An Experimental Study of Eco-Friendly Concrete By Replacing Coarse Aggregate With Recycled Over Burnt Brick

K Roja[1], A S Kumar[2]
[1]Dept of of Civil Engineering
[2]Assistant Professor, Dept of of Civil Engineering
[1, 2]Aditya Engineering College

Abstract- *The present investigations give us a detailed concept regarding the changes for conservation of Natural resources. The reasonable improvement for development includes the utilization of non-ordinary and creative materials such as recycling of waste materials and using them in order to compensate the lack of natural resources and to find alternative ways for conserving the environment. In this present study, the strength of concrete for M40 grade of Concrete was used as reference mix. The coarse aggregate was replaced with 0%, 25%, 50% ,75% and 100%of over burnt bricks by volume of concrete. Cubes and cylinders of size 150mmX150mmX150mm and 150mmX300mm were casted. All the specimens were cured for the period of 7 ,28 and 56days before testing. Compressive strength, split tensile strength and unit weight were determined at the age of 7, 28,56 days respectively. The results indicated an increase the compressive strength and split tensile strength at 25% at all ages i.e. 7 days, 28 days and 56days and decreases with further increases of over burnt bricks.*

Keywords- Over Burnt Bricks, Compressive strength, Split tensile Strength, Over burnt brick concrete.

I. INTRODUCTION

A very immeasurable changes has been at the decision of 20th century. Concrete is the universally accepted construction material for its effective strength properties and it's durability. Because of high usage of this concrete, the constituents of concrete like fine aggregate and coarse aggregate which are naturally available in nature are subjected to depletion. So there is an urgent need to workout for the other alternate materials which can replace the natural fine aggregate and coarse aggregate.

1) Over Burnt Bricks:

This material was chosen because in brick making, a lot of bricks are refused due to non-conformity in the outline form of brick produced due to high temperature in the kiln. Concrete is a composite material, so by taking advantage of the situation for the people, this paper presents the research that is carried out on the concrete when natural coarse aggregate is partially replaced by over burnt brick aggregate.

Figure 1: Over burnt bricks heating in a brick kiln.

2) Over Burnt Bricks Aggregate Concrete:

The Aggregates are generally cheaper than cement and impart great volume stability, strength, density and durability to concrete. Coarser and finer particles are so graded that voids are packed to minimum and cement-sand mortar matrix fills the gaps and interspaces and binds the entire matrix to form rock like solid substance called concrete. Natural aggregate are derived from any one of rocks belonging to igneous, sedimentary or metamorphic origin. But artificial aggregate mainly consists of broken bricks and also air cooled blast furnace slag, cinder expanded slag and shale.

Bricks are manufactured in clamps, local kilns and energy efficient large kilns to produce hand moulded burnt clay bricks and are called artificial bricks. In the ancient days natural mud blocks cut to size were used for housing units to monuments and also for minor culverts, bridges and drains. In India, present demand for bricks which stands second in demand of the construction materials after the cement. The fuel used for burning of air dried bricks itself cost around 30 to 40% of production cost of bricks. Construction industry as a whole contributes 17% of CO_2 in our country out of which cement contributes about 17% and bricks industry contributes

about 3%. Government of India has already restricted burning of fuel in cement industry and brick industry in urban areas.
In the present study, in order to have the effective usage of bricks up to its potentiality, it is proposed to use the over burnt bricks by replacing the natural coarse aggregate at 25%, 50%, 75% and 100% then the test results are compared with the conventional concrete of M40 grade.

II. LITERATURE REVIEW

There has been many studies regarding the use of Over burnt bricks in a concrete to improve its properties. These research work are presented as follows:

Kiyoshi Eguchi et al. (2007)(1) studied the characteristics of strength, durability, fire-resistant property, structural performance and workability of the recycled concrete were investigated. Eventually, the economics and environmental loads of the developed method were evaluated and its effectiveness was confirmed. The CO_2 emission was higher in the production method in which the amount of material transported was more. According to mechanical properties tested, among the concrete properties of the recycled concrete, the compressive strength, the elastic modulus and the drying shrinkage strain were affected by the replacement ratio of the recycled coarse aggregate. When recycled concrete was produced by the present method, the cost and the environmental loads was decreased in comparison to construction without recycling.

