Properties of Concrete Coarse Aggregate Partially Replaced With Coal Washrey Rejects

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Abstract: ***The interest of normal aggregates is quickly turning out to be high step by step in the development industry. Different endeavors are being made to discover substitutes for normal aggregates. In India, around 70% of power is created by burning of good quality coal. During the time spent coal washing, substantial amounts of sullied coal are being rejected and bringing on transfer issues. These rejected sullied coals are called as Coal Washery Rejects (CWR). To keep up the ecological manageability, an endeavor has been made in the present study to utilize new material CWR as fractional substitution of coarse aggregate in concrete. The compressive strength of concrete containing CWR at various substitution levels (0% - 30%). The compressive strength qualities were compared with M 25 evaluation of conventional concrete (CC). From the outcomes, it is watched that the expansion in CWR substitution level diminished the compressive strength. This decrease was marginal at 20% and 30% substitution levels, however beyond 30%, the reduction was especially huge. Henceforth, it is uncovered that 30% CWR substitution can be considered as ideal level in the development business. From the compression strength results durable property Rapid chloride permeability test (RCPT),tests were conducted at the replacement level of 30 % only.***

Keywords: compression strength, coal wahsrey rejects, RCPT, concrete etc

1. Introduction

Totals which possess around 70-80% of solid volume assume an essential part in the concrete properties. The accessibility of good quality aggregates is exhausting step by step because of enormous development in the development industry. Henceforth, a few inquires about are being centered around the utilization of different mechanical waste materials and by-products as aggregate substitutes, for example, coal fiery debris, granulated blast furnance slag, fiber glass waste materials, waste plastics, elastic waste and others [1 and 2]. The workability of concrete diminished with the expansion in base fiery debris content because of the increment in water request. The compressive, part ductile and flexural quality properties of solid utilizing base fiery remains as fine total were lower than control concrete at all ages. Be that as it may, following 28 days the quality contrast between base fiery debris cement and control concret examples was less unmistakable [3]. The early age compressive strength of concrete utilizing granulated blast furnance slag (GBFS) as fine aggregates was lower than cement made with waterway sand, however at later ages the strength was higher [4].

The aggregate substitution of coarse aggregates with solidified slag influences emphatically the compressive, part malleable and flexural strength properties [5]. It was proposed that copper slag can be utilized as a trade for fine aggregate to acquire a solid with great quality and solidness prerequisites [6]. The fuse of plastic aggregates (PA) diminished the droop of the new concrete. The strength properties and modulus of flexibility of solid utilizing PA as coarse total are dependably lower than the control concrete [7]. Bhikshma and Manipal called attention to that critical change in the solid properties when reused total is utilized alongside the steel filaments [8].

Around 67% of power delivered in India is by ignition of coal. The aggregate stores of coal in India are evaluated to be 106,260 million tones. As the interest of coal has the most astounding forward linkage impact with warm power, railroads trains, manures industry, concrete, steel, electric force and various different commercial ventures, the utilization of coal is required to increment at speedier rate. India keeps on being the 6th biggest maker of coal with its yearly creation of almost 100 million tones. The stores of high positioning coal i.e. anthracite and coking bituminous coals are less when contrasted with the low positioning bituminous and lignite coals. The coal as it originates from mines comprise of numerous polluting influences, for example, magnesium sulfate, sulfur in type of pyrites, slate and fire mud. These substances have higher particular gravity than unadulterated coal and henceforth, it requires coal washing strategy to clean coal before utilizing. specific gravity of unadulterated coal is 1.2 to 1.7 and for polluted coal is 1.7 to 4.9. In this way, coal must be screened to size and it must be cleaned by jigging or by substantial media detachment [9].

Indian coal is thought to be of low quality since it contains fiery remains as high as 45%, high dampness content (4–20%), low sulfur content (0.2–0.7%), and low calorific qualities (between 2500–5000 kcal/kg) (IEA, 2002). High cinder content in the coal supplied to the force pants postures ecological issues as well as results in poor plant execution. In this manner, coal washing is important from financial and environment perspective.

Amid the coal washing process, wiped coal did by the water stream over a weir and the decline sinks at the base. Decline is expelled time to time from the washer and put away in shelter stockpiling. This decline which is put away in shelter stockpiling is called coal washery rejects (CWR) [10]. The era of rejects from washeries in Coal India Limited (CIL) in 2004-05 was 2.44 Mt. Gathered load of washery rejects up

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to March'05 was 18.15Mt. The coal washery rejects (CWR) are the major ecological danger amid the procedure of coal washing. Transfer of this tremendous amount of rejects in a domain well disposed way makes a genuine issue. For unraveling the transfer of expansive measure of coal washery rejects, reuse of CWR in solid industry can likewise be considered as the most possible application [11]. Subsequently, this examination is meant to present CWR, as an other option to coarse aggregates in the concrete industry and study the mechanical and durable properties of CWR based concrete

2. Materials

2.1 Cement

Ordinary Portland Cement 53 grade (Penna) was used corresponding to IS 12269 (1987). The chemical properties of the cement as obtained by the manufacturer are presented in the table1 below

Table 1: Properties of cement

Physical properties	Results
Fineness	8%
Normal consistency	31.5%
Vicat initial setting time(minutes)	43mins
Vicat final setting time (minutes)	256min
Specific gravity	3.15
7-days compressive strength	39.65
28-days compressive strength	54.86

2.2 Aggregates

Crushed granite stones of size 20 mm and 10 mm are used as coarse aggregate. The bulk specific gravity in oven dry condition and water absorption of the coarse aggregate 20 mm and 10mm as per IS 2386 (Part III, 1963) are 2.6 and 0.3% respectively. The bulk density, impact strength and crushing strength values of 20 mm aggregate are 1580 kg/m3, 17.9% and 22.8% respectively. The gradation of the coarse aggregate was determined by sieve analysis as per IS 383 (1970) and presented in Table2.

