AN EXPERIMENTAL STUDY ON MECHANICAL PROPERTIES OF BLENDED CEMENT CONCRETE

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Abstract

Blended cement are now being considered superior as compared to conventional OPC category of cement. The partial replacements of cement with combination of admixture such as Fly Ash, Silica Fume and quarry dust are used for making blended cement concrete. This fly ash, silica Fume and quarry dust which is released directly into environment can cause environmental pollution. By using corrosion Inhibitor with correct proportion and proper curing it reduces the corrosion rate. The various mix proportion used for test are 0% (conventional), 5%, 10% and 15% replacement of cement with combination of fly ash , silica fume and quarry dust. The mechanical properties of conventional cement concrete in R.C structures are studied. The mechanical properties and corrosion rate of blended cement concrete in R.C structures are going to study. The mechanical property and corrosion rate of blended cement concrete are going to compared with conventional concrete.

Keywords*— *Blended Cement, Fly Ash, Corrosion Inhibitor, Quarry Dust, Silica Fume.

1. Introduction

In recent years, many researchers have established that the use of supplementary Cementitious materials (SCMs) like fly ash (FA), silica fume, Metakaolin (MK), and rice husk ash (RHS),quarry dust(QD), hypo sludge etc. can, not only improve the various properties of concrete - both in its fresh and hardened states, but also can contribute to economy in construction costs.

Presently large amounts of fly ash are generated in thermal industries with an important impact on environment and humans. Leaving waste materials in to environment directly results to damage

of natural climatic conditions, hence use of waste materials is made at most importance in present study. Silica fume is a by- product in the production of silicon alloys such as ferro-chromium, ferro-manganese, calcium silicon etc. which also creates environmental pollution and health hazard. Silica fume concrete may be appropriate in places where high abrasion resistance and low permeability are of utmost importance or where very high cohesive mixes are required to avoid segregation and bleeding. Quarry dust a waste from the stone crushing unit accounts 25% of the final product from stone crushing unit. To reduce the impact of the quarry dust on environment and human, this waste can be used to produce new products or can be used as admixture in concrete so that the natural resources are used efficiently and hence environmental waste can be reduced.

The addition of corrosion inhibitor to concrete can increase the protection of the steel. A corrosion inhibitor is a chemical compound added to concrete, to delay corrosion of the steel. This study analyses the performance of the commercially available organic inhibitor on its corrosion control ability and its influence on concrete strength properties.

1.1 Objectives

1) To determine the mechanical properties of conventional and blended cement concrete in R.C structures
2) To compare results of the mechanical properties of conventional and blended cement concrete in R.C structures
3) To determine the corrosion rate of conventional and blended cement concrete with and without corrosion inhibitors.
4) To compare results of the corrosion rate of conventional and blended cement concrete with and without corrosion inhibitors.

2. Materials

2.1 Cement

The cement is a binding material. Conforming to IS456-2000-53 grade.

2.2 Fly Ash

Fly ash is composed of the non-combustible mineral portion of coal. Particles are glassy, spherical 'ball bearings' finer than cement particles. Sizes of particle are 0.1µm-150 µm. it is a pozzolonic material which reacts with free lime in the presence of water, converted into calcium silicate hydrate (C-S-H) which is the strongest and durable portion of the paste in concrete.

2.3 Quarry Dust

Quarry dust is collected from stone crushing units of Lakshmi Mills village, Tiruppur, Tamil Nadu.It was initially dry in condition when collected and was initially dry in condition when collected and was sieved by IS: 90 micron sieve before mixing in concrete.

2.4 Fine Aggregate

The materials smaller than 4.75mm size is called fine aggregates. Natural sand is generally used as fine aggregate. Conforming to grading zone-III of table 3 of IS: 10262-2009.

2.5 Coarse Aggregate

Coarse aggregate obtained from local quarry processing units has been used for this study.

