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An Experimental Study on Strength of Concrete by Partial Replacement of Cement with Fly-Ash and Rice Husk Ash with addition of Steel Fibres

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ABSTRACT: Many researches has been currently going to modify and improved the concrete properties by the addition of different types of materials. The aim of this paper is to study the behavior of M40 grade of concrete with w/c of 0.43 and to determine the compressive strength, flexural strength and split tensile strength of concrete cement when cement is replaced by fly ash, rice husk ash with addition of steel fiber. Three different replacements levels namely 10%, 20%, and 30% of fly ash and rice husk as well as with combined replacement of fly ash and rice husk ash chosen for the study concern to replacement method and steel fiber substitute in concrete was 0%, 0.25%, 0.50%, 0.75%, 1.0% respectively. It was seen that the workability of concrete had been found to be decrease with increasing the percentages of fly (FA), rice husk (RHA) and steel fiber. Maximum compressive strength obtained for 28 days is 53.77 N/mm^2 with the replacement of 10% of cement by fly ash (FA). Maximum flexural strength obtained for 28 days is 5.89 N/mm^2 with the replacement of 10% of cement by fly ash (FA). Maximum split tensile strength obtained for 28 days is 4.21N/mm^2 with the replacement of 10% of cement by fly ash (FA). The combination of 20% fly ash+10% rice husk and 0.75% of steel fiber gives optimum strength results.

Keywords: Fly ash (FA), Rice husk ash (RHA), Steel Fibres (SF), Compressive Strength, Flexural Strength and Split Tensile Strength.

I. INTRODUCTION

Ordinary Portland Cement (OPC) is becoming an energy exhaustive and pricey constituent in the production of concrete, which is the most widely used construction material. It is expected that the cement requirement will grow threefold to about 3.5 billion tonnes by the year 2015. Although the requirement is vast, the raw materials required for the cement production is relatively less. In addition to the expensive process of cement production, the environmental impact due to the emission of Carbon dioxide (CO_2) is alarming, since it is the major source for global warming. Bhanumathidas and Mehta (2001) have estimated that to produce one ton of cement, nearly 1.5 tones of earth minerals are consumed and one ton of CO_2 is emitted in the atmosphere. One of the efficient methods to conserve the natural resources and reduce the impact on the environment is to go for SCMs, wherein the quantity of OPC can be saved. Since most of the SCMs are waste materials, which are pollutants when dumped in the lands, blending of them in concrete becomes a safe and effective disposal method. Some of the waste materials which improve the properties of concrete are fly ash, Ground Granulated Blast furnace Slag (GGBS), silica fume, RHA, LP, copper slag and so on. Most of the SCMs are pozzolanic in nature and hence they are helpful in the increasing the strength and reduce the permeability of concrete with age. Therefore, the blending of cement with SCMs have always resulted in many advantages such as saving in cement, recycling of waste products, and increase in physical properties along with increased durability of concrete and reduced impact on the environment through reduced green house gases production. Pozzolana, fly ash, GGBS and limestone are the main materials that are permitted by the European Standards EN 197-1(2000).

Also the concrete is weak in tension, so with the addition of steel fibres it's flexural and tensile strength is also enhanced. The advantage of adding steel fibres is that it prevents crack from proceeding by applying tweaking forces at the tips of the crack, thus delaying their advancement across the concrete and helps in attaining a gradual failure and, increasing the tensile and flexural strength to many folds.

II. MATERIAL USED

Cement: Ordinary Portland cement of 43 grade has been used in this experimental work. OPC 43 grade of J.K SUPER cement has been used after investigate the strength of cement at 28 days as per IS 4031-1988.

Fine Aggregate: Locally available river sand passing through 4.75mm IS sieve conforming to grade zone I of IS 383-1970 was used as fine aggregate. It was having a fineness modulus, specific gravity are 2.31, 2.89 respectively.

