WASTE BRICK KILN DUST AS A CONSTRUCTION MATERIAL IN CIVIL ENGINEERING

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Abstract- Now day's building construction is going rapidly with the rate of 6.6% from 2005 as projected increase in building area in India. So scarcities of constructional materials are going to increases and demand of building construction, road construction also increases. On the other hand in this paper we focused to find out the physical properties of waste brick kiln dust (B.K.D.) as a constructional material in civil engineering as partial replacement of OPC cement through various lab testing's like sieve analysis, specific gravity, optimum moisture content (OMC) and shear testing.

Keywords: Sieve Analysis, Specific Gravity, Optimum Moisture Content and Shear Testing

1. INTRODUCTION

In India there are more than 10000 brick kiln operating and it's consuming about 35 million tonnes (MT) of coal in a year for baking the soil brick. The brick production industry a largely resource and energy consecutive as well as polluting industry which is mostly due to obsolete traditional production technologies employed in India has been recognized by The Central Pollution Control Board, Delhi (CPCB) . While the cluster of brick kilns are mainly source of air pollution which affect local population agriculture and vegetation. At global level they also contribute to climate change. Indian brick industries have been divided into three regional differences

India is divided into 3 broad regions – northern mountainous region, Gangetic plain and peninsula (triangular plateau region) as shown in figure 1.

(i). Northern Mountainous Region: The brick production in the northern mountainous region is very low and is limited to valleys e.g. Srinagar, Jammu and Dehradun.

(ii) Gangetic Plains: The Gangetic plains of north India account for about 65% of total brick production. Haryana, Punjab, Bihar, Uttar Pradesh, and West Bengal are the mainly brick producing states in this region as shown in table 1 below. Brick kilns, generally of medium size and large sizes production capacities (2–10 million bricks per year), are located in clusters around major towns and cities.

(iii). Peninsular Region: Peninsular and coastal India account for the remaining 35% of brick production. In this region, bricks are produced in numerous small units (production capacities generally range from 0.1 to 3 million bricks per year). Gujarat, Orissa, Madhya Pradesh, Maharashtra, Karnataka and Tamil Nadu are important brick producing states in the peninsular plateau and coastal India.

Figure 1: Different Regions of India
Source: mapindia.com

Table 1: Estimated numbers of kilns in major brick producing states in the Gangetic plains

S. No.	States	Typical production capacity of a kiln (number of bricks/year)	Total number of kilns
1	Punjab	4-8 million	3000-4000
2	Haryana	4-8 million	2000-3000
3	UP	2-8 million	15000-18000
4	Bihar	2-5 million	4000-6000
5	West Bengal	2-5 million	3000-5000

1. Scope and Aim of the Research

The aim of study is to find out the utilization of B.K.D. as a construction material in civil engineering works as a partial replacement of cement. The physical and mechanical properties of B.K.D. have to be known before its use in concrete. Main focus of this research is on properties of B.K.D. first and after that as a construction material. Scope of this study is also can be used in Government running projects like development of rural roads, National Rural Employment Programme, Rural Landless Employment Guarantee Programme, and Jawahar Rozgar Yojana etc. It also can help to overcome the problem of environment pollution through Brick factories as per more concerning in Central Pollution Board Delhi and enhance building constructional materials.

2. Testing's of Physical properties of B.K.D.

Brick kiln dust (B.K.D.) locally called "Rubbish" was taken from brick production place near Motiram, Gorakhpur as shown in figure 2 was used for civil engineering construction works.

3.1 Sieve Analysis of B.K.D.

To decide the percentage of retained sample in each sieve and sieve size taken as per IS 460-1962.Sieve size was in between 4.75 mm to 75 microns. Fig. of B.K.D. is shown in figure 2 and its observation of sieve analysis is shown in table 2.

Figure 2: B.K.D.

Table 2: Observations of Sieve Analysis of B.K.

