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RESEARCH ARTICLE

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REPLACEMENT OF FINE AGGREGATE BY GRANITE POWDER IN CONCRETE

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ABSTRACT

Concrete plays a vital role in construction industry irrespective of scale of construction. An average in India 450 million cubic meter of concrete is used annually, approximately 1 tonne for each person in Indian. Due to scarcity of sand we are far behind the global consumption of concrete. Huge amount of granite dust and granite waste materials are produced by granite industry. The wastes that are disposed after polishing granite unites are being disposed into environment. This causes severe health issues. Instead this waste granite powder can be used for preparing concrete as partial substitute of sand**.** Today natural sand becoming costlier, for the reason of its abundant application in construction industry. Hence study towards easy and cheap substitute to natural sand is begun. Already fly-ash, filter sand, quarry dust are used as substitute natural sand.

The primary objective of this work is to find out suitability of granite powder in concrete as fine aggregate. The sand is replaced by granite powder in different proportions such as 0%, 10%, 30%, 50%, 70%, 90% and 100%. The experiments are conducted on M20, M30 and M40 grade concrete with 28 days of curing. The workability tests such as slump cone test, compaction factor test, Vee-Bee consistometer test and flow table test, and water absorption test, soroptivity test, density test. The compressive strength test also studied in the work.

INTRODUCTION

Fine aggregate is the important material in the manufacturing of concrete. Sand occupies a very significant position in the preparation of concrete and sand acts as major filler in concrete. In today's condition of construction industry the depletion condition of sand resources and hazards of sand mining on environment are affecting the construction field; that is the main reason behind the experiment to find out material which can be used for replacing the natural sand. So that the natural sand mining with environmental damage can be avoided. Now days the natural sand became costlier due to its abundant application. Because of this finding new resource of finer particle is very important. Already quarry dust, siliceous stone dust and bottom ash used as replacing material

Although sea shore sand is used in several countries like Sri Lanka, India, UK, Singapore and Inland Europe maximum studies bring into being

limited range of replacement. Several investigators find out similar resources to replace sand and among all granite powder is foremost source. By using increasing percentage of granite powder concrete is manufactured.

Industrial by products are causing problems to the human beings and environmental system by contaminating soil, air and water. Finding the maximum permeable limit of industrial waste that can be used as replacing material is helpful to environment also it results in economical construction practice, by reducing the usage of ancient material such as natural sand.

OBJECTIVE

Concrete plays a vital role in construction industry irrespective of scale of construction. An average in India 450 million cubic meter of concrete is used annually, approximately 1 tone per each person in Indian. Due to scarcity of sand we are far behind the global consumption of concrete. Huge amount of granite dust and granite waste materials are produced by granite industry. The wastes that are disposed after polishing granite unites are being disposed into environment. This causes severe health issues. Instead this waste granite powder can be used for preparing concrete as partial substitute of sand**.** Today natural sand becoming costlier, for the reason of its abundant application in construction industry. Hence study towards easy and cheap substitute to natural sand is begun. Already fly-ash, filter sand, quarry dust are used as substitute natural sand.

The important aim of this study is to identify the maximum permeable replacement of natural sand by granite powder in different grade of concretes like M20, M30 and M40. In this work natural sand replaced by Granite Powder in 0%, 10%,30%,50%,70%,90% and 100% by weight of natural sand. Also 0.5% of super plasticizer conplast-430 is adopted in the work.

Workability characteristics like slump cone test, flow table test, Vee-Bee consistometer test, compaction factor test are conducted on fresh concrete to determine the workability of modified concrete with granite powder.

Water absorption , soroptivity test are conducted to determine the compactness or water tightness of hardened concrete modified by replacing natural sand by granite powder.

Density test, compressive strength of hardened concrete are conducted over hardened concrete to study the characteristic of hardened concrete, interms suitability and maximum permeable limit of granite powder as substitute to natural sand.