2.6 Water

Ordinary potable tap water available in laboratory was used for mixing and curing of concrete.

2.7 Admixture

Commercially available Super-plasticiser has been used to enhance the workability of fresh concrete for selected proportions of ingredients.

2.8 Steel

High yield strength cold twisted deformed bar of Fe 415 graded conforming to IS 1786 has been used.

2.9 Corrosion Inhibitor

Now-a-days, Calcium/sodium nitrites, sodium tetra borate, sodium benzoate, zinc borate are some of the inorganic inhibitors used in concrete. The amount of inhibitor added normally is in the range 10 – 15 ml/m3 of concrete. According to NACE (National Association of Corrosion Engineers) inhibitors are substances which when added to an environment decrease the rate of attack on a metal

A corrosion inhibitor is an admixture that is used in concrete to reduce the corrosion of rebar. Both organic and inorganic type of inhibitors is widely used in concrete. This has been considered as one of the most cost-effective solutions to the wide spread corrosion problem due to their convenient and economical application to both new structures and repair of existing buildings.

3. Mix design procedure

In present study M40 grade concrete was designed as per IS: 10262-2009. The weight ratio of mix proportion is 1: 1.96: 3.78 keeping water cement ratio 0.4. It was proposed to investigate the properties of concrete, cast and cured in water. In this experimental work, physical properties of materials used in the experimental work were determined. M40 grade of reference concrete was mixed and cured in potable water.

Table 1 Mix Proportion For Conventional concrete

Cement	Fine Aggregate	Coarse Aggregate	W/C
1	1.96	3.78	0.4
350Kg/m^3	687.42 Kg/m^3	1321.9 Kg/m^3	140 Kg/m^3

Table 2 Quantity for mix proportion of partial replacement of cement in concrete

Cement Kg/m^3	Silica fume Kg/m^3	Fly ash Kg/m^3	Quarry dust Kg/m^3	Fine aggregate Kg/m^3	Coarse aggregate Kg/m^3	w/c Kg/m^3
332.5	5.83.	5.83	5.83	687.42	1321.9	140
315	11.6	11.6	11.6	687.42	1321.9	140
297.5	17.5	17.5	17.5	687.42	1321.9	140

4. Experimental Details

4.1Compressive strength test

Compressive strength is one of the important properties of concrete. Concrete cubes of size 150 x150x150mm where cast without adding of Corrosion Inhibitor. After 24 hrs the specimen were de moulded and subjected to water curing. After 7, and 28 days of curing three cubes were taken and allowed to dry and tested in compression machine. The ultimate load at which the cubes failed was noted.

Compressive strength= $Ultimate\ load/_{Area}$

4.2 Spilt tensile strength test

Standard metallic cylinder moulds (150 x 300 mm) are casted After 24 hours the moulds were de moulded and subjected to water curing. Before testing the cubes were air dried for 2 hours. Crushing loads, split tensile strength, flexural strength were noted and average of 6 specimens was determined at 7days and 28days. The ultimate load of the specimen is at which the cylinder failed and the stress value is obtained in N/mm².

Tensile stress (N/mm²) =2P / Πdl

P is the ultimate load at which the cylinder fails.

D is the diameter of the cylinder

L is the length of the cylinder

4.3 Flexural strength test

Concrete is relatively strong in compression and weak in tension. Direct measurement of tensile strength of concrete is difficult. Concrete beams of size 100 x 100 x 500 mm are found to be dependable to measure flexural strength property of concrete. The systems of loading used in finding out flexural strength are central point loading and third point loading. The testing machine may be of any reliable type of sufficient capacity for the tests and capable of applying the load at the rate specified.

