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# THE EFFECT OF SAND PARTICLE SIZE & SHAPE ON COMPRESSIVE STRENGTH OF CEMENT

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## ABSTRACT

*It is well recognized that the mortar is commonly used in the masonry work. The sand is an important ingredient of mortar. About 75% volume consist of mortar in sand and more effects on strength of cement mortar. Sand is composed of different sized particles e.g. ranging from 4.75mm to 150 micron in varying proportions various studies on mortar properties have been done with correlating its Fineness Modulus to various parameters. It is a fact that the same fineness modulus may have different particle size distribution patterns., These gradation of particles affect the performance of mortar by improving the workability, compressive strength etc. but in this research studies we used crushed sand with same gradation only the shape of sand particle angular shape and Natural river sand in rounded shape so the main focus on this paper to compare the workability and compressive strength of mortar with different shape of sand particle in mortar.*

***Keywords: Compressive Strength Of Cement, Crushed Sand, Fineness Modulus, River Sand.***

## I.INTRODUCTION

The Main ingredients of Mortar are cement, sand, and the performance of Mortar affected by properties of sand. Mostly the sand extracted from river banks. Also large-scale extraction of river banks depletes natural resources.. It is a well-known fact that the sand having cubical particles with grounded edges gives higher and compression strength to the concrete. The grains should be of durable material and the size of the grains must be such that it should give minimum voids. The presence of clay and slit is avoided since it retards the setting of the cement and making concretethe main aim of research is to make use of this artificial sand in mortar replacing Natural sand by overcoming the Mechanical Factors affecting it this utilization. Testing of both Natural and Crushed sand to determine their Properties including fineness modulus and construction standards, thus it contributes an improvement in the quality of mortar. The Fineness modulus (FM) is an empirical figure obtained by adding the total percentage of the sample of an aggregate retained on each of a specified series of sieves, and dividing the sum by 100. The sieve sizes are 150µ, 300µ, 600µ, 1.18 mm, 2.36 mm, 4.75 mm, the same value of fineness modulus may therefore be obtained from several different particle size distributions. In general, however, a smaller value indicates a finer aggregate. Fine aggregates range from a FM of 2.00 to 4.00, and coarse aggregates from 6.50 to 8.00. Combinations of fine and coarse aggregates have intermediate values.

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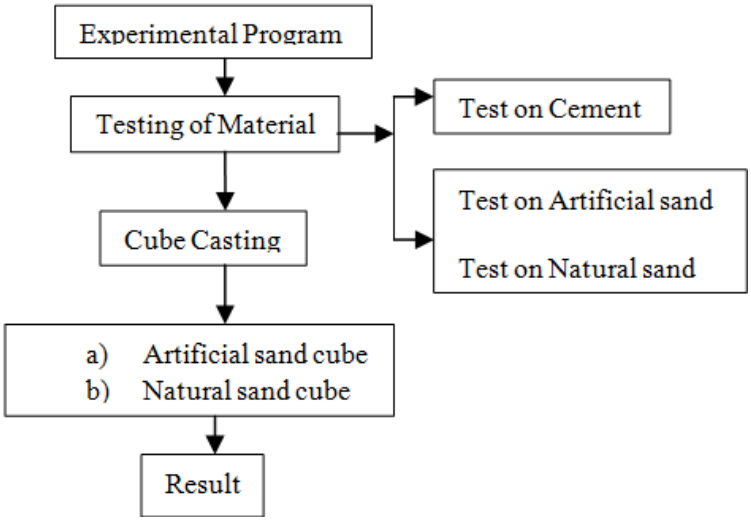
For the compressive strength test required the standard sand but in this work e used the ordinary sand. The result of ordinary sand gives the 66% of standard sand as per IS guideline hencethe searching of alternate for river sand is continued by crushed sand in the construction industry in terms of quality and economy.

## II. LITERATURE REVIEW

A survey of Literature has shown that numerous studies have been conducted in past to utilize crushed rock sand in mortar and concrete. Craig-yr-Hesg using 12% unseparated sandstone quarry fines (Lamb, 2005) Galetakis and Raka (2004) studied the effect of varying replacement proportion of sand with quarry dust (20, 30 and 40%) on the properties of concrete in both fresh and hardened state Saifuddin (2001) studied the influence of partial replacement of sand with quarry dust and cement with mineral admixtures on the compressive strength of concrete. Celik and Marar investigated the effect of partial replacement of fine aggregate with crushed stone dust at different percentages in the properties of fresh and hardened concrete. Ilangovan (2000) Sahuetal.(2003) observe that concrete made using crushed rock attained a comparable strength in concrete. (Ahn and Fowler, 2001) including micro fines from 7 to 18% without the use of admixtures Hanson considered structural concrete.

