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EXPERIMENTAL STUDY ON STRENGTH VARIATION OF CONCRETE BY USING DEMOLISHED BRICK AGGREGATE AT ELEVATED TEMPERATURES

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ABSTRACT: This thesis illustrates about the performance of concrete with partial replacement (I.e. 25%) of normal aggregate with cement coated brick aggregate under various heat exposure conditions. For the purpose of reference normal aggregate is used to cast cylinders and were exposed to high temperatures ranging from room temperature to 1000˚C with 200˚C interval. About 132 cylinders were casted as a whole, for experimentation with brick aggregate, where six cylinders were dedicated for each temperature. The physical and mechanical properties of both the aggregates such as specific gravity, flakiness index, fineness modules, crushing value, and impact value were studied. Both the NAC and RBAC specimen were exposed to 200˚C,400˚C, 600˚C, 800˚C and1000˚C for the duration of 3 hours. The split tensile strength of both concrete was compared to assess their relative performance before and after exposure to elevated temperatures. It is concluded that at elevated temperatures the percentage residual split tensile strength of recycled brick aggregate concrete is similar to that of natural aggregate concrete. Hence the Recycled bricks can be replaced with the natural aggregates satisfactorily.

Key Words: Demolished Brick , Coarse aggregate, NAC and RBAC Specimens.

1. INTRODUCTION Use of recycled materials aggregates in civil engineering applications is beneficial because it reduces the environmental impact and economic cost of quarrying operations, 2 | P a g e processing, and transport. Reuse of construction and demolition waste is becoming increasingly desirable eduetorising hauling costs and tipping fees for placing this material into landfills. In recent years, sustainable construction in initiatives have also made reuse of construction and demolition debris (as aggregates and otherwise)an appealing option when considering design alternatives for many types of structures. Incorporating recycled aggregates into cement itioumaterials is practical, as cement itiousmaterials are non-homogeneous composites that allow material of different sizes and compositions to be bounding cement itiousmatrix. Much research has been performed on the use of recycled concrete aggregates (RCA) in Cement Concrete, but in India, very little research has been done on the use of recycled brick masonry as aggregates for concrete. The use of brick

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as aggregate in concrete is far from novel concept. After World War II, in England and Germany, rubble from brick buildings damaged or destroyed by bombs was crushed at rubble recycling plants producing crushed Brick aggregate that was used in new concrete construction. Since this time, brick aggregate has not commonly been used in concrete in most Western countries. Brick aggregate concrete has however, become common in locations where sources of natural aggregate are not available and the cost of importing natural aggregate is prohibitive. In these areas brick aggregate concrete is most often used in non-structural or non-critical applications. Existing studies on brick aggregate concrete often include only reword is carded brick that does not include them or tar fraction With the large amount of brick masonry rubble produced in India each year, this material may provide as significant source of aggregates that can be used to produce more sustainable concrete. In addition to reducing the amount of waste that is present in the form of land fill (or used in low-grade applications such as road bed gravel), other benefits can be realized. Brick aggregates are lighter than natural normal weight aggregates, and would provide haul cost savings.

2. MATERIALS USED

i) CEMENT Cement is a binder, a substance that sets and hardens on drying and also reacts with carbon dioxide in the air dependently, and can bind other materials together. Cements used in construction can be characterized as being either hydraulic or non-hydraulic, depending upon the ability of the cement to be used in the presence of water. 3 | P a g e Non-hydraulic cement will not set in wet conditions or underwater,• and is attacked by some aggressive chemicals after setting. Hydraulic cement is made by replacing some of the cement in a• concrete mix with activated aluminium silicates, pozzolans, such as fly ash, to activate cement setting in wet condition or underwater and further protects hardened concrete from chemical attack, because of hydration.

ii) WATER

The water used in concrete plays an important part in the mixing, laying, compaction, setting and hardening of concrete. The strength of concrete directly depends on the quantity and quality of water used in the mix.

iii) AGGREGATES

Aggregates are granular materials such as sand, gravel, or crushed stone that, along with water and cement, are an essential ingredient in concrete. Aggregate was originally viewed as an inert material dispersed through the cement paste largely for economic reasons. In fact, aggregate is truly not inert and its physical, thermal and sometimes also chemical properties influence the performance of concrete. Aggregate is cheaper than cement and it is, therefore, economical to put into the mix as much as the former and as little of the latter as possible. But economy is not the only reason for using aggregate: it confers considerable technical advantages on concrete, which has a higher volume stability and better durability than hydrated cement paste alone. For a good concrete mix, aggregates need to be clean, hard, strong particles free of absorbed chemicals

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or coatings of clay and other fine materials that could cause the deterioration of concrete.

