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A TESTING STUDY ON THE PARTIAL REPLACEMENT OF CONCRETE CONTAINS FINE AGGREGATE AND BRICK POWDER

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ABSTRACT

The world's most popular material for building infrastructure is concrete. The primary ingredient in mortar and concrete preparation, fine aggregate is crucial to mix design and proportion. Rock fragments that have been weathered and worn down into fine aggregate come in different grades or sizes depending on the degree of wear. Fine aggregate is hard to come by these days. Sand costs a lot of money. It is brought in from a great distance. The construction sector will be impacted by the lack of or scarcity of fine aggregate, so it is necessary to discover a new alternative material to replace the fine aggregate so that environmental harm is avoided. And trash from many industries, including construction and industrial, is produced in vast quantities in India and simply dumped on the ground. This could result in the loss of vast tracts of land that are harder to locate.

Better savings and environmental freedom would result from the partial replacement of fine aggregate with alternative material. Brick powder, a substitute material, is employed in this project. This brick powder is created by crushing brick fragments from masonry walls that have been torn down in a laboratory and replacing some of them with fine aggregate. The percentages of placement are 0%, 15%, 20%, and 25%.In the current work, experiments are conducted to examine the compressive strength of concrete cast in a typical mould and allowed to cure for 14 or 28 days. For this experiment, concrete of the M25 grade is employed. In comparison to conventional concrete, the compressive strength is calculated at various fine aggregate replacement levels. Additionally, the ideal replacement level is determined by compressive strength.

According to the test findings for compressive strength, 20% crushed brick replacement for fine aggregate resulted in the best replacement of fine aggregate when compared to the corresponding conventional concrete strength.

Keywords: Cement, Fine aggregate, Coarse aggregate, Water.

1. INTRODUCTION

Concrete is a mixture of cement, water, coarse aggregate, fine aggregate, and several other components, each of which is mixed in a different ratio to obtain a particular strength[1]. Because of its strength and durability, concrete is the most often used building material. Sand is often used to make fine aggregate, an essential part of concrete. Not just in India but all throughout the world, there are enormous amounts of waste generated during building and destruction. Sand is used as a fine aggregate, but the dearth of natural resources has prompted a quest for substitute materials[5]. In this experiment, we look into the viability of substituting brick powder for fine aggregate in concrete.

These wastes are primarily growing each year. According to estimates, 11 billion metric tonnes of concrete are produced annually, with fine aggregate (mainly natural rock) accounting for 70–75% of that total, water for 15%, and cement as the remaining 10-15%. The concrete industry has evolved a number of techniques to accomplish this goal by substituting alternative waste materials instead of fine aggregate due to growing environmental pressure to decrease solid waste and recycle as much as possible[4]. Notably, the need for fine aggregate is extremely high in the modern world, which is always focusing on building bigger and better infrastructure.

This study's objective is to assess the mechanical characteristics of concrete made with brick powder in place of fine aggregate. In order to conduct their investigation, they will cast concrete examples using various ratios of brick powder in place of some of the fine aggregate. We will assess the concrete specimens' compressive strength, flexural strength [7], and split tensile strength and compare them to a control mix of concrete manufactured with conventional sand-based fine aggregate. Waste bricks will be crushed and ground to create the brick powder used in this investigation. Standard Testing techniques will be used to establish the brick powder's particle size distribution, specific gravity, and water absorption. The mix design for the concrete specimens will adhere to all applicable norms and recommendations.

The study will also look into how varied brick powder amounts affect how easily concrete can be worked. The fresh concrete mix's consistency will be assessed using the slump test, and the flowability of the concrete will be assessed using the compacting factor test. The findings of this study will be helpful in understanding how brick powder can be used to partially substitute fine aggregate in concrete[2]. Engineers, builders, and architects who are looking for environmentally friendly and sustainable building materials will find this research to be helpful. The project's goals are as follows:

- To investigate how concrete performs when brick powder (brick rubble) partially replaces fine aggregate.
- to ascertain the ideal combination of fine aggregate and brick powder for concrete to produce better strength.
- To evaluate the utility of crushed brick as a partial replacement of Sand in Concrete.
- To study and compare the performance with conventional concrete.
- To understand the effectiveness of brick as in strength enhancement.
- To reduces the amount of waste generated by the construction industry.
- Reduce the cost of producing concrete. This is because brick powder is usually less expensive than fine aggregate, and it is often readily available at construction sites.
- To reduce shrinkage cracking. This is because brick powder has a low shrinkage rate, which helps to offset the shrinkage of the cement paste.

