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

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Abstract— This investigation studied the mechanical properties of concrete containing CWR at different replacement levels (0% - 50%).The values of the mechanical properties like Compressive strength test, Split tensile strength, Flexural strength, Modulus of Elasticity and Bond strength 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[1], Fly Ash, Cement, Compressive Strength Test, Split Tensile Strength, Flexural Strength, Modulus of Elasticity and Bond strength

I. Introduction

Concrete plays a momentous role in the construction of structures all over the world. According to Construction Materials (2007), concrete is an important material which is a mixture of aggregates (sand and gravel) and cement paste (water and cement). Concrete plays a momentous role in the construction of structures all over the world. According to Construction Materials (2007), concrete is an important material which is a mixture of aggregates (sand and gravel) and cement paste (water and cement). The global demand of concrete is significantly increasing due to infrastructure growth worldwide. Therefore using alternative sources as replacement for cement and aggregates appears to be a challenging task. Industrial 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 gases gets reduced.

There are many industrial waste products that have the potential to replace aggregates in concrete such as: plastic, fly ash, rubber, steel slag and leather wastes. However, fly ash and coal washery rejects are the industrial waste materials that are discussed in depth in this particular research.

A. General

The relative abundance of coal in India appeared differently in relation to other fossil stimulates settles on it a trademark choice as the fundamental wellspring of fuel, be it for steel making, control era or for various employments. Mean stores of coal in the country are evaluated to the demand of 267 Billion Tons. Coking coal, which is just 14% of the aggregates stores, is available primarily in Eastern bit of India. Coking coal is a central basic for create of Iron and Steel through impact heater course. In India, the yearly need of coking coal for various metallurgical purposes may be up to the tune of 35 million tons, out of which the availability from the indigenous sources is around 10 million tons so to speak. Whatever is left of the coking coal necessities are supervised through imports from different countries. To deal with the extended request of coking coal deliberate attempts must be made to change the ponderousness among need and availability by growing the era of coal of pined for quality through better organization of open resources of mediocre review. Low unstable coking coal (LVCC), however not very impressive in qualities yet copiously open in Eastern part of the country may be a brisk choice.

B. Scope

The reason for this examination is to decide the attainability of utilizing fly ash and coal washery rejects as a substitution of cement and coarse aggregate in concrete. Utilizing an items, for example, fly ash and coal washery rejects in concrete can impact the Durability properties of concrete. The first extent of this review is to explore the crisp and solidified properties of concrete with fly ash and coal washery rejects as a substitution of cement and coarse aggregate common assets (total mining). Likewise, it lessens the measure of CO2 outflows and it spares vitality when fly ash remains replaces a portion of the vitality (serious delivered cement).

II. Experimental study

The experimental investigation was focused on mechanical 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, 15].

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 [2,3].

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.

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 2 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.[10,11]

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

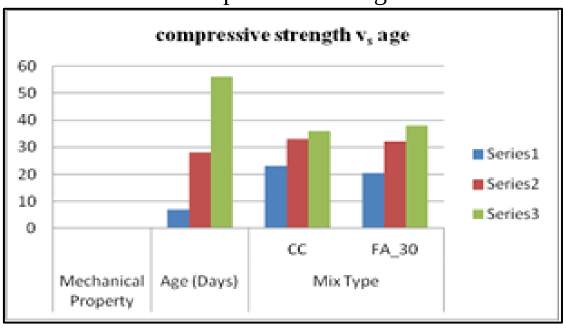

Fig. 3: Compressive Strength versus Age

B. Splitting Tensile Strength of FA based on concrete

In this fragment, splitting tensile strength of both CC and FA based cement blends were learned at different curing periods. Table 10 shows the splitting tensile strength of cement made with deficient substitution of CWR and FA.

From the substitution of FA have achieved comparable advantages of splitting tensile at 7 and 28 ages(days) and accomplished higher advantages of splitting tensile strength at 56 days as differentiated to that of conventional concrete (CC) as showed up in Fig 2.[12,13]

Mechanical Property (MPa)	Age (days)	Mix type	
		CC	FA 30
Splitting tensile strength (MPa)	7	2.48	2.52
	28	3.68	3.72
	56	4.05	4.62

Table 3: Splitting tensile strength of FA based on concrete

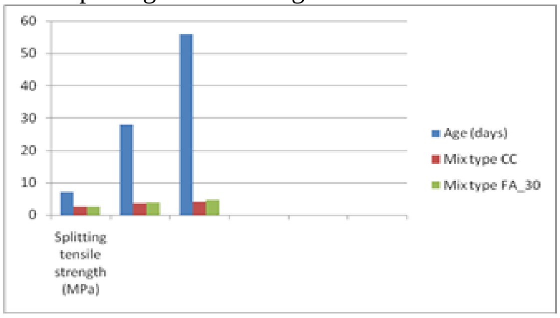

Fig. 2: Splitting Tensile strength versus Age

C. Flexural of FA based on concrete

In this area, flexural strength of both CC and FA based cement blends were learned at different curing periods. Table 4 exhibits the flexural quality estimations of concrete made with halfway substitution of CWR and FA.

