Comparison of Strength Parameters of Conventional Concrete with Spent Fire Brick Concrete

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Abstract- Concrete is the combination of cement, aggregates and water with or without suitable admixtures. With the increase in population they are large demand for building material which causes a chronic shortage of building materials. The civil engineers have been challenged to convert the industrial wastes to useful building and construction materials. The usage of sand as fine aggregate in concrete production is very high. So, there is large demand for alternative materials for fine aggregates in construction industry. To overcome the demand for river sand, researchers have identified some alternatives for sand, like Quarry Dust Waste, Robo sand, silica fume, furnace slag, welding slag, Fly ash, etc. Reuse of industrial solid not only saves landfill space but also reduces the demand for extraction of natural raw materials. The utilization of these materials should be in such a way that the locally available such alternative materials should be selected so as to achieve economy without compromising design strength.

Key words: Spent fire brick, compressive strength

I. INTRODUCTION

In the present work spent fire brick is used as partial replacement of fine aggregate and the strength parameters are studied.

The main objective is to study the strength of concrete in which sand is partially replaced by Crushed Spent Fire Brick. The strength parameters include:

- Compressive Strength
- Split Tensile Strength
- Flexural Strength

1.1 MATERIALS AND THEIR PROPERTIES.

The following materials are used in the present experimental work.

1. Cement: KCP cement of 53 grade.
2. Fine aggregate: Locally available Godavari river sand conforming to Zone-II grade is used.
3. Coarse aggregate: Locally available coarse aggregate passing through 20 mm but retained on 10mm sieve are used.
4. Crushed spent fire brick: Crushed spent fire brick is procured from locally available Industries.
5. Water: Ordinary potable water without acidity and alkalinity available in the laboratory is used.
6. Super Plasticizer: Conplast SP 430 is used to reduce the frictional properties of concrete.

Specific gravity test, Sieve analysis, bulk density test are conducted for sand, crushed spent fire brick and coarse aggregate to verify their suitability as per the specification laid down in IS 383:1970 for use in concrete.

Table 1.1 Sieve Analysis of Sand

Sieve size(mm)	Wt. retained	% by wt. retained	Cumulative % by wt. retained	% by wt. passing
4.75	30	0.6	0.6	99.4
2.36	65	1.3	1.9	98.1
1.18	375	7.5	9.4	90.6
600	837	16.74	26.14	73.86
300	3615	72.3	98.44	1.56
150	40	0.8	99.24	0.76
pan	38	0.76	-	-
	5000		235.72	
Fineness Modulus of Sand : 2.36			**Specific Gravity : 2.52**	

Table 1.2Sieve Analysis of Crushed Spent Fire Brick

Sieve Size(mm)	Weight of aggregate retained	% by Weight retained	Cumulative % retained	% Passing
4.75	0	0	0	100
2.36	235	4.70	4.70	95.30
1.18	982.5	19.65	24.35	75.65
0.60	1170	23.40	47.75	52.25
0.30	2225	44.50	92.25	7.75
0.15	207.5	4.15	96.40	3.60
pan	180	3.60	-	-
	5000		265.45	
Fineness modulus of coarse aggregate : 2.65			**Specific Gravity : 2.53**	

From the above, it is observed that,

1. Both sand and crushed spent fire brick have almost the same specific gravity, fineness modulus and pH value.
2. The % of Silica, % of Alumina, % of water absorption are found to be different.
3. The crushed spent fire brick is made of very fine clay material, exposed to very high temperature during manufacturing process as such it is not as inert as sand, but does not affect the quality of concrete when used as an ingredient.
4. This clearly substantiates the suitability of crushed spent fire brick as an ingredient in making concrete.

1.2 CRUSHED SPENT FIRE BRICK

Fire brick is the product made of highly purified clays generally used as one of the construction materials for metallurgical based industries such as manufacturing and processing of Iron and steel, Alloy castings etc.Ex. Rashtreeya Ispath Nigam Limited (well known as Visakhapatnam Steel Plant) in Visakhapanam. There are number of such industries processing steel and allied products in India. The quantum of Fire bricks usage per annum is very high and depends on capacity of the industry.

