Green Concrete

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Abstract : The paper covers the aspect on how to choose a material for green concrete. 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. The use of fly ash in concrete contributes the reduction of greenhouse emissions. It has been observed that 0.9 tons of CO2 is produced per ton of cement production. Also, the composition of cement is 10% by weight in a cubic yard of concrete. Thus, using green concrete it is possible to reduce the CO2 emission in atmosphere towards eco-friendly construction technique. To avoid the pollution and reuse the material, the present study is carried out.

Furthermore, a concrete structure made of normal concrete can be permeable which expedites the steel reinforcement corrosion process when exposed to severe weather conditions. Therefore, this reduces its durability and service life. Implementing sustainable/green technologies in concrete design and production can solve these problems and extend the structure life span.

In this study, the emission inventory data of CO2 in concrete production is investigated and used to determine the level of green concrete. Example calculation is provided together with an actual case study. Inventory data of each component is collected separately through local sources such as cement companies, aggregate plants, and from literature survey and combined together to be a total emission factor for concrete production. Examples of how to reduce the CO2 emission in concrete by changing mix proportions, or using supplementary materials are also demonstrated. In the case study on a townhome project, the amount of CO2 emission (from material) of each individual house and of the whole project is determined. Suggestions on the use of supplementary materials to replace cement and on the use of admixtures to change mix proportion in order to reduce CO2 emission is also provided.

The concrete mixture was produced which tested and compared by conducting compressive test and Split tensile test for 7 days,14 days and 28 days. In M25 concrete mix 50% of cement was replaced by fly ash & sand was totally replaced by 50% of quarry dust and 50% of marble powder.

I. Introduction

Green concrete is a concept of using eco-friendly materials in concrete, to make it more and more sustainable. This concrete should not be confused with its color. Green concrete is a revolutionary topic in the history of concrete industry. Thus, green concrete is an excellent substituent of cement as it is cheaper, because it uses waste products, saving energy consumption in the production. So, by reuse of the Industrial waste materials we reduce impact on environment and reduce disposal problem of industries.

Green concrete is 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 lowered. 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. Concrete has a global consumption rate of 25 gigatons per year and it is the most widely used building material used in construction today. Different kinds of strategies are being implemented to improve sustainability of concrete. One of the strategies include incorporating recycled materials in concrete. Another important goal is to reduce CO2 emissions by reducing the Portland cement content. This can be achieved by partially replacing Portland cement with cementitious by-product materials.

Lastly, reduce long-term resource consumption, and select low impact construction methods. If either of the above strategies are instigated, a 'green concrete' would be accomplished. Waste can be used to produce new products or can be used as admixtures so that natural resources are limited and used more efficiently, and the environment is protected from waste deposits. Inorganic residual products like stone dust, crushed concrete, marble waste is used as green aggregates in concrete. Further, by replacing cement with fly ash, micro silica in larger amounts, to develop new green cements and binding materials, increases the use of alternative raw materials by developing or improving cement with low energy consumption. Considerable research has been carried out on the use of various industrial by-products and micro-fillers in concrete.

II. Literature Review

1. 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.

2. 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.
3. 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 environmentally friendly concrete. Marble sludge powder, quarry rocks, crushed concrete and fly ash 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.
4. Desai (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.

III. MATERIALS USED

1. WATER

Potable water was used for this experiment.

2. CEMENT

The most common cement used is Portland Cement (Part I-Fly ash based) conforming to IS: 1489

3. 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

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 river beds, 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, especially as fine aggregates.

5. FLY ASH AS CEMENTITIOUS MATERIAL

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 several 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 around30%. 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 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.

6. STONE CRUSHER WASTE AS FINE AGGREGATES

Quarry Rock Dust can be defined as residue, tailing or other non-valuable waste material after the extraction and processing of rocks to form fine particles, less than 4.75mm. Quarry dust is made while blasting, crushing, and screening coarse aggregate. Quarry dust has rough, sharp and angular particles, and as such causes a gain in strength due to better interlocking.

