EFFECT OF BACTERIA ON PARTIAL REPLACEMENT OF CONCRETE WITH FLY-ASH AND GGBS

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Abstract

The responsibility of the construction industry is not only to provide quality construction but also to provide a clean environment. With the rapid industrialization and urbanization, the generation of industrial by-product is also increasing very rapidly. This is not only pollutes the environment but also creates disposal problems. This paper gives information about the research carried out on cement with a partial replacement with fly ash and GGBS with bacteria in the mix giving great results and being highly sustainable and eco-friendly. From the results of the investigation, it has been observed that, the performance of blended cement concrete is better than that of the conventional concrete.

Keywords: *Bacillus pasteurii, compressive strength, flexural strength, and Bio-calcification.*

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1. INTRODUCTION

1.1 Cement

Cement concrete is one of the most widely used construction material by mankind and it is the main material used for the infrastructure development of every country. Cement is a binder, a substance that sets and hardens independently, and can bind other materials together. Cement is generally graded according to a few set of specifications defined (those defined to IS 650:1996) which differentiate the various grades of cements. The most important factor considered for cement grading is the average compressing strength of the material in a given particular amount of time over a particular area in a particular composition of the cement mortar mixture. The cement used for this research is 43 grade ordinary Portland cement (OPC).

1.2 Bacteria

Bacteria are relatively simple, single celled organisms. The bacteria used were Bacillus pasteurii. It is a bacterium with the ability to precipitate calcium carbonate in the presence of any carbonate source [1]. The bacterium is used in this project for the same and for the improvement in the strengths of the concrete test specimens were observed. The microbes are a bacillus species and are completely not harmful to human beings. They precipitate inorganic crystals hence the healing of the cracks takes place in the concrete and it can withstand any temperature conditions.

1.3 Fly ash

The finely divided residue resulting from the combustion of ground or powdered coal, which is transported from the firebox through the boiler by flue gases". Fly ashes are generally finer than cement and consist mainly of glassy-spherical particles as well as residues of hematite and magnetite, char, and some crystalline phases formed during cooling. Use of fly ash in concrete started first in the United States in the early 1930's. Fly ash closely resembles volcanic ashes used in production of the earliest known hydraulic cements about 2,300 years ago. Those cements were made near the small Italian town of Pozzuoli - which later gave its name to the term "pozzolan." A pozzolan is a siliceous or siliceous / aluminous material that, when mixed with lime and water, forms a cementitious compound. Fly ash is the best known, and one of the most commonly used, pozzolans in the world.

1.4 Ground Granulated Blast Furnace Slag (GGBS)

Ground granulated blast furnace slag (GGBS) hardens very slowly and, for use in concrete, it needs to be activated by combining it with Portland cement. A typical combination is 50 per cent GGBS with 50 per cent Portland cement, but percentages of GGBS anywhere between 20 and 80 per cent are commonly used. The greater the percentage of GGBS, the greater will be the effect on concrete properties.

1.5 Calcification

Bacterial concrete, as the name suggest is an improvisation provided to cement using living microbes which are capable of doing so. Using microbes such as Bacillus pasteurii which as properties of bio calcification can secrete calcium carbonate as an extracellular product thus filling the pores and the cracks internally making the structure more compact and resistive to seepage. As the texture becomes more compact the compressive strength is also considerably increased. Thus, this process can reduce the seepage considerably permanently [2].

2. PROCEDURE

2.1 Preparation of Bacterial Solution

Primarily 12.5g of Nutrient broth (media) is added to a 500ml conical flask containing distilled water. It is then covered with a thick cotton plug and is made air tight with paper and rubber band. It is then sterilized using a cooker for about 10-20 minutes. Now the solution is free from any contaminants and the solution is clear orange in colour before the addition of the bacteria. Later the flasks are opened up and an exactly 1ml of the bacterium is added to the sterilized flask and is kept in a shaker at a speed of 150-200 rpm overnight. After 24 hours the bacterial solution was found to be whitish yellow turbid solution [4].

