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Experimental Study on Strength Properties of Partial Replacement of Fine Aggregate with Stone Dust, Brick Dust, Saw Dust and Steel Slag in Concrete

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ABSTRACT: The river sand which is most commonly used as fine aggregate in the preparation of concrete, poses the problem of acute shortage in many areas. Concrete industry relies heavily on conventional materials such as cement, gravel and sand for the production of concrete. So, Attempt is being made in this project to use the locally available waste materials to replace the river sand to produce good quality concrete. In this present thesis fine aggregate is replaced by brick dust, Stone Dust,Saw Dust and Steel slag. By replacing the fine aggregate with brick dust,saw dust, Stone Dust and steel slag the compressive strength increased and economy.This study aims to reduce the usage of sand as fine aggregate as it is costly and shortage in nature. The principle objective of the present investigation is to increase the economy of concrete. To increase the compressive strength, economy and of concrete by using stone dust,saw dust,brick dust and steel slag. To reduce the waste that occurs from the above industries to maintain ecological balance.

In this investigation the cubes are casted to find out the compressive, spilt tensile and flexural strengths for various proportions of brick dust,Stone Dust,Saw Dust and Steel slag.At 60% Stone dust replacement of fine aggregate shows better performance. At 30% Brick dust replacement of sand shows better performance. At 60% Saw dust replacement of sand shows better performance. At 60 % Steel slag replacement of sand shows better performance.Water absorption test is carried out in this present thesis.

KEYWORDS: Stone dust, brick dust, saw dust,steel slag, Compressive Strength, Split tensile Strength, Durability, Flexural strength and regression analysis.

I.INTRODUCTION

Rapid urbanization in developing countries such as India is creating a shortage of adequate housing in cities. Using artificial aggregates for quality concrete is a natural step to mitigating this problem. The world-vast consumption of fine aggregate in concrete production is very high. Several developing countries have encountered difficulties in meeting the supply of fine natural aggregate to satisfy the increasing infrastructural development needs in recent years.

To overcome the stress and demand for river fine aggregate, researchers and practitioners in the construction industries have identified some alternative materials such as fly ash, slag, limestone powder, and siliceous stone powder. In India, attempts have been made to replace river sand with crusher dust.

The successful utilization of crusher dust as fine aggregate and blast furnace slag as coarse aggregate would turn this waste material that causes the disposal problem into a valuable resource. The utilization will also reduce the strain on the supply of fine natural aggregate, which will also reduce the cost of concrete.

Quarry dust is a by-product of the crushing process which is a concentrated material to use as aggregates for concreting purpose, especially as fine aggregates. In quarrying activities, the rock has been crushed into various sizes; during the process the dust generated is called quarry dust and it is formed as waste. So it becomes as a useless material and also results in air pollution. Therefore, quarry dust should be used in construction works, which will reduce the cost of construction and the construction material would be saved and the natural resources can be used properly. Most of the developing countries are under pressure to replace fine aggregate in concrete by an alternate material also to some extent or totally without compromising the quality of concrete. Quarry dust has been used for different activities in the construction industry, such as building materials, road development materials, aggregates, bricks, and tiles.

The study on replacement of sand with sawdust in concrete perhaps can give positive outcomes. The significance of sawdust concrete production is to reduce the sawdust waste that could save the environment for a long term run. This is because almost all sawmill dumped the sawdust at landfill which causing the landfill to pile up and increased its volume day by day.

Fine aggregate and coarse aggregate are used enormously in the construction of different projects like airports, highways, skyscrapers, nuclear plants, dams, etc. Also, the demand for these materials is high in privatization and globalization. To meet this high demand for coarse and fine aggregate the increased extraction from the natural resources is required. Fine aggregate is one of the important constituents in concrete and mortar. Natural resources are also getting exhausted in meeting this high demand for fine aggregate in the construction industry. The construction industry will be directly affected due to the shortage or non-availability of the natural sand, as natural resources are depleting, finding an alternative material for the partial or complete replacement of natural sand is needed, such that we can prevent the damage to the environment. Else this will lead to an ecological imbalance due to the increasing use of natural fine aggregate. Thus, the need of an hour is to find the partial replacement of fine aggregate for construction industries. Many Researcher's and Engineers are working with their ideas to find an alternative way to partial or complete replacement of fine aggregate so that the natural resource consumption can be decreased. These days sustainable infrastructural development needs an alternative material that can satisfy technical properties of fine aggregate and should be available easily economically, domestically with a great amount.