Fine Aggregate :

Aggregate most of which passes 4.75mm IS sieve is called as Fine Aggregate.Fine Aggregate is classified into the following three categories

a) Natural Sand : Fine aggregate resulting from the natural disintegration of rock and which has been deposited by streams or glacial agencies.

b) Crushed Stone Sand : Fine aggregate produced by crushing hard stone.

c) Crushed Gravel sand : Fine aggregate produced by crushing natural gravel. Natural sand (River sand) confing to IS standards is considered as fine aggregate material for this project.

3. EXPERIMENTAL WORK CASTING OF TEST SPECIMENS To

study the split tensile strength of concrete at elevated temperatures, 144 cylinders of 300x150 (dia) mm sizes are cast, out of which 72 cylinders are made of standard concrete and 72 cylinders are made of recycled aggregate concrete.

MIXING

(i) The cement and aggregate (Normal and Brick aggregates) are weighed and kept aside.

(ii) Water of required quantity is measured using measuring jars.

(iii) Aggregates and cement are placed one after the other into the pan mixer.

(iv) Now the pan mixer is turned on and the materials are allowed to mix in dry state for about 30sec and then water is added to the mix and then operated for 15 sec more. (v) After obtaining a homogeneous mix, the mix is removed from the pan mixer. ii)

SAMPLING

(i)The moulds are cleaned thoroughly and oil is applied uniformly on all the surface of the moulds.

(ii) The moulds are filled with concrete up to the top surface.

(iii) The moulds are then placed on a 2mx1m vibrating table.

(iv) The vibrating table is turned on for 40 sec as per IS:2514-1965 and the samples are allowed to compact. Add concrete to fill the moulds up to top surface to compensate the settled material.

(v) Level the top surface and smoothen it with a trowel.

(vi) These specimens are de-moulded after 24 hours

CURING OF SPECIMENS After the specimens are de-molded, these are stored in water at room temperature for a period of 28 days. After 28 days of curing, all the specimens are allowed for surface dry condition before exposing to high temperature. iv) Exposing specimens to elevated temperature and testing: To determine the strength after exposure to elevated temperatures, the specimens are heated in Bogie Hearth Furnace for temperature ranges 200oC to 1000oC at an

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interval of 200oC. After exposing to specified temperatures for 3 hours, these

v) Heating specimens: The test specimens were subjected to temperature from 27oC to 1000oC at intervals of200oC each for 3 hours duration. The specimens were heated individually to the specified target temperatures. The specimens were placed on bed of the furnace, target temperatures were set in the controlled panel after the specimens were placed inside the furnace. Initially the temperature inside the furnace was 27oC. It takes some time for the furnace to reach the target temperature depending upon the set temperature i.e., more time for higher temperatures and vice versa. Following attainments of the desired temperature, the exposure continued for 3 hours. Then the furnace is turned off and the specimens are taken out of the furnace and are tested in their respective states.

vi) Testing of specimens: After curing for 28 days, the control specimens are tested for split tensile strength of concrete in a 40-Ton Universal Testing Machine (as shown in Fig.) according to IS (specify the code7.3 Specimen Marked for Testing

4. RESULTS AND DISCUSSIONS

i) TESTS ON CEMENT The basics tests to be performed on cement are carried out and are provide by the supplierFollowing are the results of various tests performed to find the properties of cement.

Table 8.1 Properties of cement

Particulars	Test Results	Requirements of IS:1489-1991(Part 1)	
CHEMICAL REQUIREMENTS			
1. Insoluble Material (% by mass)	27.26	X+((4*(100-X))/100)	Max
2. Magnesia (% by mass)	0.87	6	Max
3. Sulphuric Anhydride (% by mass)	2.54	3	Max
4. Loss on Ignition (% by mass)	1.58	5	Max
5. Total Chlorides (% by mass)	0.001	0.1	Max
PHYSICAL REQUIREMENTS			
1. Fineness (m2/kg)	323	300	Min
2. Standard Consistency (%)	32.5		
3. Setting Time (minutes)			
a. Initial	245	30	Min
b. Final	330	600	Max
4. Soundness			
a. Le-Chat Expansion (mm)	1	10	Max
b. Autoclave Expansion (%)	0.04	0.8	Max
5. Compressive Strength (Mpa)			
a. 72+/-1hr. (3 days)	26	16	Min
b. 168+/-2hr. (7 days)	35.4	22	Min
c.6 72+/-4hr. (28 days)	54	33	Min
6. Drying Shrinkage (%)	0.025	0.15	Max
7. % of Fly Ash addition	31	15	Min
		35	Max

