Scientific Journal of Impact Factor (SJIF): 5.71

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 6, Issue 04, April -2019

Influence of Addition of Glass Fibre on High Performance Concrete (HPC) with Partial Replacement of Cement by Silica Fume and Fine Aggregate by Coal Bottom Ash

Quasar Hussain Kambay[1], Suminder Meerwal[2]

[1]*Student M.Tech (Structural Engineering), Department of Civil Engineering, MMEC Mullana, Ambala, Haryana, India*
[2]*Assistant Professor, Department of Civil Engineering, MMEC Mullana, Ambala, Haryana, India*

ABSTRACT: - *Like other fields of technology, civil engineering too has moved over from conventional and dictatorial approach of designing. New and advanced tailor made ingredients are being added to the conventional mix and their consequent effects on the finished product are being analysed. Albeit, strength properties of ingredients is more of a vision of civil engineers but at the same time eco-friendly approach of the ingredients is also probed. For the same purpose, industrial disposals like silica fume (SF) by (6, 9 & 12%) & coal bottom ash (CBA) by (5, 10 & 15%) were used as substituents of two primary ingredients of concrete viz. cement and Fine aggregate. To accomplish the goal of HPC, alkali resistant glass fibre with (0.4, 0.8 & 1.2%) by concrete weight was also engrossed into the concrete. Chemical additive super-plasticizer by 0.4% of the weight of cementitious material was also engrossed to the concrete mix. The impact of these constituents on concrete compressive strength was checked by the suitable test. The behaviour of glass fiber reinforced concrete (GFRC) under compressive loads was correlated with that of traditional mix.*

Keywords: *- Glass fiber, GFRC, CBA, Silca Fume, Compressive Strength.*

1. INTRODUCTION

Concrete is an age old material used in construction engineering. It possesses a variety of good engineering properties such as good compression strength, highly workable, sound insulation properties etc. Plain concrete, though, incorporates certain good properties but it lacks good tensile strength and ductility because of this it cracks. Formation of crakes leads to the ingress of moisture into the concrete, which when comes to the contact of reinforced bars leads to its corrosion, which ultimately is among the pivotal causes of less durability of concrete elements. A special brand of concrete, called high performance concrete (HPC) has evolved gradually since past few decades. This type of concrete sounds a new prototype of concrete but it actually constitutes same old ingredients with similar practices of casting. The new brand of concrete contains cement substituents that alter its properties at both fresh and hardened stage.

The related research works carried out prior to this study were analysed to get a sense of behaviour of concrete formed by some of these mixes. Singla A and Kumar M (2017) observed 5% increase of M30 concrete at 1.6% of GF. Kumar T (2016) noticed increase in compression strength ranges from 20-30 percent w.r.t traditional mix was at 0.05% GF. Alam M.A. et al (2015) found the optimum value at 0.06% of glass fiber. Garad S and Phadtare N (2014) achieved maximum strength after 28 days of curing at 5% fiber content. Patel R.P et al (2013) found the peak augmentation in strength at .1% addition. Shakor P.N and Pimplikar S.S (2011)studied GFRC formed with the addition of glass fiber at varying percentage. The optimum compressive strength of M60 GFRC was obtained by the addition of 1.5% of glass fiber. Ghorpade V.G (2010)**,** at fiber content of 1%, 10% SF & 1% superplasticizer accomplished apex strength.

