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Experimental Investigation on Partial Replacement of Fine Aggregate with Brick Debris in Concrete

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Abstract - *Fine aggregate has been extensively used in the construction industry as a key component of concrete production. Although river sand is one of the major sources of fine aggregate, different sources exhibit different properties This research was conducted on a variety of river sands and alternative fine aggregates to assess their suitability for concrete manufacture. Four samples replacement level are being produced which contain the replacement of sand by substituting the first samples with 5 % of brick debris , second sample with 10 % of brick debris and third sample with 15 % , four sample with 20 % , 30 % of brick debris. Many researchers are finding different materials to replace fine aggregate. Fine aggregates are weathered and worn out particles of rocks and are of various grades or sizes depending upon the amount of wearing. Now a Days fine aggregate is not readily available, it is transported from a long distance in rainy season non availability or shortage of fine aggregate will affect the construction industry, hence there is a need to find the new alternative material to replace the fine aggregate. Concrete is most material being used in infrastructure development throughout the world Fine Aggregate is a prime material used for preparation of mortar and concrete and which plays a major.*

Key Words: *Brick debris, Waste Management, Workability, Compressive strength, Flexural strength, Split tensile strength.*

1. INTRODUCTION

Many waste product produced at construction sites they can be biodegradable or less biodegradable. The pollution rate can be controlled by reusing these waste materials for construction activities. The productive use of these waste material represents a means of alleviating some of the problems of solid waste management. Consequently, the appropriate use of aggregates from the debris can conserve some ecological balance. The major constituent of conventional concrete is sand which has become scarce and highly expensive. Hence the need for an alternative for the river sand has become a major concern for all. Moreover the surplus excavation of sand from river bed creates a major threat to the environment. The water head in the river bed decreases which results in lower ground water level due to digging of river sand. The use of river sand as fine aggregates leads to exploitation of natural resources, lowering of water table, sinking of *bridge piers and erosion of river bed. There is a general increase in researches for the use of waste materials in place of natural resources in order to make the concrete industry more sustainable, in terms of protecting the environment and reducing the cost of the concrete. It can therefore be seen that incorporating recycled waste brick bat debris as an fine aggregate in structural concrete has the potential to not only produce environmental benefits in the reduction of landfill and the consumption of raw materials, but to also reduce costs for industry cost.*

2. BACKGROUND

Several authors (12)(13)(14)(15) have a relay on the utilization of Industrial waste (waste Brick debris) in concrete by partially replaced from fine aggregates. While other authors (21)(24)(23)have focused on the utilization of Construction waste (Brick Debris) in concrete as a substitutional replacement of coarse aggregates. After reviewing all the papers on partial and full replacement of fine aggregates with industrial waste and coarse aggregates with construction waste separately, it was noticed that upto10% level of substitution of fine aggregates with waste brick debris gives high strength as collate to conventional concrete and while replacing coarse aggregates by industrial waste up to 30% level gives higher strength as collate to conventional concrete. So finally all authors noticed that partially replacing fine aggregates with industrial waste and coarse aggregates with construction waste can be suitably used in making better development in concrete.

3. AIM AND OBJECTIVE

The aim of the project is to experimental investigation on partial replacement of fine aggregate with brick debris in concrete.

Objective:
This study is conducted to achieve the following objectives

1. *To find out the optimum percentage of crushed brick debris as a fine aggregate out of 5%, 10%, 15% and 20% to get maximum strength of concrete.*
2. *To determine strength workability by using brick debris as partial replacement of fine aggregate using different proportions.*
3. *To determine the effect of various percentage of brick debris waste as partial replacement fine aggregate towards compressive strength of concrete.*
4. *To study experimental behavior of concrete with crushed brick bat debris.*
5. *To reduce the waste brick debris which comes from construction industries.*

4. MATERIALS AND METHODOLOGY

- ***Cement:*** *Cement is a binder, a substance that sets and hardens and can bind other materials together. It plays an important role in construction sector. Ordinary Portland Cement of 43 Grade cement conforming to IS: 8112*

