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EFFECTS OF STONE DUST WITH PARTIALLY REPLACING NATURAL SAND IN PROPERTIES OF CONCRETE

Utpal Kant Choubey[1], Mr. Amit Ahirwar[2]
[1]M.tech scholar Rabindranath Tagore University, Bhopal
[2]Assistant Professor Rabindranath Tagore University, Bhopal

ABSTRACT: The purpose of this study is to evaluate the performance of stone powder (substitute) in concrete when mixed with concrete to ensure workability, durability, and strength of concrete using OPC (class 43). Efforts to improve concrete performance in recent years suggest that natural substitutes for sand, combined with grout, can improve the strength and durability of concrete. Stone powder is filler from which high-strength cement compounds can be made. Stone powder was used for natural sand in this study, which varies between 30% and 50% at a distance of 10% of the total weight of natural sand, and in the same way, natural sand is partially replaced by Stone dust from 30% to 50% distance varies from 10% by weight to natural sand. 36 mixes (test mix, control mix, and variation mix) were made for the M30 and M35 concrete.

This study examines the performance of the concrete mix in terms of compressive strength for 7 days and 28 days, beam flexural strength for 28 days, and cylinder tensile strength for 28 days. Total number of samples for cubes 108, cylinders 54, and cast beams 54 for testing to examine the impact of stone dust on concrete. These concrete samples were hardened deeply in water at normal atmospheric temperature. Based on the results, stone powder concrete was found to increase the overall strength (resistance to compression, bending, and breakage) and durability of the concrete mix mix at any age compared to concrete. Normal, its use should be encouraged to improve performance for ecological sustainability.

Key words: Concrete, stone powder, workability, compressive strength, flexural strength, tensile strength.

I. INTRODUCTION

Large amounts of crushed stone were underused as replacement material left over after crushing the stones to obtain coarse aggregate / concrete ballast. Crushed stone powder does not meet standard specifications for fine aggregates in cement and concrete mortar. Efforts have been made to replace the sand in the river with stone dust. When the coarse aggregate is produced by the noise of the stone ballast, a large amount of ballast dust is generated as waste. This is a serious removal problem. For many reasons in India, acres of land have become arid due to the removal of gravel dust. The main objective of this study was to examine the possibility of effectively using the ballast powder discharged in the concrete. The test result, obtained through a well-planned and carefully executed program, shows good prospects for using this gravel powder as a partial replacement for river sand in the production of quality concrete. Crushed stone powder is a material obtained from a stone crusher. After crushing the stone, the product called gravel powder remained in the crusher. If it can be used as a fine aggregate in cement concrete as a substitute for sand, it can be totally or partially replaced in a percentage of 0%, 30%, 40%, 50%, which gives it greater resistance than sand with the help of proper mixing.

Mechanical Properties of Stone Dust

In a context of rapid growth, the construction industry faces a severe shortage of conventional construction materials. Natural sand is used as a fine aggregate in concrete. In recent years, sand costs have increased due to environmental concerns and administrative restrictions in India. In comparison, the cost of sand is three to four times that of stone dust, even on river banks and in places where natural sand is locally and readily available.

Selection of admixture

According to the report of the Committee 212 of the American Concrete Institute (ACI), the mixtures were divided into 15 groups according to the types of materials that make up the mixtures or according to the characteristic effects of their use. The development and use of additives has a revolutionary and versatile use of concrete additives for the production of high-strength concrete, self-compacting concrete with low water-cement content, adding the additive to concrete and for working with concrete.

II. LITERATURE REVIEW

To choose specific research objectives, it is necessary to follow a typical process to conclude that the problem is unique, new and important in a given area. This involves searching for related material in magazines, books, research articles, and scientific research that has been published in various conferences, magazines, and transactions. Studying and understanding literature other than scientific research is a bit easy because the concepts are elaborated in simple and explanatory techniques. Meanwhile, this content cannot be used as the basis for defining research objectives, as it is not supported by adequate review by various researchers working in the field. Reviewing a scientific research article is a tedious task. Previous research knowledge is required. Scientific research work is highly structured, compact and precise to explain.

