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Partial Replacement of Over Burnt Crushed Brick as Coarse Aggregate in Concrete

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ABSTRACT: Concrete is considered as the world's most used construction material. Typically concrete mixtures are comprised of cement, fine aggregate, coarse aggregate and sand. Replacing some of these materials makes significant changes in cost as well as performance. This project focuses on the coarse aggregate in concrete. The burnt brick is available from brick manufacturing plant. A large number of bricks are rejected due to non-conformity with the required specifications. One such major non-conformity is the distorted form of brick produced due to the uneven temperature control in the kiln. These rejected bricks can also be a potential source of coarse aggregate. This project presents the effects of over burnt brick bat inclusion on the mechanical properties of concrete matrix in wet and hardened state properties. Brick bats which are made from over burnt bricks were used as coarse aggregate which is hard and absorb less water. Over burnt bricks are produced by burning the raw materials along with good quality bricks. Due to its distorted shape, over burnt bricks are considered as wastage. But there is a scope of using the over burnt bricks as a source of aggregate for construction. The over burnt brick aggregate can solve the problem of shortage of aggregate.

KEYWORDS: Over burnt brick aggregates, blending, optimum proportion, parameter, Compressive strength, Consistency.

I. INTRODUCTION

Construction industry is going rapidly with the passage of time as we seen in the last decade. With this rapid growth of construction, a concern of waste management is also increasing at the same rate. The demands for the natural resources are increasing day by day. On the other hand, waste from the industry being disposed as landfill and cause environmental and landfill issues. Concrete is the base material in construction industry, which is the second most widely used construction material within the world. The main constituent of concrete is cement, fine aggregate, coarse aggregate and Water. The Coarse mixture consumes 75-80% of the quantity of the concrete, thus dictating the strength and density relationship. Replacing some of the materials makes significant changes in cost as well as performance. The cost of coarse aggregate rapidly increasing also the availability of the aggregate is getting reduced. The major cost of the concrete belongs to the aggregate. The most economical technique of managing the waste is reusing of these products in a good and economic approach. Concrete is strong in compression and weak in tension. Fine and coarse mixture frame the majority of concrete mixture. Sand, natural gravel and crushed stone are mainly used for this purpose. Since one of the major materials in residential construction is brick, they form a large portion of waste generated from demolished building sites. These materials are regarded as waste when they are damaged or broken in the production process or from demolished construction sites. At present, gravel is widely used as coarse aggregate. There is an urgent need for preserving natural resources for sustainable development and save the resources for future generation. This compels the use of other coarse aggregate which are locally available and also cheap. Over burnt brick aggregates (OBBA) are progressively used as partial replacements of natural aggregates. Over burnt brick is a brick that has been treated in a kiln at an elevated temperature to harden and give mechanical strength and to improve its resistance to moisture. Depending on the methods of heating and handling in the manufacture of bricks, a certain percentage of brick is broken, under burnt or over burnt. It possesses chemical elements such as magnesia, silica, lime, alumina and iron etc. thus making its use in concrete production very practical. One of the advantages of concrete containing burnt bricks or clay is that it has greater fire resistance than concrete made with natural aggregates. OBB are one of the types of aggregate used in certain places where natural aggregates are not available. It is produced by

burning the raw materials along with good quality bricks. Due to its distorted shape, over burnt bricks are considered as wastage. But there is a scope of using the over burnt bricks as a source of aggregate for construction.

II. LITERATURE SURVEY

Vikash Kumar Gautam and Devesh Jaysawal has found that use of crushed bricks were satisfactory as coarse combination for preparing concrete of acceptable strength characteristics. The similar procedure for blending coarse aggregate is adopted for the assembly of Over Burnt Brick Aggregate (OBBA).

Bidve Ganesh Shivkanth drawn the following conclusions based on the results and observation made in experimental research study. It is observed that with the increase in percentage of over burnt brick bat workability of waste decreases.

Vikash Kumar Gautam, Darmendra Kumar Dubey and Pritesh Kumar Rai have found that waste over burnt bricks will be used satisfactory as coarse combination for creating concrete of acceptable strength characteristics. In this study he conclude that the over burnt brick is light in weight and it is helpful for making light weight concrete structure. The most optimum proportion of waste over burnt brick to be additional into light-weight concrete combine is 25th.

