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EXPERIMENTAL ANALYSIS ON PARTIAL REPLACEMENT OF CEMENT BY RICE HUSK ASH, COARSE AGGREGATE BY KADAPPA STONE AND FINE AGGREGATE BY PLASTIC WASTE IN CONCRETE

Md Munazirul Haque[1], Hirendra Pratap Singh[2], Rakesh Sakale[3]

[1]PG Student, School of Research & Technology, People's University Bhopal (M.P.) India.

[2]Asst. Prof. School Of Research & Technology, People's University Bhopal (M.P.) India.

[3]Prof. School of Research & Technology, People's University Bhopal (M.P.) India.

ABSTRACT

The growing volume of industrial waste is a worrying reality that has given rise to problems with environmental sustainability and earth surface ecology. By emitting carbon dioxide and other damaging chemicals into the atmosphere while being manufactured, fibre production contributes to global warming. Additionally, it processes waste generated during production and field use. Therefore, using industrial waste in the composition of concrete can aid in reducing ecological and environmental issues. In this investigation, fibre (waste polypropylene fibre) was added to cement concrete as an additional material. A synthetic hydrocarbon polymer called polypropylene fibre (PPF) used as partial replacement of fine aggregate was added to the concrete to increase its compressive and split tensile strength. In this investigation, we created a variety of specimens using different amounts of polypropylene waste, including (0%, 0.25%, 0.5%, 0.75%, and 1.00%). The compressive strength and split tensile strength of the fiber-reinforced concrete (FRC) were measured after 7 and 28 days of curing, whereas the density of the FRC was assessed right away after the preparation of the concrete mix. According to the results, adding polypropylene fibre causes the density of new fiber-reinforced concrete (FRC) to slightly or barely decrease from 2397 kg/cm3 to 2393 kg/cm3. For all curing ages up to a specific point, adding discarded polypropylene fibre increases the strength of fibre reinforced concrete (FRC). The strength of the Fibre Reinforced Concrete (FRC) suddenly decreases after that. For maximal strength with a low coefficient of brittleness, 0.5% polypropylene fibre addition is advised. The Fibre Reinforced Concrete (FRC)'s compressive strength increases by 10% and its split tensile strength by 17% with the addition of 0.5% waste polypropylene fibre. In our research we prepared different concrete mixes with partial replacement of cement with variable percentage of Rice Husk Ash i.e. 0%, 2.5%, 5%, 7.5% and 10% and we tested these mixes for compressive strength at 7 days, 21 days and 28 days. Waste kadappa stones were partially replaced as coarse aggregates in 20%, 40% and 60% respectively are casted and tested for compressive strength at 7 and 28 days.

1. INTRODUCTION

1.1 GENERAL

The most popular building material utilised worldwide is cement concrete. It is important to understand it better and enhance its qualities. It is becoming more and more crucial to manage and treat both the solid waste created by municipal garbage and industry by using waste and recycled materials in cement concrete mixtures.

One of the most significant inventions of the 20th century was plastic. Plastic consumption has been steadily increasing and is now a significant environmental issue. The use of plastic in the concrete industry is regarded as a feasible application for resolving the disposal of a significant volume of recovered plastic material.

According to certain researchers, the physical, chemical, and mechanical properties of plastic material particles utilised as aggregate in cement concrete mix were assessed. The results demonstrated that the mechanical properties of cement concrete are not significantly changed by the inclusion of polymeric materials in fractions 610% in volume inside a cement matrix.

In composite materials for building purposes, several researchers calculated the use of trash from consumed plastic bottles as a partial replacement of the fine aggregate. The study shows that plastic bottles can be successfully used as a partial replacement for fine aggregate in cementitious concrete composite, which appears to present an appealing low-cost material with consistent or reliable properties and which would help to resolve some of the solid waste problems caused by the manufacture of plastics.

Therefore, the potential for using waste plastic in cement concrete mixes has been examined in this study and contrasted with control samples. Only instances of plastic being utilised as a fibrous material in concrete are discussed in this section. The numerous varieties of fibrous waste material's diverse characteristics are depicted. Finally, this paper evaluates potential future investigations on the use of industrial waste polymer as fibrous material in cement mortar and cement concrete mix.

1.2 GOALS OF THE RESEARCH WE PROPOSED

By using them as fibrous material for creating a cement concrete mix, the very essential goal of this study work is to develop a sustainable and environmentally friendly alternative for the use of industrial waste fibre in concrete. The following goals are being pursued by this thesis or research project:

1. To examine the mechanical and physical properties of the recycled industrial polymer fibre used in concrete mixtures.
2. Using industrial waste fibre, prepare the different polymer modified concrete quantities.
3. To ascertain the ideal proportion of industrial waste fibre to cement in order to create concrete with the best compressive strength, split tensile strength, and flexural strength.
4. To examine the potential for including industrial waste fibre in cement concrete.
5. To assess the polymer-modified concrete's split tensile strength and compressive strength, which is made of industrial waste fibre.