- ***Fine Aggregate****: Sand is a granular material which is mainly composed of finely divided rocky material and mineral particles. Hence, it is used as fine aggregate in concrete. Fine aggregate conforming to IS: 2386-1963.*

- ***Coarse Aggregate****: Coarse aggregates used consisted of machine crushed stone angular in shape passing through 20mm IS sieve and retained on 4.75mm IS sieve. Machine crushed aggregates of 20mm nominal size from local source we used as a coarse aggregate. It was free from impurities such as dust, clay, and organic matter etc.*

- ***Water****: Water participates in chemical reaction with cement and cement paste is formed and binds with coarse aggregate and fine aggregates.*

- ***Crushed Brick Bat Debris:*** *Waste brick was collected from construction site of Maharashtra state police housing welfare corporation SP quarter, Wardha. Collected brick debris was pulverized in jaw crusher and then sieved through 4.75 mm IS sieve.*

PROPERTIES OF MATERIALS

Table no 1**.** Properties of the constituent materials

S. No	Parameter	OPC used	Brick Debris	FA	CA
1	Normal Consistency	34 %	-	-	-
2	Initial setting time (minute)	81	-	-	-
3	Final setting time (minute)	240	-	-	-
4	Specific gravity	3.12	-	2.75	2.63
5	Fineness modulus	4.62 %	3.77	3.62	5.2
6	Water Absorption	-	-	1.0	0.95
7	Soundness of cement	2.05	-	-	-

Fig -1: Figure

Table no 2. Mix Proportion M30

No.	Ingredients	Kg/ m3	Proportion
1.	OPC cement	330 kg/m3	WC= 0.43
2.	Fine Aggregate	658 kg/m3	1: 2 : 3.70
3.	Coarse Aggregate	1222 kg/m3	

Table no 3. Gradation analysis of the fine Aggregate

No.	Sieve Size	Weight of Aggregate retained	Weight retained (%)	Cumulative % weight retained	Percentage passing (%)
1	4.75	0	0	0	100
2	2.36	10	10	1	99.0
3	1.18	215	225	22.5	77.5
4	500µ	385	610	61.0	39.0
5	300µ	215	825	82.5	17.5
6	150µ	140	965	96.5	3.5
7	75µ	25	990	99.0	1
8	pan	10	1000	100.0	--

Table no 4. Gradation analysis of the coarse Aggregate

Sr No	Is Sieve Size	Retained On Each Sieve In Gms	% Retained On Each Sieve	Cumulative % Retained	Cumulative Passing %	Specification Limit Remark Is-383
1	20 mm	190	9.50	9.50	90.5	90- 100
2	12.5 mm	1598	79.9	89.4	10.6	5-20
3	4.75 mm	155	7.75	97.15	2.85	0-10
4	2.36 mm	-	-	-	-	-
5	Pan	57	2.85	100	0	-

Table no 5. Gradation analysis of the brick debris

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	4.0	96.0
3	1.18	125	165	16.5	83.5
4	500µ	175	340	34.0	66.0
5	300µ	155	495	49.5	50.5
6	150µ	290	785	78.5	21.5
7	75µ	155	940	94.0	6
8	Pan	10	1000	100.0	--

5. A REVIEW FOR OTHER SOURCES

Kumar and Siva: *conducted laboratory tests. The final concrete so created underwent tests for compressive strength, workability, and flexural strength. The outcomes are contrasted with a concrete made of simple cement. They achieved light weight concrete by using low weight ingredients, such as plastic waste. When compared to regular cement concrete, the workability of concrete made from building waste is unreliable, but the compressive strength was significantly increased.*

