

Properties Assessment of Green Concrete Containing Quarry Rock Dust and Marble Sludge Powder as Fine Aggregate

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Abstract - Green concrete is prepared by partial or complete replacing of material like cement, fine aggregate or coarse aggregate with wastage of Industries (like that stone chips, quarry rock dust, marble sludge powder and blast furnace slag etc.). At present time about 6% of all CO₂ emission is due to Cement production so in this paper study of Cement is partially replace with Marble dust is also carried out to reduce the CO₂ emission from the Cement industries [1]. Marble sludge powder can be used as filler and helps to reduce the total voids content in concrete. Natural sand in many parts of the country is not graded properly and has excessive silt on other hand quarry rock dust does not contain silt content or organic impurities and can be produced to meet desired gradation and fineness as per requirement [2]. Consequently, this contributes to improve the strength of concrete. This paper presents the feasibility of the usage of quarry rock dust and marble sludge powder as hundred percent substitutes for natural sand in concrete and thus Green Concrete is helpful in reducing the consumption of natural resources and also reduces the pollution of environment. It is found that the compressive strength, workability and durability studies of concrete made of quarry rock dust are nearly equal to the conventional concrete.

Keywords - Green Concrete, Marble sludge powder, Quarry rock dust.

I. INTRODUCTION

Green concrete has nothing to do with color. Green concrete is a concrete in which Cement, fine aggregate and coarse aggregate are partially or completely replaced with Industrial waste material. The substitution material can be of waste or residual product in manufacturing process. The substituted materials could be waste materials that remain unused, that may be harmful (material that contains radioactive elements). Today there are critical shortages of natural resources in present scenario. Production of Concrete and utilization of concrete is rapidly increased which results in increased consumption of natural resources like fine and coarse aggregate as the largest Concrete component. By using Green Concrete we can reduce the use of natural resources such as limestone, shale, clay, natural river sand that are being consume for the development of human mankind and that are not given back to the earth. To avoid the pollution and reuse of waste material, the present study is carried out. As the properties are as good as the sand, thus the marble sludge powder and quarry rock dust is used as fine aggregate in the

cement concrete [3]. The main aim of this project is to find out properties of green concrete containing quarry rock dust and marble sludge powder as fine aggregate and comparative analysis with normal concrete.

II. OBJECTIVE

The main perspective of research is to construct concrete block with different mixing ratio of quarry rock dust and marble sludge powder as fine aggregate. To ascertain the strength of concrete blocks for various combinations and comparative assessment of green concrete with normal concrete.

III. METHODOLOGY

Green concrete is differing from conventional concrete like that material used for concrete mix. Material used for green concrete are-cement, quarry rock dust and marble sludge powder (replacement of sand), coarse aggregate, water and admixtures. Whole project work is completely based on Indian standard code. Indian standard code used in this project are as follows:-IS : 456 : 2000 (Indian standard Plain and reinforced concrete code of practice), IS : 516 : 1959 (Indian standard methods of test for strength of concrete), IS : 1199 : 1959 (Indian Standard Methods of Sampling and analysis of concrete), IS : 10262 : 2009 (Indian standard Recommended Guidelines for concrete mix design) and IS : 8112 : 1989 (Specification for 43 Grade ordinary Portland cement) and IS : 2386 (Part IV)-1963 (Indian standard methods of tests for aggregates for concrete).

In this project work sand is completely replaced by quarry rock dust and marble sludge powder in different-different ratio. The most suitable ratio is 50% quarry rock dust and 50% marble sludge powder used as the place of sand [4]. In the second part of this project only cement is partially replaced by marble dust in different-different ratio and most suitable ratio is 10% marble dust is used as a Cementous material. Cement used in this project is 43 Grade Ordinary Portland Cement and aggregate used with nominal size 10mm and 20mm. Quarry rock dust and marble sludge powder are used after testing physical chemical properties and comparing with cement and sand [5]. The water cement ratio used for green concrete is according to clause 3.1 of IS: 10262: 2009 and this ratio for M-20 concrete is taken as 0.55 like (W/C=0.55).

Two type of concrete mix are prepared first one is for conventional concrete and second one is for Green concrete. There are four type of concrete mix are prepared for Green concrete in which first one is Mix-A for which sand is replaced by 40% marble sludge powder and 60% quarry rock dust, second one is Mix-B for which sand is replaced by 50% marble sludge powder and 50% quarry rock dust, third one is Mix-C for which sand is replaced by 60%marble sludge powder and 40% quarry rock dust, fourth one is Mix-D for which cement is replaced by marble dust in different ratio. All of constituents of conventional and green concrete are mixed in a fix proportion according to Indian standard codes which are discussed above and also concrete cubes are prepared according to Indian standard codes and then three- three concrete cubes are tested after 3 days, 7 days, 14 days and 28 days and calculate average strength of three cubes. For finding the workability of concrete different workability test like slump test, slump flow and flow table test are carried out. At finally comparison between conventional concrete and green concrete is carried out and conclusion is obtained.

The physical characteristics of the waste are furnished in Table-1. The fineness modulus of marble sludge powder and quarry rock dust is comparable to that of fine sand of 2.2 to 2.6. The coefficient of uniformity for fine sand is generally should be less than 6. Similarly the coefficient of gradation should be between 1 and 3 for fine sand. The chemical characteristics of the river sand, marble sludge powder and quarry rock dust are furnished in tables below.

