A Comparative Study of Flexure Strength of Conventional Concrete And High Volume Fly Ash

Vinayak Tammanache[1], K. P. Thejaswi[2]

[1]*Postgraduate Student, Department of Civil Engineering, KLS Gogte Institute of Technology, Belagavi, Karnataka, India*

[2]*Assistant Professor, Department of Civil Engineering, KLS Gogte Institute of Technology, Belagavi, Karnataka, India*

---***---

Abstract – *The use of concrete containing high volume fly ash (HVFA) has recently gained importance due to efficient, durable and sustainability for various applications in construction field. In this study, 50% of the cement was replaced by high volume fly ash. The conventional M30 grade of cement was made using OPC 53 grade. The optimize mix ratio and flexure strength properties of beam using loading frame. In this context properties of the HVFAC, its design and are compared with test results.*

In this paper high volume fly ash mix shows lower normalized flexural strength compared with that of the conventional concrete mix. Comparison was made between 7 days and 28 days curing of beams, it was found that there is not much variation in the flexural strength of conventional concrete. For HVFAC it was found that there was drastic change in the flexural strength between 7 and 28 days curing, from this it can be confirmed that as the days of curing increases; HVFAC gains more strength than that of conventional concrete. The behaviour of the HVFAC and conventional concrete beams is virtually identical in regard to crack morphology and crack progression.

Key Words: **high volume fly ash, superplasticizer, SBR latex polymer, loading frame, flexure strength, deflection.**

1. INTRODUCTION

For building construction the concrete is made from Portland cement, coarse aggregate, fine aggregate and water. The concrete is under modification with the advance techniques, but the goals remain same. The reason for modification is to check for addictive materials like silica fume, husk, fly ash, etc. to prepare a high performance concrete.

From last few decays high volume concrete has also around interest in mitigating environmental impact high volume fly ash (HVFA) concrete contains more than 40%. Fly ash (FA) by the mass of cementation material must of studies have cement replacement by 40 to 70% FA. The result shows that HVFA gave good results on workability, strength development resistance to alkali, silica reaction and durability.

HVFA concrete gains lower flexure strength compare to normal concrete at early ages (i.e., 7&28 days) however the strength is gradually increased over longer time periods. Fly ash is beneficial in concrete, brick making, soil stabilization & other application, but in our country fly ash is used in less quantity.

This report as M30 target strength by replacing cement about 50 percent of its mass by fly-ash. In this context properties of the design are also studied. As compared to original mix design of M30 grade concrete.

1.1 Objectives

1. The main objective of the study is to use high volume fly ash concrete as a sustainable material compared to conventional concrete.
2. To check the feasibility of the use of high volume fly ash as 50% replacement of cement.
3. To check the feasibility of the parameters given below according to.
    a. Flexural strength IS:516-1959, (Reaffirmed1999)
4. A comparative study based on the test parameters for conventional concrete and HVFA concrete.
5. To study flexural Strength Properties of beams using Loading Frame.

1.2 Materials

Water

As per IS 456-2000, the preparation of concrete the water cement ratio is very important. Water is most essential ingredient in concrete. Strength and other properties of concrete are highly dependent on the water and the water cement ratio. For normal construction the water cement ratio (w/c) 0.46 has been used.

Concrete

The design of M30 concrete mix was designed as per IS 10262:2009 and SP 23-1983. Most commonly used cement content in the mix design is taken as 380kg/m^3 which satisfies minimum requirement of 240kg/m^3 in order to avoid the balling affect. Good stone aggregate and natural river sand of Zone-II was used coarse and fine aggregate respectively. The size of aggregate 20mm and 10mm a sieve analysis conforming to IS 383- 1970 was carried out for both the coarse and fine aggregate.

Admixture

Admixture are added to the concrete mixture immediately before or mixing. The uses of admixture in reduce the amount of water requirement in concrete and workability, strength etc. of the concrete. Conplast SP430 Fosroc superplasticizer and SBR Latex polymer was used during present study.

