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Green Concrete by using Industrial Waste Material- fly ash, quarry dust, marble powder

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Abstract – Green concrete is a concept of using eco-friendly materials in concrete, to make the system more and more sustainable. This concrete should not be confused with its color. There are many choices of selection of materials in any type of constructions. Fly ash is not highly reactive; the heat of hydration can be reduced through replacement of part of cement with fly ash. Industrial waste such as marble powder, quarry dust, fly ash etc. to reduce consumption of natural resource and energy and pollution of the environment. So by reuse of the industrial waste materials we reduce impact on environment and also reduce disposal problem of industries. The concrete mixture were produced which tested and compared by conducting compressive test and Split tensile test for 7days, 14days and 28days. In M25 concrete mix 50% of cement was replaced by fly ash and sand was totally replaced by 50% of quarry dust and 50% of marble powder.

Keywords:-Green concrete, fly ash, quarry dust, marble powder, compressive strength, split tensile strength.

1. INTRODUCTION

Green concrete is very often and also cheap to produce, because for example, waste products are used as a partial substitute for cement, charges for the disposal of waste are avoided; energy consumption in production is lower. To improve the environmental friendliness of concrete to make it suitable as a "Green Building" material**.** Inorganic residual products are used more efficiently as green aggregates in concrete and the environment is protected from waste deposits. Marble sludge powder, quarry dust and fly ash are some of the materials used for making green concrete, as sustainable construction. Green concrete Technology we can save the natural materials for future use or the generations, but if we use waste materials for construction the virgin materials will become a

sustainable material and as well as the cost will be reduced. The objectives of work

1] To study & analyse the following properties of green concrete

a) Compressive strength,

b) Split tensile strength

2] To check and compare the green concrete with Normal concrete.

1] In our project, industrial waste such as marble powder, fly ash & quarry dust are using as green concrete & analyzing the waste material which are benefits to use in low cost concrete material.

2] By use such materials without replacement of cement, It shows very low strength i.e.1 N/MM^2 (7 days).

Fig.1

3] In addition to above material replaced fly ash 25% by cement & It shows strength up to 5 N/MM^2 (7 Days).

Fig.2

2. LITERATURE REVIEW

Garg and Jain (2014), studied on green concrete: efficient & eco-friendly construction materials. It presents the feasibility of the usage of by product materials like fly ash, quarry dust, marble powder/ granules, plastic waste and recycled concrete and masonry as aggregates in concrete. It concluded that, it focuses on known benefits and limitations of a range of manufactured and recycled aggregates. Use of concrete product like green concrete in future will not only reduce the emission of CO2 in environment and environmental impact but it is also economical to produce.

Dhoka (2013), carried out "green concrete: using industrial waste of marble powder, quarry dust and paper pulp" The green concrete is prepared by using industrial waste of marble powder, quarry dust with proper proportions". The versatility of green concrete & its performance derivate will satisfy many future needs.

Wangchuk et.al.(2013), studied that green concrete for sustainable construction. It is characterized by application of industrial wastes to reduce consumption of natural resources and energy and pollution of the environment. Replacement of materials over nominal concrete is what makes green concrete more environmental friendly concrete. Marble sludge powder, quarry rocks, crushed concrete and fly ashes are some of the materials used for making green concrete, a sustainable construction. With green concrete technology we can save the natural materials for future use or the generations to come and sustain it for good amount of time.

Desai et.al. (2013), carried out green concrete: need of environment. Green concrete has capable of application of industrial wastes to reduce consumption of natural resources and energy and pollution of the environment. 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 or organic impurities and can be produced to meet desired gradation and fineness as per requirement. It concluded that, this contributes to improve the strength of concrete. Green concrete is an effective way to reduce environment pollution and improve durability of concrete under severe condition.

3. Materials

Cement:

The most common cement used is Portland Pozzolana Cement (Part I-Fly ash based) conforming to IS: 1489 (PART-1) 1991 is being used.

Coarse Aggregate:

Crushed Coarse aggregate passing through sieve of size 12.5-20mm and normal continuous grading is used. The specific gravity is 2.4.

Quarry Dust:

The most widely used fine aggregate for making of concrete is the natural sand mined from the riverbeds. However, the availability of river sand for the preparation of concrete is become scarce due to excessive non-scientific methods of mining from the riverbeds, lowering of water table, sinking of bridge piers, etc. are becoming common problems. The present scenario demands identification of substitute materials for the river sand for making concrete. Quarry Dust as a by product from crushing process during quarrying activities is one of those materials that have recently gained attention to be used as concreting aggregates, specially as fine aggregates. In concrete production it could be used as a partial or full replacement of natural sand. Besides, the utilization of quarry waste, which itself is a waste material, will reduce the cost of concrete production.