Steel slag is an industrial by-product obtained from the steel manufacturing industry. This steel slag damages and affects the environment and it is difficult to decompose. If this product is used in the concrete, it influences both the mechanical and physical properties of concrete along with its durability. Walnut shell is lingo cellulosic material forming the thin endocarp or husk of the walnut shell fruit. It is very hard and takes years and years to decompose or breakdown. To solve the problem in effective manner steel slag and walnut shell is used in concrete by replacing natural aggregates.

The main objective of the present investigation is to evaluate the possibilities of using stone dust, brick dust, sawdust, and steel slag as a replacement to fine aggregate. The current research aimed to study 30%, 60%, and 100% of traditional fine aggregate was replaced with quarry dust. Dust and coarse aggregate was replaced with Blast furnace slag. Compressive strength, split tensile strength, and flexural strengths were found after 7 days and 28 days of curing.

II.RELATED WORK

To evaluate the strength characteristics in terms of compressive, split tensile and flexural strengths are tried with different percentages of stone dust, brick dust, sawdust, and steel slag (30%, 60% & 100%).

The parameters studied were**:**

- In the M20 design mix, the percentage of stone dust, brick dust, sawdust replaced by the fine aggregate in proportions of 30%, 60%, & 100%.
- 6 Cubes of size 150 x 150 x 150 mm tested for each percentage of replacement.
- Water absorption test also conducted for the replacement of 30, 60, and 100 % of replacement of fine aggregate with stone dust, brick dust, sawdust, and steel slag.

III.METHODOLOGY

The experimental methods adopted were in accordance with the standard procedures in BIS. They are briefly presented in the following sub-sections.

5.1 TESTS CONDUCTED ON CEMENT

Specific Gravity Test: According to IS 2720 – part – 3

Specific gravity is the ratio of the density of a substance compared to the density (mass of the same unit volume) of a reference substance. Apparent specific gravity is the ratio of the weight of a volume of the substance to the weight of an equal volume of the reference substance. The reference substance is nearly always water for liquids or air for gases.

Fineness Test: According to IS 4031-1968

Fineness is defined as the surface area of cement particles per unit weight, which means more number of particles per unit weight. If the percentage of fineness is more than 90 %, the Cement is supposed to be fresh. If it is less than 90 %, then that Cement should be avoided to use.

Standard consistency Test: According to IS 4031 (Part 4) 1988

The standard consistency of a cement paste is defined as that consistency, which will permit the Vicat plunger to penetrate to a depth of 5 to 7mm from the bottom of the Vicat mould.

Initial Setting and Final Testing Time Test: According to IS 4031 (Part 5) 1988

The time period elapsed between the time of adding water to the Cement to the time when the needle fails to pierce the mould for 5 + 0.5mm. The time period elapsed between the time of adding water to the Cement to the time when the annular ring fails to make an impression on the mould is called the final setting time.

Compressive strength of Cement: According to IS 8112-1989

The compressive strength of Cement is determined from mortar cubes of size 7.07 X 7.07 X 7.07c.m and cement to sand ratio 1:3. The strength is obtained for 3,7,28 days. The strength obtained on the 28th day is called the compressive strength of Cement.

5.2 TESTS CONDUCTED ON COARSE AGGREGATE

Water Absorption of coarse Aggregate

(IS: 2386- PART- 3).Water absorption gives an idea of the strength of aggregate. Aggregates having more water absorption are more porous in nature and are generally considered unsuitable unless they are found to be acceptable based on strength, impact, and hardness tests.

Specific Gravity

(IS: 2386- PART- 3).The specific gravity of an aggregate is considered to be a measure of the strength or quality of the material. The specific gravity test helps in the identification of stone.

Sieve Analysis

(IS: 383- 1970) A sieve analysis (or gradation test) is a practice or procedure used (commonly used in civil engineering) to assess the particle size distribution (also called gradation) of a granular material. The size distribution is often of critical importance to the way the material performs in use. A sieve analysis can be performed on any type of non-organic or organic granular materials, including sands, crushed rock, clays, granite, feldspars, coal, and soil, a wide range of manufactured powders, grain, and seeds, down to a minimum size depending on the exact method. Being such a simple technique of particle sizing, it is probably the most common method.

