LABORATORY INVESTIGATION ON DLC INCORPORATING FLY ASH AND RHA AS PARTIAL REPLACEMENT OF OPC

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AIM: Laboratory Investigation on DLC Incorporating Fly Ash and RHA as Partial Replacement of OPC

ABSTRACT: Fly ash and Rice hush ash can be used as cement replacement in concrete .This research paper looks at the comparative study of a standard DLC mix when fly ash and rice husk ash substituted each for cement with respect to compressive strength .the result from the research shows that when we replace cement with fly ash its strength is increases from 0 to 10% ,then its decreases .When we talk about rice husk its strength also increases in a proper manner but the fly ash shows better results, fly ash utilization in concrete as partial Replacement of cement gaining importance day by day. fly ash is produced by coal in thermal power plant and with the help of technological improvement we produced good quality fly ash. when we talk about rice husk it is produced by rice mill industry as a waste product of paddy (rice).In this study we used IRC SP 49:2014 code for dry lean concrete .fly ash is a fine particulate material with main constituents being silica, aluminum oxide, ferric oxide these chemicals are responsible for its better pozzolanic activity. When we compare to rice hush ash .also its increases the workability and durability of dry lean concrete.

KEYWORDS: dry lean concrete, fly ash, rice husk ash, partial replacement, compressive strength

1. INTRODUCTION

The purpose of this research paper is to investigate the replacement of cement with Fly ash and RHA in the production of DLC with express objective of reducing the production of green house gases emission by manufacturers of pozzolans .pozzolans are materials which has little or no inherent cementitious properties ,but which develop cementitious properties in the presence of calcium hydroxide and water .such materials are derived from natural deposits.fly ash are basically produced by combustion of coal in thermal power plant .when we talk about RHA it is mainly the waste product of rice mill industry there are currently three classes of pozzolana defined by ASTM: class N, class C, class F ,class F is fly ash nominally produced from anthracite ,bituminous and some sub bituminous coals. The paper deal with the physical strength properties of DLC when the ordinary Portland cement is replaced with fly ash and RHA of varying proportion .presently large amount of fly ash and RHA are generated in the coal industry and rice mill industry and its affect the humans and environment because it's a waste product of these industry .this project describes the feasibility of using fly ash and RHA in concrete production as partial replacement of cement in India the industry of fly ash and RHA are abundant because India has large number of thermal power plant and rice mill industry so we can use all these waste material in place of cement .fly ash and RHA are also good because these are waste products and when we used in concrete production it also help to environment .if varying fly ash and RHA contents on the physical and mechanical property of fresh hardened concrete we have been investigated .this results shows that these industrial bi products improving the concrete performance up to 30% .the compressive strength of DLC was measured for **7days** .in order to evaluate the effect of fly ash and RHA on mechanical behavior of DLC.

2. OBJECTIVE

In the research paper our objective is to study the characteristic of partial replacement of cement in dry lean concrete with fly ash and RHA for road sub base and to compare it with the compressive strength of concrete .also trying to find the 10% of fly ash replaced in dry lean concrete that makes the strength of dry lean concrete for road sub base is maximum .now a day fly ash and RHA have waste products of thermal power plant and rice mill industry .so by partial replacing cement with these materials are proposing a method that can be of great use in reducing pollution to a great extent .

3. MATERIALS

The materials used in the preparation of DLC are cement, sand, coarse aggregate, Rice Husk Ash, Fly ash, and water etc.

CEMENT: Ordinary Portland Cement (OPC53), IS: 12269-1987 which is available in the market has been used. The physical properties of the cement used are as listed in table below.

TABLE-3.1 Physical properties of ordinary Portland cement

PROPERTIES	TEST VALUES
Specific Gravity	3.15
Consistency	30%
Initial setting time	30 min
Final setting time	600 min

SAND: The narmada river sand available in the market and having specific gravity of 2.66 (Conforming to Zone II) has been used. The physical properties of the fine aggregate are as listed in table below:

TABLE-3.2 Physical properties of Fine Aggregates

PROPERTIES	TEST VALUES
Specific gravity	2.66
Water absorption	1%
Fineness modulus	2.61

Fig: 3.1 sieve analysis of Sand

Table-3.3 SAND GRADING

Weight of sample =2000gm

IS sieve (mm)	Weight retained (gm)	Cumulative weight (gm)	Cumulative % retained	Cumulative % passing	Zone II
10	0	0	0	100	100
4.75	106	106	5.3	94.7	90-100
2.36	154	260	13	87	75-100
1.18	160	420	21	79	55-90
0.6	773	1193	59.65	40.35	35-59
0.3	214.4	1407.4	70.37	29.63	8-30
0.15	428.4	1835.8	91.79	8.3	0-10
PAN	164.6				
TOTAL		2000=00			

FM= (sum of all cumulative % weight retained up to 0.15 mm)/100

261.11/100= 2.61

Thus the gradation of sand lies in zone II.