Usually the Fire brick is used for inner lining of kiln meant for firing. Due to continuous exposure to high degrees of temperature about 1,000 to1,200ºC for a period of 10 to 15 days, fire bricks lose some of the physical and mechanical properties and need to be replaced by fresh fire bricks. The usage and replacement of fire bricks is periodical in nature in metallurgical based industries. The fire bricks disposed off after use are called as **Spent Fire Bricks.**

The Spent Fire Brick being an industrial solid waste to be disposed off properly without causing environmental problems in the vicinity of dump. Usually the waste materials are disposed by land filling. In the similar manner the spent fire bricks are also used as land filling material.

The fire bricks so generated as waste are physically cleaned and mechanically crushed to grade conforming to fine aggregates. The fineness modulus of crushed spent fire brick powder is nearly equal to river sand used in concrete. As such the crushed spent fire brick can be used in place of river sand partially in making the concrete.

II.EXPERIMENTAL WORK

The experimental program is aimed to compare the strength of concrete in which sand is replaced by optimum % of crushed spent fire brick.To study the properties of concrete, mix of M30 is considered.The different ingredients of concrete are mixed as per proportion of mix design. The concrete so obtained is used for casting of cubes, cylinders and beams. They are then cured for 7, 14, and 28 days and tested for strength properties.

The following strength tests are conducted.

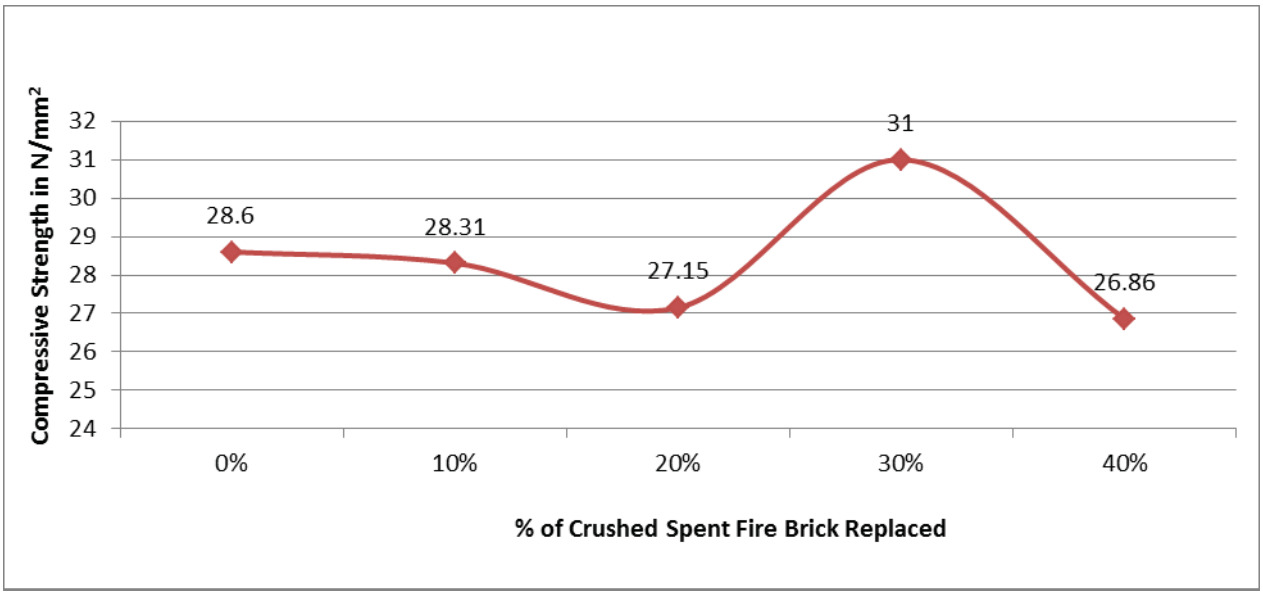
1. Compression test
2. Split tensile test and
3. Flexural test.

2.1. Optimization of Crushed Spent Fire Brick

As per the mix design, the river sand is partially replaced by Crushed Spent Fire Brick in 10%, 20%, 30% and 40% and specimen are cast as per the procedure laid down in IS 456-2000. After 24 hours, the test specimens are demoulded and placed in fresh water tank for curing. After 7 days, they are tested for Compressive Strength. The test results are tabulated as follows. Graph is also drawn. It is observed that concrete with 30% replacement gave maximum strength and the maximum 7 days compressive strength is 31 N/mm^2. A graph is also drawn.

