Durability Properties of Fly Ash Blended Concrete Made with Coal Washery Rejects as Coarse Aggregate

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Abstract— This investigation studied the durability properties of concrete containing CWR at different replacement levels (0% - 50%).The values of the durability properties like water absorption, RCPT, Drying shrinkage were compared to M 25 grade of conventional concrete (CC). From the results, it is revealed that 30% CWR replacement can be considered as optimum level in the construction industry.Coarse aggregate replaced with five percentages (10%, 20%, 30%, 40%, and 50%) of fly ash by weight. Tests were conducted for properties of fresh concrete (workability), and compressive strength was determined at 7, 28 and 56 days. Test results indicate significant improvement in the strength properties of plain concrete by the inclusion of fly ash as partial replacement of either fine aggregate (sand) or cement and can be effectively used in concrete structures.

Key words: Coal Washery Rejects, Fly Ash, Cement, Water Absorption test, Drying Shrinkage, RCPT

I. INTRODUCTION

Concrete plays a significant role in the construction of structures around the world. As indicated by construction materials (2007) concrete is a composite material obtained by mixing cement, sand, gravel and water. A concrete mix can be considered to consist of two main parts, aggregates (sand and gravel) and cement paste (water and cement).

The global demand of concrete is significantly increasing due to infrastructure growth worldwide. Hence using alternative sources as replacement for cement and aggregates appears to be a challenging task. Mechanical waste materials (recycled materials) can be used as alternative sources in concrete as they can assist in solving some environmental concerns, as they diminish the problem of waste disposal and reduce the intensive use of energy and natural resources (aggregate mining). In addition the amount of emission of gasses gets reduced.

There are many potential industrial waste products that have the potential to replace aggregates in concrete such as plastic, fly ash, rubber, steel slags and leather wastes. In any case, fly ash and coal washery rejects are the industrial waste materials that are Discussed In depth in this particular research.

A. General:

The comparative more than adequate quality of coal in India equated to other fogey fires made it a raw choice as the first source of fire, be it for steel preparing, power propagation or for other advantages. Sum up to appropriate of coal in the country are figured to the order of 267 billion tons. Coking coal, which is only 14% of the total deposits, is usable mainly in eastern part of India. Coking coal is an important requirement for fabrication of iron and steel through blast furnace path. In India, the annual prerequisite of coking coal for different metallurgical works may be up to the 35 million tons, out of which the accessibility from the beginning sources is about 10 million tons only. The remaining of the coking coal prerequisites are handled through consequences from various countries. To meet the increased demand of coking Coal conjunctive attempts have to be prepared to adjust the unbalance between requirement and accessibility by improving the manufacturing of coal of wanted quality through good direction of accessible resourcefulness's of substandard grade. Low volatile coking coal (LVCC), though substandard in qualities but the more than adequate quality available in eastern part of the country may be a quick alternative.[2,3]

B. Scope:

The intension of this invention is to find out the quality of being doable of using fly ash and CWR as a substitute of cement and CA in concrete. Utilizing products such as FA and CWR in concrete can determine the durability properties of concrete. The original range of this study is to inquire the new and inured properties of concrete with FA and CWR as a substitute of cement and CA.

C. Clean Coal Technology:

"Clean" coal technology is a concept for the technology which moderates the discharge of carbon dioxide (CO_2) and other greenhouse gases and it is mainly used for electrical power generation. This expelling has established to catch and store the carbon dioxide from coal fired plants. Also it'll protect the human health. As a result, clean coal technology is being developed to decrease the pollutant discharge to the environment. Some of the techniques involve that can be used to accomplish this include washing of minerals chemically and waste from the coal, gasification also progressed technology for treating fire gases to remove polluting materials to increasingly tight levels and at higher perfection. Carbon dioxide will technology to capture the carbon dioxide from the fire gas and dewatering brown coal to improve the calorific value, and thus the efficiency of the changeover into electricity. Historically the primary focus of clean coal technology was on sulphur and nitrogen dioxides. The exits regarding the economic proofs of these technologies and the time period of delivery, potentially high hidden economic costs in terms of social and environmental damage and the costs and disposing of removed carbon and other toxic matter.

II. EXPERIMENTAL STUDY

The experimental investigation was focused on durability properties of fly ash blended concrete made of coal washery rejects. Mix proportion was designed using IS 10262-2009 and IS 456-2000 with mean target strength of 38.25 MPa (M30) for control mix.[14-17]

Ordinary portland cement (type 1) was used in this study. A coarse aggregate with a maximum nominal size of 19 mm and a fine aggregate with a fineness modulus of 3.4 in the experiment. CWR and fly ash were used; their geometry and apparent shape are shown in Fig. 1,2. Super plasticizer of SP-430 was used to adjust the workability of mixtures.

