International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 5, No. 1, March - May 2020
Pages 14-22 | Cosmos Impact Factor (Germany): 5.195
Received: 02.03.2020 Published: 28.05.2020

"COMPRESSIVE STRENGTH OF CONCRETE BY PARTIAL REPLACEMENT OF CEMENT WITH FLY ASH AND ADDITION OF STEEL FIBRE"

Satish C. Jyanopanthar[1], Anathkumar Vannal[2], Hanumesh[3]
[1]Assistant Professor, Civil Engineering Department, RTE Society's Rural Engineering College, Hulkoti Karnataka , India -582205
[2]U.G. Student, Civil Engineering Department, RTE Society's Rural Engineering College, Hulkoti Karnataka , India -582205
[3]U.G. Student, Civil Engineering Department, RTE Society's Rural Engineering College, Hulkoti Karnataka , India -582205

ABSTRACT

In today's world the main emphasis is on green and sustainable development. Cement industries one of the major contributors to pollution by releasing carbon dioxide. One ton of OPC production produces approximately one ton of carbon dioxide so by partially replace in cement with pozzolanic material such as fly ash , the cement industry can serve both purposes of meeting the demands of construction industry and at the same time providing a green and clean environment. Fly ash is difficult to decompose so using fly ash is a major step towards sustainable development. Also the concrete is weak in tension, so with the addition of steel fibres it's flexural and tensile strength is also enhanced. Fly ash is obtained from thermal power plants as a waste material. Fly ash does not have cementitious property by itself which is responsible for strength generation. But in presence of water it reacts with free lime obtained from cement and form hydrated products (C_2S and C_3S) which helps in attaining the strength and also improving the durability. As the fly ash is very fine in structure, it fills more voids and provides superior pore structure and thereby improves its strength at later stages due to reduced permeability.

In this project an attempt is made to study the behavior of M_{25} grade of concrete and to determine the compressive strength of concrete reinforced with steel fibres. The steel fibre of 0%, 0.5%, 1%, 1.5% and 2% are used for the concrete, by replacement of cement with fly ash (20%, 30%). The test will be performed according to bureau of Indian standards. The material required for the cement, fine and coarse aggregates, fly ash and steel fibres. The test to be conducted is compressive strength of concrete with 28 days of curing.

KEY WORDS: Fly Ash, Puzzolonic behaviour, partial, replacement, *compressive strength.*

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 5, No. 1, March - May 2020
Pages 14-22 | Cosmos Impact Factor (Germany): 5.195
Received: 02.03.2020 Published: 28.05.2020

INTRODUCTION

As a result of booming infrastructural development around the world, the demand for cement production is also increased. Ordinary Portland Cement (OPC) is mainly used as a cementitious material for the concrete production. Concrete usage around the globe is second only to water. Nowadays, concrete industry is known to be the major consumer of natural resources, such as water, sand and aggregates, and manufacturing Portland cement also requires large amounts of each of them. As a result, the energy consumption for the cement production is high. It was estimated that the production of cement was increased from 1.5 billion tons in 1995 to 2.2 billion tons in 2010. For manufacturing each tone of the Portland cement about 1.5 tons of raw materials is needed. The production of 1 tone ordinary Portland cement consumes 4GJ energy and produces about 1 ton of carbon dioxide (CO_2) to the atmosphere which leads to environmental pollution.

In this study, concrete specimen were prepared by using fly ash from Raichur thermal power plant station (RTPS) as a replacement material for cement and addition of steel fibers were done in consecutive percentages of 0.5% , 1.0% , 1.5% , and 2% . The fly ash replaced the cement by 20% and 30% by weight

Materials

Cement

Ordinary Portland cement of 43 grade was used in this project. It was tested as per IS 8112-1989 recommendation. The chemical composition of cement is as below

Fine aggregates

Natural sand confirming to IS 383-1970 of zone I is used. Specific gravity and absorption capacity of fine aggregate is calculated according to the test procedures confirming to IS-2386 and the results obtained are compared with the code specifications.

