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European Journal of Advances in Engineering and Technology, 2014, 1(2): 89-92

Research Article

ISSN: 2394 - 658X

Studies on Partial Replacement of Sand with Flyash in Concrete

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ABSTRACT

Fly ash is generally used as replacement of cement, as an admixture in concrete, and in manufacturing of cement. Concrete containing fly ash as partial to complete replacement of fine aggregate will improve its strength on long-term basis. In this investigation fly ash is used as sand replacement material. The material mix of proportion 1:1.58:3.2:0.48. Each category comprises of various percentages of sand replacement material in increasing order i.e. 20%, 40%, 60%, 80% and 100%. The workability is maintained constant range for all mixes. Strength characteristics such as compressive strength split tensile strength and modulus of elasticity of concrete mixes are found out for 7, 14 and 28 days curing period and results are analyzed.

Key words: Concrete, fly ash, sand, compressive strength, split tensile strength and modulus of elasticity

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INTRODUCTION

Fly ash is a waste product which is generated in thermal power stations. The quantity of fly ash produced from thermal power plants in India is approximately 250 million tons each year, and its percentage utilization is less than 13%. Majority of fly ash produced is of Class F type. Fine aggregate is natural resource in nature and to meet the demand of concrete in construction we are exploiting it gradually. Here concrete is made by using flyash as replacement to sand. In this way we can save the natural resource by reducing its usage by using alternative product. The demand for building materials like cement, sand and coarse aggregate is increasing in the country due to increase in growth of population, economy and living standards of the people. Cement production in the country is estimated to be 347metric tones per annum. Cement production grew by 5% year by year. Cement concrete is the most preferred material of the construction for its wide variety of skills, ease in production and use. There are three aspects in the use of concrete. The first one is the durability aspect. The second aspect is the economy in construction by improved design and cost reduction in cost of materials. The third aspect is energy conservation and environment protection. We can satisfy these three aspects by using the fly ash in concrete.

MATERIALS USED

- **Cement:** Ordinary Portland cement of 43 grade is used. Specific gravity of cement is found to be 3.1.
- **Sand:** Locally available river sand passing through 4.75 mm I.S .Sieve is used. The specific gravity of the sand is found to be 2.62 and confirmed to grading zone-II as per IS: 383-1970 specification.
- **Coarse aggregate:** The crushed stone aggregates were collected from the local quarry. The coarse aggregates used in the experimentation were 20mm and down size aggregate
- **Fly ash:** The (class –F) Fly ash, which is major ingredient of present work was procured from RayalaSeema Thermal Power Station, Muddanur, Kadapa District, Andhra Pradesh .
- **Water:** Potable fresh water available from local sources was used for mixing and curing of these specimens.
- **Super plasticizer:** Conplast SP430A1 1% is used

CASTING AND CURING

The cubes were cast in steel moulds of inner dimensions of 150 x 150 x 150 mm, the cylinders were cast in steel moulds of inner dimensions as 150mm diameter and 300mm height. All the materials are weighed as per mix proportion of 1:1.58:3.2 with a W/C ratio of 0.48 which correspond to M20 grade of concrete. Sand is replaced with fly ash. Each mix comprises of various percentages of sand replacement material in increasing order i.e. 20%, 40%, 60%, 80% and 100%. The specimens were cured for a period of 7, 14 and 28 days.

TEST RESULTS AND DISCUSSION

Influence of Fly Ash on Workability

The workability of mixes has been measured by Slump test. The values of Slump results are presented in Table 1 and Fig. 1 From this it is observed that the Slump value decrease with increase in the % of fly ash in the concrete mix. The decrease of workability may be due to higher water absorption of fly ash.