Marble Powder:

Marble has been commonly used as a building material since ancient times. Disposal of the waste materials of the marble industry, consisting of very fine powders, is one of the environmental problems worldwide today. However, these waste materials can be successfully and economically utilized to improve some properties of fresh and hardened properties of mortar and concrete. Marble waste powder is an industrial waste containing heavy metals in constituent. Fineness with 90% of particles passing by300μm sieves. Marble powder was collected from the deposits of marble factories during shaping. It was retained on IS-150 micron sieve before mixing in concrete.

Water: Water used for manufacturing of Green concrete is potable and simply a tap water.

Fly Ash:-
When pulverized coal is burnt to generate heat, the residue contains 80% fly ash and 20% bottom ash. Fly ash produced in Indian power stations are light to mid-grey in color and have the appearance of cement powder. Use of Fly ash concrete in place of PCC will not only enable substantial savings in the consumption of cement and energy but also provide economy. The use of fly ash has a number of advantages. It is theoretically possible to replace 100% of Portland cement by fly ash, but replacement levels above 80% generally require a chemical activator. Studies have found that the optimum replacement level is around 30%. Moreover, fly ash can improve certain properties of concrete, such as durability. Because it generates less heat of hydration, it is particularly well suited for mass concrete applications. The use of fly ash in concrete in optimum proportion has many technical benefits and improves concrete performance in both fresh and hardened state. Fly ash use in concrete improves the workability of plastic concrete, and the strength and durability of hardened concrete. Generally, fly ash benefits concrete by reducing the mixing water requirement and improving the paste flow behavior.

Materials properties

Materials	colour	Specific Gravity	Methods
Cement	Grey	3.15	Pycnometer
Fly ash	Grey	2.08	Pycnometer
Coarse aggregate	Grey	2.4	Perforated Basket
Marble powder	White	1.95	Pycnometer
Quarry dust	Black & Gray	2.26	Pycnometer

3.1 Mix design
Mix design proportion of standard (M25) grade concrete

Table No.1:

Material(kg)	Mix1 (Normal M25)	Mix2 (A+B)	Mix3
Cement	380	190	0
Fly ash	0	190	380
Fine aggregate	523.70	0	0
Coarse aggregate	1138.83	1138.83	1138.83
Marble powder	0	401.5	401.5
Quarry dust	0	473.2	473.2
Water in lit.	190	190	190
W/c ratio	0.5	0.5	0.5

(A= Marble powder, B= Quarry dust)

Table No.2 Mix proportion (M25 Grade)

	Normal concrete C:FA:CA	Green concrete C:A:MP:QD:CA
Weight ratio	1:1.37:2.98	1:1:2.1:2.49:5.99
W/C ratio	0.5	0.5

C=cement, FA= Fine aggregate, CA= Coarse aggregate, A= Fly ash, MP= Marble powder, QD= Quarry dust

3.2 Experimental Methodology
Compressive strength:-
Concrete cubes confirming to IS: 516:1964 of size 150x150x150mm were casted. After 24 hours the moulds were de-moulded and subjected to dry curing at normal temperature. These tests were carried out in accordance with IS: 516-1959 on Compression Testing Machine (Fig.3). The maximum compressive load on the specimen was recorded as the load at which the specimen failed to take any further increase in the load. The average of 3 samples was taken as the representative value of compressive strength. The compressive strength was calculated by dividing the maximum compressive load by the cross-sectional area of the cube specimen. Figure.3 shows the compressive testing machine and some of tested cubes.

Fig.3 Compression Testing Machine

Split tensile strength:
Tensile strength of concrete ranges from 10 to 18 % of the compressive strength. It can be measured by the direct tensile loading test. During casting the cubes is mechanically vibrated on table vibrator (figure 4). However the application of direct tensile load to the test specimens is rather difficult. For this reason the tensile strength of concrete is usually measured by the indirect tension test like splitting test. Tensile splitting strength tests of concrete block specimens were determined at 28 days. After curing, the specimens shall test for Split Tensile Strength using a calibrated compression testing machine of 2,000 KN capacities. The loading rate on the cube is 10N/mm^2 per min.