2. LITERATURE REVIEW

2.1 JOURNALS

(Manaswini C, Vasu Deva, 2015) reviewed that with increasing creation of industrial waste, waste utilization can save us money and is claimed to be of great usefulness by researchers when added to concrete in the form of fibres. We can use metallic fibres and waste PP, PET, HDPE fibres as reinforcement of standard concrete. We know that, both these products are available in large quantity and at a cheaper cost; we can access effects of the incorporation of waste metallic fibres (WMF) and polypropylene fibres (WPF) on the fresh and hardened concrete properties. Numbers of experiments have been performed to observe the performance of FRC in compression, tension, shear, flexure in the extreme environments etc. By the detailed study on this paper we can say that there is almost a 41.25% increase in the compressive strength when waste metal fibres are used. Also we can say that, addition of fibres Reduce plastic disposal problem and it provides Sustainable, durable and economical construction.

According to (1) (Amit Rai, Dr. Y.P Joshi, 2014) in conventional concrete, micro-cracks develop before structure is loaded because of drying shrinkage and other causes of volume change. When a structure is loaded, the micro cracks open up and propagate because of the development of such micro-cracks, results in inelastic deformation in the concrete structure. Fibre reinforced concrete (FRC) is cementing concrete reinforced mixture with more or less randomly distributed small fibres. In the FRC, a numbers of small fibres are dispersed and distributed randomly in the concrete structure at the time of mixing, and thus improve concrete properties in all directions. The fibers help to transfer the load to the internal micro cracks. FRC is cement based composite material that has been developed in the recent years. It has been successfully used in construction with its exceptional flexural and tensile strength, resistance to the spitting, impact resistance and outstanding permeability and frost resistance. It is an effective way to increase the toughness, shock resistance and resistance to the plastic shrinkage cracking of the mortar. These fibers have many more benefits. Steel fibers can improve the structural strength to decrease in the heavy steel reinforcement requirement. Freeze thaw resistance of the concrete is also improved. Durability of the concrete is improved to reduce in the crack widths. Polypropylene and Nylon fibers are used to advance the impact resistance. Many developments have been made in the fiber reinforced concrete (FRC).

In the research program of (22) (Pravin V Domke, 2012), to reduce the impact on the atmosphere or surroundings due to agricultural and industrial waste products such as Rice Husk Ash (RHA) and (coconut fibers) COIR which are the waste products of paddy industry and agricultural industry. Use of these materials in the conventional concrete is not only improves the strength of the concrete but also leads to the appropriate disposal of these materials, resulting in reducing the impact of these resources on environment. It is found that the rice husk ash is obtained by burning of rice husk in a controlled way, which is highly reactive pozzolonic material and the coir having excellent mechanical and physical properties to be utilized in effective way in improvement of composite materials. This research paper describes about the results obtained from the comprehensive investigation done on the partial replacement of cement with RHA cement concrete and shows evidently up to how much percentage the cement can be replaced by RHA and COIR. Many other references are available on the use of waste plastic as aggregate, filler or fibre replacement in the preparation of cement mortar and cement concrete mix (24) (Siddique et al. 2008). waste as polyethylene terephthalate (PET) bottle such as Light weight fibrous material (15) (Choi et al 2005).