MATERIAL USED

In this experimental study, Cement, sand, granite powder, coarse aggregate, water are used.

Cement: Ordinary Portland cement of 43 grade was used which is confirming to IS 12269:1989

Coarse aggregate: Locally available aggregate with maximum size 20mm and with specific gravity 2.66 was used.

Sand: Locally available sand (zone II) with specific gravity 2.64, confirming to IS 383-1970 was used.

Water: Portable water was used for experiment.

Granite powder: In this experimental work the GP generated in processing plant of granite is used.

METHODOLOGY

The mix design procedure adopted to obtain a M20, M30 and M40 grade concrete is in accordance with IS 10262-2009. The final mix ratio was 1:2.07:3.27, 1:1.55:2.66 and 1:1.31:2.34 with water cement ratio of 0.55, 0.45 and 0.40 respectively for M20, M30 and M40 grade of concrete. The specimens were casted for the different percentage of replacement of natural sand by granite powder. Weigh batch method was used for material mix proportions. Concrete was placed in moulds in 3 layers by tamping each layer. The specimens were casted by keeping the moulds on the vibrator for better compaction. The casted specimens were removed from moulds after 24 hours and the specimens were kept for water curing for 28 days. The strength properties were studied through compressive strength for various replacements of sand with granite powder

EXPERIMENTAL RESULTS

WORKABILITY TEST RESULTS

Workability is measured through slump, compaction factor, Vee-Bee degree and percentage flow. Table 1 gives the workability test results for M20, M30 and M40 grade concrete. The variations in the workability are depicted in the form of graph.

Table 1: Workability results of concrete (M20, M30 and M40)

Description of workability		Percentage replacement of natural sand by granite powder						
		0%	10%	30%	50%	70%	90%	100%
Slump(mm)	M20	68	72	75	81	73	67	62
	M30	65	69	73	77	70	66	60
	M40	67	71	74	79	75	68	63
Compaction factor	M20	0.914	0.921	0.932	0.944	0.938	0.929	0.922
	M30	0.921	0.927	0.933	0.942	0.936	0.928	0.919
	M40	0.924	0.930	0.938	0.949	0.941	0.935	0.928
Vee-Bee degree(sec)	M20	94	90	84	80	88	96	102
	M30	97	90	86	82	91	98	104
	M40	101	96	92	85	93	102	107
Percentage flow	M20	32.86	33.76	35.08	36.46	34.86	33.24	31.94
	M30	33.42	34.81	35.78	36.92	34.19	32.97	32.05
	M40	34.29	35.72	36.93	37.82	35.49	33.49	32.67

