Experimental study on Strength of Concrete made with Fresh and Debris Brick Bats

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Abstract- The research was conducted to study the possibility of utilizing the 50% Fresh Bricks Bats and 50% Debris Bricks Bats as Coarse Aggregate in structural concrete. This paper discusses about a lab experiment of Light weight concrete making. A concrete cube were prepared by using Cement, Coarse Aggregate, Fresh and Debris Brick Bats, Fine Aggregate and Water and tested to study the compressive strength at 3, 7, 28 and 90 days. Compressive strength of concrete can be defined as the measured maximum resistance of a concrete to axial loading. Compressive strength is measured for hardened concrete specimens. Use of Brick Bats as Coarse Aggregate for structural concrete is recommended when natural aggregate is not easily available, high strength of concrete is not required and the bearing capacity of the soil is low. Mix design is done for M 25 grade of concrete as per IS: 10262-2009. Finally it was observed that the replacement of 50% Fresh Brick Bats in Coarse Aggregate provides 22.81% at 28 days compressive strength test which is very nearer to the Conventional Concrete mix strength 32.89%. This is quite significant and this mix also gives satisfactory performance of Light weight concrete cube making.

KEYWORDS- Coarse Aggregate, Fresh Brick Bats, Debris Brick Bats, Compressive Strength

I. INTRODUCTION

Concrete is most widely used construction material today. Concrete has attained the status of a major building material in all the branches of modern construction. It is difficult to point out another material of construction which is as variable as concrete. Concrete is the best material of choice where strength, durability, impermeability, fire resistance & absorption resistance are required. Attempts have been made to make use of various ingredient of construction waste by screening or detailed reprocessing. Recycling or re-using of bricks, glass, wood concrete, etc. has been done and observed that utilization of this concrete waste as an aggregate in new building construction has a positive effect on economy also. In Conventional Concrete roughly 70% to 80% of concrete volume is of aggregate and the aggregates are filler in concrete having little effect on finished product. But research reports have proved that this component contributes much in determining stability, workability, durability and strength of the concrete.

The adequacy of recycled or reused aggregate is impeded for structural applications due to the issues associated with it, such as weak interfacial transition zones between cement paste and aggregate, porosity and transverse cracks within demolished concrete, high level of sulphate and chloride contents, impurity, poor grading and large variation in quality. Although, it is environmentally & economically beneficial to use recycled or reused concrete aggregate in construction, however the current legislation and experience are not adequate to support and encourage recycling of construction & demolished waste in India. Lack of awareness, guidelines, specifications, standards, data base of utilization of reusing materials in concrete is major cause for poor utilization of recycling and reusing the materials in construction.

Bricks Bats are one of the types of aggregates used in certain places where natural aggregates are not available or costly. Generally, Brick Bats are used as Coarse Aggregates which are made from slightly over burnt bricks. This will be hard & absorb less water.

According to Tse.A.C. and Akpen.G.D. [1], a significant decline in the utilization of all cement manufacturing plants in Nigeria since the 1990s has raised the already exorbitant cost of cement above the reach of the average Nigerian thereby encouraging a rise in the emergence of a strong local burnt bricks industry in many parts of Nigeria and Benue state in particular. The raw materials for burnt brick production which comprise predominately of various proportions of sand, silt and clay soils are derived from the deposits along the flood plains of major rivers and seasonal streams. These deposits when mixed, kneaded, compacted in moulds and fired, produce bricks for building construction. It is however interesting to note that burnt bricks fired at a kiln temperature, of 1000 produce red to reddish brown bricks but beyond this temperature, a dark blue coloured vitrified clinker results which melts and fuses together in a heap usually discarded by natives and referred to as “iron stone”. This research is therefore important as it tries to compare the compressive strength of concrete made with the conventional gravel and crushed burnt bricks as the coarse aggregates.