## III .METHODOLOGY




**3.1 Experimental Program -** The experimental program divide in to two parts first is preparing concrete cube for river sand and second part is to prepare the cube for crushed sand. Before casting the cube we test the material and mix design of M20 Grade concrete. In the present study an ordinary Portland cement (OPC 53 grade) was used. The physical properties of the cement tested according to Indian standards procedure confirms to the requirements of IS 12269 and the physical properties are given in Table 1.

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**Table No1. Experimental Values Of Test On Sand And Aggregate**

| **Test on Cement** | | |
|---|---|---|
| Fineness | 6.5% | |
| Consistency | 35% | |
| **Test on sand** | | |
| Test | Natural Aggregate | Artificial sand |
| Fineness Modulus | 3.9 | 4.86 |
| Moisture content | 0.97% | Nil |
| Silt Content | 4.5% | 2% |

**Table No.2 Fineness Modulus And Particle Size Distribution Of Fine Natural Aggregate.**

| Fine aggregate 1000 gm. | | | | | |
|---|---|---|---|---|---|
| Sr No | IS Sieve Size | Retained weight of crush in each sieve (gm) | % retained in each sieve | % which passed each sieve | % age cumulated |
| 1 | 4.57 | 135 | 13.5 | 86.5 | 13.5 |
| 2 | 2.36 | 190 | 19 | 81 | 32.5 |
| 3 | 1.18 | 325 | 32.5 | 67.5 | 65 |
| 4 | 600 | 215 | 21.5 | 78.5 | 86.5 |
| 5 | 300 | 91 | 9.1 | 90.9 | 95.6 |
| 6 | 150 | 15 | 1.5 | 98.5 | 97.1 |
| 7 | 90 | 29 | 2.9 | 97.1 | 100 |
| 8 | 75 | 0 | 0 | 100 | 100 |
| 9 | Residue | | | FM | 3.90 |

**Table No.3 Fineness Modulus And Particle Size Distribution Of Fine Crushed Aggregate.**

| Fine aggregate 1000 gm. | | | | | |
|---|---|---|---|---|---|
| Sr No | IS Sieve Size | Retained weight of crush in each sieve (gm) | % retained in each sieve | % which passed each sieve | % age cumulated |
| 1 | 4.57 | 210 | 21 | 79 | 21 |
| 2 | 2.36 | 570 | 57 | 22 | 78 |
| 3 | 1.18 | 135 | 13.5 | 8.5 | 91.5 |
| 4 | 600 | 50 | 5 | 3.5 | 96.5 |
| 5 | 300 | 30 | 3 | 0.5 | 99.5 |
| 6 | 150 | 5 | 0.5 | 0 | 100 |
| 7 | 90 | 0 | 0 | 0 | 100 |
| 8 | 75 | 0 | 0 | 0 | 100 |
| 9 | Residue | | | FM | 4.86 |

The river sand conforming to zone II as per IS-383-1987 was used for making reference concrete and its loose and compacted bulk density values of sand were 1455&1726 Kg/M$^3$respectively. Crushed Fine aggregate conforming to IS 383-1987 of size 4.75 mm Passing. The loose and compacted bulk density values of aggregate 1460&1690 Kg/M$^3$ respectively.

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### 3.2 Sample Preparation

Here we prepare the 6 No's for River sand and 6 No's for Crushed sand cube sample Take 4500 gm. of Natural sand, 1500 gm. of cement (i.e. Ratio of cement to sand is 1:3) in a non-porous enamel tray and mix them with a trowel for one minute. Add water quantity (P/4 + 3.0) % of combined weight of cement and sand and mix the three ingredients thoroughly until the mixture is of uniform colour. The time of mixing should be less than three minutes and not more than four minutes. Immediately after mixing fill the mortar into a cube mould of sizes 7.06cm. Compact the mortar either by hand compaction in a standard specified manner or on the vibrating table. Place the moulds in cabin at a temperature of 27º ± 2º C for 24 hours Remove the specimen from the moulds and submerge them in clean water for curing.

