FIBROUS HIGH STRENGTH CEMENT CONCRETE BY USING FLY ASH

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Abstract

Cement production is causing atmospheric pollution in many ways. Efforts to replace the consumption of cement by using mineral admixtures as partial replacement are quite significant and desirable in this regard. In the present paper, High strength concrete mix like M60 is taken as basic reference mix. High strength is carried out by using fly ash at various percentages as replacement to Ordinary Portland Cement (OPC) and CONPLAST SP 430 chemical at various percentages add in water content. FIBRES are added to enhance the strength properties further.

Steel fiber high-strength concrete (SFHSC) become in recent decades a very popular material in structural engineering. As a result of increased application of SFHSC, many experimental studies are conducted to investigate its properties and develop new rules for proper design. Concrete is being widely used for the construction of most of the buildings, bridges, etc throughout the world. Hence it is the backbone to the infra structure development of a nation. India is taking major initiatives to improve and develop its infrastructure by constructing express highways, power projects and industrial structures. A huge quantity of concrete is required to meet out infrastructure development.

Index Terms Concrete, Fly Ash, Super Plasticizer, Fibers and Compressive Strength

1. Introduction

Concrete is the key material used in various types of construction, from the flooring of a hut to a multi storied high rise structure from pathway to an airport runway, from an underground tunnel and deep sea platform to high-rise chimneys and TV Towers. In the last millennium concrete has demanding requirements both in terms of technical performance and economy while greatly varying from architectural masterpieces to the simplest of utilities. It is the most widely used construction materials. It is difficult to point out another material of construction which is as versatile as concrete.

Concrete is one of the versatile heterogeneous materials, civil engineering has ever known. With the advent of concrete civil engineering has touched highest peak of technology. Concrete is a material with which any shape can be cast and with equal strength or rather more strength than the conventional building stones. It is the material of choice where strength, performance, durability, impermeability, fire resistance and abrasion resistance are required.

2. Materials

2.1. High Strength Concrete:

High-strength concrete (HSC) is a relatively new construction material. Technology for producing high strength concrete has sufficiently advanced that concrete with compressive strength greater than 40Mpa are commercially available and strength much higher than that can be produced in laboratories. High-strength concrete offers significantly better structural engineering properties, such as higher compressive and tensile strengths, higher stiffness, better durability, when compared to the conventional normal strength concrete (NSC). Concrete of very high strength entered the field of construction of high raised buildings and long span bridges. In India, there are cases of using high strength concrete for pre-stressed concrete bridges. The higher strength

Concrete could be achieved by using one of the following methods or combination some or many of the following:

a. Higher cement content
b. Reducing water cement ratio
c. Better workability and hence better compaction

2.2. Fly Ash:

More than 2000 years ago, roman builders recognized that certain volcanic ash were capable of forming effective cements, when combined with lime. The Romans, widely exploited this pozzolanic property of volcanic ash, and many structures from the roman period are still intact. The modern recognition is that Fly ash is pozzolanic, and this has lead to its use as a constituent of contemporary Portland cement concrete.

2.3. Fibers:

Plain concrete possesses a very low tensile strength, limited ductility and little resistance to cracking. Internal micro cracks are inherently present in the concrete and its poor tensile strength is due to the propagation of such micro cracks, eventually leading to brittle fracture of the concrete.

In the past, attempts have been made to impart improvements in tensile properties of concrete members by way of using conventional reinforced steel bars and also by applying restraining techniques. Although both these methods provide tensile strength to the concrete members, they however, do not increase the inherent tensile strength of concrete itself.

2.4. CONPLAST SP430:

Conplast SP430 is a chloride free, super plasticizing admixture based on selected sulphonated napthalene polymers. It is supplied as a brown solution which instantly disperses in water.

2.5. Cement:

Ordinary Portland cement 53 grade conforming to I.S specifications is used in the Present investigation. The cement is tested for its various properties as per IS code. The results on cement are shown in table.

Table1:
PHYSICAL PROPERTIES OF PORTLAND CEMENT

S. NO	PROPERTY	TEST RESULTS
1	Normal consistency	31%
2	Specific gravity	2.5
3	Initial setting time Final setting time	30 min 600 min
4	Soundness(expansion) Lechatlier Method	2 mm
5	Fineness of cement	7%

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2.6. Fine Aggregate:

The locally available sand is used as fine aggregate in the present investigation. The sand is free from clayey matter, salt and organic impurities. The sand is tested for various properties like specific gravity, bulk density etc., in accordance with IS 2386-1963(28). Grain size distribution of sand shows that it is close to the zone-I of IS 383-1970(29).