Mechanical property	**Age (Days)**	**Mix type**	
		CC	**FA 30**
Flexural strength(MPa)	7	3.46	3.52
	28	4.78	4.85
	56	5.42	5.85

Table 4: Flexural strength of FA based concrete

From the results it is seen that the concrete blends with deficient substitution of FA have accomplished equivalent estimations of flexural quality at 7 and 28 ages(days) and finished higher estimations of flexural quality at 56 days when differentiated to that of conventional concrete (CC) as showed up in Fig 3. [4,6,9]

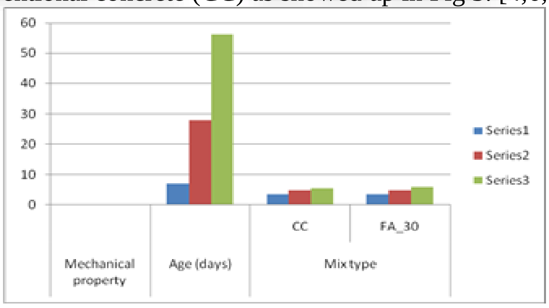

Fig. 3: Flexural strength versus Age

D. Modulus of Elasticity (MOE) of FA based on concrete

In this area, MOE of both CC and FA based concrete blends were learned at different curing periods. Table 5 shows the MOE estimations of concrete made with deficient substitutions of CWR and FA[7]

Mechanical Property	Age (days)	Mix type	
		CC	FA_30
MOE (MPa)	7	22.45	21.9
	28	28.91	28.12
	56	31.48	33.10

Table 5: MOE of FA based concrete

From the results it is seen that the concrete blends with fragmented substitution of FA have finished lower estimations of MOE at 7 and 28 ages(days) and accomplished higher estimations of MOE at 56 days when differentiated to that of conventional concrete (CC) as showed up in Fig 4.

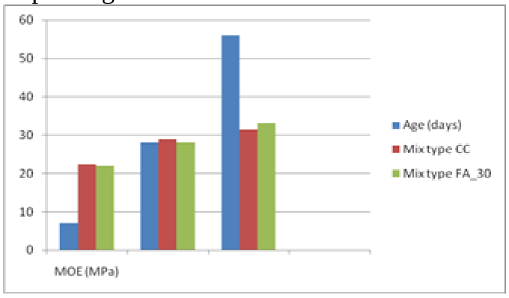

Fig. 4: MOE versus Age

E. Bond strength of FA based on Concrete

In this area, Bond strength of both CC and FA based concrete blends were learned at different curing periods. Table 6 exhibits the bond quality estimations of cement made with halfway substitutions of CWR and FA.[5]

Mechanical Property	Age (days)	Mix type	
		CC	FA_30
Bond Strength (MPa)	7	6.83	6.45
	28	8.98	8.45
	56	9.58	10.96

Table 6: Bond strength of FA based concrete

From the results it is seen that the concrete blends with deficient substitution of FA have finished lower estimations of bond quality at 7 and 28 ages (days) and accomplished higher estimations of bond quality at 56 days when differentiated to that of conventional concrete (CC) as showed up in Fig. 5.

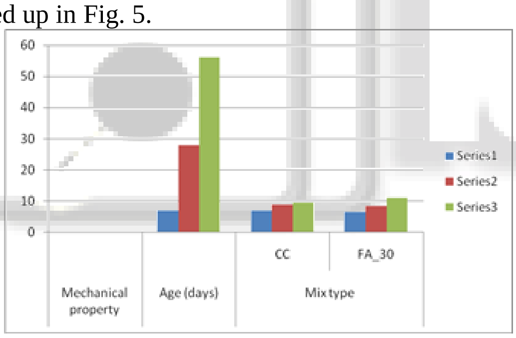

Fig. 5: Bond strength versus Age

V. CONCLUSIONS

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

1) From the outcomes it is seen that the concrete mixes with halfway substitution of CWR and FA have achieved lower or equal estimations of compressive, splitting tensile, flexural strength, bond strength and MOE properties at ages of 7 and 28 days when contrasted to that of conventional concrete.
2) From the outcomes it is seen that the concrete mixes with fractional substitution of CWR and FA have accomplished higher estimations of compressive, splitting tensile, flexural strength, bond strength and MOE properties at age of 56 days when contrasted to that of conventional concrete.
3) Due to the Pozzolana responses of FA, the execution of FA based concrete is high at the later ages.

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