

Experimental Study on Concrete with Manufactured Sand and Partial Replacement of Cement by Brick Dust

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ABSTRACT: In this study, effects of Brick dust on strength were experimentally investigated. The Study focus on partial replacement of cement by Brick dust in M₃₀ grade concrete. They were incorporated into concrete at the levels of 10%, 20% and 30%. This paper presents a detailed experimental study on compressive strength, split tensile strength and flexural strength at an age of 7, 14 and 28 days. Test results shows that use of Brick dust in concrete has improved the performance of concrete in strength at a 20% replacement. Although the highest compressive strength of concrete was observed was 20% Brick dust replacement for ordinary Portland cement and were reduced as the increase in the replacement ratios.

KEYWORDS: Brick dust, M-sand, Compressive strength, Split tensile strength, Flexural strength

I. INTRODUCTION

Concrete is one of the most used material, which required large quantities of Portland cement. Ordinary Portland cement production is the second only to the automobile as the major generator of Carbon di-oxide, which pollute the atmosphere. In addition to that large amount of energy was also consumed for the cement production. Hence, it is inevitable to find an alternative material to the existing most expensive, most resource consuming Portland cement. Brick dust is the potential material to be used as FA & also help in protecting the environment surrounding. Due to rapid growth in construction activity, the available sources of natural sand are getting exhausted & also, good quality sand may have to be transported from long distance, which adds to the cost of construction. Therefore, it is necessary to replace natural sand in concrete by alternate material, without compromising the quality of concrete. The artificial sand produced by proper machines can be a better substitute to river sand. The strength, durability and other characteristic of concrete depends on the properties of its ingredients, proportion of mix, method of compaction and other controls during placing and curing.

II. MATERIAL PROPERTIES

2.1 Materials

In concrete, the selection of proper ingredients evaluating their properties and understanding the interaction between different materials plays a major role in performance of the concrete. The ingredients used are cement, Brick dust, natural sand, manufacture sand, coarse aggregate. The performance requirements of concrete enhancements of the following

1. Ease of placement and compaction by no segregation.
2. Long term mechanical properties.
3. Early strength.
4. Toughness.
5. Volume stability.
6. Long term durability properties.
7. Longer service life.

2.2 Brick dust

Brick dust is a waste product obtained from different brick kilns and tile factories. There are numerous brick kiln which have grown over the decades in an unplanned way in different part of the country. Tons of waste products like brick dust come from these kilns and factories. So far, such materials have been used just for filling low lying areas or dumped as waste material. is a waste product obtained from different brick kilns and tile factories. There are numerous brick kiln which have grown over the decades in an unplanned way in different part of the country. Tons of waste products like brick dust come from these kilns and factories. So far, such materials have been used just for filling low lying areas or dumped as waste material.

The properties of Brick dust as shown in Table 2.1

Table 2.1: Properties of Brick dust

S.No	Property	Description
1	Colour	Brick Red
2	Form	Powder
3	Bulk density	1837 Kg/m ²
4	Specific Gravity	2.26



Figure 2.1 Brick dust

2.3 M-sand

Manufactured sand / M- sand is an fine aggregate, which is an eco friendly and economical alternative to river sand. It is manufactured by crushing suitable stones and are finely graded to match the IS standard requirements. Otherwise, M-sand is crushed aggregates produced from hard granite stone which is cubically shaped with grounded edges, washed and graded with consistency to be used as a substitute of river sand.

The properties of Concrete M-sand are shown in below,

- Specific Density : 15.1 kN/m³
- Sieve size : 150 microns – 4.75mm
- Specific Gravity : 2.4



Fig. 2.2 M-sand

III. MIX DESIGN

3.1 GENERAL

The process of selection suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required strength and workability as economically as possible, is termed the concrete mix design. The proportioning of ingredient of concrete is governed by the required performance of concrete in two states, namely the plastic and the hardened states. If the plastic concrete is not workable, it cannot be properly placed and compacted. The property of workability therefore becomes of vital importance.

3.2 MIX PROPORTIONS

Cement	=	379 Kg/ m ³
Brick dust	=	163 Kg/m ³
Water	=	197 Kg/m ³
Fine aggregate	=	645 Kg/m ³
Coarse aggregate	=	941 Kg/m ³
Water –cement ratio	=	0.51

The table 3.1 shows the mix proportion of concrete.

Table 3.1 Mix proportion.

Mix proportions	Cement kg/m ³	Fine Aggregate kg/m ³	Coarse Aggregate kg/m ³	Water kg/m ³	Brick dust kg/m ³
Mix 1 (0%)	542	645	941	197	0
Mix 2(10%)	487.8	645	941	197	54.2
Mix 3 (20%)	433.6	645	941	197	108.4
Mix 4 (30%)	162.6	645	941	197	162.6

IV. EXPERIMENTAL PROGRAM

4.1 MECHANICAL PROPERTIES

4.1.1 Compression Test (Ref: IS: 516-1959)

Compression test is the most common test conducted on hardened concrete, partly because it is an easy test to perform, and partly because most of the desirable characteristics properties of concrete are qualitatively related to its compressive strength. Compressive strengths were attained as a result of the compressive tests conducted on the cube specimens of size 150mm x 150mm x 150mm . Cube was placed on the platform of the compression testing machine. The load was applied gradually till the concrete cubes get failed. The specimens are subjected to compressive loads in compression testing machine as per IS: 516-1969 and the crushing load is noted which gives the compressive strength of that cube. The compressive strength is the ratio of crushing load to the surface area of the specimens expressed in N/mm^2 . Similarly the compression strength values of all the cubes are found.



