JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Effect on Properties of Concrete with Carbon Black and Robo Sand as a Partial Replacement to Cement and Natural Sand

[1]Dhanaiyendran R, [2]Naresh Kumar R, [3]Rahul Gandhi M E, [4]Tamilmani T, [5]Tamizheniyan P

[1]Assistant Professor, [2]Student, [3]Student, [4]Student, [5]Student
[1]Department of Civil Engineering, [2]Department of Civil Engineering, [3]Department of Civil Engineering, [4]Department of Civil Engineering, [5]Department of Civil Engineering
[1]V.S.B Engineering College, Karur, Tamil Nadu, India, [2]V.S.B Engineering College, Karur, Tamil Nadu, India, [3]V.S.B Engineering College, Karur, Tamil Nadu, India, [4]V.S.B Engineering College, Karur, Tamil Nadu, India, [5]V.S.B Engineering College, Karur, Tamil Nadu, India,

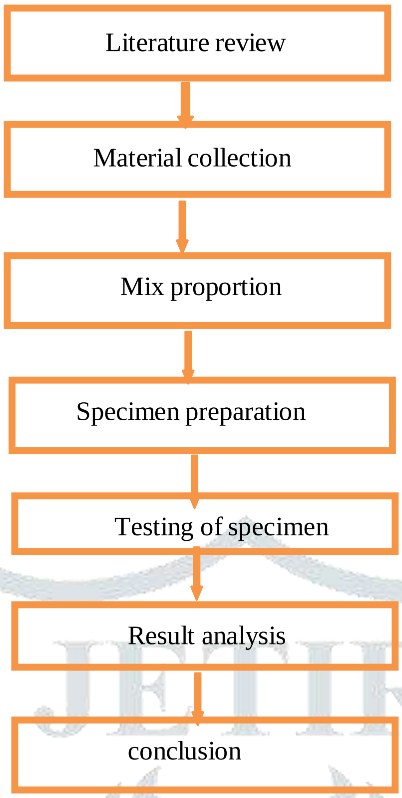
Abstract: The sustainability, strength and durability of any of the constituent materials of concrete play an important role in studying and determining the effects on the properties of concrete. Pores in concrete seem to be an immense problem ever since the concrete was discovered. The presence of pores can have negative consequences, including the attraction of water which can result in acid intrusion, freezing and thawing damage, reduced resistance to chloride ions, and decreased compressive strength, etc. Less permeability of concrete plays an important role in gaining strength and reducing the corrosion of reinforcement in concrete. In this paper, an examination is conducted on the characteristics of concrete by incorporating quarry dust (Robo sand) as a substitute for natural fine aggregate, along with the utilization of carbon black as a partial replacement material of cement in concrete by using different percentages of both materials. Experiments have been conducted by introducing carbon black in concrete which is a waste of the rubber industry to act as a filler and which imparts the enhanced properties of concrete. In this present experimental study, various properties of concrete have been studied using quarry dust (Robo sand, artificial sand, stone dust) as a replacement for natural fine aggregate and This study investigates the potential of carbon black as a replacement material for cement in concrete, exploring various combinations of both materials at different percentages. Eventually, the experimental investigation conducted between various percentages of mixes and compressive strength, split tensile strength and flexural strength have been evaluated.

***IndexTerms* – Carbon black, robo sand, compression strength test, split tensile test and flexural test.**

I. INTRODUCTION

Concrete, being the most widely used building material globally, has faced challenges due to the depletion of limestone reserves and the energy-intensive nature of cement production. River sand, traditionally a popular choice for fine aggregate in concrete, has raised environmental concerns and experienced scarcity, resulting in increased prices. Consequently, there is a need for affordable and environmentally friendly alternatives to both cement and river sand, preferably in the form of by-products. Robo sand has emerged as a promising substitute for river sand, offering additional advantages to concrete. While it enhances concrete strength compared to an equal amount of river sand, it does affect workability negatively. However, when fly ash and Robo sand are used together, it is possible to mitigate the loss in early strength caused by one component with the strength gain provided by the other. Similarly, the reduction in workability from one material can be partially offset by the improved workability resulting from the inclusion of the other material.

II. METHODOLOGY



III. MATERIALS USED

Cement

Cement commonly used is Portland cement. Cement is produced through the high-temperature combustion of a mixture containing calcareous and argillaceous materials. For this experimental work, Chettinad cement (brand name) 53 grade of ordinary Portland cement is used and its properties are listed. The cement samples were tested as per the procedure given in IS: 4031-1996 and IS: 4032-1999.

PROPERTIES	VALUE
Type of cement	OPC
Grade of cement used	G53
Specific gravity	3.14
Fineness	96%
Standard consistency	38%
Initial setting time	30 min
Final setting time	8 hours

Robo sand

Robo Sand is derived by crushing stones in a quarry to obtain the desired granular material. The sand used in concrete must have a proper gradation of 150 microns to 4.75 mm. The fineness modulus of Robo sand is 2.52. The uniformity coefficient is less than 6and its specific gravity is 2.66.

