ANALYSIS OF BEHAVIOUR OF FLY-ASH CEMENT CONCRETE WITH ADDITION OF RICE HUSK ASH

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ABSTRACT - *Cement is widely noted to be most expensive constituents of concrete. The entire construction industry is in search of a suitable and effective waste product that would considerably minimize the use of cements and ultimately reduces the construction cost. Rice husk ash (RHA) which has the pozzolanic properties is a way forward. The possibility of uses RHA as a construction materials need to be investigated. Three grades of ordinary Portland cement (OPC) namely; 33, 43 and 53 as classified by Bureau of Indian Standard (BIS) are commonly used in construction industry. But the usage of cement in concrete causes lot of environmental pollution due to emission of green house gases. So that it is necessary to reduce usage of cement by introducing new supplementary cementitious materials which are the by-products of industries to reduce to relative problem. A comparative study on effect of concrete properties when ordinary Portland cement (OPC) is varying grades is partially replaced by RHA and FA is discussed in this project. Percentage replacement of OPC by RHA and FA are 0%, 10%, 20%, 30% and 40% respectively. The compressive strength test, standard consistency test, initial setting time test, final setting time test and workability test of concrete are mainly studied. The studies suggests that up to 30% mix of fly ash (20%) and rice husk ash (10%) are increased the compressive strength of concrete and decrease the final setting time of cement.*

***Key Words*: Fly Ash(F.A.), Rice Husk Ash(R.H.A.), Ordinary Portland Cement(O.P.C.), Consistency, Initial Setting Time, Final Setting Time, Workability, Compressive Strength,**

1. INTRODUCTION

Traditionally, rice husk has been considered a waste material and has generally been disposed of by dumping or burning, although some has been used as a low-grade fuel. Energy plays a crucial role in growth of developing countries, like India. In context of low availability of non-recoverable energy sources coupled with requirements of large quantities of energy to materials like cement, steel etc., the importance of industrial wastes as building materials cannot be underestimated. In India about 110 million tones of fly ash has been produced by 68 major thermal power stations and are likely to be doubled within next 10 years. It has been a published fact from research that waste materials like fly ash; rice husk ash etc, through their use as construction materials can be converted into meaningful wealth. Also, a partial replacement of cement with fly ash is desirable, and indeed essential due to a variety of technical, economical and ecological reasons. A properly proportional fly ash and rice husk ash in concrete mix improves properties of the concrete that may not be achievable through the use of Portland cement alone. The resulting concrete mix becomes strong, durable and economical and also eco-friendly as it utilizes an ecological hazardous material.

One of the main advantageous of high-volume mineral admixtures in high-strength concrete is reducing the cement content, which has not only economic and environmental benefits but also means reducing heat of hydration and increasing durability properties. As a rule of thumb, the total heat of hydration produced by the pozzolanic reactions involving mineral admixtures is considered to be half as much as the average heat produced by the hydration of Portland cement. To achieve high-strength and workability while reducing creep and shrinkage Chang et al. Using super plasticizers and pozzolona materials in the mix designs of high-performance concrete.

It has been a published fact from reason that waste material like fly ash , rice husk etc, through use as construction materials can be converted in to meaning full wealth. Also a partial replacement of cement by fly ash is desirable and indeed essential due to a variety of technical ecological and economical reason. The properly proportion fly ash and rice husk ash in concrete mix improve properties of the concrete that may not be achievable through the use of Portland cement alone. The resulting concrete mix become strong durable economical and also eco-friendly as it utilized an ecological hazardous materials.

One of the main advantageous of high volume mineral admixture in high strength concrete is reducing the cement content which has not only economic and environmental benefit also mean reducing heat of hydration and increasing durability properties of concrete. Rice husk ash contain high silica content which is more than 90%, it reduces shrinkage cracks and leads to increase the strength of concrete. The many researchers are done research on rice husk ash and they presented their results of modified concrete properties. The rice husk ash is obtained by burning of rice husk ash at temperature between 550oC to 700oC, then the rice husk may forms as cellular micro structure is produced. The rice husk ash has rich silica content of non-crystalline (or) amorphous silica form. It shows that rice husk can be used as supplementary cementitious materials due to its pozzolanic action.

2. FLY ASH CEMENT CONCRETE WITH RICE HUSK ASH:

Fly ash cement concrete is same as cement concrete. The conventional concrete consist cement, sand and coarse aggregate of different ratio on different grade of concrete. In the case of fly ash cement concrete with rice husk ash, some specific quantity of cement is replaced by rice husk ash and fly ash. Fly ash and rice husk ash are cementitious material there is no any negative effect on cement up to some specific quantity of replacement.