Table 1: Physical characteristics of marble sludge powder, quarry rock dust and river sand

Sample code	Moisture content (%)		Bulk density (kg/m ³)	Fineness modulus	Effective size (mm)	Coefficient of uniformity	Coefficient Of gradation
	Wet	Dry					
Marble sludge powder	23.35	1.59	1118	2.04	0.17	1.58	1.37
Quarry Rock dust	24.25	2.10	1750	2.35	0.22	4.50	2.20
River sand	25.00	2.50	1430	2.20	0.20	6.00	2.00

The above table shows the Physical Properties of marble sludge powder, quarry rock dust and marble sludge powder which are nearly equal thus the above material can be used as a replacement material to each other.

IV. RESULTS AND DISCUSSIONS

The 150 mm size concrete cubes are used as test specimens to determine the compressive strength of concrete. The results of standard cubes are compiled in Tables-11. The Indian standard method resulted in highly conservative results of compressive strength for the M20 grades of concrete. Compressive strength is obtained as per IS: 516-1959. The compressive strength of conventional concrete is after 7 and 28 days is 12.2 and 19.9 N/mm². Compressive strength of green concrete is obtained by comparing three mix of green concrete in which mix-A (sand is replaced by 40% marble sludge powder and 60% quarry rock dust), mix-B (sand is replaced by 50% marble sludge powder and 50% quarry rock dust) and mix-C(sand is replaced by 60%marble sludge powder and 40% quarry rock dust). Mix-a , mix-B and mix-C gives compressive strength after 28 days 19.2, 20.0 and 19.0 N/mm² respectively thus mix-B gives better result as compare to other both mix. At finally find a comparative analysis between characteristic compressive strength of conventional concrete and Green concrete (mix-B). Thus Green concrete gives strength very close to conventional concrete and then according to IS: 516:1959 these results are acceptable. These results are shown in Table 2.

Table 2: Analysis of Compressive Strength

Average compressive strength in N/mm ²					
S. NO.	Type	Conv. Conc.	Mix-A	Mix-B	Mix-C
1	7days	12.2	10.4	10.9	10.1
2	14days	17.5	16.5	17.4	16.2
3	28days	19.9	19.2	20.2	19

Workability of Concrete: These concrete are manually mixed M-20 concrete with water cement ratio is 0.55.

The workability of fresh concrete was measured in terms of slump and slump flow value which are presented in Table-3. The properties of fresh concrete were measured according to IS: 1199-1959 The ingredients of concrete were thoroughly mixed in mixer machine till uniform consistency was achieved. Slump for conventional and Green concrete are 120mm and 140 mm respectively. Slump flow for conventional and Green concrete are 200, and 230 mm respectively without using any admixtures.

Table 3. Workability of concrete

S. No.	Type	Slump (mm)	Slump flow (mm)
1	Conventional concrete	120	200
2	Green concrete	140	230

Replacement of cement by marble dust in different ratio:

The 150 mm size concrete cubes are used as test specimens to determine the compressive strength of concrete. Tests are performed for M-20 Concrete. The results of standard cubes are compiled in Tables-13. Compressive strength is obtained as per IS: 516-1959. The compressive strength of conventional concrete is after 7 and 28 days is 12.2 and 19.9 N/mm². Compressive strength of green concrete is obtained by comparing four mix of green concrete in which mix-D1 (cement is replaced by 5% marble dust), mix-D2 (cement is replaced by 10% marble dust), mix-D3 (cement is replaced by 15% marble dust) and mix-D4 (cement is replaced by 20% marble dust). Mix-D1, mix-D2 and mix-D3 and mix-D4 gives compressive strength after 28 days 19.5, 19.6 and 18.8 and 17.3 N/mm² respectively thus mix-D2 gives better result as compare to other mix of green concrete. Average characteristic compressive strength of M-20 Green concrete (Replacement of cement by 10% marble dust Mix-D2) at the age of 28 days is 19.6 N/mm² which is 1% less than strength of conventional concrete thus strength of Green concrete (Mix-D2) is very close to the strength of conventional concrete then this error in strength is acceptable according to IS: 516: 1959. Results are shown in Table 4.

Table 4. Average Characteristic Compressive Strength of M-20 Concrete

Average compressive strength in N/mm ² for M-20 Concrete						
S. No.	Type	Conv. Conc.	Mix-D1	Mix-D2	Mix-D3	Mix-D4
1	7days	12.2	11.9	11.9	11.6	11.2
2	14days	17.5	17.2	17.3	16.8	16.2
3	28days	19.9	19.5	19.6	18.8	17.3

V. CONCLUSION

Using all the result of different test on both conventional and green concrete one can conclude that the quarry rock dust and marble sludge powder may be used as a replacement material for fine aggregate. The chemical compositions of quarry rock dust and marble sludge powder such as Fe₂O₃, MnO, Na₂O, MgO, K₂O, Al₂O₃, CaO, and SiO₂ are comparable with that of cement. The replacement of fine aggregate with 50% marble sludge powder and 50% Quarry rock dust (Green concrete) gives an excellent result in strength aspect and quality aspect. The Replacement of cement with 10% marble dust in concrete mix gives an excellent result in strength aspect and quality aspect. Green Concrete gives better Result

as compare to Conventional Concrete without using any admixture. Emission of CO₂ is reduced. Use of waste material is increased.

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