2. LITERATURE REVIEW

Nili et al. (2012) conducted research on the use of waste materials in concrete as partial replacements for aggregates and even cement, potentially as an environmentally friendly building material. Waste materials that make up 60 pe include recycled concrete aggregate (RCA), waste glass of all types (mostly container glass), polyethylene (PET), scraped PVC pipes[4], rubbers of different types, recycled ceramic materials from sanitary installations, and recycled ornamental stones (Granite and Marble). To assess their utilisation and significance in the concrete and mortar, several parameters for each category of recycled materials were documented. The material should be affordable and eco-friendly, and this has been considered.

The "Effects of Manufactured Sand on Compressive Strength and Workability of Concrete" were studied by Nimitha Vijayaraghavan and Aswayal in vol. 2, No. 4, Nov 2013. The construction business uses a tremendous amount of concrete. Sand makes up about 35% of concrete's volume. Careful blending of cement, fine and coarse aggregates, water, and any admixtures required to achieve the best quality and economy results in high-quality concrete[2]. In general, cement and coarse aggregates are manufactured in factories, making it simple to manage and control their quality requirements. Most frequently, tap water is used to mix concrete.

The fine aggregates or sand used are typically sourced naturally, particularly from river bottoms or river banks. The natural sand is currently disappearing at an alarming rate as a result of ongoing sand mining. Several environmental problems have been caused by sand dragging from riverbeds. The government has outlawed the pulling of sand from rivers due to several environmental concerns[3]. Natural sand is now scarce and significantly more expensive as a result. Finding an alternative to river sand is urgently needed. Sand can only be permanently replaced by synthetic sand.

3. METHODOLOGY

PROCESSOF CASTINGTHECUBES

BATCHING

The process of getting accurate measurements of all ingredients asper specification sand to ensure uniformity of proportions is called batching. The high quality of the ingredients used in the mix as well as the proper material distribution determine the quality of the concrete. The strength mainly depends on the quality of concrete[6]. To achieve full strength of the concrete the ingredients quality and quantities are measured correctly. The materials for making concrete can be batched either volumetrically or weight batching may be done in case of volume batching the material are taken in lotre. While in weigh batching the materials are taken in kgs. If the proper care taken and moisture present in aggregate is considered, both methods of batching will give equally accurate results.

MIXING

To produce consistent concrete, the ingredients must be well mixed. The mass should be homogeneous [3], uniform in colour, and consistency as a result of the mixing. There are two popular ways to mix concrete:1. Hand blending 2. Automated mixing

HAND MIXING

Concrete projects of a small scale or of no importance typically involve hand mixing. In order to compensate for the subpar concrete generated by this approach, it is desirable to add 10% additional cement as the mixing cannot be thorough and efficient. An impervious brick or concrete floor big enough to hold one bag of cement should be used for hand mixing. Alternately layer the measured amount of coarse aggregate and fine aggregate. Pour the cement on top of it, then mix the dry ingredients together with a shovel, [6]turning the mixture repeatedly to ensure colour homogeneity. This homogenous mixture is dispersed at a 20 cm thickness. The mixture is sprinkled with water from a water can with a rosehead while being simultaneously turned over. Up till a good uniform, homogeneous concrete is created, this process is repeated.

Fig1. Dry Mix

MACHINE MIXING

When a large quantity (say for a slab etc.) of mortar is required, we adopt machine mixing. In

machine mixing we get a suitable mortar in large quantities continuously (without interruption) at a fast rate. In this method first cement and sand in correct/required [6]proportion are put into the drum of a mixer and then water is poured before revolving the drum. The drum is revolved for a sufficient time to form a required paste of consistency. So, the mixing of ingredients is performed in a machine called mixer so this method is known as machine mixing.

Fig 2. Mixing machine

CASTING OF CUBES

As soon as the sample has been blended, pour the concrete into the cube moulds and compact it either manually or vibratorylly. The strength of the cube will decrease if there is any air trapped [5] in the concrete. The cubes must therefore be completely compressed. To avoid the aggregate, sand, and cement paste in the mix from segregating, care must also be taken not to over compact the concrete. The final compressive strength might also be affected by this.

Fig 3. Casted cubes

COMPACTION

Making concrete cubes requires compaction, which is a crucial phase in the process. Compaction serves to eliminate air gaps from the concrete mix, resulting in dense, robust, and long-lasting concrete.

HAND COMPACTION

For tiny, inconsequential concrete projects, hand compaction is the preferred method. This technique is occasionally utilised in situations where there is a need for a significant amount of reinforcement that cannot typically be compacted[4] by mechanical means. Rodding, ramming, or tamping are the methods used for hand compaction. The uniformity of concrete is maintained at a higher degree when hand compaction is used.

