e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:05/Issue:10/October-2023 Impact Factor- 7.868 www.irjmets.com

INFLUENCE OF CEMENT KILN DUST (CKD) ON CONCRETE

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ABSTRACT

Cement Kiln Dust has not yet been employed in cement as a whole or partial substitute for FA in concrete mix, leaving a research void in this area. Therefore, using CKD will also protect the environment from pollution brought on by CKD dust particles together with the examination of research gaps. As some of the cement manufacturing factories are not able to reuse cement kiln dust in formation of cement as it is very expensive process so we could save man power as well as financial expenditures yearly. The study aims to determine the performance of concrete utilizing CKD as sand substituting item. Total ten mixes were prepared with 1:2:4 ratio. Replacement rates were 10%, 20%, 30% 40%, 50%, 60%, 70%, 80%, 90% and 100% for CKD as substtute of sand . Cubical specimens' compression strengths were tested after 7 and 28 days of curing . Additionally, research was done on dry density and water absorption. As per observed results, 10% replacement of CKD for Sand yielded maximum strength among all mixes. However, only One of the CKD mixes achieved little higher strength than controled mix. Besides, water absorption decreased by mixing CKD while Slump also decreased to Zero slump. While dry density of CKD ranges in between 2400 Kg/m^3 to 2600 Kg/m^3.

Keywords: Cement Kiln Dust Concrete, Fine Aggregates, Compressive Strength.

I. INTRODUCTION

The influence of CKD on compressive strength of cement mix and the corrosion behavior of embedded reinforcement was explored. They found that substituting CKD for up to 5% of the cement by weight had no negative impact on the cement paste strength or reinforcement passivity. [8].

It is found that adding CKD and blast furnace slag to standard Portland cement in the proper proportions increased the mix's compressive strength and corrosion resistance [3].

RCRA regulations of the Environmental Protection Agency (EPA) apply. However, this does not rule out the possibility that cement kiln dust contains something hazardous to the environment [12-13]. To keep CKD safe, it must be treated carefully to avoid contamination of the environment, and the toxic behavior of CKD must be established based on cases [9].

The corrosion performance of rebars in a variety of mortar specimens was studied using BFS and CKD at the same time in this study. Partially immersing whole reinforced concrete specimens in a 3.5 percent w/w NaCl solution replicating seawater conditions exposed them to high chloride conditions. During the test period, measurements of concrete performance included half-cell potential, compressive strength, and electrochemical tests of steel corrosion rates in concrete (using Linear Polarization and Tafel Techniques). The corrosion activity and mineral admixture efficiency were also examined by evaluating the rebar's weight loss and carbonation depth. The test findings demonstrate that adding BFS and CKD to OPC cement in the right ratio increases compressive strengths and resistance to corrosion. [3].

The goal of this research was to see if (CKD) could be used as cementations ingredient in concrete mixes and mortar mixes. The influence of CKD on strength and ability of the cover zone to absorb water, an important aspect in the deterioration process, was studied in concrete and mortar mixtures. The compressive strengths, flexural strengths, and toughness of concrete samples containing CKD are all provided as experimental results. The absorption parameters of several mortar samples containing CKD were measured using the initial surface absorption tests of mortar and sorptivity of mortar. It was discovered that replacing cement with CKD does not result in increased strength in all of the samples tested, and that proper CKD addition had no detrimental effects on strength attributes. It's also been proven that mortars made with the right amount of CKD have

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greater absorption properties. However, there are some restrictions to how much water can be absorbed by mortar with increasing CKD contents and decreasing mortar strength.[7]

II. METHODOLOGY

First came the gathering of the materials and testing of them. In the laboratory, all 11 mixtures were created, and CKD was added to them in the amounts of 10%, 20%, 30%, and 100%.

To determine the dry density and water absorption the results were evaluated and charts were generated. Results led to a conclusion on the mixes behaviour, and suggestions for improvement were made.

