A Study on Low Performance Concrete using Mineral Admixtures (Brick Kiln Dust and Silica Fume)

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Abstract— The mix proportions should be prepared in such a way that the coarse aggregate participation in volume should be reduced and the fine aggregate in the powder form is to be increased. In present work, cement is a permanent agent, the replacement of cement by Silica Fume in percentages namely(0% 5%,10%and 15%) and Brick Kiln Dust (BKD) in percentages namely (0% 5%,10% and15%) with W/C ratio of 0.50 the study on fresh properties of LPC; Compressive strength and split tensile strength of LPC were made. it was found that the replacement of cement by15% silica fume (FA) and 10% Brick kiln Dust (BKD) gives maximum compressive strength and split tensile strength respectively Dumping of brick dust and other waste brick particles, flakes etc., not only occupy land but also create environmental problems. The problems could be reduced to a large extent by using these waste materials in cement concrete. The reasons for using brick dust include economical gain and beneficial modification of certain properties of fresh and hardened concrete elements. This study gives an overview of the physical and chemical properties of brick dust as a mineral admixture (BDMA), which is dumped as waste from brick and tile factories in Bangladesh. Various properties of brick dust have been studied. Experimental results indicate that brick dust could be used for partial replacement of cement in concrete. Concrete cubes prepared with 20% cement replaced by brick dust (BDMA) shows compressive strength comparable to concrete cubes prepared with Portland cement only. Concrete prepared with 20% cement replaced by BDMA also shows good resistance to chemical attack, specially the sulfate attack. They also show better pore refinement after long period. Chemical composition and lime reactivity strength of brick dusts have been found to be within the range given for good pozzolanic material. The pore refinement and relatively low heat of hydration in the presence of BDMA show that certain properties of concrete could be improved by using brick dust in combination with Portland cement.India is the second largest producer of clay fired bricks, accounting for more than 10 percent of global production. India is estimated to have more than 100,000 brick kilns, producing about 150-200 billion bricks annually, employing about 10 million workers and consuming about 25 million tons of coal annually. India's brick sector is characterized by traditional firing technologies; environmental pollution; reliance on manual labour and low mechanization rate; dominance of small-scale brick kilns with limited financial, technical and managerial capacity; dominance of single raw material.

Key words: Low strength concrete, Silica fume, Brick kiln dust, Compressive and flexural strengths

I. INTRODUCTION

Concrete is one of the most common materials used in the construction industry. In the past few years, many research and modification has been done to produce concrete which has the desired characteristics. There is always a search for concrete with higher strength and durability. Low performance concrete used to the plain concrete cement, cements concrete road, etc. Low performance concrete also reduced the pollution, disease and environment effect low performance concrete is mixed silica fume(15% constant) and brick kiln dust. In India, the brick-making industries have flourished over the last three decades and have produced a huge amount of brick-kiln dust, i.e. a mixture of coal and wood ash and soil dust particles. The physico-chemical properties of brick-kiln dust were found to be similar to those of fly ash, though with slightly lesser values. India is the second largest producer of clay fired bricks, accounting for more than 10 percent of global production. India is estimated to have more than 100,000 brick kilns, producing about 150-200 billion bricks annually, employing about 10 million workers and consuming about 25 million tons of coal annually. India's brick sector is characterized by traditional firing technologies; environmental pollution; reliance on manual labour and low mechanization rate; dominance of small-scale brick kilns with limited financial, technical and managerial capacity; dominance of single raw material (clay) and product (solid clay brick); and lack of institutional capacity for the development of the sector. In a first of its kind detailed performance assessment, the principal investigating organizations – Genentech Knowledge Solutions Pvt. Ltd., Enzen Global Solutions Pvt Ltd, and University of Illinois – examined the energy, environmental and financial performance and brick maker input for five main brick firing technologies during 2011:Fixed Chimney Bull's Trench Kiln (FCBTK - India) Zig-zag Kiln (natural and forced draft - India) Vertical Shaft Brick Kiln (VSBK – India and Vietnam) Down-Draught Kiln (DDK- India) This study is one of two research components aimed at developing strategies for the introduction and promotion of cleaner walling materials in India.Concrete is probably the most commonly used construction material in the world . For desired characteristics of concrete, many research and modifications have been made in concrete. • The definition of high-performance concrete is more controversial.