Crushing Value

(IS: 2386 -PART- 4) the aggregate crushing value provides a relative measure of resistance to crushing under a gradually applied compressive load. To achieve a high quality of concrete, aggregate possessing low aggregate crushing value should be preferred.

Fineness modulus

Fineness Modulus (FM) is used in determining the degree of uniformity of the aggregate gradation. It is an empirical number relating to the fineness of the aggregate. The higher the FM is, the coarser the aggregate.

5.3 TESTS CONDUCTED ON FINE AGGREGATE

Sieve Analysis

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5.4 MIX DESIGN PROCEDURE.

5.5 Cube Compressive Strength Test:

According to IS 516-959, After 28 days of curing, the cubes were taken out from the curing tank, dried, and tested using a compression testing machine. These cubes were loaded on their sides during compression testing such that the load was exerted perpendicularly to the direction of casting. The cubes were placed in the compression testing machine, and the loads are applied gradually at a rate of 30kN/cm2/sec. The average value of the compression strength of 3 cubes was taken as the compression strength. The compressive strength of conventional concrete was found to be 30.47N/mm2.

Compressive strength = p/a

Where p=compressive load (kN), a=Area of cube (150X150mm).

5.6 CASTING

According to IS 516-1959, the cubes were casted in steel mould of having dimensions 150x150x150mm. For all test specimens, moulds were kept on table vibrators for compaction. Concrete was poured in three layers into the mould and they are kept on vibrator for 2-3 minutes after they are removed and left aside. After 24 hours they are de molded and specimens are kept for curing a period of 3,7,28 days.

IV.EXPERIMENTAL RESULTS

The results of the present investigation are present both in tabular and graphical forms; the interpretation of the results is based on current knowledge available in the literature as well as on nature 0 results obtained. The significance of the result is assessed with reference to the standards specified by the relevant IS Codes.

Sl.no	Mix proportions	Average compressive strength of concrete N/mm^2		
		3 days	7 days	28 days
1.	Normal Pcc(A)	8.55	13.26	29.57
2.	30% steel slag(B)	13.12	27.60	33.27
3.	60% steel slag(C)	17.62	35.25	39.86
4.	100% steel slag(D)	13.07	26.15	34.99

Table-1: Variation of strength for replacement of sand with steel slag

Compressive strength increased with an increased percentage of fine aggregate with steel slag up to 100% replacement. After that, it begins to decrease. The maximum compressive strength obtained at 100% replacement is 17.62MPa. The max percentage of increase of strength at 100% is 7.6%.

Compressive strength increased with an increased percentage of fine aggregate with steel slag up to 100% replacement. After that, it begins to decrease. The maximum compressive strength obtained at 100% replacement is 35.25MPa. The max percentage of increase of strength at 100% is 22.02%.

Compressive strength increased with an increased percentage of fine aggregate with steel slag up to 100% replacement. After that, it begins to decrease. The maximum compressive strength obtained at 100% replacement is 39.86MPa. The max percentage of increase of strength at 100% is 10.12%.

Compressive strength increased with an increased percentage of fine aggregate with sawdust up to 30% replacement after that it begins to decrease. The maximum compressive strength obtained at 30% replacement is 10.06MPa. The max percentage of increase of strength at 30% is 2.70%.

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Compressive strength increased with an increased percentage of fine aggregate with sawdust up to 30% replacement after that it begins to decrease. The maximum compressive strength obtained at 30% replacement is 13.50MPa. The max percentage of increase of strength at 30% is 4.7%.
Compressive strength increased with an increased percentage of fine aggregate with sawdust up to 30% replacement after that it begins to decrease. The maximum compressive strength obtained at 30% replacement is 12.06MPa. The max percentage of increase of strength at 30% is 3.6%.