Table - 1 Workability of Concrete

S.No	% replacement of fly ash	Slump	Water/(cement+flyash)
1.	0	60	0.45
2.	20	50	0.45
3.	40	45	0.36
4.	60	40	0.33
5.	80	35	0.33
6.	100	30	0.32

Influence of Fly Ash on Compressive Strength

The compressive strengths for all mixes are presented in the following tables and Fig.s. From this, it can be observed that the 7 days, 14 days and 28 days compressive strength increase with the increase in the percentage of fly ash up to 40% and then decreases to 100%. For 20% replacement of fly ash there is increase in cube compressive strength by 11.96% over sand in concrete. For 40% replacement level, the compressive strength has increase by 12.58% when compared with reference concrete. At 100% replacement of fly ash, the compressive strength has decreased by 14.49% over fly ash concrete.

Table - 2 Compressive Strengths of Fly Ash Concrete for 7, 14 and 28 Days

S.No	% of flyash added	Compressive Strength (N/mm^2) for 7 days	% change in compressive strength	Compressive Strength (N/mm^2) for 14 days	% change in compressive strength	Compressive Strength (N/mm^2) for 28 days	% change in compressive strength
1.	0	22.3	--	32	--	38.09	--
2.	20	24.45	2.15	43.56	11.56	50.05	11.96
3.	40	26.31	4.01	44.45	12.45	50.67	12.58
4.	60	19.96	-2.34	34.75	2.75	38.18	0.09
5.	80	14.36	-7.94	26.27	-5.73	33.51	-5.73
6.	100	7.42	-14.88	17.74	-14.26	23.6	-14.26

Comparative Study of Compressive Strengths for 7, 14 and 28 Days

We can observe from the following graph compressive strength increases with Increase in age of concrete. From the graph 28 days compressive strength is more compare to the 7 and 14 days compressive strength. Maximum compressive strength obtained at 40% flyash in all the ages of concrete. The graphical representation of compressive strengths is shown in Fig. 2.

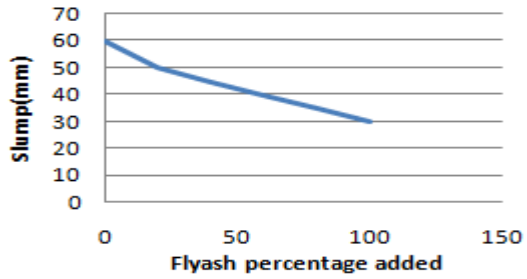

Fig. 1 Slump vs flyash(%)

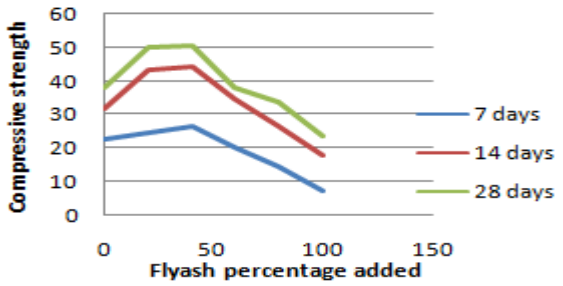

Fig. 2 Compressive strength vs % fly ash for 7, 14 and 28 days

Influence of Fly Ash on Spilt Tensile Strength

The variation of 7 days, 14 days and 28 days Split tensile strength of fly ash mixes is presented in the following tables and figures. From these it is observed that the split tensile strength decrease with the increase in the percentage of fly ash up to 100%. For 20% of fly ash there is minor increase in split tensile strength by 2.5% over the fly ash concrete. For 80% and 100%, the split tensile strength has decreased by 29 and 36% respectively over granite aggregate concrete (reference mix).