In other research, by (3) Assunc¸a˜o et al. (2004) used sodium polystyrenesulfonate (NaPSS) produced from waste polystyrene cups as an admixture in the cement concrete mix. The results proved that NaPSS can be used acceptably either as a plasticizer or as an admixture for reduction of water in cement concrete mix. The slump increase of cement concrete was up to around 300% with 0.3% content of NaPSS per weight of cement in the mix. The fruitful use of waste material represents a means of reducing some of the troubles of solid waste management (16) (Davis and Cornwell, 1998). The recycle or reuse of wastes is very significant from different points of view. It helps to save and sustain naturally available resources that are not replenished, it reduces the pollution of the environment and it also helps to keep and recycle energy production processes. Wastes from different sources and industrial by-products should be considered as potentially precious resources which required suitable treatment and application. Plastic wastes are among these wastes; their disposal has ill effects on the environment due to their long biodegradation period, and therefore one of the logical methods for reduction of their negative effects is the application of these materials in other industries and other constructional activities (17) (Hassani et al., 2005). Concrete plays a very important role in the advantageous use of these materials in the construction activities. Although some of these materials can be constructively included or use in concrete, both as part of the fibrous material or as aggregates, it is important to understand that not all waste materials are suitable for such type of use (2) (Anon., 2003). Cement Concrete contains several flaws and micro cracks. The rapid spreading of micro cracks under an applied load is considered accountable for the low tensile strength of cement concrete. It is logical to assume that the tensile strength as well as the flexural strength of cement concrete can be significantly increased by introducing closely spaced fibres. These fibres would capture the spreading of the micro cracks, thus delaying the beginning of the tensile cracks and increasing the tensile strength of the material (27) (Yin and Hsu, 1995). The enhanced presentation of fibre reinforced concrete over its unreinforced equivalent comes from its better capacity to absorb energy during rupture or cracking, while a plain unreinforced matrix fails in a brittle material at all occurrences of cracking stress. This energy-absorption characteristic of fibre reinforced concrete is often termed ‘‘toughness’’ (5) Banthia and Trottier (1995). In the research by (23) Rebeiz and Fowler (1996) found that very good flexural strength can be achieved with reinforced polymer concrete (PC) using unsaturated polyester resins based on recycled polyethylene terephthalate (PET). (25) Soroushian et al. (1995) stated that polypropylene is used only as synthetic fibres to improve the toughness of cement concrete mix. (18) Hınıslıog˘lu and Ag˘ar (2004) investigated the opportunity of using various plastic wastes containing high density polyethylene (HDPE) as polymer additives to asphalt concrete mix. The result shows that the waste HDPE-modified bituminous binders present superior resistance against permanent deformations due to their high stability and high organize amount; it also contributes to the recycling of plastic wastes as well as in protection of the atmosphere. The relations between the fibre and cement matrix, as well as the structure of fibre reinforced cementitious material are the necessary properties that have an effect on the performance of a cement based fibre composite material or a mixture. However, to know these properties, the need for calculating or analyzing the fibre contribution and the prediction of the composite’s performance is necessitated. Such considerations are the following:

1- The matrix composition of the mixture.
2- Type, geometry and surface characteristic of the fibres.
3- The condition of the matrix before and after the failure.
4- The length efficiency and orientation of fibres through the cement matrix.
5- Optimum volume dosage of fibres in the cement concrete mix.

This chapter discusses the mechanism of fibre-matrix relations, where various models are used and compute the bonding between the fibres and cement mixture. As the bonding of fibre and the matrix plays a very important role in the composite behaviour. Also, this chapter presents a review of literature related to the examination and tests done for Fibre Reinforced Concrete (FRC) in general with a importance of civil engineering application.

2.2 PROPERTIES OF FIBRE REINFORCED CONCRETE MATERIALS

The mechanical behaviour of Fibre Reinforced Concrete materials are dependent on the structure of the composite material, which is both the properties of the cement concrete and the properties of the fibre type used in the cement mixture. Hence, composites analysing and forecast on their performance in various loading conditions, such internal organization or structure of the composite must be characterized. The properties that measured were divided into three groups:

1. The structure of the cement concrete matrix.
2. Shape, geometry and the distribution of fibres in the cement concrete matrix.
3. The structure and the interface between the fibre and cement concrete matrix.
4. Bubble acting as extra fine filler and improved total surface area of constituents relative to water volume.
5. Water flow between cement particles is restricted.
6. Workability improved due to action of air bubbles as ball bearing which helps out the movement of particles each other.

3 MATERIALS USED IN OUR WORK

3.1 INTRODUCTION

Planning ahead, following the right procedures, and using the right methods are all necessary for an efficient investigation into the improvement of the mechanical characteristics of fiber-reinforced concrete. The planning and preparation that was done before the testing of the fresh and hardened qualities of Fibre Reinforced Concrete (FRC) is the basis for the criteria to evaluate mechanical properties. The following are these varied activities:

1. Test for aggregate impact value 2. Test for aggregate water absorption
3. Coarse and fine aggregate sieve analytical test
4. Cement fineness test
5. Cement setting time test
6. Concrete fibre doses are chosen.
7. The choice of the mixture
8. Mixing concrete
9. Getting the test samples ready.

The majority of engineering research projects include testing as a necessary activity, which includes or consists of the planning and subsequent execution of the action plan. This chapter discusses preliminary design and planning, including experiments with coarse and fine aggregates, fibre selection and dosage rates, target concrete specimen strengths, mix proportioning, and the number of mix batches and concrete specimens needed to complete the thesis's objectives.

3.2 MATERIALS USED IN OUR WORK

The following are the materials that were used in our thesis work:-

1. Binding substance, such as cement
3. Coarse aggregate 2. Fine aggregate (Sand)
4. Waste polypropylene fibre from industry
5. Drinking water.

1 Binding Material

The binding substance known as cement is produced as a powder by the calcination of lime and clay. It can be mixed with drinkable water to make mortar or with sand, stone, and water to make concrete. Limestone, chalk, and shells are some of the common ingredients used to make cement, along with iron ore, silica sand, clay, slate, and slag from blast furnaces. The basic components of cement are silicates and lime aluminates made from clay and limestone. Heat these materials to create cement.