Fly ash

Fly ash is a finely divided waste product resulting from the combustion of pulverized coal in power plants. It contains large amounts of silica, alumina and small amount of unburned carbon, which pollutes environment. In the present work the fly ash (FA) by the mass of cementation material must of studies have cement replacement by 50% fly.

1.3 Methodology

1. Collection of materials required.
2. Material characterization.
3. To design for a conventional concrete M30 grade conforming to IS 10262:2019.
4. To design HVFAC concrete M30, by replacing 50% of cement by fly ash.
5. To estimate the quantities for a mix design of
   - HVFAC mix
   - Conventional M30
6. To conduct workability tests like slump test and compaction factor test.
7. Casting various beams size (150*150*1000) mm required for flexure strength test.
8. Curing the beam specimens for 7 day and 28 days.
9. To conduct the flexure strength test of beams using loading frame.

2. MIX DESIGN

Design of M30 concrete mix was designed as per IS 10262:2009 and SP 23-1983

1. Characteristic strength of concrete (f_{ck}) - 30N/mm^2
2. Maximum size of crushed aggregate - 20mm
3. Degree of workability - 0.80 compaction factor
4. Type of exposure – moderate
5. Minimum cement content – 240kg/m^3
6. Cement type and Grade – OPC 53 grade
7. Chemical admixture type – superplasticizer
8. Statistical coefficient (K) – 1.65
9. Value(S)-4.00

I. **Mix proportions for Conventional Concrete.**
   a. Cement = 296 kg/m^3
   b. Water = 148 kg/m^3
   c. F.A. = 652 kg/m^3
   d. C.A. = 1396 kg/m^3
   e. Chemical admixture = 2.96 kg/m^3
   f. w/c ratio = 0.5

II. **Mix proportions for HVFA**
   a. Water = 145 kg/m^3
   b. Cement = 161 kg/m^3
   c. Fly ash = 161 kg/m^3
   d. C.A. = 1428.78 kg/m^3
   e. F.A. = 585.92 kg/m^3
   f. Polymer = 1% of 161
   g. Super plasticizer = 1.4% of 161
   h. w/c ratio = 0.45

3. EXPERIMENTAL SETUP AND PROCEDURE

3.1 Beam Test setup

The beam were simply supported with an effective span 900mm and subjected to a point bending load as shown in fig. 1 with load applied at mid span of the beam.

Fig. 1-Loading arrangement for beam

3.2 Testing Procedure

The beam specimens were loaded by point loading produced by a hydraulic-piston supported on a rigid steel frame. A spreader beam transferred the load symmetrically to ensure pure bending at mid span of the beam. The load applied Load at intervals and continued until collapse of beam specimen. Mid-point was directly recorded whereas the mid-span deflection was measured with LVDT (linear variable differential transformers) attached parallel on the specimen. The load and deflection values were used to develop load deflection plots.
Appearances of cracks were visually inspected during the loading. The beam specimens were subjected to the load up to the failure point, as can be seen in fig.2.

Fig. 2: Beam failure

ss

4. RESULTS AND DISCUSSION

4.1 Flexural Strength (Beam) – As per IS 516:1959 (Reaffirmed1999)

Flexural strength is given by:-

Flexural Strength (MPa) = Pl/bd^2

Where P= Load in KN

b= Breadth in mm

d = Depth in mm

Table-1: Flexural Strength 7 day's conventional concrete

SL No.	Length, mm	Width mm	Depth, mm	Area, mm²	Load, KN	Flexural Str. Mpa
1	1000	150	150	150000	29.3	8.68
2	1000	150	150	150000	27.96	8.28
3	1000	150	150	150000	31.3	9.27
Average Flexural Strength						**8.74**

The results of flexure test were summarized and present in load vs deflection curve shown in charts...

