Study And Analysis of Green Concrete by Using Industrial Waste Materials as Sustainable Construction

Bakigari Udayasree[1*], Dr. G. Shravan Kumar[2]

[1,2]*PhD Scholar, Professor, Department of Civil Engineering, Sarvepalli Radhakrishnan University, Bhopal, M.P, India*

Abstracts: Presently, the problem is to transition to a new form that can sustain the natural system. This demand a new ideas of the community's methods for providing construction and infrastructure. Perhaps there is a need for a concerted effort to develop innovative and alternative novel construction materials. Industrial waste such as marble powder, quarry dust, and fly ash, among others, are used to reduce consumption of natural resources and energy as well as environmental pollution. By reusing industrial waste, we are able to reduce environmental impact and industrial waste disposal issues.in this analysis 7-day, 14-day, and 28-day compressive and split tensile tests were performed on the concrete mixtures that were then compared. In M25 concrete mix, 50% of the cement was substituted with fly ash, and the sand was completely replaced with 50% quarry dust and 50% marble powder. Cement is reduced by 15% to 25% when such waste is utilized. Green concrete is an efficient method for reducing environmental contamination and enhancing the extreme durability of concrete. This trend will remain during all stages of the construct-ability and rehabilitation of infrastructure. The versatility of green concrete and its performance derivatives will satisfy many future requirements.

Keywords: Green Concrete, Replacement Materials, Sulphate Attack, Alkali Aggregate Reaction, Durability Of Concrete, Environmental Effect

1. INTRODUCTION

At present,India actively participates in the construction of infrastructure including infrastructure projects, industrial construction, and express highways and bridges. This effort adapt to the demands of globalisation. Concrete, in significant quantities, is utilised in the construction of buildings and other structures. Due to the widespread use of the inexpensive and dependable material concrete in the infrastructure of residential, industrial, transportation, defence, and utility sectors, as well as in the construction and utility sectors, has become a substantial industry.Annually, India generates in excess of 170 million cubic meters of concrete. One-fourth of the economy is allocated to the construction industry. As industry expands, the proportion of refuse produced increases. Over seven percent of global CO2 emissions are produced by the concrete industry. Alternative techniques for producing cost-effective concrete materials are urgently required. Therefore, it is acknowledged that substantial enhancements in productivity, product performance, energy efficiency, and environmental performance are imperative for sustainable development[1].

"Green concrete" refers to concrete that is produced using Eco-friendly concrete refuse materials. Green concrete is concrete that is manufactured with the reduce amount of carbon emissions and from recycled materials as feasible. Green concrete is also known as structures that conserve resources and have a reduced environmental impact, such as in terms of energy consumption, CO2 emissions, and wastewater. The concept of "green concrete" is a groundbreaking development in the concrete industry's past. In 1998, this was initially devised in Denmark by Dr. WG. Slag, recycled concrete, power plant byproducts, glass byproducts, incinerator detritus, red dirt, charred clay, debris, fly ash, and foundry grit are all examples of concrete byproducts [2]. Green Concrete refers to concrete that has been treated with additional measures implemented during mix design and placement to guarantee a durable structure with a low-maintenance exterior over its life cycle, for instance. CO2 emissions, energy conservation, and wastewater. The Centre for Green Concrete is dedicated to the reduction of concrete's ecological footprint. In order to facilitate this, novel technological advancements are created. The technology encompasses every stage of the life cycle of a concrete structure, including structural design, specification, manufacturing, and maintenance, as well as every facet of performance [3].

2. OBJECTIVES OF THE STUDY

1. To reduce greenhouse gas emissions, i.e., carbon dioxide emissions from the cement industry.

2. To study & analyse the properties of green concrete strength and durability in comparison with standard concrete.

3. MATERIALS AND METHODOLOGY

3.1. Used Materials

1. Cement- According to is 8112-1989, ordinary portland cement (43 grade) with a specific surface area of 3300 cm2/g and a normal consistency of 28% is used [4].

2. Fine Aggregate - Sand with a medium size that passes through a 4.75 mm is sieve.

3. Course Aggregate- Regular continuous grading is applied, with crushed course aggregate going through a sieve with a size range of 5 to 20 mm. The specific gravity is 2.7 and there are less than 3% of elongated and flaky particles present.