U.S. Agrawal, S.P. Wanjari, D.N. Naresh (2019) in this study, M-25 grade concrete was made with geopolymer fly ash sand (GFS), which was manufactured using fly ash and an alkaline activator solution as an alternative material to sand. of the natural river (NRS).

Carina Ulsen, Ester Tseng et. al. (2018) this article compares the use of secondary kilns and impact crushers to produce coarse recycled aggregate of residual cement from demolished road surfaces and building materials. The grinding mechanism directly influences the properties of recycled aggregates at different levels: particle size distribution, aggregate shape, generation of micro fractures and with respect to the release of the hardened porous cement paste from the particle surface to recover the material.

Sanjay Mundra, P.R. Sindhi (2016) the study examines the use of crushed stone sand as an alternative to natural river sand, which is traditionally used as a fine aggregate in concrete cement. Various mixing projects have been developed for different types of concrete based on IS, ACI and UK codes that use natural river sand and limestone sand. In all cases, the cube compressive strength test and the beam flexion test were performed.

Rolands Cepuritis, Stefan Jacobsen et.al. (2016) Studies of the properties of sand particles (shape, void content, particle size distribution of the load) and of the rheology of concrete (bag flow, yield strength and plastic viscosity) show that the shape of the particles it is 0.125 / 2 mm and the filling properties ≤ 0.125 mm are the most important factors for the workability of the concrete, if the sand content 0/8 mm is kept constant.

Euibae Lee, Sangjun Park, Yongjic Kim (2016) In this study, experimental results are presented to evaluate the drying properties of concrete shrinkage using dune sand (DS) and crushed sand (CS) as fine aggregate (FA). Concrete mixes were made to obtain the desired workability by varying the ratio between DS and FA (ratio DS / FA) and the water content.

III. OBJECTIVES OF STUDY

- Provide basic information on the use of concrete synthetic sand.
- Access to existing concrete products with artificial sand.
- Draw conclusions and recommendations based on the results of the research and indicate areas for subsequent studies.
- Study of the influence of synthetic sand on the compressive and tensile strength of concrete.
- Determination of the strength of concrete for different qualities.
- Optimal use of artificial sand usable in construction.
- Determine the different strengths of concrete, the different properties of concrete.
- Make our economic structure without compromising its strength.
- The main objective of this study is to use stone powder in concrete to increase tensile and flexural strength, because we know that concrete is highly compressed and has little stress.
- Comparison of compressive strength and tensile strength between normal concrete and stone powder reinforced concrete.
- To analyze the flexural strength, divide the tensile strength of M30 and M35 concrete.

IV. EXPERIMENTAL PROGRAM

Concrete is a composite material that is produced by adding cement, fine aggregate, coarse aggregate, and water. It can be used for any type of structure, depending on choice and needs, and the percentage of concrete can be changed according to the load and strength requirements of construction jobs. Concrete is inexpensive compared to steel construction and also has low maintenance costs. Simple mechanism for work.

Coarse Aggregate

This is the aggregate that is largely maintained on a 4.75mm IS display and only contains much thinner material than allowed for the various types described in IS-383: 1970. Depending on the size, the large aggregate is explained as a classified aggregate of its nominal size, i.e. 40mm, 20mm, 16mm, 12.5 and 10mm etc. For example, a graduated aggregate with a nominal size of 20mm represents an aggregate that mostly passes through a 20mm screen.

Table - Properties of Coarse Aggregate of 10mm & 20mm size

Properties	Value	
	10mm	20mm
Density (OD)	1354 kg/m^3	1475 kg/m^3
Density (SSD)	1481 kg/m^3	1564 kg/m^3
Bulk Density (Dry)	1525 kg/m^3	1476kg/m^3
Sp. Gravity (OD)	2.61	2.62
Sp. Gravity (SSD)	2.62	2.66
Water Absorption	0.46%	0.45%

Crushed Stone Dust

It is an industrial by-product. It is a crushing of stones that breaks down into fine aggregates. It has a gray color and is like a good addition. This causes environmental problems like cushioning problems. There are many advantages to turning stones into useful by-product powders, such as maintaining an ecological balance. It is also used for various activities in the construction industry, such as road construction and the production of building blocks and tiles with a unit weight. Late Gujarat aggregate used in this investigation. That it meets the requirements of the quality control code, dimensions, etc.