A. *Civil Engineering Research Foundation (Cerp):*

works were The earlier research: first being the study of physical and mechanical properties of brick masonry and its assemblages classified into two different categories; second the effect of in-plane shear behavior of the masonry wall elements and the wall capacity for un-reinforced and reinforced brick masonry elements with analysis.

- Toughness
- Volume stability
- Extended service life in severe environments.

B. Properties Of Material:

Soil amendments with different proportions (5-50%) of brick-kiln dust were assessed for their effects on penetration and development of *Meloidogyne javanica* juveniles in roots of eggplant and on plant growth and yield, in comparison with inoculated or non-inoculated non-amended soil. All brick-kiln dust levels suppressed the penetration of the juveniles into the roots and their further development to older stages. The least plant growth and yield occurred in soil inoculated and non-amended. Brick-kiln dust amendment improved plant growth and increased yield components of eggplant, compared to inoculated soil, with the largest yield observed at the 30% level which was even significantly more than the yield in non-inoculated soil. Thus, brick-kiln dust can be used as an eco-friendly nematicide-cum-non-conventional fertilizer up to the 30% level.In India, the brick-making industries have flourished over the last three decades and have produced a huge amount of brick-kiln dust, i.e. a mixture of coal and wood ash and soil dust particles. The physico-chemical properties of brick-kiln dust were found to be similar to those of fly ash, though with slightly lesser values (Upadhyay, 2004). Moreover, soil amendments with brick-kiln dust resulted in a better growth and yield of different crops (Raghav and Khan, 2002; Raghav, 2006) Root-knot nematodes (*Meloidogyne* spp.) are devas-tating pests on most Brick-kiln dust contains CA, Mg, Na, Cd, Zn, N, Cal, S, Mo and Si elements plus high levels of P and K, and its nature is alkaline with pH ranging from 8.2-10.5 (Upadhyay, 2004). In the present study, soil amendment with brick-kiln dust was harmful to the nematode at all levels. The alkaline nature of brick-kiln dust may have directly affected the juveniles, leading to less penetra-tion into the roots and subsequently delayed develop-mint. Rive and Khan (2009a) also reported the harmful effect of brick-kiln dust extract on hatching and mortal-it of *M. javanica* juveniles. Edongali (1982) stated that juvenile penetration is affected by the concentration of different elements, irrespective of the type of element in the soil solution12.5 and 15) of SF, four percentages (10, 15, carry out the 7-day, 28- day and 90-day compressive strength and 28-day flexural

strength tests. An equation relating compressive strength to flexural strength has been developed based on experimental evaluation. Moreover, a comparison of this equation with the ACI 363 (1997) formula has also been made. Ultimately, the project aims to provide some guidelines for concrete mix composition that can be used in the formulation of HSC for the Jordanian market[3].

C. Materials And Methods:

Amendment of soil. Fresh brick-kiln dust was collect-ed in gunny bags from the brick kiln, Manzoor Garhi, situated about 15 km away from Aligarh, India. Soil was collected from an agricultural field to a depth of 20 cm, after discarding the surface litter. The soil was steam sterilized in an autoclave at 20 lb pressure for 20 min-utes. The autoclaved soil was dried and then mixed with brick-kiln dust in different ratios (w/w) separately. *Soil pH*. The pH of each soil sample was determined by adding 20 g soil samples to 40 ml of double distilled water (DDW)