3. PROBLEM STATEMENT:

Fly ash and rice husk ash are both pozzolanic cementitious material and react same with cement. Both increase compressive strength up to certain limit. The workability and w/c ratio of concrete are increase with respect to increase the quantity of fly ash and rice husk ash. To optimize the result and to check the accuracy of mix design nine separate mixes were to be made and tests were to be carried out to determine the efficiency of the batch. Each batch of concrete were made M25 with w/c ratio about 0.43 fix for all batches. Total fifty four cubes with trial replacement of rice husk ash and fly ash were casted by me. Workability test was done by slump cone of M25 grade of concrete with w/c ratio about 0.43. Standard consistency test, initial setting time test and final setting time test of cementitious materials mix was done by me. They are design as follows.

4. PLANING FOR EXPERIMENT:

For this project three types of materials are taking by me. And they are arranged in three pattern i.e. Pattern-1(P-1), Pattern-2(P-2) and pattern-3(P-3). Mixes are divided in to nine batches i.e. (A-1, B-1, C-1, D-1, D-2, D-3, E-1, E-2, E-3.) are arranged in three pattern of P-1, P-2 and P-3. Composition of patterns and batches will be same for all work in this project Works. Composition of cementitious materials in batches and pattern are given in table no (4-a).

Table-4(a): combined table for batches and pattern:

S.N.	Batch Designation		Adopted Mix Proportions	Cementitious materials (cement + fly ash + rice husk ash) in %
	Title	Cementitious material Description		
Pattern-P-A (0 to 40% replacement of cement by fly ash)				
01.	A-1	Cement	1:1.26:2.73	100+0+0
02.	B-1	Cement +fly ash		90+10+0
03.	C-1			80+20+0
04.	D-1			70+30+0
05.	E-1			60+40+0
Pattern-P-B (30% total replacement of cement by fly ash and rice husk ash)				
06.	D-1	Cement + fly ash + rice husk ash	1:1.26:2.73	70+30+0
07.	D-2			70+20+10
08.	D-3			70+15+15
Pattern-P-C (40% total replacement of cement by fly ash and rice husk ash)				
09.	E-1	Cement + fly ash + rice husk ash	1:1.26:2.73	60+40+0
10.	E-2			60+30+10
11.	E-3			60+20+20

5. MIX DESIGN:

Mix design is the process of selecting the ingredients in specific quantities for different type of works. For this project I was done mix design by INDIAN STANDERD RECOMMENDED METHOD OF CONCRETE MIX DESIGN based on (IS 10262-1982). M25 grade concrete mix was taking by me. The procedure of mix design is as follows.

5.1 Concrete mix design:

(A) Design required:
1. Characteristic compressive Strength required in the field at 28 days. = 25MPa.
2. Maximum size of aggregate. =20mm(angular).
3. Degree of Workability = 0.80 (compacting factor)
4. Degree of quality control = Good.
5. Type of exposure = Moderate.

(B) Test data for materials:
1. Specific gravity of cement.= 3.15
2. Specific gravity of coarse aggregate = 2.63
3. Specific gravity of fine aggregate = 2.62
4. Water absorption of coarse aggregate = 0.58%
5. Water absorption for fine aggregate = 1.0%
6. Free surface moisture for coarse aggregate = Nil
7. Free moisture for fine aggregate = 1.85%
8. Conforming zone by sieve analysis of sand = zone-2

(C) Target mean strength = 33.25Mpa.

(D) Selection of water cement ratio = 0.43

(E) Selection of water sand content
Required sand content = 31.6%
Required water content = 186kg/m^3

(F) Determination of cement content = 432.56

(G) Determination of coarse and fine aggregate contents(per m^3)
Water: 0.43 = 186
Cementitious materials: 1 = 432.6kg
Fine aggregate: 1.26 = 543.68kg
Coarse aggregate: 2.73 = 1181.31kg

(H) actual quantities required for the mix(per bag)
Cement = 50kg
Fine aggregate = 64kg
Coarse aggregate = 135.76kg
Water = 21.13litres

6. EXPERIMENTAL PROGRAM:

In this project cementitious material mixed into three pattern of describe in above Table- 4(a). To find out the properties of all mixes and compare the value of all patterns to each other, various testing was done by me. Testing is divided in to two parts. First one is testing of cementitious materials and second one is testing of concrete.

