Experimental Study on Strength of Concrete by using PS Sand as a Fine Aggregate

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Abstract— Concrete is considered to be the most widely used and versatile material of construction all over the world. In recent years, concrete technology has made significant advances which have resulted in economical improvements in strength of concretes. This economic development depends upon the intelligent use of locally available materials. One of the important ingredients of conventional concrete is natural sand or river sand. Scarcity of good quality Natural River sand due to depletion of resources and restriction due to environmental consideration has made concrete manufactures to look for suitable alternative fine aggregate. One such alternative is "Manufactured sand". Because of crushing quarries and converting them as fine aggregates, demand for coarse aggregates also increases. To meet this demand, another alternative to river sand is PS Sand (Processed Slag Sand) which can be used as fine aggregates in manufacturing concrete. An attempt has been made in this study to determine the compressive strength of M20 grade concrete using PS sand as fine aggregate.

Key words: Ordinary Portland cement, Natural Sand, Manufacture Sand, PS Sand and Compressive Strength

I. INTRODUCTION

Concrete is the most commonly used construction material in the world. It is basically composed of two components paste and aggregate. The paste contains cement and water and sometimes other cementitious and chemical admixtures, whereas the aggregate contains sand and gravel or crushed stone. The paste binds the aggregates together. The aggregates are relatively inert filler materials which occupy 70% to 80% of the concrete and can therefore be expected to have influence on its properties. The proportion of these components, the paste and the aggregate is controlled by the strength and durability of the desired concrete, the workability of the fresh concrete and the cost of the concrete. The global consumption of natural sand is very high, due to the extensive use of concrete. In general, the demand of natural sand is quite high in developing countries to satisfy the rapid infrastructural growth, in this situation developing country like India facing shortage in good quality natural sand. Particularly in India, natural sand deposits are being depleted and causing serious threat to environment as well as the society. Increasing extraction of natural sand from river beds causing many problems, losing water retaining sand strata, deepening of the river courses and causing bank slides, loss of vegetation on the bank of rivers, exposing the intake well of water supply schemes, disturbs the aquatic life as well as affecting agriculture due to lowering the underground water table etc are few examples. Therefore looking for an alternative to river sand has become a necessity. The cheapest and easiest alternative to natural sand is manufacturing sand by crushing rocks/stones in desired size and grade by suitable method. Due to the conversion of quarries into fine aggregates, demand for coarse aggregates increases. One such alternative to river sand is PS sand (Processed Slag) can be used as fine aggregate in manufacturing concrete.

[1] Hudson, B. P. carried out an experimental work on "Manufactured Sand for concrete" to determine workability, strength and durability of concrete with manufactured sand as replacement to natural sand in proportions of 0%, 20%, 40%, 60% and 100% is studied. The experiments were conducted on M 20 and M 30 concrete grade and it was concluded that, 60% replacement showed an increase in strength of about 20% and other replacements to an order of minimum 0.93% in both the grades.

[5] Nagabhushana and Sharadabai. H.studied the "Use of crushed rock powder as replacement of fine aggregate in mortar and concrete" Crushed Rock Powder (CRP) is used as a partial and full replacement for natural sand. For mortar, CRP is replaced at 20% 40%, 60%, 80% and 100%. The basic strength properties of concrete were investigated by replacing natural sand by CRP at replacement levels of 20%, 30% and 40%.

The objective of the present work is determine the compressive strength of M20 grade concrete by replacing Manufacture sand by Processed Slag sand with 0%, 20%, 40%, 60%, 80% and 100% and cubes are tested for 3, 7 and 28days.

II. MATERIALS

A. Cement

Portland cement is the most common type of cement in general usage. It is a basic ingredient of concrete, mortar and plaster. Of the various ingredients used in concrete, cement is the most energetically and expensive. In the present investigation OPC 43 grade cement is used.