Table - 3 Split Tensile Strength for 7, 14 and 28 Days

S.No	% of flyash added	Split tensile Strength (N/mm^2) for 7 days	% change in Split tensile strength for 7 days	Split tensile Strength (N/mm^2) for 14 days	% change in Split tensile strength for 14 days	Split tensile Strength (N/mm^2) for 28 days	% change in Split tensile strength for 28 days
1.	0	2.4	--	2.57	--	3.25	--
2.	20	2.48	.08	3.11	0.54	3.34	0.09
3.	40	2.55	0.15	3.34	0.77	3.4	0.15
4.	60	2.36	-0.04	2.55	-0.02	3.34	0.09
5.	80	2.1	-0.3	2.12	-0.45	2.31	-0.94
6.	100	1.98	-0.42	2.04	-0.53	2.1	-1.15

Comparative Study of Split Tensile Strengths for 7, 14 and 28 Days

We can observe from the following graph split tensile strength increases with Increase in age of concrete. From the graph 28 days split tensile strength is more when compared with the 7 and 14 days strength. Maximum tensile strength obtained at 40% fly ash in all the ages of concrete. The graphical representation of Split tensile strengths is shown in Fig. 3.

Modulus of Elasticity (E)

We can observe from the following graph modulus of elasticity increases with increase in percentage of fly ash in concrete. From the graph 7 days modulus of elasticity is increasing up to 40% then decreases. Maximum modulus of elasticity is obtained at 60% fly ash in concrete. The graphical representation of modulus of elasticity is shown in Fig. 4.

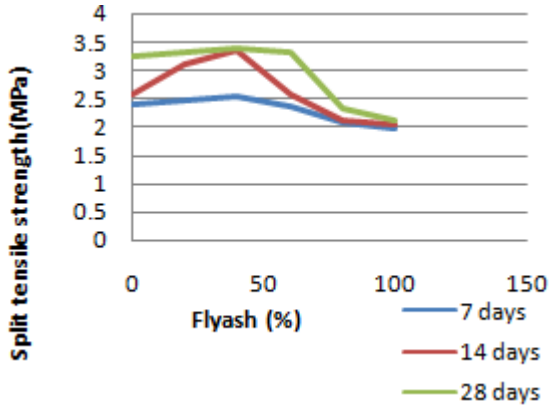

Fig. 3 Split tensile strength vs fly ash (%)

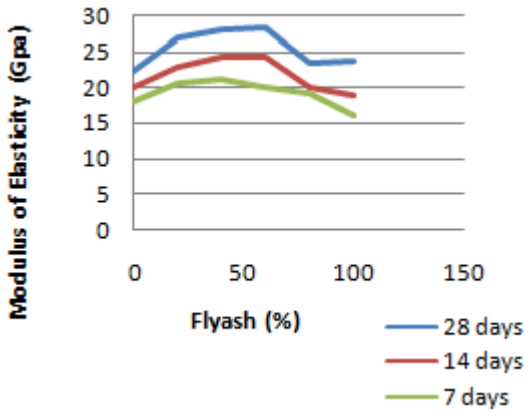

Fig. 4 Modulus of elasticity vs fly ash (%)

Table - 4 Modulus of Elasticity (E) values

S.No	% of fly ash added	Modulus of Elasticity(E) value For 7 days	Modulus of Elasticity(E) value For 14 days	Modulus of Elasticity(E) value For 28 days
1.	0	$1.8*10^4$	$2.01*10^4$	$2.22*10^4$
2.	20	$2.05*10^4$	$2.3*10^4$	$2.71*10^4$
3.	40	$2.1*10^4$	$2.43*10^4$	$2.8*10^4$
4.	60	$2.0*10^4$	$2.42*10^4$	$2.84*10^4$
5.	80	$1.9*10^4$	$2.0*10^4$	$2.34*10^4$
6.	100	$1.6*10^4$	$1.9*10^4$	$2.36*10^4$

CONCLUSION

- The workability for fly ash concrete decreases when compared with sand concrete.
- The compressive and split tensile strengths increase with increase in flyash percentage in the concrete mix up to 40% and decreases beyond 40%.
- The modulus of elasticity of concrete increases upto 60% replacement of sand with flyash and it decreases beyond 60%.
- It is economical, and eco-friendly.
- The replacement of sand with fly ash upto 50% is beneficial for the concrete works.
- This study could enlighten the local people to use fly ash to replace sand for concrete works.
- We can save natural resources by partial replacement of sand with fly ash, as sand is scarce.

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