Green Concrete Study on the Strength characteristics of Brick waste debris as Partial Replacement of fine aggregate in concrete

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Abstract: Concrete **is** mainly based on the fine aggregate and coarse aggregate which are the prime material used for the preparation of mortar and concrete. River sand is becoming a scarce item nowadays. Hence the manufactured sand or alternative sand is playing a major role in the construction industry nowadays. At present fine aggregate is not readily available, it is transported from a long distance. Those resources like river, crusher factory are also exhausting very rapidly. The non-availability or shortage of fine aggregate will affect the construction industry , hence there is a need to find the new alternative or replacement material the fine aggregate, from these it saves the environment. At present study to investigate the suitability of using brick waste debris in place of fine aggregate. Brick waste debris were obtained from demolished construction masonry walls etc, and crushed in site or laboratory and are replaced in partial fine aggregate. In this study the replacement level of percentage were 0%, 5%,10% ,15% and 20%. From the research mechanical properties of concrete with replacement of brick waste debris has studied.

Keywords: Brick waste debris, mechanical properties, fine aggregate, mix design, sand.

INTRODUCTION

The construction industry will be directly and adversely affected due to the shortage or non-availability of the natural sand, as natural resources are depleting so finding an alternative material for the partial or complete replacement of natural sand is necessary so we can prevent the damage to the environment situation. So this will lead to an ecological imbalance due to the increasing use of natural fine aggregate. More number of Researcher's and Engineers are working with their ideas to find an alternative way to partial or complete replacement of fine aggregate so that the utilisation of natural resource consumption can be decreased. At present infrastructural development needs an alternative material that also satisfy technical properties like fine aggregate so it can satisfy the both technical and environmental solution in economically. Gamashta and Gumashta (2006) examined different properties in reused concrete and brick masonry waste materials and suggests suitable recommendations for further enhancing life of structures, thereby resulting in sufficient economy to the cost of buildings. Manaseeh Joel ([2010) studied suitability of Crushed granite fine (CGF) to replace river sand in concrete production was investigated Slump, compressive and indirect tensile strength tests were performed on fresh and hardened concrete. From their research obtained with the partial replacement of river sand with 20% CGF with the use of river sand as fine aggregate. Based on economic analysis and results of tests, river sand replaced with 20% CGF is recommended for use in the production of concrete. Nili et al (2012) worked on the concrete potential as a friendly environmental construction material to use different type of waste materials as a partial replacement for aggregates and even cement. Six type of waste materials include: recycled concrete aggregate (RCA), waste glass of all kinds mostly (container glass, thin film transistor liquid crystal display [TFT-LCD], crushed clay brick aggregate, various plastic types such as polyethylene (PET), scraped PVC pipes and rubbers , recycled ceramic materials from sanitary installation and recycling ornamental stones (Granite and Marble). They studied mechanical and durability properties. Also reuse of these materials in concrete were evaluated as environmental and cost efficiency. Sai Samanth and Prakhar (2016) conducted an study of analysis of properties of concrete replaced by recycled construction and demolition debris as aggregates in concrete mix. Determining the replacement ratio of this debris as fine and coarse aggregate is presented in this paper with experimental results. This effective utilization of the debris as aggregates without altering the properties of conventional concrete contributes in solid waste management and also helps in finding partial replacement for sand and quarry. Thaniya Kaosol (2010) has made study on the reuse of concrete waste

as crushed stone for hollow concrete masonry units. The main objective was to increase the value of the concrete waste, to make a sustainable and profitable disposal alternative for the concrete waste. Attempts were made to utilize the concrete waste as crushed stones in the concrete mix to make hollow concrete blocks. Tiwari Darshita et al.,(2014), as per IS-10262, cubes is formed of grade for M20, M25, and M30. The cubes were crushed in the labs and follow the criteria of IS code of 1343. The crushing strength is measure for 3days, 7days, and 28 days. And observed that for M20 grade in which sand is partially replaced by the brick powder. When added 10% brick powder the compressive strength is decreases and when added 20% brick powder the strength is increased. If increased the brick powder more than 20% then decrease the compressive strength of M20 grade concrete. Seeni et al. (2012) have made an attempt to partially replace fine aggregates with waste material obtained from China Clay industries. Out of the replacement percentages of 10% to 50%, the highest strength was achieved at 30% in compressive, split and flexural strength. In another study conducted by Wakchaure et al (2012) using artificial sand in place of river sand, it was found that for M30 mix using artificial sand, the compressive strength increased by 3.98%, flexural strength by 2.81% and split tensile strength by a marginal value than concrete which used river sand.

