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Partial Replacement of Sand with Stone Dust in Concrete of Variable Grades

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Abstract:
Due to frequent use of concrete in different kinds of construction activities, there is rapid increase in the demand of its constituents like cement, sand and coarse aggregates etc. As sand is one of its important constituent which is being widely used as a fine aggregate, has led to increase in large scale mining process. As a result of which the availability of natural resources is depleting very fast and the availability of the natural sand has become scarce. This has led to evolving some alternative material which may be easily available and having the same kind of properties. The stone dust may be one of the best alternative of the natural sand as it is a byproduct of stone crusher. The main purpose of the present study is to find out the best substitution of the natural sand by replacing it with stone dust in concrete of variable grades. Three grades of concrete M20, M25 and M30 were used in the experimental work. The specimens of all the grades were cast with replacement of sand with stone dust in varying percentages from 10% to 50%gradually increasing it with 10%. The compressive strength of the concrete was obtained and compared with the strength of the conventional concrete.

Key Words: Concrete, Compressive strength, natural sand, stone dust.

Introduction;

Concrete is being used as major construction material since for a long. Conventionally, the concrete is a composite material comprising of cement, sand and coarse aggregates in different appropriate proportions. The strength and durability of the concrete is directly affected by the type of use of aggregates. The most commonly used fine aggregate is a natural sand, which may be either river sand or quarried sand. As most of the total volume of the concrete, which is about 70% is constituted by coarse and fine aggregates, so, it becomes necessary to find out suitable and good quality aggregates for concrete.

Due to the fast growing population and human requirements the construction activities are also increasing and as a result the available natural resources being used are huge. As the global requirement of the natural sand is very high, specially developing nations like India, the demand for natural sand is very high to maintain its Infrastructure growth.

The large extraction of the natural sand from quarry or river bed is leading to so many serious problems like loosening of suitable strata and water retaining sides causing slides, loss of vegetation, damage to flora and fauna, affecting the agriculture and horticulture due to the lowering of the underground water table.
Beside this, due to the depletion of the natural resources of the sand the cost of the sand is also increasing at a very fast rate. This study shows the use of stone dust as an alternative to the natural sand in concrete.

Materials and methods;

Cement:
Ordinary Portland cement (OPC 43 grade) confirming to IS 8112-1983 was used.

Coarse Aggregate:
Specific gravity 2.71
Proportioning of 20mm to 10mm -1.5:1

Fine Aggregate (Natural Sand):
Grading zone – zone III
Specific gravity – 2.65

Stone Dust:
Stone dust used in this experimental study was obtained from local crusher at Rampur Bushehr Shimla HP.
Grading zone – zone II
Specific gravity – 2.67

Table No: 1 Sieve Analysis of Stone Dust

Sieve size	weight Retained (weight of test sample -1Kg)	Percentage Retained	Cumulative Percentage Retained	Percentage Finer
10mm				100
4.75mm	0.008	0.8	0.8	99.2
2.36mm	0.038	3.8	4.6	95.4
1.18mm	0.239	23.9	28.5	71.5
600	0.344	34.4	62.9	37.1
300	0.29	29	91.9	8.1
150	0.069	6.9	98.8	1.2
Pan	0.012	1.2	100	0

Mix Design:

Suitable design mix ofconcrete for different grades M20, M25 and M30 was prepared as per the guidelines laid in IS 10262: 2009.

In the experimental study the proper mix of a particular design was prepared and the cubes of size 150x150x150mm were cast for conventional concrete first and then the natural sand was replaced with stone dust by 10%, 20%, 30%, 40% and 50% in variable grades of concrete. The objective of casting of these specimens was to find out the changes in compressive strength of concrete by using stone dust.

Concrete Mix Proportion
Grade of concrete: M20
Table No: 2 Different proportions of Constituents of Concrete.

%age of stone dust	Cement in Kg	Fine aggregatesin Kg	Stone dust in Kg	Coarse aggregates (10mm) in Kg	Coarse aggregates (20mm) in Kg	Water in Liters
0%	320	705	0	512	769	160
10%	320	634.50	70.50	512	769	160
20%	320	564	141	512	769	160
30%	320	493.50	211.50	512	769	160
40%	320	423	282	512	769	160
50%	320	352.50	352.50	512	769	160