Fig. - Crushed Stone Dust

Chemical Admixture

Chemical additives are the building blocks of concrete rather than Portland cement, water, and aggregates that are added to the mix immediately before or during mixing. Concrete manufacturers primarily use additives to reduce the cost of concrete construction. Modification of the properties of hardened concrete to guarantee the quality of concrete during mixing, transport, positioning and hardening during concrete. There are different types of chemical additives used in the design, such as: B. deceleration mixture, acceleration mixture, water reduction mixture, air entrapment mixture, superplasticizer mixture, and deceleration superplastic mixture. Superplasticizers, also known as high performance plasticizers or water reducing plasticizers (HRWR), reduce the water content by 10-25% and can be added to concrete with a low to normal performance ratio and water will be produced for the concrete High performance concrete uses a water reducing naphtha superplasticizer according to IS 9103: 1999. The superplasticizer used for experimental performance is KavassuPlast SP-431 / Shaliplast SP-431.

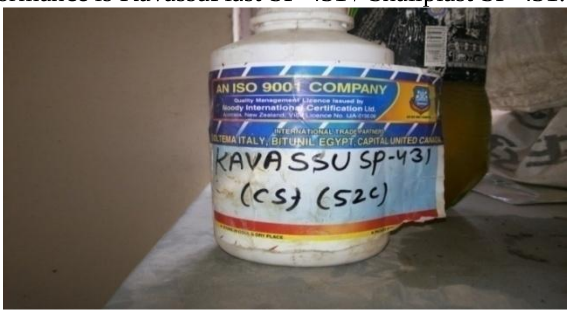


Fig. - Brand of super plasticizers Kavassuplast SP*431(CS-52 C) / Shaliplast SP- 431

V. RESULTS AND DISCUSSION

Workability Test Result

The input of all mixes is recorded and displayed in tabular and graphical form. The design drop was 100 mm and the maximum reduction value found was 70 mm for M30 concrete. In the case of the M35, the design drop was 68 mm and the maximum theft value found was 100 mm. When checking the collapse of various concrete mixes, many variations were found. Modifications were made with cement by adding a percentage of cement with partial replacement of the fine aggregate with stone powder that differs from (0%, 30%, 40%, 50%) for concrete mixes M30 and M35.

The results are presented in a table and the diagrams are based on these results as follows:

Table - Slump on partial replacement of fine aggregate by Stone dust for M30

S.No	% Stone dust (Partial replacement of fine aggregate)	
1.	0	70
2.	30	40
3.	40	30
4.	50	25

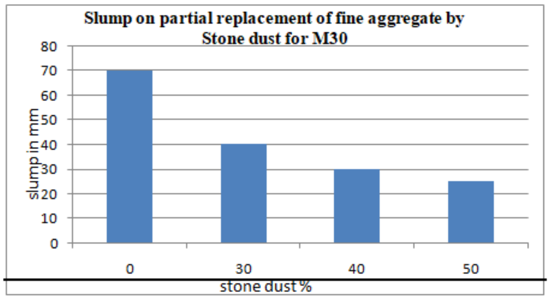


Fig - Slump on partial replacement of fine aggregate by Stone dust for M30

Table - Average 28 Days Flexural Strength of Beam M30 grade Stone dust

As per IS:456-2000 the Flexural Strength= 3.83 N/mm²

S.No	Replacement of fine aggregate with Stone dust % (by Weight of cement)	Average 28 Days Flexural Strength M30 grade in N/mm²
1.	0	5.39
2.	30	5.875
3.	40	6.07
4.	50	6.12.

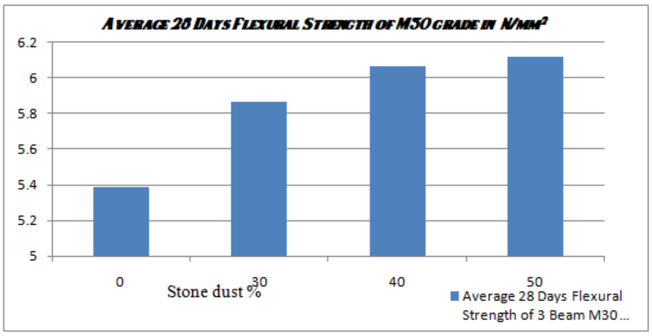


Fig no. - Average 28 Days Flexural Strength of M30 grade Stone dust

Table - Average 28 Days Flexural Strength of Beam M35 grade Stone dust

As per IS:456-2000 the Flexural Strength= 4.14 N/mm²

S.No	Replacement of fine aggregate with Stone dust % (by Weight of cement)	Average 28 Days Flexural Strength of M30 grade in N/mm²
1.	0	6.22
2.	30	6.40
3.	40	6.47
4.	50	6.52.