### 3.3 Testing of Cement Mortar Cubes

Take the cube out of water at the end of three days with dry cloth. Measure the dimensions of the surface in which the load is to be applied. Let be 'L' and 'B' respectively. Place the cube in compressive testing machine and apply the load uniformly at the rate of 35N/mm$^2$. Note the load at which the cube fails. Let it be 'P'. Calculate the compressive strength of the cube by using formula. The compressive strength at the end of three days should not be less than 16N/mm$^2$ Repeat the same procedure (steps 1 to 4) for other two cubes.

Repeat the whole procedure (Step 1 to 6) to find the compressive strength of the cube at the end of 7 days and it should not be less than 22 N/mm$^2$

**Table No.4 Compressive Strength Of Cement (Natural Sand)**

| Compressive strength Of Cement | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sr.No | Date of casting | Date of Testing | Age days | Area in Sq. mm | Maxi Load in ( N) | Comp. strength N/mm2 | Avg comp. Strength N/mm2 |
| 1 | 23/2/2017 | 27/2/2017 | 3 | 4990 | 50.9 | 10.2 | 10.31 |
| 2 | 23/2/2017 | 27/2/2017 | 3 | 4990 | 56.4 | 11.3 | |
| 3 | 23/2/2017 | 27/2/2017 | 3 | 4990 | 47.2 | 9.45 | |
| 4 | 23/2/2017 | 2/3/2017 | 7 | 4990 | 63.6 | 12.7 | 15.23 |
| 5 | 23/2/2017 | 2/3/2017 | 7 | 4990 | 79.8 | 16.0 | |
| 6 | 23/2/2017 | 2/3/2017 | 7 | 4990 | 85.2 | 17.0 | |

**Table No.5 Compressive Strength Of Cement (Crushed Sand)**

| Compressive strength Of Cement | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sr.No | Date of casting | Date of Testing | Age days | Area in Sq. mm | Maxi Load in ( N) | Comp. strength N/mm2 | Avg comp. Strength N/mm2 |
| 1 | 23/2/2017 | 27/2/2017 | 3 | 4990 | 67.4 | 13.5 | 13.26 |
| 2 | 23/2/2017 | 27/2/2017 | 3 | 4990 | 62.3 | 12.48 | |
| 3 | 23/2/2017 | 27/2/2017 | 3 | 4990 | 68.8 | 13.8 | |
| 4 | 23/2/2017 | 2/3/2017 | 7 | 4990 | 107.5 | 21.5 | 21.13 |
| 5 | 23/2/2017 | 2/3/2017 | 7 | 4990 | 109 | 21.8 | |
| 6 | 23/2/2017 | 2/3/2017 | 7 | 4990 | 100.5 | 20.1 | |

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As per IS 269(1967) for ordinary Portland cement the compressive strength at 3 days should not be less than 16.3 N/mm$^2$ and at 7 days should not be less than 22.4 N/mm2 for the standard sand but using other river sand the result should be 66% of the standard sand. Table No.6

| S.NO. | As per IS Requirement for (Standard sand) Compressive strength in N/mm$^2$ | | As per IS Requirement for (Ordinary sand 66% of standard result ) | | Natural sand Compressive strength in N/mm$^2$ | | Crushed sand Compressive strength in N/mm$^2$ | |
|---|---|---|---|---|---|---|---|---|
| | 3 Days | 7 Days | 3 Days | 7 Days | 3 Days | 7 Days | 3 Days | 7 Days |
| 1 | 16.3 | 22.4 | 10.75 | 14.78 | 10.31 | 15.23 | 13.26 | 21.13 |

## IV. CONCLUSION

1. From the above investigation we conclude that the physical properties of natural and crushed sand satisfied the IS requirement.
2. For fineness modulus test we found variation in size of particles available in sample for crushed sand absent of dust or silt content in sample. Its affects the workability of mortar
3. River sand found the silt content 4.5% & crushed sand 2% which is workable for mortar.
4. For 3 day testing the river sand sample of give the strength less than 4% of actual IS Requirement and crushed sand sample satisfied the IS Requirement.
5. For 7 day testing the river sand and crushed sand sample satisfied the IS Requirement.
6. From the above observation we found that and shape of crushed sand it gives the better compressive strength result as compare to river sand.

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