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Partial Replacement of Natural Sand by Microfines for Cement Concrete

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ABSTRACT

The purpose of this study was to investigate the PARTIAL REPLACEMENT OF NATURAL SAND BY MICROFINES FOR CEMENT CONCRETE. The suitability of crushed stone dust waste as a fine aggregate for concrete has been assessed by comparing its basic properties with that of conventional concrete. Two basic mixes were chosen for natural sand to achieve M25 and M30 grade concrete. The equivalent mixes were obtained by replacing natural sand by stone dust partially and fully. The test results indicate the crushed stone dust waste can be used effectively to replace natural sand in concrete. In the experimental study of strength characteristics of concrete using crushed stone dust as fine aggregate it is found that there is increase in compressive strength, flexural strength and tensile strength of concrete.

KEYWORDS: Cement, Fine Aggregate, Coarse Aggregate, Stone Dust, Water, Natural sand, micro fines

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INTRODUCTION

1.1. GENERAL

Conventional cement concrete is a composite material obtained by mixing cement, fine aggregate, coarse aggregate and water. Aggregates have a significant influence on mechanical as well as rheological properties of cement concrete.

Physical properties such as particle size distribution, specific gravity, shape and surface texture markedly influence various properties of concrete in fresh state. River sand is being used as fine aggregate in concrete for centuries. However, river sand is not a renewable natural resource.

Now a days there is an acute shortage of good quality of natural sand due to boom in the construction activities. Extraction of river sand in excess of permitted quantities have caused ecological imbalance .This resulted in skyrocketing of cost natural river sand and also its shortage. Seeking for river sand alternatives has become urgent. It was identified that the alternative materials for river sand include manufactured sand, industrial by products (some forms of slag, bottom ash), recycled aggregates, etc. Among these materials, manufactured sand is receiving great attention for river these days as replacement sand.

Manufactured sand is produced by crushing rock depositions to produce a fine aggregate which is generally more angular and has rougher surface texture than river sand particles. The shape and texture of crushed sand particles could lead to improvements in the strength of concrete due to better interlocking between particles. However, angular fine aggregate makes the mortar of lower workability than spherical sands for the same water content. Water reducers and mineral admixtures can be used to improve workability. By using appropriate crushing technology (Impact crushing), it is possible to produce cubical particle shapes with uniform grading, consistently under controlled conditions. The unclassified impact crusher product presented the high packing density, and mortars produced from it had comparatively low porosity, low absorptivity and the high unconfined compressive strength.

The production of manufactured sand also generates high percentages of microfines (namely stone dust), particles that pass the 75 mm sieve, ranging from 5% to 20%. Previous researches have shown that good quality concrete can be made using manufactured sand with high amount of microfines.

OBJECTIVES AND SCOPE OF PRESENT WORK

2.1. Objectives:

1. To study the workability properties of concrete with natural river sand and M-sand as fine aggregates.

2. To evaluate the mechanical properties of concrete with Natural sand fine aggregate.
3. To evaluate the mechanical properties of concrete with Microfines as fine aggregates.
4. To study the effects of micro fines on workability properties of Microfines concrete.

2.2. Scope of present work:

1. To procure and characterize the materials.
2. To design the concrete mix using IS 10262:2009 with Natural sand as fine aggregate.
3. To cast cubes, cylinders and beams with Natural sand and Microfines as fine aggregate.
4. To evaluate compressive strength, split tensile strength conventional concrete with Natural sand as fine aggregate.
5. To determine the compressive strength, split tensile strength of concrete with Microfines with 0%, 10% and 20% of fines.
6. To compare the properties of Natural sand and Microfines concrete.

METHODOLOGY

3.1. Materials

➢ **Collection of materials**

The materials used in the preparations of concrete mix include Cement, Fine aggregate, Coarse aggregate and Microfines.