D. Background:

He growth in India's economy and population, coupled with urbanization, has resulted in an increasing demand for residential, commercial, industrial, and public buildings as well as other physical infrastructure. Building construction in India is estimated to grow at a rate of 6.6% per year between 2005 and 2030[1]. The building stock is expected to multiply five times during this period, resulting in a very large increased demand for building materialsSolid fired clay bricks are among the most widely used building materials in the country. India is the second largest producer of clay fired bricks, accounting for more than 10 percent of global production[2]. India is estimated to have more than 100,000 brick kilns, producing about 150-200 billion bricks annually[3].Brick making in India is characterized by the following features: Brick making is a small-scale, traditional industry[4]. Almost all brick kilns are located in the rural and peri-urban areas. It is common to find large brick making clusters located around the towns and cities, which are the large demand centers for bricks. Some of these clusters have up to several hundred kilns. The brick production process is based on manual labor, and brick kilns are estimated to employ around 10 million workers. Brick production is a seasonal vocation, as the brick kilns do not operate during the rainy season. Most of the workers migrate with their families from backward and poor regions of the country. Families, including young children, work in harsh, low paying conditions. There is typically a lack of basic facilities, such as access to clean drinking water and sanitation. Bricks are fired to a temperature of 700 -1100 ºC, requiring a large amount of fuel for the firing operation. Brick kilns are estimated to consume roughly 25 million tonnes of coal per year, thus making them among the highest industrial consumers of coal in the country. A rapid increase in brick production and the clustering of brick kilns have given rise to environmental concerns: o Combustion of coal and other biomass fuels in brick kilns results in the emissions of particulate matter (PM), Including blaccarbon (BC), sculpture dioxide (SO_2), oxides of nitrogen (NO_x), and carbon monoxide (CO). The emission of these Kayali, 1998.

Silica Fume

II. DISCUSSION

A. *Workability:*

From the results of workability tests namely, slump and flow, it is observed that slump and flow values of all the grades of HPC mixes significantly increase with increase in humidity at a constant temperature.

B. *Silica Fume Products:*

Silica fume (SF) is a byproduct of the smelting process in the silicon and ferrosilicon industry. The reduction of high-purity quartz to silicon at temperatures up to 2000 produces Si vapors, which oxidizes and condense in the low temperature zone to tiny particles consisting of non-crystalline silica. By-products of the production of silicon metal and the ferrosilicon alloys having silicon contents of 75% or more contain 85–95% non-crystalline silica. The by-product of the production of ferrosilicon alloy having 50% silicon has much lower silica content and is less pozzolanic. Therefore, Si content of the silica fume is related to the type of alloy being produced.

Silica fume is also known as micro silica, condensed silica fume, volatilized silica or silica dust.

C. *Compressive Strength:*

From the results of compressive strength test it is observed that the compressive strength of LPC mixes is significantly affected by the variation in temperature and humidity. The results indicate that the compressive strengths of LPC mixes decreases for increased relative humidity levels under a specific constant temperature. This implies that the combined effect of humidity and temperatures on LPC mixes is necessary to be taken into account while proportioning LPC mixes at site, particularly in the context of tropical countries.

III. PROPOSED MIX DESIGN METHOD FOR LPC

A. *2009 As Per Is 10262:*

- Type of cement: OPC43 grade
- Type of BKD: BKD type conforming to IS121298
- Max size of aggregate: 20mm
- Minimum cement content contact: 400kg/m^3
- Max w/c ratio: 0.50
- Workability: 100mm slump
- Exposure condition: severe(IRC)
- Degree of Supervision: good
- Specific gravity of cement: 3.15
- Specific gravity of fine aggregate: 2.67
- Specific gravity of coarse aggregate(20mm): 2.76
- Specific gravity of coarse aggregate(10mm): 2.68