Muhammad Adil and Attur Rahman investigated that the behavior of concrete which includes the compressive strength of hardened concrete and slump value of fresh concrete. The variable parameter of the study was the percentage replacement of coarse aggregate with OBBA. Within the scope of this study, it can be concluded that, by replacing natural coarse aggregate with OBB aggregate workability increases for 20% replacement only and decreases for all other replacement. Maximum slump value of 3 in was obtained at 20% replacement, for coarse aggregate replacement.

III. METHODOLOGY

3.1 Material Used

- **Cement:** The cement used is Portland Pozzolana Cement (PPC) of 43 grade.
- **Fine Aggregate:** M-sand is employed as fine mixture. The sieve analysis conducted in accordance with IS 2386 (Part 1)-1963.
- **Coarse Aggregates:** Naturally sieved 20mm single sized coarse aggregate was utilized in the investigation. So comparison might be created with the over burnt crushed brick mixture.
- **Over burnt brick Aggregate :** The collected over burnt brick area unit crushed to 20mm mixture manually. The over burnt brick was collected from Amina bricks, Avaneeswaram, Kollam, Kerala.
- **Water:** Drinking water is used, pH value of 6.8.

3.2 Experimental works on materials

- **Specific gravity test:** Specific gravity test of aggregates is conducted to measure the strength or quality of the material while water absorption test determines the water holding capacity of the coarse and fine aggregates.
- **Sieve analysis:** The sieve analysis determines the gradation (the distribution of aggregate particles, by size, within a given sample) in order to determine compliance with design, production control requirements, and verification specifications.
- **Crushing value test:** The objective of this test is to determine the aggregate crushing value of coarse aggregate. Coarse aggregate crushing value is the percentage by weight of the crushed material obtained when test aggregates are subjected to a specified load under standardized conditions. Aggregate crushing value is the numerical index of the strength of the aggregate.
- **Impact value test:** Aggregate Impact Value test determines the Aggregate Impact Value which provides a relative measure of the resistance of an aggregate to sudden shock or impact which may vary from its resistance to gradually applied compressive load. Resistance of the aggregates to impact is termed as toughness.
- **Fineness test:** Fineness test is used to change the proper grinding of cement and measures the surface area of the cement particles per unit mass.
- **Setting time of cement:** Setting time of cement is the time elapsed between the water is added to the cement and the cement paste loses its plasticity completely and has attained sufficient firmness to resist certain definite

pressure.

- **Slump test:** The concrete slump test measures the consistency of fresh concrete before it sets. It is performed to check the workability of freshly made concrete, and therefore the ease with which concrete flows. It can also be used as an indicator of an improperly mixed batch.
- **Compressive strength test:** Compressive strength test and mechanical test measures the maximum amount of compressive load of a material which can bear before fracturing. The test piece, usually in the form of a cube, prism, or a cylinder, is compressed between the platens of a compression-testing machine by a gradually applied load.

IV. MIX DESIGN

4.1 Mix Design Calculations

As per IS10262-2019 and IS456-2000

❖ Data required for proportioning

- Grade Designation = M20.
- Type of cement and Grade of cement = Portland Pozzolana cement 43 grade.
- Nominal size of aggregate = 20 mm.
- Exposure condition = Mild (IS456-2000)
- Workability in terms of Slump = 75 mm (IS456-2000)
- Type of fine aggregate = Zone II
- Water cement ratio = 0.5 (IS456-2000)

❖ Test data of materials

- Specific gravity of cement = 3.15
- Specific gravity of fine aggregate = 2.6
- Specific gravity of coarse aggregate = 2.55
- Specific gravity of over burnt brick = 2.9
- Specific gravity of water = 1

❖ Summary

- Cement = 348.32 kg/m³
- Water = 191.58 kg/m³
- Fine aggregate = 770.57 kg/m³
- Coarse aggregate = 1026.69 kg/m³
- w/c ratio = 0.5

V. CASTING AND CURING OF TEST SPECIMEN

5.1 Hand Mixing

Hand mixing is practiced for a small unimportant concrete works. Hand mixing should be done over an impervious concrete or brick floor of sufficiently large size to take one bag of cement. Spread out the measured quantity of coarse aggregate and fine aggregate in alternate layers. Pour cement on the top of it, and mix them dry by shovel, turning the mixture over an again until uniformity of colour is achieved. This uniform mix is spread out in thickness of about 20 cm water is taken in water-can fitted with a rose-head and sprinkled over the mixture and simultaneously tamped over. This operation is continued till such time is good uniform, homogeneous concrete is obtained.

