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Review Paper:
STUDY ON STRENGTH CHARACTERICTICS OF CONCRETE CONTAINING GRANITE WASTE AS A PARTIAL REPLACEMENT OF COARSE AGGREGATE

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ABSTRACT

Granite industry has grown significantly in the last decades. Accordingly, the amount of mining and processing waste has increased. Stone waste is generally a highly polluting waste due to both its highly alkaline nature, and its manufacturing and processing techniques, which impose a health threat to the surroundings. In order to utilize stone waste effectively and also find alternative for natural aggregate used in concrete is our aim to cured out the harmful effect of stone waste and it's disposal it is necessary and also limited sources of natural aggregates finding their alternatives is necessary because mining of natural resources in order to obtain natural aggregates destroys natural balance and many state governments and their high-courts imposes ban on excavation work of natural resources to obtain natural aggregates The problem of environmental pollution caused by disposal of granite waste can be solved by using it as a partial replacement of natural aggregate and also at same time it solves the problem of shortage of natural aggregate in construction industry. The objective of this paper is to utilize granite waste as a partial replacement (10%, 20%, 30% & 40 %) of 20mm coarse aggregate and test it for strength of such concrete.

***Keywords:* Granite, Aggregate, Compressive Strength, Flexural Tensile Strength.**

I. INTRODUCTION

Today industry's disposal of stone waste is one of the environmental problems around the world. Presently in India, about 960 million tonnes of solid waste is being generated annually as by-products during industrial, mining, municipal, agricultural and other process out of this 350 million tonnes are organic waste from agricultural sources; 290 million tonnes are inorganic waste of industrial and mining sectors and 4.5 million tonnes are hazardous in nature. In India, stone dust is settled by sedimentation and then dumped away which results in environmental pollution, in addition to forming dust into summer and threatening both agricultural and public health. So it is necessary to use this stone waste in various industries especially the construction, agriculture, glass and paper industries would help to protect the environment as this stone waste is used in any manner also incorporation of this stone waste is economical also as it replaces the costly ingredients like aggregates in concrete and comes almost free of cost In this study an effort has been made to explore the possibility of using these materials as part replacement of natural coarse aggregates for making concrete.

1.1 Objective:-

The main objective of this study is to investigate the potential use of granite waste in concrete as replacement for coarse aggregate and is to arrive at a suitable mix design for the application of discarded granite waste as a partial replacement of coarse aggregate in concrete; and to test and analyze the workability, density of hardened concrete, compressive and flexural strength, of concrete of grade M30.

II. LITERATURE SURVEY

Rania et al. (2011) studied the use of recycled marble and granite waste of different sizes in the manufacturing of concrete bricks, with full replacement of conventional coarse and fine aggregates with marble waste scrapes and slurry powder of content up to 40 percent by weight. Results on the physical and mechanical properties of the bricks qualified them to be used in the building sector as non-load bearing spacing construction materials, where all cement brick samples tested in this study complied with the Egyptian code requirement for structural bricks.

Patel et al. (2013) investigated on design mix for M30 grade of concrete by partially replacing fine aggregate with five different percentages by weight of powder(0%, 5%, 10%, 15%, and 20%) and he found that mean strength of all concrete mixes with marble powder was 5-10% higher than references concrete conforming it IS456-2000.

Roshan and kuldeep (2014) investigated on strength characteristics of concrete containing coarse aggregates with partial replacement by marble and granite waste aggregates in three different percentage by weight of coarse aggregates 20% (10% marble +10% granite), 30% (15% marble +15% granite), 40% (20% marble +20% granite) and he found that Compressive strength, split-tensile strength and flexural strength are increased for replacement of 20% and 30%.However for the 40% replacement of marble and granite waste aggregates with coarse aggregates marginal decrease in compressive strength is recorded.

2.1 Methodology

The testing of the raw materials i.e. cement, fine aggregate(sand), coarse aggregate(10mm & 20mm) and granite 20mm aggregate as per relevant Indian Standard Codes of Practice .The physical properties of cement, sand, coarse aggregate and granite aggregates used in this study are presented in Tables below:

Table 1: Physical Properties of Cement.