2.7. Coarse Aggregate:

Machine crushed angular granite metal from local source is used as coarse aggregate. It is Free from impurities such as dust, clay particles and organic matter etc. The coarse aggregate is also tested for its various properties. The specific gravity and fineness modulus of coarse are 2.64, 7.14 respectively. The bulk density of coarse aggregate is 1700 kg/m3.

3. Casting of test specimens:

The present experimental program includes casting and testing of specimens for elastic properties. Specimens are prepared for M60 grade of concrete with and without FLY ASH. Total of 12 cube specimens, are cast. The details of casting and testing of specimens are described below.

TABLE 2: MIXING PROPORTIONS

S. NO.	NOTATION	CEMENT %	FLY ASH %	FIBRES %
1	C00	100	0	0.0
2	C01	100	0	0.5
3	C02	100	0	1.0
4	C03	90	10	0.5
5	C04	90	10	1.5
6	C05	85	15	0.0
7	C06	85	15	0.5
8	C07	80	20	0
9	C08	80	20	0.5
10	C09	75	25	0.0
11	C10	75	25	0.5
12	C11	70	30	0.0
13	C12	70	30	0.5
14	C13	65	35	0.0
15	C14	65	35	0.5

2.9. Mixing:

Manual mixing is adopted throughout the experiment work. First the materials cement, fly ash, fine aggregate, coarse aggregate are weighed exactly. First the cement and fly ash are blended with hand and then fine, coarse aggregate is added to this and thoroughly mixed. Water is weighed exactly and added to the dry mix and entire mix is thoroughly mixed till uniformity is arrived at. Immediately after thoroughly mixing, the fresh concrete is tested for workability using compaction factor apparatus.

2.10. Casting of specimens:

For casting C.I Metal CUBES of size 150x150x150mm have been used. The moulds have been cleaned of dust particles and applied with mineral oil on all sides, before concrete is poured into the mould. Thoroughly mixed concrete is filled into the mould.

2.11. Curing of specimens:

After casting the molded specimens are stored in the laboratory free from vibrations, in moist air and at room temperature for 24 hrs. After this period, the specimen are removed from the moulds and immediately submerged in the clean fresh water of curing tank. The curing water is renewed after every 5 days. The specimens are cured for 7 and 28 days in the present work.

2.12. Testing of cube specimens:

The cube specimens cured as explained above are tested as per standard procedure after removal from curing tank and allowed to dry under shade. The cube specimens are tested for

- Compressive strength in 7days
- Compressive strength in 28days

2.13. Results:

Cubes are casted with M60 grade concrete. Up to thirty five percent of cement is replaced by a combination of Fly Ash in different proportions and fibers are added to the combinations in different percentages. as shown in table 3.

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The cubes are tested after 28 days.

An experimental study is to be conducted to find out the compressive strength and at 7days and 28 days. In concrete the partial replacement of cement by Fly ash as varied from35%, 30%, 25%, 20% and 15%, 10% by weight. M60 grade of concrete is designed according to DOE (Direct Elimination) method. Steel Fibers are mixed in concrete like 0%, 0.5%, 1% and 1.5%. CONPLAST SP 430 is mixed in concrete like 10ml, 20ml, 30ml, and 50ml.

TABLE 3.1:
COMPRESSIVE STRENGTH VALUES FOR 7 DAYS

S. NO.	NOTA-TION	CEMENT %	FLY ASH %	FIBRES %	COMP. STRENGTH 7 DAYS
1	C00	100	0	0.0	42.73
2	C01	100	0	0.5	43.60
3	C02	100	0	1.0	45.34
4	C03	90	10	0.5	46.09
5	C04	90	10	1.5	47.09
6	C05	85	15	0.0	44.47
7	C06	85	15	0.5	46.22
8	C07	80	20	0	45.26
9	C08	80	20	0.5	45.26
10	C09	75	25	0.0	44.47
11	C10	75	25	0.5	47.09
12	C11	70	30	0.0	42.73
13	C12	70	30	0.5	46.09
14	C13	65	35	0.0	40.9
15	C14	65	35	0.5	41.09