Fig. 1: coal washery reject

Fig. 2: Fly Ash

III. Mix Design

CA particles of size 20 mm and 10 mm were utilized concerning with regards to sufficient bond with the suport of RFC in the building structures. 20 mm and 10 mm CA particles were mixed in 60:40 extent by % weight of aggregate total. 20 mm CA was substituted by 20 mm CWR at 30%.m 25 grade of conventional concrete (CC) has been designed as per is 10262:2009 and is 456:2000. Mix proportions of constituent materials are shown in following table. [12]

Mix Type	Cement Kg/M^3	FA Kg/M^3	Water L/m^3	20 Mm Kg/M^3	10 Mm Kg/M^3	CWR 20 Mm/Kg/M^3	Sand Kg/M^3
(M 25)	384	0	192	683	456	0	636
FA_220	267	81	192	546	456	137	636

Table 1: Mix proportions

IV. Test Methods

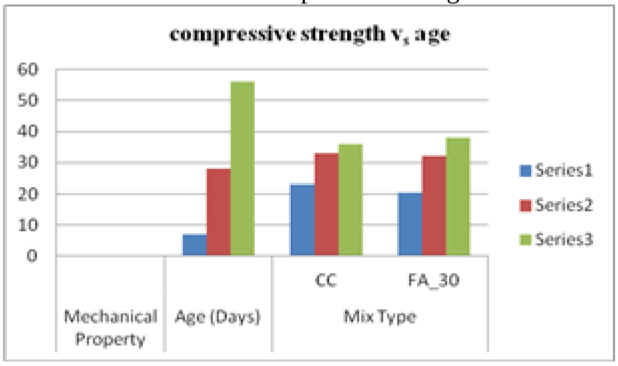
A. Compressive Strength of Based Concrete:

This segment talks about the compressive strength of both CC and FA based concrete mixes at various curing periods. Table 12 demonstrates the compressive strength values of concrete with incomplete substitution of CWR and FA.

From the outcomes it is seems that the concrete mixes with fractional substitution of FA have accomplished lower estimations of compressive strength at 7 and 28 ages(days) and achieved higher values of compressive strength at 56 days as compared to that of conventional concrete (CC) as shown in graph 1.

Mechanical Property	Age (Days)	Mix Type	
		CC	FA_30
Compressive Strength, F'_c (Mpa)	7	23.2	20.43
	28	33.06	32.24
	56	35.84	37.89

Table :2 compressive strength values



Graph 1: compressive strength versus age

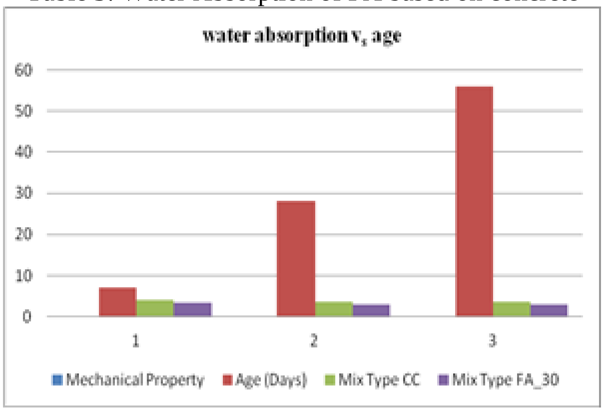
B. Water Absorption of FA Based On Concrete:

In this section, water absorption of both CC and FA based concrete mixes were studied at different curing periods. Table 13 shows the water absorption values of concrete made with partial replacement of CWR and FA.

From the table 3, it is observed that FA based concrete have attained lower percentage of water absorption values at all ages when compared to those of M25 grade of CC. Significant reduction was observed in the water absorption values of FA based concrete mainly due to continued pozzolanic action of fly ash with the age and micro filling of fly ash as shown in graph 2.[6,8,10,11]

Mechanical Property	Age (Days)	Mix Type	
		CC	FA_30
Water Absorption (%)	7	3.95	3.45
	28	3.71	3.06
	56	3.59	2.86