NEED OF THE STUDY

To study the usage of debris brick aggregate as a partial replacement of sand in concrete.

To study and compare the performance conventional concrete .

To understand the effectiveness of brick as in strength enhancement.

MATERIALS USED FOR RESEACH WORK

Cement, water and Aggregates

Concrete is prepared by mixing of cement, aggregates, water etc. which are economically available. Ordinary Portland cement of 43 grade conforming to IS 8112 was used throughout the work. The fine aggregate used in this investigation was clean river sand, whose maximum size is 4.75 mm, conforming to grading zone II. Machine crushed recycled brick was used with an angular in shape was used as fine aggregate. The physical and chemical properties of the materials are presented in Table 1 and Table 2.

Table 1: properties of Cement, sand, Debris Brick powder and coarse aggregate

Sl.No	Material	Cement	Fine aggregate	Debris Brick	Coarse aggregate
1	Fineness by Sieving (%) 90 micron mesh	82	-	-	-
2	Normal Consistency	32%	-	-	-
3	Initial Setting Time (minutes)	45	-	-	-
4	Final Setting Time(minutes)	240	-	-	-
5	Specific Gravity	3.17	2.51	2.32	--
6	Bulk density	-	1445	1500	1590
7	Water Absorption		0.8	0.94	0.41

Table 2 :Chemical properties of brick powder

Sl.No	Material	Percentage
1	SiO_2	60 - 65 %
2	Al_2O_3	35 - 40 %
3	Fe_2O_3	1.9 – 2.7 %

Figure 1: a) Natural river sand b)Debris brick waste

Debris Brick Powder

Brick bats crushed in powder form were used as a fine aggregate for making concrete. The waste bricks as obtained from demolished building were collected and pulverized to get the particle passing 4.75 mm sieve and

retained on 0.075 mm sieve to get the grading zone II of fine aggregate. 5%, 10%, 15% and 20% brick powder is used as replacement of sand in the experiments.

METHODOLOGY

Experimental Programme and Casting of the Specimens

The experiment was to conducted to find the properties of concrete made with debris brick waste as fine aggregate. To study the compressive strength, flexural strength and split tensile strength of concrete prepared by using debris debris brick aggregate waste with different percentage of replacements with sand. The concrete mix concrete mix design was prepared as per Indian Standard for control concrete. The concrete grade was M25. The Proportion of materials shown in Table 3. The replacement levels of sand by debris brick waste powder were used in terms of 5%,10%,15%, and 20% in concrete.

In order to study the effect of replacement of sand in various ratio of debris brick aggregate 36 numbers of cube of 150mm size, 36 numbers of beams of size 100 mm x 100 mm x 500 mm and 36 numbers of cylinders of 150mm diameter to a height of 300mm were cast and used as test specimens to determine the compressive strength, flexural strength and split tensile strength respectively at the age of 7,14 and 28 days. Three specimens were tested every time at the required days and mean value was taken. The workability of fresh concrete was measured in terms of slump values. Three specimens were tested every time at the required days and mean value was taken. The workability of fresh concrete was measured in terms of slump values. The ingredients of concrete were thoroughly mixed till uniform consistency was achieved. The cubes, beams and cylinders ere compacted on a vibrating table.

Sieve analysis

The fine aggregate used in this investigation was natural river sand, whose maximum size is 4.75 mm, conforming to grading zone II. Debris Bricks aggregates were used in powder form as a fine aggregate for making concrete to get the particle passing 4.75 mm sieve and retained on 0.075 mm sieve to get the grading of fine aggregate. Sieve analysis test was carried out on the natural sand and debris brick bat aggregate as per IS 2386-PART I as shown in Table 3 and its particle size distribution values of brick debris is plotted in Figure 2. From the graph it found that both the sand(natural sand and debris brick aggregate) are well graded sand, also debris brick fine aggregate can used for replacement or alternate for nature sand.