Table No: 3 Grade of concrete: M25

%age of stone dust	Cement in Kg	Fine aggregates in Kg	Stone dust in Kg	Coarse aggregates (10mm) in Kg	Coarse aggregates (20mm) in Kg	Water in Liters
0%	361	671	0	510	765	162
10%	361	603.90	67.10	510	765	162
20%	361	536.80	134.20	510	765	162
30%	361	469.70	201.30	510	765	162
40%	361	402.60	268.40	510	765	162
50%	361	335.50	335.50	510	765	162

Table No: 4 Grade of concrete: M30

%age of stone dust	Cement in Kg	Fine aggregates in Kg	Stone dust in Kg	Coarse aggregates (10mm) in Kg	Coarse aggregates (20mm) in Kg	Water in Liters
0%	378	658	0	513	769	159
10%	378	592.20	65.80	513	769	159
20%	378	526.40	131.60	513	769	159
30%	378	460.60	197.40	513	769	159
40%	378	394.80	263.20	513	769	159
50%	378	329	329	513	769	159

Results and Discussions

Based on the experimental work and details of results and analysis of different specimens of various grades of concrete, their effect on compressive strength with combination of stone dust in comparison with the conventional concrete were ascertained. The experimental tests analysed that there was a reasonable increase in the compressive strength of concrete prepared with stone dust replacing sand in conventional concrete of different grades.

Compressive Strength:

The compressive strength of conventional concrete as well as concrete with stone dust at different percentages have been determined at 7, 28 and 56 days of curing. The results so obtained have been placed under figures and tables.