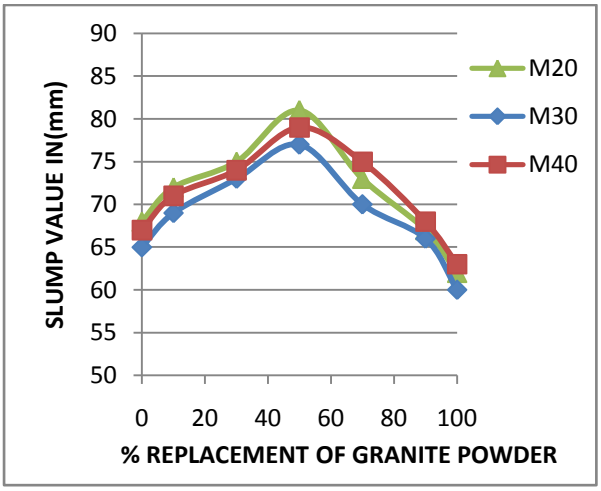

Fig 1: Variation of slump

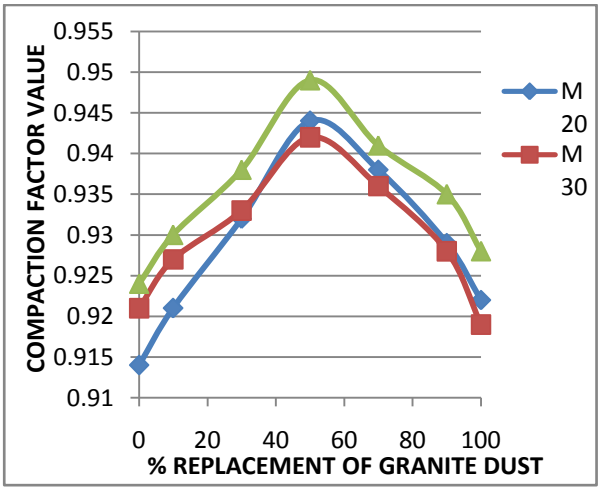

Fig 2: Variation of compaction factor value

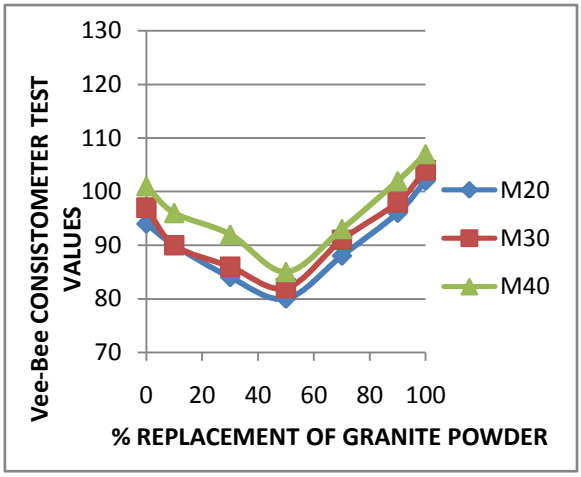

Fig 03: Variation of Vee-Bee degree

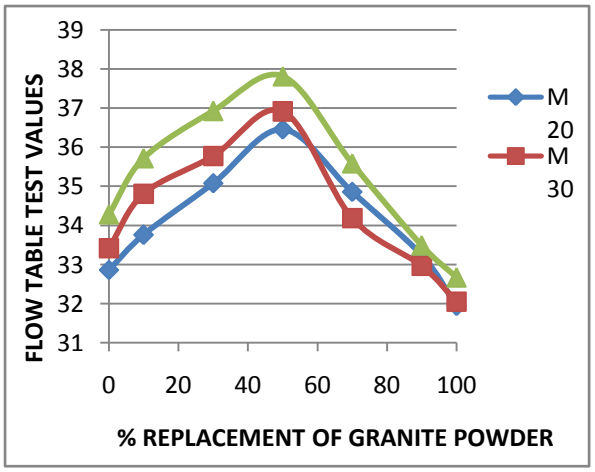

Fig 04: Variation of percentage flow

NEAR SURFACE CHARACTERISTIC TEST RESULTS

Table 2: Surface characteristic test results for M20, M30 and M40 grade concretes

Description of near surface characteristic test		Percentage replacement of natural sand by granite powder						
		0%	10%	30%	50%	70%	90%	100%
Percentage water absorption	M20	0.63	0.58	0.51	0.47	0.53	0.58	0.62
	M30	0.61	0.56	0.52	0.45	0.49	0.54	0.59
	M40	0.58	0.55	0.51	0.47	0.49	0.53	0.56
soroptivity	M20	7.96	7.64	7.38	7.04	7.52	8.09	8.86
	M30	7.84	7.52	7.21	6.83	7.15	7.32	7.49
	M40	7.71	7.58	7.42	7.37	7.51	7.84	8.06