COARSE AGGREGATES: crushed granite conforming to IS: 383:1987 and having specific gravity 2.70 has been used. the coarse aggregate with nominal size of aggregates as 20mm (50%) and 10mm (50%) as per Indian standard were used . the physical properties of the coarse aggregate are listed in table below:

TABLE-3.4 Physical properties of coarse aggregates

PROPERTIES	CA-20	CA-10
Type	Crushed	Crushed
Specific gravity	2.65	2.70
Water absorption	0.50%	0.50%
Fineness modulus	6.8	6.5

Grading of 20 mm size Aggregate
Sample weight 5088 gm
Table-3.5

Sieve size(mm)	Weight (gram)	% wt. retained	Cumulative % retained	Cumulative % passing
26.5	0	0	0	100
19	1925.3	37.84	37.84	62.16
9.5	2951.04	58	95.84	4.16
4.75	105.83	2.08	97.92	2.08

Grading of 10 mm size Aggregate
Sample weight 3235gm
Table-3.6

Sieve size	Wt.(gm)	% wt. retained	Cumulative % retained	Cumulative % passing
26.5	0	0	0	100
19	0	0	0	100
9.5	869.57	26.88	26.88	73.12
4.75	1223.15	37.81	64.69	35.31
2.36	940.74	29.08	93.77	6.23

WATER: water is an important ingredient of concrete as it actively participated in the chemical reaction with cement .clean portable water which is available in college campus has been used.
FLY ASH: The fly ash used was of class F with specific gravity of 2.10
Chemical characteristics
Fly ash is a fine particular material with the main chemical constituents being SiO_2, Al_2O_3, Fe_2O_3 and Cao these chemicals are responsible for its pozzolanic activity. The general variation in three principal constituents will be as follows Sio_2 (25-60%), Al_2O_3 (10-30%) and Fe_2O_3 (5-25%)
TABLE-3.7 Chemical requirements of fly ash (As per BIS)

SNO.	Characteristics	Requirements	
		Siliceous Fly Ash	Calcareous Fly Ash
1	$Sio_2+Al_20_3+Fe_2O_3$ (%by mass, Min.)	70	50
2	SiO_2 (% by mass, Min.)	35	25
3	Reactive silica (% by mass, Min.)	20	20
4	MgO (% by mass, Max.)	5	5
5	SO_3 (%by mass, Max.)	3	3
6	Na_2O (%by mass, Max.)	1.5	1.5
7	Total Chlorides (% by mass, Max.)	0.05	0.05
8	Loss on Ignition (% by mass, Max.)	5	5

Fig:3.2 Fly Ash

TABLE-3.8 Chemical requirements of Fly Ash (As per ASTM)

SN.	Characteristics	Requirements	
		Siliceous Fly Ash	Calcareous Fly Ash
1	$SiO_2 + Al_2O_3 + Fe_2O_3$ (%by mass, Min.)	70	50
2	Moisture Content (%by mass, Max.)	3	3
3	SO_3 (%by mass, Max.)	5	5
4	Loss by Ignition (%by mass, Max.)	6	6

Rice husk ASH: RHA is a carbon neutral green product. Lots of ways are being thought of for disposing them by making commercial uses of this RHA. RHA is a good super pozzolan. This super pozzolan can be used in a big way to make special concrete mix.

TABLE-3.9 Physical properties of RHA (As per Bui and Stroeven, 2009)

Fineness-medium particle size (μm)	8.6
Specific gravity	2.14
Pozzolanic activity index (%)	99
Water absorption test (%)	104

Fig: 3.3 Rice Husk Ash

TABLE-3.10 Chemical properties of RHA (As per Bui and Stroeven,2009)

Chemical compound	Percentage
SiO_2	97.69
Al_2O_3	0.00
Fe_2O_3	0.22
CaO	0.29
MgO	0.00
Na_2O	0.41
K_2O	1.39

4. METHODOLOGY

- Collection of Fly Ash and Rice Husk Ash.
- Physical test conducts on both materials.
- Preparation of standard mix of 1:12 OPC.
- Partially replace cement with Fly Ash as 0%, 5%, 10%, 15%, 20%, 25%, and 30%.
- This procedure again done for RHA with 0%, 5%, 10%, 15%, 20%, 25%, and 30 %.
- Making a number of samples of concrete cubes.
- Testing of cubes to 7days.