Sriharsha and Murthy: *used demolition debris from old structures of the construction industries and the blast furnace slag, which is easily available from iron ore industries. This set the stage for further research in this area using the feasible results from experimental studies, in order to produce test blocks or bricks as practicable. Laboratory tests are performed to evaluate the physical characteristics of these test samples, such as compression strength and water absorption. All of the aforementioned samples' strength characteristics are investigated using both conventional mixes and altered proportions. Every sample's compressive strength and water absorption are computed, compared to every combination, and conclusions are drawn. In order to examine concrete that had coarse aggregate partially replaced with construction and demolition waste materials such broken bricks, plastic garbage, and waste ceramic tiles.*

Sai Samanth and Prakhar and Nili, M. Biglarijoo examined *the characteristics of concrete that has recycled construction and demolition waste in place of fresh aggregates. This research presents experimental findings to determine the replacement ratio of this waste as fine and coarse aggregate. In addition to helping with solid waste management, this efficient use of the debris as aggregates without changing the qualities of traditional concrete also aids in finding a partial replacement for sand and quarry. The current research project concentrates on the demolished bricks as an alternative source in light of the literature evaluation. Bricks are sometimes utilized in place of coarse aggregate since they are often left over after a construction site is demolished. About 30% of the construction in India is carried out on the sites of previous structures, where the majority of the waste construction is lost. Concrete blocks can be made from such leftover construction materials.*

6. MIX DESIGN

Mix design of the concrete is done strictly as per the specification of the IS 10262: 2009. According to IS code specification mix of M30 grade is designed, 5 different types of mix are prepared with different percentage i.e. 0% ,5%,10% ,20% and 30% of crushed as Partial Replacement of Fine Aggregate. CC mix is prepared with 0% of crushed brick debris or we can also pronounce it is controlled concrete (Normal concrete), CBD 5 mix contains 5% of the crushed brick debris. While CBD10, CBD15, CBD20 and CBD30 contains 10, 15, 20 and 30 percentage of crushed brick debris respectively.

MIX DESIGN PROCEDURE

- Grade designation: M30 RCC
- Type of cement: 43 grade Ordinary Portland Cement (IS 12269)
- Maximum nominal size of coarse aggregate: 20 mm
- Minimum amount of cement: 320 kg/m³
- Maximum water-cement ratio: 0.45
- Workability: 75 – 100 mm slump
- Exposure condition: Severe (Reinforced concrete)
- Type of aggregate: Crushed Angular Aggregates

MATERIAL DATA

Table No 6.

No	Material Test	Quantity
1	Cement used	OPC 43 Grade
2	Specific Gravity of Cement	3.12
3	Specific Gravity Fine Aggregate	***2.75***
4	Specific Gravity of Coarse Aggregate	2.63
5	Water Absorption of Fine Aggregate	1.00 %
6	Water Absorption of Coarse Aggregate	0.95 %
7	Free Water in Fine Aggregate	Nil
8	Free Water in Coarse Aggregate	Nil
9	Sand Confirming to Grading Zone	II

Table No. 7 Compressive strength for 7 days (M30)