S.No.	**Property**	**Experimental value**	**Specified Value (as per IS:8112-1989)**
1.	Fineness	3.5 %	< 10 %
2.	Consistency	31.5 %	-
3.	Initial setting time of cement	75 minutes	> 30 minutes
4.	Final setting time of cement	185 minutes.	< 600 minutes
5.	Compressive. Strength(N/mm^2) 3 days 7days 28 days	 25.60 36.05 46.85	 >23 >33 >43

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Table 2: Sieve Analysis of Fine Aggregates (Sand)

S.No	Is Sieve Size	Cumulative % wt. Retained	% passing	% passing as per IS:383 Zone-II	Remarks
1	10 mm	0.00	100	100	Sum of Cumulative % wt. retained =266.01 **Fineness Modulus (F.M.)** = 266.01 /100 = 2.66
2	4.75mm	2.93	97.07	90-100	
3	2.36mm	7.20	92.80	75-100	
4	1.18mm	29.60	70.40	55-90	
5	600µ	45.87	54.13	35-59	
6	300µ	83.54	16.46	8-30	
7	150µ	96.87	3.13	0-10	
8	Pan	100	-	-	

Table 3: Sieve analysis of Coarse Aggregates 10mm

S.No.	Is Sieve Size	% wt. Retained	Cumulative % wt. Retained	% passing	% passing as per IS:383
1	20 mm	0.00	0.00	100	100
2	10 mm	8.30	8.30	91.70	85-100
3	4.75mm	77.15	85.45	14.55	0-20
4	2.36mm	10.95	96.40	3.60	0-5
5	Pan	-	-	-	-

Table 4: Sieve analysis of Coarse Aggregates 20mm

S.No.	IS Sieve Size	% wt. Retained	Cumulative % wt. Retained	% passing	% passing as per IS:383
1	40 mm	0.00	0.00	100	100
2	20 mm	7.35	7.35	92.65	85-100
3	10 mm	86.85	94.20	5.8	0-20
4	4.75 mm	4.60	98.80	1.20	0-5
5	Pan	-	-	-	-

Table 5: Sieve analysis of granite Aggregates 20mm

S.No.	IS Sieve Size	% wt. Retained	Cumulative % wt. Retained	% passing	% passing as per IS:383
1	40 mm	0.00	0.00	100	100
2	20 mm	9.70	9.70	90.30	85-100
3	10 mm	81.70	91.40	8.60	0-20
4	4.75 mm	5.10	96.50	3.50	0-5
5	Pan	-	-	-	-

Table 6: Combined Sieve Analysis of Course Aggregate

S.No.	IS Sieve Size	% passing		% of Different passing			
		10 mm	20 mm	10 mm (50 %)	20 mm (50 %)	Combined (100 %)	% passing as per IS:383
1	40 mm	100	100	50.00	50.00	100	100
2	20 mm	100	92.65	50.00	46.32	96.32	95-100
3	10 mm	91.70	5.8	45.85	2.90	48.75	25-55
4	4.75 mm	14.55	1.20	7.27	0.60	7.87	0-10
5	Pan		-	-	-		-

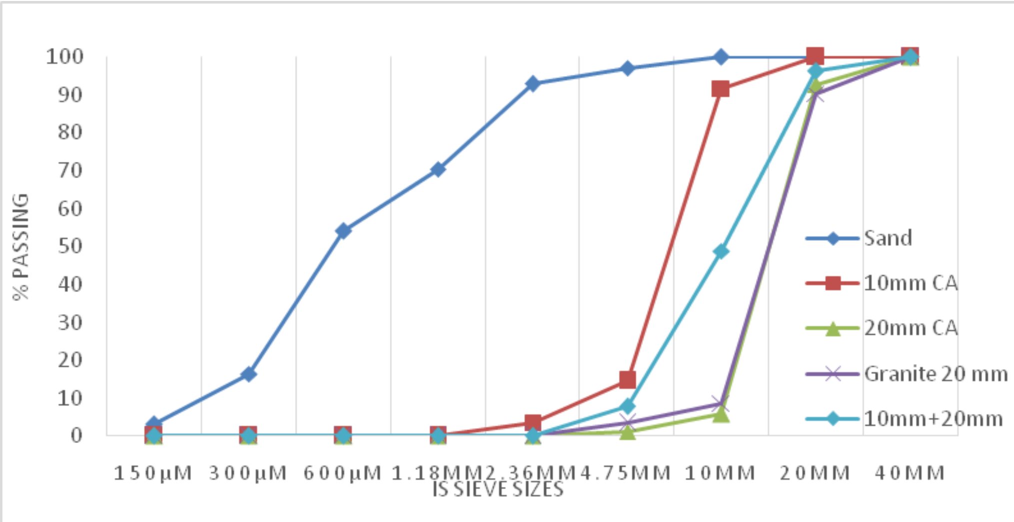

Fig 1: Grading curves for fine & coarse aggregate

Table-7: Specific gravity & water absorption of Aggregate

S.No.	Material	Specific Gravity	Water Absorption
1	Fine aggregate(Sand)	2.57	1.10%
2	coarse aggregate (10mm)	2.70	0.60%
3	coarse aggregate (20mm)	2.64	0.41%
4	Granite	2.66	0.15%

