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Experimental Analysis of properties of Conventional and Light Weight Concrete mixed with Brick and Ceramic Tile Waste

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Abstract– *Due to the day to day innovations and development in construction field, the use of natural aggregates is increased tremendously and at the same time, the production of solid wastes from the demolitions of constructions is also quite high. Because of these reasons the reuse of demolished constructional wastes like ceramic tile and brick waste came into the picture to reduce the solid waste and to reduce the scarcity of natural aggregates for making concrete. The ceramic tile waste and brick waste are not only occurring from the demolition of structures but also from the manufacturing unit.*
Studies show that about 20-30% of material prepared in the brick and tile manufacturing plants are transforming into waste. This waste material should have to be reused in order to deal with the limited resource of natural aggregate and to reduce the construction wastes.
Crushed waste ceramic tiles and brick waste are used as a replacement to the coarse aggregates. The ceramic waste crushed tiles and crushed brick waste were partially replaced in place of coarse aggregates by 0%, 25% and 50%. M25 grade of concrete was designed and tested. The mix design for different types of mixes were prepared by replacing the coarse aggregates at different percentages of crushed tiles and bricks. Experimental investigations like workability, Compressive strength test, Split tensile strength test, Flexural strength test for different concrete mixes with different percentages of waste crushed tile and brick waste after 14 days curing period has done.
Keywords: *Crushed tiles, brick waste, Compressive strength, Workability, Flexural strength, Split Tensile strength.*

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I. INTRODUCTION

1.1 CONCRETE

Concrete is a composite material consist of mainly water, aggregate, and cement. The physical properties desired for the finished material can be attained by adding additives and reinforcements to the concrete mass that can be easily moulded into desired shape can be formed by mixing these ingredients in certain proportions. Over the time, a hard matrix formed by cement binds the rest of the ingredients together into a single hard (rigid) durable material with many uses such as buildings, pavements etc., The technology of using concrete was adopted earlier on large-scale by the ancient Romans, and the major part of concrete technology was highly used in the Roman Empire.

1.2 PROPERTIES OF CONCRETE

Generally the Concrete is a material having high compressive strength than to tensile strength. As it has lower tensile stress it is generally reinforced with some materials that are strong in tension like steel. The elastic behavior of concrete at low stress levels is relatively constant but at higher stress levels start decreasing as matrix cracking develops. Concrete has a low coefficient of thermal expansion and its maturity leads to shrinkage. Due to the shrinkage and tension, all concrete structures crack to some extent. Concrete prone to creep when it is subjected to long-duration forces. For the applications various tests be performed to ensure the properties of concrete correspond to the specifications. Different strengths of concrete are attained by different mixes of concrete ingredients, which are measured in psi or Mpa. Different strengths of concrete are used for different purposes of constructions.

1.3 LIGHT WEIGHT CONCRETE

One of the disadvantages of concrete is its high self weight. Density of normal concrete will be in the range of order of 2200 to 2600 kg/m3. This heavy self weight will make the concrete to some extent as an uneconomical structural material. Attempts have been done in the past to reduce the self weight of concrete to increase its efficiency of concrete as a structural material. The light weight concrete density varies from 300 to 1850 kg/m3 by the use of various ingredients. Lightweight concrete has become more popular in recent years and have more advantages over the conventional concrete.

1.4 CONSTRUCTION WASTE IN INDIA:

In the present construction world, the solid waste is increasing day by day from the demolitions of constructions. There is a huge usage of ceramic tiles and bricks in the present constructions is going on and it is increasing in day by day construction field. They are mostly produced using natural materials that contain high content of clay minerals. However, despite the ornamental benefits of ceramics, its wastes among others cause a lot of nuisance to the environment. And also in other side waste tile and bricks are also producing from demolished wastes from construction.

Indian tiles production is 100 million ton per year in the ceramic industry and over 250 billion bricks are produced annually in India, about 15% to 30% waste material generated from the total production. This waste is not recycled in any form at present. There are some researches are also going on solid waste from construction to reuse them again in the construction to reduce the solid waste and to preserve the natural basic aggregates. These researches promotes to use the recycled aggregates in the concrete mix and they got good result when adding some extent percentages of recycled aggregates in place of natural coarse aggregate.

