Analysis of Concrete Made from Recycled Bricks

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***Abstract*— An alternative to cut back the environmental impact of concrete production is to include specific amount of residuals within the dosing, limiting the replacement percentages to avoid vital losses within the mechanical properties of the final material. The substitution of cement & aggregate by waste material improves the mechanical properties also improves the compressive strength, flexural strength, tensile strength, etc. In this experimental work, strength of Concrete made up of recycled bricks has been determined. Which will contribute greatly towards the sustainable utilization of waste litter which is easily available construction site. Substitution of course aggregates by 10%, 20% & 30% of bricks on M-25, M-30 & M-35 grade of concrete is done and its effect being analyzed for 7, 14, 28 and 50 days. Investigation shows that workability of the concrete decreases with the increment in percentage of replacement of the bricks in the concrete. However, Compressive strength has increased from 10% to 20% replacement but it decreases at 30% replacement..**

Keywords*— *Recycled Bricks, Workability, Compressive Strength, Flexure Strength, Split Tensile Strength.

I. INTRODUCTION

Reducing the consumption of non-renewable resources is a key factor to sustainable natural resources. Concrete is known for using a lot of non-renewable natural resources and also has an uprising demand in construction works all around the world. Construction and Demolition Waste (C&DW) is the largest type of waste in the world in terms of amount generated. Specifically, the construction sector generated 871 million tons in 2014, equivalent to 33.5% of the total waste generated.

Concrete industry uses 12.6 billion tonnes of raw materials each year and thus is the largest user of the natural resources in the world [1]. The global market for construction aggregates is expected to increase 5.2% per year until 2015, up to 48.3 billion tonnes. About 75% aggregates are required for the production of concrete, out of which coarse aggregates form 65%. It is noted that the production of one tonne of Coarse Natural Aggregates (NA) results the emission of 4600 tonnes of carbon, whereas, production of one tonne of Coarse Recycled Concrete Aggregates (RCA) produces 2400 tonnes of carbon. Considering the global consumption of 10 billion tonnes per year of aggregates for concrete production, the carbon footprint can be determined for NA as well as for RCA. Some authors have reported the density of RCA to be 7–9% lower than that of NA. Also the water absorption of RCA and NA has been reported to be 4.9–5.2% and 1.0–2.5% respectively. The gradation curves for RCA lie in the range which is required for aggregates to be accepted for use in the concrete production.

Concrete waste and ceramic materials are the most abundant components within C&DW and its use as aggregates in the manufacture of concrete has been the subject of numerous studies to date, most of them regarding recycled concrete aggregates (RCA) and, to a lesser extent, recycled brick aggregates (RBA). RBA can be classified into two categories depending on their origin. Firstly, the porous ceramic materials, such as fired clay, which have undergone vitrification during the firing, process (bricks, roof tiles, etc.). They have low hardness and high water absorption (12–18%). Secondly, the waterproof and semi-permeable materials that have undergone vitrification (ceramic stoneware, ceramic tiles, etc.), with high hardness and low water absorption (5–7%). These differences will have a clear influence on the properties of the concrete made with them [2].

Due to lack of natural stone aggregate, construction industries in various countries are inclined towards using brick chips as coarse aggregate for making concrete. It is observed from the literature that majority of the studies related to the utilization of Construction and demolition waste (CWD) as RCA in concrete.

Although, in most cases, the results with recycled aggregates are not as good as those obtained with natural aggregates, current trends indicate that their recycling will be regulated in the midterm. For this reason, the construction sector must study in detail the use of this waste to produce concrete, complying in any case, with the requirements imposed by the related regulations. Therefore, assuming that there will be a reduction in the quality of the concrete, it is necessary to assess how far this reduction takes place and to ascertain the extent to which recycled aggregates can be incorporated for each specific application.

II. LITERATURE

Sagoe-Crentsil, et. al. (2001) [3] has performance tests have been carried out for fresh and hardened properties of concrete made with commercially produced coarse recycled concrete aggregate and natural fine sand. Test results indicate that the difference between the characteristics of fresh and hardened recycled aggregate concrete and natural aggregate concrete is perhaps relatively narrower than reported for laboratory-

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crushed recycled aggregate concrete mixtures. Water absorption rates and carbonation of recycled concrete and reference concrete were comparable for most applications. However, the abrasion loss of recycled aggregate concrete made with ordinary portland cement increased by about 12% compared to normal concrete, while the corresponding drying shrinkage was about 25% higher at 1 year.

