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Experimental study on the properties of PFRC using M-Sand

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Abstract - *Now days due to high global consumption of natural sand, sand deposit is being depleted and causing serious threat to environment as well as society. River sand is becoming a scarce commodity and hence an exploration alternative to it has become imminent. Manufactured sand is the good alternative to river sand and it is purposely made, fine crushed aggregate produced under controlled conditions from a suitable sand source rock. Plastics are non-biodegradable common environmental polluting materials. These are going to affect the fertility of soil. Design mix of M25 grade concrete with replacement of 0%, 20%, 40%, 60%. 80% and 100% of M-sand have been considered for laboratory analysis viz. slump test, compressive strength for cube and split tensile strength for cylinder, sieve analysis and specific gravity tests for both fine and coarse aggregates and M-Sand and results were compared with standards to achieve the desired parameter.*

Key Words: **M-Sand, Polypropylene fibers, Polypropylene Fiber Reinforced Concrete (PFRC), Compressive strength, Split Tensile Strength.**

1. INTRODUCTION

Concrete is the second most consumed material in the world. The versatility and mould ability of this material, its high compressive strength, and the discovery of the reinforcing and pre-stressing techniques which help to make up for its low tensile strength have contribute largely to its widespread use. Fiber Reinforced Concrete can be defined as a composite material consisting of mixtures of cement, mortar or concrete and discontinuous, discrete, uniformly dispersed suitable fibers. Continuous meshes, woven fabrics and long wires or rods are not considered to be discrete fibers. Fiber is a small piece of reinforcing material possessing certain characteristics properties. Concrete is composite material having properties of high compressive strength, low tensile strength, low post cracking capacity, brittleness and low impact strength. These properties can be improved by addition of fibre in the concrete. Polypropylene Fibre Reinforced Concrete is an embryonic construction material which can be described as a concrete having high mechanical strength, Stiffness and durability. By utilization of Polypropylene fibres in concrete not only optimum utilization of materials is achieved but also the cost reduction is achieved. Concrete modification by using polymeric materials has been studied for the past four decades. In general, the reinforcement of brittle building materials with fibres has been known from ancient period such as putting straw into the mud for housing walls or reinforcing mortar using animal hair etc. Many materials like jute, bamboo, coconut, rice husk, cane bagasse, and sawdust as well as synthetic materials such as polyvinyl alcohol, polypropylene (PP), polyethylene, polyamides etc. have also been used for reinforcing the concrete. Research and development into new fibre reinforced concrete is going on today as well. The uses of plastic fibres in the concrete are going to improve the mechanical properties of concrete.

M.Shanmugaraja has been observed that the authors have carried out experiments to study only the mechanical properties of concrete for various percentage replacement of fine aggregates by manufactured sands. The percentage of increase in the compressive strength is noticed and the flexure strength is increased at the age of 28 days by replacing 50% of natural sand with M-Sand. A. P. Sathe effect of polypropylene (PP) fibres on various properties of concrete such as compressive strength, tensile strength, workability, and fracture properties with various content of fibre (0% ,0.5%,1.0%,1.5%). The result of this present investigation indicates that by adding of 0.5% of polypropylene fibre shows maximum compressive and tensile strength.

1.1 OBJECTIVE OF THE STUDY

- to study the properties of fibre reinforced concrete when fine aggregate is replaced by manufactured sand and with the addition of plastic fibres i.e. polypropylene fibres.
- To Give an alternative way to reinforce concrete other than traditional steel rebar.
- To determine the change in compressive strength and tensile strength when river sand is replaced in percentages with M-sand and polypropylene fibers.

2. MATERIALS AND METHODOLOGY

2.1 Cement

In this study, Portland pozzolana cement (PPC) is a kind of blended cement which is produced by either inter grinding of OPC clinker along with gypsum and pozzolanic materials. PPC confirm to IS: 1489:1991-part-1. The cement used was fresh and without lumps. Advantages of PPC: Low heat of hydration, Reduction in water demand, Reduced bleeding due to high fineness of cement and Resistance to chloride attack. All the mixes in the present work will be prepared using PPC of UltraTech cements. Since UltraTech Cement (PPC) makes concrete more impermeable, denser as compared to OPC. The specific gravity of cement was found to be 3.14.

2.2 Fine Aggregates (River Sand)

The fine aggregate used throughout the experimental investigation is from single source. Fine aggregates passing 4.75mm is considered Sieve analysis of fine aggregate is performed to determine the particle size distribution of fine aggregate as per IS: 383-1970, it belong to zone II. The specific gravity was found to be 2.7.

