Experimental study on strength of concrete containing brick kiln dust and silica fume

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Abstract: *Concrete is an extensively used material in the world. Production of constituents of concrete leads to the depletion of the natural resources as well as it leads to the environmental pollution. Brick kiln dust is considered as a waste material in the Brick industries. In order to fulfill the insufficient of aggregates, have to use some alternative materials like brick kiln dust and silica fume etc. In this study concrete mix designs are prepared by using IS method (for M30 grade concrete).Furthermore, this study examined the properties of concrete by partially replacing the cement by silica fume(SF) and fine aggregate by brick kiln dust(BKD) by varying weight percentages of Silica fume(15% constant) and brick kiln dust (`15%,20%,25%,30%) respectively. Mechanical properties of concrete such as Compression and Split tensile strength are evaluated. Results showed increase in strength till 25% and then it got reduced for 30%. So 25% replacement of brick kiln dust is chosen as optimum value and also experimental values are compared with the theoretical values as per IS:456-2000.*

Keywords: Brick kiln dust, Silica fume, Compressive strength and split tensile strength.

1.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 was always a search for concrete with higher strength and durability. 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. For brick making availability of good soil is crucial. Recently numbers of additives are added or are replaced with clay to increase the performance of bricks including fly ash, bagasse ash, rice husk ash etc. The utilisation of waste from different industrial sector is appreciable for the environment and for the economy of the state also. The waste from the brick production facilities is also a cause of concern as the brick sector of India is unmanaged and has poor worker skill which causes high waste generation .The fly ash generated is being utilised by various other industries and have sufficient recycling values. The rest of the waste is being dumped on the roadside or in land filling causing environmental concerns. The presence of water bodies near the brick kilns also adds the high risk of water contamination and poses a threat to water ecology.

2. EXPERIMENTAL DETAILS:

2.1 Cement:

Cement is a fine powder used in construction which is mixed with other materials and water. Cement is a binder that sets and hardens and can bind other materials together. Portland cement set and become adhesive due to a chemical reaction between the dry ingredients and water.

Table 1:Physical properties of cement

S.NO	Properties	Result
1	Fineness modulus	4.5
2	Specific gravity	3.16
3	Consistency	32%
4	Initial setting time	50 mins
5	Final setting time	450 mins

2.2. Fine aggregate:

The sand is used for the experimental procedure and is locally procured from a river and confirmed to Indian Standard Specifications. It is passed through a 4.75mm sieve, washed to remove any dust and then used as it is for further investigations.

Table 2:Physical properties of fine aggregate

S.NO	Properties	Result
1	Fineness modulus	3.415
2	Specific gravity	2.65
3	Water absorption	0.82%

2.3. Coarse Aggregate:

Locally available CA having the maximum size of 20mm is used in our work. The aggregates are washed to remove

any dust and are dried. The aggregate are tested as per indian standard specifications.

Table 3:Physical properties of coarse aggregate

S.NO	Properties	Result
1	Fineness modulus	7.91
2	Specific gravity	2.78
3	Water absorption	1.5%
4	Crushing value	22.33

2.4. Water:

The control on the quality of water is often neglected. So quality of water is checked to its purity.

2.5. Brick kiln dust:

Brick kiln industries are the third largest industry where the coal is used to baking the clay brick. As per population are increasing the growth of brick kilns increasing to fulfill the demand of the clay bricks. But results has some losses in the form of environmental pollution and residue of brick kiln called brick kiln dust. These wastes are utilized for the low laying areas or dumped as the waste.Brick kiln dust is the waste obtained from burning of clay bricks in the form of brick kilns. It possess good pozzolanic property.

Table 4:Physical properties of brick kiln dust

S.NO	Properties	Result
1	Fineness modulus	2.31
2	Specific gravity	2.395
3	Water absorption	20.48%
4	Bulk density (g/cc)	1.39

Table 5:Chemical compositions of brick kiln dust

S.NO	Chemical component	% of Chemical component
1	SiO_2	67.43
2	Fe_2O_3	7.99
3	AI_2O_3	1.99
4	CaO	2.12
5	Na_2O	0.08
6	MgO	2.46
7	LoI	1.10

2.6. Silica fume:

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. 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 duct.