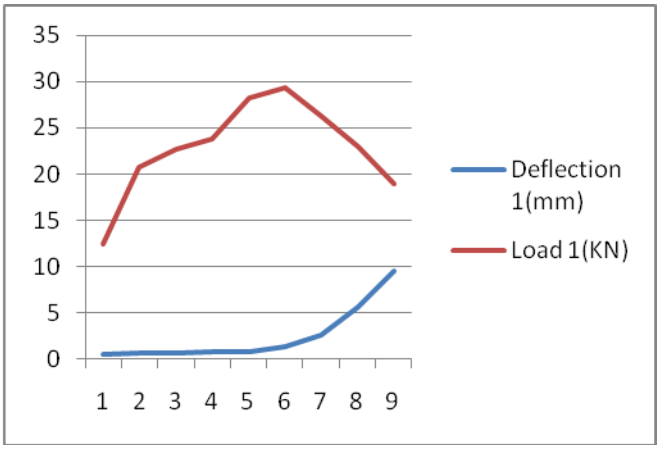


Chart-1: Load vs deflection graph for beam specimen 1

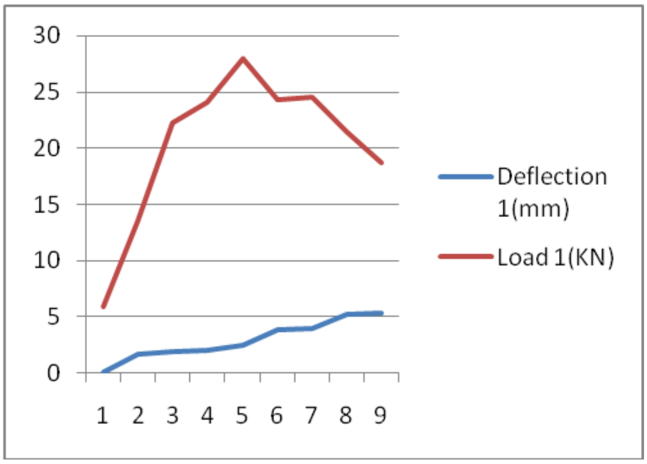


Chart-2: Load vs deflection graph for beam specimen 2

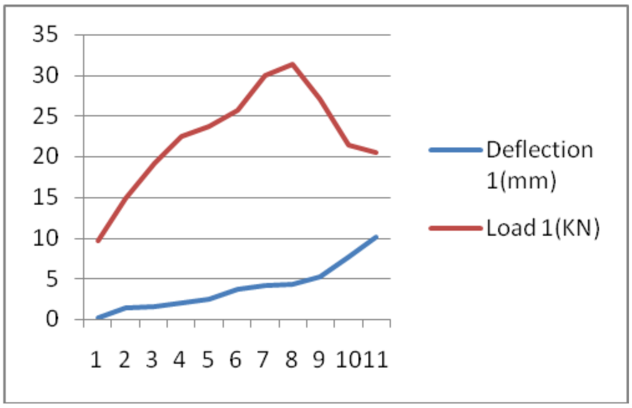


Chart-3: Load vs deflection graph for beam specimen 3

Table-2: Flexural Strength 7 day's High Volume Fly Ash concrete

SL No.	Length, mm	Width mm	Depth, mm	Area, mm²	Load, KN	Flexural Str. Mpa
1	1000	150	150	150000	21.61	6.40
2	1000	150	150	150000	20.82	6.16
3	1000	150	150	150000	24.23	7.18
Average Flexural Strength						**6.58**

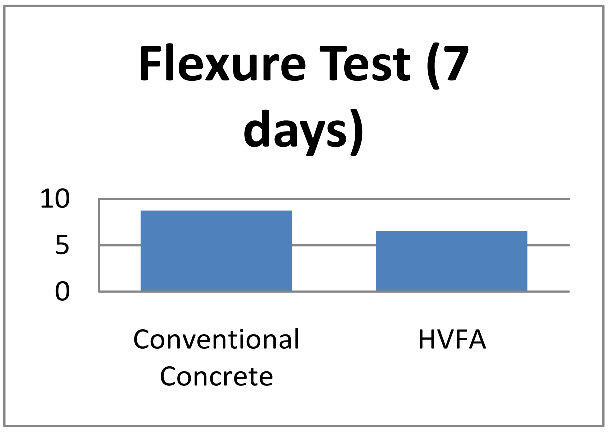


Chart-4: Flexure strength test graph (7 days)

The results of flexure test were summarized and present in load vs deflection curve shown in charts..