Shayan, A., & Xu, A. (2001) [4] had attempted to improve the surface properties of RCA and report on the influence of the improved RCA on the strength development and durability properties of 50 MPa-strength grade concrete. In addition to strength development, drying shrinkage, alkali-aggregate reaction (AAR), sulfate resistance, and chloride permeability were also investigated. The results are encouraging and show that RCA can be used to produce 50 MPa structural concrete with durability properties similar to those of concrete made with virgin aggregate.

S.Deepika Et. Al. (2017) [5]. Sugarcane bagasse ash and slag-based ambient-cured geopolymer specimens showed enhancement in compressive strength and workability in comparison with slag-based geopolymer. No efflorescence was observed in SCBA-based unburnt bricks, but water absorption in SCBA unburnt bricks was higher compared with fly ash bricks. Sugarcane bagasse ash blended paver block specimens exhibited significant resistance against water penetration and sorption compared with control specimens.

III. OBJECTIVE

To determine the optimum quantity of recycled bricks required to obtain a desired strength of concrete and compare the results by conventional concrete by various tests namely compressive strength, tensile strength and flexural strength by replacing 10%, 20%, and 30%.

IV. METHODOLOGY USED

In order to study the influence of the use of recycled aggregates on the concrete properties, different percentages of natural aggregates have been replaced in volume by RBA (10%, 20%, and 30%)

This study shows the effect on the concrete strength made out of recycled bricks using destructive test equipment. Concrete made by using recycled bricks has been brought to use for making test specimens. There are M25. M30, M35 of mixed proportion are utilized. The beams, cubes and cylinders are prepared on normal aggregate and 60% and 40% different size 10 mm (40%), 20 mm (60%), utilized for concrete cubes and recycled bricks component are utilized in concrete with the replacement of course aggregates of 0%, 10%, 20% and 30% . These cubes are tested on 7, 14, 28 and 50 days and beams and cylinders are tested on 28 days. The cement used in all mixes is ordinary Portland cement and natural sand is used in the experiment.

Cement, fine aggregate, coarse aggregate with recycled bricks are being used to carry out the testing procedure. The samples were made from various grade of concrete by replacement of the course aggregates by 0%, 10%, 20% and 30% by recycled bricks and their strength analysis is evaluated. The outcomes are studied and represented in graphical frame for complete analysis of the comparative study of resultant concrete strength with partial replacement at various stages. Various tests were performed on the prepared samples are discussed below.

V. RESULTS AND DISCUSSIONS

A. *Compressive Strength*

The results below shows the variation in compressive strength of concrete mixes of M25, M30, and M35 grade with recycled bricks.

TABLE I. COMPRESSIVE STRENGTH OF CONCRETE MIXES OF M-25 GRADE WITH RECYCLED BRICKS

Compressive strength of concrete mixes of M-25 grade				
Days/%	0 %	10%	20 %	30 %
7	19.06	16.96	18.04	17.13
14	26.40	21.41	23.38	22.03
28	30.61	25.45	26.44	23.66
50	31.47	27.73	28.52	25.17

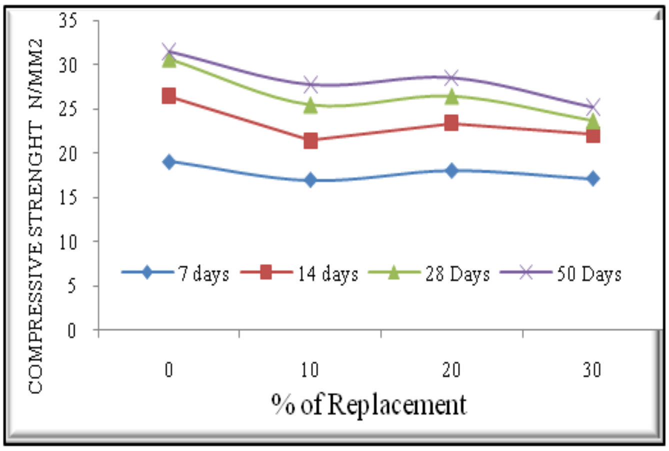

Fig. 1. Compressive Strength of Concrete Mixes of M25 Grade

TABLE II. COMPRESSIVE STRENGTH OF CONCRETE MIXESOF M-30 GRADE WITH RECYCLED BRICKS

Compressive strength of concrete mixes of M-30 grade				
Days/%	0 %	10%	20 %	`30 %
7	26.152	21.44	23.349	22.047
14	29.811	26.50	27.991	26.777
28	39.795	34.71	36.777	32.149
50	40.471	35.76	38.918	34.266