Coarse aggregate: The coarse aggregate are obtained from a local quarry has been used. The Coarse aggregate with a maximum size 20mm having a specific gravity 2.89. In this experiment work coarse gravel of 20mm and crushed in 60:40.The physical properties of coarse aggregate like fineness modulus, specific gravity are 2.31, 2.89 respectively.

Fly Ash: Fly ash used was obtained from Rajiv Gandhi Thermal Power Plant, Khedar, Hissar, India. Fly ash is one of the residues generated in the combustion of coal. Fly ash is generally captured from the chimneys of power generation facilities, whereas bottom ash is, as the name suggests, removed from the bottom of the furnace. In the past, fly ash was generally released into the atmosphere via the smoke stack, but pollution control equipment mandated in recent decades now require that it be captured prior to release. It is generally stored on site at most US electric power generation facilities. Depending upon the source and makeup of the coal being burned, the components of the fly ash produced vary considerably, but all fly ash includes substantial amounts of silica (silicon dioxide, SiO_2) (both amorphous and crystalline) and lime(calcium oxide,(CaO). Fly ash has whitish gray in colour and having specific gravity and bulk density are 2.10, 1120kg/m3.

Rice Husk Ash: Rice husk ash used was obtained from rice mill located in Sirsa. The Specific gravity of rice husk ash is 1.99 and bulk density is 105.9kg/m3 RHA, produced after burning of Rice husk (RH) has high reactivity and pozzolanic property. Indian Standard code of practice for plain and reinforced concrete, IS 456- 2000, recommends use of RHA in concrete but does not specify quantities. Chemical compositions of RHA are affected due to burning process and temperature. Silica content in the ash increases with higher the burning temperature. Rice husk ash has sligth black in colour.

Steel Fibre: steel wire of 0.5 mm diameter has been used in this investigation. The steel fibre of length 40 mm and of aspect ratio 80 has been used in this experimental work. All the steel fibres are straight in shape

Water: Water used for mixing and curing was clean and free from injurious amounts of oils, acids, alkalis, salts and sugar, organic substances that may be deleterious to concrete. As per IS 456- 2000 Potable water is generally considered satisfactory for mixing and curing of concrete. Accordingly, potable tap water was used for the preparation of all concrete specimens.

Table 1: Chemical Properties of Cement (OPC), Fly Ash And Rice Husk Ash.

Materials	**SiO_2 (Sillica)**	**$A1_2O_3$ (Alumina)**	**Fe_2O_3 (iron oxide)**	**CaO (calcium oxide)**	**Mgo (Magnisium oxide)**	**LOI (Loss on ignition)**	**K_2O (Potassium oxide)**	**Na_2O_3 (Sodium oxide)**	**SO_3 (sulphur tri oxide)**
Cement	19.69	5.52	3.69	62.90	2.52	0.9	0.89	0.24	2.73
Fly ash	46.8	23.7	13.2	1.2	1	6.9	0.82	0.95	1.72
Rice husk ash	92.1	0.51	0.40	0.55	0.08	-	1.53	-	0.12

Table 2: Characteristics Properties Of Cement.

Sr. No.	Characteristics	Experimental value	Specified value as per IS:8112-1989
1	Consistency of cement(%)	33%	-
2	Specific gravity	2.98	3.15
3	Initial setting time(minutes)	35	>30 As Per IS 4031-1968
4	Final setting time(minutes)	282	<600 As per IS4031-1968
5	Compressive strength(N/mm2) 3 days 7 days 28 days	26.56 39.57 47.96	>23 >33 >43
6	Soundness(mm)	1.00	10
7	Fineness of cement	5%	10% As Per IS 269-1976

III. EXPERIMENTAL PROGRAMME

Experimental programme comprises of test on cement, concrete with partial replacement of cement with FA and RHA with addition of steel fiber.