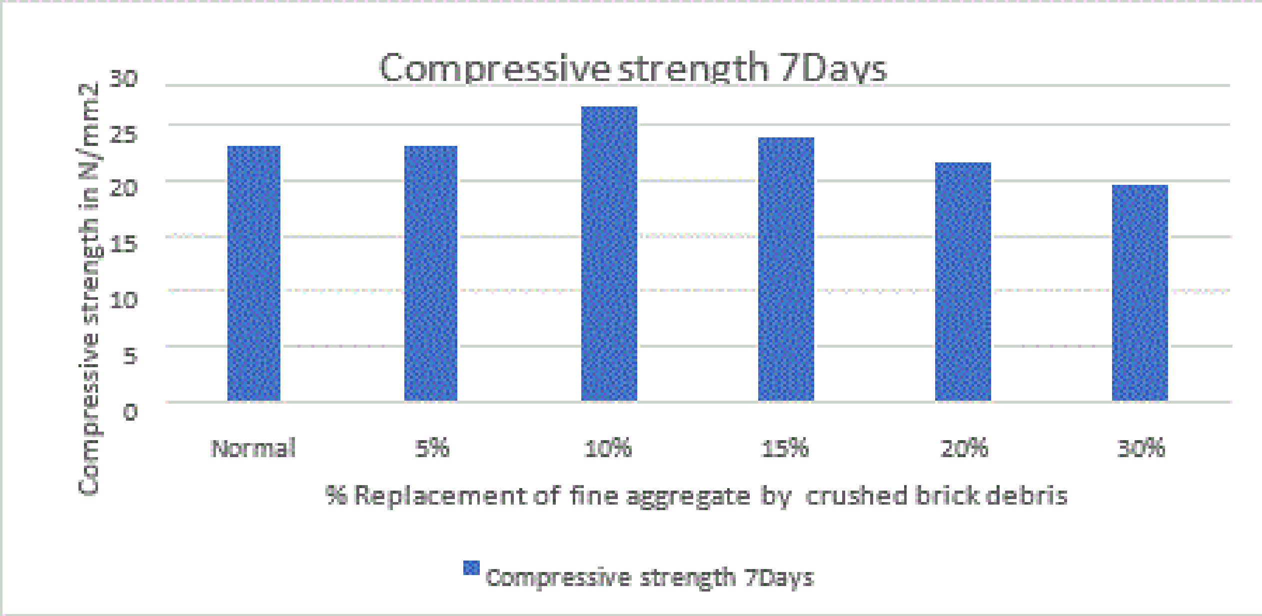
No.	Mix % of brick debris	Days	Area mm²	Weight kg	Load kN	Compressive strength N/mm²
1	Normal CC (0%)	7	150x150	8.100	515	22.88
2	5%	7	150x150	8.025	609	23.06
3	10%	7	150x150	8.086	596	26.49
4	15%	7	150x150	7.910	535	23.78
5	20%	7	150x150	7.865	484	21.51
6	30%	7	150x150	7.820	438	19.46

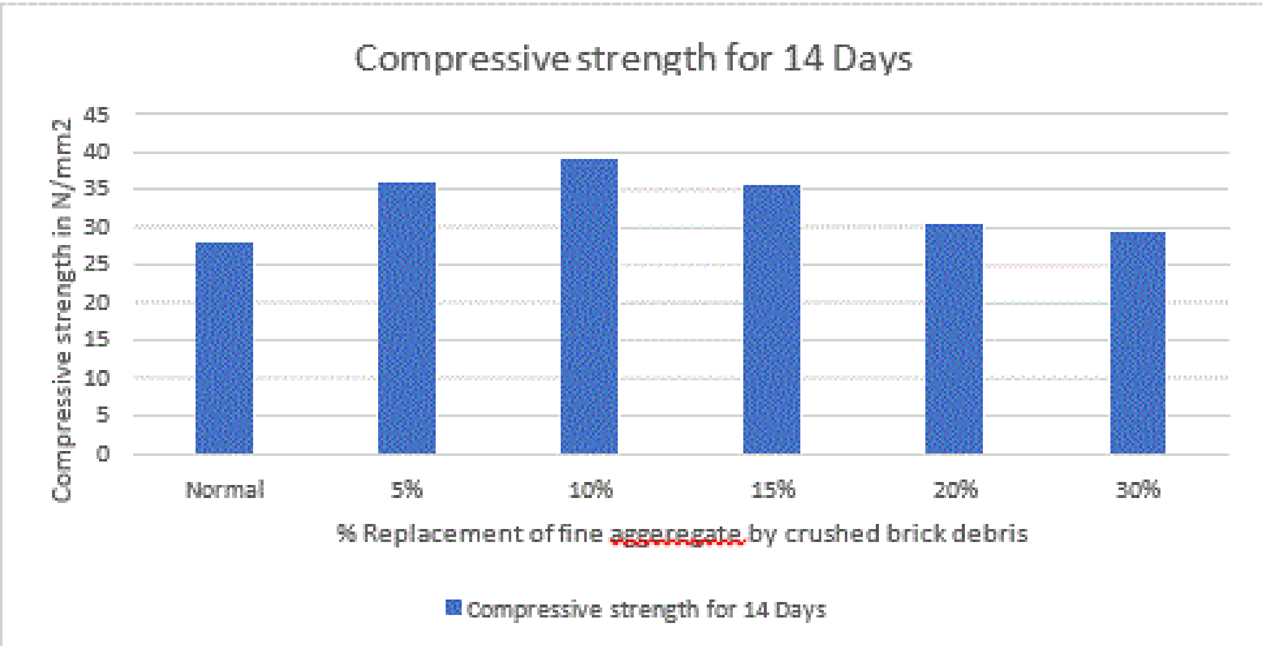
Table No. 8 Compressive strength for 14 days (M30)