1.5 TILE AND BRICK AGGREGATE CONCRETE:

Crushed tiles and bricks are replaced in place of coarse aggregate by the percentage of 0%, 25% and 50%. For analyzing the suitability of these crushed waste tiles and bricks in the concrete mix, workability test was conducted for different mixes having different percentages of these materials. Slump cone test is used for performing workability tests on fresh concrete. And compressive strength test is also conducted for 14 days curing periods by casting cubes to analyze the strength variation by different percentage of this waste materials. This present study is to understand the behavior and performance of solid waste in concrete. The waste crushed tiles as well as crushed bricks are used to partially replace coarse aggregate by 0%, 25% and 50%.

1.6.ENVIRONMENTAL AND ECONOMIC BENEFITS OF TILE AGGREGATE CONCRETE:

The usage of tile and brick aggregate as replacement to coarse aggregate in concrete has the benefits in the aspects of cost and reduction of pollution from construction industry. The cost of concrete manufacturing will reduce considerably over conventional concrete by including tile aggregate and brick aggregate since it is readily available at very low cost and there-by reducing the construction pollution or effective usage of construction waste.

II. LITRATURE REVIEW

Ilya Joohari, Nor Farhani Ishak, and Norliyati Mohd Amin : This paper presents the result of replacing natural course aggregate with recycled cement-sand brick (CSB) towards the mechanical properties of concrete. Natural aggregates were used in this study as a control sample to compare with recycled coarse aggregates. This study was also carried to determine the optimum proportion of coarse aggregates replacement to produce lightweight concrete.

Salahaldein Alsadey: Sustainability and material use have been becoming increasingly important in industry and academia in recent years. The investigation reported in this paper is carried out to study the feasibility of using crushed brick to substitute the coarse aggregate in concrete, replacing stone aggregate (partly) by crashed brick. the target compressive strength of stone aggregate concrete was 34 MPa remaining concretes were made by replacing the stone aggregate (partly) by equal volume of brick aggregate while everything else was keptunchanged.

Rekha Kasi, Potharaju Malasani: This paper presents the comparative analysis of different properties of both the Recycled Brick Aggregate (RBA) and Granite Aggregate (GA). The results indicate that the crushed clay bricks are suitable to replace the granite aggregate in concrete production. Trial mixes of RBA concrete were prepared by replacing the GA with 25%, 50%, 75% and 100% crushed clay bricks by volume

Ahmed Tareq Noaman, Ghassan Subhi Jameel, Shamil K Ahmed: The utilization of minimum natural materials content in the production of concrete represents the main concern of many researchers. In addition, lightweight aggregate concrete is desired for its low weight and modified physical properties. This study aims to produce lightweight aggregate concrete with adequate strength utilizing crushed clay brick (CCB) aggregates from discarded or brokenbrick pieces. The CCB aggregates are utilized by replacement of natural aggregate at (10%, 20% and 30%).

III.IMPLEMENTATION

3.1 MATERIALS USED

In this investigation, the following materials were used:-

1. Ordinary Portland Cement of 53 Grade cement
2. Fine aggregate and coarse aggregate
3. Water.
4. Waste Bricks and tiles

Fig.3.1 TILE WASTE

Fig. 3.2 BRICKS WASTE

3.2 EXPERIMENTAL DETAILS:

This chapter deals with the various mix proportions adopted in carrying out the experiments and experimental results obtained with respect to their workability, compressive strength, split tensile strength, flexural strength.

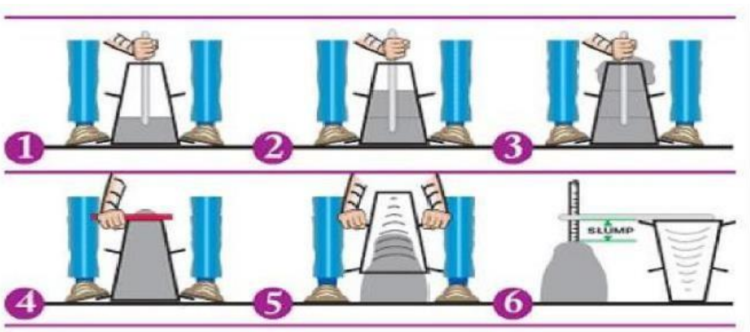


Fig. 3.3 Concrete Slump Test Procedure

When the slump test is carried out, following are the shape of the concrete slump that can be observed:

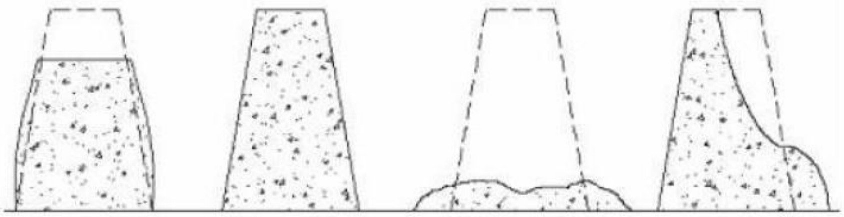


Fig.3.4 Types Of Concrete Slump Test Results

Fig. 3.5 Compression Testing On Cube Specimen

Fig. 3.6 Cracks In Cube After Compression Test

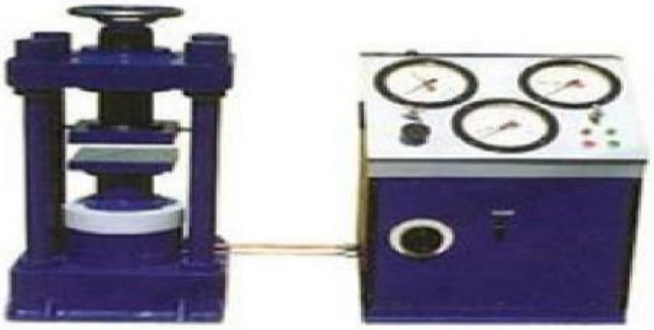


Fig. 3.7 Compression Testing Machine

Fig. 3.8 Split Tensile Testing And Specimen (Cylinders)

Fig. 3.9 Flexural Testing Machine And Specimen

IV. RESULTS AND DISCUSSIONS

4.1.1 WORKABILTY:

The ideal concrete is the one which is workable in all conditions i.e, can prepared easily placed, compacted and moulded. In this chapter, the workability is assessed by two methods as follows:

4.1.1.1 Slump Cone Test:. The test was conducted for fresh concrete prepared before the moulding process. A total of 5 concrete mixes are prepared at different times. Workability Results obtained from slump cone test for M25 grade of concrete is shown in table .

Table 4.1 : Test results from slump cone test for workability in mm

Sr.No.	Mix Code	Aggregate Replacement (C.A.+T.A.+B.A.)	Workability (in mm)
1.	M0	100+0+0	64
2.	M1	75+25+0	69
3.	M2	50+50+0	79
4.	M3	75+0+25	57
5.	M4	50+0+50	51

The workability from the slump cone test is in increasing manner as the mix proportion replacement by tiles increasing and decreasing as we replace by bricks. The workability range of concrete increasing as mentioned while being in medium range overall.

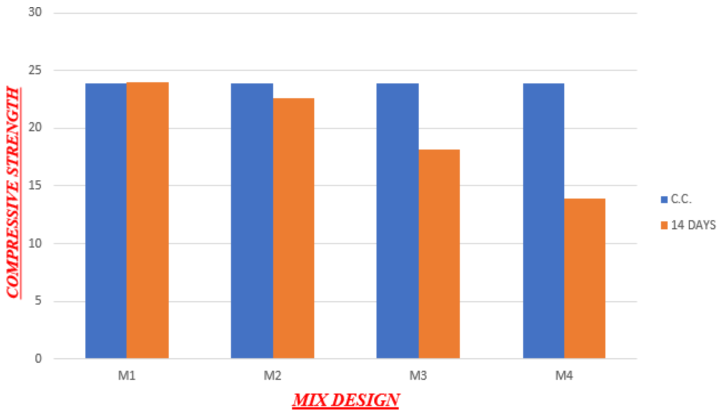
4.1.2 Compressive strength:

A total of 15 cubes of size 150 x 150 x 150mm were casted and tested for 14 days testing eachof 3 specimens after conducting the workability tests. The results are tabulated below:

Table 4.2 : Test results for Compressive strength test

Sr. No.	Mix Code	Aggregate Replacement(C.A.+T.A.+B.A.)	Compressive Strength of M25 grade in N/mm^2 (14 days)
1.	M0	100+0+0	23.93
2.	M1	75+25+0	23.95
3.	M2	50+50+0	22.56
4.	M3	75+0+25	18.19
5	M4	50+0+50	13.87