Calcination, or heating the components indicated above to 1450 °C in a kiln, is the method used to create cement. This produces clinker, a hard substance that is ground into a powder along with some gypsum to create OPC, the most popular type of cement. Following is a list of the many cement types according to Bureau of Indian Standards (BIS) classification:

1. Regular Portland Cement
2. Portland Pozzolana Cement
3. Portland cement with rapid hardening
4. Cement made of Portland Slag
5. Portland Cement that Is Hydrophobic
6. Portland Cement Low Heat
7. Portland Cement Resistant to Sulphates.

Where there is no exposure to sulphates in the soil or in ground water, OPC is typically utilised in conventional concrete building. It is clear that this cement is manufactured in the highest volume compared to other cements. Depending on the cement's compressive strength after 28 days, OPC is divided into three grades: 33 grade, 43 grade, and 53 grade. The study's OPC 43 grade is depicted in Figure 3.1. Cement's qualities were discovered and are detailed in the next chapter.

Figure 1 Cement Used In Our Thesis

2 Fine Aggregate

In the experimental sieving procedure, the majority of the aggregates pass through a 4.75 mm BIS Sieve, which is referred to as a fine aggregate.

i) Natural Sand: Fine aggregates formed by the slow dissolution of rock that have been left behind by glaciers or rivers.

ii) Crushed Stone Sand - Crushed stone sand is a fine aggregate made by crushing hard stone.

iii) Crushed Gravel Sand - Crushed gravel stone is a fine aggregate made by crushing natural gravel.

The fine aggregates can be classed as coarse, medium, or fine aggregates depending on the particle size. According to (13) BIS: 383-1970, the fine aggregates are separated into zone I, zone II, zone III, and zone IV grading zones based on the particle size distribution. From grading zone I through grading zone IV, the grading zones are finer. The investigation depicted in Figure-3.2 used sand that confirmed to zone II. The next chapter contains information on the characteristics of fine aggregates, including their specific gravity and fineness modulus.

Figure-2 Photograph of Fine Aggregate Used In Our Work

3 Coarse Aggregates

The majority of the particles that were retained on the 4.75 mm BIS Sieve during the laboratory sieve study are referred to as coarse aggregates. The following are the several kinds of coarse aggregates:

i) Uncrushed gravel or stone that develops naturally as a result of the weathering process that breaks down rock.

ii) Crushed stone or gravel that is produced when hard stone or gravel is crushed in a quarry.

iii) Stone or gravel that has been partially crushed and is made from the blending of the first two. The nominal size of the graded coarse aggregate is divided into four categories: 40 mm, 20 mm, 16 mm, and 10 mm. Crushed aggregates are likely to increase strength due to the interlocking of angular particles, however rounded aggregates increased the flow ability of the concrete mix due to lower internal friction between rounded aggregate. Throughout the experimental investigation depicted in Figure-3.3, crushed stone aggregates with nominal sizes of 20 mm and 10 mm were employed in a 50:50 ratio. The aggregates were cleaned to get rid of dirt and dust, and they were then dried until they were surface dry. The next chapter contains information on the characteristics of coarse aggregates, including their specific gravity and fineness modulus.

Figure 3 Photograph of Coarse Aggregate Used In Our Work

Concrete is a material synonymous with strength and longevity has emerged as the dominant construction material for the infrastructure needs of the present situation. Due to the vast usage of concrete in this century, concrete ingredients are in depleting stage. There is an interest mounting up to the handling of waste materials as different aggregates and significant research was performed on the use of many different materials as aggregate substitute such as waste Kadappa and other industrial wastes. There is an interest mounting up to the handling of waste materials as different aggregates and significant research was performed on the use of many different materials as aggregate substitute such as waste Kadappa and other industrial wastes. These waste materials can solve few problems like lack of aggregates in construction sites and environmental problems. In the last decade,

4 Waste from Industry Fibre made of polypropylene

Thermoplastic polymer polypropylene (PP), commonly referred to as polypropene, is employed in a wide range of applications. They are produced in vast quantities and rank fourth in production volume behind polyesters, polyamides, and acrylics. The annual global production of polypropylene fibres is over four million tonnes. In the