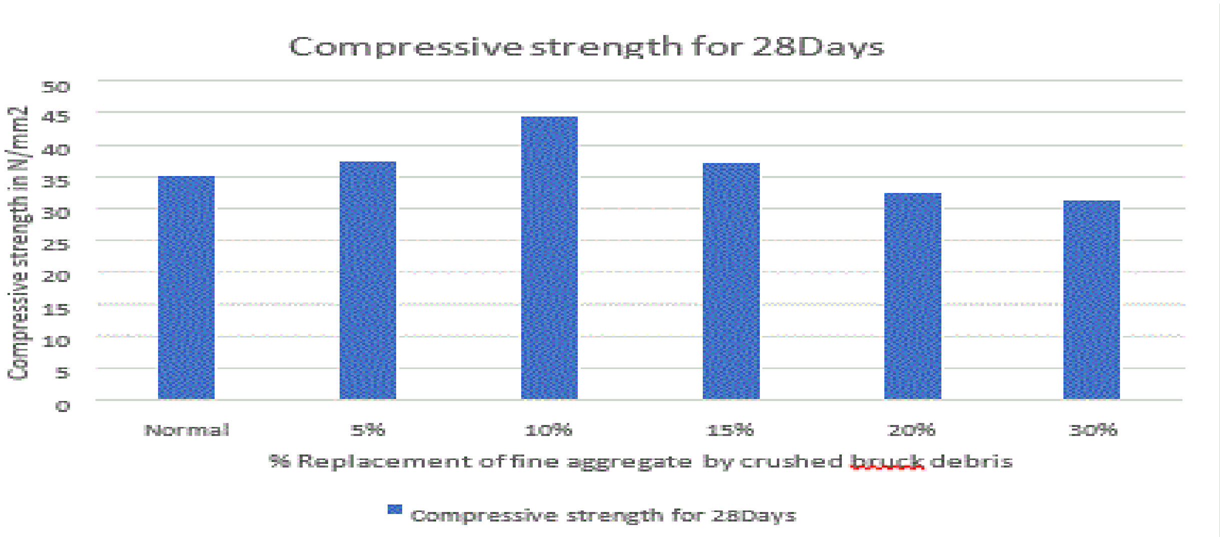
No.	Mix % of glass powder	Days	Area mm²	Weight kg	Max Load kN	Compressive strength N/mm²
1	Normal CC (0%)	14	150x150	8.250	627	27.87
2	5%	14	150x150	7.930	805	35.77
3	10%	14	150x150	7.810	878	39.02
4	15%	14	150x150	8.210	794	35.28
5	20%	14	150x150	7.950	680	30.22
6	30%	14	150x150	7.510	654	29.06

Table No. 9 Compressive strength for 28 days (M30)

No.	Mix % of Glass powder	Days	Area mm²	Weight kg	Load kN	Compressive strength N/mm²
1	Normal CC(0%)	28	150x150	7.923	786	34.93
2	5%	28	150x150	7.114	841	37.38
3	10%	28	150x150	8.355	998	44.35
4	15%	28	150x150	8.060	835	37.11
5	20%	28	150x150	7.732	726	32.27
6	30%	28	150x150	7.405	702	31.20


