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A STUDY ON STEEL FIBER REINFORCED CONCRETE PARTIAL REPLACEMENT OF CEMENT BY FLYASH AND SILICA FUME

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ABSTRACT

The application of silica fume has great effects on industry and on silica fume production in routine and commercial applications but remains cohesive, resulting in an extremely strong early and later age, including resistant to aggressive surroundings. The silica fume production system is very resistant. This study analyzes the nature and the influence of silica fume on fresh concrete characteristics. The strength parameters of the concrete were investigated in the partial substitution of cement with silica fume. First, the strength parameters of concrete without partial substitution were studied; then the strength parameters were studied through partial substitution with silica fume, with the placing of cube and cylinder on a compression testing machine (CTM).

1. INTRODUCTION

1.1 GENERAL

The Portland cement concrete, enhanced with more or less randomly distributed fibres, is fiber reinforced cement (FRC). In FRC, thousands of small fibers are dispersed and randomly spread over concrete when mixed and therefore better concrete properties are achieved in any direction.

FRC is a material based on cement, which in recent years has been developed. With its excellent bending resistance, spitting resistance, resistance to impact, and excellent permeability and frost resistance, it was used in construction efficiently. It is a good way to resist plastic shrinkage of morter and increase resistance, shock and tension. Fiber is a small part of the reinforcement material with certain features. In a cross-section they can be circular, triangular or flat. A convenient parameter called the aspect ratio often describes the fire. The fiber's typical ratio is the ratio between its span and diameter. The main reason for the integration of fibers into a cement matrix is to increase the strength and tensile strength of the resulting compound and improve the cracking deformation characteristics. To be a viable building material for FRC, the existing reinforced system must be able to be complemented in a cheap way.

The plain cement has a very low tensile strength and limited ductility and there is natural resistance to cracking inner micro cracks in cement. The poor tensile strength of the concrete is due to the propagation of such micro cracks that result in a broken concrete fracture.

In the past, there have been attempts to impart the development of concrete parts' tensile properties through the use of conventional steel bars and the use of restricting techniques. Although both methods provide concrete components with tensile strength, they do not increase the inherent tensile strength of the concrete itself.

Even before loading, structural cracks (micro-cracks) develop in flat concrete and similar fragile materials primarily due to drying decreases or other volume changes. Smaller microns rarely exceed the breadth of these original cracks, but the other two sizes can be superior.

When micro-cracks are loaded and propagated, further cracks are created in places of minor defects, due the effect of the stress concentration.

Because they are deletergents by different obstacles, they proceed slowly or through tiny jumps. The growth of these micro cracks is the primary cause of concrete elastic deformations.

Additional small, closely spaced and evenly dispersed fibers into concrete were recognized to serve as a crack arrester and would significantly improve its static and dynamic characteristics. The reinforced cement type is known as fiber.

As an effective way to increase concrete performance, FRC is gaining concentration.

During batching and mixing, the fibers are added to the fresh concrete to ensure that they can be spread evenly across the concrete.

2. LITERATURE REVIEW

2.1. GENERAL

Some of the early research works used various pozzolanic materials to replace cement with super plasticizer to develop high-performing concrete. The development also includes mineral mixtures in the field of fibre-reinforced concrete. Therefore, under an overview of the various studies.

Aitkin [1] (1995) cited high-performance concrete development. The compressive strength of some used concrete has dramatically increased over the last few years. A concrete from 120 Mpa was delivered in 1998, while 40 Mpa was considered a sign of high strength until relatively recently. The spectacular increase in compressive force is directly linked to a number of recent techniques, in particular, the discovery that super-containing plasticizers are additionally normally dispersing with the same mixing water that is required to hydrate all or less of the cement particle. The decrease in water/cement ratio leads to the hydrated concrete paste with so dense and strong a micro structure that ground aggregates can become the weakest component of a concrete. The highly reactive pozzolana of silica fume significantly improves the paste/assembly interface and reduces deboning. Finally, the use of additional cemented materials, such as fly ash and slag, helps to overcome slump losses that are dangerous at low w/c levels.

In polish research on high-performance cement, Ajdukiewicz and Radomski[2] (2002) examine the trends. The main trends in high quality concrete (HPC) research in Poland have been analyzed. They saw examples of the investigations in question. E are briefly described as fundamental engineering and economic problems relating to the structural uses when in Poland HPC are presented and the requirements that justify the increased use of this material.