Table 2.1 7 days Compressive Strength of concrete for different % of crushed spent fire brick

S.No	% of crushed spent fire brick replaced	7 days Compressive Strength in N/mm^2
1	0%	28.60
2	10%	28.31
3	20%	27.15
4	30%	31.00
5	40%	26.86



Graph 2.1 7 days Compressive Strength Vs % of Crushed Spent Fire Brick

Test results of Conventional Concrete and Concrete mix in which sand is replaced by optimum % of crushed spent fire brick at different ages

Table 2.2 Compressive Strength of Conventional Concrete and Concrete with Optimum Spent Fire Brick at different ages

Age of Specimen in days	Compressive Strength in N/mm^2 (Conventional Concrete)	Compressive Strength in N/mm^2 (Spent Fire Brick Concrete)
7	30.92	35.28
14	34.55	38.18
28	41.67	42.39

Table 2.3 Split Tensile Strength of Conventional Concrete and Concrete with Optimum Spent Fire Brick at different ages

Age of Specimen in days	Split Tensile Strength in N/mm^2 (Conventional)	Split Tensile Strength in N/mm^2 (Spent Fire Brick)
7	1.90	2.26
14	2.03	2.26
28	2.47	2.56

Table 2.4 Flexural Strength of Conventional Concrete and Concrete with Optimum Spent Fire Brick at different ages

Age of Specimen in days	Flexural Strength in N/mm^2(Conventional)	Flexural Strength in N/mm^2(Spent Fire Brick)
7	5.07	5.60
14	5.33	6.00
28	5.80	6.40

III.CONCLUSIONS

1. The specific gravity and fineness modulus, bulk density (at both the states) and pH value of crushed spent fire brick are nearly equal to that of river sand. Hence sand can be suitably replaced by crushed spent fire brick.
2. The slump decreases with increase in % of crushed spent fire brick.
3. By varying the crushed spent fire brick content from10% to 40%, based on 7 days compression test the optimum quantity of crushed spent fire brick is found to be 30% of sand by weight .
4. Due to replacement of sand by optimum % of crushed spent fire brick, High early strengths are observed
5. It is found that the crushed spent fire brick is suitable and economical alternative for the natural sand, as it gives the required strength and shows better results .
6. The compressive strength, Split Tensile Strength and Flexural Strength of concrete with partial replacement of sand by crushed spent fire brick are shown marginal increase to that of concrete with the river sand at the age of 7 days, 14 days, and 28 days as shown below:

   The increase in 7 days strength is

   14.10 % in compressive strength

   18.95 % in split tensile strength

   10.47 % in flexural strength

   The increase in 14 days strength is

   10.51 % in compressive strength

   11.33 % in split tensile strength

   12.57 % in flexural strength.

   The increase in 28 days strength is

   1.73 % in compressive strength

   3.64 % in split tensile strength

   10.34 % in flexural strength

REFERENCES

[1] B.V.Bahoria,Dr.D.K.Parbat, Dr.P.B.Naganaik,Dr.U.P.Waghe “Comprehensive literature review on use of waste product in concrete” IJAIEM of Volume 2 in Issue 4, April 2013.

[2] C.S. Adabaa, J.C. Agunwambab , C.U. Nwojic , O.E. Onya, “Comparative cost and strength analysis of cement and aggregate replacement materials” Nigerian Journal of Technology (NIJOTECH)Vol. 31, No. 2, July, 2012, pp. 111-115.

[3] S. Keerthinarayana and R. Srinivasan “experimental investigation on strength and durability of concrete partially replacing the fine aggregate with “Crushed Spent Fire Bricks” (CSFB)”Nature Environment and Pollution Technology vol. 9 no. 3 pp. 489-494 2010.

[4] Vinayak Vijapur, and Manjunath .G. Tontanal, "An experimental investigation on behavior of self cured steel fiber reinforced concrete" International Journal of Emerging Trends in Engineering and Development Issue 3, Vol.5 September 2013 ISSN 2249-6149.
[5] IS 383 -1970 "Specifications for Coarse and Fine Aggregates from Natural Sources for Concrete", Bureau of Indian Standards, New Delhi.
[6] IS 456 -2000 "Code of Practice for Plain and Reinforced Concrete", Bureau of Indian Standards, New Delhi, 4th revision.
[7] IS 516 -1959 "Methods of Tests for strength of concrete", Bureau of Indian Standards, New Delhi.
[8] IS 10262 -2009 "IS Method of Mix Design", Bureau of Indian Standards, New Delhi.

Photographs

Photo.1.Cube compression test

Photo.2.Cylinder Split Tensile strength