IJournals: International Journal of Software & Hardware Research in Engineering
ISSN-2347-4890
Volume 4 Issue 10 October, 2016

Experimental Investigation on Strength Characteristics of Fly Ash as Partial Replacement of Cement for M-20 grade of Concrete

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ABSTRACT: The development of concrete technology can decrease the use of natural resources and energy sources and lessen the burden of pollutants on environment. The research of this paper carried out to study the consumption of fly ash in cement concrete as a partial replacement of cement as well as a preservative so as to provide an environmentally consistent way of its disposal and reuse. In this paper we study the behavior of M20 grade of concrete having mix proportion of 1:1.5:3 of cement, sand, aggregate with water-cement ratio of 0.45 and determine the compressive and split tensile strength of concrete at 7, 14 & 28 days when cement was replaced with four percentage of class C Fly-ash that is 2.5%, 5%, 10% and 20%. All the tests are performed according to bureau of Indian standard. The result obtained were compared and examined with respect to standard specimen of M20 grade of concrete. Test results indicate that use of fly ash in concrete has improved the performance of concrete in strength. The optimum percentage of adding fly ash was determined to be 10% & 20% which showed the maximum improvement in Split tensile and Compressive strength.

Key Words: Fly Ash, compressive Strength, Split Tensile Strength, W/C Ratio

1. Introduction

Concrete is a most commonly used building material which is a mixture of cement, sand, coarse aggregate and water. It is used for construction of multi-storey buildings, dams, road pavement, tanks, offshore structures, canal lining. The method of selecting appropriate ingredients of concrete and determining their relative amount with the intention of producing a concrete of the necessary strength durability and workability as efficiently as possible is termed the concrete mix design. The compressive strength of harden concrete is commonly considered to be an index of its extra properties depends upon a lot of factors e.g. worth and amount of cement water and aggregates batching and mixing placing compaction and curing. The cost of concrete prepared by the cost of materials plant and labour the variation in the cost of material begin from the information that the cement is numerous times costly than the aggregates thus the intent is to produce a mix as feasible from the practical point of view the rich mixes may lead to

high shrinkage and crack in the structural concrete and to development of high heat of hydration is mass concrete which may cause cracking. The genuine cost of concrete is related to cost of materials essential for produce a minimum mean strength called characteristic strength that is specific by designer of the structures. This depends on the quality control measures but there is no doubt that quality control add to the cost of concrete. The level of quality control is often an inexpensive cooperation and depends on the size and type of job nowadays engineers and scientists are trying to enhance the strength of concrete by adding the several other economical and waste material as a partial substitute of cement or as a admixture fly ash, silica fume, steel slag etc are the few examples of these types of materials. These materials are generally by-product from further industries for example fly ash is a waste product from power plants and silica fume is a by-product resulting from decrease of high purity quartz by coal or coke and wood chips in an electric arc furnace during production of silicon metal or ferrosilicon alloys. Now days In India, large amount of fly-ash is generated in thermal power plants with an imperative blow on environmental and living organism. The use of fly-ash in concrete can decrease the utilization of natural resources and also diminishes the consequence of pollutant in environment. In current studies, many researchers found that the use of additional cementitious materials like fly-ash in concrete is economical and reliable. Fly-ash is one of the residues generated in the combustion of coal. In the past, fly-ash was generally released into the atmosphere via the smoke stack, but pollution control equipment mandated in recent decades now require that it be captured prior to release. Therefore Fly ash is used in large amount because it enhances the property of concrete. The use of fly ash as a material has enhanced in recent years because when mixed in definite proportions it improves the properties of both fresh and hard concrete like durability, strength, permeability and compressive strength, flexural strength and tensile strength.

2. Object of Study

In the present Experimental Investigation the following are the main objectives.

1. Comparative study of the behavior of the concrete with & without fly ash.
2. To determine the compressive strength and split tensile strength of the fly ash.
3. To study the behavior of concrete using fly ash, in strength enhancement
4. To find the optimum percentage of fly ash for obtaining the maximum strength of concrete.

3. Materials & Methodology

3.1 Materials:

3.1.1 Cement: Ordinary Portland cement (OPC) Of 53 grades satisfying the requirements of IS: 8112-1939 is used. The specific gravity of cement was found to be 3.0.