3.2. Cement:

Cement used is **53 Grade OPC** (Ordinary Portland Cement). The physical properties of cement obtained in conducting appropriate tests are given in Table 1.

Table 1: Physical properties of cement

Sl. No	Properties	Obtained values	Maximum values
1	Fineness	3.5%	Not more than 10%
2	Setting Time Initial Final	 35 min 490 min	 Not less than 30 min Not more than 600 min
3	Specific Gravity	3.06	3.15

Table 2: Physical properties of cement

IS Sieve Designation	Cumulative Percentage	
	Retained	Passing
4.75 mm	0	100
2.36 mm	0	100
1.18 mm	19.9	80.1
600 µm	55.3	44.7
300 µm	95.6	4.4
150 µm	99.1	0.9

3.3. Fine aggregate:

3.3.1. Natural sand:

Fine aggregate or natural sand is an accumulation of grains of mineral matter derived from the disintegration of rocks. It is distinguished from gravel only by the size of the grains or particles, but is distinct from clays which contain organic materials.

Locally available clean river sand was used as fine aggregate with water absorption of 0.6%. The results of sieve analysis conducted concluded is tabulated.

The particles which will pass through the 4.75 mm IS sieve and the material retained on 150 micron sieve those partial are called microfines.

Cement is called a hydraulic product the hydraulic product are stable in aqueous environment (water resistance).

There are various types of cement available in market and each type is used under certain condition due to its special properties.

Fig 4.2: Cement

Fig3.3.1: Natural sand

Table 2: Physical properties of River sand

Sl. No	Properties	Obtained values
1	Specific Gravity	2.613

3.3.2. Microfines

M-sand can be obtained by crushing of stones and used as a fine aggregate. M - sand consist of high percentage of microfines. A microfine is also called as stone dust. Stone

dust is a waste material. It s is obtained from crusher plants. It has potential to be used as partial replacement of natural river sand in concrete.

The microfines are collected in crusher plant of B M R construction.

Fig3.3.2: Microfines

Table 4: Physical properties of Microfines

Sl. No	Properties	Obtained values
1	Specific Gravity	2.72

3.4. Course aggregate:

Coarse aggregate is a broad category of coarse particle material used in construction. Aggregates are most mined materials in the world. Crushed stone of 20mm maximum size used as coarse aggregate with water absorption of 0.103%.

The coarse aggregate is defined as an aggregate most of which is retained on 4.75 mm IS sieve . It is obtained by disintegration of rocks. The coarse aggregate may be classified as rounded, partial rounded, flaky, angular, and elongated based on its shape and surface texture. Generally angular aggregates are preferred and used for construction works

Fig3.4: Coarse aggregate

3.5. Water:

Water used for concrete generally must be fit for drinking. Water should be free from acids, oils, alkalis, vegetables and other organic impurities. Soft water also produces weaker concrete. Water has two main functions in a concrete composite. Mainly it reacts chemically with the cement to form a cement paste in which the inert aggregates are held in suspension till the cement pasties hardened. Secondarily, It serves as a vehicle in the mixture of cement and fine aggregate.

3.7. PROPERTIES OF CONCRETE

3.7.1. Fresh concrete properties:

The results of the slump tests carried out on the fresh concrete, results gives an indication of the workability of the concrete for a water cement ratio of 0.45, a maximum slump of 110mm is observed, which is considered as a good workability. Super plasticizer dosage of 0.5% is used to achieve 75 ±10 mm slump are shown in Fig for alternative fine aggregates.

Fresh concrete was prepared using conventional ingredients. Then natural sand was replaced by microfines with various percentages. The fresh concrete was used to cast cubes, cylinders.

3.7.2. Workability

Workability can be defined as the property of the concrete which determines the amount of useful internal work necessary to produce full compaction. Fresh concrete is a freshly mixed material which can be moulded into any shape. The relative quantities of cement, aggregates and water mixed together, control the properties of concrete in the wet state as well as in the hardened state. To enable the concrete to be fully compacted with given efforts, normally a higher water/ cement ratio than that calculated by theoretical considerations may be required the quality of concrete satisfying the above requirements is termed as workable concrete. The word workability signifies much wider and deeper meaning than the other terminology consistency often used loosely for workability.