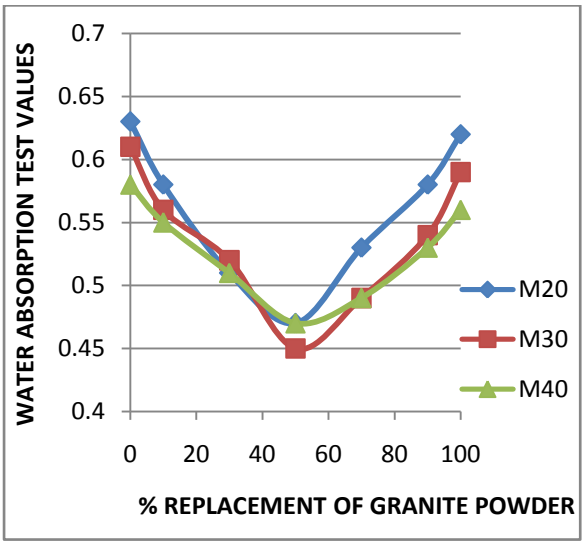

Fig 05: Variation of water absorption

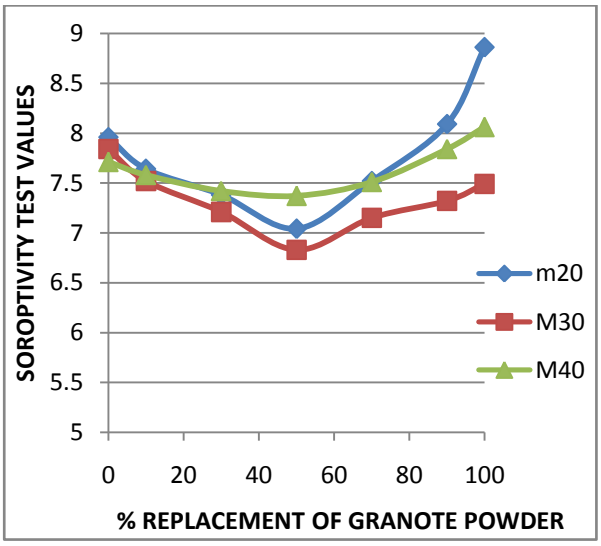

Fig 06: Variation of soroptivity

DENSITY TEST RESULTS

Following table gives the density of concrete produced by replacing fine aggregate by granite powder for M20grade concrete.

Table 3: Overall variation of density test results for M20, M30 and M40 grade concretes

Percentage Replacement fine aggregate by granite powder	Density of concrete M20	Percentage increase or decrease of density with respect to reference mix	Density of concrete M30	Percentage increase or decrease of density with respect to reference mix	Density of concrete M40	Percentage increase or decrease of density with respect to reference mix
0	2416.3	0.00	2439.51	0.00	2441.48	0.00
10	2435.56	0.80	2446.42	0.28	2475.06	1.38
30	2440.49	1.00	2458.27	0.77	2492.84	2.10

50	2453.33	1.53	2470.12	1.25	2513.58	2.95
70	2403.95	-0.51	2439.51	0.00	2475.06	1.38
90	2380.25	-1.49	2419.75	-0.81	2429.63	-0.49
100	2351.6	-2.68	2401.98	-1.54	2391.11	-2.06