Table 8: Detailed Mix Proportions for mix design as per IS: 10262-2009

Mix	%Replacement	Cement (kg/m^3)	Sand (kg/m^3)	Coarse Aggregate(kg/m^3)			Water (kg/m^3)	Admixture (kg/m^3)	W/C Ratio
				10mm	20mm	Granite(20mm)			
M0	0	373.0	679.0	593.75	593.75	0.0	164.0	4.85	0.44
M1	10	373.0	679.0	593.75	534.41	59.34	164.0	4.85	0.44
M2	20	373.0	679.0	593.75	475.0	118.75	164.0	4.85	0.44
M3	30	373.0	679.0	593.75	415.63	178.12	164.0	4.85	0.44
M4	40	373.0	679.0	593.75	356.2	237.5	164.0	4.85	0.44

Following tests are carried out on concrete as per their Indian Standards:

2.2 Workability

Each batch of concrete shall be tested for workability immediately after mixing as per IS: 1199–1959. Workability is defined as the ease with which concrete can be mixed, handled, transported, placed in position and compacted without excessive bleeding or segregation. In this study Compaction factor test was used to find out the workability of the concrete mix. Compacting factor test is done to determine the workability of fresh concrete as per IS: 1199–1959.The compacting factor test gives the behaviour of fresh concrete under the action of external forces. This test is more accurate than slump test especially for concrete mixes of medium to low workability.

In order to find compacting factor, sample of concrete is placed in the upper hopper up to the brim. The trap-door is opened so that the concrete falls into the lower hopper. The trap-door of the lower hopper is opened and the concrete is allowed to fall into the cylinder. The excess concrete remaining above the top level of the cylinder is then cut off with the help of plane blades. The concrete in the cylinder is weighed. This is known as weight of partially compacted concrete. The cylinder is filled with a fresh sample of concrete and vibrated to obtain full compaction. The concrete in the cylinder is weighed again. This weight is known as the weight of fully compacted concrete.

Compacting factor is calculated by the ratio of weight of partially compacted concrete to the weight of fully compacted concrete.

Table 9: Compaction factor for Different types of workability

S.No.	Degree of Workability	Compaction factor
1.	Low	0.85
2.	Medium	0.92
3.	Good workability	0.95

2.3 Density of Concrete

Density of hardened concrete is determined after 28 days of curing. In order to find density of concrete we take out samples out of water tank and put them in oven for 24 hours at temperature 110°c after 24 hours. We take weight of empty mould and weight of mould containing fully compacted concrete and their difference in weight is determined. Density of concrete is calculated by the ratio of difference in weight of empty mould and weight of mould containing fully compacted concrete to the volume of mould. Three samples of 150x150x150 mm sizes was taken for this test.

2.4 Water Absorption Test

Water absorption of concrete specimen was determined after 28 days of curing as per IS: 1124-1974. Three samples of 150x150x150 mm sizes was taken for this test. In order to find water absorption of concrete we take out samples out of water tank and allowed to surface dried. When they get surface dried weight W1 is taken the they are placed in oven for 24 hours at a temperature of 110°c and after 24 hours weight W2 is taken and then water absorption is calculated by the formula given below.

$$\text{Water Absorption} = \frac{W1 - W2}{W2} * 100$$

2.5 Compressive Strength Test

Compressive strength test of concrete specimen is most widely used test to measure its compressive strength. Two types of concrete specimens either cubes of 150 mm X 150 mm X 150 mm or 100 mm X 100 mm X 100 mm depending upon the size of aggregate are used for this purpose. In this study cubical moulds of size 15 mm x 15mm x 15 mm are used. This test was performed as per IS: 516-1959 to find out the compressive strength of concrete after 7 days and 28 days curing of concrete cubes. At least three specimen of 150x150x150 mm must be tested at each replacement level. Concrete is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing.