According to Chong.C.V.Y [2], there are four recognized stages in firing of burnt bricks: (a) Drying (upto 100°C) (b) Dehydration (between 100°C to 700°C) (c) Oxidation (between 550°C and 900°C) (d) Vitrification (950°C and above). At the onset of the vitrification, there is sintering of the individual clay particles. During this period dimensional shrinking of up to 15% occurs. Firing ultimately produces a consolidated but porous mass which contains both microcrystalline mullite and vitreous materials, together with unchanged quartz. The vitrified brick can then be crushed and used as coarse aggregate in concrete production.

According to Rashid.M.A, et,al., [3], he investigated the properties of higher strength concrete made with crushed brick as coarse aggregate and found that higher strength concrete (fcu = 31.0 to 45.5 N/mm^2) with brick aggregate is achievable whose strength is much higher than the parent uncrushed brick implying that the compressive strength of brick aggregate concrete can be increased by decreasing its water-cement ratio.

According to Bhattacharjee.E, et.al., [4], the specific gravity and water absorption of over burnt brick is found out to be 1.71% and 6.502% respectively.

II. MATERIALS

Cement

The most common cement used is an Ordinary Portland Cement. The Ordinary Portland Cement of 43 grade is being used [5]. Out of the total production, Ordinary Portland Cement accounts for about 80% to 90%.

Coarse Aggregate

In this Investigation, crushed granite stone of size 20 mm and 12 mm is used as Coarse Aggregate and it had been tested as per Indian Standards [6]. Aggregates are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. One of the most important factors for producing workable concrete is a good gradation of aggregates. Good grading implies that a sample fraction of aggregates in required proportion such that the sample contains minimum voids. Samples of the well graded aggregate containing minimum voids require minimum paste to fill up the voids in the aggregates. Minimum paste means less quantity of cement and less water, which are further mean increased economy, higher strength, lower shrinkage and greater durability.

Brick Bats

The Fresh Brick Bats (FBB) and Debris Brick Bats (DBB) are collected locally and then broken into pieces of required sizes related to Coarse Aggregate and sieved through 4.75 mm sieve to remove the finer particles. The water absorption observed for Fresh Bick Bats is 6.2% and for Debris Brick Bats is 8.7%

(a)

(b)

Fig. 1 (a) and (b). Fresh and Debris Brick Bats

Fine Aggregate

The fraction of 4.75 mm to 150 microns is termed as Fine Aggregate. In this investigation, the locally available river sand is used as Fine Aggregate. Zone II Fine Aggregate is collected from sieve analysis [6].

Water

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Since it helps to from the strength giving cement gel, the quantity and quality of water are required to be looked into very carefully. Potable tap water available in laboratory was used for mixing and curing of concrete [7].

III. MIX DESIGN

A Conventional Concrete mix of M 25 grade was designed as per IS: 10262-2009 [8] and the same were prepared to test the sample with both FBB and DBB. The mix design proportions were shown in Table 3.

Table 1 Mix Design

	Water	Cement	Fine Aggregate	Coarse Aggregate	20 mm CA	12 mm CA
By Weight (gm)	176	375	619	1180	708	472
By Volume (m^3)	0.47	1	1.65	3.15	1.89	1.26

IV. METHODOLOGY

Cement used for the study was tested for the parameters specific gravity, fineness, consistency tests, setting tests, soundness tests, compressive strength [5]. Aggregates were tested for Fineness Modulus, Specific Gravity and Water Absorption [9] as per IS codes. Concrete was tested for compressive strength under three different mixes. In CC mix, the conventionally used Cement, Coarse Aggregate and Fine Aggregate were mixed with Water and analysed for strength parameters. In R – 1 mix, only 50% of Coarse Aggregate is replaced with Fresh Brick Bats and other ingredients were as same in CC mix. In R – 2 mix, only 50% of Coarse Aggregate is replaced with Debris Brick Bats and other ingredients were as same in CC mix.

V. RESULTS AND DISCUSSION

The various tests done on cement are shown in table 2. All the parameters are within the permissible limits.

