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COMPARATIVE STUDY OF CONCRETE WITH PARTIAL REPLACEMENT OF FINE AGGREGATE WITH BRICK BALLAST USING M25 GRADE

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ABSTRACT

Sand-like fine aggregate is a component in concrete construction all around the world. There are several projects that use cement to partially replace fine or coarse aggregate, however i have done my research on using brick ballast to partially replace sand. This project illustrates how fine aggregates can be largely replaced by brick ballast. The ideal percentage of replacements is created, and strength and workability characteristics are researched. I have performed partial replacements by brick ballast with a variety of percentages as 0%, 5%, 10%, 15%, 20%, 25% & 30%. With the inclusion of the brick ballast, the workability of concrete is reduced. According to the test results, fine particles in place of brick ballast provide concrete with a 30% greater maximum strength. Therefore, we employ the ideal proportion of brick ballast to provide the maximum strength needed for the structure.

Keywords: Brick ballast, Compressive Strength, Flexural Strength, Split Tensile Strength.

I. INTRODUCTION

Concrete is the most widely used material in the construction industry, and it is second only to water in terms of its use. Fine aggregate is an important component of this material. There is a huge demand for aggregate in the construction industry due to liberalization, globalization, and the construction of major infrastructure projects such as expressways, airports, and nuclear plants. To meet this demand, coarse and fine aggregates must be extracted from natural resources. As more and more natural fine aggregate is used, it is creating an imbalance in the environment. Therefore, in construction industries, it is essential to partially or completely replace fine aggregate with compatible materials such as Sintered Fly Ash, Quarry Dust, Glass Powder, Brick Ballast, etc. Modern technological society is producing a large amount of solid waste in both the residential and industrial sectors, which presents an engineering challenge for proper disposal.

Brick ballast is widely used in regions like Bangladesh and in West Bengal (India). Where natural aggregate deposits are limited, brick ballast can be used as a substitute for aggregate. It can be used for rigid pavement, small- to medium-span bridges, culverts, and buildings up to 6 stories.

Brick ballast are readily available in the area and are much less expensive than crushed stone aggregate. Despite its widespread use and the high performance of concrete-based structures built with brick aggregate, there has been no systematic investigation of mix design for brick aggregate concrete.

II. LITERATURE REVIEW

DEVENNY AND KHALAF Crushed brick was first used in cementitious materials with Portland cement in Germany in 1860, according to research.

KOYUNCU H (2004) examined minor roads, the production of concrete blocks, and the use of recycled aggregate from ceramic industry waste in land fill construction

MARIAENRICAL FRIGIONE (2010) had investigated the use of recycled PET bottles as fine aggregate in concrete and found that the workability, compressive strength, split tensile strength, and ductility were marginally better than reference concrete**.**

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III. MATERIALS AND PROPERTIES

CEMENT

The cement utilized in this investigation is Elephant OPC 53 grade. It has undergone physical testing in accordance with IS: 12269:1981. Physical specifications for 53-Grade Ordinary Portland Cement

Characteristic	Requirement	Test Method
Fineness	225 m^2 /Kg	IS 4031 (Part 2)
Soundness	Not more than 10mm	IS 4031 (Part 3)
Initial Setting Time	Not less than 30 minutes	IS 4031 (Part 5)
Final Setting Time	Not more than 600 minutes	IS 4031 (Part 5)
Normal Consistency	5-7 mm	IS 4031 (Part 4)
Specific Gravity	3.15	-

FINE AGGREGATES

Locally-sourced sand that met Indian Standard Specifications was used for the project. To remove any particles larger than 4.75 mm, the sand was sieved through a 4.75 mm sieve. Specific density, bulk density, fineness modulus, water absorption, and sieve analysis are a few of the other tests that were performed. Tables 3.5 and 3.6 below include the results. The grading zone II included the fine aggregate. Absorption for this aggregate is 1.23%. The fine aggregate had a bulk specific gravity of 2.60 and an SSD specific gravity of 2.6.

COARSE AGGREGATE

A coarse aggregate is defined as the material that is retained on IS sieve no. 4.75. In most cases, crushed stone is used as a coarse aggregate. The maximum size of the coarse aggregate is determined by the type of activity. In this investigation, coarse aggregate with a maximum size of 20 mm that was readily available locally was used. The aggregates were cleaned to get rid of dirt and dust, and they were then dried until they were surface dry. Aggregates underwent testing. The outcomes of numerous tests on coarse aggregate are provided below.