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mill, these fibres are produced via traditional melt spinning. The thermoplastics made from propane gas are polypropylene fibres. Petroleum byproducts are used to produce propane gas. Propylene polymerizes at high temperatures and pressure to create a lengthy polymer chain. However, only specific catalysts can be used to create polypropylene fibres with regulated or dominant molecular topologies. Previously, "Stealth" was the name given to polypropylene fibres. These monofilament strands are graded 100% virgin homopolymer polypropylene microreinforcement fibres. The solely hydrocarbon monomeric compound C3H6 serves as the basis for polypropylene. These fibres' primary function is to lessen the development of shrinkage fractures in freshly filled concrete. These fibres are just 0.9 gm/cc dense. They have a high degree of crystallinity, are very stiff, and have good resistance to chemical and bacterial attack. These fibres are roughly 70% crystallin, with molecular weights ranging from 90,000 to 300,000 g/mole. Since there are various polymers like acrylic, polystyrene, and others on the market, it is typically not readily accessible. It is frequently opaque or dyed with colouring pigments.It has strong fatigue loading resistance. Commercial isotactic polypropylene has a melting point that ranges from 160 to 166 °C, whereas perfectly isotactic polypropylene has a melting point of about 171 °C. The fibres made of polypropylene are non-magnetic, secure, rust-free, alkali resistant, and simple to use. These have a hydrophobic character and are chemically inert. The performance of post-peak ductility, fracture strength, toughness, impact resistance, pre-crack tensile strength, flexural strength resistance, fatigue resistance performance, and other properties are improved by the addition of fibres. Although polypropylene fibres are strong, they have a low elastic modulus and tensile strength. Up to 12% by volume of polypropylene fibre is said to have been utilised effectively with hand packing fabrication techniques, however 0.1% of 50 mm fibre in concrete has reportedly been shown to result in a 75 mm slump loss. At fibre levels of 0.1 to 0.3% by volume, polypropylene fibres have been shown to lower the uncontrolled plastic and drying shrinkage of concrete.

5 Potable Waste

The type of water we use has an impact on how quickly new concrete sets up and how strong hardened fibre reinforced concrete (FRC) is. Additionally, it raises the possibility of fibre deterioration, particularly when utilising steel fibres. Water is necessary for the hydration of cement, however, as well as the shaping and placement of concrete in the desired shape and position. According to their research, (4) (Balaguru and Shah, 1992) claimed that a minimum water/cement ratio of 0.28 is necessary for appropriate water for hydration. Concrete can be used with water that is suitable for drinking. Water cannot be utilised for concrete mixing if it contains excessive levels of sodium, potassium salts, or suspended particulates. To prevent water pollution from split admixtures and other sources, care must be exercised with the water. The specimens in our investigation were cast using fresh, pure tap water. According to (9) BIS: 456-2000, the water was largely free of any organic materials, sugar, silt, oil, chloride, and acidic material.

4 MIX DESIGN AND TESTING OF PREPARED SAMPLES

4.1 GENERAL

This chapter discusses the process of designing a mix for FRC as well as the numerous tests carried out on the test samples made using these mixes. In this chapter, several tests of the workability of concrete containing varying percentages of polypropylene fibre will be undertaken, including the slump cone test, compressive strength test, and split tensile strength test.

4.2 CONCRETE MIX DESIGN METHOD

The term "concrete mix design" refers to the process of choosing appropriate concrete materials and calculating their relative proportions with the goal of producing a concrete with the needed strength, workability, and durability as efficiently as feasible. The Bureau of Indian Standards (14) BIS: 10262-2009 was used as the foundation for the BIS mix design approach used in our investigation.

1 Target Mean Strength of The Concrete Mix:-

Target strength for mix proportioning

$f'_{ck} = f_{ck} + 1.65\,\sigma$

Where,

f'_{ck} = target average compressive strength at 28 days

f_{ck} = characteristic compressive strength at 28 days and

σ = standard deviation

From Table 4.1, Standard Deviation, σ = 4 N/mm^2

Therefore, target strength = 20 + 1.65 x 4 = 26.6 N/mm^2

Table 1 Assumed Standard Deviation According To IS 456: 2000 (Table-8)

Grade of Concrete	Assumed Standard Deviation in N/mm^2
M-10	3.5
M-15	3.5
M-20	4.0
M-25	4.0
M-30	5.0
M-35	5.0
M-40	5.0
M-45	5.0
M-50	5.0

2 Selection of Water/Cement Ratio For The Concrete Mix

Minimum cement content, maximum water-cement ratio and minimum grade of concrete for different exposures with normal weight aggregates of 20 mm nominal maximum size **(Table 5 of IS:456-2000)**.

Table2 Minimum Cement Content And Maximum W/C Ratio With Exposure Condition With Their Grades

S. No.	Exposure	Reinforced Concrete		
		Minimum Cement Content kg/m3	Maximum Free Water-Cement Ratio	Minimum Grade of Concrete
1	Mild	300	0.55	M-20
2	Moderate	300	0.50	M-25
3	Severe	320	0.45	M-30
4	Very Severe	340	0.45	M-35
5	Extreme	360	0.40	M-40

From Table 2, maximum water-cement ratio is 0.55 for M 20 grade concrete. Hence we will adopt water/cement ratio = 0.55.