Khaldoun rahal et al (2007)(2) compared the mechanical properties of recycled aggregate concrete (RAC) and conventional normal aggregate concrete (NAC). Ten mixes of concrete with target compressive cube strength ranging from 20 to 50MPa were casted using normal or recycled coarse aggregates. The development of the cube compressive strength and the indirect shear strength at ages of 1, 3, 7, 14, 28 and 56 days, the compressive strength, the strains at maximum compressive stress and the modulus of elasticity tested by using concrete cylinders at 28 days are reported. The 28-day target compressive strength for all five mixes was achieved except for the 40 and 50MPa RAC where the observed strength was slightly lower than the target strength. On the average, the 56-day cube strength was 5% and 3% higher than the 28-day strength for RAC and NAC respectively.

Martín-Morales et al. (2011)(3)examined the characteristics of recycled aggregate, resulting from of a non-exhaustive production process. This aggregate was found to contain impurities, such as crushed clay brick, crushed ceramic materials, and gypsum. The tests used to analyze this material were those recommended in the Spanish Structural Concrete Code. In reference to geometrical requirements, the recycled aggregate fulfilled particle shape requirements in all cases.

G. S. Patil and P. B. Autade et al .(2015)(5) studied the suitability of crushed over burnt bricks as coarse aggregates for concrete and to know that, crushed over burnt bricks can be used to produce concrete with lower weight and hence lower dead loads as such can be used on low bearing capacity soils. Crushed over burnt bricks can also be used to produce concrete with higher compressive strength with reduced weights if the bricks are properly burnt. Reducing the water-cement ratio increases the compressive strength.

III. OBJECTIVE OF PRESENT WORK

The main objective of the present investigation is:

To design the mix proportions of the concrete mix for M40 grade concrete. To study the strength properties of concrete like compressive strength, split tensile strength and unit weight for M40 grade of concrete by replacing the coarse aggregate with Over burnt bricks at 0%,25%, 50%, 75% and 100% for 7, 28 and 56 days. To find out the differences between properties of normal concrete and concrete containing Over burnt bricks as replacement of coarse aggregates of standard size 150mmx 150mmx150mm (length x breadth x height), standard cylinders of size 150mm x 300mm (Length x breadth) were casted and tested for 3, 7, 28, and 56 days compressive strength split tensile strength respectively.

IV. MATERIALS

OVER BURNT BRICKS:

Over burnt bricks used in the present work were taken from the locally available clay brick industry, which were hammered to get in the size ranging from 10 mm to 20mm. The over burnt brick pieces then obtained were sieved to remove the free particle pieces in the form of crushed powder during hammering.

The specific gravity of over burnt bricks is 2.36 and water absorption is 14.85%.

Figure 1: over burnt bricks

CEMENT:

The binding substance that sets and hardens and can bind other materials together is known as cement. In this research work Ordinary Portland cement (OPC) of grade 53 is used. The specific gravity of cement is 3.15.

AGGREGATES

Coarse Aggregate is locally available fine and coarse aggregate is used. These coarse aggregates having the maximum size of 10 mm and 20mm were used in the present work. The following tests are conducted on coarse aggregate. The specific gravity of fine and coarse is 2.61 and 2.78.

WATER:

Potable fresh water available which is free from concentration of acid or organic substances was used for mixing the concrete.

CHEMICAL ADMIXTURES:

Conplast SP 430 is a dim cocoa fluid which quickly scatters in water. Conplast SP 430 having the large amounts of water decrease and enhances the quality, thickness, workability without expansion in cement.

Mix proportions

Cement	=	435 kg/m^3
Water	=	174kg/m^3
Fine aggregate	=	630 kg/m^3
Coarse aggregate	=	1188 kg/m^3
Water-cement ratio	=	0.4

Figure 2: Crushing the over burnt bricks

Figure 3: Casting

Figure 4: Casting

V. EXPERIMENTAL TESTING PROCEDURE

COMPRESSIVE STRENGTH:

Compression strength of a material is defined as the cube reached ultimate stress when the material fails completely. In this investigation, the cube specimens of size 150 mm x 150 mm x 150 mm of are casted for tested concretes for the design mix.

Concrete specimens are removed from the mould and cure it under water for period of testing and the cubes are removed from the curing tanks and cleaned to wipe off the surface water. It is placed on the machine such that the load is applied centrally. The smooth surfaces of the specimen are placed on the bearing surfaces. The top plate is bought in contact with the specimen by rotating the handle. The oil pressure valve is closed and the machine is switched on.

In each case the cube was positioned in such a way that the load was applied perpendicularly to the direction of casting with a loading rate of 140 kg^2/cm/min was maintained and it was continued till the specimen fails, i.e. with further increment of load, no resistance was offered by the specimen, that maximum load was recorded. The compression test is done at the desirable ages of 7 days, 28 days, 56 days. For

strength computation, the average load of three specimens is considered as the maximum load.