Table: 4.1 BLENDING FOR DRY LEAN CONCRETE (DLC)

Ratio of blending (1:12)		**20mm**	**10mm**	**SAND**	**TOTAL**
		30%	**30%**	**40%**	**100%**
Sieve size (mm)	Avg. of passing 20mm 10mm SAND			% of passing	Acceptable limit as per MORTH
26.5	100	100	100	100	100-100
19	62.16	100	100	88.64	75-95
9.5	4.16	73.12	100	63.18	50-70
4.75	2.08	35.31	94.7	49.09	30-55
2.36	0	6.23	87	36.68	17-42
0.6	0	0	40.35	16.14	8-22
0.3	0	0	29.63	11.85	7-17
0.15	0	0	8.3	3.32	2-12

Fig: 4.1 Cube Casting

4.1COMPRESSIVE TEST:

Out of many test applied to the concrete, this is the utmost important which gives an idea about all the characteristics of concrete. By this single test one can judge whether concreting has been done properly or not.

Compressive strength of concrete depends on many factors such as water-cement ratio, cement strength, quality of concrete material, quality control during production of concrete etc. Test of compressive strength is carried out on cube. For cube test, specimens of size 15cm × 15cm ×15cm are used.

The prepared concrete is poured in the mould and tempered properly so as not to have any voids. the top surface of these specimen should be made even and smooth. After 24 hours these moulds are removed and test specimen are put in the water for curing. This is done by putting cement paste and spreading smoothly on whole area of specimen. These specimens are tested by compression testing machine after 7days curing. Load should be applied gradually at the rate of 140 kg/cm^2 per minute till the specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

4.2 Mix Proportion of Cement, RHA/ Fly Ash, Sand and Aggregate for 3 Cubes (150x150x150 mm^3)

Table:4.2

S.No.	Replacement of Cement%	Cement (kg)	RHA/FlyAsh (kg)	Sand (kg)	Aggregate(kg)	
					10mm	20mm
`1	0%	1.4175	0.00	6.804	5.103	5.103
2	5%	1.3467	0.0708	6.804	5.103	5.103
3	10%	1.2757	0.1418	6.804	5.103	5.103
4	15%	1.2049	0.2126	6.804	5.103	5.103
5	20%	1.1340	0.2835	6.804	5.103	5.103
6	25%	1.0630	0.3545	6.804	5.103	5.103
7	30%	0.9923	0.4252	6.804	5.103	5.103

5. RESULT AND DISCUSSION

The quantity of water with respect to batch number, percent fly ash and RHA by weight and total pozzollanic content is presented. The quantity of fly ash and RHA increases more water is required to maintain a consistent slump, thus increasing the water to pozzolan ratio. For the 3 batches of concrete for which the mix design is presented in table separately for both materials.

Compression test carried out on sample cubes by using compression testing machine. The specimens were loaded at a constant strain rate until failure. The results of compressive strength cubes for **7days** curing is given in **Table-5.1** and **Table-5.2,** and its corresponding graph is shown in **figure-5.1**

Compressive strength at 7days of Fly Ash Table-5.1

SNO.	Designation of the mix	Compressive load in tons			Average compressive load in tons	Average compressive strength in N/mm^2
		Cube 1	Cube 2	Cube 3		
1	FA 0%	26	27	25	26	11.55
2	FA 5%	29	28	30	29	12.88
3	**FA 10%**	32	29	34	31.66	**14.07**
4	FA 15%	27	25	28	26.66	11.85
5	FA 20%	25	23	26	24.66	10.96
6	FA 25%	22	21	22	21.66	9.62
7	FA 30%	18	20	19	19	8.44

Compressive strength at 7days of Rice Husk Ash Table-5.2

SNO.	Designation of the mix	Compressive load in tons			Average compressive load in tons	Average compressive strength in N/mm^2
		Cube 1	Cube 2	Cube 3		
1	RHA 0%	26	27	25	26	11.55
2	RHA 5%	27	28	27	27.33	12.14
3	**RHA 10%**	28	30	27	28.33	**12.59**
4	RHA 15%	27	24	25	25.33	11.25
5	RHA 20%	22	19	21	20.66	9.19
6	RHA 25%	17	19	16	17.33	7.70
7	RHA 30%	16	15	17	16	7.11

