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INVESTIGATION IN DEVELOPING LOW-COST CONCRETE BY USING BRICK POWDER AND QUARRY STONE DUST

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ABSTRACT

The increased emphasis on the life-cycle cost analysis for building project requires that new attention to be focused on service life and durability of concrete structures. Durability is the ability to resist weathering action, chemical attack or any other process of deterioration. Concrete's great versatility and relative economy in filling wide range needs has made it a competitive building material. This high demand for concrete in construction lead to the increase in the release of carbon dioxide in cement production and also to the scarcity of natural river sand. So there is an urge to replace the conventional concrete materials. Materials like Brick powder (BP) and Quarry dust (QD) are chosen based on the criteria of cost and durability properties. This project is concerned with the evaluation of changes in compressive strength and flexural strength in different mixes of M40 Grade concrete which include conventional aggregate concrete, concrete with 10% replacement of cement by brick powder(BP) and fine aggregates with varying percentages of 0%,5%, 10%, 15%, 20% & 25% by Quarry Dust (QD). We can conclude that concretes made by Brick Powder and Quarry Sand Dust have given good strength and durable properties when compared to conventional concrete in severe environment.

Keywords: Brick powder (BP), Quarry dust (QD), M30 Grade concrete

1. INTRODUCTION

1.1 Construction and Demolition Waste in India:

With quick urbanization the quantum of construction & demolition waste (C&D Waste) is continuously increasing. While it is estimated that the construction industry in India generates about 10-12 million tons of Construction and Demolition (C&D) waste annually, efforts to manage and use this waste is very petite. This has led to Private contractors utilizing unempirical dumping methods there-by putting harsh pressure on scarce urban land as well as dropping life spans of landfills.

Fig. 1: Constructional waste.

1.2 MATERIALS

1.2.1 Cement

Cement is a binder, a substance that sets and hardens on drying and also reacts with carbon dioxide in the air dependently and can bind other materials together. Cements used in construction can be characterized as being either hydraulic or non-hydraulic, depending upon the ability of the cement to be used in the presence of water.

- Non-hydraulic cement will not set in wet conditions or underwater, and is attacked by some aggressive chemicals after setting.
- Hydraulic cement is made by replacing some of the cement in a concrete mix with activated aluminum silicates, pozzolanas, such as fly ash, to activate cement setting in wet condition or underwater and further protects hardened concrete from chemical attack, because of hydration.

1.2.2 Water

The water used in concrete plays an important part in the mixing, laying, compaction, setting and hardening of concrete. The strength of concrete directly depends on the quantity and quality of water used in the mix.

1.2.3 Aggregates

Aggregates are granular materials such as sand, gravel, or crushed stone that, along with water and cement, are an essential ingredient in concrete. Aggregate was originally viewed as an inert material dispersed through the cement paste largely for economic reasons. In fact, aggregate is truly not inert and its physical, thermal and sometimes also chemical properties influence the performance of concrete. Aggregate is cheaper than cement and it is, therefore, economical to put into the mix as much as the former and as little of the latter as possible. But economy is not the only reason for using aggregate: it confers considerable technical advantages on concrete, which has a higher volume stability and better durability than hydrated cement paste alone. For a good concrete mix, aggregates need to be clean, hard, strong particles free of absorbed chemicals or coatings of clay and other fine materials that could cause the deterioration of concrete.

1.2.4 Brick powder

The sustainable construction concept was introduced due to the growing concern about the future of our planet because construction industry is a huge consumer of natural resources and, simultaneously, waste producer. Concrete industry, in particular, is one of the biggest natural resource consumers as a consequence of being one the most used construction materials. Concrete is a material that is often seen as a potential place for wastes, because of its composite nature (a binder, water and aggregates) and because its widely used, which means that if a waste could be used in con-Crete, then certainly large quantities of it can be recycled. Since aggregates in concrete comprise about 60% to 75% of the total volume of concrete any reduction in natural aggregates consumption will have significant impacts in the environment. Environmental constrains of stone pits, such as noise, dust, vibrations, consider-able impact on the countryside, besides the consumption of anon-renewable material tend to considerably limit their exploitation.