Mixture Proportioning: The mix proportion was done as per the IS 10262-1982[11]. The target mean strength was 48.25 Mpa (40) for the OPC control mixture. Mix design is a term used for determining quantities of different constituents, which in our experiment was done with Indian standard method. The quantities of cement, coarse aggregate, fine aggregate, fly ash, rice husk ash and steel fiber were found out with help of this method. The proportions for normal mix of M40 Normal Mix were: - Cement: Sand: Coarse Aggregate: Water. After calculating the quantity, all constituents were weighed using electronic weighing machine. First of all cement, flyash and rice husk ash were thoroughly mixed in dry state, and sand was later added to the mixture. To the above mixture coarse aggregate was added. Now the whole mixture was mixed manually. Steel fibres were added during mixing according to the weight of concrete (0% to 1%). Water was finally added to the dry mixture. After mixing operation, moulding was done and as the moulds were filled tamping was done simultaneously for compaction.

Then moulds were transferred to vibrators where they were vibrated for 1-2 minutes to provide uniform compaction. After 24 hours demoulding was done and the specimen was placed in curing tank for 7 and 28 days.

IV. EXPERIMENTAL METHODOLOGY

Compressive Strength: To examine the compressive strength Standard cubical moulds of size 150mm × 150mm×150mm made of cast iron were used to cast concrete specimens to test compressive strength of concrete.

Fig. 1. Cube Under Compression Testing Machine (Ctm).

To determine the compressive strength we casted cubes with different percentage of fly ash, rice husk ash and steel fiber in the concrete. After that the specimen are tested at 7 days and 28 days at compression testing machine (CTM) as per I.S. 516-1959[17].

Flexural Strength: To examine the flexural strength of plane mortar and mortar with various percentages of fly ash, rice husk ash and steel fiber content in concrete has been investigated by testing beams of 150mm × 150mm × 700mm under two-point load because of small span between the supports. In this flexural strength, the effective length of the beam was 640 mm.

Split Tensile Strength: To examine the Split tensile strength of plane mortar and mortar of various percentages of FA, RHA and steel fiber contents in concrete has been investigated by testing cylinders of 300mm × 150mm under CTM of 1000 KN capacity.

Fig. 2. Test Set Up For Beam.

Fig. 3. Cylinder under Ctm.

V. TEST RESULTS

Table 3: Compressive Strength Results.

Sr. No	Fly ash	Rice husk ash	% of steel fiber	Compressive strength after 7 days N/mm2	Compressive strength after 28 days N/mm2
1	0%	0%	0%	39.55	52.66
2	10%	0%	0%	40.22	53.77
3	20%	0%	0%	39.99	53.73
4	30%	0%	0%	37.55	50.36
5	0%	10%	0%	38.81	51.99
6	0%	20%	0%	37.33	48.22
7	0%	30%	0%	35.77	45.99
8	10%	10%	0%	37.32	50.73
9	20%	10%	0%	36.95	49.47
10	20%	10%	0.25%	37.55	51.33
11	20%	10%	0.50%	38.29	52.33
12	20%	10%	0.75%	38.66	53.10
13	20%	10%	1.0%	37.03	49.33
14	20%	10%	0%	33.92	45.77

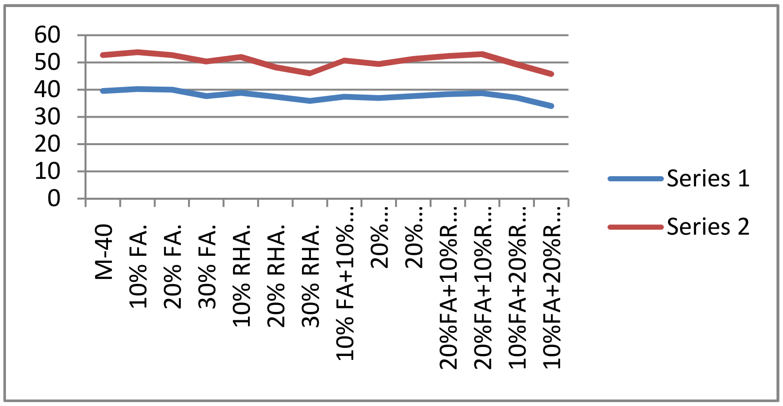

Fig. 4. Variation of Compressive Strength at Different Ages.