2.3 Coarse Aggregates

The coarse aggregate which is used throughout the experimental investigation are naturally irregular and partly rounded (angular) at the edge having 10-20 mm size of aggregate. Also coarse aggregate having size 20 mm is considered for the study (i.e. 20mm down). Sieve analysis of coarse aggregate is performed on both the samples to determine the particle size distribution of coarse aggregate. As per IS: 383-1970 grading of coarse aggregates were confirmed as well graded aggregate for both sample**.** The specific gravity of coarse aggregates was found to be 2.68.

2.4 M-Sand

Manufactured sand is a substitute of river sand for construction purposes. It is produced from hard granite stone by crushing. The crushed sand is of cubical shape with grounded edges, washed and graded to as a construction material. Sieve analysis of M-sand is carried out and it belongs to zone II. The specific gravity of M-Sand is found to be 2.72.

2.5 Polypropylene Fibers

Polypropylene is one of the cheapest & abundantly available polymers polypropylene fibers are resistant to most chemical & it would be cementitious matrix which would deteriorate first under aggressive chemical attack. Its melting point is high (165° C). Polypropylene short fibers in small volume fractions between 0.5 to 1.5 commercially used in concrete.

2.6 Water

Water fit for drinking is generally considered fit for making concrete. The water should be free from acids, oils, alkalis, vegetables or other organic impurities. Soft water also produces weaker concrete. Water has two functions in a concrete mix. Firstly, it reacts chemically with the cement to form a cement paste in which the inert aggregates are held in suspension until the cement paste has hardened. Secondly, it serves as a vehicle or lubricant in the mixture as fine aggregates and cement. Portable water is used for both mixing concrete and also for curing.

2.7 Mix Design

The mix was designed as per IS 10262:2009 for M25 grade concrete with 0.5 water cement ratio. Concrete mixes are prepared by partial replacement of natural sand by manufactured sand with different percentages (0%, 20%, 40%, 60%, 80%, 100%) respectively and adding fixed percentage of plastic fibres (0.5% of weight of cement) for every mix.

2.8 Test specimen

Cement, sand and aggregate were taken in mix proportion 1:1.83:2.96 which correspond to M25 grade of concrete respectively. The 150mmX150mmX150mm size concrete cubes, cylinder of size 100mm diameter and 200mm height were used as test specimens to determine the compressive strength, split tensile strength.

2.9 Test procedure

The cubes and cylinders are casted and cured for 7-days and 28-days to achieve the desired strength. Cubes are tested under compressive loads using compression testing machine (CTM) and cylinders are subjected to tensile load i.e; load perpendicular to the axis line using CTM. Thus compressive strength and split tensile strength are tested.

3. Results and Discussion

The compressive strength results of different mixes are given by fig1. It has been observed that, the compressive strength of concrete at 7-days produced with M-Sand and polypropylene fibers goes on increasing up to 100% m-sand and 0.5% PP Fiber. Thus it can be concluded that, the optimum compressive strength gained after 7-days curing period is at 100% M-Sand replacement and 0.5% PP Fiber. It

has been observed that, the compressive strength of concrete at 28-days produced with M-Sand and polypropylene fibers goes on increasing up to 100% m-sand and 0.5% PP Fiber. Thus it can be concluded that, the optimum compressive strength gained after 28-days curing period is at 100% M-Sand replacement and 0.5% PP Fiber. The optimum strength gained after 7-days and 28-days curing period is at 100% m-sand replacement to fine aggregates. It has been observed that, the split tensile strength of concrete at 28-days produced with M-Sand and polypropylene fibers goes on increasing up to 100% m-sand and 0.5% PP Fiber. Thus it can be concluded that, the optimum compressive strength gained after 28-days curing period is at 100% M-Sand replacement and 0.5% PP Fiber.

