss of weight of cube specimens for resistance against alkali attack was found to be -

- For MD 10% at 28 days - **0.26%**
- For MD 10% and PF 0.5% to 2.0% at 28 days found increasing **- 0.31 to 0.51 %**

B. FOR M30

1. **Compressive Strength:**

For both 14 and 28 day curing periods of cubes, the results demonstrated that minimal compressive strength was obtained at 0% addition of polypropylene fiber and optimal compressive strength was obtained at 1.5 percent addition of polypropylene fiber.

The ideal percentage increase in concrete compressive strength was found to be 12.61 percent after 28 days of curing.

2. Split Tensile Strength:

At 14 and 28 days of curing, the results demonstrated that a 0% addition of polypropylene fiber resulted in the lowest split tensile strength, while a 1.0 percent addition of polypropylene fiber resulted in the highest split tensile strength.

The ideal percentage increase in split tensile strength of concrete was found to be 23.72 percent after 28 days of curing.

3. Flexure Strength:

At 14 and 28 days of curing, the minimum flexural strength was obtained at 0% addition of polypropylene fiber, whereas the maximum flexural strength was reached at 1.0 percent addition of polypropylene fiber. The ideal percentage increase in flexural strength of concrete was found to be 25.18 percent after 28 days of curing.

4. Durability:

It was concluded that the percent loss of weight of cube specimens for resistance against acid attack was found to be -

- For MD 10% at 28 days - **96%**
- For MD 10% and PF 0.5% to 2.0% at 28 days found increasing - 1**.09 to 1.89%**

The results revealed that the percent loss of weight of cube specimens for resistance against alkali attack was found to be -

- For MD 10% at 28 days **- 0.37%**
- For MD 10% and PF 0.5% to 2.0% at 28 days found increasing **- 0.48 to 0.77%**

Even when modest volume fractions of PPF are utilized, the results show that polypropylene fibers (PPF) prevent early age shrinkage and moisture loss of the concrete mix. The use of fiber in concrete affects the workability of fresh concrete, according to the findings of this study. It was determined that as the percentage of fiber added to the concrete increased, the workability of the concrete reduced. When the volume dose rate exceeds 1.5 percent, the concrete becomes stiff and difficult to compact, and its strength declines. It did, however, lessen bleeding and segregation in the concrete mix.

By replacing 10% of the cement in the concrete mix with marble dust, the mix became more cost-effective. It was discovered that marble dust concrete mix was more cost effective (about Rs150/m^3) than ordinary concrete mix.

5.2 Recommendations for Future Studies

The use of polypropylene fiber Concrete has been the subject of numerous investigations. The majority of the research focuses on improving the physical and mechanical qualities of concrete. Chemical assault is the main cause of corrosion in hardened concrete, hence polypropylene fiber reinforced concrete has been detected in experimental research. It can also be utilized for dynamic structures after improving its tensile strength.

- It can replace mechanically compacted concrete after boosting its tensile and flexural strength.
- If polypropylene fiber aggregate proves to be effective in boosting concrete strength, it might be used in place of fine aggregate rather than recycling, which is not cost-effective.
- The economic comparison of PPF reinforced concrete with various additions such as marble dust, fly ash, furnace slag, and so on has a lot of room for improvement.
- Concrete can be utilized in heavy structures such as bridges, dams, and foundation construction after it has been strengthened.
- Similarly, as concrete's strength improves, it can be used for prefabricated constructions.
- PPF reinforced concrete can also be used in rigid pavement for impact load resistance on expressways and roads, where military tanks and planes can land.

Polypropylene fiber in concrete is widely utilized in the construction of concrete frames, making it one of the most important application areas in the worldwide fiber industry. The demand from the segment will continue to rise as the concrete industry grows in the process of designing and building in-situ frame buildings.

Following are some scope in polypropylene fiber concrete having marble dust:

- Polypropylene fibers make concrete lightweight, making it ideal for use in precast concrete blocks.
- PPF is also used in the production of corrosion-resistant concrete, which makes it more durable.
- Marble dust is used as a concrete cost optimizer since it minimizes the amount of cement used.
- There is a lot of research potential in concrete with marble dust and polypropylene fiber, as well as other additions, to build a concrete that is strong, durable, and cost-effective.

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