Flexural strength =$\frac{pl}{bd^2}$

p is the ultimate load at which the beam fails.

d is the diameter of the beam

b is width of beam

5. Results of conventional concrete specimens

5.1Compressive strength test

Compressive strength of all the 6 cubes are tabulated below

Table3 Compressive strength test results

Sl. No	Specimens	Compressive strength at 7 days	Compressive strength at 28 days
1	Cube 1	28.53	42.53
2	Cube 2	27.82	42.16
3	Cube 3	28.64	42.65
Average		28.33	42.43

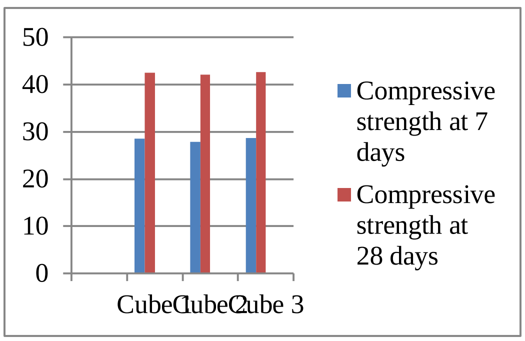

Figure 1 compressive strength of conventional concrete at 7 days & 28 days

5.2 Spilt tensile strength test

Spilt tensile strength of all the 6 cylinders are tabulated below

Table 4 Spilt Tensile strength test results

Sl. No	Specimens	Spilt tensile strength at 7 days	Spilt tensile strength at 28 days
1	Cylinder 1	3.21	5.38
2	Cylinder 2	3.18	5.41
3	Cylinder 3	3.23	5.43
Average		3.21	5.41

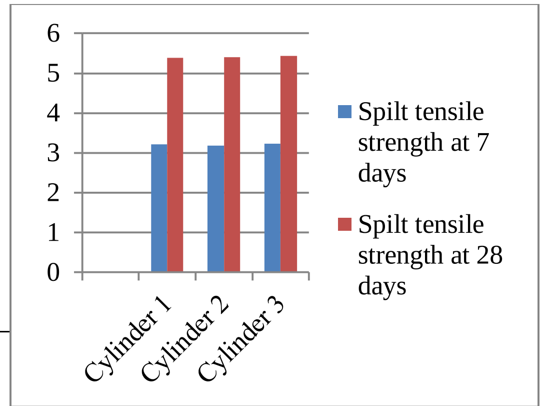

Figure 2 split tensile strength of conventional concrete at 7 days & 28 days

5.3 Flexural strength test

Flexural strength of all the 6 beams are tabulated below

Table 5 Flexural strength test results

Sl. No	Specimens	Flexural strength at 7 days	Flexural strength at 28 days
1	Prism 1	4.98	6.69
2	Prism 2	4.95	6.65
3	Prism 3	4.92	6.68
Average		4.95	6.67

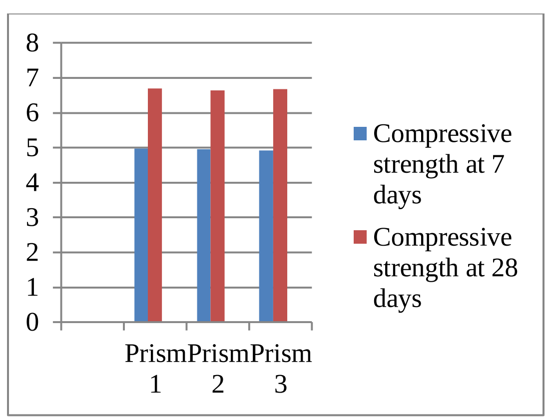

Figure 3 Flexural strength of conventional concrete at 7 days & 28 day

6. Conclusion

- The properties of the cement fly ash, silica fume and quarry dusts are determined and compared in this paper.
- The replacement materials are said to have similar material properties as that of the cement and can be used as a replacement for cement
- The conventional concrete is casted and the strength values are represented in this experimental work

7. Works to be done

- Replacement of cement with combination of fly ash , silica fume and quarry dust to determine their mechanical properties
- Casting of reinforced concrete beams to determine their rate of corrosion with and without corrosion inhibitor.

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