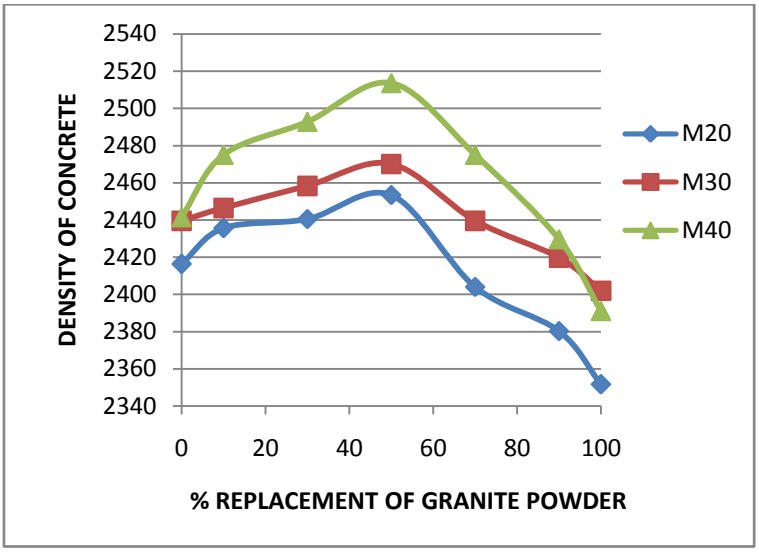

Figure 07: Variation of density

STRENGTH TEST RESULTS

Following table provide overall result of compressive strength for various percentage replacement of natural sand by granite powder. Also percentage increase in compressive strength of concrete produced by replacement of natural sand by granite powder.

Table 4: Overall results of compressive strength results @ 7 days

% replacement FA by GP	Compressive strength for M20 concrete (MPa)	% variation of compressive strength with reference mix	Compressive strength for M20 concrete (MPa)	% variation of compressive strength with reference mix	Compressive strength for M20 concrete (MPa)	% variation of compressive strength with reference mix
0	17.26	0.00	23.85	0.00	32.52	0.00
10	17.56	1.71	24.00	0.63	32.96	1.36
30	18.07	4.72	24.22	1.56	33.78	3.87
50	18.22	5.57	25.04	4.98	33.93	4.32
70	17.26	0.00	23.19	-2.79	32.07	-1.37
90	16.22	-6.01	22.37	-6.20	30.52	-6.15
100	15.19	-12.02	21.04	-11.79	29.85	-8.20