Table 2 Tests Results of Cement

Physical Properties	Test Result	Test method/ Remarks	Requirement
Specific gravity	3.15	IS:4031(Part II) -1988	-----
Fineness (m^2/Kg)	311.5	Manufacturer data	Min. 225
Normal consistency	30%	IS:4031(Part IV) -1988	-----
Initial setting time (minutes)	90	IS:4031(Part V) -1988	Min. 30
Final setting time (minutes)	220	IS:4031(Part V) -1988	Max. 600
Soundness Lechatlier Expansion (mm) Autoclave Expansion (%)	 0.8 0.01	IS:4031(Part III) -1988	 Max. 10 Max. 0.8%
Compressive strength (MPa) 3 days 7 days 28 days	 21 32 47	IS:4031(Part VI) -1988	 23 MPa 33 MPa 43 MPa

The results of tests done on aggregates are presented in table-2, and all the parameters were within the permissible limits.

Table 3 Tests Results of Aggregates

Type of Tests	Coarse Aggregate	Fine Aggregate
Fineness Modulus (%)	6.99	2.61
Specific Gravity	2.65	2.58
Water Absorption (%)	0.5	1

Standard metallic cube moulds of 150 x 150 x 150 mm were casted for Compressive Strength. A table vibrator was used for compaction of the hand filled concrete cubes. The specimens were demoulded after 24 hours and subsequently immersed in water for different age of testing i.e., 3, 7, 28 and 90 days. For each age three specimens were tested for the determination of average Compressive Strength. The Compressive Strength results are shown in table 4 and the comparative Compressive Strength results vs Age with Conventional Concrete mix are graphically shown in fig 2 and 3.

Jackson.N, et al., [10] investigated the properties of higher strength concrete made with crushed brick as coarse aggregate and found that higher strength concrete (fcu = 31.0 to 45.5 N/mm^2) with brick aggregate is achievable whose strength is much higher than the parent uncrushed brick implying that the compressive strength of brick aggregate concrete can be increased by decreasing its water-cement ratio. Bricks are a versatile and durable building and construction material, with good load-bearing properties. Various researches have been carried out on porosity, permeability and absorption of bricks.

A similar trend was observed in case of a 50% substitution of waste ceramic tiles with coarse aggregate with a compressive strength of 22.89 MPa [11].

Table 4 Tests Results of Concrete

S.No	Age (days)	Compressive Strength (MPa)		
		CC	R – 1	R – 2
1.	3	14.52	9.93	9.70
2.	7	19.48	15.93	14.67
3.	28	32.89	22.81	17.19
4.	90	35.70	23.19	18.30