The layer of concrete can only be as thick as 15 to 20 cm. To pack the concrete between the reinforcement and sharp corners and edges, a 2-meter-long, 16-mm-diameter rod is poked into the concrete. To effectively pack the concrete and remove trapped[4] air, continuous rodding is done over the entire surface. Sometimes bamboo or cane are used for rodding purposes instead of iron rod. Ramming needs to be done carefully. In unreinforced foundation concrete or in ground floor construction, light ramming is permitted. Ramming shouldn't be allowed when working with reinforced concrete or when building upper floors, where concrete is poured into formwork that is supported by struts. If ramming is used in the instance mentioned above, the formwork may fail or the reinforcement's location may be disturbed, especially if a steel rammer is used.

Fig 4. Compaction

FINISHING

After the cubes have finished their first drying, they should be clearly marked. This can be accomplished by inking the cube's specifications on a small piece of paper, then placing it on top of the concrete until it deforms. At the end of the 24-hour period, the cube must be taken out of the mould and submerged in clean water heated to between 240°C and 300°C until it is 14 or 28 days old. The cubes must undergo testing in both saturated and dry-on-the-surface conditions.

Fig 5. Finishing of surface

CURINGOFCUBES

The process of curing is used to maintain moisture on the completed surface of concrete, such as columns, beams, masonry walls before and after plastering, slabs, etc. This process causes a rise in strength and a fall in permeability[4]. Curing also has a significant role in reducing concrete cracks, which have a negative impact on durability. Portland cement should be allowed a minimum of 14 days to cure. Depending on the cement type and construction type, the curing time will vary.

In order to slow down moisture loss after the concrete cubes have been cast, they should be maintained moist and shielded from the sun and wind. To keep the cubes moist, cover them with a damp hessian towel, hessian, or polythene sheeting. During the curing process, the cubes should be kept at a temperature of 20°C to 25°C[7]. For concrete with a defined compressive strength of 20 N/mm2 or less, the curing period should be at least seven days; for concrete with a stated compressive strength of more than twenty days. To keep the proper moisture content during the curing process, the cubes should be wet often.

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Fig 6. Curing of cubes

COMPRESSIVE STRENGTH OF THECUBES

Concrete cube compressive strength testing is a common test method used to assess concrete's compressive strength[3]. The technique for the test is as follows:

Sampling: According to the applicable standard, samples of new concrete are used to create the concrete cubes. Usually, 150 mm x 150 mm x 150 mm cubes are used for the test.

Preparation: The cubes are taken out of the curing tank after the curing process is complete, and any loose particles on the surface are cleaned off. The cubes are then flattened out using a grinding machine.

Testing: After that, the cubes are put into a compression testing device. Up until the cube breaks, a constant 140 kg/cm2 of stress is applied[2]. The highest load is noted, and the compressive strength is computed via the formula below:

Compressive strength=Maximum load/Cross-sectional area of cube

The cube's cross-sectional area is obtained by multiplying its length by its width. In N/mm2orMPa, the compressive strength is measured.

Reporting: The average of three cubes is used to represent the test results in records and reports. Any unusual results are looked into, and if necessary, the test may be repeated.

Concrete cube compressive strength testing is a common test procedure used to make sure that concrete satisfies the appropriate strength standards for its intended purpose. It is significant to highlight that a variety of factors[5], including curing conditions, mix design, and testing processes, have an impact on the test result. In order to guarantee accurate and trustworthy results, the test should be carried out in accordance with the pertinent standards and by skilled experts.

Fig 7. Compressive Testing Machine(CTM)

4. RESULTS

Table 1. Cement Tests Results

Experiment name	Result
Fine ness of cement	7%
Standard consistency	30%
Initial setting time	30minutes
Final setting time	10hours
Specific gravity	3.16

Table 2. Fine aggregate Tests Results

Experiment name	Result
Sieve analysis of fineness modulus	2.26
Specific gravity	2.58
Silt content	1.5%

Table 3. Coarse aggregate Tests Results

Experiment name	Result
Sieve analysis of fineness modulus	7.47
Water absorption	0.3%
Specific gravity	2.66

Table 4. Brick powder Tests Results

Experiment name	Result
Sieve analysis of fineness modulus	2.55
Specific gravity	2.62
Silt content	2.5%