Fig.-6(a): Compressive testing machine

Table-6(a): Consistency, Initial and Final setting time results:

S.N.	Cementitious materials mixes (Cement + fly ash + rice husk ash)	Consistency of cement %	Initial setting time (minutes)	Final setting time (minutes)
01.	A-1	32	45	545
02.	B-1	32	70	645
03.	C-1	31	75	690
04.	D-1	31	85	710
05.	E-1	30	100	785
06.	D-2	35	65	680
07.	D-3	36	95	750
08.	E-2	32	65	715
09.	E-3	36	75	695

Table-6(B): Slump test results

S.N.	Batch	Value of slump (mm)
01.	A-1	71
02.	B-1	73
03.	C-1	77
04.	D-1	78
05.	D-2	72
06.	D-3	71
07.	E-1	80
08.	E-2	77
09.	E-3	68

Table-6(c): Effect of age on compressive strength, w/c = 0.43

S.N.	Batch designation	7 days	28 days	% Increase
01.	A-1	21.37	32.97	54.00
02.	B-1	20.80	30.43	46.00
03.	C-1	19.52	29.28	50.00
04.	D-1	19.28	28.34	47.00
05.	D-2	23.33	37.34	60.05
06.	D-3	22.63	36.80	62.60
07.	E-1	15.98	22.70	33.68
08.	E-2	20.29	30.80	51.78
09.	E-3	21.10	32.45	53.82

7. RESULTS AND DISCUSSIONS

7.1 Standard Consistency, Initial Setting Time and Final Setting Time of Cementitious materials:

7.1.1 Pattern-1

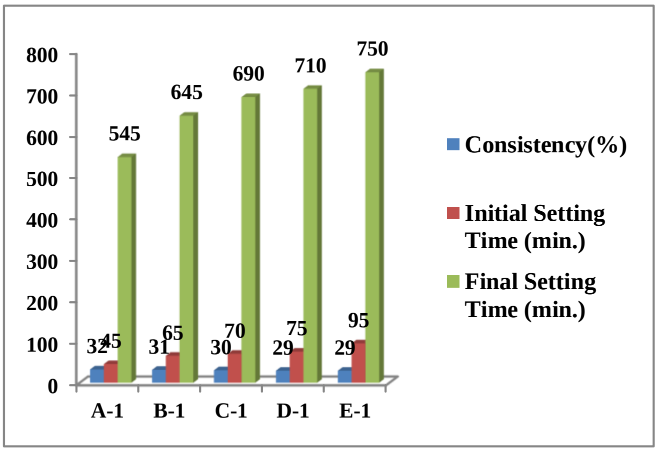

Fig.-7(a): Consistency, initial setting time and final setting time of cementitious materials (P-1)

7.1.2 Pattern-2

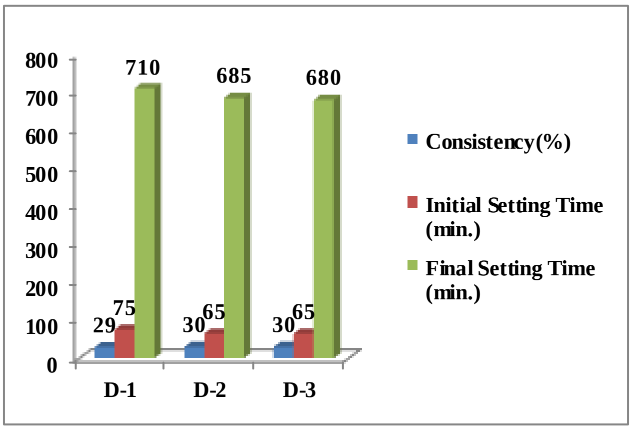

Fig.-7(b): Consistency, initial setting time and final setting time of cementitious materials (P-2)

7.1.3 Pattern-3

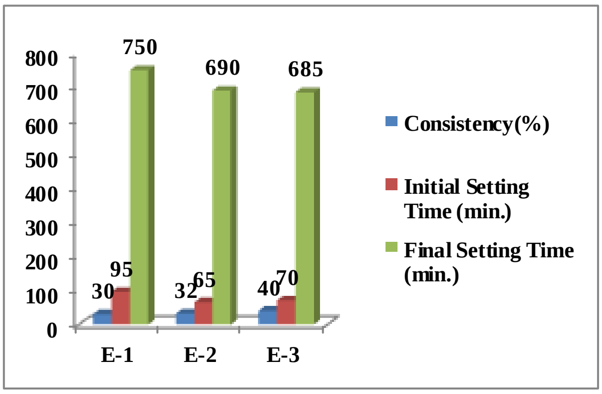

Fig.-7(c): Consistency, initial setting time and final setting time of cementitious materials (P-3)