The following test is conducted to measure workability in this study.

3.7.3 Slump Test:

Slump test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site of work. It is not suitable for very wet or very dry concrete. It is used conveniently as a control test and gives an indication of the uniformity of concrete from batch to batch.

Test procedure is as follows:
The apparatus for conducting the slump test essentially consist of metallic mould in the form of frustum of a cone having the internal dimension as under.

Bottom diameter: 20cm
Top diameter: 10cm
Height: 30cm

The thickness of the metallic sheet for the mould should not be thinner than 1.6mm. Sometimes the mould is provided with suitable guides for lifting vertically up.

For tamping the concrete, a steel tamping rod 16mm diameter, 0.6m long with bullet end is used. The internal surface of the mould is thoroughly cleaned and freed from superfluous moisture and adherence of any old set concrete before commencing the test.

The Mould is placed on a smooth, horizontal, rigid and non-absorbent surface. The mould is then filled in three layers, each approximately 1/3rd of the height of the mould. Each layer is given 25 blows by tamping rod taking care to distribute the strokes evenly over the cross section after the top layer has been tamped, the concrete is struck off level with a trowel and tamping rod. The mould is removed from concrete immediately by raising it slowly and carefully in a vertical direction. This allows the concrete to subside. This subsidence isreferred as slump of concrete. The difference in level between the height of the mould and that of the highest point of the subsided concrete is measured. This difference in height in mm is taken as slump of concrete. The pattern of slump indicates the characteristic of concrete in addition to the slump value. If the concrete slumps evenly it is called true slump. If one half of the cone slides down, it is called shear slump. In case of shear slump, the slump value is measured as the difference in height between the height of the mould and the average value of the subsidence.

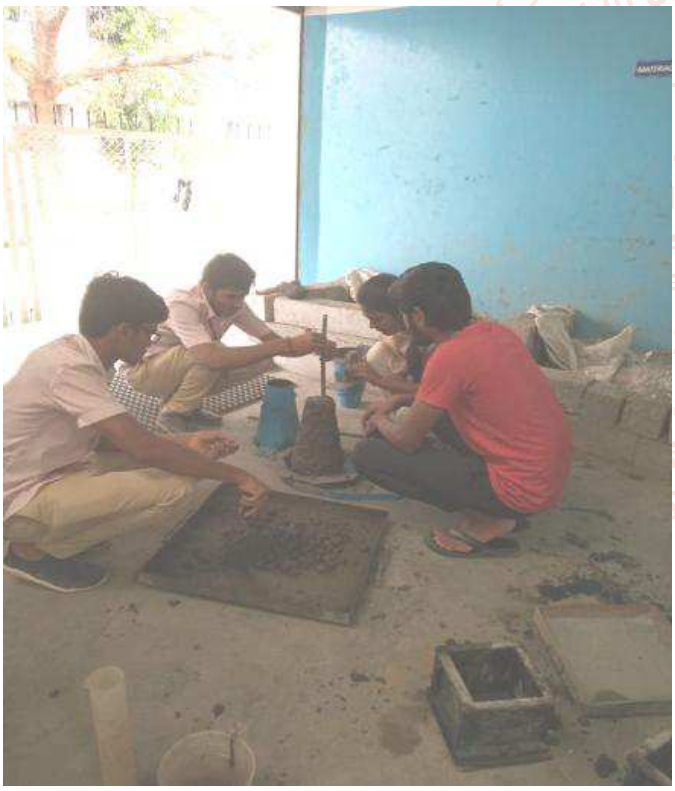

Fig3.7.3: Slump test

PROPERTIES OF HARDENED CONCRETE

3.8 Compressive strength:

The concrete was mixed manually according to IS: 516-1959 specifications. The compressive strength of concrete i.e., ultimate strength of concrete is defined as the load which causes failure of the specimen divided by the area of the cross section in uniaxial compression, under a given rate of loading. In the first step, for constant water-cement ratio optimum dosage of super plasticizers was calculated for 100 ±10mm slump. In the next step Pre calculated materials were dry mixed and the calculated amount of water was added. It is mixed until uniform colour is obtained.