S.NO,	Sieve size	Weight retained W_1 (grams)	% Retained in each sieve $\frac{W_1}{W} \times 100$	Cumulative weight retained (grams)	% passing (100- col. 4)
	1	2	3	4	5
1	4.75 mm	33.8	11.27	11.27	88.73
2	2.00 mm	32.1	10.70	21.97	78.03
3	1.00 mm.	37.0	12.33	34.30	65.7
4	425 micron	36.3	12.10	46.40	53.7
5	212 micron	37.2	12.40	58.80	41.2
6	125 micron	46.0	15.33	74.13	25.87
7	75 micron	32.5	10.83	84.96	15.04
	Total				367.64

$$\text{Fineness modulus} = \frac{total\ of\ \%age\ passing}{100} = \frac{367.64}{100}$$

= 3.67

The grading curve is shown in figure 3 as below

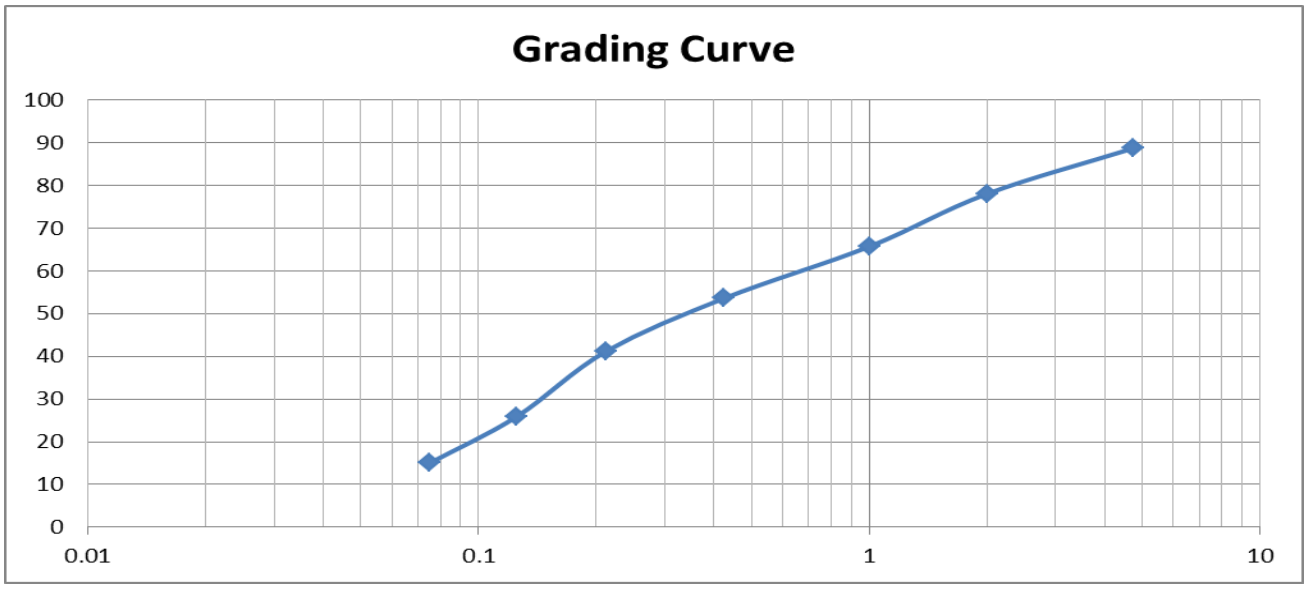

Figure 3: Grading Curve of B.K.D.

2.1. Specific Gravity of Brick Kiln Dust

Specific gravity of brick kiln dust passing through 4.75 mm IS sieve is done by density bottle and its observation is shown in table 3.

Table 3: Observations of Specific Gravity of B.K.D.

S. No.	Observation	Records
1	Weight of sample taken (in g)	400
2	Weight of density bottle (W_1 g)	590
3	Weight of density bottle + dry B.K.D. (W_2 g)	990
4	Weight of bottle + dry B.K.D. + water (W_3 g)	1622
5	Weight of bottle + water (W_4 g)	1466

Specific gravity of B.K.D. = $\frac{(W_2-W_1)}{(W_4-W_1)-(W_3-W_2)}$

$= \frac{(W_2-W_1)}{(W_2-W_1)-(W_3-W_4)}$

$= \frac{990-590}{(990-590)-(1622-1466)} =$ 2.35

2.2. OMC Test of Brick kiln dust

In this experiment 3 kg sample of B.K.D. taken and dry it in oven at temperature 105℃ for 24 hours. After that started experiment with adding 6% of water by weight of B.K.D. then adding 3% water to determine its OMC.