3.1.2. Fine Aggregates*:* Sand is the main component grading zone-II of IS: 383-1978 was used with specific gravity of 2.62 and water absorption of 1.8% at 24 hours.

3.1.3. Coarse Aggregates: Mechanically crushed stone of 20mm maximum size, satisfying to IS: 383-1978 was used. The specific gravity was found to be

2.62 and 2.64 and water absorption is 0.16% and 0.18% at 24 hours of 20mm aggregates respectively.

3.1.4 Class C Fly Ash: Fly ash produced from the burning of younger lignite or sub-bituminous coal, in addition to having pozzolanic properties, also has some self-cementing properties. In the presence of water, Class C fly ash will harden and gain strength over time. Class C fly ash generally contains more than 20% lime (CaO). Unlike Class F, self-cementing Class C fly ash does not require an activator. Alkali and sulfate (SO4) contents are generally higher in Class C fly ashes. In addition to economic and ecological benefits, the use of fly ash in concrete improves its workability, reduces segregation, bleeding, heat evolution and permeability, inhibits alkali-aggregate reaction, and enhances sulfate resistance. Even though the use of fly ash in concrete has increased in the last 20 years, less than 20% of the fly ash collected was used in the cement and concrete industries. One of the most important fields of application for fly ash is PCC pavement, where a large quantity of concrete is used and economy is an important factor in concrete pavement construction.

3.2 Methodology:

3.2.1 Compressive Strength Test: In this study, a total number of 45 cubes for the control and cement replacement levels of 2.5%, 5%, 10% and 20% were produced respectively. For the compressive strength, 150mm x 150mm x 150mm cubes mould were used to cast the cubes and 3 specimens were tested for each age in a particular mix (i.e. the cubes were crushed at 7, 14 & 28 days). All freshly cast specimens were left in the moulds for 24 hours before being de – moulded and then submerged in water for curing until the time of testing.

3.2.2 Split Tensile Strength:

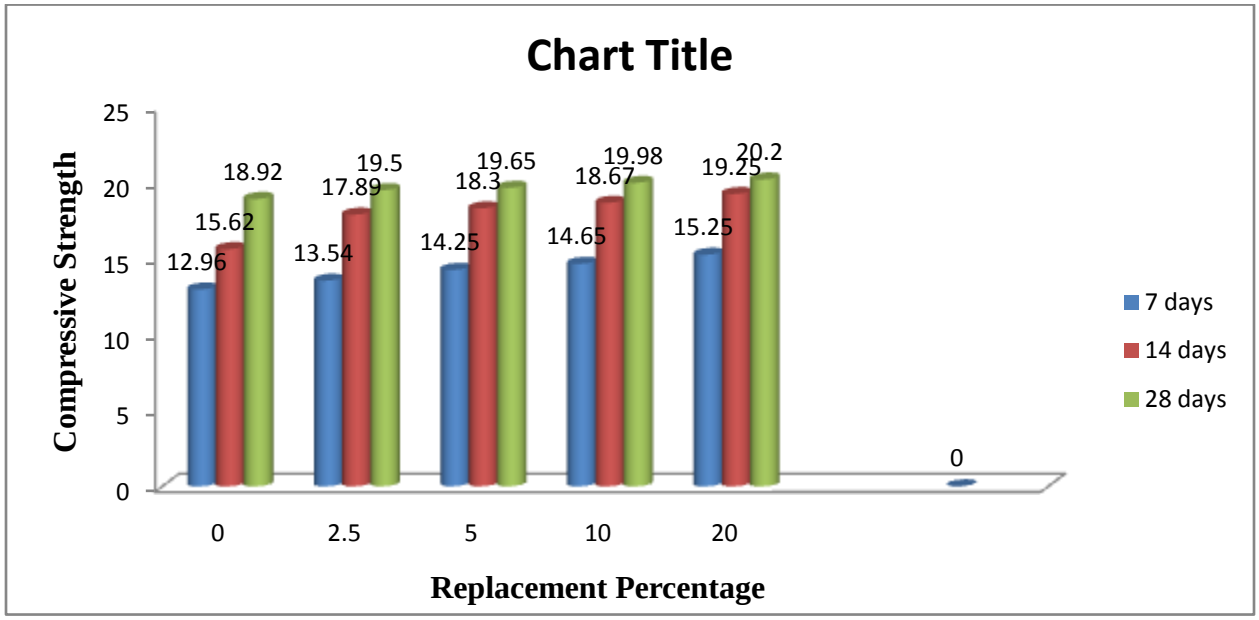
Cylinders of size 15 cm diameter and 30 cm height are casted for determining Split Tensile Strength. Test on cylinders are performed at the age of 7, 14 & 28 days of the specimen. Placement of specimen in machine is done as per IS: 516-1959. Load is applied until specimen fails and load at which specimen fails is recorded. As specified in the IS code Split Tensile Strength is calculated and tabulated below:-