Table 3: Water Absorption of FA based on concrete



Graph 2: Water Absorption versus Age

C. Rcpt of Fa Based On Concrete:

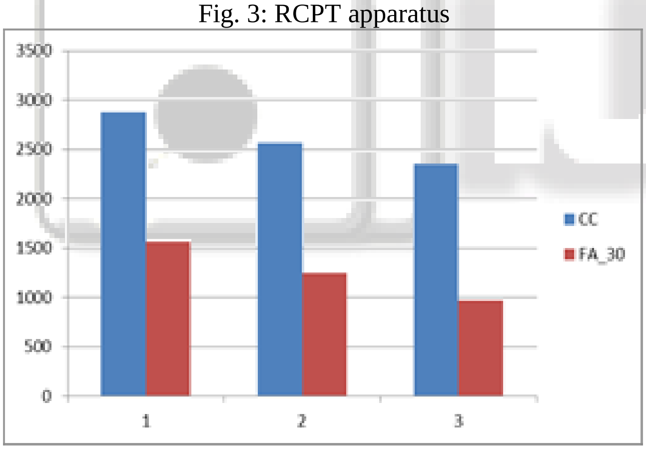
In this section, RCPT of both CC and FA based concrete mixes were studied at different curing periods. Table 4.3 shows the RCPT values of concrete made with partial replacement of CWR and FA.

From the table 4, it is observed that FA based concrete have attained low penetrating rates at all ages when compared to those of m 25 grade of CC. After 7 and 28 days of curing, penetrating rates of FA based concrete were observed as low. After 56 days of curing, FA based concrete has fallen under the category of very low. This significant reduction in the penetrating rates was observed in FA based concrete mainly due to the pozzolanic action and micro filling of fly ash as shown in graph 3.[4-5]

Mix Type	Age (Days)	Charge Passed (Coulombs)	Chloride Penetrating Rate
FA_30	7	1563	Low
	28	1249	Low
	56	968	Very Low
CC	7	2876	Moderate
	28	2569	Moderate
	56	2355	Moderate

Table 4: RCPT of FA based concrete

Fig. 3: RCPT apparatus



Graph 3: RCPT versus Age

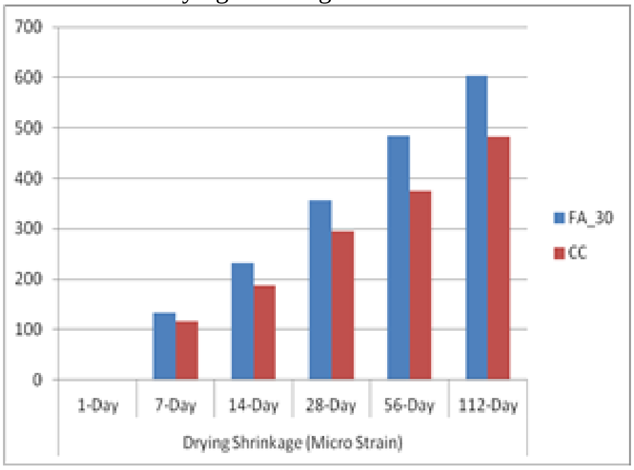
D. Drying Shrinkage of FA Based On Concrete

In this section, drying shrinkage of both CC and FA based concrete mixes were studied at different curing periods. Table 15 shows the drying shrinkage values of concrete made with partial replacement of CWR and FA.

It was observed that CC has attained a lower drying shrinkage strain of 483 x 10^{-6} (483 micro strains) after 112 days of dryness as compared to that of FA based mix. This was mainly attributed to the lower glue volume, higher CA content of CC as compared to that of FA based mix. But the difference between the drying shrinkage values of FA and CC at 112 days was reasonably comparable about 100 micro strains. This is due to the pozzolanic and micro filling of FA in FA mixes.[7-9]

Mix Type	Drying Shrinkage (Micro Strain)					
	1-Day	7-Day	14-Day	28-Day	56-Day	112-Day
FA_30	0	134	232	356	484	604
CC	0	117	188	295	375	483

Table 5: Drying Shrinkage of FA based concrete



Graph 4: Drying Shrinkage versus Age

V. CONCLUSIONS

Based on the test results, the following conclusions are drawn:

1) The designed FA based concrete was performing heightened durability properties at afterward ages as equated to that M 25 grade of CC mainly due to continued pozzolanic action of Fly Ash with the age and micro filling of Fly Ash.
2) It is observed that the strength factors have been reduced slightly for the concrete mixes CWR_20 and CWR_30. The 28 days compressive strength of the concrete mixes CWR_20 and CWR_30 are corresponding to that of M25 grade of CC.
3) The further increase in replacement of CWR decreased the strength properties mainly as in the point of the concrete mixes CWR_40 And CWR_50.

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