Table 4: Observations of OMC of B.K.D

S. No.	Weight of Mould	Weight of Mould + Weight of Wet B.K.D	Weight of Crucible+ Wet B.K.D (A)	Weight of Crucible+ dry B.K.D (B)	Wt. of Crucible (C)	Water percentage
	1	2	3	4	5	6
1	2.731	4.118	31.652	31.371	17.613	6
2	2.731	4.188	34.256	33.394	16.298	9
3	2.731	4.203	33.286	32.390	16.584	12
4	2.731	4.253	32.511	31.323	16.865	15
5	2.731	4.294	36.271	34.517	17.068	18
6	2.731	4.357	40.265	37.434	15.866	21
7	2.731	4.440	33.804	31.173	16.574	24
8	2.731	4.555	46.978	40.100	17.432	27
9	2.731	4.546	52.64	43.847	17.703	30

Table 5: Calculation Table of OMC of B.K.D

S. No.	Weight of wet B.K.D.= (Weight of Mould + Weight of Wet B.K.D)- (Weight of Mould)	Volume of mould in cc	Bulk density (γ)	Moisture content $(\omega)=\frac{A-B}{B-C}\times 100$	Dry density = $(\frac{\gamma}{1+\omega})$
	1	2	3	4	5
1	1.387	1000	1.387	2.04	1.359
2	1.457	1000	1.457	5.04	1.387
3	1.472	1000	1.472	5.67	1.393
4	1.522	1000	1.522	8.22	1.406
5	1.563	1000	1.563	10.05	1.420
6	1.626	1000	1.626	13.13	1.437
7	1.709	1000	1.709	18.02	1.448
8	1.825	1000	1.825	30.34	1.400
9	1.815	1000	1.815	33.63	1.358

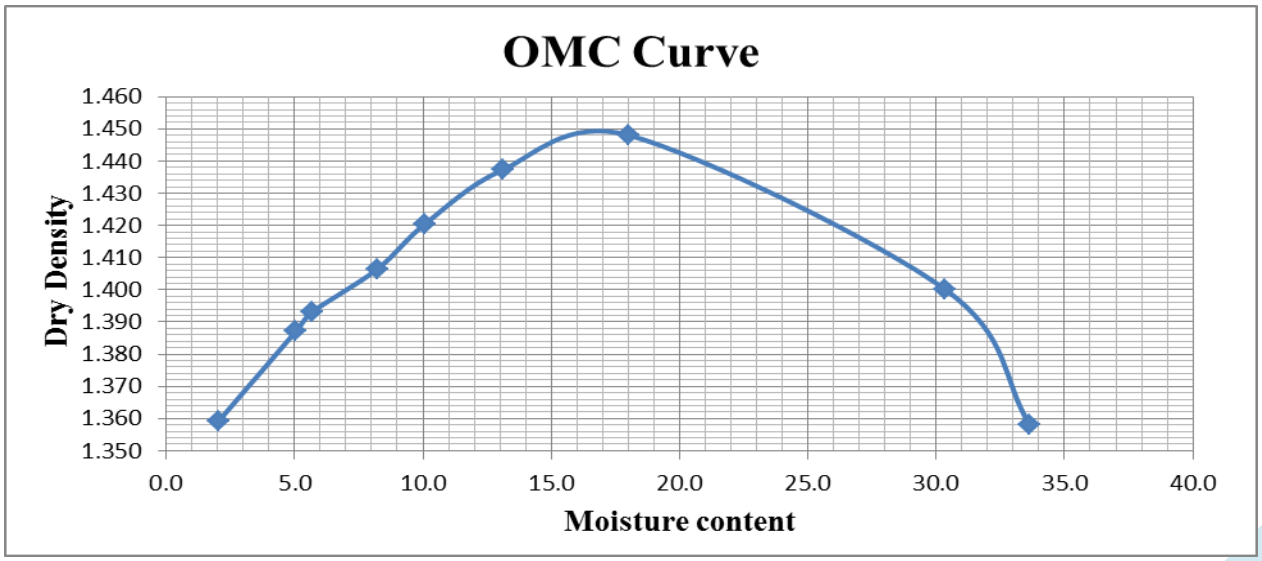

Figure 4: Graph between Dry Density and Moisture Content

Maximum dry density of BKD = 1.444
Optimum moisture content = 17

2.3. Shear Test of Brick kiln dust

As shear test is done to know the problem of civil engineering like slab bridges, angle of fraction, design of retaining walls, pipes and design of foundation. This test gives us value to predict parameters as above. So the lab testing of B.K.D. gives value for above parameters.