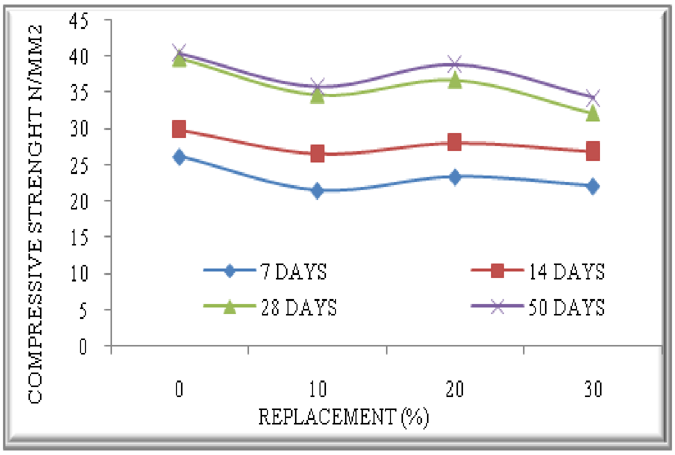

Fig. 2. Compressive Strength of Concrete Mixes of M30 Grade

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TABLE III. COMPRESSIVE STRENGTH OF CONCRETE MIXES OF M-35 GRADE WITH RECYCLED BRICKS

Compressive strength of concrete mixes of m-35 grade				
Days/%	0 %	10%	20 %	30 %
7	30.195	25.388	28.13	26.346
14	32.531	29.419	30.52	29.666
28	44.299	36.488	37.32	32.377
50	45.4	37.577	38.17	33.12

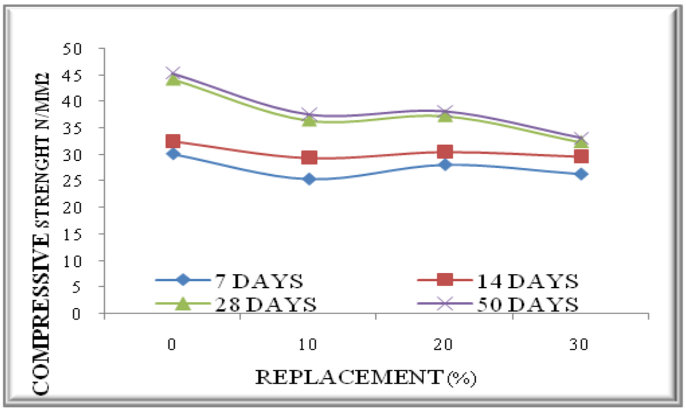

Fig. 3. Compressive Strength of Concrete Mixes of M35 Grade

From, the graph it is clears that on the partial replacement of coarse aggregate by recycled bricks.

The compressive strength has increased from 10% to 20% replacement but the compressive strength decreases at 30% replacement. However, the compressive strength on replacement is always less than the conventional concrete.

B. *Workability*

In this part different test results on concrete are presented and analyzed. This includes workability of concrete contain recycled bricks. The table below depicts the analysis of concrete slump test with M25, M30 and M30 grade at different level of replacement (0%, 10%, 20% and 30%).

TABLE IV. COMPRESSIVE STRENGTH OF CONCRETE MIXES OF M-35 GRADE WITH RECYCLED BRICKS

Slump of recycled bricks				
Grade of Concrete	0%	10%	20%	30%
M-25	74	70	68	64
M-30	85	70	65	62
M-35	95	91	85	80

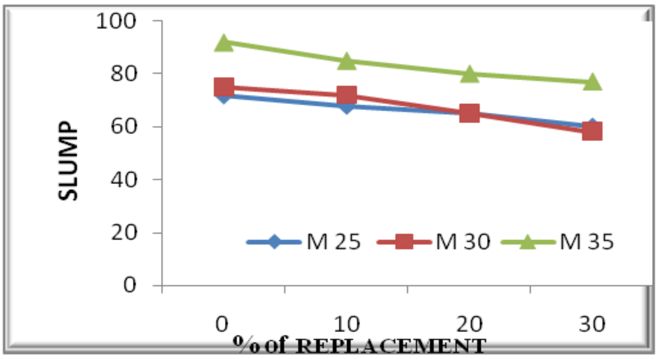

Fig. 4. Slump of recycled bricks

Workability of the concrete decreases with the increment in percentage of replacement of the bricks in the concrete. This is because the water absorption increases with increases in replacement that is from 10% replacement to 30%.

C. *Split Tensile Strength*

The result of the Split tensile strength determine by compression testing machine, with the fractional replacement of recycled bricks by cement with level of 0, 10, 20 and 30% with result determine the age of 28 days are appeared in the Table below for M-25, M-30 and M-35 concrete.