TABLE 3.2:
COMPRESSIVE STRENGTH VALUES FOR 28 DAYS

S. NO.	NOTA-TION	CEMENT %	FLY ASH %	FIBRES %	COMP. STRENGTH 28 DAYS
1	C00	100	0	0.0	65.37
2	C01	100	0	0.5	66.9
3	C02	100	0	1.0	69.96
4	C03	90	10	0.5	69.59
5	C04	90	10	1.5	72.04
6	C05	85	15	0.0	68.03
7	C06	85	15	0.5	70.71
8	C07	80	20	0	69.24
9	C08	80	20	0.5	68.34
10	C09	75	25	0.0	68.03
11	C10	75	25	0.5	72.04
12	C11	70	30	0.0	65.37
13	C12	70	30	0.5	70.51
14	C13	65	35	0.0	62.57
15	C14	65	35	0.5	62.04

Discussions:

Compressive strength for 7days:

C00:

The cube specimen with 100% cement, 0% fly ash, and 0% fibers are tested as per the standard procedure.
From which, the compressive strength found to be 42.73 N/mm^2 (7days).

C01:

The specimen with 100% cement, 0% fly ash, and 0.5% fibers are tested as per the standard procedure.
From which, the compressive strength found to be 43.60N/mm^2 (7DAYS). Since, the fibers are added to the cement.

C02:

The CUBE specimen with 100% cement, 0% fly ash, and 1.0% fibers are tested as per the standard procedure.
From which, the compressive strength found to 45.34N/mm^2 (7DAYS). Since, the fibers are added to the cement.

C03:

The CUBE specimen with 90% cement, 10% fly ash, and 1.5% fibers are tested as per the standard procedure.
From which, the compressive strength found to be 47.09 N/mm^2. (7DAYS). Since, 10% fly ash, and 1.5% fibers are added to the cement.

C04:

The CUBE specimen with 85% cement, 15 %fly ash, and 0% fibers are tested as per the standard procedure.
From which, the compressive strength found to 44.47N/mm^2 (7DAYS). Since, 15 %fly ash is added to the cement

C05:

The CUBE specimen with 85% cement, 15% fly ash, and 0.5% fibers are tested as per the standard procedure.
From which, the compressive strength found to be 46.22 N/mm^2. (7DAYS). Since, 15% fly ash, and 0.5% fibers are added to the cement.

C06:

The CUBE specimen with 80% cement, 20 %fly ash, and 0% fibers are tested as per the standard procedure.
From which, the compressive strength found to 45.26N/mm^2 (7DAYS). Since, 20 % fly ash is added to the cement.

C07:

The CUBE specimen with 75% cement, 25% fly ash, and 0% fibers are tested as per the standard procedure.
From which, the compressive strength found to be 44.47 N/mm^2. (7DAYS). Since, 25% fly ash is added to the cement.

C08:

The CUBE specimen with 75%cement, 25 %fly ash, and 0% fibers are tested as per the standard procedure.
From which, the compressive strength found to 47.09N/mm^2 (7DAYS). Since, 25% fly ash is added to the cement.

C09:

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The CUBE specimen with 70% cement, 30% fly ash, and 0% fibers are tested as per the standard procedure.

From which, the compressive strength found to be 42.73 N/mm². (7DAYS). Since, 30% fly ash is added to the cement.

C10:

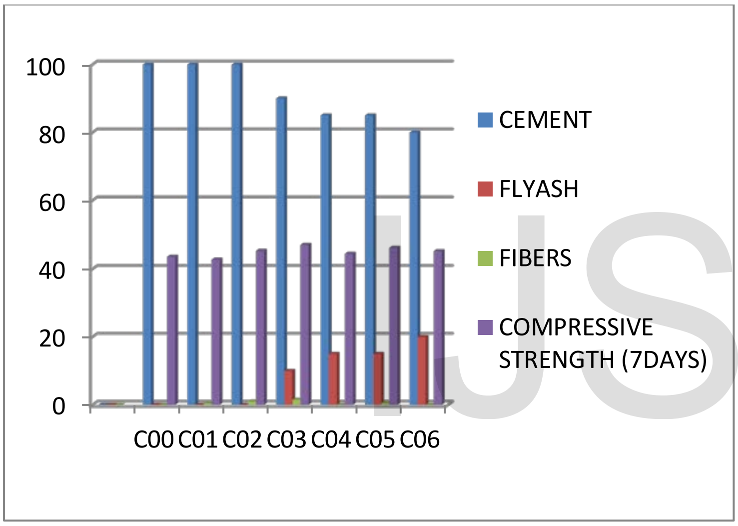
The CUBE specimen with 70% cement, 30% fly ash, and 0.5% fibers are tested as per the standard procedure

From which, the compressive strength value found to be N/m46.09N/mm² (7days). Since, 30% fly ash, and 0.5% fibers are added to the cement.