Coarse aggregates

Locally available crushed graveled aggregates confirming to IS 383-1970 are used. The coarse aggregates of 20mm down size were used.

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 5, No. 1, March - May 2020
Pages 14-22 | Cosmos Impact Factor (Germany): 5.195
Received: 02.03.2020 Published: 28.05.2020

Water

Water fit for drinking is generally considered fit for making concrete. Water should be free from acids, oils, alkalies, vegetables or other organic impurities. Soft water also produces weaker concrete. Water has two functions in a concrete mix. Firstly, it reacts chemically with the cement to form a cement paste in which the aggregates are held in suspension until the cement paste has hardened. Secondly, it serves as a lubricant in the mixture of fine aggregate and cement.

Steel Fibres

Steel fibres of 1mm thickness and 60mm length giving aspect ratio of 60 of hooked end shape were used.Density of steel fibre was 7850 kg/m^3.

Fly ash

Fly ash is used as the mineral admixture which is replaced by the cement with percentages of 20% and 30%. The fly ash of class F is used by its weight of cement conforming IS 1727-1967

Super plasticizer

The super plasticizer of Conplast is used to improve the workability property at a dosage of 0.5-1.0% of binding agent

METHODOLOGY

To determine the compressive strength of the M25 grade of concrete with partial replacement of cement by fly ash in addition with steel fibres, for 28 days of curing and also comparative study of strength with conventional concrete.

To evaluate the cost difference between the fly ash based steel fibre reinforced concrete and conventional concrete

Compressive strength test:

Procedure

For compressive strength test, cube specimens of dimensions 150 x 150 x 150 mm were cast for M25 grade of concrete. Superplasticized (0.6% to 0.8% by weight of cement) was added to this. The moulds were filled with 0%,0.5%, 1%, 1.5%,and 2% fibres. Vibration was given to the moulds using table vibrator. The moulds are shown in the figure 2.2. The top surface of the specimen was levelled and finished. After 24 hours the specimens were demoulded and were transferred to curing tank where in they were allowed to cure for 28 days. After 28 days curing, these cubes were tested on digital compression testing machine as per I.S. 516-1959 as

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 5, No. 1, March - May 2020
Pages 14-22 | Cosmos Impact Factor (Germany): 5.195
Received: 02.03.2020 Published: 28.05.2020

shown in the figure 1. The failure load was noted. In each category three cubes were tested and their average value is reported. The compressive strength was calculated as follows.

Compressive strength (MPa) = Failure load / cross sectional area.

Figure: 1. Testing of Compressive strength test specimen

Figure: 2 Mould used for compressive test

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 5, No. 1, March - May 2020
Pages 14-22 | Cosmos Impact Factor (Germany): 5.195
Received: 02.03.2020 Published: 28.05.2020