Table 6: Physical properties of silica fume

S.NO	Categories	Description
1	Size	Less than 1 μm
2	Shape	Spherical
3	Specific gravity	2.2

Table 7: Chemical properties of silica fume

S.NO	Chemical component	% of Chemical component
1	Silica	99.886
2	Alumina	0.043
3	Ferric oxide	0.040
4	Calcium oxide	0.001
5	Titanium oxide	0.001
6	Potassium oxide	0.001
7	Sodium oxide	0.003

2.7.MIX DESIGN

As per the code IS:10262:2009, the mix design is found and the amount of materials is calculated. According to the mix ratio, the amount of materials is given below, in table 3.1

Table 8: MIX PROPORTION

Water	cement	Fine aggregate	Coarse aggregate
186	442.857	669.686	1188.450
0.42	1	1.51	2.68

3. RESULS AND DISCUSSION

3.1. COMPRESSIVE STRENGTH TEST:

The strength in compression of the concrete is determined from cubes of (15cmx15cmx15cm). totally, 27 cubes are casted for 7 days, 14 days, and 28 days.

$$\text{Compressive strength} = P/A \ N/mm^2$$

Where,

P – Load in N
A – Area in mm^2

Table 9: Compressive strength with SF and BKD

SI. NO	% OF REPLACEMENT	7 DAYS CURING	14 DAYS CURING	28 DAYS CURING
		Stress (N/mm^2)	Stress (N/mm^2)	Stress (N/mm^2)
1	0%	27.23	34.44	37.06
2	15%SF+15%BKD	29.79	37.356	44.92
3	15%SF+20%BKD	32.04	36.77	46.80
4	15%SF+25%BKD	32.70	42.87	47.38
5	15%SF+30%BKD	33.79	43.16	45.78

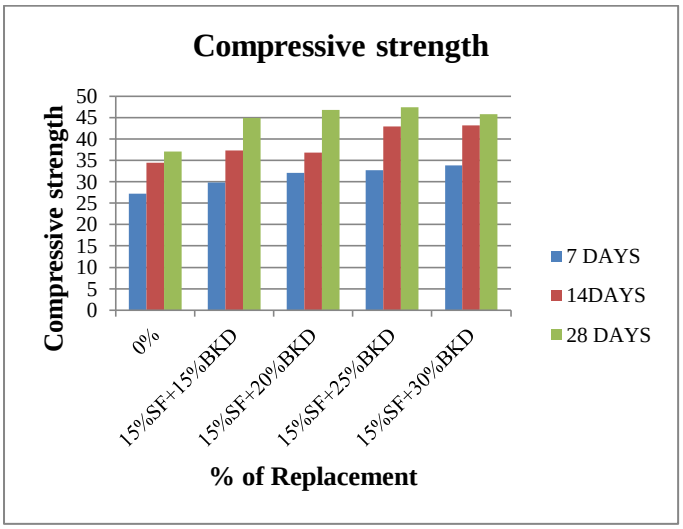

Figure.1. Compressive strength with SF+BKD

3.2. SPLIT TENSILE STRENGTH TEST:

The split tensile strength of concrete is determined from cylinder of radius 75mm and height 300mm.

Split tensile strength of concrete=$2P/ \pi d L$

Where,

P –Maximum applied load.
d –Diameter of cylinder.
L –Length of cylinder.