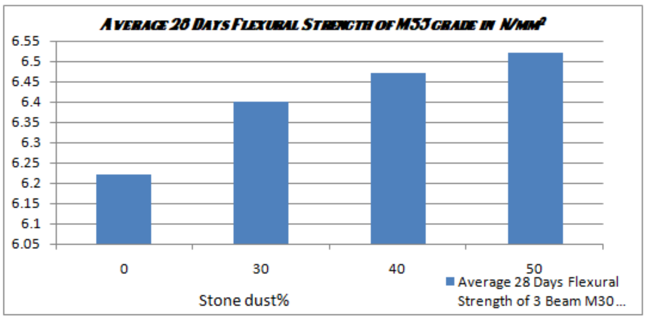


Fig. - Average 28 Days Flexural Strength of M35 grade Stone dust

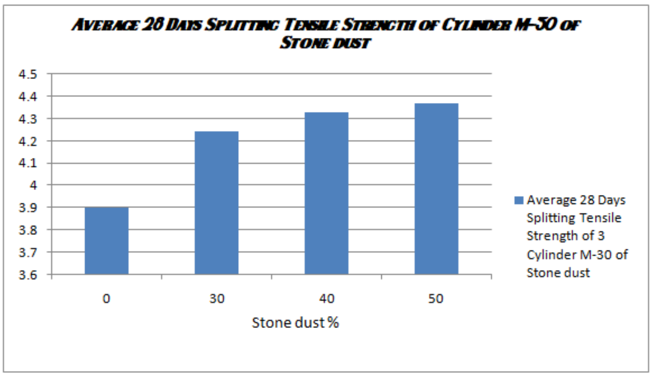
Splitting Tensile Strength

The split tensile strength of concrete mixes partial replacement with stone dust by weight of OPC was measured with cylinder specimen of size 300 mm(length) x 150mm(diameter).The specimens were tested after curing for 28 days fully immersed in water tank as per IS: 5816-1999 for a method of test splitting tensile strength of concrete.

Table - Average 28 Days Splitting Tensile Strength of Cylinder M-30 of Stone dust

As per IS:456-2000 the Splitting Tensile Strength= 3.83 N/mm^2

S.No	Replacement of fine aggregate with Stone dust % (by Weight of cement)	Average 28 Days Splitting Tensile Strength of Cylinder M-30 of Stone dust in N/mm^2
1.	0	3.90
2.	30	4.242
3.	40	4.330
4.	50	4.37



Sulphate Acid attack test

In acidic environments, some samples developed brown colour patches on their surfaces with time. This effect could be more clearly seen in the higher concentration of 0.2 N. In spite of these effects, samples could largely retain their structural integrity and shape throughout the duration of study.

Table - Average 28 & 56 Days Sulphate Acid attack test

Age (Days)	Mix Designations	Compressive Strength (N/mm^2)			Reduction in Compressive Strength (%)	
		In Ordinary Water	In Sulphuric Acid With Concentration		In Sulphuric Acid With Concentration	
			0.1 N	0.2N	0.1 N	0.2N
28	A	35	35.28	33.9	2.0	3.9
	B	38.5	38.59	36.85	2.3	4.5
	C	33.2	32.50	31.46	1.5	3.2
	D	35.6	34.65	33.80	2.1	4.5
90	A	39.3	36.76	34.63	4.5	5.8
	B	41.4	39.33	36.85	5.0	6.3
	C	35.2	32.87	31.23	3.3	5.0
	D	38.7	35.98	34.48	4.3	8.3

