International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 04 | Apr 2019 www.irjet.net p-ISSN: 2395-0072

EXPERIMENTAL STUDY OF CONCRETE AS A PARTIAL REPLACEMENT OF CEMENT BY FLY ASH AND SILICA FUME

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Abstract - The use of Silica Fume and Fly Ash in the present days is to increase the strength of cement concrete. The Fly Ash was replaced by 0%, 5%, 10%, 15%, 20%, 25%, 30%, and 35% and Silica Fume was replaced by 15% common for all mixes as a partial replacement of cement for 7, 14 & 28 days for M20, M25 and M30 grade of concrete. Casted 150 mm X 150 mm X 150 mm cubes for Compressive strength, 100 mm X 100 mm X 500 mm beams for Flexural Strength, and Cylinder size 150 mm diameter and 300 mm height are casting for Split Tensile Strength and Slump cone for workability of concrete and other properties like compacting factor and slump were also determined for three mixes of concrete. The use of cement and production of cement creates much more environmental issues & costlier. To avoid such circumstances, the content of cement is reduced in concrete and replaced by silica fume which reduces cost & addition silica fume also increases strength. Concrete is the most widely used and versatile building material which is generally used to resist compressive forces. By addition of some pozzolanic materials, the various properties of concrete viz, workability, Strength, Resistance to cracks and permeability can be improved.

Key Words: Compressive Strength, Flexural Strength, Split Tensile Strength, Workability of Concrete, Fly Ash and Silica Fume.

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.

1.1 Sand

Sand is a naturally occurring coarse material collected of finely separated rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. Sand may also consign to a textural class of soil or soil type; i.e. a soil contain more than 85% sand-sized particle (by mass).

1.2 Cement

Ordinary Portland cement is used to prepare the mix design of M-20, M-40 and M-50 grade. The cement used was fresh and without any lumps water-cement ratio is 0.42 for this mix design using IS 456:2007.Cement is an extremely ground material having adhesive and cohesive properties which provide a binding medium for the discrete ingredients. Chemically cement constitutes 60-67% Lime (CaO), 17-25% Silica (SiO_2), 3-8% Alumina (Al_2O_3), 0.5-6% Iron Oxide (Fe_2O_3), 0.1-6% Magnesia (MgO), 1-3% Sulphur Trioxide (SO_3), 0.5-3% Soda And Potash (Na_2O+K_2O).

1.3 Aggregate

Aggregate are the essential constituent in concrete. They provide body to the concrete, decrease shrinkage and effect economy. Construction aggregate, or basically "Aggregate", is a wide group of coarse particulate material used in construction, as well as sand, gravel, crushed stone, slag, recycled concrete and geo-synthetic aggregates. Aggregates are the mainly mine material in the world.

1.4 Silica Fume

Silica Fume is a byproduct in the decrease of high-purity quartz with coke in electric arc furnaces in the manufacture of silicon and ferrosilicon alloys. Micro silica consist of fine particle with a surface area on the order of 215,280 ft^2/lb (20,000 m^2/kg) when precise by nitrogen adsorption techniques, with particle just about one hundredth the size of the average cement Because of its excessive fineness and high silica content, micro silica is a very efficient pozzolanic material particle.

1.5 Fly Ash

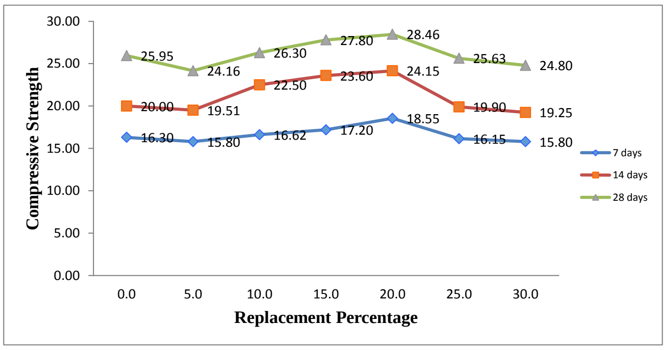
Fly ash is a group of materials that can vary significantly in composition. It is residue left from burning coal, which is collected on an electrostatic precipitator or in a baghouse. It mixes with flue gases that result when powdered coal is used to produce electric power. Since the oil crisis of the 1970s, the use of coal has increased. In 1992, 460 million metric tons of coal ash were produced worldwide