Fig. 2: Brick dust.

1.2.5 Quarry Stone dust

It is obtained from the screenings left from the crushed stone. It is a byproduct in Quarry stone crusher plants. Nowadays, this is being used as fine aggregate because of the difficulty in getting natural sand. Special crushers are introduced in India for making fine aggregate from rocks. In the present work QSD from existing crushers which is a byproduct was used. Stone dust is a multipurpose material for yard construction. A compacted layer of stone dust is well suited to a yard or passageway surface. It is also a great choice for the sub-base in laying paving blocks and slabs, and for jointing natural stone, such as slate. As a stone dust surface is extremely compact and waterproof, banking must be taken into consideration during installation. Properties of Stone dust is a by-product of crushing, with a typical grain size of 0 – 3 to 4mm or 0 – 6 to 8mm. Because stone dust contains very fine mineral aggregates (grain size 0mm), it forms a hard, load-bearing surface.

Fig. 3: Quarry dust.

2. LITERATURE REVIEW

Kathiresan M, Gunasekar M. Brick is one of the most common masonry units as a building material due to its properties. In these paper, totally 100 numbers of bricks are to be casted with partial replacement of marble sludge powder. The percentage of replacement is carried out in this work as 0%, 5%, 10%, 15% and 20% by total volume. The strength and durability test of bricks is to be calculated. Concrete containing quarry dust as fine aggregate can be effectively utilized in the construction industry with good quality materials, appropriate dosage of super plasticizer, appropriate mixing methods, and proper curing thereby ensuring sustainable development against environmental pollution **(Devi and Kannan).** The investigation proposes that the stone dust can be replaced up to 50% without any effect on mechanical and physical properties and the economical saving will be 56% also as discussed by **Nanda et al.** The study of **Ilangovana et al.** gives attention to physical and chemical properties of quarry dust with respect to requirements of codal provision which are satisfied. The 100% replacement of sand with quarry dust gives better results in terms of compressive strength studies.

3. OBJECTIVE OF THE STUDY

The present study deals with the replacement of cement by 10% brick powder and replacement of fine aggregates with varying percentages (0%,5%, 10%, 15%, 20%, 25%) by Quarry sand Dust for M 40 grade of concrete.

1. To study the effect of replacement of different percentages (0%,5%, 10%, 15%, 20%, 25%) in fine aggregates by quarry dust and 10% cement by brick powder in the concrete.
2. To determine the workability of freshly prepared concrete by Slump test & Compaction factor test.
3. To determine the compressive strength of cubes at 7, 14, 28 days curing

4. EXPERIMENTAL WORK

Experimental work carried out including properties of various materials used and their mix proportions. The details of method of casting of specimens and their testing procedures are explained.

Materials used:

- Ordinary Portland cement (53Grade),
- Brick powder
- Quarry dust,
- Fine & Coarse Aggregates,
- Super plasticizer (Conplast SP-430)
- Water.

4.1 Variable parameters:

a) Quarry Dust : Natural sand is replaced by Quarry Dust in 0%,5%, 10%, 15%, 20% & 25% proportions.

b) Brick powder : Cement is replaced by Brick powder in four proportion.

4.2 Mix Design

Table. 1: Quantities of materials in cement concrete (M40).

