Experimental Investigation on the Concrete as a Partial Replacement of Fine Aggregate with Stone Dust and Brick Dust

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Abstract— This project work involves in an experimental study on the concrete by using stone dust and brick dust on the mechanical properties of the concrete. In this experimental study two types admixtures are used in preparation of concrete mix. Stone dust and brick dust are added from 0% to 25% by weight of fine aggregate with increment of 5%. A comparative analysis has been carried out for conventional concrete to that of the admixture concrete in relation to their compressive, split tensile and flexural strength properties. As the stone dust and brick dust content increases in cement concrete, the compressive and split tensile values are proportionally increasing. It is observed that at 20% of stone dust and brick dust is the optimum dosages for concrete mixture.

Key words: Stone Dust, Brick Dust, Workability, Compressive Strength, Split Tensile Strength, Flexural Strength

I. INTRODUCTION

Concrete is a mixture of binding material, coarse and fine aggregates and water. It is a versatile construction material due to its reasonable cost and easy availability of its constituents. Owing to increasing urbanization and other development activities in different sectors its consumption is increasing day-by-day. Increase in construction activities requires production of more and more quantity of concrete, which needs more and more natural river sand and coarse aggregate. During the process of production of coarse aggregate in crushing plants, a huge quantity of stone dust is produced which is considered worth less for any substantial use. This stone dust being a waste material can effectively be used in concrete making, as partial replacement of fine aggregate. The use of stone dust in concrete as partial replacement of fine aggregate will be an alternative material instead of conventional fine aggregate. This will result in conservation of natural resources (fine aggregate) up to some extent, besides helping in environment protection and disposal of stone dust in abundance. The presence of stone dust in sand increases the water demand and so the filler effect (Bonavetti Celik and Marar)(1996) have reported that on increasing the dust content up to 10%, improved the compressive strength, split tensile & flexural strength of concrete and drying shrinkage improved. However, the dust content exceeding 10% decreased the compressive strength, flexural strength and drying shrinkage gradually.

The main objective of this thesis is to determine the concrete strength of M20 grade by partial replacement of fine aggregate from 0% to 25% with Stone dust and Brick dust. The other objective is to reduce the cost of construction but also helps to reduce the impact on environment by consuming the material generally considered as waste product.

The mix design of M20 grade concrete was designed as per the method specified in IS 10262-2009.

Cubes of size 150mm × 150mm × 150mm, Cylinders of size 300mm×150mm and prisms of size 100mm × 100mm × 500mm were casted and tested for compressive strength, split tensile strength and flexural strength after the completion of respective curing periods.

II. EXPERIMENTAL PROGRAM

A. Materials Used:

1) Cement:

Ordinary Portland cement of grade 53 is used for this experimental work.

2) Fine Aggregate:

The material which passes through BIS test sieve number 4 (4.75mm) is termed as fine aggregate usually natural sand is used as a fine aggregate at places where natural sand is not available crushed stone is used as fine aggregates. In our region fine aggregate can be found from bed of Krishna River. It conforms to IS 383 1970 comes under zone II.

3) Coarse Aggregate:

The material which is retained on BIS test sieve number 4 (4.75mm) is termed as coarse aggregate. The broken stone is generally used as a stone aggregate. Coarse aggregate used is locally available crushed angular aggregate of size 20mm and 10mm are used for this experimental work.

4) Brick Dust:

Brick dust is a waste generated from Brick production. The brick dust is being dumped on the roadside or in land filling causing environmental concerns.

Fig. 1: Brick Dust

5) Stone Dust:

Fig 2: Stone dust

Stone dust is a waste material obtained from crusher plants during the process of making of coarse aggregate of different sizes, about 175 million tons stone dust is produced every year, which is kept in abundance. Stone dust was collected from local stone crushing units of Mirzapur, Vindhyachal Road, Uttar Pradesh. It was initially dry in condition when collected, and was sieved before mixing in concrete.

Physical Properties	Stone dust	Fine aggregate
Bulk density (kg/cm3)	18.18	15.3
Water Absorption%	6.2	9.4
Specific Gravity	2.8	2.73
Fineness Modulus	2.49	2.10
Bulking of sand (%)	4.91	5.55

Table 1: Physical Properties of Stone dust and Fine aggregate

B. Mix Design:

The mix proportion chosen for this study is M20 grade with water-cement ratios of 0.55. In this test total 54 Cubes of standard size 150x150x150mm and 54 Cylinders of standard diameter 150mm and height 300mm and 54 Prisms of size 500x100x100mm were casted for each design mix and cured for 7,14 and 28 days and tested as per code IS: 516-1959. The mix proportion chosen for this study is given in Table 2.