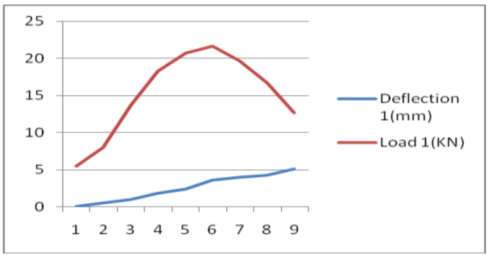


Chart-5: Load vs deflection graph for beam specimen 1

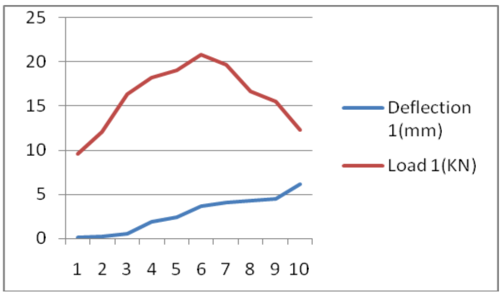


Chart-6: Load vs deflection graph for beam specimen 2

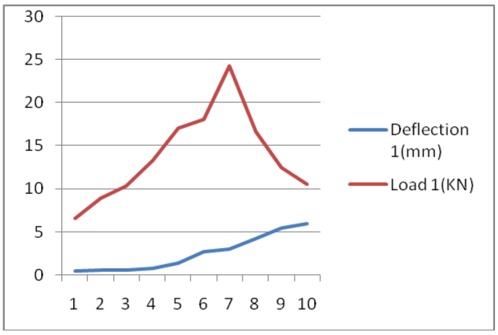


Chart-7: Load vs deflection graph for beam specimen 3

Table-3: Flexural Strength 28 day's Conventional concrete

SL No.	Length, mm	Width mm	Depth, mm	Area, mm²	Load, KN	Flexural Str. Mpa
1	1000	150	150	150000	44.3	13.12
2	1000	150	150	150000	43.1	12.77
3	1000	150	150	150000	40.5	12
Average Flexural Strength						**12.63**

The results of flexure test were summarized and present in load vs deflection curve shown in charts...