Material	**Quantity** (kg/m^3)
Cement (grade 53)	411.11
Water	148
Fine aggregate	668.1675
Coarse aggregate	1315.101
Water: cement	0.45

The final mix proportions are:

Cement : fine aggregate : coarse aggregate : water = **1: 1.62 : 3.19 : 0.36**

4.2.1 Mix Proportions

M40 grade of concrete is considered. Natural sand is replaced with Quarry-dust with various percentages 0%, 5%, 10%, 15%, 20% & 25%. Cement is replaced with brick powder by 10%. The mix design for concrete is carried out as per IS 10262. Details of mix proportion for M40 concrete given below:

4.2.2 Mixed design proportions for Brick & Quarry dust Concrete

- In this research work 15 Standard cubic specimens of size 150mm (nine sample for each percentage) were casted for the compressive strength of concrete and it was kept under curing for 7, 14 days & 28 days of age. Total cubes for compressive strength testing was 63 (9 cubes * 7 proportions).
- Mass of ingredients required will be calculated for 9 no's cubes assuming 10% wastage
- Volume of the Cube = $9*1.10*(0.15)^3$ =0.0334125 m^3

Table. 2: Material Proportions Cubes (M40).

BP-QD	0%-0%	10%-0%	10%-5%	10%-10%	10%-15%	10%-20%	10%-25%
Cement (Kgs)	16.2545	14.6291	14.6291	14.6291	14.6291	14.6291	14.6291
Brick powder(kg)	0	1.6254	1.6254	1.6254	1.6254	1.6254	1.6254
water (lit)	4.94505	4.94505	4.94505	4.94505	4.94505	4.94505	4.94505
Fine aggregate (Kgs)	22.3251	22.3251	21.2089	2.09259	18.9764	17.86	16.7438
uarry dust (kg)	0	0	1.1162	2.23251	3.3487	4.46502	5.58127
Coarse aggregate (Kgs)	43.9408	43.9408	43.9408	43.9408	43.9408	43.9408	43.9408

4.2.3 Sample Production

The cement, fine and coarse aggregates were weighted according to mix proportion of M_{40}. All are mixed together in a bay until mixed properly and water was added at a ratio of 0.45. The water was added gradually and mixed until homogeneity is achieved. Any lumping or balling found at any stage was taken out, loosened and again added to the mix.

For the second series of the mixture, the Quarry dust was added at 5%, 10%, 15%, 20% and 25% by weight of fine aggregates and the Brick dust was added 10% by the weight of cement. Immediately after mixing, slump test and compaction factor were carried out for all the concrete series mixture. A standard 150×150×150mm cube specimens were casted.

The samples were then stripped after 24hours of casting and are then be ponded in a water curing. As casted, a total of (63) 150×150×150mm cube specimens were produced.

Fig. 4: Concrete mould after demoulding.

4.2.4 Curing

The method of curing adopted was the ponding method of curing and produced samples were cured for cubes at 7days, 14days, 28 days and beams at 28days.

Fig. 5: Water curing.

4.3 Test For Fresh Properties of Concrete (Workability Test)

4.3.1 Slump Test

which can be employed either in laboratory or at site of work. It is not a suitable method for very wet or very dry concrete. It does not measure all factors contributing to workability, nor is it always representative of the placability of the concrete. It is not a suitable method for very wet or very dry concrete. It does not measure all factor contributing to workability. The slump test was carried in accordance with B.S:1882 PART2:1970.

Fig. 6: Slump cone test.

4.4 Testing

4.4.1 Compressive Strength of Concrete

The compression test was conducted according to IS 516-1959. This test helps us in determining the compressive strength of the concrete cubes. The obtained value of compressive strength can then be used to assess whether the given batch of that concrete cube will meet the required compressive strength requirements or not. For the compression test, the specimen's cubes of 15 cm x 15 cm x 15 cm were prepared by using hwa concrete as explained earlier. These specimens were tested under universal testing machine after 7 days, 14 days and 28 days of curing. Load was applied gradually at the rate of 140kg/cm^2 per minute till the specimens failed. Load at the failure was divided by area of specimen and this gave us the compressive strength of concrete for the given sample.

Fig. 7: Compressive Strength test of cube sample.

5. RESULTS AND DISCUSSIONS

As per experimental programme results for different experiments were obtained. They are shown in table format or graph, which is to be presented in this chapter.