4. Water- Potable, homogeneous tap water is used in the production of green concrete.

5. Fly Ash- The byproduct of burning powder coal for heat production is composed of 80% fly ash and 20% bottom ash. Fly ash, which is generated in power stations in India, possesses a slight to medium grey hue and resembles powdered cement. Fly ash concrete, when substituted for PCC, will not only result in significant energy and cement consumption savings, but it will also contribute to economic efficiency. The application of fly ash offers several benefits. Theoretically, fly ash can be used in lieu of Portland cement in the amount of 100%. However, beyond 80% replacement, a chemical activator is typically necessary. Research has indicated that an ideal replacement level is approximately 30%. Fly ash has the potential to enhance specific characteristics of concrete, including its durability. Because it produces less heat of hydration, it is ideally adapted for applications involving mass concrete. The optimal proportion of fly ash in concrete has numerous technical advantages and enhances the performance of fresh and hardened concrete. The incorporation of fly ash into concrete enhances the strength and longevity of cemented concrete, as well as the workability of plastic concrete. Fly ash generally enhances the performance of concrete by decreasing the amount of water needed for mixing and enhancing the flow characteristics of the paste.

6. Waste paper Pulp- Green concrete is made from waste paper pulp from the paper industry, marble powder from marble cutting and artistic items made of marble, and quarry dust from the mining sector. For every tone of recycled paper, over 300 kg of pulp waste are created [6]. Concrete mixes including residuals may be made to have the same slump and strength as a reference concrete without residuals by modifying the mixture to an analogous density. The major ingredients of pulp and paper mill residual solids are cellulose fibres, moisture, and fillers used in papermaking, primarily calcium carbonate or kaolinitic clay. Using the widely dispersed industrial wastes in civil building practises might result in a noticeable reduction in the contamination of the environment caused by waste from the manufacturing of paper and lime, as well as a genuine chance to save costs associated with civil construction.

7. Quarry Dust- Analysis the cost, workability, compressive strength, and cement content consumption of concrete built using quarry dust. When 40% of the sand in concrete is replaced with quarry dust, the modulus of rupture, split tensile strength, and compressive strength all significantly rise [7].

8. Marble Powder- One of India's most growing industries is the extraction of ornamental sedimentary carbonate rocks, often known as marble and granite. Heavy metals are included in marble waste powder, an industrial waste product. With 90% of the particles passing through 50 µm sieves and 50% falling beneath 7 µm, marble powder has a very high Blaine fineness value of around $1.5 m^2/g$ [8]. When compared to controls, specimens with 6% waste sludge showed the highest compressive and flexural strengths. Waste sludge up to 9% might be used as an addition in concrete with good results.

3.2 Methodology

3.2.1 Mix Percentage

The results of the mixing percentage of materials are shown in the following Table 1.

Table 1. Mixing Percentage of Materials

Materials	Mix 1 (Normal M20)	Mix2 (Using Marble Powder & Quarry Dust)	Mix 3 (By 10% replacement of cement with Paper Pulp)
Cement in kg	375.50	375.50	340.50
Fly Ash	0	190	380
Paper Pulp (% replaced)	0	0	10% (34.074kg)
Fine Aggregate (kg)	585.50	0	585.50
Course Aggregate (kg)	1209.80	1209.80	1209.80
Marble powder (kg)	0	290	0
Quarry Dust (kg)	0	290	0
Water in liters	185	185	185
Cement/Aggregate Ratio	0.25	0.25	0.19
C.A/F.A ratio	2.10	2.10	2.10

3.2.2 Test Analysis

The workability and consistency of fresh concrete is measured by slump test according to IS:1199- 1959[9].

- **Test Comparison with Normal Concrete**

Table 2. Test Comparison with Normal Concrete

Specification of concrete block	Slump in mm
Normal concrete	180
Green concrete	210

- **Test Comparison Hardened Concrete**

According to IS 516-1959 [10], test of compressive strength and split tensile strength were performed on hardened concrete

4. RESULT

4.1 Result of Compressive strength

The compressive strength of a variety of specimens was determined in accordance with the is 516-1959 standards. the specimens underwent surface drying prior to undergoing testing on a universal testing machine with a capacity of 200 kilogrammes. the findings of compressive tests conducted at three different dry curing ages -7 days, 14 days, and 28 days using industrial refuse as a 50% replacement for cement are detailed in Table 3 and Figure 1.

Table 3. Test Result of Compressive strength

Compressive strength (N/mm²)			
Days	7	14	28
Normal Concrete	21.8	24.92	27.11
	21.36	23.39	28.90
	20.49	24.28	28.12
Average	21.21	24.29	28.04
Green Concrete	19.73	20.53	23.12
	17.63	20.80	22.17
	17.65	20.20	23.79
Average	18.33	20.51	23.02