C11:

The CUBE specimen with 65% cement, 35% fly ash, and 0% fibers are tested as per the standard procedure.

From which, the compressive strength value found to be 40.09 N/mm² (7days). Since, 35% fly ash is added to the cement.



COMPRSSIVE STRENGTH FOR 28DAYS

C00:

The CUBE specimen with 100% cement, 0% fly ash, and 0% fibers are tested as per the standard procedure. From which, the compressive strength found to be 65.37N/mm² (28days).

C01:

The specimen with 100% cement, 0% fly ash, and 0.5% fibers are tested as per the standard procedure.

From which, the compressive strength found to be 66.9N/mm² (28DAYS). Since, the fibers are added to the cement.

C02:

The CUBE specimen with 100% cement, 0% fly ash, and 1.0% fibers are tested as per the standard procedure.

From which, the compressive strength found to 69.96N/mm² (28DAYS). Since, the fibers are added to the cement.

C03:

The CUBE specimen with 90% cement, 10% fly ash, and 1.5% fibers are tested as per the standard procedure.

From which, the compressive strength found to be 72.04 N/mm². (28DAYS). Since, **10**% fly ash, and 1.5% fibers are added to the cement.

C04:

The CUBE specimen with 85% cement, 15 %fly ash, and 0% fibers are tested as per the standard procedure.

From which, the compressive strength found to 68.03N/mm² (28DAYS). Since, 15 % fly ash is added to the cement

C05:

The CUBE specimen with 85% cement, 15% fly ash, and 0.5% fibers are tested as per the standard procedure.

From which, the compressive strength found to be 70.71 N/mm². (28DAYS). since, 15% fly ash, and 0.5% fibers are added to the cement.

C06:

The CUBE specimen with 80% cement, 20 %fly ash, and 0% fibers are tested as per the standard procedure.

From which, the compressive strength found to 69.24N/mm² (28DAYS). Since, 20 % fly ash is added to the cement.

C07:

The CUBE specimen with 75% cement, 25 %fly ash, and 0% fibers are tested as per the standard procedure.

From which, the compressive strength found to 72.04N/mm² (28DAYS). Since, 25% fly ash is added to the cement.

C08:

The CUBE specimen with 70% cement, 30% fly ash, and 0% fibers are tested as per the standard procedure.

From which, the compressive strength found to be 65.37 N/mm². (28DAYS). Since, 25% fly ash is added to the cement.

C09:

The CUBE specimen with 75% cement, 25% fly ash, and 0% fibers are tested as per the standard procedure.

From which, the compressive strength found to be 68.03 N/mm². (28DAYS). Since, 30% fly ash is **added** to the cement.

C10:

The CUBE specimen with 70% cement, 30 %fly ash, and 0.5% fibers are tested as per the standard procedure.

From which, the compressive strength found to 70.51N/mm² (28DAYS). Since, 30% fly ash is added to the cement.

C11:

The CUBE specimen with 65% cement, 35% fly ash, and 0% fibers are tested as per the standard procedure.

From which, the compressive strength found to be 62.57 N/mm². (28 DAYS). Since, 35% fly ash is added to the cement.

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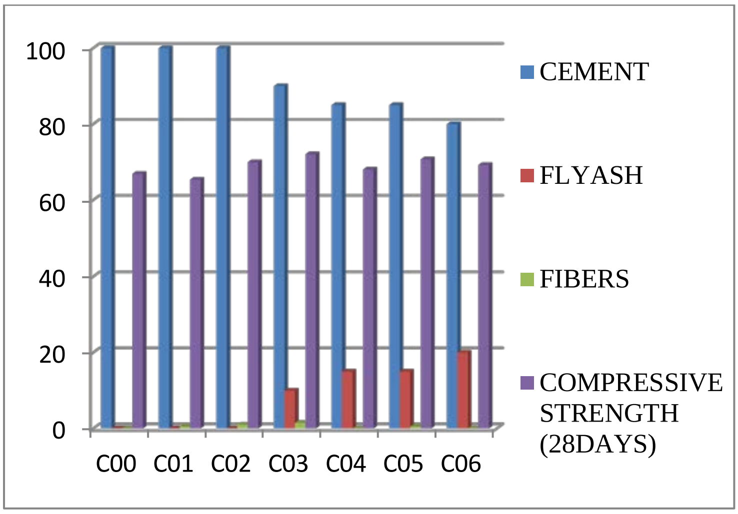

CONCLUSIONS:

1. In the case of high strength concrete mixes as the water cement ratio is low. When fibers are used in the mix with mineral admixtures, the workability is adversely affected. Hence role of super plasticizer becomes necessary to maintain the workability level.
2. On increasing the Fly ash content from 0-35 percentage of compressive strength is reduced as such elastic properties have been reduced.
3. As the total percent of fiber is increased the compressive strength is also increasing.
4. As the percentage of steel fiber is increased there is marginal increase in the compressive strength for all the combinations.
5. 20% fly ash generates marginal increase in strength. To compensate for the loss of strength when higher percentages of fly ash are used.