Table 3 : Particle size distribution analysis of the brick debris

Sl.No	Sieve size	Weight of Aggregate retained	Weight retained(%)	Cumulative % weight retained	Percentage passing(%)
1	4.75	0	0	0	100
2	2.36	40	40	4	96
3	1.18	150	190	19	81
4	0.6	180	370	37	63
5	0.3	165	535	53.5	46.5
6	0.15	300	835	83.5	16.5
7	0.075	100	935	93.5	6.5
8	Pan	10	1000	100	0

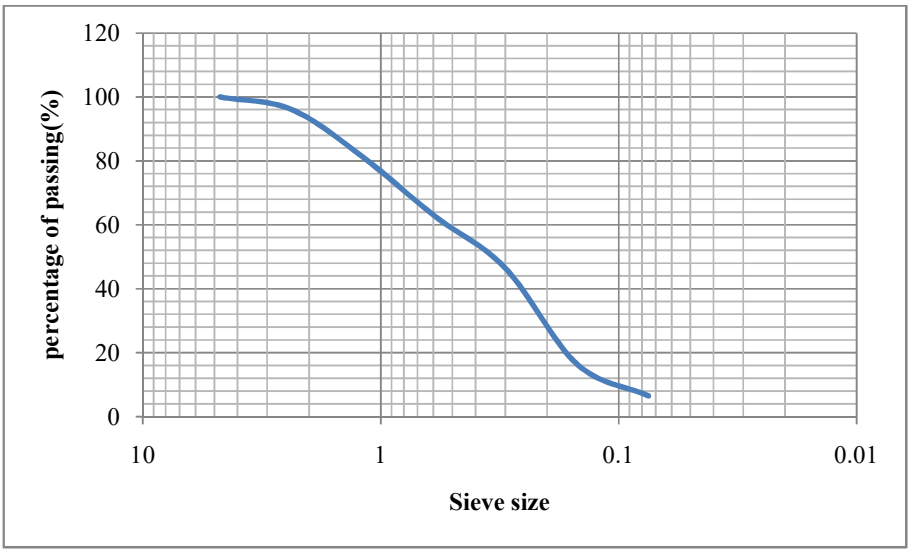

Figure 3: Sieve analysis graph for brick debris

RESULTS AND DISCUSSIONS

Compressive Strength

The cubes were casted in standard size of 150X150X150 mm as per IS standard and tested for compressive strength at 7, 4 and 28 days of curing. The average compressive strength values of 7, 14 and 28 days were obtained and are listed in the following Table 4.

The cubes were tested in the laboratory in accordance to code IS 1343-1980. The results of compressive strength of cubes for 7, 14 and 28 days for various mixes are compared and presented in Figure.4 The compressive strength for 5% ,10%,15% and 20% replacement of sand by debris brick aggregate were compared with normal concrete . It is observed that the compressive strength of cubes increases initially at 22% ,18% and 5% debris brick aggregate in 7days strength. When the percentage of debris brick aggregate increased to 20% reduces the strength. In 14 days test results the increase in value of 26%, 37%,5% and 2% was observed when compared to 5% ,10%,15% and 20% replacement of sand by debris brick aggregate were compared with normal concrete. In 28 days test results the increase in value of 6% and 10% was observed in 5% and 10% replacement of sand by debris brick aggregate were compared with normal concrete. From the above results it was observed that at 14 days strength achieved maximum strength level when compared to 7 and 28 days. It has observed that maximum increasing percentage of strength as 10% when replacing of 10% debris brick aggregate used as a replacement material of natural sand.

Table 4:Compressive strength values for 7,14 and 28days

Sl.No	Specimen	Compressive Strength (MPa)		
		7 days	14 days	28 days
1	Normal Concrete(NC)	23.22	28.65	23.55
2	BFA5%	28.34	36.05	24.57
3	BFA10%	27.50	39.37	25.67
4	BFA15%	24.45	30.30	20.43
5	BFA20%	22.46	29.33	21.56