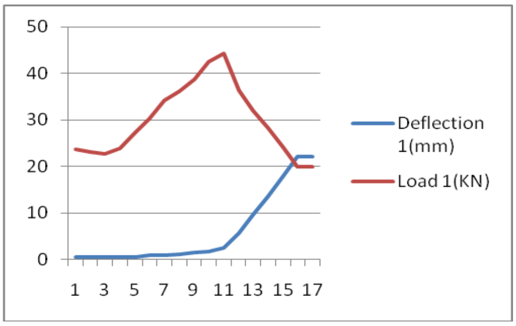


Chart-8: Load vs deflection graph for beam specimen 1

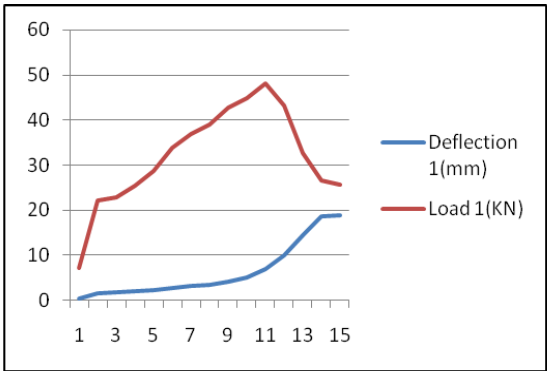


Chart-9: Load vs deflection graph for beam specimen 2

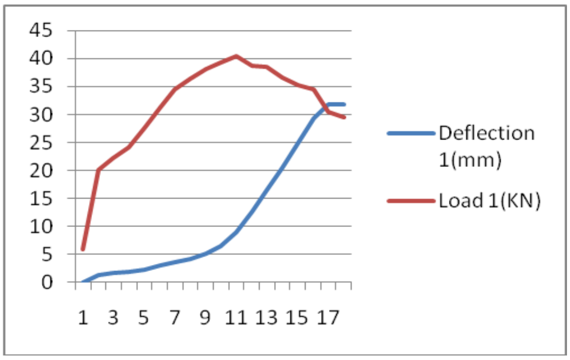
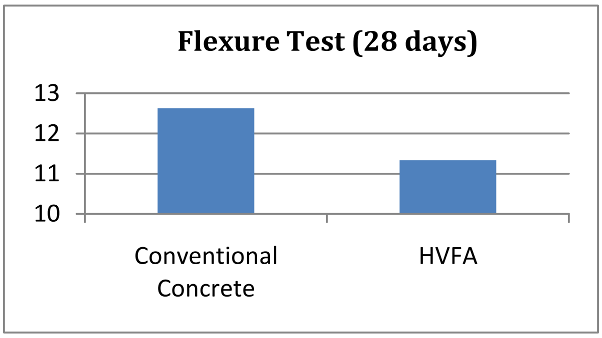


Chart-10: Load vs deflection graph for beam specimen 3

Table-4: Flexural Strength 28 day's High Volume Fly Ash concrete

SL No.	Length, mm	Width mm	Depth, mm	Area, mm²	Load, KN	Flexural Str. Mpa
1	1000	150	150	150000	39.3	11.64
2	1000	150	150	150000	40.3	11.94
3	1000	150	150	150000	38.6	10.43
Average Flexural Strength						**11.33**



The results of flexure test were summarized and present in load vs deflection curve shown in chart….