7.2 Workability test results:

7.2.1 Pattern-1

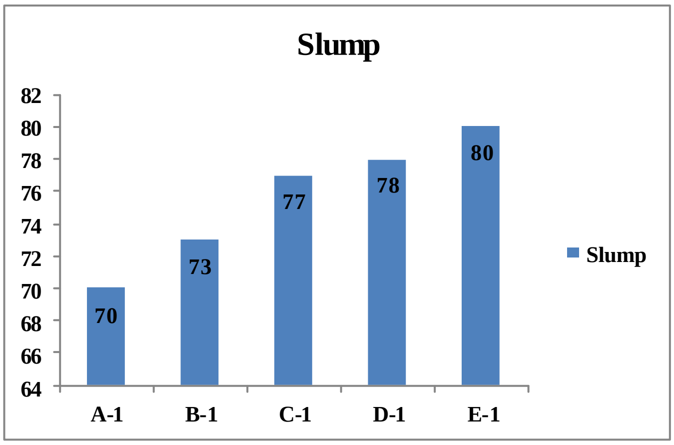

Fig.-7(d): Slump value for w/c ratio 0.43 (P-1)

7.2.2 Pattern-2

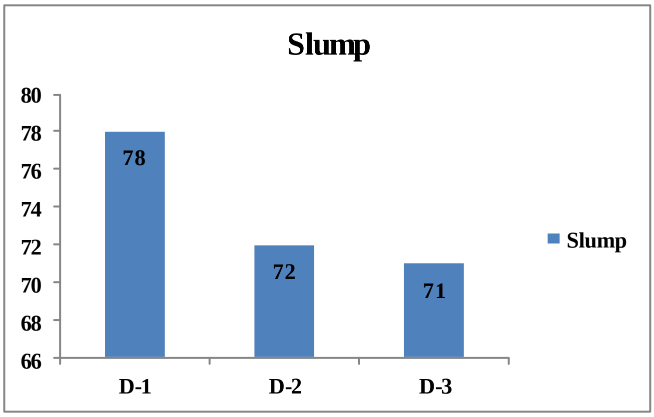

Fig.-7(e): Slump value for w/c ratio 0.43 (P-2)

7.2.3 Pattern-3

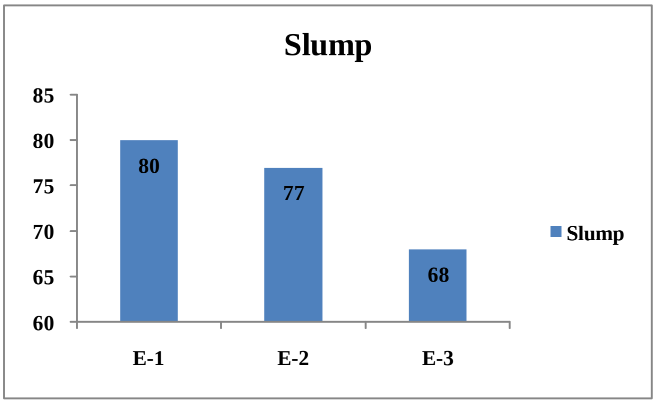

Fig.-7(f): Slump value for w/c ratio 0.43 (P-3)

