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Effect of Partial Replacement of Fine Aggregate With Soil on the Strength Properties of Concrete

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ABSTRACT: River sand is the major part in the concrete, nowadays river sand availability is reduced due to over usage for concrete, therefore it results in environmental effects such as ground water decrease, soil erosion and many others. Local soil is present, and the paper discusses the use of fine aggregates in the construction of concrete instead of using river sand historically. Instead, recycling of this waste soil was proposed in the development of useful building material.

This work examines the possibility of using soil as partial replacement of fine aggregate for new concrete. In this study soil was partially replaced as 25%, and 50%. Concrete are made for M_{25} mix and tested for its compressive strength, up to 7, 28, days of age and compared with conventional concrete.

KEYWORDS: River sand, Excavated soil, Environmental effects, Concrete, and Compressive Strength.

I. INTRODUCTION

River sand is the major part in the concrete, nowadays river sand availability is reduced due to over usage for concrete, therefore it results in environmental effects such as ground water decrease, soil erosion and many others. Instead, recycling of this waste soil was proposed in the development of useful building material. It will also avoid the disposal of waste soil in low lying areas that could create a lot of problems for society. The properties must be defined through comprehensive testing and it must be demonstrated with the specifications of I.S relating to concrete making. R.Kamalambigai [1] T.S.Thandavamoorthy [2] studied for making concrete from soil as a replacement of river sand. Researcher determined that the properties of soil is as good as the normal river sand and this study has showed that it can as well be replaced as river sand. In the production of concrete river sand because its obtainability now a days has become insufficient, and also costly.

Nagabhushana and Sharada Bai [3] their investigations are the properties of grout and concrete in which Crushed Rock Powder (CRP) was used as a partial and full replacement for river sand. For grout, Crushed Rock Powder is replaced the proportions from 20%, to 100%. The mechanical properties of concrete were calculated by substituting river sand by Crushed Rock Powder at standby levels from 20% to 100%.

Aggarwal et.al, [4] In this work to investigate the use of bottom ash as a partial replacement of sand. Mechanical properties were studied. For various ratios from 0% to 50% replacements of fine aggregates with bottom ash can easily be calculated to the strength increase of normal concrete with ages.

Siddique [5] Results of this study carried out to estimate the mechanical properties of concrete mixtures in which sand was replaced partially with Class F fly ash and this proportion was 10%,20%,30%,40% and 50% by weight. of class F fly ash Test results was shown substantial progress in the strength properties of plain concrete by the addition of fly ash as partially increased of replacement of sand and could be effectively used in structural concrete.

II. Materials Required

2.1 Cement: The cement used for this study is Ordinary Portland Cement is conforming to Indian Standard IS 12269 – 1987[6] of grade 43.

2.2 Fine aggregate: The fine aggregate is collected sand has been sieved in 4.75 mm sieve.

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2.3 Coarse aggregate: The coarse aggregate is chosen by shape as per IS 2386 (Part I) 1963, [7] surface texture characteristics of aggregate is classified as in IS 383 - 1970.

2.4 Water: This is the minimum expensive but most vital ingredient of concrete. The water which is used for production of concrete should be fresh and free from harmful impurities such as oil, alkali, acid, etc. Portable water was used for the experiment from nearby area.

2.5 Soil: The soil samples used as sand substitute material as a fine aggregate, and the sample is collected locally available.

Specific Gravity

The Specific gravity of the aggregates used is checked by following IS 2386 (Part III) – 1963[8], following the Indian Standards specification. The concrete design parameters depend also on the particular gravity of the materials used.

Sieve analysis

Sieve analysis is done as per IS 2386 (Part I)-1963[7]. The first step involves arranging the IS sieves in the order of from 4.75mm to 150µ and pan. 2kgs of sand taken from the river and placed on top of most sieves. Fifteen minutes of sieving is finished, and weight retained on each IS sieve is found. It is measured using the value fineness modulus above.

III. Mix Proportions

The concrete used in this study was proportioned to attain strength of 25MPa. Cement content=420Kg/m^3 Fine aggregate=600Kg/m^3 Coarse aggregate=1222Kg/m^3 and Water= 190Kg/m^3. The mix proportion is **1:1.43:2.91/0.45.**

The fine aggregate mix proportion is determined using IS 10262:2009[9] as shown in Table.1. And the compressive force results as shown in table.2

Table 1. Mix Proportions

Sample	Ratio
Water cement ratio	0.45
Mix ratio S_1	1:1.43:2.91
Mix ratio of S_2	1:1.28:2.7
Mix ratio of S_3	1:1.19:2.6

Table 2. Compressive Strength test

Type of fine aggregate	7 days in N/mm2	28 days in N/mm2
S_1	20.0	30
S_2	21.07	31.6
S_3	19.55	29.3
S_4	25	37.5