Figure 5: Compression testing machine-Cube testing

SPLIT TENSILE STRENGTH:

The cylinder specimen is of the size 150 mm diameters and 300mm length. The test is carried out by placing a cylindrical specimen horizontally between the loading surfaces of compression testing machine and the load is applied until failure of cylinder, along its longitudinal direction. The cylinder specimens are tested at 28 days. The average of three specimens was reported as the split tensile strength.

$$F_t = 2*P/\pi*D*L \ (N/mm^2).$$

Where
P= Maximum load in kN applied to the specimen
D= Cross sectional dimension of cylinder on which load is applied
L = Length of specimen in mm
F_t = Split Tensile strength test

Figure 5: Compression testing machine-Cylinder testing

UNIT WEIGHT:

When compared to normal concrete the unit weight of over burnt bricks concrete is low for cubes and cylinder. This can be called as light weight concrete.

VI. RESULTS AND DISCUSSIONS

The present experimental study is carried out to find out the compressive strength, Split Tensile Strength of 150mm*150mm*150mm cubes and 150mm*300mm cylinders for different ratios of over burnt bricks to the coarse aggregate. The cubes are tested for compressive strength and Split Tensile Strength at 7 days, 28days, 56 days. The compressive strength and Split Tensile Strength values are taken as the average of the three test results. The results of compressive strength and Split Tensile Strength of specimens are presented in the tabular forms. Also the graphical representation of compressive strength and Split Tensile Strength of concrete cubes of various mixes is also presented.

Table 1:Compressive Strength

S.NO	Mix	Compressive Strength N/MM²			Average Compressive Strength N/MM²		
		7 days	28 days	56 days	7 days	28 days	56 days
1	0%	32.94	49.01	50.86	32.31	49.77	51.57
		30.00	49.95	51.07			
		34.00	50.35	52.79			
2	25%	34.26	51.02	54.67	35.28	52.26	54.31
		37.21	52.36	53.48			
		34.38	53.42	54.79			
3	50%	29.00	48.67	50.72	28.21	48.60	50.63
		28.40	49.01	51.01			
		27.23	48.12	50.18			
4	75%	26.00	46.81	47.82	25.55	47.15	47.77
		25.67	47.67	46.98			
		25.00	46.98	48.53			
5	100%	20.00	44.65	45.81	20.30	44.72	45.91

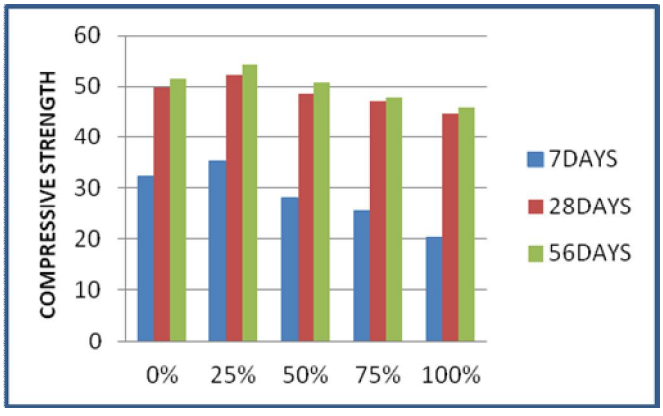

Chart 1:Variation of compressive strength gives the higher strength for the replacement 25% for 7,28,56days.

Table 2: Split Tensile Strength

S.NO	Mix	Split Tensile Strength N/MM²			Average Split Tensile Strength N/MM²		
		7 days	28 days	56 days	7 days	28 days	56 days
1	0%	2.4	3.7	4.2	2.5	3.8	4.2
		2.6	3.8	4.2			
		2.5	3.9	4.2			
2	25%	2.6	4.1	5.3	2.3	4.3	5.2
		2.6	4.2	5.4			
		3.2	4.6	4.9			
3	50%	2.4	3.8	3.9	2.4	3.6	3.9
		2.4	3.6	3.8			
		2.4	3.4	4.0			
4	75%	2.3	3.2	3.8	2.2	3.2	3.7
		2.2	3.2	3.7			
		2.1	3.2	3.6			
5	100%	2.0	3.0	3.5	2.0	2.9	3.4
		2.0	2.9	3.3			
		2.0	3.1	3.4			

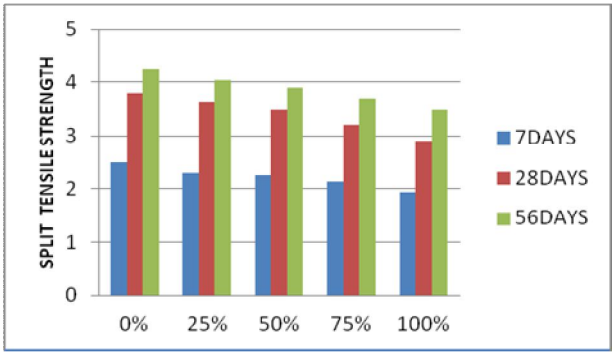

Chart 2: Variation of Split Tensile Strength gives the higher strength for the replacement 25% for 7,28,56days.