2. RESULT AND DISCUSSION

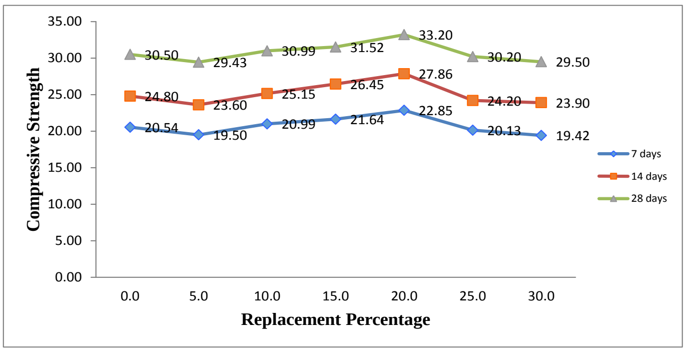
2.1 Compressive Strength Test Results

The results of the compressive strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The compressive strength test were conducted at curing ages of 7, 14, and 28, days. The compressive strength test results of all the mixes at different curing ages are given in Table 4.1. Variation of compressive strength of all the mixes cured at 7, 14, and 28, days are also shown in Graph 4.1, 4.2, & 4.3 shows the variation of compressive strength of concrete mixes w.r.t control mix (100%OPC+0%SF+0%FA) after 7, 14, and 28, days respectively.

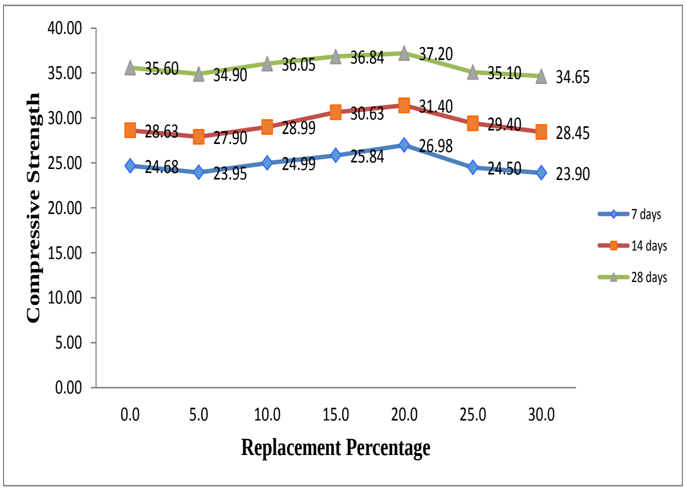
Graph: 2.1 Compressive Strength in N/mm² at various ages for M20



Graph: 2.2 Compressive Strength in N/mm² at various ages for M25



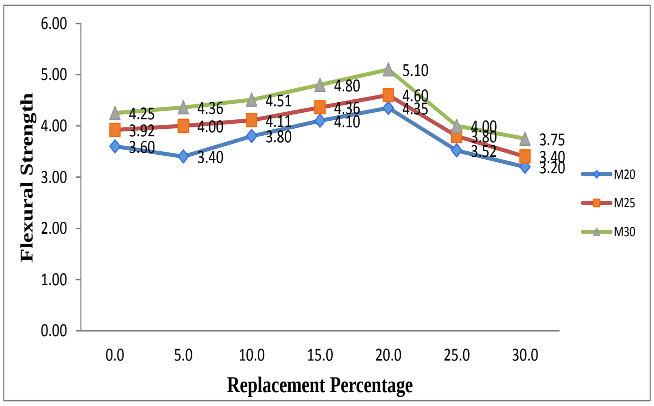
Graph: 2.3 Compressive Strength in N/mm² at various ages for M30



2.2 Split Tensile Strength Test Results

The results of the splitting tensile strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The splitting tensile strength test was conducted at curing ages of 28 days. The splitting tensile strength test results of all the mixes at different curing ages are shown in Table 4.3.Variation of splitting tensile strength of all the mixes cured at28 days is also shown in Fig. 4.2 shows the variation of splitting tensile strength of concrete mixes w.r Table 4.3 Splitting tensile strength (MPa) results of all mixes at different curing ages.