2. EXPERIMENTAL PROGRAMME

2.1 MATERIALS USED AND TEST RESULTS

The materials used in the manufacturing of this special brand of concrete called the high performance concrete (HPC) along with their characteristics are given below;

2.1.1 CEMENT

In present research project, 43 grade Ordinary Portland Cement (OPC) was used. The tests were performed on the cement in accordance with IS: 8112-1989 and their values are listed below;

Table-1: Physical Indices of Cement

Sr.No	Characteristics	Observations
1.	Normal Consistency (in %age)	30
2.	Specific Gravity	3.08
3.	Fineness (in %age)	6.66
4.	Initial Setting Time (Minutes)	70
5.	Final Setting Time (Minutes)	278
6.	Soundness (in mm)	2.30
7.	Compressive Strength (in MPa)	
	3 Day	24.31
	7 Day	34.22
	28 Day	44.97

2.1.2 FINE AGGREGATES

Locally available sand was used in this project work. Tests conducted on sand in accordance with IS: 383-1970. The results obtained are listed in the given table;

Table-2: Physical Indices of Fine Aggregates

Sr.No	Characteristics	Observations
1.	Percentage Water Absorption	1.90
2.	Specific Gravity	2.685
3.	Loose Bulk Density (in kg/m^3)	1525
4.	Percentage Fineness Modulus	2.73
5.	Compacted Bulk Density (in kg/m^3)	1620

2.1.3 COARSE AGGREGATES

The coarse aggregates used in present work were crushed stones of different sizes, maximum size of which was 20 mm. The amalgam of 20 mm and 10 mm aggregates, having higher percentage of 20 mm aggregates was used to accomplish a better quality concrete. The tests done on the aggregates as per IS: 383-1970 and their values are notified as;

Table-3: Physical Indices of Coarse Aggregate

Sr.No	Characteristics	Observations
1.	Fineness Modulus (in %age)	6.90
2.	Specific Gravity	2.695
3.	Loose Bulk Density (in kg/m^3)	1150
4.	Water Absorption (in %age)	0.50
5.	Compacted Bulk Density (in kg/m^3)	1595

2.1.4 WATER

For both curing and casting of concrete specimens, water should be free from any presence of excessive amount of malicious elements. Water used for the project was from a running tap.

2.1.5 GLASS FIBRE (GF)

The glass fibre was acquired from India Mart. The physical indices of the industrial by product have been listed below in table-4.

Table-4: Physical Indices of Alkali-Resistant (AR) Glass Fiber

Sr.No	Characteristics	Observations
1.	Tensile Strength (in MPa)	1720
2.	Specific Gravity	2.67
3.	Elastic Modulus (in GPa)	73
4.	Diameter (in Micron)	14
5.	Length (in mm)	12
6.	No. of Fibres (Million/Kg)	240

2.1.6 COAL BOTTOM ASH (CBA)

The related attributes are given below in table-5.

Table-5: Physical Attributes of Coal Bottom Ash

Sr.No	Characteristics	Observations
1.	Colour	Grey
2.	Bulk Density (kg/m^3)	1108
3.	Specific Gravity	2.30

2.1.7 SILICA FUME (SF)

The attributes of silica fume used in this study confirmed to the guidelines laid down by the IS 15388-2003. Table-6 showcases the related attributes of the silica fume.

Table-6: Attributes of Silica Fume

Sr.No	Characteristics	Observations
1.	Specific Gravity	2.21
2.	Moisture	1.15%
3.	Silicon Dioxide (SiO_2)	85.9%
4.	Colour	Light Grey
5.	Ignition Loss	3.10%

2.1.8 CHEMICAL ADDITIVE

CONMIX SP 1030, which is a water reducing additive falls in the category of Sulphonated Nepthalene Formaldehyde (SNF). It obeys the regulations set by IS: 9103-1999. Table-7 lists the attributes of chemical additive used in present case.

Table-7: Indices of the Chemical Additive

Sr.No	Characteristics	Observations
1.	Physical Exhibition	Liquid Brown
2.	pH	7 to 8
3.	Specific Gravity	NIL
4.	Chloride Quantity	1.20

3. RESULTS AND DISCUSSION

Table-9 showcases the compressive strength values which were computed after laboratory testing of cubes after both 28-day and 56-day curing. Variation in strength is demonstrated by figure-3.1 by a graphical representation.