Table 10:Split tensile strength with SF and BKD

SI.NO	% OF REPLACEMENT	7 DAYS CUING	14 DAYS CUING	28 DAYS CURING
		Stress (N/mm^2)	Stress (N/mm^2)	Stress (N/mm^2)
1	0%	1.623	2.105	3.112
2	15%SF+15%BKD	1.727	2.250	3.250
3	15%SF+20%BKD	1.780	2.567	3.456
4	15%SF+25%BKD	1.877	2.660	3.550
5	15%SF+25%BKD	1.923	2.850	3.330

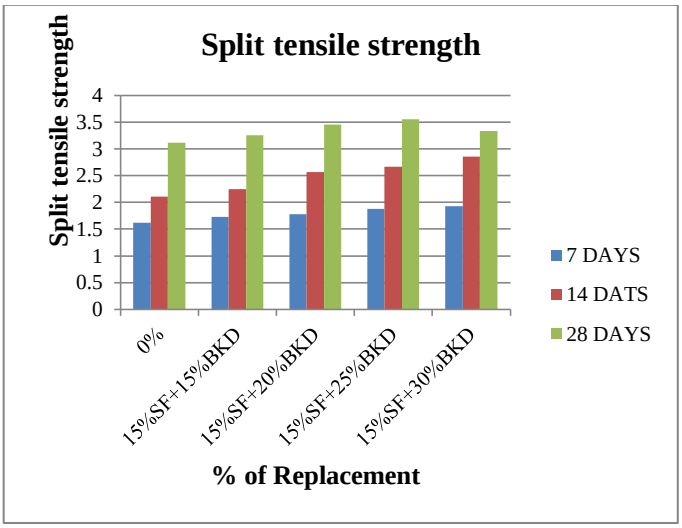

Figure .2. Split tensile strength with SF and BKD

4.CONCLUSION

From the results of Experimental investigation following conclusion are made.

- Experimental investigation, it is found that silica fume and brick kiln dust can be used as alternative material to the cement and fine aggregate.
- Using of brick kiln dust in concrete reduces the cost.
- The results show that composites with silica fume and brick kiln dust are reliable materials to be used in practice for the production of structural elements to be used in civil construction.
- Increase in compressive strength when compared to control mix concrete.
- The 28 days average split tensile strength obtained for 25% brick kiln dust mix concrete shows 13.53% increase in split tensile strength when compared to control mix concrete.
- The optimum level of replacement of brick kiln dust is found to be 25% and the results are better than that of control mix.

REFERENCES:

[1] M. Kamal Uddin, "Use of brick kiln dust in concrete as mineral admixture and partial replacement of cement" , Vol. 32(1),pp.69-78, December 2004.Journal of Civil engineering (IEB).

[2] E. R.Singh, E. R.Kaushik, and E. G.Singh, "Study of Self Compacting Concrete Using Brick Dust and Marble Powder," Vol.3.3,pp. 1283-1286,June 2013.International Journal of Engineering Research and Application.

[3] S. Sharma, R. Mall and K. Raza, "Effect of waste brick kiln dust with partial replacement of cement with adding super plasticizer in construction of paver block" ,Vol. 3(9),pp. 2261-2266, September 2014.International Journal of Science, Engineering and technology Research.

[4] M. B.Sharif, A. Anjum, M.A. Tahir, and M. Yousaf, "Performance of Pozzolanic Concrete Using Different Mineral Admixtures", Vol. 12, pp. 73-81,January 2013. Pak. J. Engg.& Appl.Sci.

[5] B. Anusha Priya, U. Vamsi Mohan, "Experimental studies on the Effect of Silica Fume and Quarry Dust in Concrete". Vol. 4, Issue 9, September 2015.International Journal of Innovative Research in Science, Engineering and technology.

[6] Bhanja,s. and Sengupta,B.(2009). "Investigations on the composite structure of silica fume concrete using statistical methods", Vol.32,pp. 1391-1394.Cement and Concrete Research.

[7] Aitcin, P.C., and Laplante, P.(1990), "Long-term compressive strength of silica fume concrete", Vol.2, No. 3, pp. 164-170. Journal of Materials in Civil Engineering.

[8] I. Demir, and M. Orhan, "Reuse of waste bricks in the production line" , Vol 38(12),pp. 1451-1455,May 2003.Building and Environmental.