3 Selection of Water Cement Ratio for The Concrete Mix

Maximum water content per cubic meters of concrete for nominal maximum size of aggregate according to IS code (Table-3 of BIS: 10262-2009).

Table 3 Maximum Size of Aggregate With Maximum Water Content

S. No.	Maximum Size Of Aggregates (mm)	Maximum Water Content (kg)
1	10	208
2	20	186
3	40	165

From Table 3, maximum water content for 20 mm size aggregate is 186 litres (for 25 to 50 mm slump range) and for 10 mm aggregate is 208 litres. Hence we adopt an average quantity of water i.e. $\frac{186}{2} + \frac{208}{2}$ = **197 litres**.

4 Calculations of Cement Content For The Concrete Mix:-

Water/Cement ratio = 0.55

Cement content = (197 / 0.55) = 358.18 say 359 kg/m^3

From Table 3, minimum cement content for mild exposure condition = 300 kg/m^3.Our calculated cement content is 358.18 kg/m^3 i.e. more than 300 kg/m^3. Hence it is OK.

5 Proportion of Volume of Coarse Aggregate And Fine Aggregate Content:-

Table 4 Volume of Coarse Aggregate Per Unit Volume of Total Aggregate For Different Zone of Fine Aggregate (Table 4 of BIS: 10262-2009)

S. No.	Nominal Maximum Size Aggregate (mm)	Volume of Coarse Aggregate per unit Volume of total Aggregate for Different Zones of Fine Aggregate			
		Zone I	Zone II	Zone III	Zone IV
1	10	0.44	0.46	0.48	0.50
2	20	0.60	0.62	0.64	0.66
3	40	0.69	0.71	0.73	0.75

From Table 4, volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate (Zone II) for water-cement ratio of 0.50 is 0.62. In our case W/C ratio is 0.55. Therefore, volume of coarse aggregate is required to be decreased to decrease the fine aggregate content. As water/cement ratio is higher by 0.05, the proportion of volume of coarse aggregate is decreased by 0.01 (at the rate of -\+ 0.01 for every +\- 0.05 change in W/C ratio). Therefore, corrected proportion of volume of coarse aggregates for 0.55 W/C ratio is **0.61**.

Table 5 Quantities Per Cubic Meter For Trial Mixes (M20)

Mix No.	W/C Ratio	Slump (mm)	Water (l/m^3)	Cement Kg/m^3	Sand Kg/m^3	Coarse Aggregate Kg/m^3	Average Cube Strength at 7 Days (MPa)	Average Cube Strength at 28 Days (MPa)
Mix-A	0.55	50	186	338	749.7	1142.4	15.30	25.48
Mix-B	0.55	100	197	359	730.89	1113.77	15.50	26.75
Mix-C	0.50	50	186	372	724.6	1143.4	14.45	24.55
Mix-D	0.50	100	197	394	700.8	1113.9	14.98	25.90

The Mix-B was selected as the design mix because its average cube strength is very close to the target mean strength of the concrete with appropriate content of cement among all the mixes.

4.3 Prepared Mixes For Testing of The Compressive Strength:-

We prepared the various mixes of concrete for the testing of compressive strength with the variable percentage (**0.25%, 0.50%, 0.75% and 1.00%**) of polypropylene fibre.

Table 6 Prepared Mixes For Tests of Compressive Strength of Concrete

Mix No.	W/C Ratio	Slump (mm)	Fibre Content in % of Cement Wt	Water (l/m^3)	Cement Kg/m^3	Sand Kg/m^3	Coarse Aggregate Kg/m^3
Mix-I	0.55	100	0.00	197	359	730.89	1113.77
Mix-II	0.55	100	0.25	197	359	730.89	1113.77
Mix-III	0.55	100	0.50	197	359	730.89	1113.77
Mix-IV	0.55	100	0.75	197	359	730.89	1113.77
Mix-V	0.55	100	1.00	197	359	730.89	1113.77

5 TEST RESULTS AND DISCUSSION

5.1 Test for Unit Weight of Fibre Reinforced Concrete

We use a mould with a 15 cm diameter and 20 cm height to measure the unit weight of fibre reinforced concrete. With the slump cone test's ramming rod, we compacted the fiber-reinforced concrete in this test. The material was filled in five layers, with each layer being 45 cm thick.