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REFERENCES

1. R.V.Balendran, T.M.Rana ,T.Moqsood, W.C.Tang, (2002), "Strength and durability performance of HPC incorporating pozzolans at elevated temperatures", Structural Survey, Vol. 20 Issue: 4, pp 123-128.

2. I.S. 383-1970, "Specification for Course and Fine Aggregate from Natural Sources for Concrete", BIS.

3. Jon M.Rouse and Sarah L.Billington, "Creep and Shrinkage of High Performance Fiber Reinforced Cementitious Composites", Materials Journal, V.104, Issue ,, PP 129-136, March 1, 2007.

4. IS 383-1970 : Indian standard specification on for coarse and fine aggregate for natural Sources for concrete "—2 revision bureau of Indian standards, New Delhi

5. IS 516-1959 : "Method of test for strength of concrete".

6. IS 7869(part 2): Indian standard specification for admixtures for concrete 1981.

7. IS 456-2000 : plain and reinforced concrete Indian standard specification.

8. A.M.Neville :"Properties of concrete" English language book society—1998

9. N.Krishnaraju :"Design of concrete mix "—CBS publisher—1985

10. M.S.Shetty:"Concrete technology"— S.Chand and company limited—2006

11. P.K.Mehtha& : "Concrete micro structure properties and materials"— J.J.M.Paulo Mc Graw Hill publishers 1997.

12. Rouse Jon M and Billington Sarah L:"Creep and Shrinkage of High-performance Fiber Reinforced Cementitious composites", Materials, Journals, V.104, Issue 2, PP.129-136, March 1st, 2007.

13. Xiaobin Lu and Cheng-Tzu Thomas Hsu : "Stress-Strain Relations of High- Strength Concrete under Triaxial Compression", J. Mater. Civ. Eng. 19, 261 (2007).

14.Michael W. Grutzeck, Scott Atkinson, and Della M. Roy "Mechanixm of Hydration of Condesed Silica Fume in Calcium Hydroxide Solutions", Special publications, vol.7, May 1986, PP:643-664.

15.Tazawa E and Yonekura A, "Drying Shrinkage and kCreep of Concrete with condensed Silica Fume", special publications, vol.91, Feb., 1986, PP:903-922.

16.Balendran. R.V, Rana T.M., Maqsood T, Tang W.C., "Strength and durability performance of HPC incorporating pozzolans at elevated temperatures", Structural Survey, Vol. 20, 2002 PP:123-128

17.Nawy EG. Fundamentals of high strength high performance concrete. Harlow, Essex, England: Longman group limited; 1996.

18.A.K Mullick "peformance of with Binary cement blends" The Indian concrete Journal, January 2007.

19.Guptha, L.M Maharajan; and satish kumar.B"studies on high volume fly ash concrete"proceedings of National seminar on flyash diposal and deposition beyond, 2000 IIT Kanpur,February,1999.

20. N.Neelamegam, J.K. Dattatreya and S.Gopalakrishna."pore structure effects in properties of concrete with binary and ternary blends". International conference in advance in concrete composites and structures,83-90.

21. Peramal.K, and Sundarrajan.R"Effects of partial replacement of cement with silica fume of strength and durability characteristics of M110 grade High performance

ISSN 2229-5518
Concrete".International conference on advances in concrete composites and structures.83-90.

22. Patodiya,S.C."Structural grade concrete with high fly ash contents", proceedings of National conference on cement and building materials from industrials wastes, Hyderabad July 1992.

23. Swamy B.L.P, Rammohan Rao, K ; and Swaroopa Rani,M., "Strength characteristics of high volume fly ash concretes", proceedings of International conference of construction materials, Indian Institute of science, Bangalore,July 2001

24. Swamy B.L.P, Sridhar,B. and Shyam Sunder,K."Studies on concrete building blocks with flyash admixture", proceedings of National conference on cement and building materials, from industrial wastes, Hyderabad, July1992.

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