Compressive strength 7Days
Compressive strength in N/mm2
0
5
10
15
20
25
30
Normal
5%
10%
15%
20%
30%
% Replacement of fine aggregate by crushed brick debris
Compressive strength 7Days


Compressive strength for 14 Days
Compressive strength in N/mm2
0
5
10
15
20
25
30
35
40
45
Normal
5%
10%
15%
20%
30%
% Replacement of fine aggeregate by crushed brick debris
Compressive strength for 14 Days


Compressive strength for 28Days
Compressive strength in N/mm2
0
5
10
15
20
25
30
35
40
45
50
Normal
5%
10%
15%
20%
30%
% Replacement of fine aggregate by crushed bruck debris
Compressive strength for 28Days

Sr. No.	Mix	Compressive Strength(N/mm2)		
		7 Day	14 Day	28 Day
1	Normal CC(0%)	22.88	27.87	34.93
2	5%	23.06	35.77	37.38
3	10%	26.49	39.02	44.35
4	15%	23.78	35.28	37.11
5	20%	21.51	30.22	32.27
6	30%	19.46	29.06	31.20

Table No. 10 Compressive strength of all concrete mix for M30

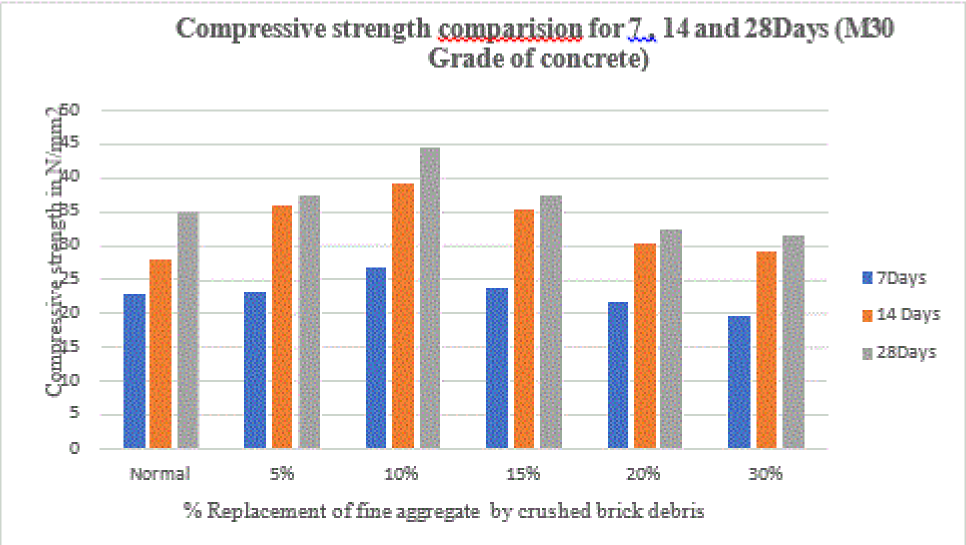


Fig: comparison of compressive strength for 7 ,14,28 days (Grade M-30)