Table 5. compressive strength test results

Brick powder replacement percentage	0%	15%	20%	25%
Compressive strength of cubes (N / mm2) 14days 28days	19.06 26.04	24.71 34.44	27.24 38.977	21.24 15.422

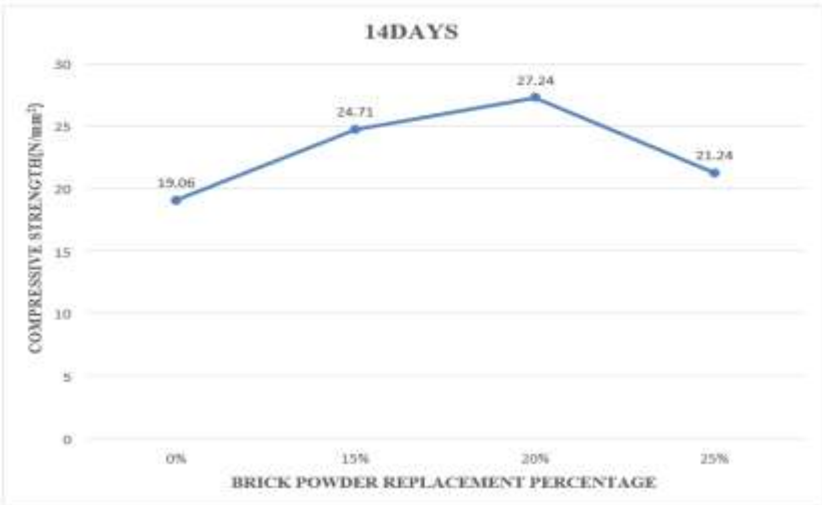

Fig 8. Graph of compressive strength for 14 Days

Fig 9. Graph of compressive strength for 28 Days

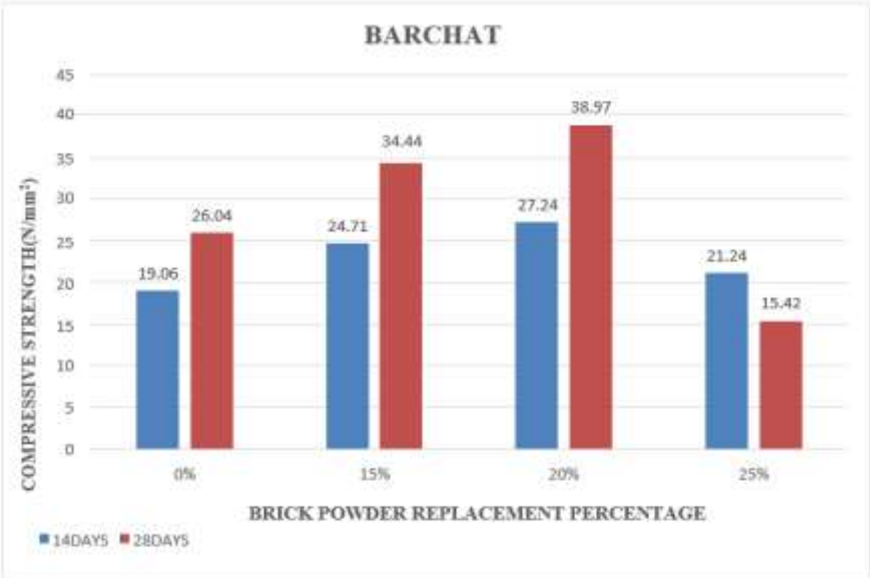

Fig 10. Bar Graph of compressive strength for 14 and 28 Days

CONCLUSION

Depending on the particular experimental setting and the outcomes, the conclusion of an experimental study on the partial substitution of fine aggregate with brick powder in concrete may vary. However, some conceivable general inferences from the research include

1. Brick powder addition lowers environmental pollution. This encourages the use of green concrete.
2. Brick powder can be used in concrete as a partial replacement for fine aggregate,

which can help to lessen the environmental effect of construction materials and enhance waste material reuse. Brick dust can be used in place of some of the fine aggregate in construction projects since it can be eaten without harming the environment.

3. This process can save as much as the total cost of sand used in the conventional way. With an increase in mix proportion richness, cost savings percentage rises.
4. According to the results of the compression test, fine aggregate replacement is best performed at 20%, or 27.24 MPa and 38.977 MPa during a 14- to 28-day curing time. Brick powder was used to replace the fine aggregate, and the resulting concrete had superior strength compared to that of ordinary concrete and various replacement percentages. The study aims to reduce environmental contamination.
5. From this study, it can be inferred that the ideal ratio to use is a 20% substitution of fine aggregate with brick powder.

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