Physical Properties of coarse aggregates

Characteristics	**Value**
Type	Crushed
Specific Gravity	2.9
Total Water Absorption	0.98%
Fineness Modulus	6.87

Mechanical Properties of Aggreagate

Property	**Value**
Elongation Index	13.2 % (should not be more than 15 %)
Flakiness Index	12 % (should not be more than 15 %)
Specific Gravity of Aggregate Slag Aggregate	G = 2.98
Aggregate impact value	4.5 % (should not be more than 30 %)
Crushing value	19.11 % (should not be more than 45 %)
Dry Loose Bulk Density	1.52 Kg/lt
Water Absorption	1.0 % (should not be more than 2 %)
Abrasion Value	14 % (should not be more than 30 %)

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BRICK BALLAST

Brick ballast is waste obtained from various brick kilns and tile factories. Today, construction works are on a large scale, so the demand for bricks is also increasing, therefore the brick kiln industry around the world has also grown due to this. There are many brick kilns in different parts of Lucknow which have grown up unplanned over the decades. Tons of waste such as brick ballast or crushed brick chips (brick mouse) originate from these kilns and factories. Until now, such materials have only been used to fill low-lying areas or are discarded as waste material. Brick ballast is made from high-quality well-burnt or slightly overburnt brick sheets of 40 mm for foundation and floor concrete and 25 mm for roof concrete. Under-fired or "jhama" (over-fired porous) bricks should not be used. About 390-420 9-inch bricks and 420-440 Indian Standard (IS) bricks make up one cubic metre. m of brick ballast. 280 to 351 9-inch bricks and 300 to 370 IS bricks made one cubic yard. m brick bats. About 125 cu. m brick bat makes 100 Cu. m of brick ballast.

Properties of Brick Ballast

Sr. No.	Characteristics	Volume
1.	Specific gravity	2.7
2.	Net water absorption	0.7%
3.	Fineness modulus	2.8
4.	Grading zone	II

WATER

Construction of concrete structures depends heavily on water. Usually, it's also acceptable for water from lakes and streams with marine life. It is not essential to sample the water when it is acquired from the aforementioned sources. Since the quality of the water could fluctuate owing to low water levels or by irregular tap water use forecasting, it is best to avoid drinking water from such sources.

DESGINMIX

Mass of Cement in kg/m^3 - 380

Mass of Water in kg/m^3 - 160

Mass of Fine Aggregate in kg/m^3 - 710

Mass of Coarse Aggregate in kg/m^3 - 1284

Mass of 20 mm in kg/m^3 - 923

Mass of 10 mm in kg/m^3 - 360

Mass of Admixture in kg/m^3 - 1.91

Water Cement Ratio - 0.42

IV. TEST RESULTS AND DISCUSSION

The experimental study's test results for flexural strength, split tensile strength, compressive strength, and slump are shown in the form of a graph and discussed as well.

A SLUMP TEST

Fresh concrete is tested for slump using various mix ratios. For typical concrete, a slump value of 59 mm was achieved. This suggests moderate workability.

Fig.1 shows the variation of slump value of concrete using Brick Ballast. From the graph it is observed that in concrete, percentage of Brick Ballast increases, it decreases the workability.

Mixture	Measured Slump (mm)
Brick Ballast 0%	**58**
Brick Ballast 5%	**61**
Brick Ballast 10%	**54**

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Brick Ballast 15%	**53**
Brick Ballast 20%	**52**
Brick Ballast 25%	**50**
Brick Ballast 30%	**49**

B COMPRESSIVE STRENGTH

The specimen, which is made of 150 mm X 150 mm X 150 mm concrete cubes, was constructed, cured, and tested for compressive strength. A reading of the maximum load at failure was taken.

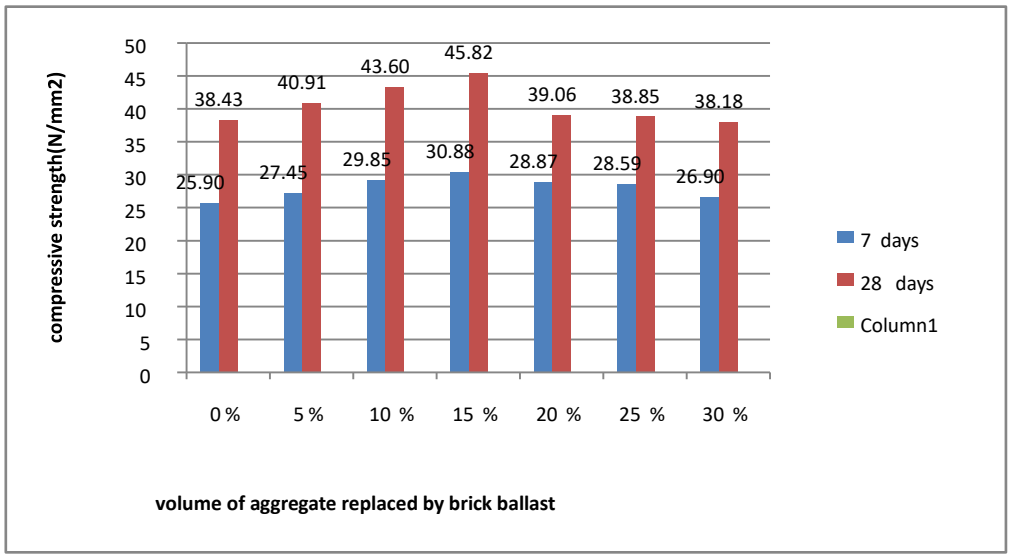

Fig.1 Compressive strength of concrete using brick ballast at 7th& 28th day

Using brick ballast, Fig. 1 depicts the compressive strength of concrete at 7 and 28 days. It was found that as brick ballast was used more frequently in place of natural materials, concrete's strength increased. The compressive strength of all concrete mixes increases when fine aggregate is replaced by brick ballast up to a 15% replacement, but once that percentage is exceeded, a decline in strength is noticed.