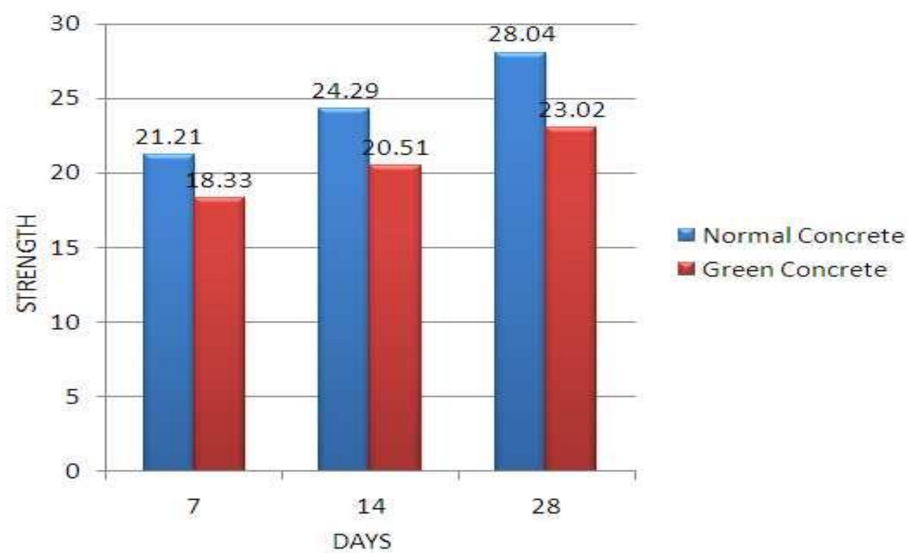

Figure 1. Graphical Analysis of Compressive strength

4.2 Result of Split Tensile Strength

The split tensile strength of several specimens was determined in accordance with the procedures outlined in IS-516-1959. The cylindrical specimens were evaluated at seven, fourteen, and twenty-eight days after they had been dried to the surface. The examination was performed using a Universal Testing Machine. The outcomes at curing ages of seven, fourteen, and twenty-eight days are shown in Table 4 and Figure 2.

Table 4. Test Result of Split Tensile Strength

Split Tensile Strength (N/mm²)			
Days	7	14	28
Normal Concrete	1.23	1.59	1.65
	1.14	1.24	1.66
	1.27	1.33	1.58
Average	1.21	1.38	1.63
Green Concrete	0.66	0.80	1.14
	0.65	0.84	1.20
	0.64	0.77	1.27
Average	0.65	0.80	1.20

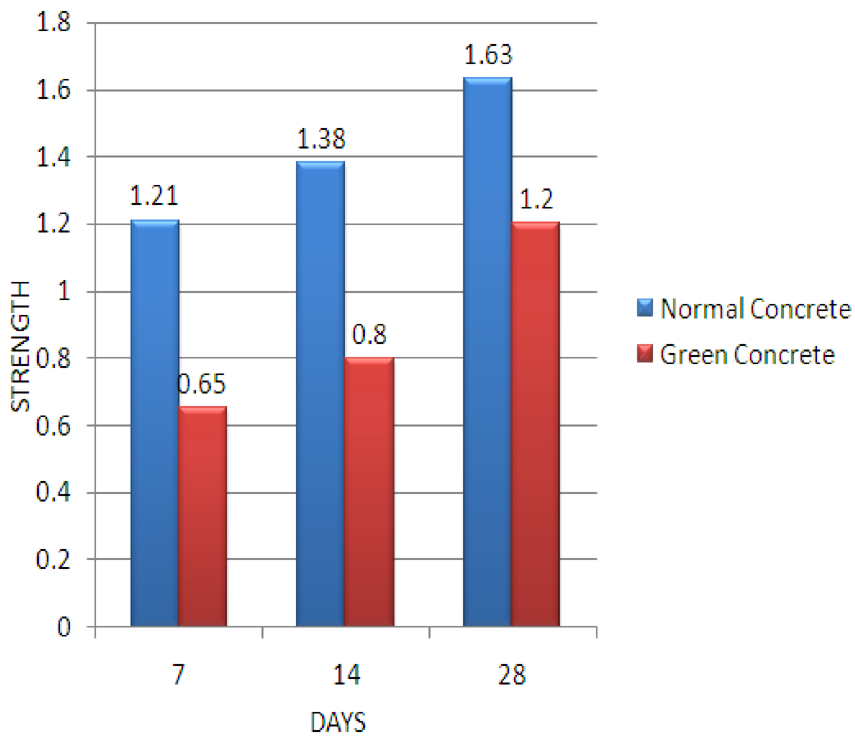

Figure 2. Graphical Analysis of Split Tensile Strength

CONCLUSIONS

1. Green concrete has a marginally greater capacity for water absorption than conventional concrete.

2. Green concrete's split tensile and compressive strengths are nearly identical to those of conventional concrete.

3. Replacing the entirety of the fine aggregates with a mixture of 50% marble powder and 50% quarry rock dust yields exceptional outcomes in terms of both strength and quality. Enhancing the marble particle content by over 50% results in an improvement in the workability

4. Green concrete improved workability.

5. Test results show that these industrial wastes are capable of improving hardened concrete performance. Green concrete enhancing fresh concrete behavior and can be used in architectural concrete mixtures containing white cement.

6. Permeability test results clearly demonstrate that the permeability of green concrete is less compared to that of conventional concrete.

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