Fig. No :1

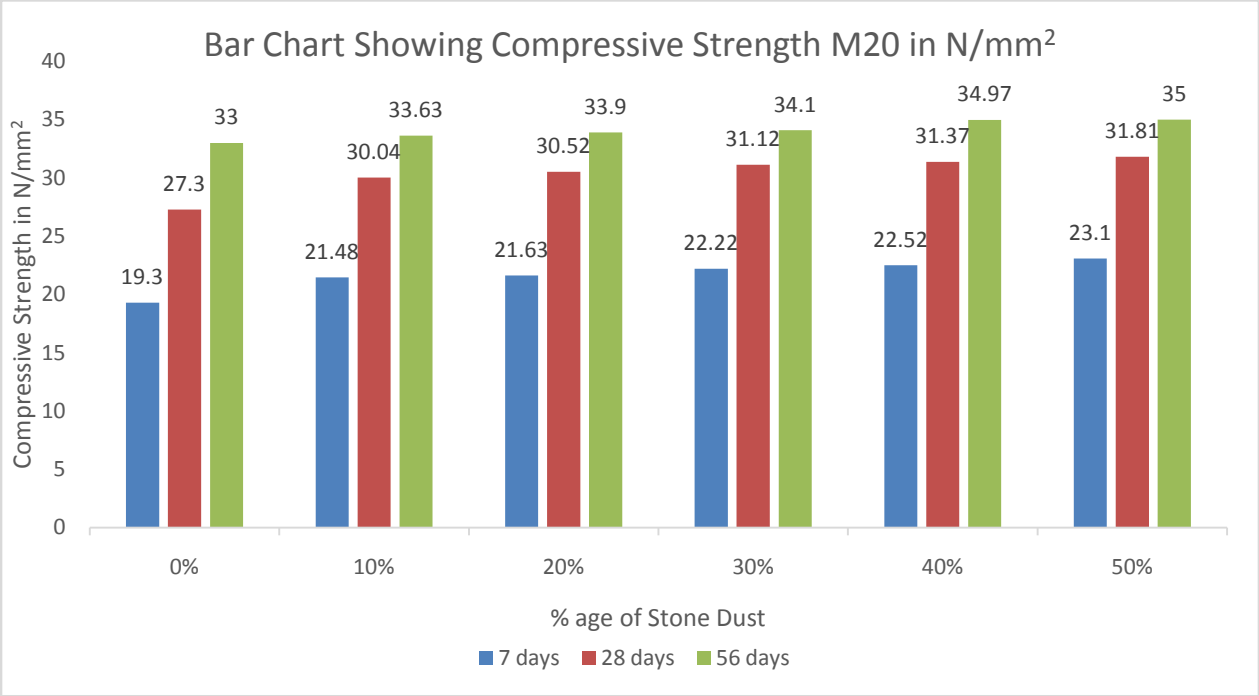

Table No: 5

Compressive Strength In N/mm² for M20						
% of Stone Dust	Compressive strength in N/mm²			Average compressive strength in N/mm²		
	After 7 days	After 28 days	After 56 days	After 7 days	After 28 days	After 56 days
0%	19.4	27.5	33	19.30	27.3	33.00
	19.5	27	31.9			
	19	27.4	34.1			
10%	20	30.4	32.89	21.48	30.04	33.63
	22.67	30.1	34.22			
	21.78	29.62	33.78			
20%	20.67	30.1	34.67	21.63	30.52	33.90
	21.33	30.8	33.22			
	22.89	30.66	34.78			
30%	22.22	31.5	35.11	22.22	31.12	34.10
	22.67	31.1	36			
	21.78	30.76	35.11			
40%	21.78	32	34.67	22.52	31.37	34.97
	22.67	31.1	34.67			
	23.11	31.01	35.56			
50%	23.40	31.9	34.67	23.10	31.81	35.00
	22.90	32.1	36			
	23.00	31.43	35.11			

Fig.No. 2

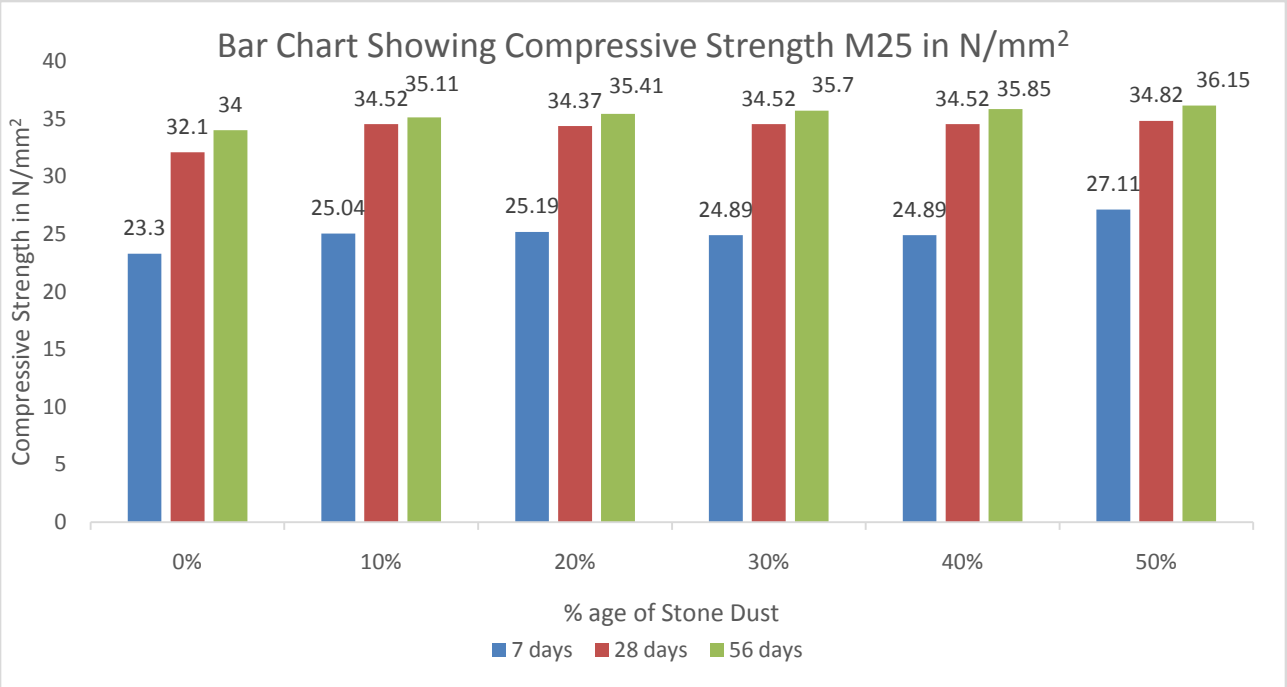

Table No: 6

Compressive Strength In N/mm² for M25						
% of Stone Dust	Compressive strength in N/mm²			Average compressive strength in N/mm²		
	After 7 days	After 28 days	After 56 days	After 7 days	After 28 days	After 56 days
0%	23	31.6	34	23.30	32.10	34.00
	23.5	31.8	34.5			
	23.4	32.9	33.5			
10%	24.89	34.67	35.11	25.04	34.52	35.11
	25.78	34.67	35.56			
	24.44	34.22	34.67			
20%	25.78	34.22	35.11	25.19	34.37	35.41
	24.89	34.67	35.56			
	24.89	34.22	35.56			
30%	23.56	33.78	35.11	24.89	34.52	35.70
	25.78	35.11	36			
	25.33	34.67	36			
40%	24	34.67	35.56	24.89	34.52	35.85
	25.78	34.67	35.56			
	24.89	34.22	36.44			
50%	28	35.11	36	27.11	34.82	36.15
	26.22	34.67	37.1			
	27.11	34.67	35.35			