5.2 Compaction of Concrete

Compaction of concrete is the process adopted for expelling entrapped air from the concrete. The test specimens are made as soon as practicable after mixing and in such a way as to produce full compaction of concrete with neither segregation nor excessive laitance. Each layer is compacted by hand or by vibration. When compacting by hand the standard tamping bar is used and the strokes of bar are distributed in a uniform manner over the cross section of the mould. The number of strokes per layer required to produce the specified conditions vary according to the type of the concrete.

5.3 Casting of Specimen

Mould were properly fixed with screws and oil is applied on the surface for easy demolding. Concrete is prepared in the mixture and put in a tray. Fresh properties of concrete are determined. The specimens are cast. In the next day, specimens were demolded and put in a curing tank.



5.4 Curing of Concrete

Curing can be described as keeping the concrete moist and warm enough so that the hydration of cement can continue. The method adopted in this project is a type of water curing i.e. immersion. Precast concrete items are normally immersed in curing tanks for certain duration. After 24 hours of casting, the concrete cubes are immersed in water. These cubes are taken out one hour before the test is continued.

VI. RESULTS AND ANALYSIS

Table 6.1 Test results of Aggregates

Test	Result		
	Fine Aggregate	Coarse Aggregate	Over Burnt Brick
Specific gravity test	2.6	2.55	2.9
Crushing value test	-	31.16 %	88.08 %
Impact value test	-	25.71 %	85 %
Water absorption test	-	0.8 %	1.75 %

Table 6.2 Observations of sieve analysis

IS Sieve size (mm)	Weight of fine aggregate retained (g)	Percentage retained (%)	Cumulative percentage retained (%)	Percentage passing (%)
4.75	0	0	0	100
2.36	350	35	35	65
1.18	40	4	39	61
0.6	500	50	89	11
0.3	70	7	96	4
0.15	26	2.6	98.6	1.4
0.075	3	0.3	98.9	1.1
Pan	11	11	100	0

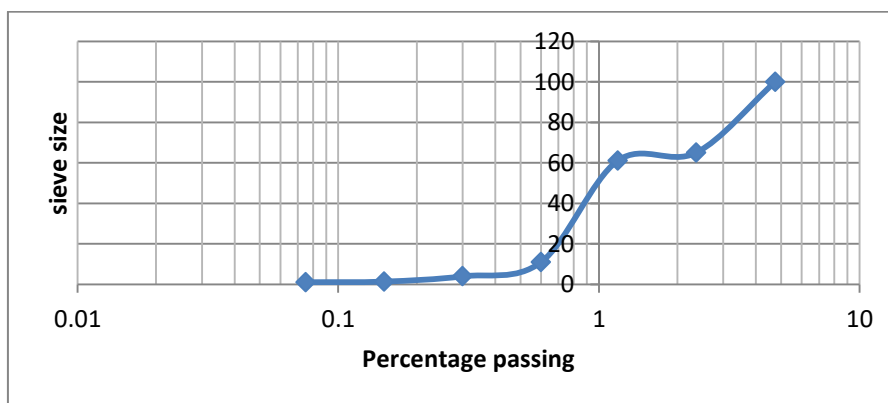


Figure 6.1 Graph showing Sieve analysis

Table 6.3 Test results of cement

Test	Result
Specific gravity of cement	3.15
Setting time of cement	50 minutes
Fineness test	71 %



Table 6.4 Test results of slump test

Replacement Of Coarse Aggregate By Over Burnt Brick (%)	Slump Value (Mm)
0	90
10	90
20	80
30	65

