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AN INVESTIGATION ON FRESH AND HARDENED PROPERTIES OF M30 CONCRETE WITH PLASTIC FIBRES AND M – SAND

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Abstract

The Construction industry has got several emoluments in terms of materials used as raw materials. All the materials that used as an alternative should be such that it should not affect of alter the properties of concrete such as workability, strength, durability etc., and also to contribute to the economy of the project. The usage of plastics has been increased to a greater extent in all fields, which leads to the generation of large quantum of plastic wastes. These non-degradable wastes can be recycled and reused in the field of civil engineering. Also in recent past, m-sand is popularly used in several projects as an alternative for river sand which reduces the cost and also helps in achieving uniform grain size. This article focuses on the use of plastic fibres and m-sand as replacement materials in concrete. In this work, an attempt has been made to replace the coarse aggregate with plastic fibres and m-sand with river sand to study the behavioral changes in concrete with varying proportions. The fresh properties of concrete are studied to ensure that the workability of concrete is not affected or reduced. Specimens such as cubes, cylinders and prisms has been casted and tested at the age of 28 days to study the strength of concrete with and without replacement materials. The study has been extended to analyze the structural behavior of concrete beams with optimum mix proportion.

***Keywords**:* Plastic fibres, M-sand, Ground water, Structural behavior, Optimum mix proportion.

1. INTRODUCTION

Plastics pose great threat to the environment from the recent past. The effects due to the accumulation of such wastes are, it affects the soil fertility, pollutes the groundwater resources, causes genetic problems etc., several attempts has been made to reduce the effect of plastic by using it construction field as an alternative material for aggregates. M-sand, which is improved version from the waste generated from quarrying process is also used as an alternate for river sand due to increase in demand and cost. By adding the plastic wastes in concrete, the development of cracks can be prevented. By adding plastic fibres, structural members can various benefits such as reduction in self weight, durability etc., nowadays,

several products have been developed relating to plastic fibres. Plastic fibres are also used in the form of fibre reinforcements and composites.

2. MATERIALS USED

The different materials used in this work are as follows;

- Ordinary Portland cement
- Fine aggregate
- Coarse aggregate-sand
- Plastic fibers

2.1 Cement

Cement is one of the most important among the ingredients of concrete. In this work, Ordinary Portland Cement of grade 53 is used. Test for cement such as consistency tests, setting time test, specific gravity were done to study the properties of the cement as per IS specifications. Table 1 gives the test values for OPC.

S.No	Property	Result
1.	Specific gravity	3.08
2.	Consistency	39%
3.	Initial setting time	44 mins
4.	Final setting time	240 mins
5.	Compressive strength	68 MPa

Table: 1 Properties of cement

2.2 Aggregates

Aggregates are the essential ingredient for all types of concrete, either PCC or RCC. It gives strength to the concrete and also supports the economy of the project. Aggregate is also one of the factors which govern the workability of concrete. The grading of aggregates should be such that, it should be well graded with the voids as a minimum.

2.3 Fine Aggregate

Sand is a generally formed disintegration of rocks by the action of physical weathering. Locally available river sand is used as fine aggregate in this study. Tests such as specific gravity and sieve analysis are carried out to study the properties of fine aggregates as per Indian Standards and the results are shown in table 2.

S.No.	Property	Result obtained
1.	Bulk density	1674(kg/m^3)
2.	Specific gravity	2.54
3.	Fineness Modulus	3.57

Table: 2 Properties of fine aggregate

2.4 Coarse Aggregate

The volume and strength to the concrete is attributed by coarse aggregate. A fraction 20 mm size is used as coarse aggregate crushed aggregate. Tests were carried out to study the physical and mechanical properties of coarse aggregate. Table 3 gives the test values for coarse aggregate.

S.No.	Property tested	Result obtained
1.	Bulk density	1622(kg/m^3)
2.	Specific gravity	2.75
3.	Fineness Modulus	6.32

Table: 3 Properties of coarse aggregate

2.5 Plastic Fibre

Plastic is used as a replacement material for coarse aggregate in this work. The plastic fibres are collected from the locally available plastic industries. All the tests relating to coarse aggregates such as Specific gravity test, Grain size distribution test were carried out to analyse and differentiate the properties of plastic fibre with coarse aggregate.