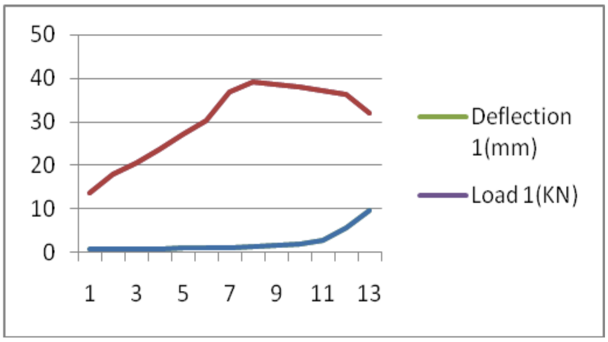


Chart-11: Load vs deflection graph for beam specimen 1

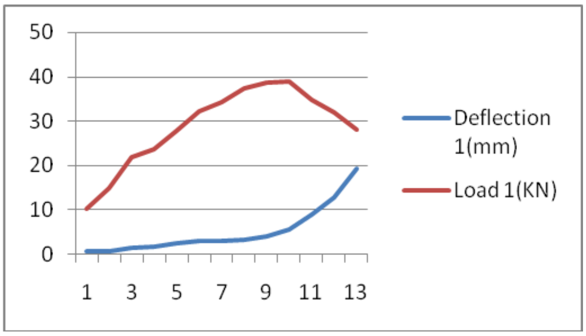


Chart-12: Load vs deflection graph for beam specimen 2

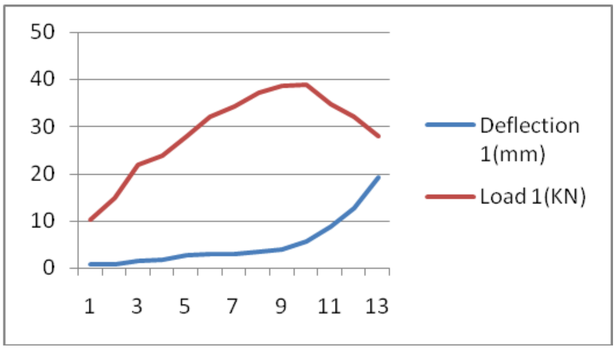


Chart-13: Load vs deflection graph for beam specimen 3

4. CONCLUSIONS

Laboratory experiments was conducted to find the fresh properties of concrete like Workability and also the testing on hardened concrete is also done to find flexural strength of concrete using loading frame. The effects of high volume fly ash on conventional M30 grade concrete are studied. To evaluate the flexural capacity of the HVFAC, three full scale beams were constructed for the mix. Behavior of the HVFAC was examined in regard to crack morphology and progression, load-deflection response and failure mechanism.

On the basis of the results, the following conclusions are presented with regard to mechanical properties of the HVFAC mixes:-

1. The high volume fly ash concrete mix shows lower normalized flexural strength compared with that of the conventional concrete mix.
2. The behavior of the HVFAC and CC beams is virtually identical in regard to crack morphology and crack progression.
3. Comparison was made between 7 days and 28 days curing of beams, it was found that there is not much variation in the flexural strength of CC between 7 and 28 days curing.

4. For high volume fly ash concrete it was found that there was drastic change in the flexural strength between 7 and 28 days curing, from this it can be confirmed that as the days of curing increases. High volume fly ash concrete gains more strength than that of conventional concrete.

REFERENCES

[1] M. V. Mohod OSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 12, Issue 1 Ver. I (Jan-Feb. 2015), PP 28-36.

[2] A. Gunaseelan, K. M. Ramalingam (2016) “Experimental Study On Performance Of High Volume Fly Ash Concrete” IJIRST –International Journal For Innovativ Research In Science & Technology, volume 2, Issue 12,

[3] E. Mello, C. Ribellato, E. Mohamedelhassan, “Improving Concrete Properties with Fibers Addition” Vol:8, No:3, 2014, International Journal of Civil and Environmental Engineering.

[4] Rebeiz, K. S., Serhal, S. P. & Craft, A. P. (2004) “Properties of Polymer Concrete using Fly Ash”, Journal of Materials Engineering, Vol-16, Issue 1, pp15-19.

[5] RafatSiddique (2003) , “Effect of fine aggregate replacement with Class F fly ash on the mechanical properties of concrete”, Cement and Concrete Research Vol. 33 PP: 539–547.

[6] A. K. Chatterjee, (2011), Indian Fly Ashes: Their Characteristics and Potential for Mechanochemical Activation for Enhanced Usability,June 2011

[7] Freedachristy and Tensing.D(2010) “Effect of class-F fly ash as partial replacement with cement and fine aggregate in mortar”, Indian journal of Engineering and material science,Vol.17,No.4,April 2010.

[8] High Volume Fly Ash Concrete Handbook (2005), CANMET, Third Edition.

[9] IS 10262:2009 Mix design M30 Grade designed as per

[10] IS 456-2000 Plain & Reinforced Concrete Code of Practice.

[11] IS: 12269-1987 - 53 Grade Ordinary Portland Cement (Reaffirmed 2004)

[12] IS: 1489 part-1 1991 - Portland Pozzolana Cement fly ash based (Reaffirmed 2005)

[13] IS 3812-2003, Pulverized Fuel Ash specification, part 1 for use as pozzolana in cement, cement mortar and concrete

[14] A.K Mullick (2005) “Use of fly ash in structural concrete”, Indian concrete journal, Vol.19, No.6June-2005

BIOGRAPHIES

Vinayak Tamammanache, P.G Student, Department of Civil Engineering, KLS Gogte Institute of Technology, Belagavi, Karnataka, India

K. P. Thejeswi, Assistant Professor, Department of Civil Engineering, KLS Gogte Institute of Technology, Belagavi, Karnataka, India