Note:
S_1 – 100% F.A
S_2 – 75% F.A and 25% Soil
S_3 – 50% F.A and 50% Soil
S_4 – 50% F.A, 50% Soil and 3% Steel fibre by weight of Cement

IV. Experimental Investigation

In this experiment easily available soil around the construction site in the ground is used as a replacement of river sand, because this would prevent dumping of this waste soil in low lying areas creating bad effect to the public. This investigation of soil was used as a replacement to river sand to the amount of 100%. First, find out

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the gradation of the soil with grain size by the help of sieve analysis test. Design mix has been done for M_{25} concrete use of IS 10262:2009 code [9] with normal constituents of concrete with OPC 43 grade cement. river sand and mechanically crushed 20 mm size of coarse aggregate.

Fine aggregate was replaced with local available soil and the replacement levels are 0%,25% & 50%. The sieve analysis, water absorption, specific gravity and compressive strength tests for river sand and local available soil are as follows. The local soil and river sand are shown in Figure 1 and 2.

Figure 1. Local soil

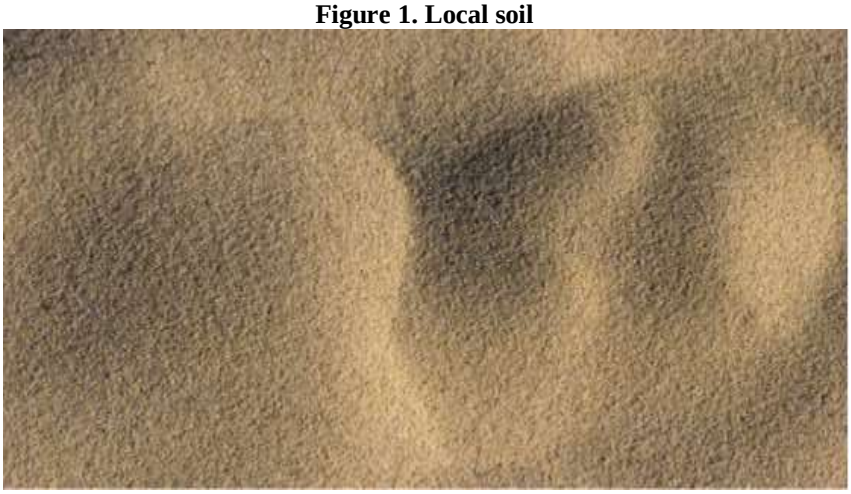

Figure 2. River Sand

4.1 Specific Gravity test:
The river sand 's specific gravity is 2.7 and the average reported soil sample gravity is 2.48. IS 2386-3[8]

4.2 Sieve analysis:
The fineness modulus of river sand is 2.80 and that of soil sample is 3.06. IS 2386-3[8]

4.3 Water absorption test:
This test procedure is drying a specimen to a constant weight, and weighing it, then dipping the specimens in to water for certain time, and weighing it again. The rise in weight as a percentage of the actual weight is stated as its absorption. The absorption of the specimens shall not be bigger than 5% with no separate unit bigger than 7%.

4.4 Compressive strength Test:
Size of the cube is 150 mm x 150mm x 150mm. Using te grade concrete is M_{25} Specimens with ordinary Portland cement (OPC) and replaced with local soil at 25% and 50%levels were cast. At the time of casting the cubes were vibrated by a table vibrator. After 24 hours, mould is removed and the samples were keep in to the water. After 7 and 28 days, the samples were tested for compressive strength using a calibrated compression testing machine of 2000kN capacity. The Compressive strength testing in CTM are tabulated in table 3.

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Table 3. Compressive Strength of Cubes

Partial Replacement %	Compressive Strength (N/mm^2) at 7 Days	Compressive Strength (N/mm^2) at 28 Days
S1	20	25.30
S2	21.5	25.2
S3	19.55	23.77
S4	21.22	28.20

4.5 Split Tensile Strength Test:

This test usually cylinders are used. Cylinders of size 150mm x 300 mm. Using M_{25} grade of concrete. Samples are replaced by soil at 25%, and 50%. At the time of casting and moulding the cylinders were vibrated by table vibrator. Next 24 hours, the specimens were removed from the mould and keep into the curing tank for curing. The 28 days of curing, the samples were tested using a compression testing machine of 2000kN capacity as per IS: 516 (1959) [10]. The Split tensile strength testing in CTM are tabulated in table 4.