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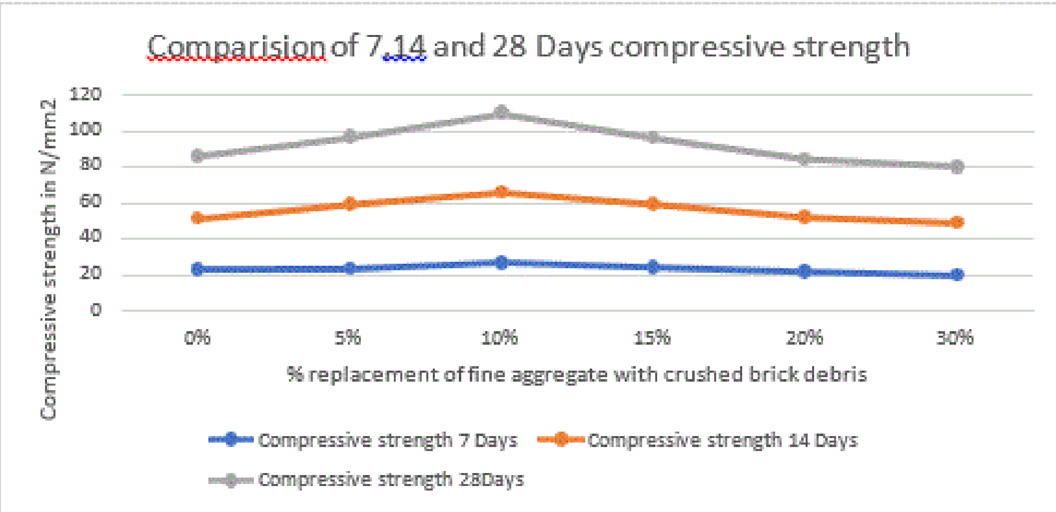
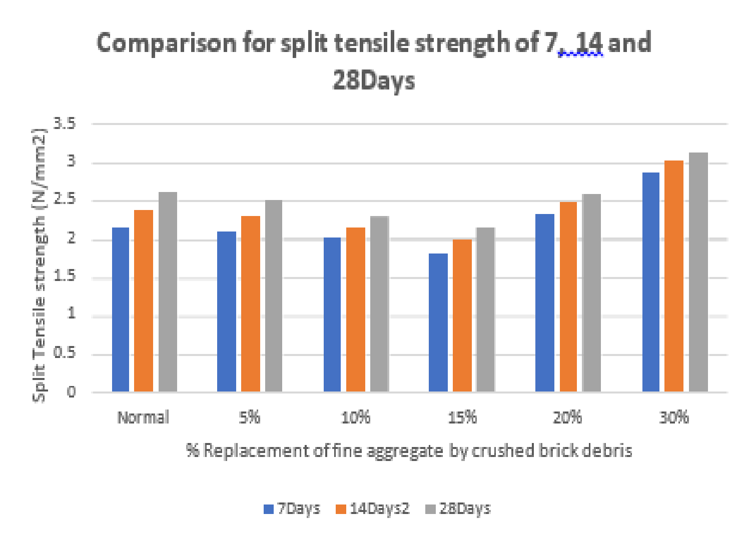


Sr.No.	Mix	Split Tensile Strength (N/mm2)		
		7 Day	14 Day	28 Day
1	Normal(CC)	2.14	2.37	2.6
2	5%	2.09	2.295	2.5
3	10%	2.01	2.155	2.3
4	15%	1.82	1.985	2.15
5	20%	2.33	2.48	2.59
6	30%	2.87	3.03	3.12

Table No. 11 Split tensile strength (For M-30 Grade of concrete)



Sr.No.	Mix	No. of Moulds	Mean Strength in N/mm^2
1	Normal(CC)	3	6.94
2	5%	3	6.97
3	10%	3	7.22
4	15%	3	6.15
5	20%	3	5.87
6	30%	3	4.55

Table No. 12 Flexural strength test result (For M-30 Grade of concrete)

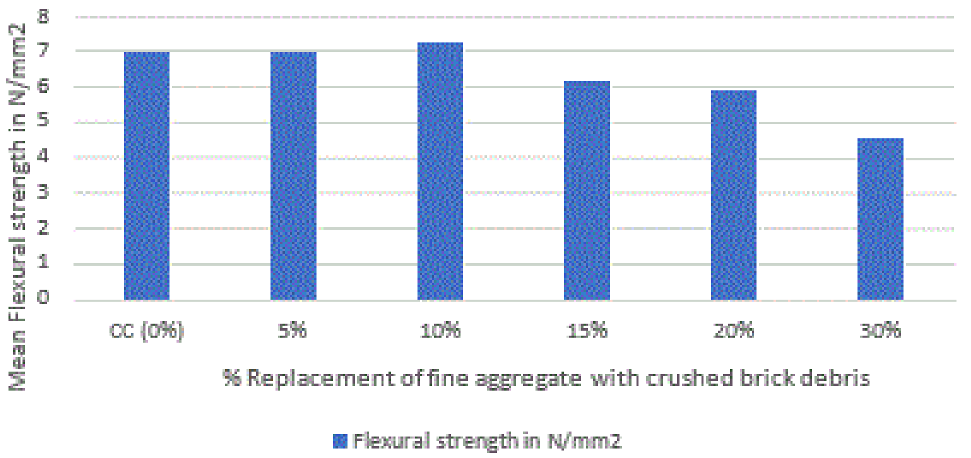


Fig. Variation in flexural strength (M-30 Grade)