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2.6 M-Sand

In order to reduce the economy of the project and also due to the increase in demand of availability of river sand, an alternative material, m-sand is used in this work. M-sand is obtained by washing and screening of stone dust obtained during quarrying operation. It satisfies the criteria of well graded or uniformly graded material.

3. EXPERIMENTAL WORK

3.1 Design: Mix Proportion

Mix proportion is carried for a grade M40 concrete as per the specifications of IS 10262-2009. In this course of study, granite powder was replaced with fine aggregate by 4%, 8%, 12%, 16% and 20% respectively. Mix proportion has varied with respect to the percentage replacement of granite powder and presented in table 4.

Water	Cement	Fine aggregate	Coarse aggregate
196.31	479	490.26	952.41
0.45	1	1.13	1.67

Table: 4 Mix propotion for M30 grade concrete

3.2 Design Mix Proportion for Various Concrete:

The mix proportion for various percentages of plastic fibre replaced and m-sand was shown in table 5.

Sl. No.	Mix design ation	Fine aggregate replace with M-sand	Coarse aggregate replace with plastic fibre
1.	CC	Conventional concrete	Conventional concrete
2.	MIX 1	5% replacement	5% replacement
3.	MIX 2	10% replacement	10% replacement
4.	MIX 3	15% replacement	15% replacement
5.	MIX 4	20% replacement	20% replacement
6.	MIX 5	25% replacement	25% replacement

Table: 5 Mix designation

3.3 *Experimental work*

Specimens are casted for different proportions of plastic fibre and m-sand as given in the mix proportion table and tested.

Table 6. gives the details of the specimen cast for various proportions of replacement are given below

S.No.	Mix Designation	% Replacement	Cube	Cylinder	Prism
1.	CC	0	3	3	3
2.	MIX 1	4	3	3	3
3.	MIX 2	8	3	3	3
4.	MIX 3	12	3	3	3
5.	MIX 4	16	3	3	3
6.	MIX 5	20	3	3	3

Table: 6 Specimen cast with various percentage of replacement

3.4 Test Results

3.4.1 Fresh concrete test results

Fresh concrete tests were performed for all mix ratios and the results are shown in table 7. It can be observed in slump tests that, the slump values decrease with increase in the proportion of plastic fibre. Thus the workability is reduced and variation is shown graphically in bar chart form in figure 1.

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S.No.	Mix designation	% Replacement	Slump value (mm)	Compaction factor
1.	CC	0	96	0.90
2.	MIX 1	5	92	0.94
3.	MIX 2	10	93	0.94
4.	MIX 3	15	90	0.91
5.	MIX 4	20	89	0.93
6.	MIX 5	25	86	0.96

Table: 7 Workability test results

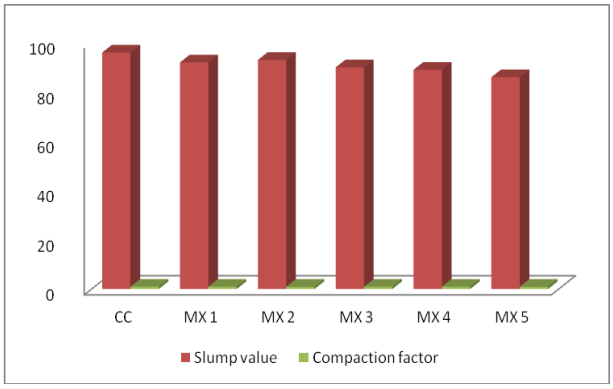

Figure: 1 Fresh concrete test results

3.4.2 Hardened Concrete Results

After completing the workability tests, cubes, cylinders and prisms were casted for each mix designation and the results are presented in table 8. It can be observed in hardened concrete tests the strength of the concrete increases with an increase in the proportion of plastic fibre upto 10%. After that the strength is reduced and variation is shown graphically in bar chart form in figure 2a, 2b and 2c.