Then concrete was poured in to the moulds in three layers with 25 blows each, Cubes of size 150x150x150mm are used. The specimens were left in the moulds for 24hours. After 24hours the cubes are demoulded, and then the specimens were kept in water tank for curing till the age of test was attained. Same procedure was followed for every replacement of fine aggregate

The various tests carried out to obtain the properties of cement concrete are listed below.

- Compressive strength
- Split tensile strength

3.8.1. Testing of cube specimens:

Specimens were cast for each fraction for 7 and 28days strength, the compression testing machine (CTM) of capacity 2000kN was used to test for the compressive strength of concrete cubes. The use of 150mm cubes has been made as per I.S.I code of practice IS: 456**. T**he standard test specimen is that two plane and parallel surfaces can always be found between which the load can be applied. The load was applied at a uniform rate till the failure occurred and the maximum load at failure was noted, thus the compressive strength of the specimen was obtained by using an expression. The average of three specimens shall be taken as the average compressive strength.

3.9. Split tensile strength:

The steel cylinder moulds were coated with oil on their inner surface. The amount of cement, sand, coarse aggregate required for 3 cylinders were weighed. The materials were first dry mixed, then mixed with water and thoroughly mixed to get a homogeneous mix. Slump test was conducted to measure degree of workability. Concrete wa**s** poured into the moulds in three layers; each layer was uniformly tamped by tamping rod with 25 numbers of blows. The top surface was finished using trowel. After 24 hours concrete cylinders were removed from moulds and the specimens were kept for curing.

RESULTS AND DISCUSSION

4.1. General

The tests results are obtained from the experimental work are discussed in this chapter. The Physical tests of the materials and compressive strength spilt tensile strength tests were carried out in the lab.

4.2 Hardened concrete properties:

The hardened properties of the concrete such as compressive strength were determined at the ages of 7, 14 and 28days, spilt tensile and flexural strength were determined at the ages of 28days.

The various tests carried out to obtain the properties of cement concrete are listed below.

- Compressive strength
- Split tensile strength

4.2.1 Compressive strength:

The Compressive strength of the concrete with natural sand and microfines are as shown in Fig4.8.1 and Fig 4.9.2. It can be noticed that, the compressive strength of concrete is high for Microfines concrete than natural sand concrete. This is true for the concrete at the age of 7, 14 and 28days.

Table 7 shows the average compressive strength for 7, 14 & 28 days and fig 1 shows the variation of 7, 14 & 28 days compressive strength of concrete with natural sand and Microfines with various percentages of fines.

CONCLUSIONS AND SCOPE FOR FUTURE WORK

5.1. Conclusion:

Based on the present study, the following conclusions can be drawn:

1. M-sand qualifies itself as suitable substitute for river sand at reasonable cost.
2. Compressive strength of Microfines concrete increases up to 10% fines, 20% and 30 % .
3. It is found that strength of Microfines concrete increases as percentage of fines increases.
4. Split tensile strength of Microfines concrete increases up to 10% fines, 20% and 30% .

5.2. Scope of Future work:

1. To study the characteristics of concrete with Microfines. The concrete having various percentages of fines.
2. The effect of temperature can be evaluated for concrete having different percentage of fines.
3. Durability studies such as Acid attack, Sulphate attack and Rapid Chloride Permeability Test (RCPT) can be done.
4. The study can be extended to evaluate the behaviour of RCC members with M-sand concrete having different percentage of fines.

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