The durability of high performance concrete was studied by Aitkin[2](2003). He examined problems of durability of normal concrete, which can be connected with environmental seriousness and the use of high water-to-binding ratios. High efficiency concrete with a water-to-binding ratio from 0.30 to 0.40 is often more resilient than regular concrete not only since it is less porous, but also given that the self-draining maturity of its capillary and porous networks is sometimes separate. The infiltration of aggressive agents is very difficult and only superficial in high efficiency concrete (HPC). However, self-deseation can be very harmful if it is not banned in the early stage of hydration reaction development, therefore HPC needs to be cured from normal concrete in a rather different fashion. In North Sea and in Canada, field knowledge has demonstrated that the HPCs are adequately implemented in harsh environments, if properly designed and cured. The fire resistance of HPC is however not as good as normal concrete, but not as bad as sometimes written in a few negative reports. Betons, of any kind, are a safe material, in comparison with other building materials from a fire resistance perspective

The studied RHA use in concrete was by AI-khalaf and A. yousif (4) (1984). In order to produce the desired pozzolan products, the use of rice husk as the partial replacement for cement, was studied in the actual temperature range, using pressure force and volume changes in different mixtures. The result was that a replacement of up to 40 per cent without any significant compression change as compared to the organization mix can be completed. By testing cubes of 50 mm, he tested on the cube of morter. In his research, he also found that it was necessary to convert rice husk to a standard and well-branded ash at 5000 centimeters for 2 hours under the most convenient and cost efficient conditions.

3. MATERIALS AND METHODS

3.1. MATERIALS

Normal Portland Cement (53 grad), water, coarse aggregates and fine aggregate are the materials used in this investigation (sand, sag). Beton improvement has been achieved through the mixing of cements with cement admixes such as the Fly Ash (FA), granulated blast furnace slag in recent years (GBFS). The incorporation in concrete mixes of these materials improves the strength of the concrete. Therefore, there is a significant reduction in the movement into concrete of aggressive substances like chloride ions and carbon dioxide which are the main cause of the deterioration of concrete structures affecting their integrity and their long life. Concrete deterioration is not only due to aggressive agents, but is mainly due to the overall quality of the concrete. Given this problem, an increasing number of concrete structures with the use of cement replacement materials are being constructed or under construction. Any attempt to alleviate the risk of degradation means therefore that we produce good performance concrete that can withstand the harsh environment.

The materials and methods together with their properties have been described in this chapter. In this context, tests are conducted on different concrete mixtures, healing regimes, mixing proportions and casting of specimens.

3.1.1 Fly ash (FA)

Fly ash is a by-product of pulverized carbon combustion in power plants. A solid substance extracted from furnace gas fired with pulverizated bituminous coal by electrostatic and mechanical means. The carbon and the volatile material are burned off during manufacturing of FA, through the high-temperature furnace zone, while most of the mineral impurities like clay, cuartz and feldspar melt in high temperatures. Fused matter is quickly transported as spherical particles of the glass to low temperature zones. Some of the mineral agglomerates form the lower ash, but most of the flue gas flows out and is called "fly ash." Thus, the mechanical separator, electrostatic precipitators, removes this ash from the gas. Its main components are the chemical composition of fly ash, SiO2, AL2O3 and Fe2O3 with lower levels of additional metal oxides.

As Fly Ash does in general need no processing for mineral admixturing due to its unique mineralogical and granulometric characteristics. Bottom ash is much harder, less reactive and consequently needs to develop a pozzolanic property with fine grinding. The average fly ash uses worldwide are approximately 15%, compared to 2 to 5% for India. Fly ash has been gathered from RTPP in this study. The grade 1 IS: 3812-1981 is compliant.

The physical properties of fly ash are shown in the following table 3.1

Table: 3.1 Physical properties of fly ash

S.NO	DESCRIPTION	
1	Specific Gravity	2.5
2	Physical Form	Powder
3	Colour	Dark grey

3.1.2Silica fume

Silica fume is a silicone by-product, or a ferro-silica by-product and 100-fold fine than cement. The smokiness of silica is also called micro silica or solid silica fumes. It has a high reactivity towards lime and consists of amorphous silica. Silica fumes usually are low in substitution at around 10%. When SF is used in concrete mixes, the start of SF affects the system's physical perception, especially close to the total surface where porosity exists. At the beginning of the hydration procedure Silica fume starts reacting. The pozzolanic effect of silica fume greatly reduced "CH" crystals in the hydrated cement paste in size and quantity. This phénomène reduces the thickness of conversion areas together with a low W/C ratio and thus significantly reduces the preferential orientation of CH crystals. These all result in a more even and strong micro-cracking conversion zone potential.
Iflica fume is a by-product of arc inductors in the silicon and ferrosilicon alloy industries, which also is known by other names such as the condensed silica fume or volatilized silica, or simply as micro silica. Quartz to silicone reduction at temperatures up to 2000°C

4. PROPERTIES OF MATERIALS

4.1. MATERIALS

This study was conducted using 40 Mpa high strength concrete and is designed according to the ASI method.

