Compressive Strength of Concrete Cubes Using Coated and Non Coated Bricks Aggregates With and Without Wire Mesh

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Abstract - In this study effect of coated and non coated brick aggregates with wire mesh and without wire mesh on the compressive strength of concrete cubes have been studied using experiments. Total 15 cube have been cast using 20 mm size of aggregates. NDT of the cube using rebound hammer and UPV have been also carried out. All the cubes were tested for compressive strength and ultimate load were recorded. Based on these data, comparative studies have been carried out to quantify the effect of normal cube and coated, non coated crushed brick aggregate with and with wire mesh.

Keywords - Concrete, Normal aggregates, coated brick and Non coated brick aggregates, compressive strength, Concrete cube.

1. INTRODUCTION

Concrete is a composite material of sand, gravel, crushed rock, or other aggregate held together by a hardened paste of hydraulic cement and water. The thoroughly mixed ingredients, when properly proportioned, make a plastic mass which can be cast or molded into a predetermined size and shape. The shape and the surface texture of aggregates influence the properties of fresh concrete more than the hardened concrete. Generally, irregular textured, angular, and elongated particles require more cement paste than smooth and rounded particles to produce workable concrete mixture because of higher void contents.

Now-a-days the aggregates are in sufficient quantity but in future there can be the lack of aggregates, so for future we have to think about artificial aggregates. One option is to create concrete by using brick aggregates. The word 'brick' refers to ceramic masonry unit which is manufactured by firing clayey soil. 'Recycled clay brick' is defined as the waste material that can be obtained from demolished masonry or non-standard discarded products at the end of the manufacturing process. Studies on brick aggregate in concrete generally involve the utilization of brick as coarse aggregate. Parent brick determines the characteristics of the concrete produced with crushed brick aggregate. Concrete unit weight decreases with increasing porosity, water demand of the mixture increases with increasing water absorption of the brick aggregate, thus concrete strength reduces proportionally and concrete strength increases with increasing brick strength. Brick is porous in nature and the bulk density of brick aggregate falls somewhere in between normal-weight and light-weight aggregate which reduces the unit weight of the concrete produced from crushed brick aggregate.

2. PREVIOUS WORK

Some of the prominent literature on brick aggregate based concrete are as follows-

Kasi Rekha, Potharaju (2015) utilized the construction debris as recycled aggregates in the production of concrete. The recycled brick aggregate (RBA) concrete was made used for the production of low grade recycled aggregate suitable for concrete production. An experimental investigation was carried out to find the effects of high temperatures on the properties of a standard RBA concrete mix made with 25% of crushed clay bricks as the coarse aggregate. They used natural crushed 20 mm single sized granite aggregate in the investigation so that comparisons could be made with the crushed clay brick aggregate. The compressive strength of both the concretes before 1000^{o} C and after exposure to high temperatures was compared to assess the relative performance. The results showed that RBA concrete preformed better than GA concrete at high temperatures. **Riaz Bhanbhro, Irfanullah Memon, Aziz Ansari (2014)** carried out studies based on properties evaluation of concrete using local used bricks as coarse aggregate and reported that due to modern requirements for living and developed construction industries, the old buildings (usually constructed with brick masonry) are demolished and are replaced with new modern buildings. Demolition of buildings results in

waste materials which can create waste related problems and environmental issues. By using recycled aggregates, weight of concrete can also be reduced, which can also solve problems related to self-weight of concrete. In this paper attempt has been made to use local used bricks as coarse aggregate. Concrete cubes made with local recycled bricks are cast and tested for overall weight of concrete, moisture content, dynamic modulus of elasticity and compressive strength (nondestructive and destructive methods). The results showed that concrete derived from recycled aggregates attained lower strength than regular concrete.

Mohammad Abdur Rashid, Md. Abdus Salam, Sukanta Kumar Shill and Md. Kowsur Hasan (2012) reported the experimental investigation on the properties of concrete obtained replacing stone aggregate by crushed clay-brick. The Compressive strength of stone aggregate concrete was 24 MPa and they replaced the stone aggregates fully or partly by brick aggregate and all other ingredient remained unchanged. In his study only variable was the volumetric replacement (0%, 25%, 50%, 75%, and 100%) of stone aggregate by brick aggregate. The result of the experiment showed that replacement of brick aggregate in place of stone aggregate concrete weighed about 14.5% less than that of natural aggregate concrete, the rate of decrease in unit weight of mixed aggregate concrete decreases with the increase in Vba/Vca ratio up to 50% beyond which the rate of decrease increases, 33% reduction in compressive strength of concrete is found due to the use of brick aggregate instead of stone aggregate for the strength range of concrete studied ,the reduction in tensile strength of mixed aggregate concrete is found to be less significant up to 50% replacement of stone aggregate by brick aggregate and 28% reduction in elastic modulus of concrete is found due to the use of brick aggregate instead of stone aggregate.