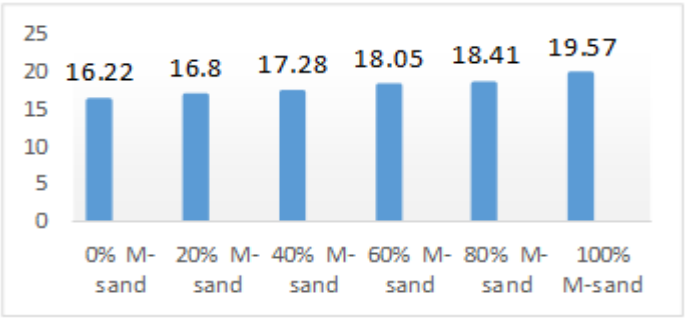

Chart 1: 7-days compressive strength

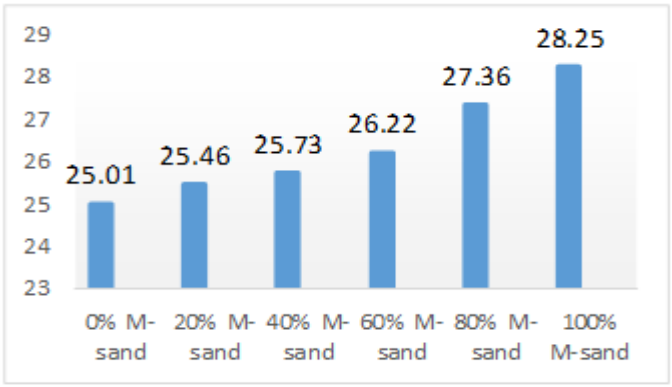

Chart 2: 28-days compressive strength

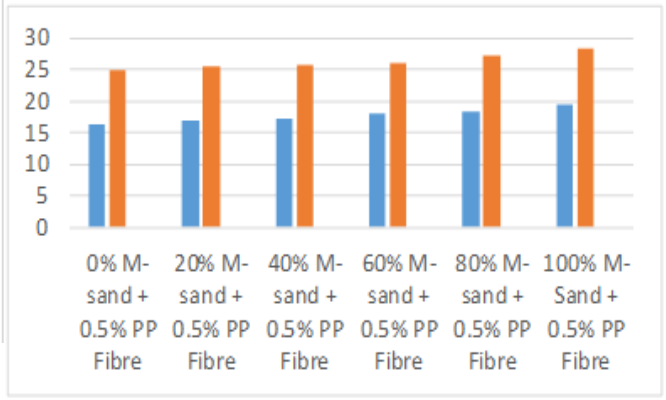

Chart 3: Comparison between 7-days and 28- days strength

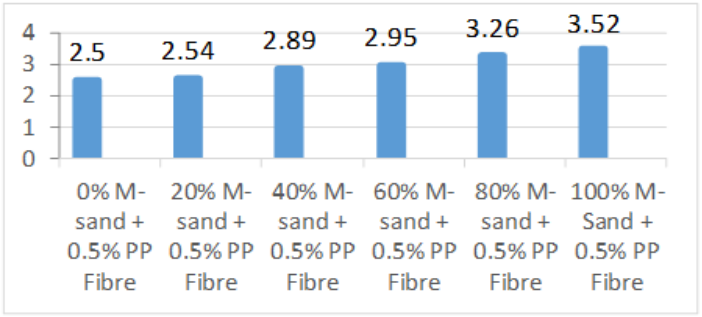

Chart 4: 28-days split tensile strength

4. CONCLUSIONS

Manufactured sand is the good alternative to river sand and it is purposely made, fine crushed aggregate produced under controlled conditions from a suitable sand source rock. Plastics are non-bio-degradable common environmental polluting materials. These are going to affect the fertility of soil. In our study the detailed experimental investigation was carried out on plastic fiber reinforced concrete by partial replacement of natural sand by manufactured sand with different percentages (0%, 20%, 40%, 60%,80%,100%) and adding fixed percentage (0.5% of weight cement) of plastic fibers (PP fibers). The mechanical properties of concrete like compressive strength and tensile strength were studied.

Based on the test results, following conclusions are drawn:

1) Concrete produced by replacing natural sand by manufactured sand with addition of 0.5% of plastic fibres imparts higher compressive and split tensile strengths due to sharp edges and better interlocking of M-sand particles and good bonding with other materials.
2) The compressive strength of 100% replaced manufactured sand concrete with 0.5% of plastic fibres is 12.95% more than reference mix (0% replaced mix).
3) The split tensile strength of 100% replaced manufactured sand concrete is 15.02% more than the split tensile strength of reference mix.
4) By the inclusion of PP fibres into the concrete, certain amount of ductile nature is induced in the concrete which can be seen through the split tensile strength test carried out.
5) The results of this experimental work establishes that river sand can be completely replaced with manufactured sand and with the addition of plastic fibers does not have any adverse impact on the mechanical characteristics of the concrete.
6) The mode of failure was changed from brittle to ductile failure due to inclusion of plastic fibres into the concrete.

Percentage replacement of natural sand by manufactured sand	Compressive strength (MPa)	Percentage increase of compressive strength w.r.t ref. mix	Split tensile strength (MPa)	Percentage increase of tensile strength w.r.t ref. mix
0% M-sand + 0.5% PP Fiber (Ref. Mix.)	25.01	0	2.53	0
20% M-sand + 0.5% PP Fiber	25.46	1.8	2.6	2.77
40% M-sand + 0.5% PP Fiber	25.73	2.86	2.71	7.0
60% M-sand + 0.5% PP Fiber	26.22	4.76	2.8	10.32
80% M-sand + 0.5% PP Fiber	27.36	9.11	2.89	13.53
100% M-Sand + 0.5% PP Fiber	28.25	12.95	2.91	15.02

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