The use of alternate materials for sand in construction works need attention with respect to their availability and applicability. The use of quarry dust sometimes causes an increase in the quantity of cement required to maintain workability.

7. RECYCLED CONCRETE AS AGGREGATES

Coarse recycled concrete and masonry (RCM) is graded aggregates produced from sorted and clean waste concrete and masonry typically for road soubise applications. The material may contain small quantities of bricks, gravel, crushed rock or other forms of stony material as blended material. Fine recycled aggregates may also be referred to as crushed concrete fines.

The shape, grading and excessive number of fines may impact the workability, bleeding rate, finish ability and susceptibility to plastic cracking of concrete. Manufactured sand can be used to replace a major proportion of natural sand with no significant loss of performance in cement-based products.

8. MARBLE WASTE AS FILLER MATERIAL

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.

IV. METHODOLOGY

1. **COMPRESSIVE STRENGTH** – Compressive strength was conducted on various specimen as per guidelines given in IS 516-1959. The specimens 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.

2. **SPLIT TENSILE STRENGTH** - Split tensile strength was conducted on various specimen as per guidelines given in IS - 516-1959. The cylindrical specimens 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 are presented.

V. RESULTS

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

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	0.8	1.20

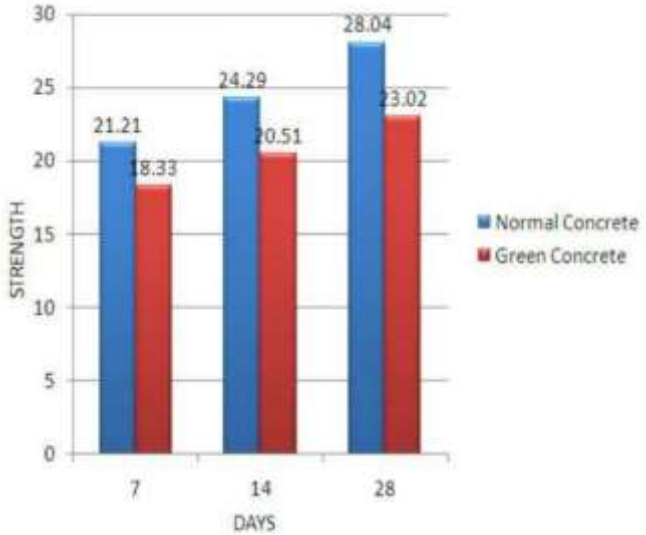

Fig no 1. Compressive Test Results

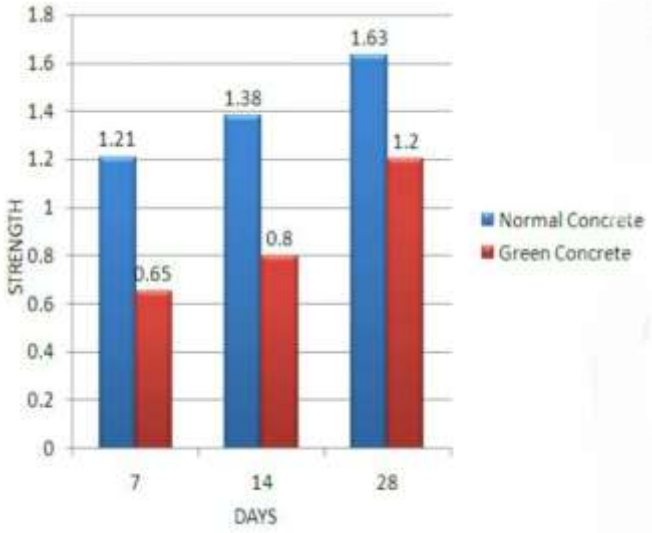

Fig no 2. Split Tensile Test Results

VI. CONCLUSION

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. Green concrete is cheaper in cost as compared to normal concrete.

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