Water	Cement	Fine Aggregate	Coarse Aggregate (60% + 40%)
286	520	737.23	1248 (748.8 + 499.2)
0.55	1	1.41	2.4

Table 2: Mix proportion (Kg/m^3) and mix ratio

III. TESTS AND RESULTS

The different tests were conducted in the laboratories as shown in below. It consists of mixing of concrete in the laboratory by partial replacing Fine aggregate with proportions (by weight) of Stone dust and Brick dust (SDBD) added to concrete mixtures were as follows: 0% (for the control mix), 5%, 10%, 15%, 20% &25% Concrete samples were prepared and cured in the laboratory, and are tested, to evaluate the concrete fresh and harden properties like Compressive strength, Split tensile strength and Flexural strength requirements.

A. Workability of Concrete

1) Slump Cone Test:

Slump cone test was conducted to determine the workability of concrete.

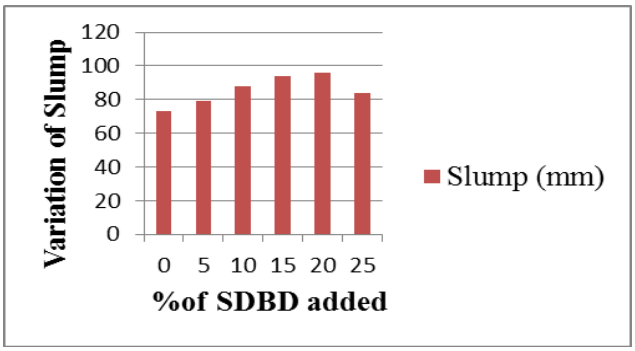

Fig. 3: Variation of slump

a) Description of result:

– From Fig 3, It is observed that the slump values will be increased as the percentage of SDBD increases from 5% to 20%, and the slump value decreases as the percentage of SDBD increases from 25%.

2) Compressive Strength Test

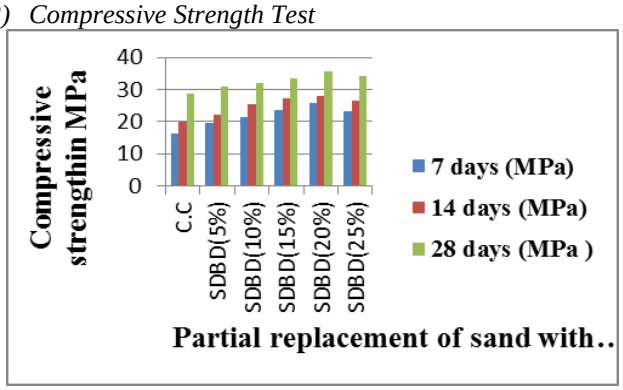

Fig 4: Variation of Compressive strength of M20 Grade Concrete

a) Description of Result:

– From the fig 4, It is observed that compressive strength of the concrete increases to 20.39%, 31.23%, 45.16% , 59.51% and 42.14% when % of SDBD increases from 5%, 10% , 15% ,20% and 25% for SDBD when it is compared with conventional concrete at 7 days.

– It is observed that compressive strength of the concrete increases to 11.85%, 27.64%, 37.73%, 41.77% and 34.71% when % of SDBD increases from 5%, 10%, 15% ,20% and 25% for SDBD when it is compared with conventional concrete at 14 days.

– It is observed that compressive strength of the concrete increases to 8.13%, 12.25%, 16.93%, 24.19% and 19.13% when % of SDBD increases from 5%, 10% , 15% ,20% and 25% for SDBD when it is compared with conventional concrete at 28 days

– It is observed that compressive strength values decreased as the percentage of SDBD increases beyond 20%