Fig. 4.1 Comparison of Compressive Strength at 14 days



4.1.3 Split Tensile strength:

The split tensile strength obtained by testing the cylindrical specimen for M25 grade of concreteto all the mixes designed for various replacements are given below:

Table 4.3: Split tensile strength results for M25 grade of concrete

Sr. No.	Mix Code	Aggregate Replacement(C.A.+T.A.+B.A.)	Split Tensile Strength of M25grade in N/mm^2 (14 days)
1.	M0	100+0+0	3.60
2.	M1	75+25+0	2.17
3.	M2	50+50+0	2.76
4.	M3	75+0+25	2.55
5.	M4	50+0+50	2.62

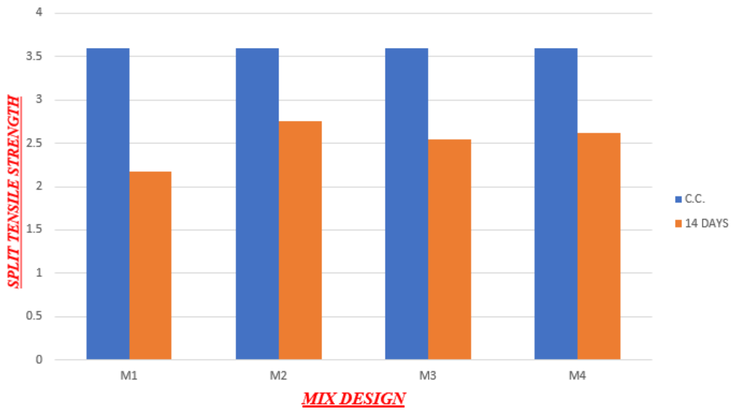


Fig. 4.2 Comparison of Split Tensile Strength at 14 days

4.1.4 Flexural Strength:

The flexural test was conducted for all mixes designed for various replacements. A Total of 5 beams were casted and tested as follows:

Table 4.4 Test results for Flexural Test at 14 days

Sr. No.	Mix Code	Aggregate Replacement (C.A.+T.A.+B.A.)	Flexural Strength of M25 grade in N/mm^2 (14 days)
1.	M0	100+0+0	7.88
2.	M1	75+25+0	6.20
3.	M2	50+50+0	5.13
4.	M3	75+0+25	10.12
5.	M4	50+0+50	5.23