Table-9: 28 & 56-Day Compressive Strength Observations

Sr.No	Representation of Sample	28-Day Compressive Strength	56-Day Compressive Strength
		N/mm^2	
1.	**CBA0SF0GF0/(M1)**	42.33	46.53
2.	**CBA5SF6GF0.4/(M2)**	43.82	48.22
3.	**CBA10SF6GF0.4/(M3)**	44.58	49.03
4.	**CBA15SF6GF0.4/(M4)**	44.12	48.53
5.	**CBA5SF9GF0.8/(M5)**	46.45	51.10
6.	**CBA10SF9GF0.8/(M6)**	48.47	53.32
7.	**CBA15SF9GF0.8/(M7)**	47.30	51.73
8.	**CBA5SF12GF1.2/(M8)**	51.15	56.25
9.	**CBA10SF12GF1.2/(M9)**	53.88	59.28
10.	**CBA15SF12GF1.2/(M10)**	52.33	57.58

The compressive strength of controlled mix at 28-day and 56-day testing was 42.33 MPa and 46.53 MPa respectively. With the addition of CBA at 5%, SF 6% and GF 0.4%, compressive strength value jumped by 3.52% at 28-day and 3.63% at 56-day testing. Addition of 10% CBA and keeping percentages of SF and GF at 6% and 0.4% respectively, resulted in hike of compressive strength. The strength values eventually decreased when CBA percentage increased up to 15%. After adding more percentages of SF and GF and experimenting them with different values of CBA, notable increment in compressive strength of GFRC was observed. The optimum or peak compressive strength was accomplished at CBA10SF12GF1.2 (CBA 10%, SF 12% and GF 1.2%) which was 27.29% at 28-day and 29.40% at 56-day, higher than the strength achieved by the reference mix. The fall in concrete strength was observed with the addition of CBA from 10 % to 15%.