Graph: 2.4 Split Tensile Strength in N/mm² at 28 days

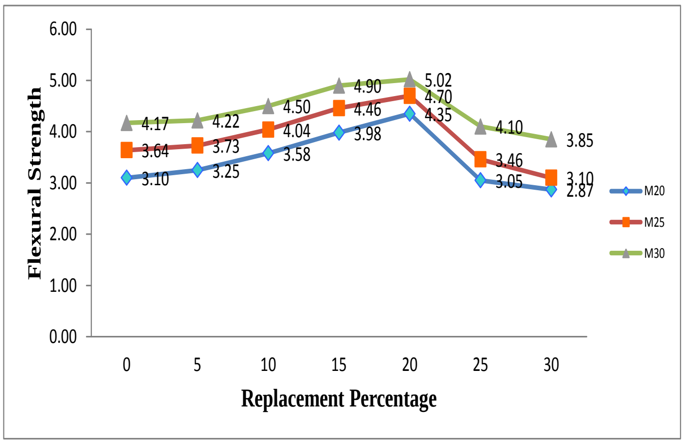


2.3 Flexural Strength Test Results

The results of the splitting tensile strength tests conducted on concrete specimens of different mixes cured at different ages are presented and discussed in this section. The splitting tensile strength test was conducted at curing ages of 28 days. The splitting tensile strength test results of all the mixes at different curing ages are shown in Table

4.3.Variation of splitting tensile strength of all the mixes cured at 28 days is also shown in Table 4.4. Graph 4.5, shows the variation of splitting tensile strength of concrete mixes w.r.t control mix (90%OPC+0%SF) after 28 days respectively.

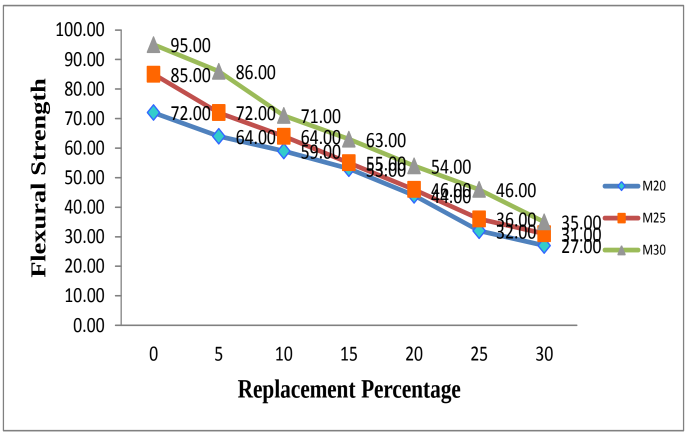
Graph 2.5 Flexural Strength in N/mm² at 28 Days



2.4 Workability of Concrete Mixes

The workability of concrete mixes was found out by slump test as per procedure given in chapter 3. Water cement ratio (W/b) was kept constant 0.5 for all the concrete mixes. The workability results of different concrete mixes were shown in below.

Graph 2.6 Slump (mm) at 28 days



3. CONCLUSIONS

Compressive strength, Flexural strength, and Split tensile strength of concrete Mixes made with and without Fly Ash and Silica Fume has been determined at 7, 14, & 28 days of curing. The strength gained has been determined of Fly Ash and Silica Fume added concrete with addition of 0%, 5%, 10%, 15%, 20%, 25% & 30% and 15% Fly Ash and Silica Fume added as a common for all replacement for M20, M25 and M30 grade as a partial replacement of cement in conventional concrete. From the results it is conclude that the Fly Ash and Silica Fume is a superior replacement of cement. The rate of strength increase in Fly Ash and Silica Fume concrete is high. 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 the combination ofFly Ash and Silica Fume are great potential for the utilization in concrete as replacement of cement.

2. Workability of concrete decreases as proportion ofFly Ash and Silica Fumes increases.

3. Maximum compressive strength was observed when Fly Ash and Silica Fume replacement is about 20% and 15% respectively.

4. Maximum split tensile strength was observed whenFly Ash and Silica Fume replacement are about 20% and 15% respectively.

5. Maximum flexural strength was observed whenFly Ash and Silica Fume replacement are about 20% and 15% respectively.

4. FUTURE SCOPE

From this research, there are few recommendations to develop, to extend and to explore the usage ofFly Ash and Silica Fume in concrete:

i.) Define the effect of Fly Ash and Silica Fume on concrete with the replacement of mixture of coarse and fine aggregate.

ii.) Define the effect of Fly ash on concrete with the replacement of mixture of coarse and fine aggregate.

ii.) Replacement of cement with Fly Ash and Silica Fume in different water cement ratio.

iii.) Selected few samples of concrete with different percentage of using Fly Ash and Silica Fume and conclude the most suitable percentage of usage to achieve the optimum compressive strength.

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