Pic:1Robo sand

Pic:2 carbon black

Carbon black

Carbon black is effectively pure carbon which is formed by incomplete burning/thermolysis of the compounds made up of hydrogen and carbon. The appearance of carbon black is a black, fine powder. It is an unwanted material obtained from the rubber manufacturing industries and hence it is difficult to dispose. Normally these wastes from rubber manufacturing industries are decomposed in the soil thereby causing soil contamination and pollution in water. By utilizing carbon black as filler, this problem can be reduced to a high degree.

Fine Aggregate

The most important function of the fine aggregate is to assist in producingworkability and uniformity in the mixture. In addition to its role in promoting plasticity and preventing the segregation of paste and coarse aggregate, the fine aggregate aids in suspending the coarse aggregate particles within the cement paste. This becomes especially significant when transporting the concrete over long distances from the mixing plant to the intended placement location. For the experimental work, locally available clean, well-graded, and manufactured sand was collected. The properties of the fine aggregate were assessed in accordance with the methods outlined in IS 383-1970.

PROPERTIES	VALUE
Type of aggregate	Natural Sand
Size of fine aggregate	4.75 mm
Specific gravity	2.73
Fineness modulus	4.5
Water absorption test	1.31%

Coarse Aggregate

Among the components of concrete, the coarse aggregate stands out as the strongest and exhibits the lowest porosity. It is a chemically stable material. The presence of coarse aggregate reduces the drying shrinkage and other dimensional changes occurring on account of the movement of moisture. Aggregates passing through a 20 mm sieve and retained on a 10 mm sieve are used as coarse aggregate. The crushed stone aggregate is collected from the local quarry and its properties are shown in the table.

PROPERTIES	VALUE
Size of coarse aggregate	20 mm
Fineness modulus	2.16
Specific gravity	2.47
Impact value	39.62%

Water

Water is an important ingredient of concrete, as it actively participates in the chemical reactions with cement to form the hydration product, calcium silicate hydrate (C-S-H) gel. A higher water-cement ratio (w/c) will decrease thestrength, durability, water tightness and other related properties of concrete. The addition of excess water ends up in the formation of undesirable voids (capillary pores) in the hardened cement paste of concrete. The PH value of water lies between 6 to 8 and it should be free from organic matter, acids, suspended solids, alkalis and impurities. Water sourced locally and meeting the specified standards outlined in IS: 456-2000 is used as the portable water supply.

IV. LABORATORY INVESTIGATIONS

PRELIMINARY INVESTIGATION

The testing of hardened concrete plays a crucial role in both quality control and verification of cement concrete works. Testing hardened concrete aims to ensure that the concrete employed on-site has achieved the designated strength criteria.

i. **Slump Cone Test**
ii. **Compaction Factor Test**

Percentage of replacement

Both carbon black and Robo sand were utilized as partial replacements in the concrete mix. Carbon black replaced cement at percentages of 8%, 16%, and 24%, while Robo sand served as a partial replacement for fine aggregate at percentages of 8%, 16%, and 24%.

Slump Cone Test

A Concrete slump test is one of the ways to check the quality and suitability of a mix, by ensuring the water-cement ratio is correct. Conducting a concrete slump test not only allows for the identification of any defects but also presents an opportunity to rectify them prior to pouring the concrete. It can be defined as the difference between the height of the concrete before removing the slump cone and the height of the concrete after removing of slump cone as measured during the concrete slump test.

% of replacement		Slump Value (mm)
Carbon black	Robo sand	
0		78
8	8	75
16	16	70
24	24	67

Compaction factor test

The compaction factor test is performed on a concrete mix to assess the ratio between its partially compacted weight and fully compacted weight. This test serves primarily to evaluate the workability of the concrete, particularly for mixes with low workability. Although initially intended for laboratory use, the compaction factor test can also be employed in the field. Due to its enhanced precision and sensitivity in comparison to the slump test, the compaction factor test proves especially advantageous for concrete mixes characterized by extremely low workability, commonly employed in vibration compaction techniques. The compaction factor apparatus is utilized to determine the compaction factor of concrete across various workability levels, ranging from low to medium and high.

% of replacement		Compaction factor
Carbon black	**Robo sand**	
0		0.92
8	8	0.91
16	16	0.86
24	24	0.83

Design mix

For the study, M20 grade with a nominal mix as per IS 456-2000 was used. The concrete mix proportion is 1: 1.5: 3 by weight and a water content ratio of 0.55 is taken.

Curing

The concrete surfaces are kept wet for 7 and 28 days after placing concrete, to promote the hardening of concrete it consists of a control of temperature and the moisture movement into the concrete the term curing of concrete is used to indicate all such procedures and processes.