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It is evident from variation in flexural Strength that flexural strength increases up to 10% replacement of sand with crushed brick bat debris The flexural strength goes on decreasing in additional percentage of replacement of sand.

CONCLUSIONS

Disposal of the construction and demolished waste created due to construction activity has a major issue nowadays. Utilization of these wastes after recycling in construction industries will be an effective solution for this.Here in this present investigation the possibility of replacement of fine aggregate with crushed brick debris which is the waste product from construction site and construction waste in concrete is explored. The variation of workability, compressive strength, split tensile strength and flexural strength of concrete have studied considering the environmental aspects also and the following conclusions are obtained.

The 7 days, 14 days and 28 days compressive strengths of concrete increase initially as the replacement percentage of fine aggregate with crushed brick debris increases, and become maximum at about 10% and later decreases.
In proportions exceeding 10%, waste bricks content was found to negatively impact the development of compressive strength.
The water absorption is found to be increases with increases in percentage of crushed brick debris content in concrete mix as fine aggregate have less water absorption in nature compare to brick debris.
Workability of concrete goes on decreasing with increasing the replacement percentage of fine aggregate with crushed brick debris.
Splitting tensile strength decreases with an increase in waste brick content. The optimum percentage of crushed brick debris for obtaining the maximum split tensile strength is 10%.

REFERENCES

[1] 43 Grade Ordinary Portland cement – Specification. IS8112-1989, Bureau Indian Standards, New Delhi.
[2] Specification for Coarse and Fine Aggregates from Natural Sources for Concrete. IS: 383-1970, Bureauof Indian Standards, New Delhi.
[3] Recommended Guidelines for Concrete Mix Design. IS: 10262-1982, Bureau of Indian Standards, NewDelhi.
[4] Methods of Sampling and Analysis of Concrete. IS: 1199-1959, Bureau of Indian Standards, New Delhi.
[5] Methods of Tests for Strength of Concrete. IS: 516- 1959, Bureau of Indian Standards, New Delhi.
[6] IS 456-2000, Code of Practice for Plain and Reinforced Concrete, Bureau of Indian Standards New Delhi.
[7] Harish. P. Gayakwad, Neha. B. Sasane(2015). "Construction and Demolition Waste Management in India", International Research Journal of Engineering and Technology (IRJET) Volume: 02 Issue: 03, e-ISSN: 2395 -0056, p-ISSN: 2395-0072 .
[8] Suribabu, Dr U. Rangaraju, Dr. M. Ravindra Krishna(2015) " Behaviour of Concrete on Replacement of Sand with Quaries Stone Dust as Fine Aggregate "International Journal of Innovative Research in Science, Engineering and Technology Vol. 4, Issue 1.
[9] Tomas Ucol-Ganiron (2012). "Concrete Debris as Alternative Fine Aggregate for Architectural Finishing Mortar" Architecture Research 2012, 2(5): 111- 114DOI: 10.5923/j.arch.20120205.06.
[10]Tomas U. GanironJr (2014). "Effect of Sawdust as Fine Aggregate in Concrete Mixture for Building Construction" International Journal of Advanced Science and Technology,Vol.63, pp.73-82
[11]Amaziah Walter Otunyo, IdongesitUdo Friday, and Theodore Alexander Israel(2015) "Exploratory Study of Crushed Periwinkle Shell as Partial Replacement for Fine Aggregates in Concrete" Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS) 4(6): 823-827