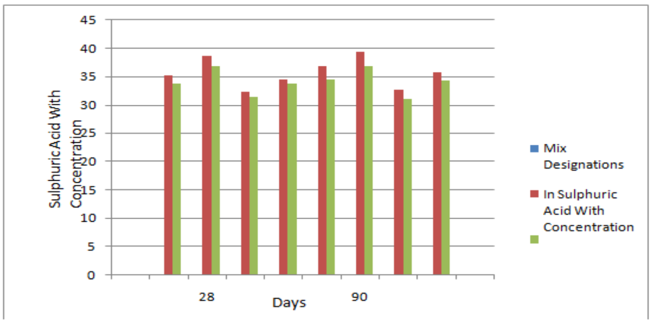


Fig. - Average 28 Days& 90 Days Sulphuric Acid with Concentration

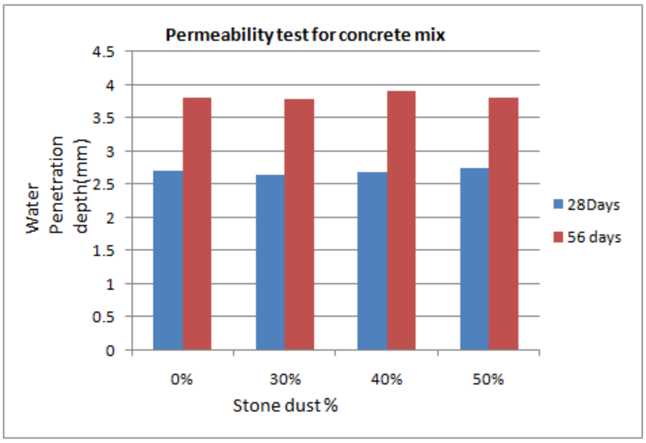


Fig. - Average 28 Days & 56 days permeability test

VI. CONCLUSION

By evaluating the results of Slump test, Density test, Compressive Strength test, Flexural Strength test and Split Tensile Strength test, following conclusions have been drawn.

Slump & Density

By replacing natural sand with stone powder by weight of natural sand (stone powder from 30% to 50% with a 10% increase), the collapse of the cement mix gradually decreased to 50% by weight of replacement of natural stone powder sand for M30 and M35 mixes.

Compressive Strength

The compressive strength of concrete has increased in M30 and M35 mixes, replacing natural sand with "30% stone dust", "40% stone dust" and "50% stone dust" The maximum compressive strength observed in the M30 class was 42.26 N / mm2 (when 50% of the stone dust was replaced by the weight of natural sand), that is, 8.02% more than the quality of the mixture control M30 and im In the case of M35, the maximum observed compressive strength was 45.32 N / mm2 (when 50% of the stone dust was replaced by the weight of natural sand), or 4.74% more than that of the M35 control mix

Splitting Tensile Strength.

Splitting tensile strength of concrete was increased in mixes M30 & M35, replacing of natural sand by '30% stone dust', '40% stone dust', '50% stone dust' maximum splitting tensile strength observed in M30 grade was 4.37 N/mm2 (when 50% stone dust was replaced by weight of natural sand) which was 12.05% greater than control mix M30 grade and in case of M35, maximum splitting tensile strength observed was 4.68 N/mm2 (when 50% stone dust was replaced by weight of natural sand) which was 4.93% greater than control mix M35 grade

Sulphate Acid Attack

The cubes were taken sulphate attack test out from various tanks after the completion of required curing time. The result of compressive strength of cubes of different mixes cured in ordinary water and sulphuric acid with concentration 0.1 N and 0.2 N for different curing periods,variation of compressive strength of concrete cubes of different mixes cured in fresh water with age. The compressive strength of concrete cubes increases with age of concrete. The 90 days and 180 days compressive strengths are approximately 7.0% and 16.7% more than 28 days strength for the mix A, 4.8% and 8.86% for mix B, 3.0% and 7.58% for mix C and 6.2% and 16.38% for mix D. The percentage wise development of strength with time in ordinary water is similar for Mix A and Mix D and it is better for these compared to Mix B and Mix C.

Permeability

The water permeability decreases with reduction 4% in w/b ratio 0.3 to 0.7 . The water permeability decreases with time, the steady state values are reached beyond 25 minutes. Incorporation of supplementary cementitious materials in concrete reduces the water permeability, leads to durable concrete.

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