RESULTS AND DISCUSSION

Table 1: Compressive strength of the specimens (cubes) in N/mm^2 for 28 days

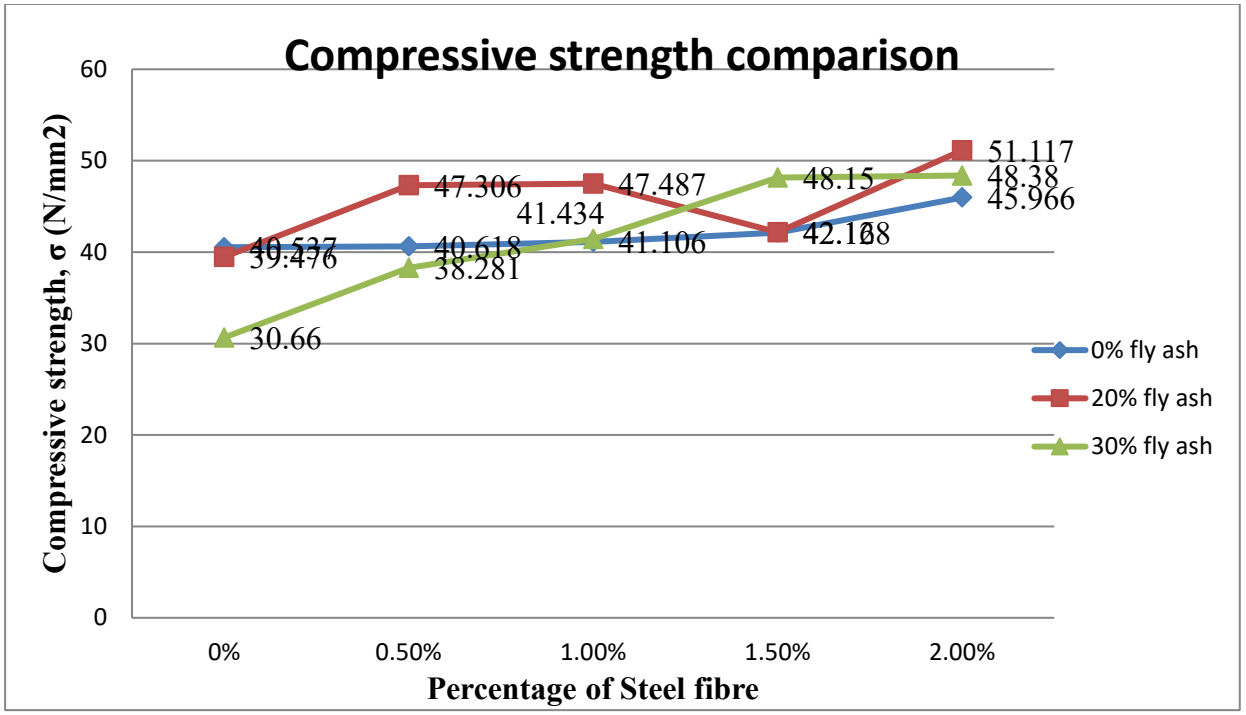
Fly ash	Steel fibres	Compressive strength, (N/mm^2)			
		1	2	3	Avg.
0%	0%	38.282	42.120	40.208	40.537
	0.5%	40.563	41.283	40.008	40.618
	1.0%	41.283	40.583	41.453	41.106
	1.5%	42.684	41.573	42.126	42.128
	2.0%	45.643	46.974	45.281	45.966
20%	0%	41.620	37.440	39.370	39.476
	0.5%	47.173	47.253	47.493	47.306
	1.0%	48.580	46.340	47.543	47.487
	1.5%	49.930	27.770	48.790	42.160
	2.0%	**50.640**	**51.780**	**50.932**	**51.117**
30%	0%	30.260	30.790	30.940	30.660
	0.5%	42.940	34.260	37.643	38.281
	1.0%	45.328	35.034	43.942	41.434
	1.5%	47.204	48.943	48.308	48.150
	2.0%	50.940	46.120	48.080	48.380

Graph No. 1: Comparison between 0%, 20% and 30% fly ash with 0%, 0.5%, 1%, 1.5% and 2% steel fibers addition

From the results it is observed that for the replacement of 20% of cement by fly ash with addition of 2% of steel fibers the compressive strength of the concrete is found to be higher. Compressive strength is lower low for no replacement of fly ash even with addition of 0, 0.5, 1.0, 1.5, & 2% steel fibres but it is clearly shows that the value of compressive strength will more or less gradually increasing. Beyond 20% fly ash replacement and addition of steel fibres the value of compressive strength again it is decreasing.

From the cost point of view, after rate analysis is made for both the concrete samples i.e. concrete with and without replacement. cost will be reduced by nearly 1.59 for the concrete with replacement of cement by fly ash with addition of steel.