Sathish Kumar R. (2012) carried out the experimental study on the properties of concrete made with alternate construction materials. In this context an experimental study was carried out to find the suitability of the alternate construction materials such as, rice husk ash, sawdust, recycled aggregate and brickbats as a partial replacement for cement and conventional aggregates. For this six concrete cubes of 150mm x150mm were casted with various alternate construction materials in different mix proportion and with different water cement ratios. Test results indicated that the compressive strength of the OPC/RHA concrete cube increases with age of curing and decreases as the percentage of RHA content increases. It was also found that the other alternate construction materials like saw dust, recycled aggregates and brick bats can be effectively used as a partial replacement for cement and conventional aggregates. The results showed that the compressive strength, of recycled aggregate are on average 70% to 80% of the natural aggregate concrete and the compressive strength of brick bat concrete and saw dust concrete was found to be in the range of 30-35% and 8-10% respectively. The compressive strength of rice husk ash concrete was found to be in the range of 70-80% of conventional concrete for a replacement of cement up to 20%. The compressive strength of brick bat concrete was found to be nearly 35 % of conventional concrete. The compressive strength of saw dust concrete was found to be nearly 10 to 15% of conventional concrete. So the concrete made with alternate construction materials like brick bats and saw dust can be used for partition, filling purposes & nailing purposes where the strength was not the criteria.

In this study effect of 4 types of brick aggregate coated and non coated brick aggregate with and without wire mesh on the compressive strength of concrete cubes have been compared using destructive and non-destructive tests.

3. PROPOSED METHODOLOGY

This study is carried out to evaluate the compressive strength of M20 grade of concrete mix with coated and non coated crushed brick aggregate.

Following mixes were prepared, namely-

1. Case 1 i.e. water + cement+ non coated crushed brick without wire mesh.

2. Case 2 i.e. water + cement+ non coated crushed brick with wire mesh.

3. Case 3 i.e. water + cement+ coated crushed brick without wire mesh.

4. Case 4 i.e. water + cement+ coated crushed brick with wire mesh.

5. Case 5 i. e. Nominal mix i.e. water + cement + aggregate.

First mix is nominal mix as per IS code considerations using cement, sand, aggregate and water. Second mix is special mix condition. In this mix we replace aggregates by 20% by non coated crushed brick without wire mesh. In third mix non coated bricks are considered using wire mesh. Similarly mix 4 and 5 use coated bricks without and with wire mesh

respectively. Results have been compared on the basis of NDT and UTM based results.

Following steps are adopted in this study-

1. Preparation of concrete mix with water, cement, sand, brick and aggregates and wire mesh.

2. Selection of mould and mould preparation for casting of cubes.

3. Compaction of concrete mix, compact each layer by using tampering rod.

4. Demoulding of cubes.

5. Curing of the cubes for 28 days in the curing tanks.

6. Testing of the cubes with help of rebound hammer after 7,14 and 28 days and by UTM after 28 days.

7. Comparative analysis of results in terms of different mix conditions.

8.Critical study of results.

4. EXPERIMENTAL RESULTS

(A) Selection of Material

Following materials were used for concrete preparation-

1. Cement –PPC (Portland-pozzolona cement) was used.

Following tests were conducted, on cement:

Consistency limit test:- Three samples were tested and results are given in Table 1

Table 1: Consistency limit test result

Type of cement	Standard consistency limit		
Portland-pozzolona cement	As per IS code IS: 4031 (part 4) 1988	As per lab test	
	30.5	Sample 1	28
		Sample 2	31
		Sample 3	30

Initial setting time and final setting time: Results are given in Table 2.

Table 2: Standard initial and final setting time of cement

Type of cement	Initial setting time			Final setting time		
Portland-pozzolona cement	As per IS code (IS 4031: PART 5)		Test time 40 min	As per IS (IS 4031: PART 5)		Test time 565 min
	Minimum	Maximum		Minimum	Maximum	
	30 min	55 min		190 min	600 min	

2. Sand – Sieve analysis for the sand was carried out in the lab as per the procedure mentioned in IS 2386 (part-I)-1963. The size of sand is 2 mm to 4.75 micron.