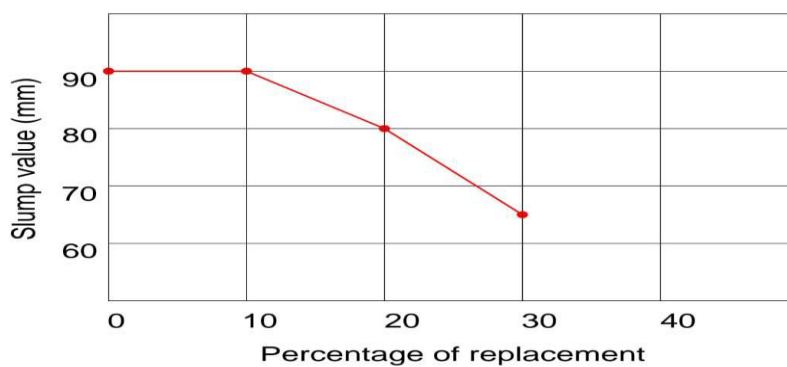


Figure 6.2 Graph showing slump value analysis

Table 6.5 28th day compressive strength test results

Replacement Of Coarse Aggregate By Over Burnt Brick (%)	Compressive Strength (N/mm ²)
0	18.9
10	16.9
20	13.4
30	12.4

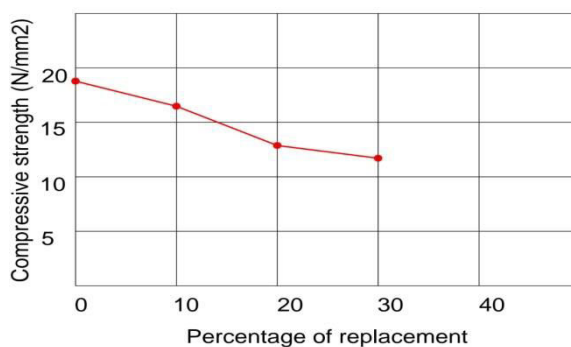


Figure 6.3 Graph showing 28th day compressive strength

- The compressive strength tests of 150mm x 150mm x 150mm size concrete cubes were conducted.
- The result indicates that as we increasing the percentage of over burnt brick from 0 to 30% the compressive

strength is decreasing. The over burnt brick can be used as coarse aggregate for structural concrete when natural aggregate is not available and high strength of concrete is not required.

From the 28th day compressive strength test result, following observations are made:

- When the natural coarse aggregate is replaced by 10% over burnt brick, the compressive strength decreased by 10.58%, ie, the compressive strength is closer to that of normal concrete.
- When the natural coarse aggregate is replaced by 20% over burnt brick, the compressive strength decreased by 29.1%.
- When the natural coarse aggregate is replaced by 30% over burnt brick, the compressive strength decreased by 34.39%.

VI. CONCLUSION

Over burnt brick aggregate has good potential as coarse aggregate in concrete. The utilization of crushed bricks as coarse aggregate decreases the compressive strength of concrete. Each of the over burnt brick aggregates should be used in the Saturated Surface Dry (SSD) condition. Proper grading of crushed over-burnt brick aggregate provides the required compressive strength of concrete with specified water-cement ratio. Based on the observations and results of experiments conducted, the following conclusions are made:

- From compressive strength test conducted, when the natural coarse aggregate is replaced by 10% over burnt brick, the compressive strength decreased by 10.58%. When the natural coarse aggregate is replaced by 20% over burnt brick, the compressive strength decreased by 29.1%. When the natural coarse aggregate is replaced by 30% over burnt brick, the compressive strength decreased by 34.39%. It shows that the decrease in percentage of replacement of natural coarse aggregate by over burnt brick increases the difference in compressive strength.
- Crushed over burnt bricks can be used to produce concrete with lower weight and hence lower dead loads, such can be used on low bearing capacity soils.
- Compressive strength of 10 % of over burnt brick aggregate concrete is more close to the normal concrete.
- 10 % of over burnt brick aggregate concrete can be used in RCC for structure like column, beam and roof of one storey and two storey buildings.
- 20% and 30% replacement may be used in column and beam structure of one storey buildings.
- The crushing value of over burnt brick aggregate is higher than that of normal aggregate.
- The concrete using over burnt brick as coarse aggregate is eco-friendly as it utilizes the industrial waste which creates large dumping problems.

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