ii) TESTS ON COARSE AGGREGATE

AGGREGATE IMPACT VALUE

Aggregate impact value = 100*(W2/W1) percent

Trial – 1

Coarse Aggregate

Total weight of dry sample = 332grams

Weight of fines passing through 2.36mm sieve = 61grams

Aggregate impact Value = 100W2/W1

= 18.37%

Brick Aggregate

Total weight of brick sample = 232grams

Weight of fines passing through 2.36mm sieve = 100.96grams

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Aggregate impact Value = 100W2/W1

= 43.51%

Trial – 2

Coarse Aggregate

Total weight of dry sample = 324grams

Weight of fines passing through 2.36mm sieve = 59grams

Aggregate impact Value = 100W2/W1

= 18.21%

Brick Aggregate

Total weight of brick sample = 240grams

Weight of fines passing through 2.36mm sieve = 106.9grams

Aggregate impact Value = 100W2/W1

= 44.54%

8.2.2 AGGREGATE CRUSHING VALUE

Aggregate crushing value = 100*(W2/W1) percent

Trial-1

Coarse Aggregate

Aggregate fill in cylinders (W1) = 2908grams

Weight of aggregate passing through 2.36mm sieve = 773grams

Aggregate crushing Value = 100W2/W1

= 26.58%

Brick Aggregate

Aggregate fill in cylinder (W1) = 1990grams

Weight of aggregate passing through 2.36mm sieve = 871.3grams

Aggregate crushing Value = 100W2/W1

= 43.78%

Trial-2

Coarse Aggregate

Aggregate fill in cylinders (W1) = 2915grams

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Weight of aggregate passing through 2.36mm sieve = 749grams

Aggregate crushing Value = 100W2/W1

= 25.69%

Brick Aggregate

Aggregate fill in cylinder (W1) = 1978grams

Weight of aggregate passing through 2.36mm sieve = 886.71grams

Aggregate crushing Value = 100W2/W1

= 44.83%

iii) TESTS ON FINE AGGREGATE

Sieve analysis of Natural Aggregate

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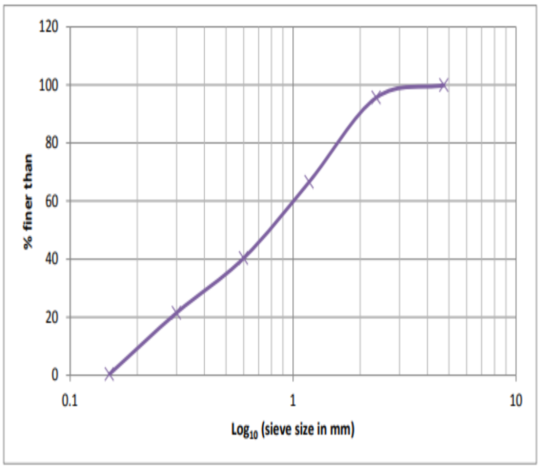
SIEVE ANALYSIS OF FINE AGGREGATE				
IS sieve size	weight retained (kg)	% weight retained	% cumulative weight retained	% cumulative weight passing
4.75 mm	0.001	0.1	0.1	99.9
2.36 mm	0.043	4.3	4.4	95.6
1.18 mm	0.29	29.03	33.43	66.57
600 microns	0.262	26.24	59.67	40.33
300 microns	0.188	18.83	78.5	21.5
150 microns	0.001	0.1	99.6	0.4
pan	0.004	0.4	100	0
	TOTAL =			

Fineness Modulus of Fine Aggregate =275.7/100 =2.76



iv) SPECIFIC GRAVITY TEST

G= (W2-W1)/[(W2-W1)-(W3-W4)]

Where W1=weight of empty pycnometer;

W2=weight of pycnometer and aggregate;

W3=weight of pycnometer, aggregate, and water;

W4=weight of pycnometer filled with water only.