Specimens stored in water shall be tested immediately on removal from the water and while they are still in the wet condition. Surface water and grit shall be wiped off the specimens and any projecting fins removed. Specimens when received dry shall be kept in water for 24 hours before they are taken for testing. The dimensions of the specimens to the nearest 0-2 mm and their weight shall be noted before testing. The load shall be applied without shock and Increased continuously at a rate of approximately 140 $kg/cm^2/min$ until the resistance of the specimen to the Increasing load breaks down and no greater load can be sustained. The maximum load applied to the specimen shall then be recorded and the appearance of the concrete and any unusual features in the type of failure shall be noted. The measured compressive strength of the specimen shall be calculated by dividing the maximum load applied to the specimen during the test by the cross-sectional area. Average of three values shall be taken as the representative of the batch provided the Individual variation is not more than ± 15 percent of the average. Otherwise repeat tests shall be made.

2.6 Flexural Tensile Strength Test

Flexural strength test of concrete specimen is used to measure its tensile strength of concrete. Two types of concrete specimens either of 150 mm X 150 mm X 700 mm or 100 mm X 100 mm X 500 mm depending upon the size of aggregate are used for this purpose. In this study moulds of size 100 mm x 100mm x 500 mm are used. This test was performed as per IS: 516-1959 to find out the tensile strength of concrete. At least three specimen of 100x100x500 mm must be tested at each replacement level. Concrete is poured in the mould and tempered properly so as not to have any voids. The load could be applied without shock and increasing continuously at a rate such that the extreme fiber stress increases at approximately 0.7N/mm/min that was at a rate of loading of 400kg/min for the 15.0 cm specimens and at a rate of 180kg/min for the 10.0 cm specimens. The load was increased until the specimen fails and the maximum load applied to the specimen during the test should be recorded. The appearance of the fractured faces of concrete and any unusual features in the type of failure should be noted. The flexural strength of the specimen shall be expressed as the modulus of rupture and shall be calculated by the formula given below:

$$\text{Modulus of Rupture (MR)} = \frac{PL}{BD^2}$$

Where, P = Maximum load applied on beam in Newton= Supported length of beam, B= Breadth of beam,
D= Depth of beam.

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IV. CONCLUSION

After completing all the test, results obtained through each test is analysed by comparing result of tests at various replacement level to the control mix.

REFERENCES

[1] Rania A.Hamza, Salah El-Haggar, and safwan khedr, (2011). Marble and Granite waste characterization and utilization in concrete bricks. International Journal of Biochemistry and Bioinformatics, Vol.1, No.4, November 2011.

[2] Prof.Roshan Lal, Er.Kuldeep Kumar, (2014). Investigation on strength characteristics of concrete containing recycled aggregates of Marble and granite waste. International Journal of progresses in civil engineering (IJPCE)..

[3] V. Sai Krupa,M. K. M. V. Ratnam, V. V. S. Sarma,(2015). Study on Strength & Durability of Concrete by Partial Replacement of Fine & Coarse Aggregates using Marble, Granite & Spent Fire Brick Waste.International Journal of Scientific Research in Science, Engineering and Technology (ijsrset.com).

[4] Binici, H., Kaplan, H., & Yilmaz, S. Influence of marble and limestone dusts as additives on some mechanical properties of concrete. Kahramanmaras, Turkey: Kahramanmaras Sutcu Imam University.

[5] Centre, M. M. (n.d.). Utilization of Marble Dust in Tiles. Jabalpur, M.P.: Macro Molecular Research Centre, Rani Durgawati University.

[6] Demirel, B. (2010). The effect of the using waste granite dust as fine sand on the mechanical properties of the concrete. International Journal of the Physical Science, Vol. 5(9).

[7] IS 10262:2009 Recommended Guidelines for concrete mix design, BIS, New Delhi.

[8] IS 456:2000 “Indian Standards Code of Practice for plain and reinforced concrete”(4th revision)Bureau of Indian Standards, New Delhi.

[9] IS: 383-1970. “Gradation/Sieve Analysis of aggregate” BIS, New Delhi, 1997.

[10] IS: 4031-1988. “Method of physical tests for hydraulic cement” Bureau of Indian Standards, New Delhi, 1989.

[11] I.S. 2386- (Part 4) 1963, Methods of test of aggregate for concrete.

[12] I.S. 516: 1959, Methods of test for strength of concrete.

[13] Gupta, R. C., Missra, A., & Raisinghani, M. (2009). Flexural Strength and Creep Characterstics of Tiles Containing Marble Powder. ARPN Journal of Engineering and Applied Sciences, 53-57

[14] Neville, A. M., & Brooks, J. J. (1987). Concrete Technology. England: Longman Group UK Limited.