5.1 Workability Test

5.1.1 Slump Test

The Slump test was performed on the BD - QD concrete to check the workability of it at different replacements viz. 5 %, 10 %, 15%, 20% and 25% the following results were obtained below table.

Table. 3: Results of slump test.

Brick dust (%)	% of Quarry dust	Slump value (cm)
0	0	22
10	0	21
10	5	20
10	10	19
10	15	19

10	20	15
10	25	14

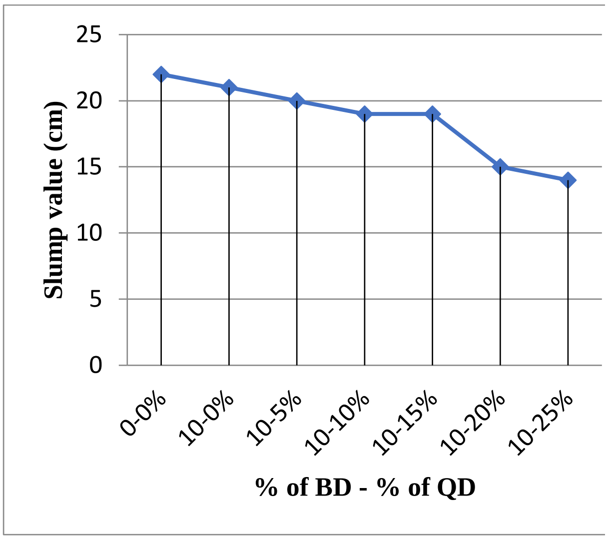

Fig. 8: Slump test results.

The above fig. 8 shows the slump results. It was observed that, the slumps decreased as the BD – QD content were increased in the mix. It was suitable for Low Workability mixes.

5.2 Compressive Strength Test

The Compressive strength generally a gradual increase up to a particular proportion of Quarry dust at constant brick powder proportion. But a gradual increase in the QD% leads to the gradual decrease in the Compressive strength and optimum values are obtained at 10% BP +10% QD for water curing.

Table. 4: Results of average compressive strength (N/mm^2).

BD (%)	QD (%)	7days	14days	28days
0	0	26.5	28.7	48.1
10	0	27.3	38.2	49.06
10	5	28.2	40.52	50.12
10	10	30.82	43.65	53.21
10	15	25.41	37.31	51.32
10	20	23.15	33.19	48.23
10	25	20.64	29	46.29

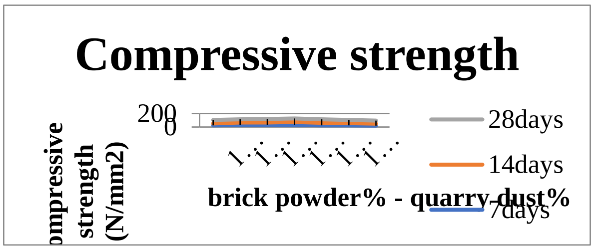

Fig. 9: Compressive strength v/s % of BD&QD.

From the above results it was observed that with the increase in percentage of BD (10%) & QD from 0% to 10% in concrete the compressive strength increases after that decreases.

6. CONCLUSIONS

The concrete can be successfully replaced with 10 % brick powder and partial replacement Quarry dust and of its weight.

- As the % replacement increases the strength decreases after the BD(10%)-QD(10%) mix proportion (hence the present study is limited to BD(10%)-QD(10%) of replacement).
- The weight loss & residual strength of the brick powder & quarry dust concrete is observed more than that of normal aggregate concrete.
- There is a significant decrease in the % compressive strength for 7, 14 and 28 days curing at after BD(10%)-QD(10%) mix proportion.
- For all types of mixes considered always an increase in strength up to a certain level is seen for both 7,14- & 28-days curing.

- Also they reduce the cost of construction when compared to conventional aggregate.

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