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Performance of Concrete by Partially Replacement of Natural Sand with Stone Dust in Concrete

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***Abstract*—Stone dust is a material which we can easily get from the local crusher plants. Stone dust has the properties that are very similar to the natural sand which prompts it is used in manufacturing of concrete. Addition of Stone dust in manufacturing of concrete can help in uplifting the quality of concrete and also help in retaining and conserving the natural sand.**

An experimental program was carried out to study the performance of concrete, workability and compressive strength of concrete made using stone dust as partial replacement of natural sand in the range of 10% - 100%.

M25 grade of concrete was designed by using Pozzolana Portland Cement (PPC) 34 % Fly Ash mixed and 100 % natural sand based for reference concrete. Workability and Compressive strength were calculated at different (percent based) replacement level of natural sand with stone dust.

Compressive strength results shows that by replacing 10% to 100 % of natural sand with stone dust in concrete slightly decreases compressive strength as compared to the conventional concrete mix.

The best possible optimum replacement level of natural sand with stone dust is 40 percent based on compressive strength.

I. INTRODUCTION

Concrete plays a very important role in the construction industry. It is widely used due to its durability, versatility and low cost.

For a concrete mix, fine aggregate is a main component of the concrete and the most commonly used fine aggregates is the natural sand. The demand of natural sand is increasing day by day in the construction field due to extensive use of concrete, the price was increasing which resulting a huge reduction in the sources of natural sand.

Because of its limited supply and excessive cost of transportation from natural source, The developing country like India facing shortage of good quality of natural sand and particularly in India, It becomes more necessary to find alternative sources of fine aggregates,

Therefore, Stone dust has been proposed as an alternative to natural sand that gives the additional benefits to the concrete.

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Stone dust can be defined as residue, tailing or waste material, left after the extraction and processing of rocks at crushing **plant at a** Stone. It is also known as stone dust, Stone waste or rock dust. When rock is crushed and sized in a Stone, the main aim has generally been to produce coarse graded aggregates of different sizes and road construction materials meeting certain specifications as per standards. As a part of normal production processes in quarries, a certain portion of the rock is reduced to such a size that it cannot be used as a part of coarse aggregates.

The production of coarse graded aggregates involves rock by drilling and blasting followed by a series of crushing and screening operations, until the desired grade is obtained. Aggregate Stone processes such as blasting, crushing and screening of coarse grade aggregates lead to the production of stone dust or Stone dust. Particle size of this Stone by-product is generally less than 5mm or depends upon the size of the lowest screening used. It consists of coarse, medium and fine sand particles as well as an appreciable amount of clay/silt fraction, i.e., finer than 75 micron size.

The production of crushed stone coarse aggregate starts with blasting of parent rock and fragmentation.

The fragmented rock is then crushed and screened through multiple stages. Crushing of quarried rock is generally carried out in multiple stages:

primary crushing, secondary crushing and tertiary crushing. By-product in the form of Stone dust is produced at the end of each stage and subsequently separated from coarse aggregate portion via screening.

II. MATERIAL USED

StoneDust:

Stone dust was collected form a local crushing plant.Stone dust is a fine stone particle. It is found when bouldersare broken into small pieces stone dust is formed.

Stone dust is grey in color as shown in below picture. In the production of concrete it could be used as a partial or full replacemen to fnaturals and Besides, the utilization of stone dust ,which it self is a waste material,will reduce the cost of concrete production.

Coarse Aggregate:

A combination of 20mm nominal size aggregate and 10mm nominal size aggregate is used as coarse aggregate in this experimental program. Both types of coarse aggregate were locally procured.

Cement:

In this study, Ultratech brand Pozzolana Portland Cement (PPC) 34 % Fly Ash based mixed was used.

Properties of PPC are following in table

Super-Plasticizer:

Sulphonated naphthalene polymers (SNP) based Super-plasticizer (Fosroc SP500) of chemical used.

The super plasticizer was in liquid form and compatible with the cement,It hasdark brown in colourand the specific gravity of the super plasticizer is 1.24

Properties of Pozzolana Portland Cement.

Properties	
Standard consistency %	31 %
Initial setting time	30 minutes
Final setting time	600 minutes
Soundnes s(lechatelier expansion)	5 mm
Fineness (% retained on 90 μ is seive)	3.5 %
7th day Compressive strength	32 MPa
28th day Compressive strength	43 MPa
Specific gravity	2.90

III. MIXING OF CONCRETE MATERIALS

For mixing the concrete materials drum mixer was used for the preparation and mixing of all concrete mixtures. A drum mixer is a mechanical device, which uses a revolving drum to combine cement, coarse aggregate, fine aggregate and water to form a homogenous mass. All the materials, i.e., cement, coarse aggregate, fine aggregate and water, were weighted with an accuracy. Drum mixer was started and firstly, coarse aggregate and fine aggregate were dry mixed thoroughly. After that, cement was added in the drum mixer and it was rotated till a uniform mass was obtained. In the end, water was added very carefully, so as to prevent any loss of water during the mixing operations. The drum mixer was rotated till we got a concrete mass with uniform colour and consistency. Care was taken during the whole operation so as to ensure the proper mixing of all ingredients. Workability of all concrete mixtures was checked immediately after the finishing of mixing operation

Sample Preparation:

All the concrete specimens were casted in steel moulds. All the moulds were cleaned and oiled properly before the mixing of concrete ingredients. They were properly tightened to correct dimensions before casting operations. Care was taken to ensure that there must not be any gap left so as to prevent the leakage of slurry. Concrete specimens were compacted in two layers using vibrating table. After the casting operations, concrete specimens were left in the casting room for approximately 24 hours, after which they were de-moulded and placed in the curing tank.