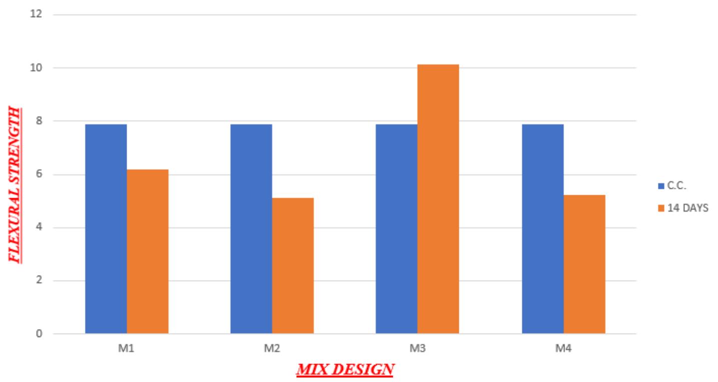


Fig. 4.3 Comparison of Flexural Strength at 14 day

4.2 DISCUSSION

4.2.1 Workability:

4.2.1.1 Slump Cone Test:

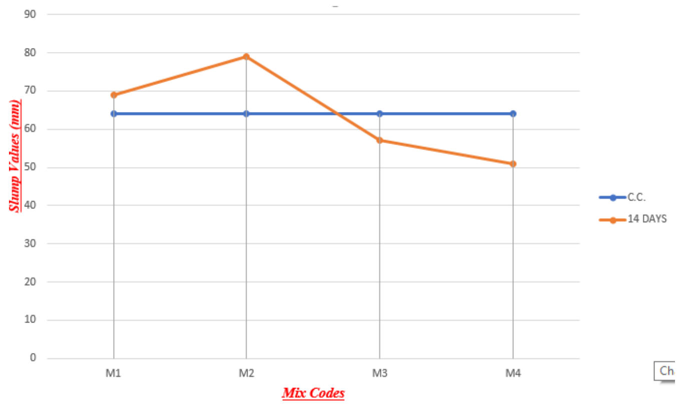


Fig. 4.4 Comparison of Workability of M25 grade concrete by Slump Cone Test

From the results it is observed that the workability is increased by an amount of 7.8% and 23%for M1 and M2 mixes respectively over conventional M25 concrete grade(M0). Also it is observed that workability is decreased by 11% and 20% for M3 and M4 mixes respectively over C.C. of M25 grade.

Hence we got more workable concrete than conventional in terms of slump value for M1 and M2 mixes i.e. tile aggregate concrete by replacing 25% and 50% of Natural Coarse aggregate.

4.2.2 Compressive strength:

The Compressive strength of concrete decreasing by 6%,24% and 42% for M2,M3 and M4 compared with the conventional concrete after 14days of curing. And M1 is has higher compression strength than C.C. Hence M1 concrete is more strong in compression than theconventional concrete.

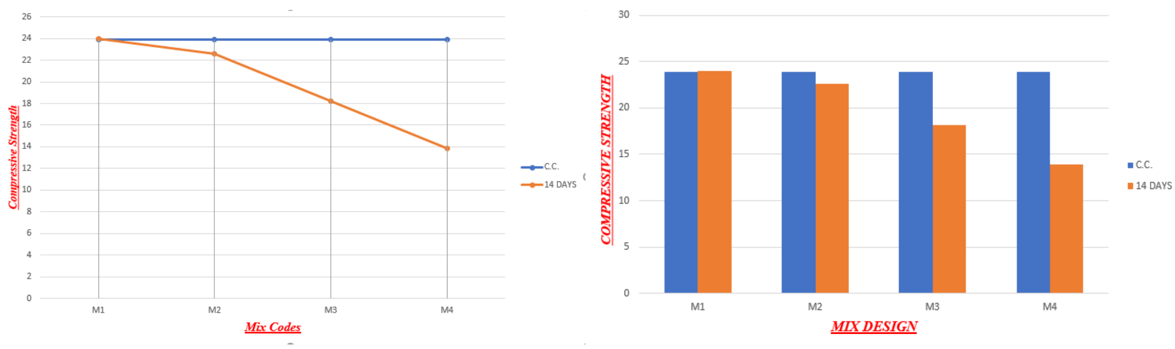


Fig. 4.5 Comparison of Compressive Strength at 14 days

4.2.3 SPLIT TENSILE STRENGTH:

The split tensile strength of concrete varies as 39%,23%,29% and 27% for M1, M2, M3 andM4 compared with the conventional concrete after 14days of curing.

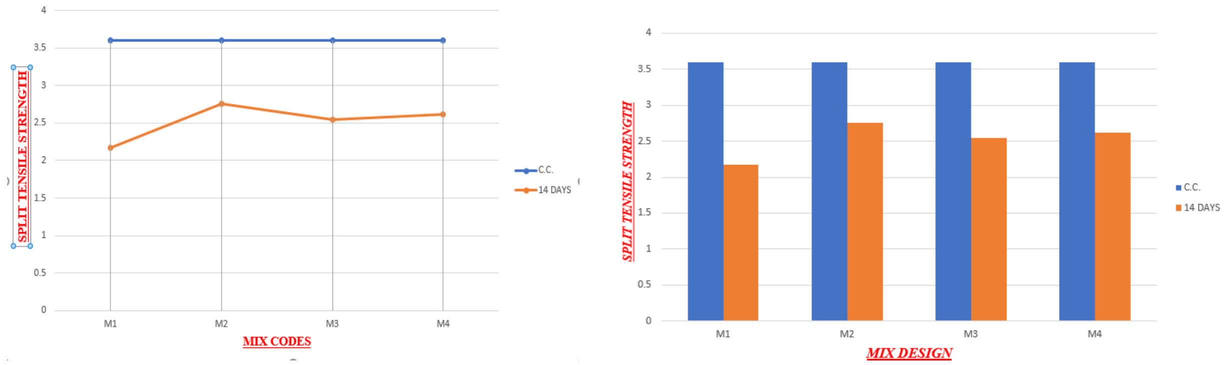


Fig. 4.6 Comparison of Split Tesile Strength at 14 days

4.2.4 Flexural Test:

The flexural test is conducted for all the mixes designed, and the results are plotted below:The M3 mix is more strong in tension than conventional concrete.