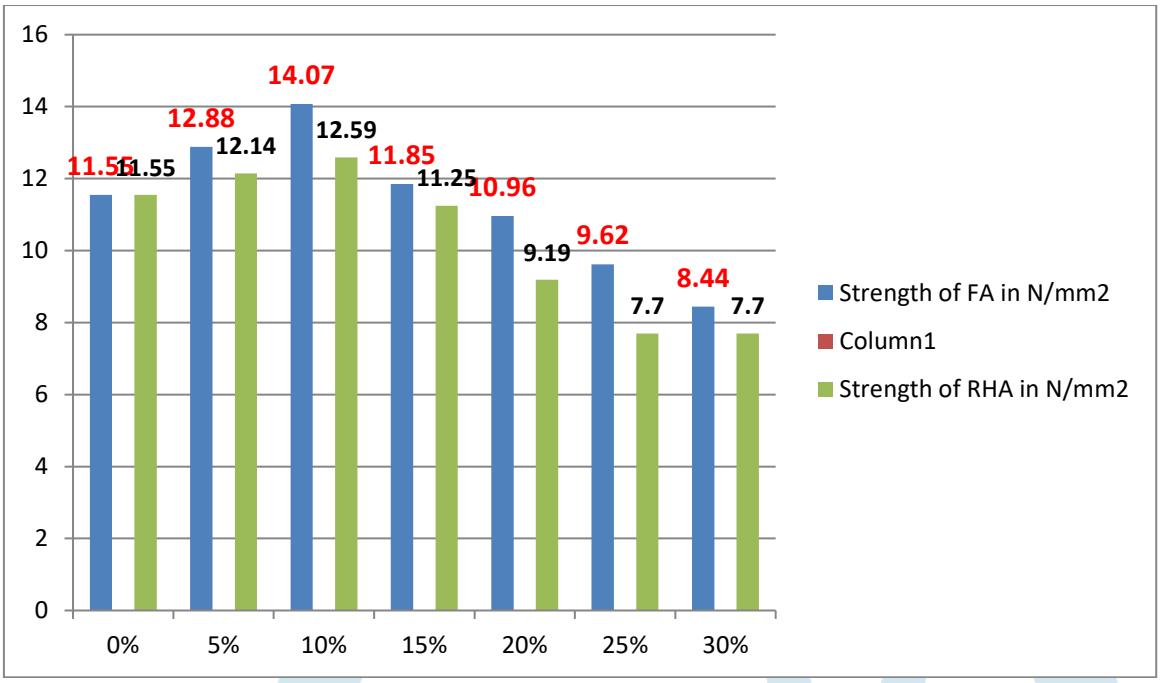

Fig-5.1 Graph Shows compressive strength of Fly Ash and RHA At 7days

6. Conclusion

Based on experiments and test results on fresh and hardened concrete the following conclusions are drawn:
when we compare both the results, it shown that Fly Ash and RHA both materials gives good compressive strength .in both cases the compressive strength is increase with the increase of percentage of Fly Ash and RHA up to 10%, after 10% both have shown decrease in strength, **but results gives an idea that the Fly Ash gives better strength than RHA.**
Improvement in fresh concrete properties: a due to addition of RHA concrete become cohesive and more plastic and thus permits easier placing and finishing of concrete.

1. As the replacement of cement by Fly Ash in dry lean concrete improves workability.

2. Being a waste material Fly Ash affect the environment, so it using as a replacement of cement will be good for environment.

3. It reduces overall cost of the construction significantly.

4. Fly Ash is having small particle, thus making dry lean concrete dense and reducing permeability, and it gives good strength

As per the code IRC SP 49: 2014 the compressive strength should not be less than 5.5 N/mm^2 at the 7day curing after they were moulded, thus replacement of Fly Ash up to 15% is suitable for preparation of road sub base .
Compressive strength:

1. Due to addition of Fly Ash it is observed that strength is increasing with addition of 5 %, 10% and 15% of Fly Ash in normal dry lean concrete.
2. When we talk about RHA it is also gives desired strength but Less than the Fly Ash.
3. The optimum replacement level of Fly Ash is 10%.because after 10% strength is slightly decreasing.
4. The use of Fly Ash as an alternative for cement and as additive to reduce corrosion and increase durability of dry lean concrete strength.
5. Fly Ash is also used in fly ash bricks, concrete blocks and also used in soil stabilization.
6. Overall it helps in reducing the pollution in environment.

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