Fig.4 Vibrating machine

4.RESULTS

4.1Many test conducted on Normal concrete cubes and Green concrete cubes as follows –

4.1.1 Compressive strength –Compressive strength was conducted on various specimen as per guidelines given in IS 516-1959. The specimen were surface dried before testing the same on Universal Testing Machine of 200 tonnes capacity. The result of compression test using industrial waste as 50% replacement of cement at the dry curing age of 7 days, 14 days & 28 days are presented in table no-3.

Table No.3 Compressive Strength Test (N/mm^2)

Days		7	14	28
Normal concrete	1	21.8	24.92	27.11
	2	21.36	23.39	28.90
	3	20.49	24.28	28.12
Average		21.21	24.29	28.04
Green concrete	1	19.73	20.53	23.12
	2	17.63	20.80	22.17
	3	17.65	20.20	23.79
Average		18.33	20.51	23.02

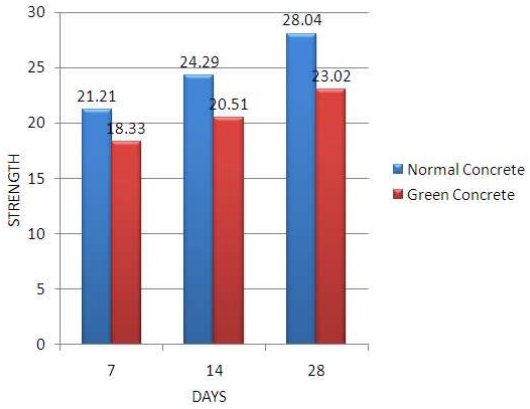

Chart 1: Compressive Strength Results

4.1.2 Split tensile strength-Split tensile strength was conducted on various specimen as per guidelines given in IS -516-1959. The cylindrical specimen were tested at the age of 7 days, 14 days & 28 days after surface drying same. The test was conducted on Universal Testing Machine. The result obtained at the curing age of 7days, 14 days & 28 days presented in table no-4.

Table No.4 Split Tensile Strength Test (N/mm^2)

Days		7	14	28
Normal concrete	1	1.23	1.59	1.65
	2	1.14	1.24	1.66

	3	1.27	1.33	1.58
Average		1.21	1.38	1.63
Green concrete	1	0.64	0.77	1.27
	2	0.66	0.80	1.14
	3	0.65	0.84	1.20
Average		0.65	0.80	1.20

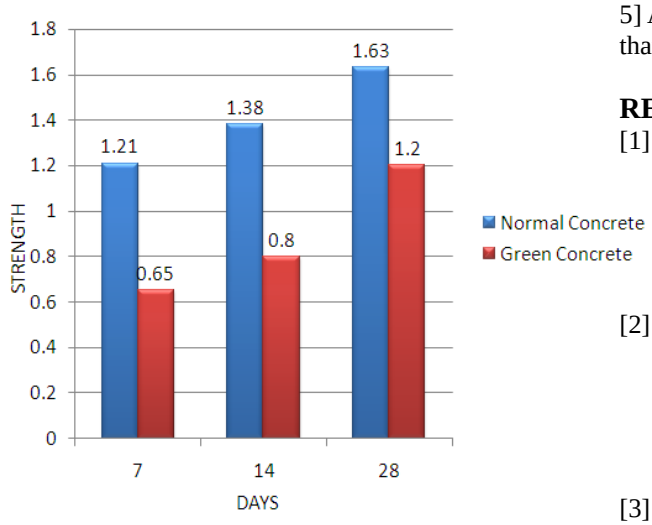

Chart 2: Split Tensile Strength Results.

4.2Cost comparison

Table No.5

Material	Normal concrete		Green concrete	
	Kg/m^3	RS.	Kg/m^3	RS.
Cement	380	2128	190	1064
Fly ash	0	0	190	570
Fine aggregate	523.70	730	0	0
Coarse aggregate	1138.83	650	1138.83	650
Marble powder	0	0	401.5	150
Quarry dust	0	0	473.2	200
Total cost		3508/-		2634/-

5. CONCLUSIONS

1] The water absorption of green concrete is slightly higher than Normal concrete.

2] The Split tensile strength and Compressive Strength of Green Concrete is nearly same to the Normal concrete with low costing, so this concrete is more economical for low cost house construction.

3] The replacement of total fine aggregates with 50% of marble powder and 50% of quarry rock dust gives an excellent result in strength aspect and quality aspect. Increase the marble powder content by more than 50% improves the workability.

4] Green concrete induced higher workability.

5] As per to cost comparison Green concrete is cheaper than Normal Concrete.

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