4.2. PROPERTIES OF MATERIALS

4.2.1. GENERAL

In the following sections, the properties of materials used in the preparation of the high strength cement M40.

4.3CEMENT

The cement used is Portland cement of 53rd grade which confirmed its IS: 12269-1987 has been used in this study.

Table.4.1: Properties of cement

Properties	Obtained
Specific gravity	3.15
Initial setting time	75 min
Final setting time	190 min
Consistency	31%

4.4. FINE AGGREGATE

During 4.75mm IS sieved, locally available sand. Natural sand in accordance with IS: 383-1987

Table.4. 2: properties of fine aggregate

Properties	Obtained
Specific gravity	2.68
Fineness modulus	20562
Bulk density	1062 to 1178 kg/m^3
Water absorption	1.5%
Grading	II

4.5.COARSE AGGREGATE

Available from local sources in accordance with IS: 383-1987

Table4.3: properties of coarse aggregate

Properties	Obtained
Specific gravity	2.83
Aggregate impact value	14%
Aggregate crushing value	18%
Water absorption	1.85%

4.6. SILICA FUME

Silica fume is a by-product of the silicon and silicon alloy production of waste. The most common form of Silica fume in a densified form is available in different forms. Silica fume used complied with ASTM C (1240-2000)

Table 4.4: properties of silica fume

Property	Value
Colour	Dark to light gray
Bulk density	450-650 g/cm^3
Specific gravity	2.32
Moisture content	1%
Sio$_2$	92%

4.7. FLY ASH

Fly ash is a by-product of the combustion in thermal power stations of pulverized coal. The fly ash as a fine particulate residuum is removed from the combustion gas before it is released into the atmosphere by a staub collection system. Particles of fly-ash are generally spherical and range from <1 μm to 150 μm in diameter.

4.8. WATER

Water used for concrete preparation should be of potable quality in accordance with ACI. In this study, all concrete mixes and curative treatments were made using normal tap water that is suitable for drinking.

5. RESULTS OF NORMAL CONSISTENCY TEST

5.1 Normal consistency of cement with replacement of fly ash

Table 5.1 shows a difference in the normal consistency of the cement paste with fly ash. With partial substitution of fly ash cement at different doses of 5, 10, 15 and 20 per cent respectively in ordinary Portland cement, the normal constancy test shows a very slight increase.

Table 5.1: Variation of Normal consistency with replacement of fly ash

S.NO	Details of Material	Normal Consistency (%)
1	100% cement + 0% FA	32
2	95% cement +5% FA	33
3	90% cement +10% FA	34
4	85% cement +15% FA	34
5	80% cement +20% FA	35

5.2 Normal consistency of cement with replacement of silica fume

Table 5.2 shows the change in the normal consistency of cement paste with addition of silica fume. The normal consistency test shows very slight increases with the partial substitution in ordinary Portland cement of silica fume of 2% and 4% at different doses of 5, 10, 15 and 20% each.

Table 5.2: Variation of Normal consistency with replacement of silica fume

S.NO	Details of Material	Normal Consistency (%)
1	100% cement + 0% SF	32
2	95% cement +5% SF	34
3	90% cement +10% SF	35