IV. TEST PROCEDURES

Workability:

Workability of concrete can be defined as in which concrete can be properly mixed, transported, compacted and finished, with minimum loss in homogeneity. Slump test is the most widely used test to measure workability of concrete all around the world in construction field.

A mould in the form of a cone with bottom diameter 200mm, top diameter 100mm and height 300mm was filled with four approximately equal layers, tempering each layer with a standard tempering rod with 25 strokes.

Compressive Strength :

Compressive strength is the most important property of hardened concrete. Compressive strength of concrete was evaluated at age of 7days and 28 days using standard cube specimens of 150mm×150mm×150mm. Compression Testing Machine (CTM) of 5000 kN capacity was used for the testing of compressive strength of concrete. Concrete specimen were demoulded 24 hours after the casting and placed in the curing tank to ensure sufficient curing. At each specified age, specimen was placed centrally between the bearing plates of CTM and load was applied continuously and uniformly at specified loading rate of 140 kg/cm2/min. the load was increased until the specimen broke and the maximum load taken by each specimen was noted down.

The compressive strength was calculated according to the following formula:

$\sigma = P/A$

where ;

σ = Compressive Strength (N/mm2)

P = Maximum load sustained by the cube (N)

A = Area of cross section of cube (mm2)

Results of the compressive strength testing were noted as average of compressive strength of 3 specimens at 7 days, 28 days for each concrete mix in N/mm2.

Total number of 66 concrete cube specimens are casted.

A set of six cubes (3 cubes for 7 days and 3 cubes for 28 days test) were cast with 0%, 10%, 20%, 30%, 40%, 50%,60%, 70%, 80% , 90% and 100% replacement of natural sand with stone dust and cubes specimen dipped fully in water tank for curing and tested for 7 days and 28 days compressive strength.

Workability Test :

Workability of conventional concrete and different concrete mixes was evaluated as slump in mm.

At high replacement level of natural sand with stone dust the slump value is zero due to more water absorption capacity of stone dust. so maintain workability the dose of super plasticizer was increased.

The slump values for different percentage of natural sand and stone dust in concrete as shown

Natural sand (%) stone Dust (%)	% Dose of Super Plasticizer
100:0	0.6 (120mm)
90:10	0.65 (115mm)
80:20	0.7 (105mm)
70:30	0.8 (105mm)
60:40	0.9 (95mm)
50:50	1.1 (90mm)
40:60	1.2 (85mm)
30:70	1.4 (80mm)
20:80	1.6 (75mm)
10:90	1.8 (75mm)

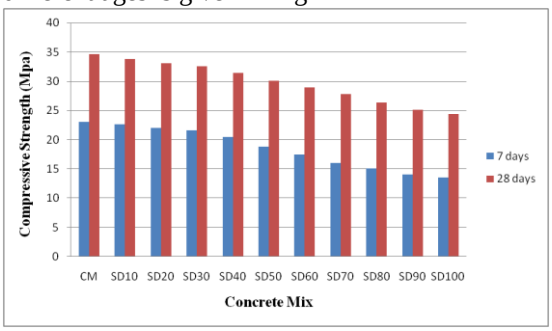
Compressive Strength Test Result :
Compressive strength of conventional concrete and different concrete mixes was tested at age of 7 days, 28 days to study the performance of concrete by partial replacement of natural sand with stone dust and different observations are given in tables.
100% Sand Mix Concrete Result

	7 days		
	SR.	Load	Strength
SAMPLES	1.	518	23.0
	2.	525	23.3
	3.	512	22.73

28 days		
SR.	Load	Strength
1.	790	35.1
2.	770	34.2
3.	775	34.4

Graphical Representation of Compressive Strength TestResults :

Graphical representation of compressive strength results of all concrete mixes at
different ages is given in Fig



V. CONCLUSIONS:

On the basis of the study conclusions are following:
1. Stone dust can be used as partial or full replacement with natural sand in concrete. The Replacement level of the natural sand 10% to 100% with Stone dust shows slightly reduction in the compressive strength of the concrete.

2. The workability of concrete was decreased when stone dust percent increased at replacement level of natural sand 10% to 100% in concrete. Workability of concrete can be maintained by adding extra dose of super plasticizer. And extra dose of super plasticizer will affect the setting time of concrete.

3. According to compressive strength test resultsthe optimum replacement of natural sand with stone dust is 40 percent.

4. Stone dust can be used where setting time is not much important due to the excess dose of super- plasticizer increases the setting time.

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