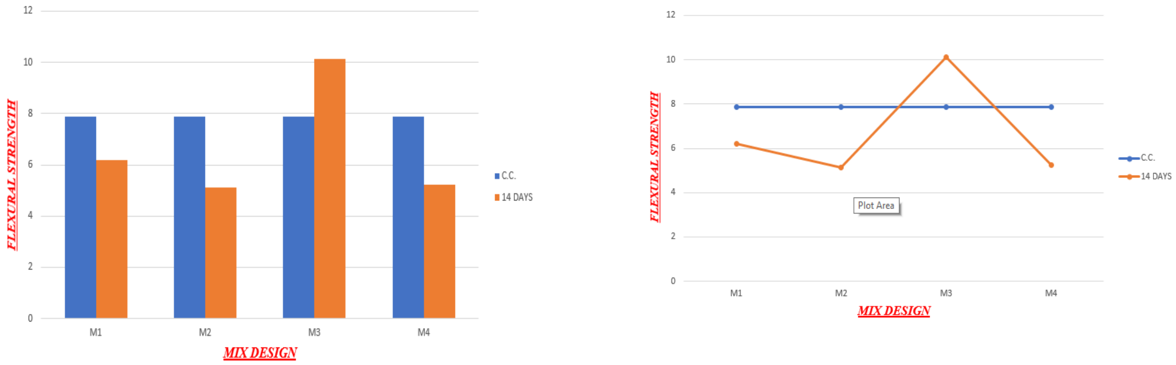


Fig. 4.7 Comparison of Flexural Strength at 14 days

V. CONCLUSIONS

The following conclusions are made based on the experimental investigations on compressive strength, split tensile strength and flexural strength considering the—environmental aspects also:

- ➢ The workability of concrete increases with the increase in tile aggregate replacement.
- ➢ The workability of concrete decreases with the increase in brick aggregate replacement.
- ➢ M3 mix of concrete produced a better concrete in terms of compressive strength thanthe other mixes. But the mixes up to 50% of tile coarse aggregate can be used.
- ➢ The properties of concrete increased linearly with the increase in ceramic tile aggregateup to 25-30% replacement later it is decreased linearly.
- ➢ The tile coarse aggregate concrete is also good in flexural and split tensile strength.
- ➢ The 25% of replacement of brick aggregate gives an optimum effect on the physical and mechanical properties of concrete.
- ➢ The compressive strength of the brick aggregate concrete is decreasing by 24% and 42% for 25% and 50% replacements respectively.
- ➢ The compressive strength of the tile aggregate concrete is decreasing by 6% and almostequal for 25% and 50% replacements respectively.
- ➢ The higher the percentage of replacement of brick aggregate, the lower the compressive and flexural strength of the concrete. But for replacement of tile aggregate it is is observed that compressive strength is bit higher for 25% replacement. So, we can replace tile aggregate upto 25-30% for same compressive strength as that of conventional concrete.

- ➢ So it can be concluded that even though the weight of the concrete is decreasing, but thetile aggregate concrete(25%) has achieved higher strength.
- ➢ The Split Tensile strength of the tile aggregate concrete is decreasing by 39% and 23%for 25% and 50% replacements respectively.
- ➢ The Split Tensile strength of the brick aggregate concrete is decreasing by 29% and 27% for 25% and 50% replacements respectively.
- ➢ The flexural strength of the tile aggregate concrete is decreasing by 21% and 35% for 25% and 50% replacements respectively.
- ➢ The flexural strength of the brick aggregate concrete is increasing by 28% and decreasing by 33% for 25% and 50% replacements respectively.
- ➢ Flexural Strength for 25% replacement with brick aggregate
- ➢ The fewest cracking produce on concrete for tile aggregate concrete with 25% of replacement of NCA. With the small cracking produce, it shows that the concrete is in high density and compressive strength.
- ➢ Since the compressive strength of 25% replaced brick aggregate concrete is 24% less, So we can decrease the percentage of brick about 5-10% and we may get good strength.

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