4. Result

4.1 Compressive Strength Test:

Table 4.1(A) Compressive Strength Result

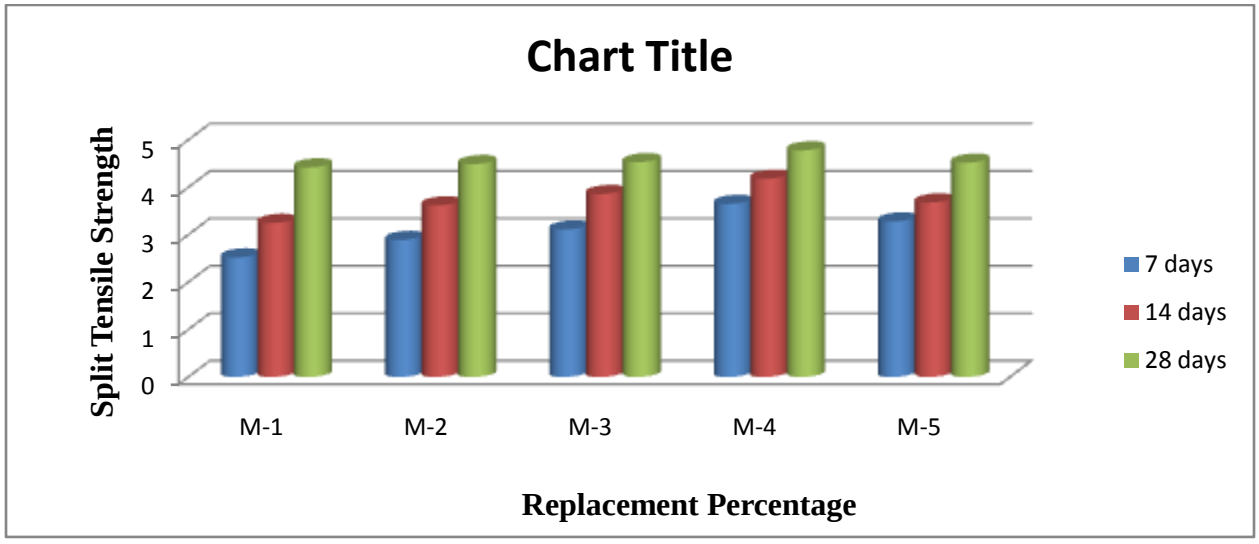
% Replacement	Compressive Strength (N/mm^2)		
	7 days	14 days	28 days
0	12.96	15.62	18.92
2.5	13.54	17.89	19.5
5	14.25	18.30	19.65
10	14.65	18.67	19.98
20	15.25	19.25	20.20



4.2 Split Tensile Strength Test:

Table 4.2(B) Split Tensile Strength

% Replacement	Split Tensile Strength (N/mm^2)		
	7 days	14 days	28 days
0	2.52	3.25	4.42
2.5	2.89	3.62	4.49
5	3.11	3.86	4.53
10	3.65	4.18	4.78
20	3.28	3.68	4.52



5. Conclusion

After performing all the tests and analyzing their result, the following conclusions have been derived:

1. The results achieved from the existing study shows that fly ash are great potential for the utilization in concrete as replacement of cement.
2. Workability of concrete decreases as proportion of fly ash increases.
3. Maximum compressive strength was observed when fly ash replacement is about 10%.
4. Maximum split tensile strength was observed when fly ash replacement is about 10%.

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