Fig.No. 3

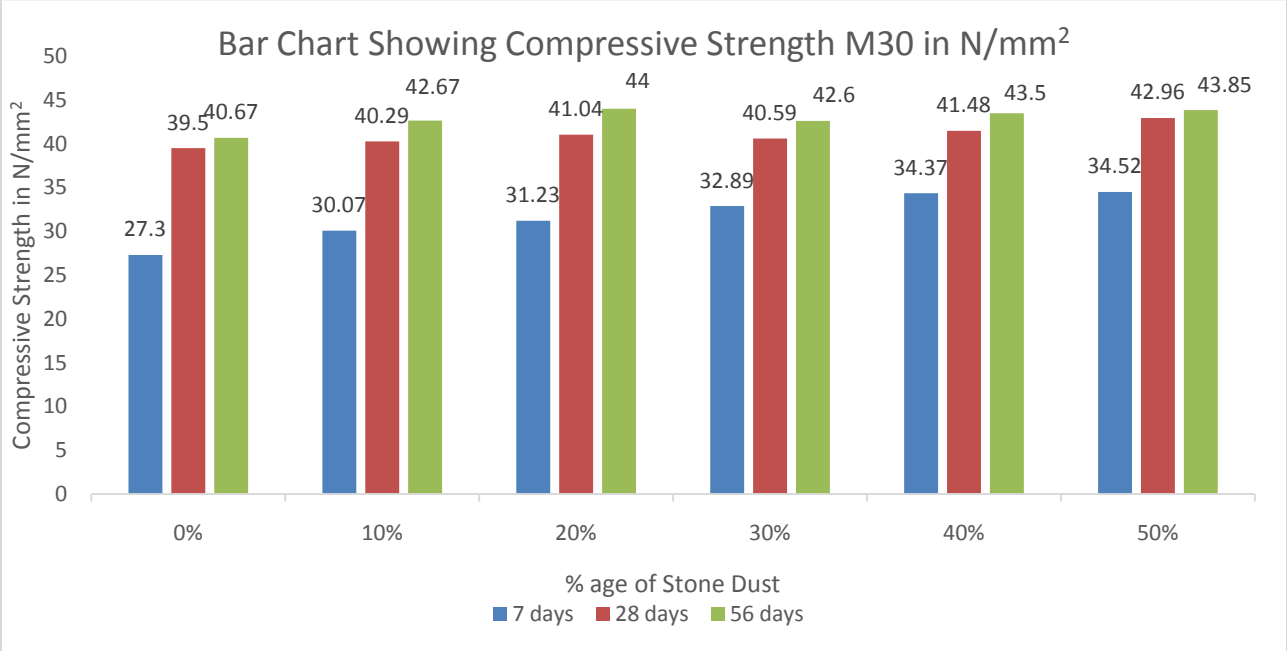

Table No: 7

Compressive Strength In N/mm² for M30						
%age of stone dust	Compressive strength in N/mm²			Average compressive strength in N/mm²		
	After 7 days	After 28 days	After 56 days	After 7 days	After 28 days	After 56 days
0%	27.9	39	40	27.30	39.50	40.67
	27	38.75	38			
	27	40.75	44			
10%	31.11	40.44	42	30.07	40.29	42.67
	30.22	40	46			
	28.89	40.44	40			
20%	31.56	41.33	46	31.23	41.04	44.00
	30.57	40.89	44			
	31.56	40.89	42			
30%	33.33	40.44	49	32.89	40.59	42.60
	33.33	41.33	44			
	32	40	42			
40%	34.67	41.78	52	34.37	41.48	43.50
	34.22	41.78	45			
	34.22	40.89	42			
50%	33.78	42.67	43.56	34.52	42.96	43.85
	35.11	43.11	44			
	34.67	43.11	44			

Conclusion and recommendations :

Based on above following conclusions can be drawn are as under:

- The properties of Stone Dust resemble the properties of the natural sand to some extent and the stone dust can be frequently used in concrete by replacing the natural sand
- From the results obtained, it can be observed that there is increase in compressive strength of concrete with stone dust in M20, M25 and M30 grades of concrete.
- The initial strength gain at 7 days is faster as compared to the strength gain at 28 and 56 days.

- It can be concluded that the natural sand can be replaced by stone dust up to 50% without decline in compressive strength.

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