7.3 Compressive strength result: (for 7and 28 days)

7.3.1 Pattern-1

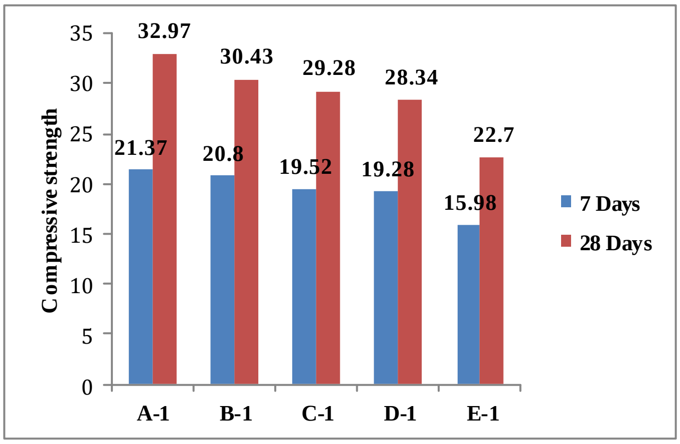

Fig.-7(g): 7 Days and 28 Days Compressive Strength of Pattern 1 for W/C 0.43

7.3.2 Pattern-2

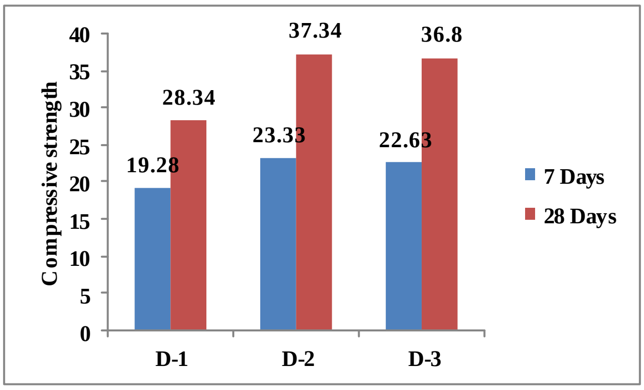

Fig.-7(h): 7 Days and 28 Days Compressive Strength of Pattern 2 for W/C 0.43

7.3.3 Pattern-3

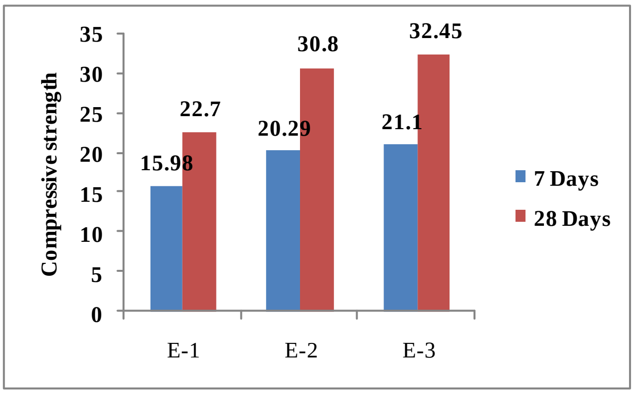

Fig.-7(i): 7 Days and 28 Days Compressive Strength of Pattern 2 for W/C 0.43

7.4 Discussion about results:

7.4.1 Consistency of Cementitious material mix:

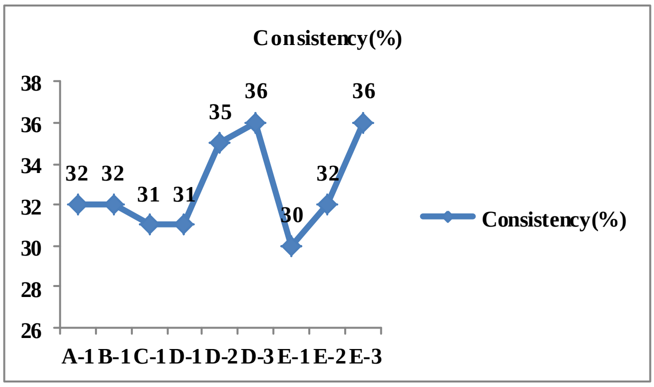

Fig.-7(j) Consistency results of all batches.