Table 2: Sieve analysis of 20 mm coarse aggregate

Sieve size	Cumulative percent passing	
	20 mm	IS 383 (1970) limits
20 mm	100	85-100
16 mm	56.17	N/A
12.5 mm	22.32	N/A
10 mm	5.29	0-20
4.75 mm	0	0-5

Table 3: Physical properties of aggregates

Properties	Coarse aggregate	CWR
Specific gravity	2.6	2.06
Water absorption (%)	0.3	0.48
Bulk density (Kg/m^3)	1580	1431
Impact strength (%)	17.9	19.5
Crushing strength (%)	22.8	26.8

2.3 Water Ordinary potable water available in the laboratory has been used.

2.4 Coal washrey rejects

In India, around 70% of power is created by burning of good quality coal. During the time spent coal washing, substantial amounts of sullied coal are being rejected and bringing on transfer issues. These rejected sullied coals are called as Coal Washery Rejects (CWR).

Figure 1: Coal washrey rejects

2.5 Mix Design

Table 4: Mix design

Mix type	Cement (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
CWR_0	384	192	683	456	0	636
CWR-30	384	192	683	456	205	636

3. Testing Procedures

3.1 Compression test

Compressive strength test was led on the cubical examples for all the blends following 7, 28 and 56 days of curing according to IS 516 . Three cubical examples of size 150 mm x 150 mm x 150 mm were thrown and tried for every age and every blend.

3.2 RCPT (Rapid chloride permeability test) (ASTM C 1202)

Rapid chloride permeability test According to ASTM C1202 test, water-saturated, 50 mm thick, 100 mm thick diameter concrete specimen is subjected to applied DC voltage of 60 V for 6 hours .In one container 3.0% NaC1 solution and in the other container 0.3 M NaOH solution. The durability of fiber reinforced concrete that is resistance to chloride penetration is studied. Rapid chloride ion penetrability tests were for copper slag specimens, an electrical current recorded at 1 minute intervals over the 6 hour time, resulting in the total charge passed in coulombs is shown in Table5 and Table 7 shows chloride permeability as per ASTM C 1202. The testing of specimens were done at 28,56 and 90days RCPT values for mix proportion.

Table 5: RCPT ratings as per ASTM C1202

Charge Passing (Coulombs)	Charge Passing (Coulombs)
>4000	High
2000-4000	Moderate
1000-2000	Low
100-1000	Very Low
<100	Negligible

4. Results and Discussion

4.1 Compression Test

Table6 demonstrates the compressive quality estimations of cement with incomplete substitution of CWR at various curing periods. From the outcomes it is seen that the solid blends with incomplete substitution of CWR have accomplished lower estimations of compressive quality at all ages when contrasted with that of ordinary cement (CWR_0) as appeared in Fig.2

Table 6: Compression strength results (Mpa)

Mix type	28 days	56 days	90 days
CWR-0	34.12	36.02	38.72
CWR-30	32.98	35.86	38.64

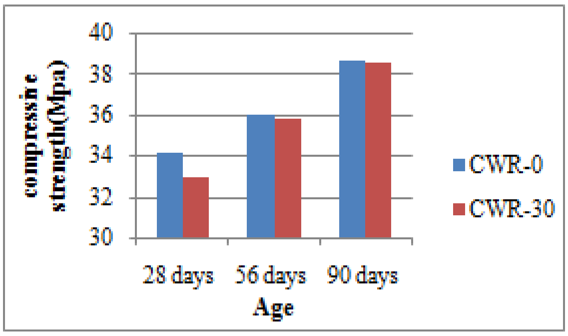

Figure 2: Compressive strength results

4.2 Rapid chloride permeability test (RCPT)

From the results of the rcpt observed that the value of the charge passing through the concrete is moderate in both conventional concrete, the values of CWR-30% replaced are compared with the conventional concrete (cc).

Table 7: RCPT values

Mix type	28 days	56 days	90 days	Charge Passing (Coulombs)
CWR-0	**3450**	**3240**	**3012**	**MODERATE**
CWR-30	**3561**	**3421**	**3121**	**MODERATE**

5. Conclusions

1) From the outcomes it is seen that the concrete mix with halfway substitution of CWR have accomplished lower estimation of compressive strength at all ages when contrasted with that of conventional concrete.
2) The lower benefit of pounding and effect strength of CWR is mostly ascribed to the lessening in compressive strength properties of CWR based concrete.
3) It observed that the strength properties have been decreased marginally for the concrete mixes CWR_30. The 28 day compressive strength of the concrete mixes CWR_30 are comparable to that of M 25 grade of CC.
4) Thus, it can be prescribed that 30% fractional substitution of CWR as coarse total is ideal in the perspective of CC.
5) The further increment in substitution of CWR diminished the compressive strength fundamentally as on account of the concrete mix CWR_40 .
6) From RCPT results it is observed that charge passing through both CC and CWR concrete are MODERATE.

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