The split tensile strength of concrete material is attempted by making barrel of size 150mm x 300mm and is reliably cured for 28 days testing. The estimations of split tensile strengths are appeared in table5.

TABLE V. TENSILE STRENGTH OF RECYCLED BRICKS

Tensile Strength Of Recycled Bricks				
Grade of Concrete	0%	10%	20%	30%
M-25	2.335	2.288	2.227	2.039
M-30	3.092	3.014	2.848	2.58
M-35	4.093	3.839	3.619	3.449

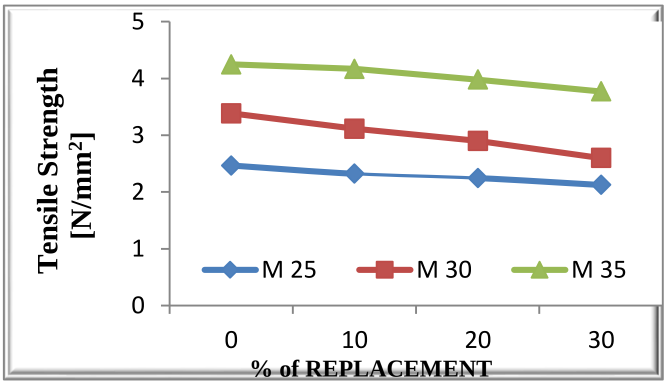

Fig. 5. Tensile Strength Of Recycled Bricks

From, the graph it is clear that on the partial replacement of coarse aggregate by recycled bricks the tensile strength has decreased from 10% to 30%. However the tensile strength on replacement is always less than the conventional concrete.

D. *Flexural Strength*

Flexural power additionally called as modulus of rapture. In concrete flexure is the bowing minute caused by the applied load, in which a concrete beam has pressure at top and tensile worry at the base side. Shafts on testing will bomb in strain because of its property and shear will show up on concrete.

TABLE VI. FLEXURAL STRENGTH OF RECYCLED BRICKS

Flexural Strength of Recycled Bricks				
Grade of Concrete	0%	10%	20%	30%
M-25	3.726	3.449	3.314	3.159
M-30	4.749	4.203	3.971	3.626
M-35	5.506	5.264	4.932	4.123

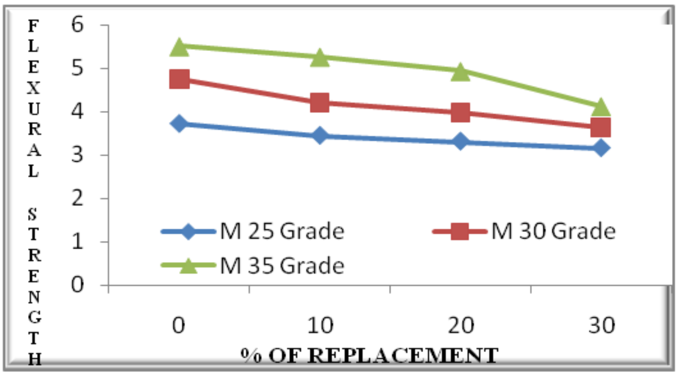

Fig. 6. Flexural Strength of Recycled Bricks

From the graph it is clear that on the partial replacement of Coarse aggregate by recycled bricks the flexural strength has decreased from 10% to 30% replacement. However the flexural strength on replacement is always less than the conventional concrete.

E. Impact Test

The property of a material to resist impact is understood as toughness because of movement of vehicles on the road the aggregates are subjected to impact leading to their breaking down into smaller pieces. The aggregates ought to have adequate toughness to resist their disintegration because of impact. This characteristic is measured by impact value test. The aggregate impact value is a measure of resistance to unexpected impact or shock, which can differ from its resistance to gradually applied compressive load.

TABLE VII. IMPACT TEST VALUE

Nomenclature	Coarse Aggregate (gm)	Recycle Bricks (gm)
W_1	618	436
W_2	112	142
Impact Value	18.12	32.56

VI. CONCLUSION

1) Impact value of course aggregates is 18.12% which is considered to be exceptionally strong. Impact value of recycled bricks are 32.56% which satisfactory and can be used for road surfacing.
2) Workability decrease with the increase in percentage of replacement.
3) Compressive strength increases from 10% to 20% but decreases at 30% replacement with of M25, M30 and M35 at 7, 14, 28 & 50 days of curing which is less than conventional concrete.
4) The Split tensile strength has decreased with the increment in percentage of replacement with of M25, M30 and M35 at 28 days of curing which is less than conventional concrete.
5) The Flexural strength has decreased with the increment in percentage of replacement with of M25, M30 and M35 at 28 days of curing which is less than conventional concrete.

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