S.No.	Mix designation	Compressive strength (MPa)	Split tensile strength (MPa)	Flexural strength (MPa)
1.	CC	34.3	2.19	2.32
2.	MIX 1	36.2	2.28	2.49
3.	MIX 2	37.5	2.47	2.88
4.	MIX 3	34.8	2.49	2.51
5.	MIX 4	34.1	2.12	2.36
6.	MIX 5	33.6	2.08	2.14

Table: 8 Hardened concrete test results at 28 days

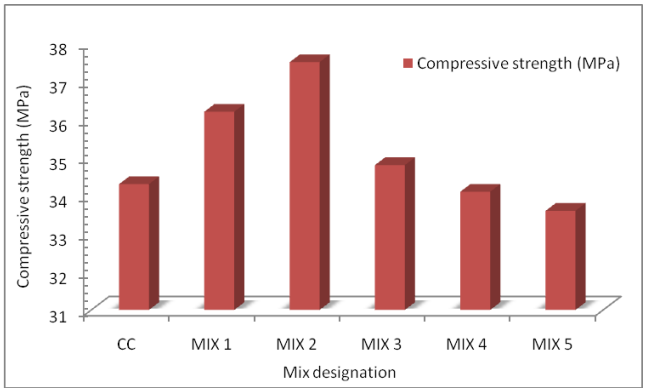

Figure: 2a Bar chart for hardened concrete test of Compressive strength (MPa)

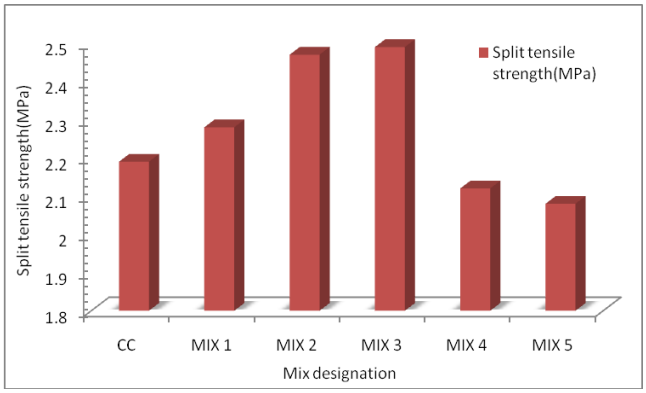

Figure: 2b Bar chart for hardened concrete test of Split tensile strength (MPa)

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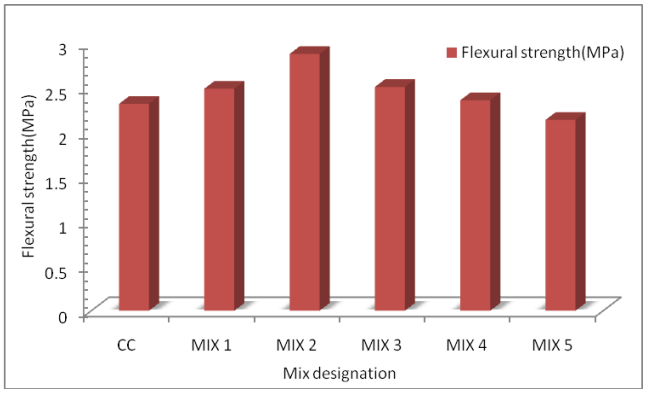

Figure: 2c Bar chart for hardened concrete test of Flexural strength (MPa)

4. CONCLUSION

The following conclusions can be arrived, from the above results;

i. From fresh concrete test results, it can be observed that the workability of concrete reduces as the percentage of plastic fibre increase. Hence it can be used where low workability of concrete is required.

ii. In the case of hardened concrete test results, there is an increase in compressive, split tensile and flexural strength with increase in percentage of plastic fibre and m-sand up to a certain stage when compared with conventional concrete.

iii. It can be concluded that the optimum proportion of replacing plastic fibre and m-sand in concrete is MIX 2 i.e., the nominal percentage is 10 for both plastic fibre and m-sand.

iv. Due to the presence of plastic fibres, the development of cracks during loading can be controlled. Hence, plastic fibre contributes to the improvement in load carrying capacity of the structural members.

v. Ductility in concrete can be improved by the addition of plastic fibres with optimum volume content. Toughness and impact load is also increased to a greater extent

vi. The use of plastic fibre in concrete contributes to cost saving in handling, storage and disposal.

vii. The introduction of m-sand in construction reduces the demand for river sand and accounts in controlling the overall cost.

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