IV. TEST RESULTS AND DISCUSSION

A. *OMC Test of Brick Kiln Dust*

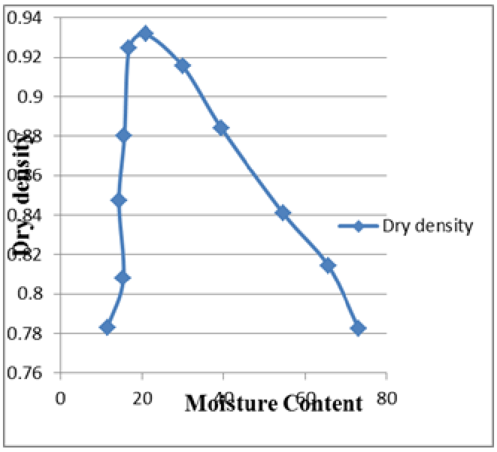

Fig: OMC Test Of Brick Kiln Dust Curve

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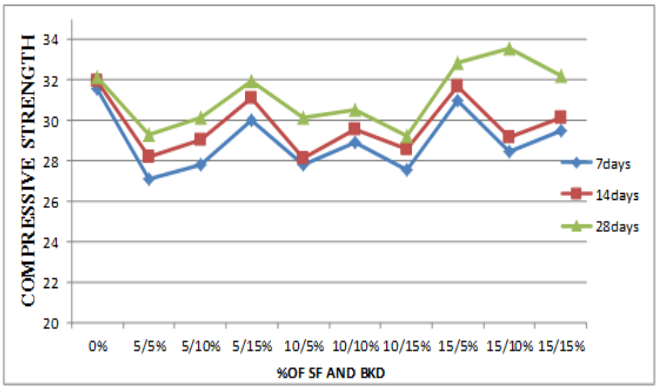
V. PRISIM TEST

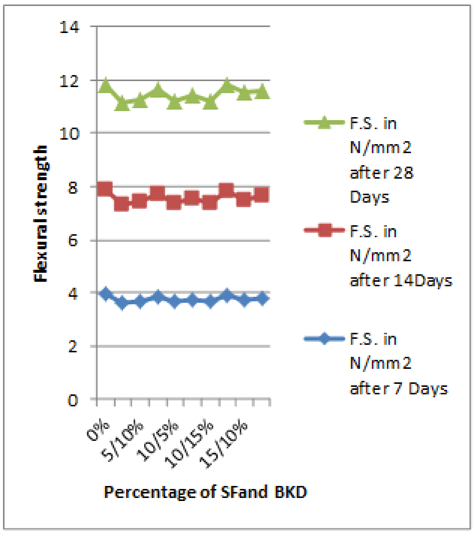
VI. TEST RESULT

%SF/BKD	7days	14days	28days
0%	31.55	31.95	32.16
5/5%	27.11	28.21	29.27
5/10%	27.77	29	30.1
5/15%	30	31.12	31.96
10/5%	27.77	28.14	30.1
10/10%	28.88	29.58	30.51
10/15%	27.55	28.55	29.25
15/5%	31	31.67	32.88
15/10%	28.43	29.16	33.56
15/15%	29.5	30.15	32.19



A. Variation compressive strength with SF and BKD after7, 14 and 28 days

%SF /BKD	F.S. in N/mm2 after 7 Days	F.S. in N/mm^2 after 14Days	F.S. in N/mm2 after 28 Days
0%	3.93	*3.95*	*3.96*
5/5 %	3.64	*3.71*	*3.78*
5/10 %	3.68	*3.76*	*3.84*
5/15 %	3.83	*3.9*	*3.95*
10/5 %	3.68	*3.71*	*3.84*
10/10%	3.76	*3.8*	*3.86*
10/15%	3.67	*3.74*	*3.78*
15/5 %	3.89	*3.93*	*4.01*
15/10%	3.73	*3.78*	*4.05*
15/15%	3.8	*3.84*	*3.97*



B. Cube Test And Reading:

VII. CONCLUSIONS:

Based on the experimental investigation on low performance concrete with cement replacement by silica fume and Brick kiln Dust the following conclusions were made: Optimum W/C ratio is taken as 0.50 due to fresh state performance, ratio beyond and less gives poor performance in fresh state of concrete. At the w/c ratio of 0.50, slump flow test, V-funnel test, T-50cm, U-box test and L-box test results were satisfied only for the following mixes SF 0%, SF5%, SF10%, SF15% and BKD 0%, BKD 5%, BKD 10%, BKD 15%... Compressive strength of LPC increases with the amount of quarry dust and brick dust by 20% and 10% as a replacement for fine aggregate respectively. Optimum compressive strength is obtained for SF 60% and BKD 30% replacement levels, based on the idea of more replacement. After that strength gradually slips while increasing Silica fumeand

Brick kiln Dust. Peak compressive strength obtained at SF 15% is 33.5MPa & BKD 10% is 38MPa and maximum split tensile strength obtained at SF 15% is 5.48 MPa& BKD 10% is 5.59 MPa respectively.

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