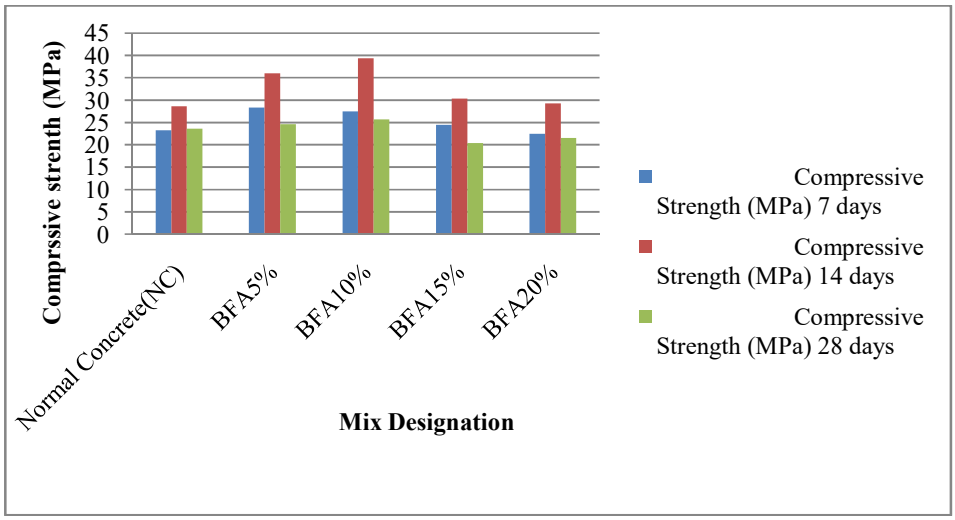

Figure 4: Compressive strength values for 7,14 and 28days

Split Tensile Strength

The cylinders were tested in the laboratory in accordance to code IS 5816:1999. The results of split tensile strength for 7, 14 and 28 days for various mixes are compared and presented in Table 5. The split tensile strength results for 7, 14 and 28 days for various mixes are compared and presented in Figure.5 The compressive strength for 5% ,10%,15% and 20% replacement of sand by debris brick aggregate were compared with normal concrete. It is observed that the compressive strength of cubes increases initially at 8% ,11% and 5% debris brick aggregate in 7days strength. When the percentage of debris brick aggregate increased to 20% reduces the strength. In 14 days test results the increase in value of 4%, and 7% was observed when compared to upto 15% replacement of sand by debris brick aggregate were compared with normal concrete. In 28 days test results the increase in value of 6% and 7% was observed in 5% and 10% replacement of sand by debris brick aggregate were compared with normal concrete. From the above results it was observed that at 14 days strength achieved maximum strength level when compared to 7 and 28 days. It has observed that maximum increasing percentage of strength as 10% when replacing of 10% debris brick aggregate used as a replacement material of natural sand.

Table 5: Split Tensile strength values for 7,14 and 28days

Sl.No	Specimen	Split Tensile Strength (MPa)		
		7 days	14 days	28 days
1	Normal Concrete(NC)	2.30	2.59	2.67
2	BFA5%	2.49	2.69	2.79
3	BFA10%	2.57	2.73	2.85
4	BFA15%	2.38	2.53	2.55
5	BFA20%	2.27	2.35	2.45

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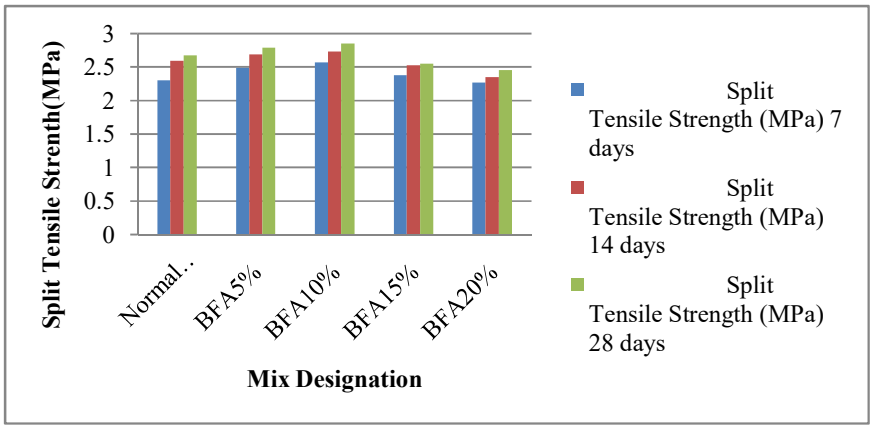

Figure 5: Split Tensile strength values for 7,14 and 28days

CONCLUSIONS

Based on the experimental study for the use of brick debris in concrete as a replacement fine aggregate, the following conclusions were observed.

The test results of compressive strength and split tensile strength shows that the optimum replacement of fine aggregate is achieved at 10% replacement of fine aggregate by crushed brick debris aggregate compared to the respective normal concrete strength.

Form the use of construction demolished brick waste this concrete has prepared so makes eco-friendly and save the environment so it called as eco-friendly concrete.

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