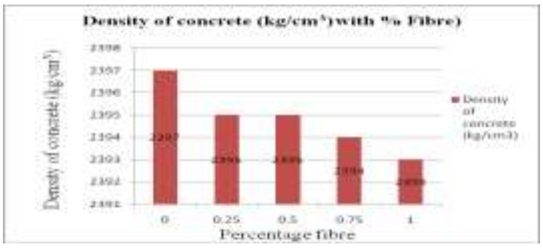
Volume of this cylinder = $\pi r^2 h$

Volume of this cylinder = $3.14 \times (7.5)^2 \times 20 = 3534.29\ cm^3$

Table 7 Density of Fresh Fibre Reinforced Concrete

S. No.	W/C Ratio	Fibre Quantity (%)	Weight of Empty Mould (kg)	Weight of Mould Filled With Water (kg)	Weight of Mould Filled With FRC (kg)	Density of Concrete (kg/cm^3)
1	0.55	0	2.340	5.870	8.472	2397
2	0.55	0.25	2.340	5.870	8.465	2395
3	0.55	0.50	2.340	5.870	8.462	2395
4	0.55	0.75	2.340	5.870	8.460	2394
5	0.55	1.00	2.340	5.870	8.458	2393

By these observations we found that the density of fresh fibre reinforced concrete is in the range between 2393 - 2397 kg/cm^3 and it was observed that if we increase the percentage of polypropylene fibre in the mix it slightly or in negligible range reduces the density of fresh fibre reinforced concrete.



Graph 1 Density of FRC with Variable Fibre Percentage

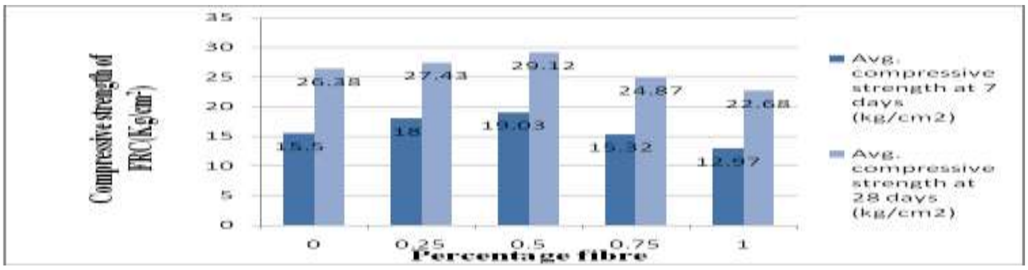
5.2 Compressive Strength of Fibre Reinforced Concrete

At the ages of 7 and 28 days, the compressive strength of all the created mixes was assessed for the various addition amounts of polypropylene fibre with cement concrete. The several Tables below list the average compressive strength values for various mixtures made by adding polypropylene fibre (0%, 0.25%, 0.50%, 0.75%, and 1.00%) at the end of various curing times (7 days and 28 days).

The compressive strength test and split tensile strength test were used in this study's fibre reinforced concrete strength testing. There are five different mixtures made with cement, sand, coarse aggregate, and varying amounts of polypropylene fibre. The test subjects were 150 mm X 150 mm X 150 mm cubes in size. Before tests were performed in accordance with the IS code, the specimens were placed in a curing tank for a period of 7 days and 28 days. When the specimens were investigated after being broken, it was discovered that the majority of failures were caused by the link between the aggregates and cement paste, not the aggregate itself. Table 4.7 in Chapter IV contains a list of the mixtures that were employed in this thesis.

Table 8 Combine Table For Compressive Strength of Fibre Reinforced Concrete

S. No.	Fibre (%)	Avg. Compressive Strength at 7 Days (kg/cm^2)	Avg. Compressive Strength at 28 Days (kg/cm^2)
1	0	15.50	26.38
2	0.25	18	27.43
3	0.50	19.03	29.12
4	0.75	15.32	24.87
5	1.00	12.97	22.68



Graph 2 Combine Test Results of Compressive Strength

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By these test results we can say that compressive strength of fibre reinforced concrete can be increased approximately **10%** by adding waste propylene fibre **0.50%** of the weight of the cement content. It is also clear by these results that more than **0.50%** waste propylene fibre start reducing the compressive strength of FRC.

5.3 Compressive Strength of concrete prepared with RHA

Testing the compressive strength of concrete made with Rice Husk Ash (RHA) involves the same procedure as testing conventional concrete. However, there may be some specific considerations when using RHA as a partial replacement for cement in concrete. Here's a general overview of the compressive strength testing process:

Calculating Compressive Strength: Measure the maximum load applied to the specimen and record the dimensions of the tested specimen. Then, calculate the compressive strength using the formula:

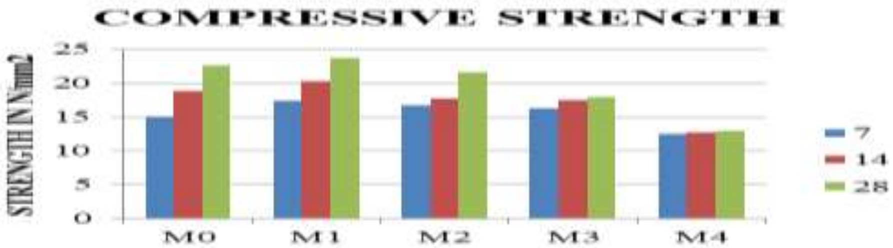
Compressive Strength (f_c) = Maximum Load / Cross-sectional Area

The cross-sectional area should be based on the average diameter of the specimen for cylindrical samples or the average of length and width for cubical samples.