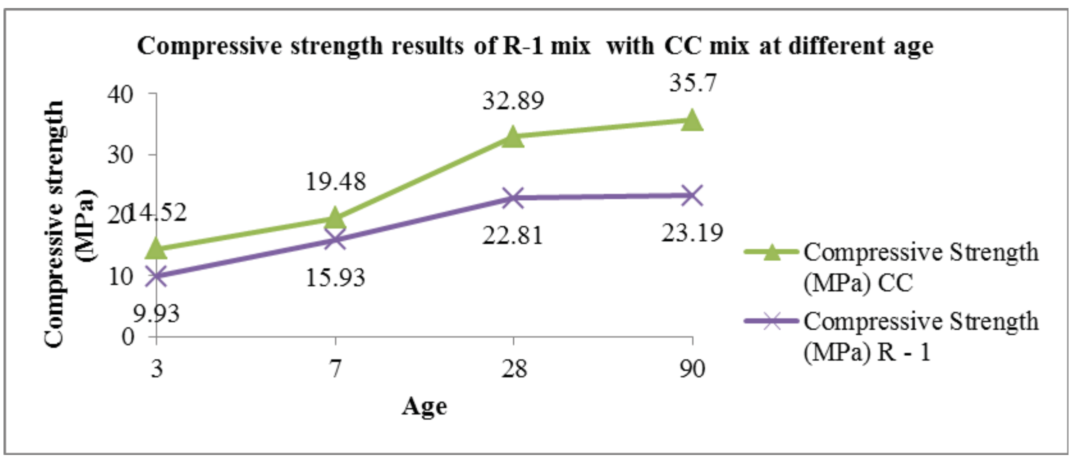

Fig. 2 Variation of Compressive strength of R-1 mix with CC mix at different age

From the fig. 2, when compared R-1 with CC it is observed that there is a difference in percentage of compressive strength with 31.61% at 3 Days, 18.22% at 7 days, 30.65% at 28 days and 35.04% at 90 days. The 28 day compressive strength of FBB is very nearer to the complete replacement of coarse aggregate with crushed over burnt bricks which gave a 28 day compressive strength of 29.5 MPa [12].

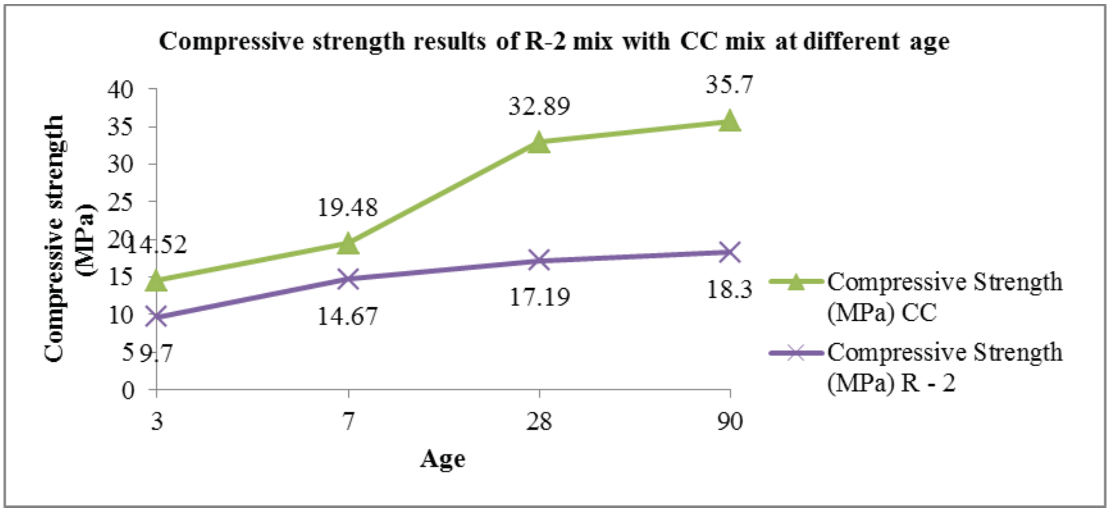

Fig. 3 Variation of Compressive strength of R-2 mix with CC mix at different age

From the fig.3, when compared R-2 with CC it is observed that there is a difference in percentage of compressive strength with 33.20% at 3 Days, 24.70% at 7 days, 47.73% at 28 days and 48.74% at 90 days. By observing the results from fig. 2 and fig. 3, the results of Fresh Brick Bats were very nearer to the Conventional Concrete mix than the results of Debris Brick Bats.

VI. CONCLUSIONS

The following conclusions can be drawn from this investigation

1. Fresh Brick Bats can be used as a partial replacement of Coarse Aggregate in concrete production.
2. Fresh Brick Bats can be used to produce concrete with lower weight and hence lower dead loads as such can be used on low bearing capacity soils.
3. Recycling of Debris Brick Bats could aid in sanitizing the environment.
4. The compressive strength of FBB concrete was found to be 30.65% of CC concrete. The compressive strength of DBB concrete was found to be 47.73% of CC concrete. So the concrete made with this alternative construction material can be used for partition & filling purposes where strength is not a criteria.

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