Table 1:

#	Mixes	Cement %	Cement Kiln Dust (CKD)%	F.A%	C.A%
1	Control Concrete	100	0	100	100
2	CKD10	100	10	90	100
3	CKD20	100	20	80	100
4	CKD30	100	30	70	100
5	CKD40	100	40	60	100
6	CKD50	100	50	50	100
7	CKD60	100	60	40	100
8	CKD70	100	70	30	100
9	CKD80	100	80	20	100
10	CKD90	100	90	10	100
11	CKD100	100	100	0	100

III. MATERIALS

3.1) Cement Kiln Dust:

Cement kiln dust (CKD) is the fine-grained, solid, highly alkaline waste removed from cement kiln exhaust gas by air pollution control devices. Because much of the CKD is actually unreacted raw materials, large amounts of it can and are, recycled back into the production process.[1].

Figure 1: CKD

The chemical composition of CKD, Cement and Fine Aggregates

Table 2:

Compound	OPC%	FA%	CKD%
SiO_2	20.78	87.84	14.78
Al_2O_3	5.16	4.52	4.21
Fe_2O_3	3.50	0.84	2.67
CaO	61.98	0.17	45.66

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3.2) Cement:

Ordinary Portland cement is a prominent cementitious product utilised in Pakistan's construction industry, hence Lucky Star OPC is chosen for research purposes. Following tables will further depicts the Mechanical Properties of cement used.

Table 3: Properties of Lucky Star Cement

Properties	Result
Fineness	97.5%
Normal Consistency	0.34 (W/C ratio)
Initial Setting time	42 min
Final Setting time	8hrs. 16min

3.3) Fine Aggregate:

Fine aggregate was obtained from Bolari. Sieve analysis test was performed as per ASTM C136 [24] to check the suitability of fine aggregate (as shown in Table 3 and Figure 3).

Table 4: Sieve Analysis of Fine Aggregate

Sieve Size (mm)	Wt. Retained (gm)	Wt. Retained (%)	Cum. Wt. Retained (%)	Cum. Wt. Passing (%)
9.54	50	1.766784452	1.766784452	98.23321555
4.75	85	3.003533569	4.770318021	95.22968198
2.36	150	5.300353357	10.07067138	89.92932862
1.18	280	9.893992933	19.96466431	80.03533569
0.6	465	16.43109541	36.39575972	63.60424028
0.25	1125	39.75265018	76.14840989	23.85159011
0.15	305	10.77738516	86.92579505	13.07420495
0 (Pan)	370	13.07420495	100	0

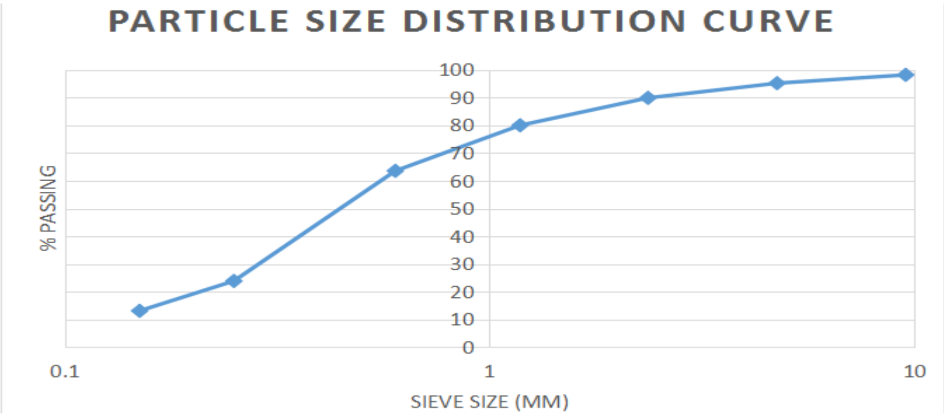

Figure 2: Particle Size Distribution Curve of Fine Aggregate

3.4) Coarse Aggregate:

Fine aggregate was obtained from Nooriabad. Sieve analysis test was performed as per ASTM C136 [24] to check the suitability of fine aggregate (as shown in Table 4 and Figure 4).