7.4.2 Initial and final setting time of cementitious material mix:

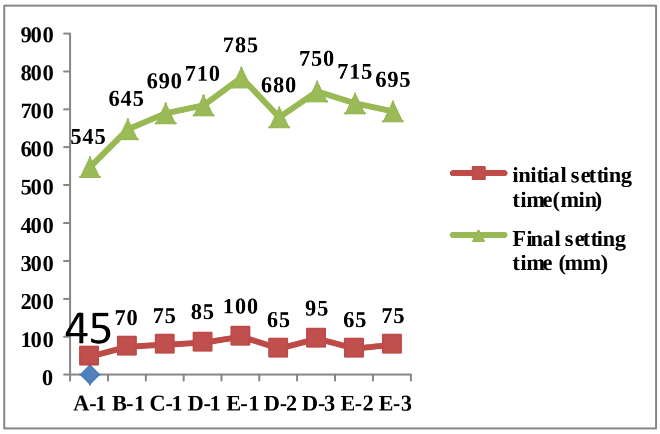

Fig.-7(k): Initial and Final setting Time Results of All Batches

7.4.3 Workability test result of concrete:

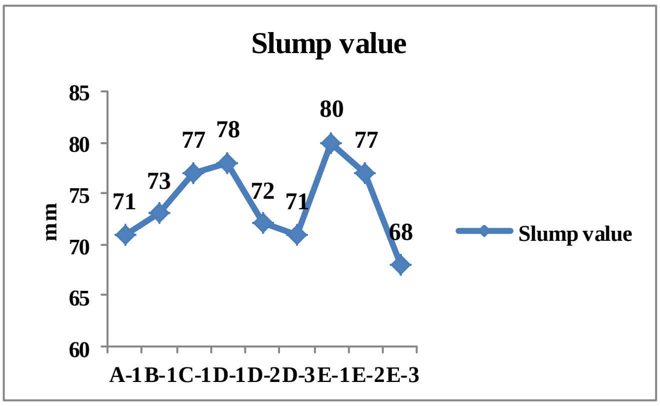

Fig.-7(l): Workability Results of All Batches

7.4.4 Compressive strength results of concrete

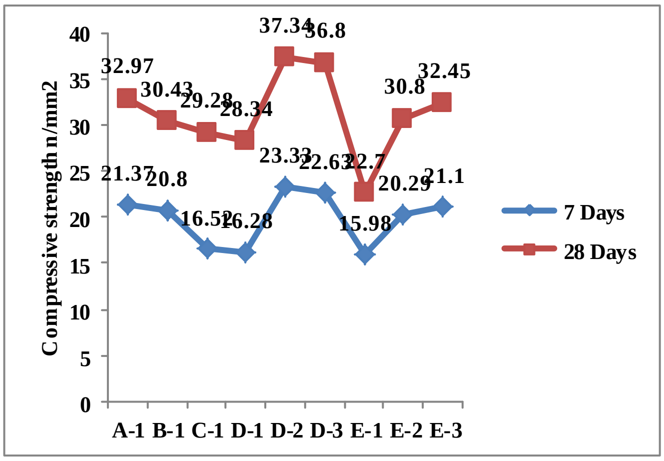

Fig.-7(m): Compressive strength of All Batches

7.4.5 Combined result for effect of age on compressive strength:

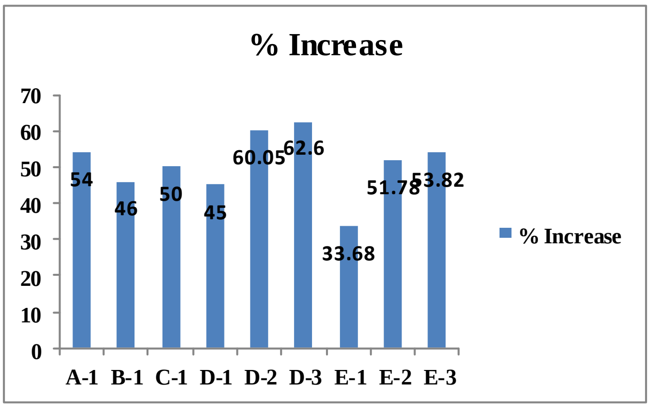

Fig.-7(n): Percentage increase in compressive strength from 7 days to 28 days.

8. CONCLUSIONS

From the experimental results, the conclusion of consistency initial and final setting time of cementitious materials, workability and compressive strength of hardened concrete are concluded as under:
When we replace cement only with fly ash, then the consistency of cement continuously get diminished. But when we add fly ash and rice husk ash in different ratio in the cement than the consistency of cementitious materials increase according to the adding of quantity of rice husk ash.

In the case of setting time of cementitious materials initial and final setting time depend upon the quantity of fly ash, with the addition of rice husk ash in the fly ash cement concrete, initial and final setting time decrease because rice husk ash increase the hydration of cement.

In the case of workability fly ash linearly increase up to batches (A-1), (B-1), (C-1), (D-1) and (E-1) respectively, whereas rice husk ash decrease the workability of remaining batches.

According the results of compressive strength, when only fly ash is present in the concrete as other cementitious materials the rate of compressive strength from 7 days to 28 days slows down but rice husk ash increase the rate of compressive strength from 7 days to 28 days. As the results of the experiments batch (D-2) as 70% cement 20% fly ash and 10% rice husk ash, the compressive strength is highest for 28 days. But the rate of compressive strength of batch (D-3) is speedily increased from 7 days to 28 day

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