Table 4: Flexural Strength Results.

Sr. No	**Fly ash**	**Rice husk ash**	**% of steel fiber**	**Flexural strength after 7 days N/mm^2**	**Flexural strength after 28 days N/mm^2**
1	0%	0%	0%	3.73	5.86
2	10%	0%	0%	3.76	5.89
3	20%	0%	0%	3.35	5.48
4	30%	0%	0%	3.15	5.26
5	0%	10%	0%	2.98	4.81
6	0%	20%	0%	2.48	3.96
7	0%	30%	0%	2.40	3.35
8	10%	10%	0%	2.48	3.91
9	20%	10%	0%	2.42	3.85
10	20%	10%	0.25%	2.54	4.04
11	20%	10%	0.50%	2.61	4.1
12	20%	10%	0.75%	2.69	4.16
13	20%	10%	1.0%	2.63	4.09
14	10%	20%	0%	2.27	3.39

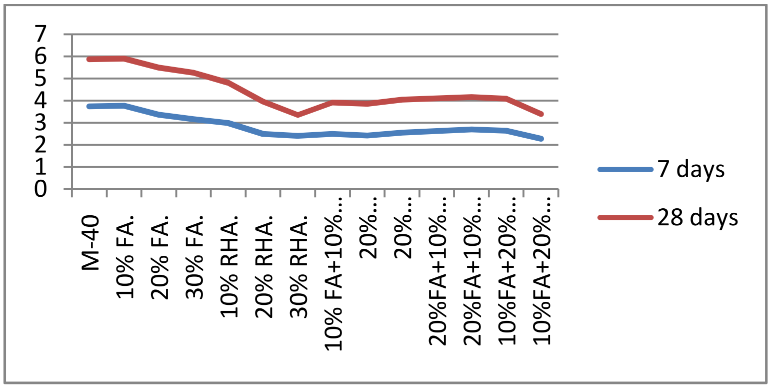

Fig. 5. Variation of Flexrual Strength at Different Ages.

Table 5: Split Tensile Strength Results.

Sr. No	**Fly ash**	**Rice husk ash**	**% of steel fiber**	**Split tensile strength after 7 days N/mm^2**	**Split tensile strength after 28 days N/mm^2**
1	0%	0%	0%	2.6	4.19
2	10%	0%	0%	2.68	4.21
3	20%	0%	0%	2.53	3.69
4	30%	0%	0%	2.35	3.46
5	0%	10%	0%	2.12	3.11
6	0%	20%	0%	1.90	2.87
7	0%	30%	0%	1.59	2.68
8	10%	10%	0%	2.19	2.89
9	20%	10%	0%	2.04	2.72
10	20%	10%	0.25%	2.15	2.97
11	20%	10%	0.50%	2.33	3.11
12	20%	10%	0.75%	2.61	3.41
13	20%	10%	1.0%	2.35	3.18
14	10%	20%	0%	1.66	2.35