C SPLIT TENSILE STRENGTH

After the specimen is cured and split tensile is tested on days 7 and 28, it was cast as concrete cylinders with a 150 mm diameter and 300 mm height. It was measured at the maximum load before failure

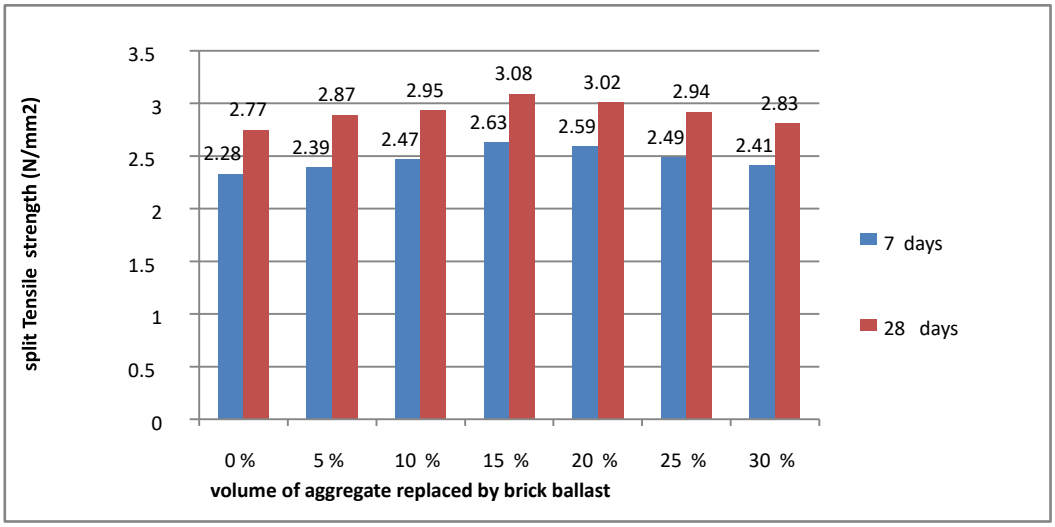

Fig. 2 Split tensile strength of concrete using brick ballast at 7th and 28th day

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D FLEXURAL STRENGTH

The 100 x 100 x 500 mm beam specimen was cast and cured at the 7th and 28th days before the flexural strength test. It was maintained horizontally between the loading surfaces of an all-purpose testing apparatus, and the force was applied until the beam broke. The failure load was documented, and the shorter distance between the crack and the support strength was calculated.

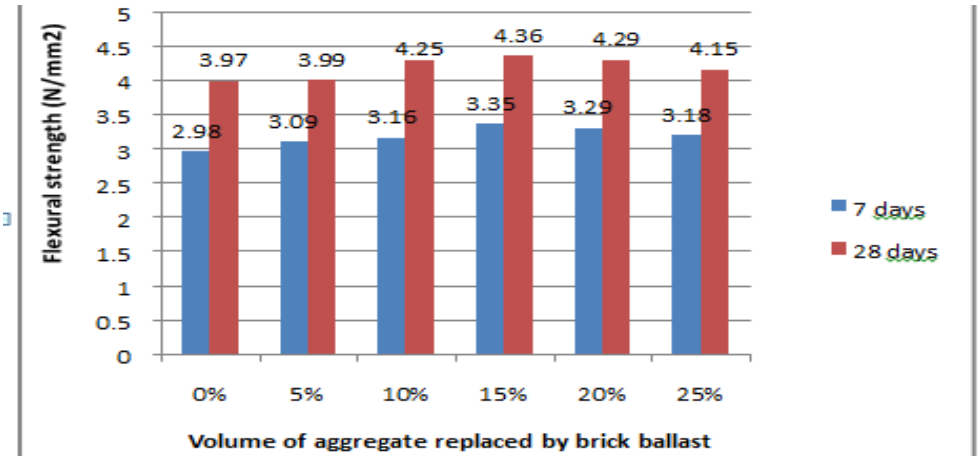

Fig. 3 Flexural strength of concrete using steel slag at 7th 28th day

V. CONCLUSION

- By replacing the brick ballast by 15%, the compressive strength can be increased to its maximum value.
- The best flexural strength value can be obtained by 15% replacing the brick ballast.
- By replacing the brick ballast by 15%, the split tensile strength can be increased to its maximum value.
- With the addition of brick ballast in place of fine aggregate, the workability of concrete declines.
- It has been determined that there is an improvement in strength when brick ballast is utilized in place of natural fine aggregate.

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