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 5, No. 1, March - May 2020
Pages 14-22 | Cosmos Impact Factor (Germany): 5.195
Received: 02.03.2020 Published: 28.05.2020



COST ANALYSIS

Table no.2 Rate analysis of conventional concrete with steel fibre

Particulars	Quantity	Rate Rs.	Per	Amount Rs.
a) Materials				
Cement	502.09	7.00	Kg	3514.63
Fine aggregates	918.83	1.25	Kg	1148.54
Coarse aggregates(20mm down)	1481.17	1.00	Kg	1481.17
Steel fibre (2%)	157.00	80.00	Kg	12560.00
			Total	18704.33
b) Labour				
Head Mason	1/4 no.	125.00	Day	3.13
Mason	1/5 no.	115.00	Day	23.00
Mazdoor	1 no.	80.00	Day	80.00
Bhisti	1/5 no.	80.00	Day	16.00

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 5, No. 1, March - May 2020
Pages 14-22 | Cosmos Impact Factor (Germany): 5.195
Received: 02.03.2020 Published: 28.05.2020

	Total	122.13
	Total cost	(18704.33+122.13) =18826.46
c) water charge	@1% of the total	188.26
d) Profit and overhead	@10% of the total	1882.64
	Grand total	**Rs.20897.36/cum**

Table no. 3 Rate analysis of concrete with flyash and steel fibre

Particulars	**Quantity (Kg)**	**Rate Rs. P.**	**Amount Rs. P.**
a) Materials			
Cement	401.67	7.00	2811.69
Fly ash (20%)	100.42	4.00	401.68
Fine aggregates	918.83	1.25	1148.54
Coarse aggregates(20mm down)	1481.17	1.00	1481.17
Steel fibre (2%)	157.00	80.00	12560.00
		Total=	18403.08
b) Labour			
Head Mason	1/40 no.	125/day	3.13
Mason	1/5 nos.	115/day	23.00
Mazdoor	1 no.	80/day	80.00
Bhisti	1/5 no.	80/day	16.00
Total=			122.13
		Total cost	(18403.08+122.13) =18525.21
c) water charge		@1% of the total	185.25
d) Profit and overhead		@10% of the total	1852.52

Grand total = Rs. 20562.98/cum

ACKNOWLEDGEMENT

The authors would like to thank Dr. V. M. Patil , Principal Rural Engineering College Hulkoti ,teaching and non-teaching staff of for giving all the encouragement needed which kept the

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 5, No. 1, March - May 2020
Pages 14-22 | Cosmos Impact Factor (Germany): 5.195
Received: 02.03.2020 Published: 28.05.2020

enthusiasm alive.

CONCLUSION

- From experimental results, it is shown that the compressive strength of concrete specimen with partial replacement of cement by fly ash by 20% with addition of 2% of steel fibres given higher value of compressive strength.
- When compared to conventional concrete of same mix, the compressive strength is 10.07% in case of concrete made with 20% replacement of cement by fly ash and addition of 2% of steel fibre.
- According to the computed rate analysis we can conclude that use of flyash by partially replacing cement and with addition of 2% steel fibre is economical when compared to conventional concrete with 2% steel fibre by 1.59% of profit
- The increase in compressive strength by 10.07% and profit of 1.59% can be utilized in major projects by replacing concrete by 20% of fly ash and adding 2% of steel fibre.