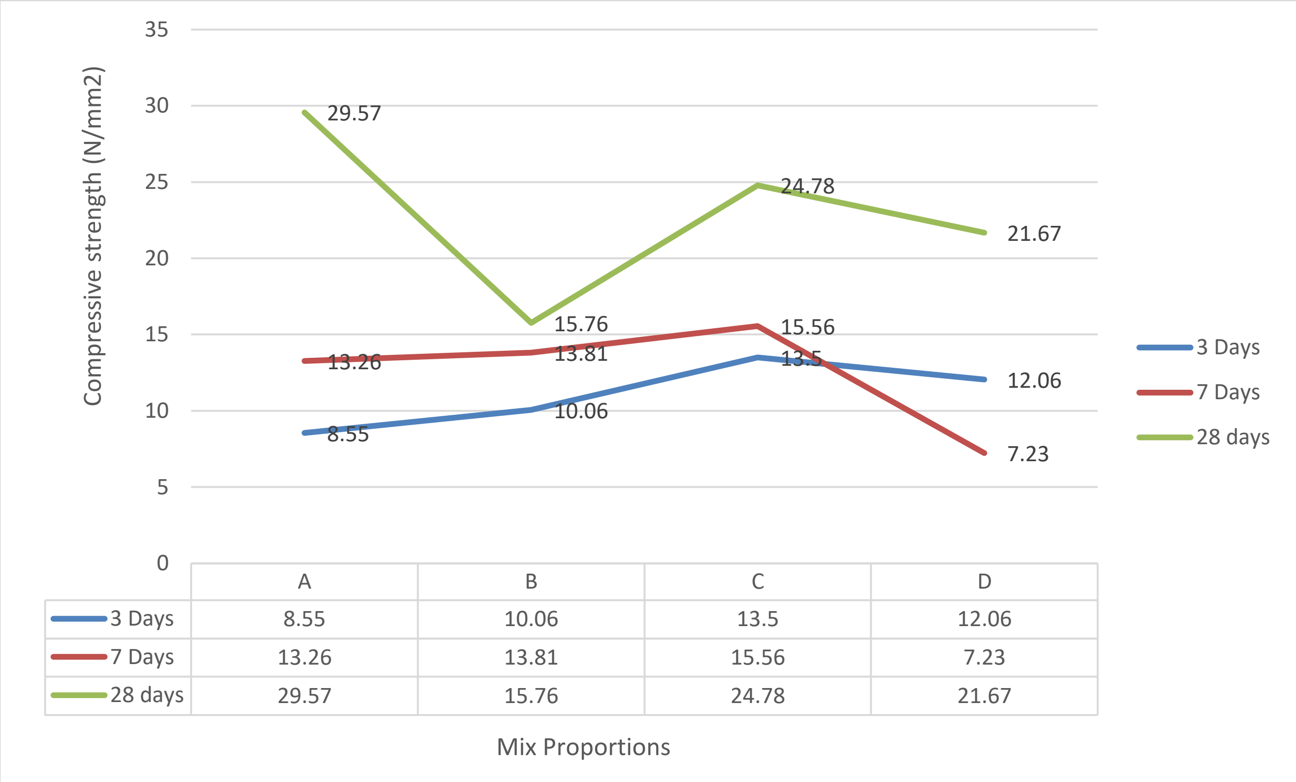

Figure-1: Graph showing variation in compressive strength according to duration of time.

V. CONCLUSION

The physical properties of stone dust, brick dust, sawdust and steel slag are satisfying of fine aggregate.
The cost of concrete made with stone dust, brick dust, sawdust and steel slag is less than conventional concrete because of the availability of stone dust, brick dust, sawdust and steel slag are at low cost.
Experimental results show that with replacement of fine aggregate with stone dust compressive strength, flexure and spilt tensile increases up to 60% of replacement and later on decreases.
Experimental results shows that with replacement of fine aggregate with brick dust compressive strength, flexure and spilt tensile increases up to 60% of replacement and later on decreases.
Experimental results show that with replacement of fine aggregate with saw dust compressive strength, flexure and spilt tensile increases up to 30% of replacement and later on decreases.
Experimental results shows that with replacement of fine aggregate with steel slag compressive strength, flexure and spilt tensile increases up to 100% of replacement and later on decreases.
From the strength test results it can be concluded that the use of stone dust, brick dust, sawdust and steel slag is suitable in construction and also it is environmental friendly.
Based on this experimental investigation, it is found that stone dust generated at yelamanda, Narasaraopeta quarry and brick dust, saw dust from Narasaraopeta and steel slag from martoor can be used as an alternative material to the natural sand.

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