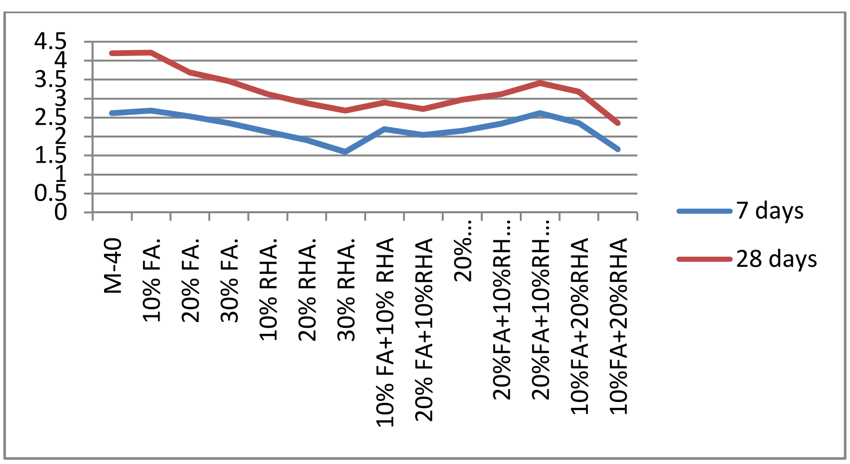

Fig. 6. Variation of Split Tensile Strengt at Different Ages.

VI. CONCLUSION

The following conclusions could be drawn from the present investigation.

1. The workability of concrete had been found to be increase with fly ash(FA).
2. The workability of concrete had been found to be decrease with increasing the rice husk(RHA) in concrete.
3. The inclusion of steel fiber reduces the workability with increasing fiber content.
4. Maximum compressive strength obtained for 28 days is 53.77 N/mm2 with the replacement of 10% of cement by fly ash (FA).
5. Maximum flexural strength obtained for 28 days is 5.89 N/mm2 with the replacement of 10% of cement by fly ash (FA).
6. Maximum split tensile strength obtained for 28 days is 4.21N/mm2 with the replacement of 10% of cement by fly ash(FA).
7. Compressive strength increase with increasing the percentages of fly ash (FA), rice husk(RHA) upto replacement (20% FA and 10%RHA) of cement in concrete and replacement steel fiber upto 0.75% of the concrete.
8. Flexural strength increase with increasing the percentages of fly ash(FA), rice husk(RHA) upto replacement (20% FA and 10%RHA) of cement in concrete and replacement steel fiber upto 0.75% of the concrete.
9. Split tensile strength increase with increasing the percentages of fly ash(FA), rice husk(RHA) and upto replacement (20% FA and 10%RHA) of cement in concrete and replacement steel fiber upto 0.75% of the concrete.
10. It is found that the addition of steel fiber into concrete the small change in compressive strength.
11. Steel fiber showed more significant effect on compressive strength, flexural strength and split tensile strength at 0.75% by volume fraction.

12The combination of 20% fly ash+10% rice husk ash and 0.75% of steel fiber gives maximum strength results

REFERENCES

[1]. Rinki K. Khot, R. S. Deotale, Abhijeet. R. Narde, (2014). To Study The Partial Replacement Of Cement By FA & RHA And Natural Sand By Quarry Sand In Concrete. *IOSR Journal of Mechanical and Civil Engineering* (IOSR-JMCE),Volume 11,e-ISSN: 2278-1684,p-ISSN: 2320-334X

[2]. Satish H. Sathawanea, Vikrant S. Vairagadeb and Kavita S Kenec, (2013). Combine Effect of Rice Husk Ash and Fly Ash on Concrete by 30% Cement Replacement.

[3]. R. S. Deotale, S. H. Sathawane, A.R. Narde, (2012). Effect of Partial Replacement of Cement by Fly Ash, *Rice Husk Ash with Using Steel Fiber in Concrete.* Volume **3** ISSN 2229-5518

[4]. Vasudev R, B Vishnuram, (2013). Studies on steel fibre reinforced concrete- a sustainable approach ”*international journal of scientific & engineering research*, volume **4**, issue 5, may-2013 1941.

[5] T. Subramani , K.S. Ramesh, (2015). Experimental Study On Partial Replacement Of Cement With Fly Ash And Complete Replacement of Sand With M sand. *International Journal of Application or Innovation in Engineering & Management (IJAIEM)* Volume **4**, ISSN 2319 – 4847

[6] Rohit Siwacha, S.S. Kajalb, Nikita Rajpalc, (2015). Effect Of Fly Ash And Rice Husk Ash On Strength Characterstics Of Pavement Quality Concrete. *International Journal of Science, Engineering and Technology Research (IJSETR)*, Volume **4**, ISSN: 2278 –7798.