Table 8.2Specific gravities of Coarse and Brick Aggregates

Trial-1

WEIGHTS	COARSE AGGREGATE	BRICK AGGREGATE
W1	648	648
W2	1008	924
W3	1713	1635
W4	1485	1485
SPECIFIC GRAVITY	2.73	2.3

Trial-2

WEIGHTS	COARSE AGGREGATE	BRICK AGGREGATE
W1	647	649
W2	1100	926
W3	1771	1631
W4	1485	1479
SPECIFIC GRAVITY	2.71	2.22

FLAKINESS AND ELONGATION INDEX FOR

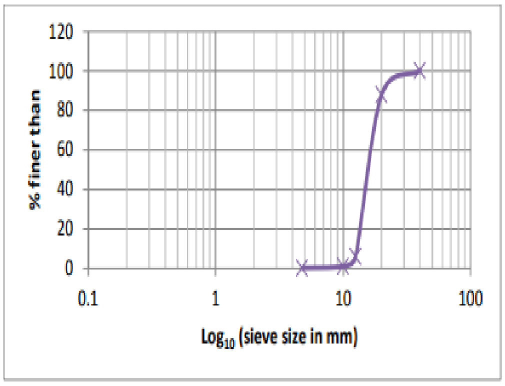
BRICK AGGREGATE

Elongation and Flakiness Index for Brick Aggregate

ELONGATION AND FLAKINESS INDEX (BRICK AGGREGATE)						
Size of aggregate		Weight of fraction (grams)	Thickness Guage size (mm)	Weight of aggregate in each fraction passing thickness guage (grams)	Length Gauge size (mm)	Weight of aggregate in each fraction retained on length guage (grams)
Passing through IS sieve (mm)	Retained on IS sieve (mm)					
63	50	0	33.9	0		
50	40	0	27	0	81	0
40	25	0	19.5	0	58.5	0
31.5	25	0	16.95	0		
25	20	2616	13.5	20.5	40.5	0
20	16	1355	10.8	18	32.4	0
16	12.5	747	8.55	14	25.6	25
12.5	10	354	6.75	3	20.2	0
10	6.3	182	4.89	2.5	14.7	0.5

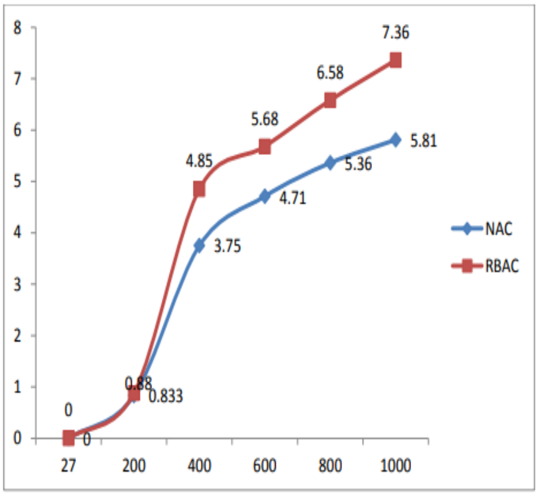
Flakiness Index = 100∑W1/∑W = 1.104%

Elongation Index= 100∑W1/∑W = 5.17%



Percentage Loss of Weight of specimen after exposed to temperatures

Temperature (°C)	% Loss of Weight	
	NAC	RBAC
200	0.833	0.88
400	3.75	4.85
600	4.71	5.68
800	5.36	6.58
1000	5.81	7.36



Comparison of % weight losses in NAC and RBAC

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DECLARATION

I hereby declare that the work done in this thesis entitled “Experimental Study on strength variation of concrete by using demolished brick aggregate at elevated temperatures” has been carried out by me, in partial fulfillment of the requirements for the award of degree of Master of Technology in Civil Engineering with specialization in Structural Engineering ,Godavari Institute of Engineering Technology and further declare that neither this thesis nor any part of this thesis has not been submitted for any other degree/diploma or any other academic award anywhere before.

5. CONCLUSIONS

- The recycled brick can be successfully replaced with granite aggregate by 25% of
- its weight.As the % replacement increases the strength decreases (hence the present study is limited to 25 % of replacement).
- The weight loss of the brick aggregate concrete is observed more than that of normal aggregate concrete at high temperatures.
- The residual strength is more in brick aggregate concrete than normal aggregate concrete at high temperatures
- There is no colour change is observed in NAC & RBAC till 400C and after that the colour has been changed from surface patches to complete pale white colour.
- More number of cracks have been observed in NAC than RBAC at 1000C.
- Some of the granite aggregate have turned to brown colour at 600 C and to san brown colour at 800C.The brick aggregate has not undergone any colour changes.
- More number of granite aggregates have turned to pale brown at 1000C and brick
- aggregate has been remained in the same colour.

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