3. Aggregates – For this study the locally available coarse aggregate was used. Grading of natural coarse aggregate considered is as per IS: 456:2000.

There are two major sources from which recycled clay brick can be obtained- construction and demolition waste, and clay brick/tile manufacturing plants. Construction and demolition waste (CDW) includes the unwanted leftover material from any construction activity which can be new construction, renovation or demolition. in this study construction and demolition waste has been used. coated brick aggregates are obtained after coating the aggregates in cement slurry and allowing to harden for 24 hrs. Non coated and coated brick aggregate are shown in Figure 1 and 2.

Figure 1: Non- coated crushed

Figure 2: coated crushed brick

4. Water - The water content of concrete is influenced by a number of factors, such as aggregate size, aggregate shape, aggregate texture, workability, water-cement ratio, cement and other supplementary cementitious material type and content, chemical admixture and environmental conditions. In this study potable water was used.

(B) Preparation of Concrete

Nominal mix of concrete of 1: 1.5:3 was used for making M20 grade concrete. The concrete was mixed by hand in the laboratory, in such a manner as to avoid loss of water or other materials. Each batch of concrete is of such a size as to leave about 10 percent excess after moulding the desired number of test specimens. To determine the workability of concrete, compaction factor test was carried out. This test is suitable for mixtures having medium and low workability i.e. compaction factor in between 0.91 to 0.81, but is not appropriate for concretes with very low workability, i.e. compaction factor below 0.71 (Gambhir, 2014). Compaction factor obtained for three samples are 0.83, 0.83, and 0.81. Wire mesh has been used to confined the coated and non coated brick aggregates.

(C) Casting of cube Specimens

The casting of cubes was done in single stage. All cubes were cast for single M20 grade of concrete mix and the mix proportion is (1:1.5:3) for cement, sand and aggregate respectively. The cubes were cast in mould of size 150 X 150 X 150 mm. The mould which is used for concrete cube is prepared after cleaning the internal surface of mould with the use of brush. The internal surface of mould is coated with grease oil to prevent adhesion of concrete. Wire mesh has been used to confine the concrete (Figure 3). A typical wire mesh arrangement in cube as shown in Figure 4. The ready mixed concrete is filled in mould in 3 layers and each layer must be compacted with the use of table vibrator shown in Figure 5. The concrete will be left for 24 hours setting. This steps is repeated for another cubes with different mixed proportion. Cube samples after casting are shown in Figure 6.

Figure 3: Wire mesh

Figure 4: Wire mesh in cube

Figure 5: Table vibration sample

Figure 6: Cube sample after of cube casting

All the cubes specimens were tested using NDT and UTM. NDT test were carried out for 7,14 and 28 days and compression test using UTM was carried out at 28 days. Tests of pulse velocity, rebound hammer and flexural strength are shown in Figure 7,8 and 9 respectively.

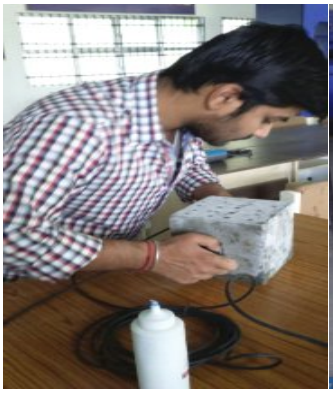

Figure 7:Test of pulse velocity

Figure 8: Test of rebound hammer

Figure 9: Compressive testing of cube

(D) Results

Various tests were performed on the prepared specimens. Results extracted from all these experiments are illustrated below on the basis of following sub-heads:

(a) Non- Destructive Tests

NDT tests were performed on all the specimens after 7, 14 and 28 days of casting and results are given below-

1. Rebound Hammer Test

The rebound hammer test results for concrete cubes with all cases normal and specials are given in Table 3 and graphically shown in Figure 10.

Table 3: Compressive strength (MPa) using Rebound Hammer

DAYS	CASE - 1	CASE-2	CASE-3	CASE-4	CASE-5
7	21.1	25.3	25.13	23.83	21.4
14	27.1	32.2	33.7	29.3	23.3
28	35.7	37.5	35.5	38.3	26.7

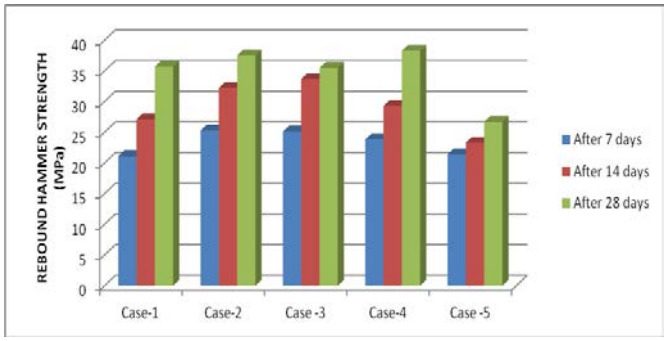

Figure 10: Average Rebound Hammer Compressive Strength

It can be observed that compressive strength increase with coating and wire mesh.