Compressive strength test

Compression test is the most common test conducted on hardened concrete, partly because it is an easy test to perform, and partly because most ofthe desirable characteristics and properties of the qualitative characteristics of concrete are intricately linked to its compressive strength. The compression test is carried out for cube specimens asshown in fig. sometimes, the compression strength of concrete is determined using part of a beam tested in flexure. The end sections of the beam remain intact even after flexural failure, primarily due to the beam's typically square cross-section. The cube specimen is 150x150x150 mm if the largest nominal size of the aggregate does not exceed 20 mm. The calculation of compressive strength is performed through the utilization of an equation,

F=P/A in N/mm^2

Compressive test at 7 days

	Compressive strength N/mm^2		
%	Sample 1	Sample 2	Average
0	13.22	13.20	13.26
8	9.21	9.12	9.16
16	12.36	12.56	12.46
24	10.38	10.73	10.56

Compressive test at 28 days

	Compressive strength N/mm^2		
%	Sample 1	Sample 2	Average
0	13.94	20.78	20.34
8	18.12	18.35	18.24
16	20.16	20.43	20.29
24	19.38	19.36	19.62

Split tensile strength test

Tensile strength is a fundamental and significant property of concrete. Due to its low tensile strength and brittle nature, concrete is not typically relied upon to resist direct tension. Nonetheless, assessing the tensile strength of concrete is crucial in determining the load capacity at which concrete members may experience cracking, as cracking represents a form of tension failure.

F=2P/πLD in N/mm^2

Split tensile test at 7 days

	Split tensile strength N/mm^2		
%	Sample 1	Sample 2	Average
0	2.24	2.39	2.32
8	1.37	1.18	1.28
16	1.46	1.64	1.57
24	1.61	1.48	1.55

Split tensile test at 28 days

	Split tensile strength N/mm^2		
%	Sample 1	Sample 2	Average
0	2.63	2.84	2.73
8	1.33	1.64	1.49
16	2.59	2.34	2.17
24	2.12	2.22	2.17

Flexural strength test

The flexural strength test is conducted as per the IS: 519-1959 codal provisions. The flexural strength is also known as the modulus of rupture or fracture strength. It is a mechanical parameter for brittle material and is defined as a material's ability to resist deformation under load. Flexural strength signifies the maximum stress reached within a material at the point of rupture. When concrete undergoes bending, it generates tensile and compressive stresses in both bending and shear. It serves as a measure of the ability of an unreinforced concrete beam or slab to withstand failure under bending conditions.

$$f_{cr} = PL/BD^2 \text{ in mm}^2$$

flexural strength at 7 days

	Flexural strength test N/mm^2		
%	Sample 1	Sample 2	Average
0	1.69	2.05	1.88
8	1.19	1.03	1.11
16	1.53	1.47	1.49
24	1.46	1.25	1.36

flexural strength at 28 days

	Flexural strength test N/mm^2		
%	Sample 1	Sample 2	Average
0	2.67	2.95	2.8
8	1.19	1.03	1.61
16	2.33	2.71	2.52
24	2.43	2.18	2.31

V. CONCLUSION

It can be concluded that the strength of concrete an increases with increase in the percentages of Robo sand and carbon black content. The optimum compressive strength, split tensile strength and flexural strength have been achieved up to 16% of carbon black and 16% of Robo sand as a partial replacement in concrete. This is because when increase in Robo sand percentage, the pores in the concrete get blocked thereby increasing the compressive strength and in turn decreasing the permeability. Likewise, increase in the percentage of carbon black as a replacement to cement showed increases in the physical properties of concrete. Moreover, replacing carbon black and Robo sand in concrete will not only provide strength to concrete but also it will help in waste management, thereby decreasing environment pollution and groundwater contaminants. Hence both wastes will be managed effectively.

VI. REFERENCE

[1] The study conducted by M. Shahul Hameed and A.S.S. Sekar on the properties of green concrete incorporating quarry rock dust and marble sludge powder as fine aggregate was published in the June 2009 issue of Volume 4 of the ARPN Journal of Engineering and Applied Sciences.

[2] The research conducted by M.H. S. Yousef and M. Al Nassar focuses on the impact of carbon powder addition on the properties of hematite radiation shielding concrete. This study is documented in pages 388 to 392 of the publication from 2011.

[3] The paper titled "Carbon Black as an Additive in Conventional Concrete" authored by Dr. Chitra, P. Vetri Selvi, and Dr. D. Vijayalakshmi was published in the February 2014 Special Issue 3 of the International Journal of Emerging Technology and Advanced Engineering, Volume 4.

[4] Sami Masadeh The Effect of Added Carbon Black to Concrete Mix on Corrosion of Steel in Concrete Journal of Minerals and Materials Characterization and Engineering, vol. 3, pp. 271-276, July 2015.

[5] Padma and Pandeeswari (2016) "Experimental Investigation on the Properties of Concrete with Carbon Black and PET" International Journal of Advanced Research (2016) Volume 4, Issue 4, 1082-1088.