[7]. M. Sivakumar,T. Manikandan, (2014). An Experimental Study on Strength Development of Concrete Containing Composite Ash (Flay Ash-F & Rice Husk Ash). *International Journal of Engineering Research & Technology (IJERT)* Vol. **3**, ISSN: 2278-0181

[8]. Tarun Sama, Dilip Lalwani, Ayush Shukla, Sofi A., (2014). 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**, ISSN: 2349-8404

[9]. Apoorv Singh, Prof. R.D Patel, Khalid Raza (2014). A Comparative Study on Compressive and Flexural Strength of Concrete Containing Different Admixtures as Partial Replacement of Cement, Vol. **4** ISSN : 2248-962.2

[10]. Alvin Harison, VikasSrivastava and Arpan Herbert. Effect of Fly Ash on Compressive Strength of Portland Pozzolona Cement Concrete. *Journal of Academia and Industrial Research (JAIR),* Volume **2**, ISSN: 2278-5213.

[11]. Godwin A. Akeke, Maurice E. Ephraim, Akobo, I.Z.S and Joseph O. Ukpata, (2013). Structural Properties Of Rice Husk Ash Concrete. *International Journal of Engineering and Applied Sciences* vol. **3** ISSN2305-8269

[12]. T. Phani Madhavi, V. Sampathkumar, P. Gunasekaran, (2013). Partial replacement of cement and fine aggregate byusing fly ash and glass aggregate. *International Journal of Research in Engineering and Technology*, eISSN: 2319-1163 | pISSN: 2321-7308.

[13]. Amit Rana1, (2013). Some Studies on Steel Fiber Reinforced Concrete. *International Journal of Emerging Technology and Advanced Engineering*, Volume **3**, ISSN 2250-2459.

[14]. IS 10153-1982. Guidelines for utilization and disposal of fly ash. Bureau of Indian Standard, New Delhi.

[15]. Indian standard Code of Practice for Plain and Reinforced Concrete, IS- 456: 2000, 4th Revision, Bureau of Indian Standards, New Delhi.

[16]. Indian standard recommended guidelines for Concrete Mix Design, IS 10262: 2009. 1st Revision, Bureau of Indian Standards, New Delhi.

[17]. Indian standard Recommended guidelines for Concrete Mix Design, IS 10262: 1982, 5th Reprint 1998, Bureau of Indian Standards, New Delhi.
[18]. Indian standard Specifications for coarse and fine aggregates from natural sources for concrete, IS 383-1970, Bureau of Indian Standards, New Delhi.
[19]. Kumar, J., Singh, V., Pareek, R.K., (2015). "A Study on the Effect of Rice Husk Ash and Fly Ash on Strength Parameters of Pavement Quality Concrete. *International Journal on Emerging Technologies;* **6**(2): 28-34(2015) ISSN No. (Online): 2249-3255, ISSN No. (Print): 0975-8364.
[20]. Arun, Pareek, R.K., Singh, V. (2015). Effect of rice husk ash & plastic fibre on concrete strength, *Int. journal of Civil and Structural Engineering*, **6** (1): 2015 ISSN 0976- 4399.
[21]. Indian standard method of tests for strength of concrete, IS 516: 1959, Edition (1991-07), *Bureau of Indian Standards, New Delhi.*
[22]. Bansal, R., Pareek, R.K., Singh, V. (2015). Effect on Compressive Strength with Partial Replacement of Fly Ash, *Int. Journal on Emerging Technologies*, **6**(1): 1-6 (2015) (ISSN No. (Print): 0975-8364 (Online): 2249-3255.