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Table 5: Sieve Analysis of Coarse Aggregate

Sieve Size (mm)	Wt. Retained (gm)	Wt. Retained (%)	Cum. Wt. Retained (%)	Cum. Wt. Passing (%)
37.5	0	0	0	100
25	25	0.504540868	0.504540868	99.49545913
19.5	830	16.75075681	17.25529768	82.74470232
12.5	2495	50.35317861	67.60847629	32.39152371
9.5	1330	26.84157417	94.45005045	5.549949546
4.75	275	5.549949546	100	0
0	0	0	100	0

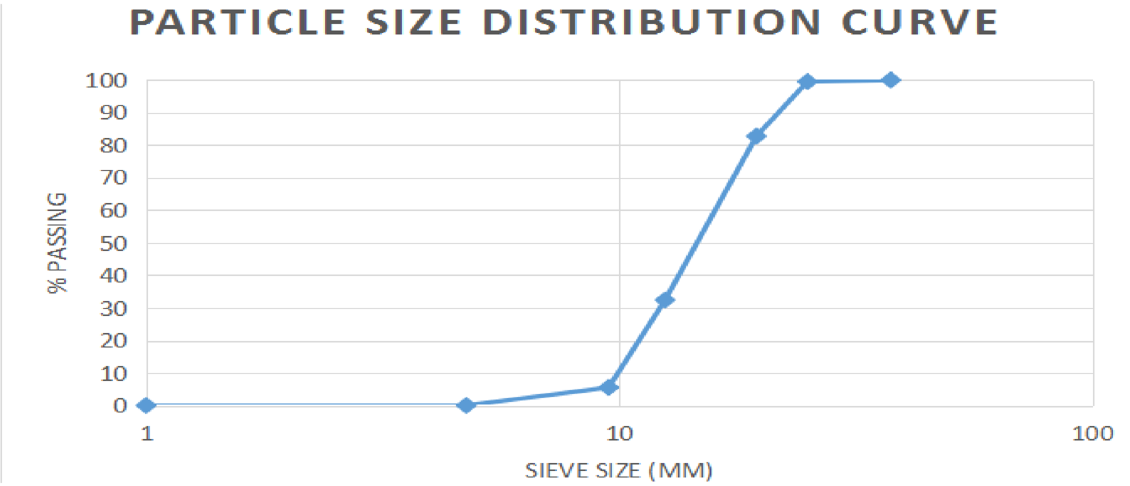

Figure 3: Particle Size Curve of Coarse Aggregate

IV. RESULTS AND DISCUSSION

According to data in Figure 4.4, water absorption reduced in all mixes when replacement material was added because the pores in the concrete matrix could hold CKD of a smaller size. Controlled Concrete had an absorption of 1.778%, it reduced to 0.557%, the lowest of all mixes, at CKD 100%. Due to the pores being filled by CKD's ultrafine particles, Figure 4.05 demonstrates that Dry Density was greatest in CKD100. However, the inclusion of CKD causes it to keep rising. At a 10% rise in CKD, a gradual increase was attained up to 25kg/m3. When 10% CKD was used in concrete, the minimum dry density was achieved.

Table 6:

Mix	Water Absorption %	Dry Density kg/m3
Control-Concrete	1.777	2480
CKD10	1.598	2520
CKD20	1.462	2545
CKD30	1.304	2565
CKD40	1.214	2577
CKD50	1.056	2588
CKD60	0.967	2600
CKD70	0.842	2625

CKD80	0.695	2651
CKD90	0.672	2670
CKD100	0.557	2680

V. CONCLUSION

In this study, CKD replacement as sand at 10% increment in concrete streungh is achieved. From results it is found that,

- With an increase of CKD as a substitute material, absorption reduced in all mixes. Normal-Concrete had an absorption of (1.778%); however, when CKD10 to 100 was added, it caused the absorption to drop to 1.598% to 0.557%, which was the lowest.
- Dry Density ranges from (2380 to 2680 kg/m3). CKD100 had highest-density of 268kg/ m^3 whereas CKD10 had lowest-density of 2480 kg / m^3.

VI. RECOMMENDATIONS

Following recommendation are suggested,

- Research on alternative cementitious materials as well as durability characteristics of concrete, such as acid attack, sulphate attack, and freeze-thaw.
- The addition of CKD to another fine aggregate replacement material, such as sawdust, rice husk ash, marble powder, sugarcane bagasse ash, or limestone powder.

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