3) Split Tensile Strength Test

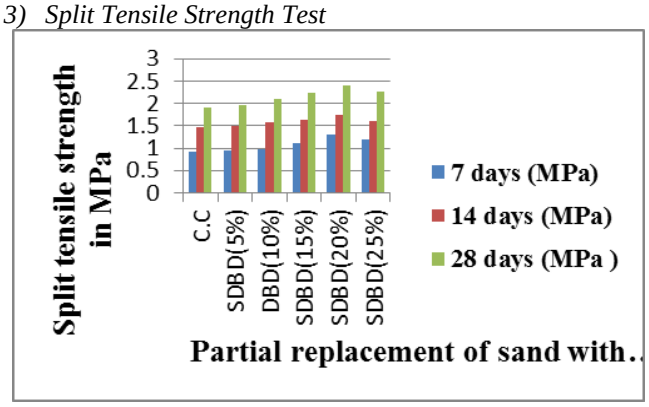

Fig. 5: Variation of Split tensile strength of M20 Grade Concrete

a) Description of result:

– From the fig 5, It is observed that Split tensile strength values of the concrete increases to 3.26%, 6.52%, 19.56%, 41.30% and 30.43% when % of SDBD increases from 5%,10%, 15%,20% and 25% for SDBD when it is compared with conventional concrete at 7 days.

– It is observed that Split tensile strength values of the concrete increases to 1.35%, 6.75%, 10.81%, 18.24% and 8.16% when % of SDBD increases from 5%, 10%,

15%, 20% and 25% for SDBD when it is compared with conventional concrete at 14 days.

- It is observed that Split tensile strength values of the concrete increases to 3.15%, 10.52% , 17.36%, 26.31% and 18.42% when % of SDBD increases from 5%, 10%, 15%, 20% and 25% for SDBD when it is compared with conventional concrete at 28 days
- It is observed that Split tensile strength values decreased as the percentage of SDBD increases beyond 20%.

4) Flexural Strength Test

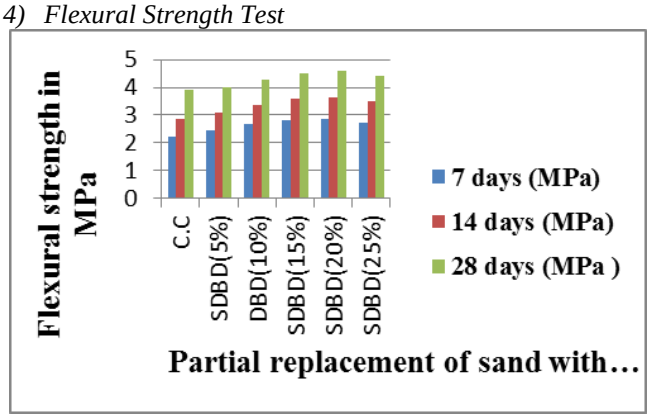

Fig 6: Variation of Flexural strength of M20 Grade Concrete

a) Description of Result:

- From the fig 6, It is observed that Flexural strength values of the concrete increases to 11.36%, 21.81%, 27.27%, 30.90% and 23.63% when % of SDBD increases from 5%,10%, 15%,20% and 25% for SDBD when it is compared with conventional concrete at 7 days.
- It is observed that Flexural strength values of the concrete increases to 8.39%, 16.78%, 25.17%, 27.27% and 22.72% when % of SDBD increases from 5%, 10%, 15%, 20% and 25% for SDBD when it is compared with conventional concrete at 14 days.
- It is observed that Flexural strength values of the concrete increases to 2.56%, 9.74%,15.38%, 17.69% and 12.82% when % of SDBD increases from 5%, 10%, 15%, 20% and 25% for SDBD when it is compared with conventional concrete at 28 days
- It is observed that Flexural strength values decreased as the percentage of SDBD increases beyond 20%.

IV. Conclusions

1) The workability of concrete measured from slump cone test values will be increased as the percentage of SDBD increases from 5% to 20%, and the slump value decreases as the percentage of SDBD increases from 25%.
2) The Compressive strength of concrete for partial replacement of fine aggregate with SDBD increased by 24.19% with 20% partial replacement and decreased by 19.13% with 25% partial replacement while compared with control Specimen.
3) The Split tensile strength of concrete for partial replacement of fine aggregate with SDBD increased by 26.31% with 20% partial replacement and decreased by 18.42% with 25% partial replacement while compared with control Specimen.
4) The Flexural strength of concrete for partial replacement of fine aggregate with SDBD increased by 17.69% with 20% partial replacement and decreased by 12.82% with 25% partial replacement while compared with control Specimen.

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