Remember that the compressive strength results will depend on the quality of the RHA, the mix design, curing conditions, and other concrete ingredients used. It's important to follow relevant standards (such as ASTM C39/C39M) and consult with experts or testing laboratories to ensure accurate and reliable results.

Table 9 Compressive Strength Testing Results of Prepared Mixes

S. No	Mix name	Compressive Strength (N/mm^2)		
		7 days	14 days	28 days
1	M0	14.89	18.76	22.62
2	M1	17.33	20.22	23.73
3	M2	16.67	17.73	21.57
4	M3	16.31	17.46	17.89
5	M4	12.44	12.67	12.93



Graph 3 Combine Test Results of Compressive Strength for different mixes

6 CONCLUSION AND RECOMMENDATION FOR FUTURE WORK

6.1 Conclusion

Following a thorough study of the test findings, it is clear that the addition of waste polypropylene fibre considerably affects the Fibre Reinforced Concrete (FRC)'s 7 and 28-day compressive strength as well as its split tensile strength. The significant difference makes it evident that adding waste polypropylene fibre in a certain quantity—0.50% of the cement's weight—increases compressive strength by up to 10% and split tensile strength by about 17% compared to normal concrete. Similar trends can also be seen in experimental outcomes. As a result, the outcomes of statistical analysis are the same as those of the experiment. This research's findings can be drawn from the experimental examination as follows:

1. The density of the concrete mix is not significantly changed by the inclusion of waste polypropylene fibre.

2. The compressive strength of Fibre Reinforced Concrete (FRC) gradually increased after 7 days and 28 days of curing with 0.25% and 0.50% addition of fibre, but after that, it started to decline as the amount of fibre added increased.

3. The split tensile strength of Fibre Reinforced Concrete (FRC) gradually increased after 7 days and 28 days of curing with 0.25% and 0.50% addition of fibre, but after that, it started to decline as the amount of fibre added increased.

4. Up to a certain extent, the use of waste polypropylene fibre increases the strength of concrete for all curing ages. The strength of the Fibre Reinforced Concrete (FRC) suddenly decreases after that. Because concrete loses its capacity to form a suitable bond at greater dosages.

5. The mix that was created by adding 0.50% fibre and 0.55 W/C ratio has the highest compressive and tensile strengths. Therefore, for maximal strength, this mixture is advised.

6. From the test results, it can be concluded that, replacement of cement by 5 % RHA and river sand increases the compressive strength, further increments decreases the compressive strength value.

7. The compressive strength test result of mix M1 on 28th day showed 5% increase in strength when compared with normal mix M0 with RHA concrete.

8. Effective utilization of RHA and waste plastic in concrete can save natural resources and hence can help to keep our environment safe.

9. Compared to conventional concrete, the compressive strength of Kadappa stone replaced coarse aggregate concrete was gradually increased up to 4.45% and 9% in 20% and 40% of coarse aggregate by WKS was replaced.

10. Effect on compression with 40% replacement of aggregate has been found to be achieving higher compressive strength. Again the strength decreased when 60% of WKS were replaced by coarse aggregate.

11. Using Kadappa stones as paver aggregate is most suitable for building paver blocks. This method can also be used in heavy weight concrete as it gives better strength than natural aggregate.

6.2 Suggestions for Further Research

To further understand the mechanical properties of fibre reinforced concrete, additional study and investigation are strongly advised. Below are a few suggestions for additional research:

1. Since the addition of fibre to concrete decreases its workability, test samples that have been prepared with the addition of super plasticizer can be used to assess how the super plasticizer affects FRC.

2. Additional research and lab experiments should be conducted to better understand the mechanical characteristics of fibre reinforced concrete (FRC). It was advised to use fibres in this way while evaluating concrete walls, beams, and slabs, as well as when carrying out additional concrete-related tests such abrasion, shatter, shear, impact, and creeping.

3. The mechanical qualities of a structure may be more effective when two or more short fibres are combined. Therefore, by adding various kinds of short fibres to the concrete mix, more research can be done. 1. Since the addition of fibre to concrete decreases its workability, test samples that have been prepared with the addition of super plasticizer can be used to assess how the super plasticizer affects FRC.

4. Depending on the temperature, the mechanical characteristics of fibre reinforced concrete may vary. So it was suggested that further research be done on the freeze-thawing conditions tests.

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