2.2 Compression Strength Test

The cubical Moulds of size 150mm x 150mm x 150mm were cleaned and checked against the joint movement. A coat of oil was applied on the inner surface of the Moulds and kept ready for the concreting operation. Meanwhile the required quantities if cement, fly ash and GGBS along with fine aggregate and coarse for the particular mix are weighed accurately for concreting The wet concrete is now poured into the Moulds and for every one third layers the mix in the Moulds is compacted manually they were tested for 14 and 28 day strengths in a compressive strength testing machine [3].

2.3 Flexural Strength Test

Moulds of 10cm x 10cm x 50cm is used and the Moulds are cleaned and the joints between the sections of Moulds shall be thinly coated with Moulds oil and a similar coating of Moulds oil shall be applied between the contact surfaces of the bottom of the Moulds and the base plate in order to ensure that no water escapes during the filling. The interior faces of the assembled Moulds shall be thinly coated with Moulds oil to prevent adhesion of the concrete. Meanwhile the required quantities of cement, fly ash, GGBS, fine aggregate and corresponding coarse aggregate for the particular mix are weighed accurately for concreting. After concreting operations, the upper surface is leveled and finished with a mason’s trowel. The corresponding identification marks were labeled over the finished surface and the beams were tested for 14 and 28 days strengths.

3. RESULTS AND ANALYSIS

The test results showed a significant difference in the specimens tested, with bacteria along with partial replacement of cement of about 30% with fly ash and GGBS. Here are the following tables and charts which will give clear information about the compression, split tensile and flexural strength test results. The tests were carried over for 14 and 28 days.

Table -1: compressive strength test results for 14 and 28 days

SI.NO	Days	30%flyash+70% cement (N/mm2)	30%GGBS+70% cement (N/mm2)
1	14	25.174	26.05
2	28	34.59	37.49

Table -2: flexural strength test results for 14 and 28 days

SI.NO	Days	30%flyash+70% cement (N/mm2)	30%GGBS+70%cement (N/mm2)
1	14	4.31	4.508
2	28	7.06	7.32

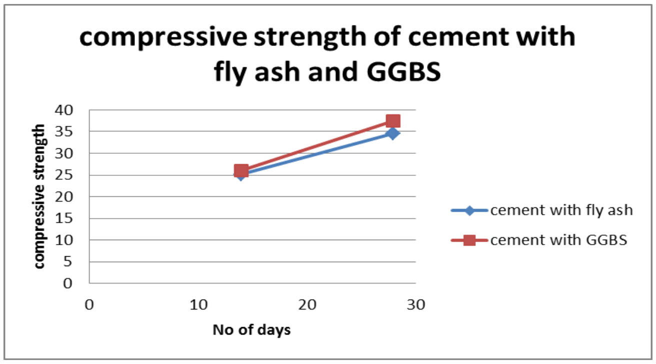

Chart -1: compressive strength test results for 14 and 28 days.

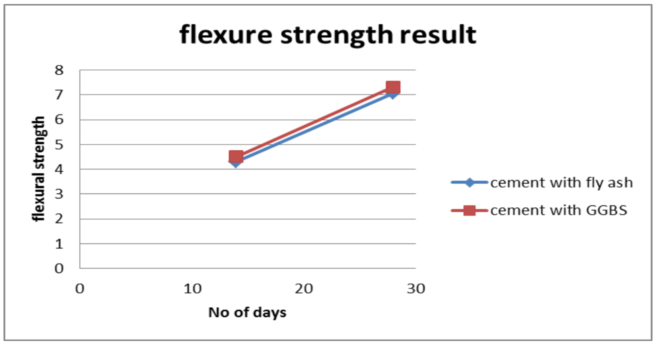

Chart -2: flexural strength test results for 14 and 28 days.

4. CONCLUSIONS

The results show that the effect of bacteria has really worked out as it is giving great strength [5] and as it is eco-friendly it is a very good material and is safe to use as it is totally harmless to living beings. This concrete can be used to prevent cracks and hence saving the structure from corrosion of steel.

Fig -1: Crack healing in the specimen with bacteria.

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