REFERENCES

- A.M. Shende, A.M. Pande, and M. GulfamPathan (2012), *"Experimental Study on Steel Fibre Reinforced Concrete for M-40 Grade",* International Refereed Journal of Engineering and Science (IRJES). Volume 1, Issue 1, pp. 043-048
- Amit Rai, Dr. Y.P Joshi, (2014), *"Applications and Properties of Fibre Reinforced Concrete",* Journal of Engineering Research and Applications. Volume 4, Issue 5, pp.123-131
- A.H.L.Swaroop, K. Venkateswara Rao, P. Kodandaramarao (2013) - *"Durability stuties on concretewith Fly-ash&GGBS"* International Journal of Engineering Research and Applications Vol.3, pp. 258-289 ISSN: 2248 – 9622
- Alvin Harison, Vikas Srivastava and Arpan Herbent (2014) - *"Effect of Fly-ash on CompressiveStrength of Portland Pozzolona Cement Concrete"* Journal of Academia and Industrial Research, Vol.2, ISSN:2278-5213.
- AmanJatale, Kartiey Tiwari, SahilKhandelwal (2013) - *"Effects on Compressive Strength WhenCement is Partially Replaced by Fly Ash"* IOSR Journal of Mechanical and Civil Engineering, e-ISSN 2278-1684, Vol. 5, pp 34-43.

International Research Journal in Global Engineering and Sciences. (IRJGES)
ISSN : 2456-172X | Vol. 5, No. 1, March - May 2020
Pages 14-22 | Cosmos Impact Factor (Germany): 5.195
Received: 02.03.2020 Published: 28.05.2020

- Arivazhagan K et al. (2011) – *"Effect of Coal Fly-ash on Agricultural Crops: Showcase project on use of fly-ash in agriculture in and around Thermal Power Station Areas of National Thermal PowerCorporation Ltd., India",*World of coal fly-ash (WOCA) Conference, May 9-12, in Denver CO USA).
- Dr. Deepa Sinha, Prof. C.B. Mishra andRavindra V. Solanki (2014*)." Comparison of Normal Concrete Pavement with Steel Fibre Reinforced Concrete Pavement",* Indian journal on of applied research, Volume: 4, Issue: 8, pp. 233-235.
- Fareed Ahmed Menon, Nafees Ahmed Menon and RizwanaliMemom(2010) -"*Study of compressivestrength of concrete with coal power plant Fly-ash as partial replacement of cement and Fineaggregate"* Mehran University Research Journal of Engineering & Technology, Vol. 29. .no.4, ISSN 0254-7821.
- Nataraja, M. C., Dhang, N and Gupta, A. P (1999*)., 'Statistical Variations in Impact Resistance of Steel Fibre Reinforced Concrete Subjected to Drop Weight Test'*,Cement and Concrete Research, Pergoman press, USA, Vol. 29, No. 7, 1999, pp.989-995
- Saravana Raja Mohan. K, Parthiban. K Associate Dean and Assistant Professor (2011) *"Strength and behaviour of Fly Ash based Steel Fibre Reinforced Concrete Composite"*International Journal Of Civil And Structural Engineering Volume 2, No 1.
- TarunSama, DilipLalwani, Ayush Shukla, Sofi A (2015) *"Effect of Strength of Concrete by Partial Replacement of Cement with Flyash and addition of Steel Fibres"* , Journal of Civil Engineering and Environmental Technology. Volume 1, Number 1; August, 2014 pp. 5-9.
- P. Jayeshkumar, L.B Zala, .F. S Umrigar (2012*) "experimental investigations on partial replacement of cement with fly ash in design mix concrete"* , International Journal of Advanced Engineering Technology. IJAET/Vol.III/ Issue IV/Oct.-Dec., 2012/126-129
- C Freeda Christy, D Tensing (2010) *" Effect of class – F flyash as partial replacement with cement and fine aggregate in mortar" ,* Indian Journal of Engineering & materials Science, Volume 17, April 2010, pp. 140-144 .
- M.A. Islam, M.M. Rahman and M. Ahmed(2011) *"Polymer-modified Concrete: World Experience and Potential for Bangladesh"* , Indian concrete journal.
- Faisal F Wafa and Samir A. Ashour (1992*) "Mechanical Behavior of High Strength Fibre Reinforced Concrete"* , Journal of Engineering Research and Applications. ISSN : 2248-9622, Vol. 3, Issue 6, Nov-Dec 2013, pp.1617-1624