4	85% cement +15% SF	36
5	80% cement +20% SF	36

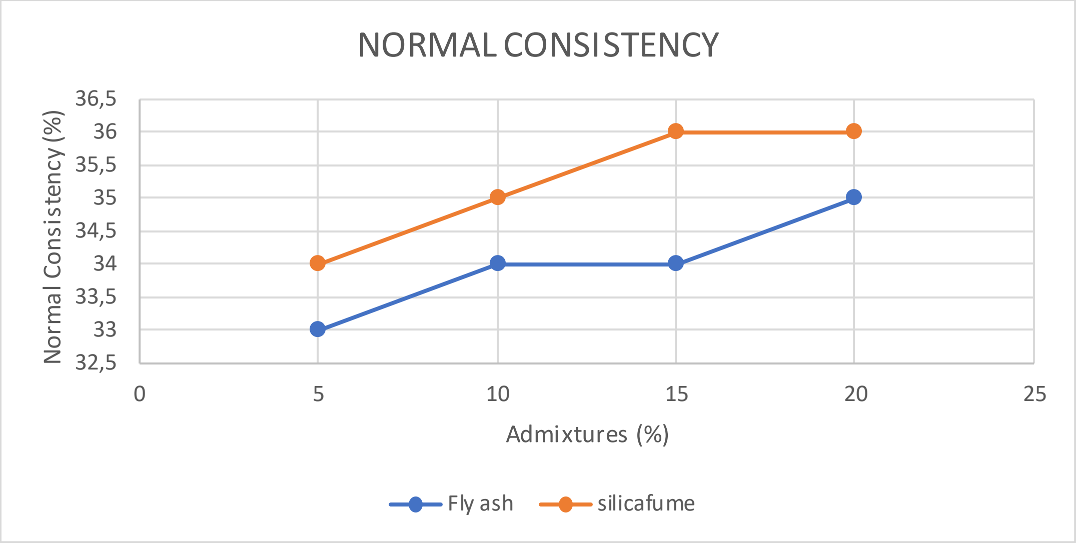

Figure 5.1: Effect on Normal Consistency for replacement of Cement with different admixtures

Figure 5.1 shows that with the increase of the admixtures when used as partial substitution for cement, the percentage of water necessary to produce the cement paste of a Standard Consistency is increasing. Normal cement consistency is 32 percent. The consistency value of normal cement paste increases up to 38 percent at 20 replacement percentage.

5.3. RESULTS OF INITIAL AND FINAL SETTING TIME

5.3.1 Initial and final Setting time of cement with replacement of fly ash

Variations in the cement's first and final fly ash fitting times. Table 5.3 notes that the initial and final setup times in the ordinary Portland cement were delayed and accelerated by replacing the fly ash.

Table 5.3: Initial and Final setting time values cement with replacement of fly ash

S.NO	Details of Material	Initial Setting Time (minutes)	Final Setting Time (minutes)
1	100% cement + 0% FA	45	300
2	95% cement +5% FA	50	300

3	90% cement +10% FA	60	290
4	85% cement +15% FA	70	280
5	80% cement +20% FA	70	260

5.3.2 Initial and final Setting time of cement with replacement of silica fume

Variations in cement's initial and final settings by adding silica fume. From table 5.4 it is noted that the initial and final set-up times in the ordinary portland cement have both been delayed and accelerated by the replacement of silica fume.

Table 5.4: Initial and Final setting time values cement with replacement of silica fume

S.NO	Details of Material	Initial Setting Time (minutes)	Final Setting Time (minutes)
1	100% cement + 0% SF	45	300
2	95% cement +5% SF	45	340
3	90% cement +10% SF	45	340
4	85% cement +15% SF	50	330
5	80% cement +20% SF	50	310

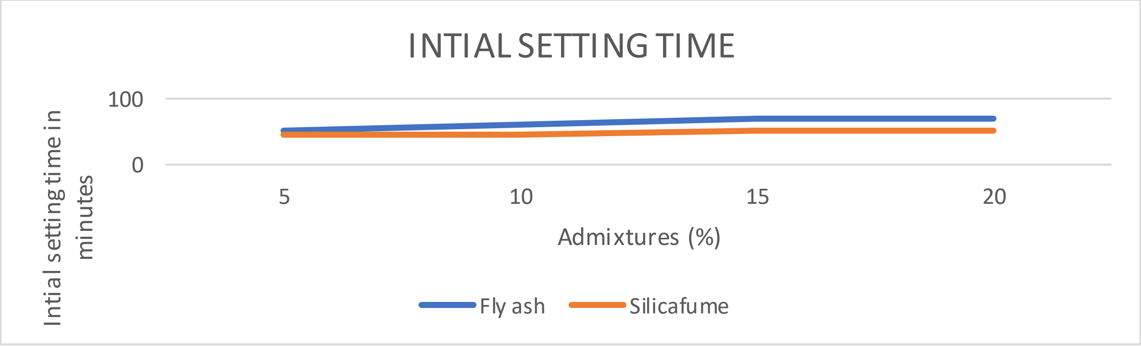

Figure 5.2: Effect on initial setting time for replacement of cement with different

Admixtures

CONCLUSIONS

The study on the effects of steel fibers with fly ash and silica fume can still be a success as the problem of concrete weakness must always be solved. From the current research, the following conclusions could be drawn.

1. The percentage of Flea Ash and silica fume increases marginally in workability.
2. Beton density is higher as steel Fiber raises proportion.
3. The factor of compaction increases when the proportion of steel fiber decreases.
4. The Steel Fibers slump had decreased by higher percentage.
5. For a workable mix, water drop agent is necessary as percentage of Steel Fiber increases.

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