2. Ultrasonic-Pulse Velocity Test

The UPV test results for concrete cube with all cases normal and special cases for 7,14 and 28 days are given in Table 4 and shown in Figure 11.

Table 4: Ultrasonic Pulse Velocity Values (m/sec)

DAYS	CASE - 1	CASE -2	CASE - 3	CASE - 4	CASE - 5
7	4034	4290	4416	4339	4103.3
14	4125	4221	4582	4665	4204
28	4213	4416	4425	4686	4403

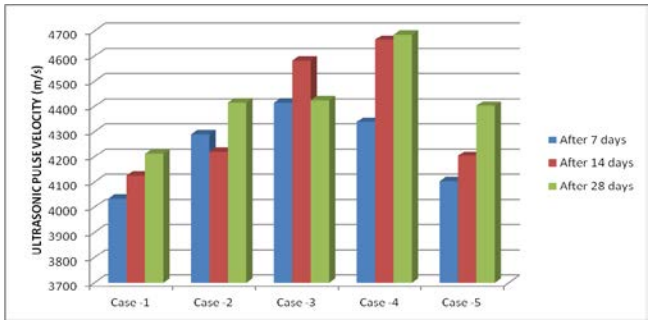

Figure 11: Average Ultrasonic Pulse Velocity Values

It can be observed that ultrasonic pulse velocity value increase with coating and wire mesh.

3. Compressive Strength Test

UTM test results for compressive strength, for concrete cubes with all cases normal and specials in 28 days are given in Table 5 and shown in Figure 12.

Table 5: Compressive Strength of Concrete Cube Sample after 28 days (MPa)

Days	CASE -1	CASE -2	CASE -3	CASE -4	CASE -5
After 28 days	21.22	23.72	23.73	28.25	25.23

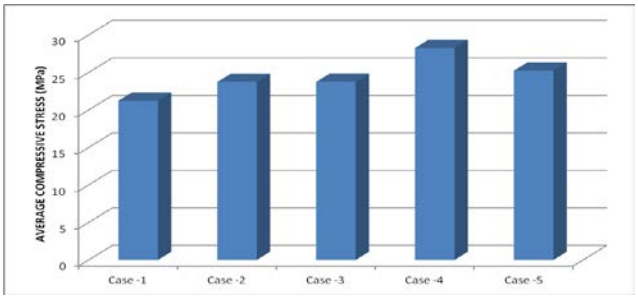

Figure 12: Average Compressive testing value

It can be observed that maximum strength is for coated aggregate with wire mesh condition. Coating and wire mesh have almost equal effect on compressive strength. Concrete with normal aggregates have second highest strength.

6. CONCLUSION

Following are the salient conclusions of the study-

(a) Rebound Hammer Strength

1. Rebound hammer reading for cubes with 20% replacement of aggregates with coated brick as aggregate and with wire mesh are higher than other cubes for after 28 days.

2. Maximum value is recorded for cubes with 20% replacement of aggregates with coated brick as aggregate and with wire mesh.

3. Rebound strength is more affected by wire mesh than the coating.

(b) Ultrasonic pulse velocity

1. Ultrasonic Pulse velocity reading for cubes with 20% replacement of aggregates with coated brick as aggregate and with wire mesh are higher than other cubes for after 28 days.

2. Maximum value is recorded for cubes with 20% replacement of aggregates with coated brick as aggregate and with wire mesh are higher than other cubes for m20 grade of concrete after 28 days.

3. Pulse velocity is almost equally affected by coating and wire mesh.

(c) Universal testing machine

1. Highest value of compressive strength is obtained for cubes with 20% replacement of aggregates with coated brick as aggregate and with wire mesh.

2. Compressive strength for cube with normal aggregates after 28 was found out to be second highest.

3. Compressive strength for cubes with 20% replacement of aggregates with coated brick as aggregate and with wire mesh is lesser than its rebound strength.

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