B. Water

Combining water with a cementitious material forms a cement paste by the process of hydration. The cement paste glues the aggregate together, fills voids within it, and makes it flow more freely. Lower water to concrete ratio yields a stronger, more durable concrete, while more water gives a free-flowing concrete with a higher slump. Impure water used to make concrete can cause problems when setting or in causing premature failure of the structure.

C. Manufacture Sand

Sand is used as fine aggregate in mortar and concrete. Natural river sand is the most preferred choice as a fine aggregate material. River sand is a product of natural weathering of rocks over a period of millions of years. It is mined from the river beds and sand mining has disastrous environmental consequences. River sand is becoming a scarce commodity

and hence exploring alternatives to it has become imminent. Rock crushed to the required grain size distribution is termed as Manufactured Sand (M Sand). In order to arrive at a required grain size distribution the coarser stone aggregates are crushed in a special rock crusher and some of the crushed material is washed to remove fines. This investigation is an attempt to evaluate the characteristics of mortar and concrete using M Sand as fine aggregate. For the purposes of comparison characteristics of mortar and concrete with river sand has also been explored.

D. Processed Slag Sand

PS sand (Processed Slag sand) is a manufactured at state of the art manufacturing unit of CCPL, by passing it through grizzly bar, grizzly screen, crusher, vertical shaft grinder, fine door screening and air classifying assembly. The PS sand undergoes some amount of grinding and the particle shape gets altered. This intervention is mainly aimed at increasing the bulk density of the raw slag and making the flaky and sharp edges of the raw slag particles more spherical. PS sand is a non-metallic product, consisting of glass containing silicates and aluminum silicates of lime, a by-product of metal smelting process and does not contain materials like chlorides, organic matter, clay, silt and shells that may affect the strength and durability of concrete. Naturally occurring river sand is highly contaminated with silt, clay, organic matter etc., has no consistency, and is not advisable for high-rise buildings and modern day construction. PS sand is perfectly suited for the purpose.

E. Coarse Aggregates

Crushed stone aggregates of 20mm size obtained from local quarry site were used for the experiment.

III. METHODOLOGY

A. Tests on Materials

1) Cement

Elements	Content
Specific Gravity	3.15
Fineness Modulus	6.23%
Standard Consistency	29%
Initial Setting time	40min
Final Setting time	285min

Table 3.1: Physical properties of Cement

Oxides	Percentages
Cao	62.85
SiO_2	20.98
Al_2O_3	5.42
Fe_2O_3	3.92
MgO	1.76
SO_3	2.36
Na_2O	0.28
K_2O	0.53
Loss of Ignition	1.90

Table 3.2: Chemical properties of Cement

Sl No	Particulars	Obtained values
1	Specific gravity	2.42
2	Fineness Modulus	4.74%
3	Bulk Density	1750 kg/m^3
4	Water absorption	0.31%

Table 3.3: Physical properties of Manufactured Sand

Sl No	Particulars	Obtained values
1	Specific gravity	2.64
2	Fineness Modulus	3.04%
3	Bulk Density	1618 kg/m^3
4	Water absorption	0.29%

Table 3.4: Physical properties of Processed Slag Sand

Sl No	Particulars	Obtained values
1	Specific gravity	2.70
2	Sieve analysis	2.26%
3	Water absorption	0.80%

Table 3.5: Physical properties of coarse aggregate

IV. RESULTS AND DISCUSSIONS

Test at Day	M20 with 0% M-Sand	M20 with 0% M-Sand	M20 with 0% M-Sand	M20 with 0% M-Sand	M20 with 0% M-Sand	M20 with 0% M-Sand
3 days	22.07	22.84	23.62	24.78	25.73	25.89
7 days	29.87	30.14	31.67	34.51	35.40	34.51
28 days	39.96	40.10	42.92	44.07	45.26	48.77

Table 4.1: 28days Compressive Strength in N/mm2with different percentage of PS sand replacing M Sand for M20 grade concrete