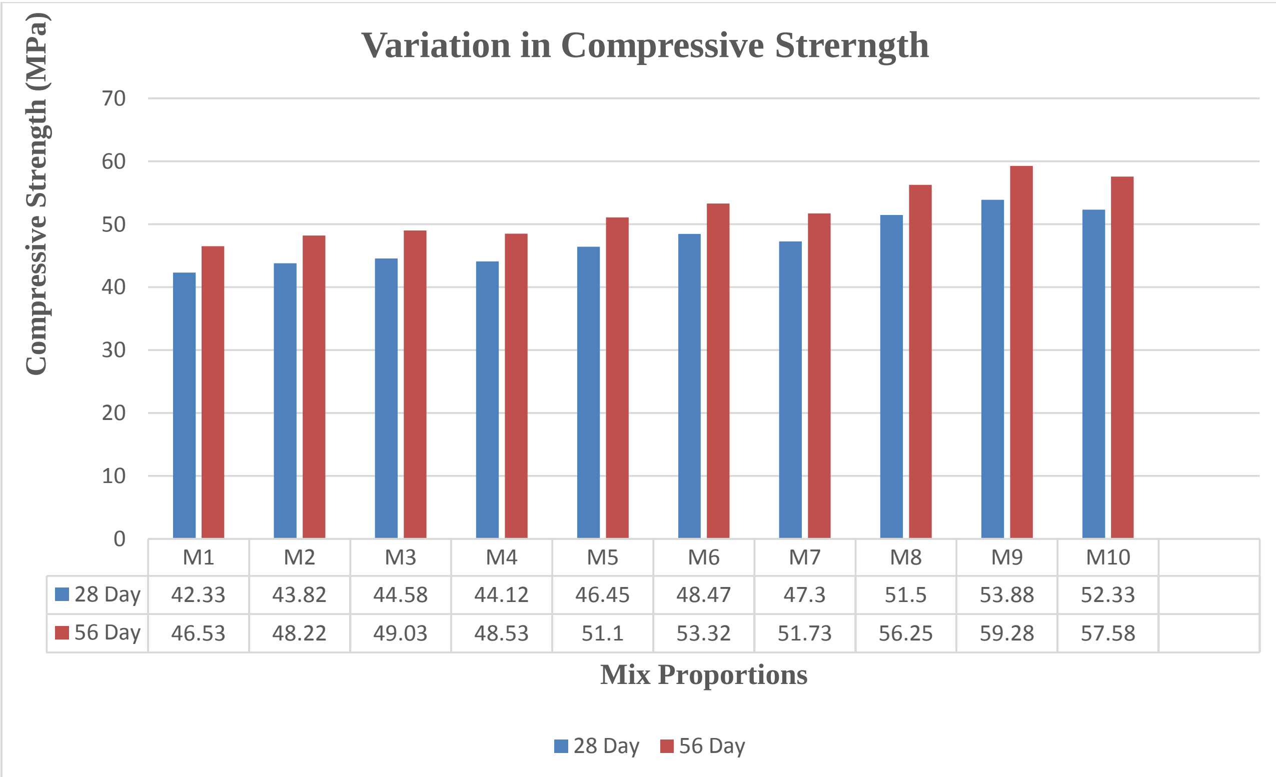

Figure-3.1: Graphical Representation of Compressive Strength Variation

4. CONCLUSION

The target strength of M35 concrete was achieved by every GFRC mix. The compressive strength of GFRC was higher than the nominal mix at both 28-day and 56-day testing. As GF, SF and CBA were introduced to the concrete by varying percentages, the compressive strength augmented with every percentage addition, achieving its apex value at CBA10SF12GF1.2 at both the ages under consideration.

Keeping in mind the environmental problems associated with the emission, disposal and spillage of CBA, it would be fair to say that adding CBA to concrete is a good step in achieving eco-friendly concrete. Also using SF as a binder by replacing a few quantity of cement with it is a step in the same direction as cement manufacturing emits high level of CO_2 to the atmosphere.

REFERENCES

[1] *Ankit Singla and Mukesh Kumar (2017), An Experimental Study on the Concrete Properties M30 due to Addition of Glass Fibers, International Journal for Technological Research In Engineering (IJTRE), ISSN: 2347 – 4718, Vol 04, Issue-06, Feb-2017, pp. 912-915.*

[2] *Tarun Kumar (2016), Glass Fiber Reinforced Concrete: Design and Analysis, IJRDO-Journal of Mechanical and Civil Engineering, ISSN: 2456-1479, Vol. 02, Issue-05, May-2016, pp. 35-41.*

[3] *Md.Abid Alam, Imran Ahmad and Fazlur Rehman (2015), Experimental Study on Properties of Glass Fiber Reinforced Concrete, International Journal of Engineering Trends and Technology (IJETT), ISSN: 2231-5381, Vol. 24, June-2015, pp. 297-301.*

[4] *Samadhan Garad and Prof. Navanath Phadtare (2014), Experimental Analysis of Glass Fiber Reinforced Composite Beams, International Journal of Advanced Engineering Technology (IJAET), ISSN: 0976-3945, Vol. 05, Issue-02, April-June 2014, pp. 85-87.*

[5] *Ronak Prakashkumar Patel, Jayraj Vinodsinh Solanki and Jayeshkumar Pitroda (2013), A Study on Glass Fiber as an Additive in Concrete to Increase Concrete Tensile Strength, Global Research Analysis (GRA), ISSN: 2277–8160, Vol. 02, Issue-02, Feb-2013, pp.85-87.*

[6] *Pshtiwan N. Shakor and S. S. Pimplikar (2011), Glass Fiber Reinforced Concrete Use in Construction, International Journal of Technology and Engineering System (IJTES), Vol. 02, Jan-March 2011.*

[7] *Vaishali G Ghorpade (2010), An Experimental Investigation on Glass Fiber Reinforced High Performance Concrete with Silica Fume as Admixture, 35th Conference on OUR WORLD IN CONCRETE & STRUCTURES: 25 - 27 August 2010, Singapore.*