Table 4. Split Tensile Strength of Cylinders

Partial Replacement %	Split tensile Strength (N/mm^2) at 7 Days	Split tensile Strength (N/mm^2) at 28 Days
S1	2.10	2.55
S2	2.32	2.32
S3	2.01	2.47
S4	2.21	2.91

V. Result and Discussion

The specific gravity of river sand is 2.782 and the soil specific gravity is 2.48.The fineness modulus of river sand is 3.09 and that of soil 3.7618.The normal water absorption of the test specimens are not be larger than 5%.The graph of Cube Compressive Strength for both 0%,25%,50% and soil with 3%steel fibre are shown in figure 3.

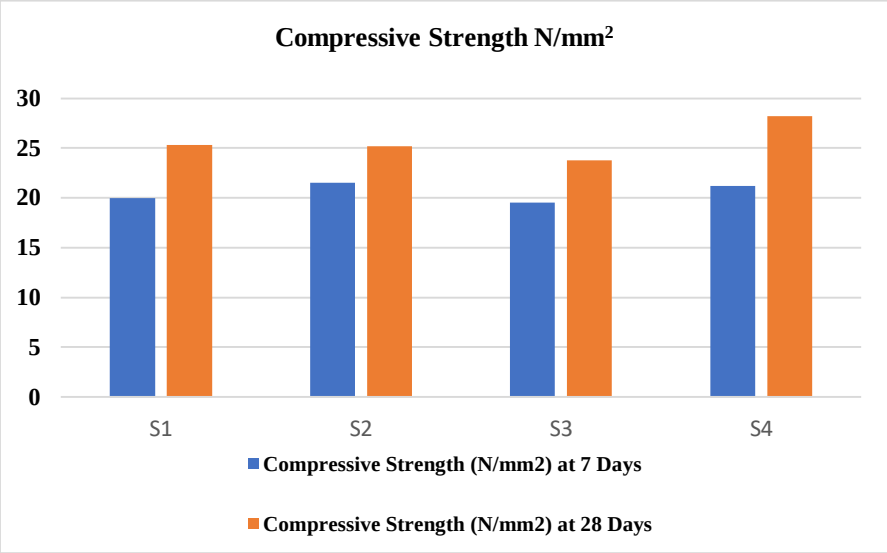

Figure 3. Compressive strength results

The graph of Cylinder Strength for both 0%,25%,50% and soil with 3% steel fibre are shown in figure 4.

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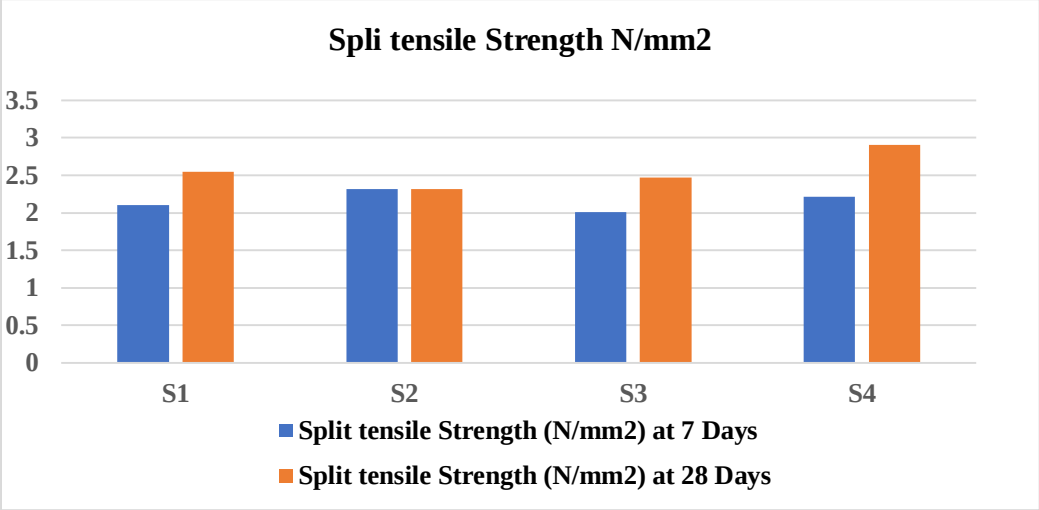

Figure 4. Split Tensile strength results

VI. Conclusions

1. The specific gravity of locally available soil was more or less equal to river sand.
2. The compressive strengths reduce sand replacement by locally available soil by 50 percent.
3. The compressive strengths are increasing 50% replacement of sand and steel fibre with locally available soil.
4. Replacements of 0 percent, 25 percent, and compressive strengths of 50 percent were above 25MPa and above the mean strength of the target. Of these four, soil replacement with steel fibre gives high strength by 50 per cent.
5. From various tests conducted, it can be concluded that the properties of locally available soil are as good when compared to normal river sand.
6. This study has proved that locally available soil can be used as fine aggregate in the production of concrete.

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