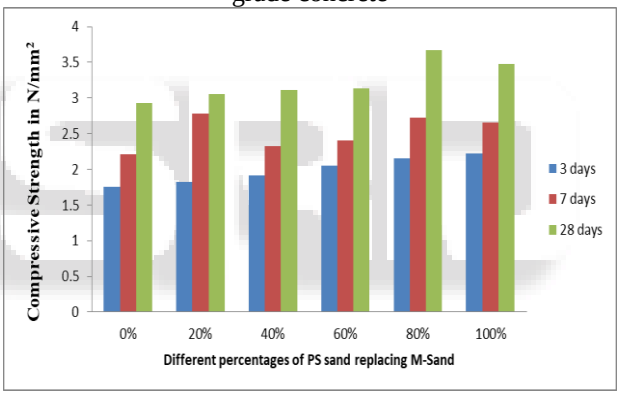

Fig. 4.1: Shows the variation of Compressive Strength at 3, 7 and 28 days for M20 grade concrete with different percentages of PS sand replacing M-Sand.

The above graph indicates the variation of Compressive Strength of concrete at 3, 7 and 28days of curing for M20 grade concrete with different percentages of Processed Slag Sand replacing Manufacture Sand. It was observed that, strength of concrete increases gradually with increases in percentage of replacement and strength of concrete at 28 days of curing for 100% replacement, it is around 20% more than the strength of concrete with no replacement.

Test at Day	M20 with 0% M-Sand	M20 with 0% M-Sand	M20 with 0% M-Sand	M20 with 0% M-Sand	M20 with 0% M-Sand	M20 with 0% M-Sand
3 days	1.75	1.82	1.91	2.05	2.16	2.22
7 days	2.21	2.78	2.33	2.41	2.73	2.66
28 days	2.93	3.05	3.11	3.14	3.67	3.87

Table 4.1: 28days Split Tensile Strength in N/mm^{2}with different percentage of PS sand replacing M Sand for M20 grade concrete

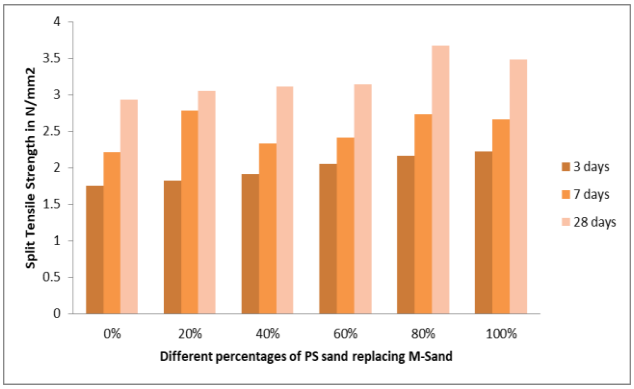

Fig. 4.2: Shows the variation of Split Tensile Strength at 3, 7 and 28 days for M20 grade concrete with different percentages of PS sand replacing M-Sand.

The above graph indicates the variation of Split Tensile Strength of concrete at 3, 7 and 28days of curing for M20 grade concrete with different percentages of Processed Slag Sand replacing Manufacture Sand. It was observed that, strength of concrete increases gradually with increases in percentage of replacement and for 100% replacement, it is around 30% more than the strength of concrete with no replacement.

V. CONCLUSION

Results were analyzed to derive useful conclusions regarding the strength characteristics of concrete with different percentages replacement of manufactured sand with Processed Slag sand for M20 grade. The following conclusions may be drawn from the study are,

1) The Processed Slag sand is a best alternative for Manufacture sand in terms of strength characteristics and it helps in conserving the natural resources.
2) Processed Slag sand yields mixes with high work ability as the particle shape is spherical and adding admixtures to the mix is not necessary.
3) The Compressive Strength and Split Tensile Strength results for M20 grade concrete have revealed that, the strength of concrete with 100% replacement of Manufacture Sand by Processed Slag sand is around 20% more than the strength of concrete with zero replacement

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