Table 6: Observations of Shear test of B.K.D

S. No.	Normal Load		Shear Force		
	In pound	In kg	Main Division	Sub Division	
				In pound	In kg
1	5	2.27	-	6	8.696
2	10	4.54	-	12	17.391
3	15	6.81	-	15	21.739

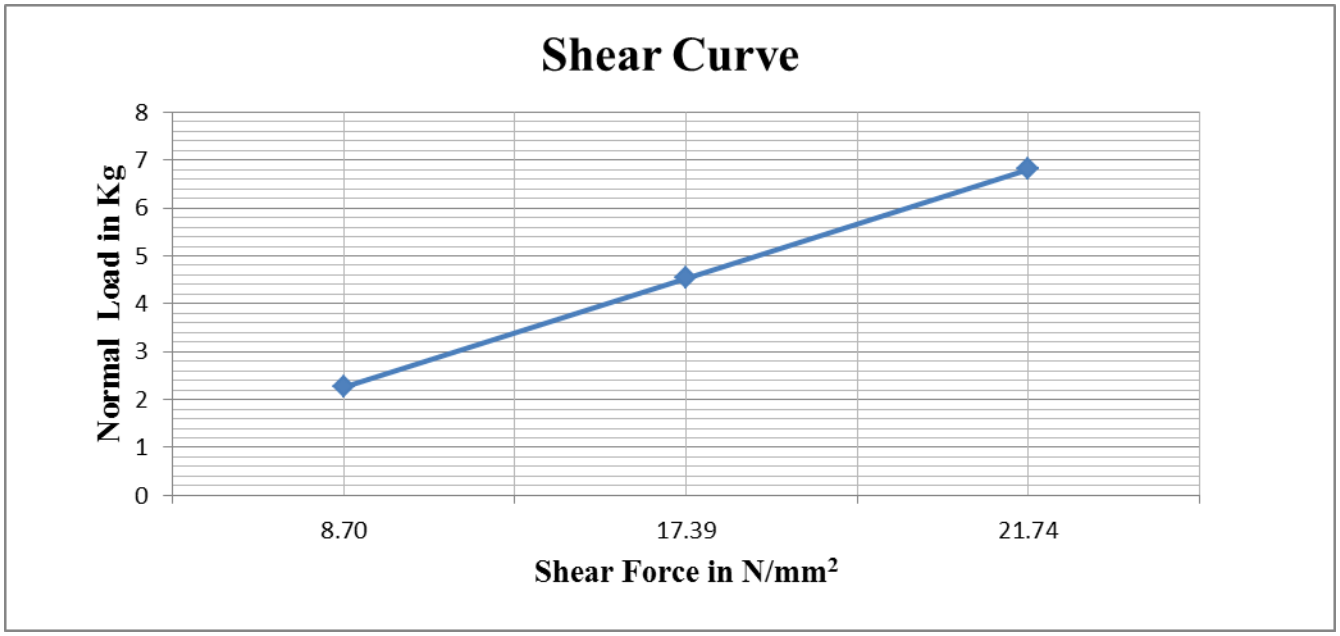

Figure 5: Graph between Normal Load and Shear Force

Shear Angle (Ø) = 19.19°

2.4. Liquid limit and Plastic Limit test of Brick kiln dust

Taking 200 gram of sample passing through 40 ASTM sieve as per IS 2720. Mixing water in the sample and following the procedure of liquid limit and plastic limit but sample of B.K.D. has no liquid limit and plastic limit that's mean B.K.D. has no Plastic Index.

3. Result and Discussions

From the above experimental study on B.K.D It has been concluded that waste brick kiln dust has meaning full properties which can be utilized in civil engineering works like building construction, road constructions and other many works. In the final term it has following physical properties as shown in table below

Table B.3.1: Physical Properties of B.K.D

S. No.	Physical Properties	Results
1	Fineness modulus	3.67
2	Specific gravity	2.35
3	Maximum dry density	1.444
4	Optimum moisture content	17
5	Shear Angle (Ø)	19.19°
6	Liquid Limit	No
7	Plastic Limit	No

4. Conclusions

From this experimental study we can conclude that waste brick kiln dust is useful as partial replacement of cement after crushing, partial replacement of fine aggregate size taken between 75 micron to 4.75 mm sieve as per IS code, partial replacement of coarse aggregate size more than 4.75 mm and also can be used as soil stabilization in construction of bricks of clay with cement stabilizations.

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