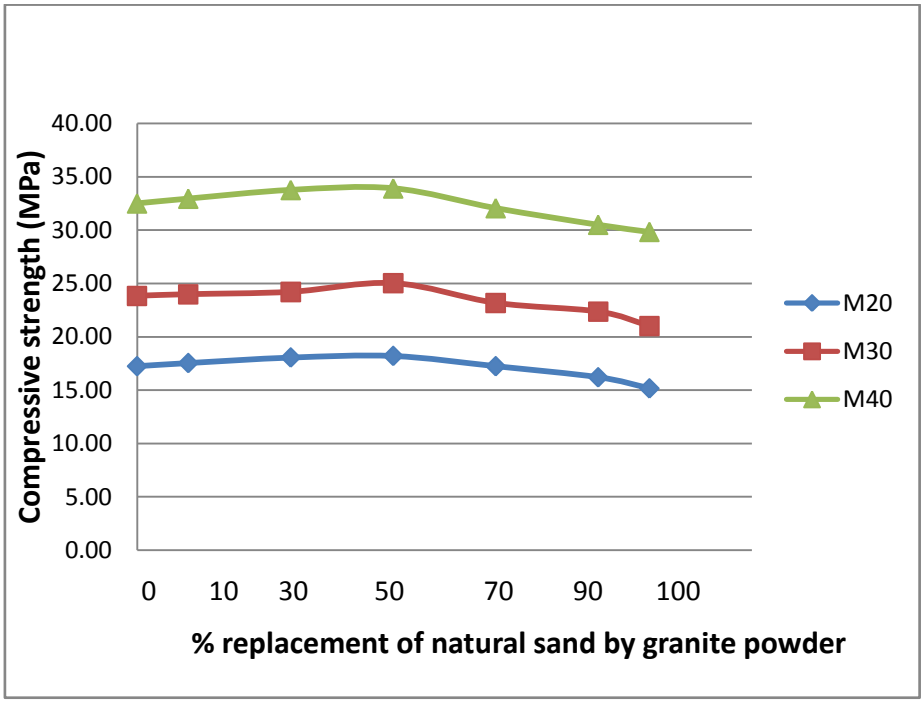

Fig 08: Variation of compressive strength @ 7days

Table 05: Overall results of compressive strength @ 28 days

% replacement FA by GP	Compressive strength for M20 concrete (MPa)	% variation of compressive strength with reference mix	Compressive strength for M20 concrete (MPa)	% variation of compressive strength with reference mix	Compressive strength for M20 concrete (MPa)	% variation of compressive strength with reference mix
0	22.67	0.00	32.67	0.00	41.04	0.00
10	23.41	3.26	32.89	0.67	41.48	1.07
30	24.22	6.84	33.78	3.40	42.15	2.70
50	24.89	9.79	34.74	6.34	42.81	4.31
70	21.63	-4.59	31.41	-3.86	40.96	-0.19
90	20.3	-10.45	30	-8.17	39.85	-2.90
100	19.19	-15.35	29.26	-10.44	38.37	-6.51

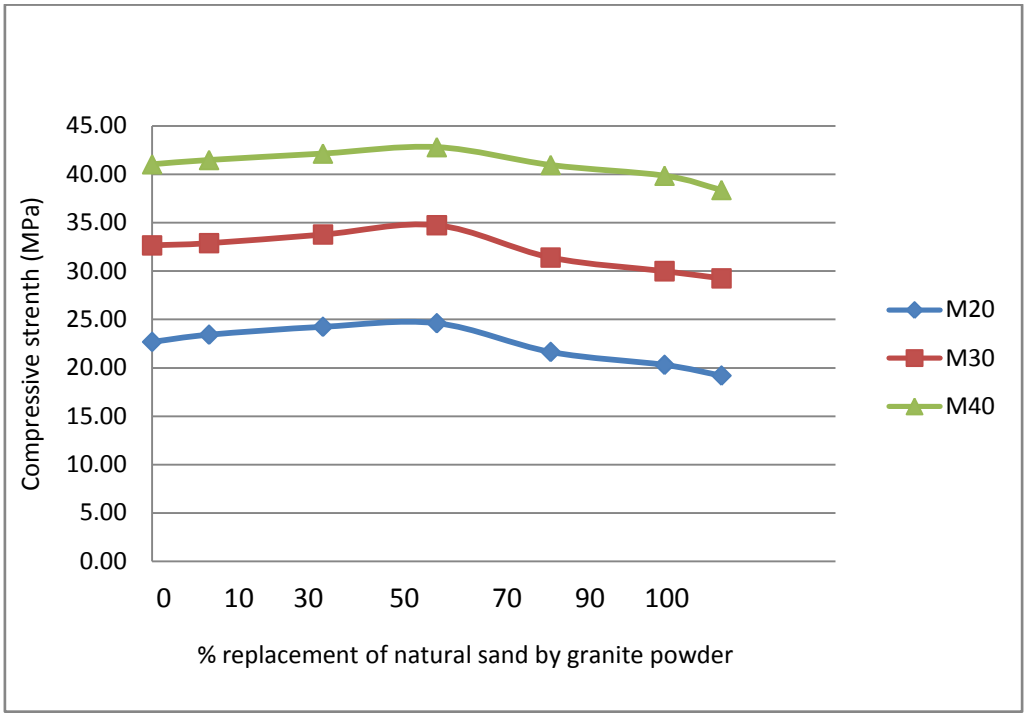

Fig 09: Variation of compressive strength @ 28 days

CONCLUSIONS

Based on the experimental work conducted on the concrete produced by replacing natural sand by granite powder the following conclusions are drawn.

- The workability of concrete (as measured from slump, compaction factor, Vee Bee degree and percentage flow) reaches the higher value when 50% natural sand is replaced by granite dust.
- The water absorption and soroptivity values reach the lowest value when 50% natural sand is replaced granite powder.
- The density of concrete increases at 50% replacement of natural sand by granite powder.
- The compressive strength of concrete reaches higher value when 50% natural sand is replaced granite powder.
- Natural sand can be replaced by granite powder up to 50% by weight, which shows positive results.
- Using granite powder in concrete production gives solution to the disposal problem of granite industrial waste.

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