Fig 4.1 Test Set up for Compressive Strength Test

4.1.2 Flexure Test (Ref: IS: 516-1959)

The flexural strength represents the highest stress experienced within the material at its moment of rupture. It is measured in terms of stress, here given the symbol f_{cr} . The flexural strengths of the respective specimens have been obtained from the flexural tests performed on the prism specimens of size 100mm x 100mm x 500mm. The flexural strength are tested using a two point loading frame machine as per standard as shown in figure 5.2.



Fig 4.2 Test Set Up for Flexural Strength

The modulus of rupture can be determined by using the formula given below

$$f_{cr} = (P_{max} \times l) / bh^2$$

where,

- f_{cr} = Flexural strength
- P_{max} = Maximum load in (N) kg.
- b = Width of the prism in mm
- h = Depth of the prism in mm
- l = Span of the prism in mm

The loading must be applied centrally and without subjecting the specimen to any tensional stresses and restraints. The axis of the specimen shall be carefully aligned with the axis of the loading device. The load shall be applied without any shock and increasing continuously at specified rate.

4.1.3 Split tensile strength Test (Ref: IS: 5816-1999)

Split tensile strength of concrete is usually found by testing plain concrete cylinders. Cylinders of size 150mm x 300 mm were casting using M₃₀ grade concrete. Specimens with Conventional Concrete and SCC of two different percentages were casted. During casting the conventional concrete cubes were manually compacted using tamping rods. After 24hours, the specimens were removed from the mould and subjected to water curing for 7, 14, 28 days. After curing, the specimens were tested for compressive strength as per IS: 5816-1999 using a calibrated compression testing machine of 2000KN capacity.

Two packing strips of plywood 3mm thick were provided between the specimen one at top and another at bottom. The specimen was placed on the plywood strip and aligned so that, the central horizontal axis of the specimen is exactly perpendicular to the load applying axis. The second plywood strip was placed length wise on the cylinder and the top platen was brought down till it touched the plywood. The load was applied without shock and increased

continuously until the resistances of the specimen to the increasing load broke down and no greater load can be sustained.

$$\text{Tensile strength of concrete } f_t = \frac{2p}{\pi dl}$$

Where ,

P = Maximum load in N applied to the specimen

L = Measured length in cm of the specimen

D = Measured diameter in cm of the specimen

V.RESULTS AND DISCUSSION

5.1 GENERAL

This chapter deals with the results obtained from the various experiments conducted to access mechanical properties. The aim of the study is to determine the compressive strength, flexural strength and split tensile strength. So the results of test specimens are presented. The discussion on the results also presented in this chapter.

5.2 MECHANICAL PROPERTIES

The mechanical properties of concrete such as compressive strength, flexural strength and split tensile strength are determined from the standard experiments. They are as follows.

5.2.1 Compressive Strength

The compressive strength of replacement of Brick dust is arrived. The compressive strength value for replacement of Brick dust Table 5.1 Shows compression test results.

Table 5.1: Compressive Strength of Cubes with Partial Replacement of Brick dust

Curing days	COMPRESSIVE STRENGTH N/mm ²			
	Mix 1(0%)	Mix 2(10%)	Mix3(20%)	Mix 4(30%)
7 days	2.12	3.53	7.84	4.99
14 days	3.09	4.11	8.30	3.80
28 days	3.56	4.43	8.21	3.71

5.2.2 FLEXURAL STRENGTH

The flexural strength of replacement of Brick dust is arrived.. Table 5.2 shows flexural strength test results

Table 5.2: Flexural Strength of beams with Partial Replacement of Brick dust

Curing days	FLEXURAL STRENGTH N/mm ²			
	Mix 1(0%)	Mix 1(10%)	Mix 2(20%)	Mix 3(30%)
7 days	1.15	1.74	3.90	2.16
14 days	2.0	2.10	4.22	1.92
28 days	2.25	2.27	4.36	1.87

5.2.3 SPLIT TENSILE STRENGTH

The variation of split tensile strength at the age of 28 days with different percentage of Brick dust. From the test results, it was observed that the maximum split tensile strength was obtained for mix of 20% replacement of cement by Brick dust. Table 5.3 flexural strength test results

Table 5.3: split tensile strength of Cylinder with Partial Replacement of Brick dust

Curing days	SPLIT TENSILE STRENGTH N/mm ²			
	Mix 1(0%)	Mix 2(10%)	Mix 3(20%)	Mix 4(30%)
7 days	1.78	1.82	1.23	2.12
14 days	2.21	2.07	4.24	1.87
28 days	3.92	6.89	8.87	1.0

VI. CONCLUSION

The compressive strength of concrete increased when cement is replaced by Brick dust for M₃₀ grade of concrete at 20% replacement of cement by Brick dust the concrete attained maximum compressive strength for M₃₀ grade of concrete. The split tensile strength of concrete is also increased when cement is replaced by Brick dust. The split tensile strength is maximum at 20% of replacement. The flexural strength of the concrete is also increased when the cement is replaced by brick dust. At 20% replacement, the flexural strength is maximum.

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