Unit weight of over burnt bricks:

Unit weight of over burnt bricks concrete, when compared to normal concrete the unit weight of over burnt bricks concrete is low for cubes and cylinder. This over burnt bricks are light weight concrete.

Table 3: Unit weight

S.No	% Over burnt bricks	Unit weight (kg/m³)
1	0	836.09
2	25%	533.08
3	50%	366.63
4	75%	326.89
5	100%	239.85

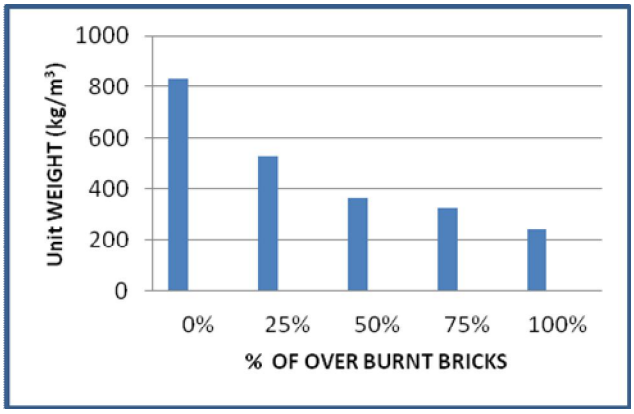

Chart 3:Unit weight of over burnt bricks is less than of normal concrete.

VII. CONCLUSIONS

1. With the replacement of coarse aggregate with over burnt bricks, the compressive strength is enhanced at 25% replacement at all ages i.e. 7 days, 28 days and 56days beyond which it is decreasing when compared with standard mix. At 7 days, 28days and 56 days the percentage increase in compressive strength is 9.19%,5.00%,5.31% respectively.
2. With the replacement of coarse aggregate with over burnt bricks, the split tensile strength is enhanced at 25% replacement at all ages i.e. 7 days, 28 days and 56 days beyond which it is decreasing when compared with standard mix. At 7 days, 28days and 56 days the percentage increase in split tensile strength is 8.1%, 13.1%,23.8% respectively.
3. As the density of over burnt bricks is less when compared to natural coarse aggregate, we can achieve a light weight concrete with the replacement of coarse aggregate with over burnt bricks and the percentage of decrease of weight is 36.24% kg/m^3 for the optimum replacement of 25% coarse aggregate with over burnt bricks.
4. As the over burnt bricks used in mix are having saturated water content, that water content in the pores of the over burnt bricks can be useful as internal curing water to reduce the heat of hydration through which the crack initiation can be reduced in case of massive concrete constructions.
5. The use of non-degradable waste materials like over burnt bricks as constructions materials, it is useful in developing an eco-friendly concrete by reducing the depletion of natural resources thereby minimizing the cost of the construction.

REFERENCES

[1] G.S. Patil, Mr. P.B. Autade. Effect of partial replacement of coarse aggregate by jhama class brick in concrete, IJERGS: International Journal of Engineering Research and General Science. ISSN: 2091- 2730.Volume3, Issue 4, Part-2, July-August, 2015.

[2] Salman Siddique, Mohd. Shadab Siddiqui, Shariq Masood Khan. Assessing the Scope of Utilizing Waste from Brick Production for Building Material. IJATES: International Journal of Advanced Technology in Engineering and Science. ISSN:2348-7550. Volume 03,Special Issue 01, May 20015.

[3] N.S. Apebo, M.B. Iorwus, J.C. Agunwamba, Comparative "Analysis of the Compressive Strength of concrete with Gravel and Crushed over Burnt Bricks as Coarse Aggregates. NJT: Nigreian Journal of Technology, ISSN 1115-8443, Volume 32, no. 1, March 2013, pp.7-12.

[4] IS: 383-1970. Specification for coarse and Fine Aggregates from natural sources for concrete.

[5] IS: 10262-2009. Guidelines for concrete mix design proportioning.

[6] IS: 456-2000. Specification for plain and reinforced Concrete.