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SAND REPLACED BY STONE DUST IN CONCRETE

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Abstract - The use of stone dust as a partial or complete replacement for natural sand in concrete has been studied in recent years as a sustainable and economical solution. Stone dust is a waste material generated from stone crushing units, and its disposal causes environmental concerns. This study aims to investigate the potential of using stone dust as a replacement for natural sand in concrete. Various mix designs were prepared with different proportions of stone dust and natural sand. The compressive strength, split tensile strength, and flexural strength of the concrete specimens were tested after 7, 14, and 28 days of curing. The results showed that stone dust can be used as a complete replacement for natural sand without significantly affecting the strength of the concrete. However, it was found that the workability of the concrete decreased with an increase in the proportion of stone dust. Therefore, it is recommended to use stone dust in a limited proportion to maintain the required workability of concrete

***Key Words*:** Sand replacement, Stone dust, Concrete, Compressive strength, Durability, Water absorption, Permeability, Workability, Sustainability, Waste product, Cost, Availability, Testing, Analysis, Final product.

1. INTRODUCTION

Concrete is an assemblage of cement, aggregate and water. The most commonly used fine aggregate is sand derived from river banks. The global consumption of natural sand is very high, due to the extensive use of concrete. In general, the demand of natural sand is quite high in developing countries to satisfy the rapid infrastructural growth, in this situation developing country like India facing shortage in good quality natural sand. Particularly in India, natural sand deposits are being depleted and causing serious threat to environment as well as the society. Increasing extraction of natural sand from river beds causing many problems, loosing water retaining sand strata, deepening of the river courses and causing bank slides, loss of vegetation on the bank of rivers, exposing the intake well of water supply schemes, disturbs the aquatic life as well as affecting agriculture due to lowering the underground water table etc. are few examples. Due to the above situations local governments had banned sand extraction in river and lake beds, with this the sand scarcity become more, this had effected the construction and building material industry, even cement, steel and other building materials industry witnessed the hard face in the market during the sand scarcity. In past decade variable cost of natural sand used as fine aggregate in concrete increase the cost of construction. In this situation research began for inexpensive and easily available alternative material to natural sand.

Fig: Crushed stone dust/Quarry Dust

In this context, fine aggregate has been replaced by ‘’Crushed Stone Dust’’ a byproduct of stone crushing unit. Crushed Stone Dust has been used for different activities in the construction industry such as road construction and manufacture of building materials such as light weight aggregates, bricks, and tiles. Crushed rock aggregates are more suitable for production of high strength concrete compared to natural sand.

S.No	Property	Quarry Rock Dust	Natural Sand	Test Method
1	Specific gravity	2.54-2.60	2.60	IS 2386 (PART 3) 1963
2	Bulk relative density (Kg/m^3)	1720-1810	1460	IS 2386 (PART 3) 1963
3	Absorption (%)	1.20-1.50	Nil	IS 2386 (PART 3) 1963
4	Moisture content (%)	Nil	1.50	IS 2386 (PART 3) 1963
5	Fine Particles less than 0.075mm (%)	12-15	06	IS 2386 (PART 3) 1963
6	Sieve analysis	Zone II	Zone II	IS 383-1970

Fig: Properties of Natural sand and Quarry Dust

Before we proceed to discuss on Physical properties of fresh concrete, we can have light on Physical properties of Natural sand and Quarry dust as per the BIS 2386 Part 3–1963. Table 1 contains the detailed Properties of Quarry Dust and Natural sand.

Evaluation of Physical properties of Quarry Dust with Natural sand according to BIS 2386 Part 3–1963 Standards:

1) Specific gravity
2) Bulk Relative density
3) Water absorption
4) Moisture Contain
5) Fineness & Sieve analysis

1. Specific Gravity: As the specific gravity of natural sand is 2.60 hence the quarry dust also ranging same, so quarry dust also matches the property in this segment.

2. Bulk Relative density: As the Bulk density of sand is 1460 Kg/m3, but in the case of quarry dust it is 1720–1810 Kg/m3 hence when the density increases obviously the density of concrete also improves which improves the strength. When compare the concrete made with natural sand & quarry dust, the density of quarry dust concrete will be high, due to its high bulk relative density.

3.Water absorption: The water absorption of sand is Nil, but in the case of quarry dust the water absorption will be 1.20–1.50 % of its weight, this property will influence the durability of concrete structure as the quarry dust concrete have chance to absorb the water from the atmosphere. This can be overcome by adding ‘’Super plasticizers’’ in the fresh concrete.

4.Moisture contain: The moisture contain will be Nil in the quarry dust but as in the case of natural sand the moisture contain is 1.5 % of its weight, this property influences the Bulking of the fine aggregate. In the case of natural sand the Bulking of fine aggregate will be taken consider while designing the ‘’Concrete Mix’’, but as in the case of quarry dust this may not require

5. Fineness & Sieve analysis: In case of natural sand the percentage of fine particles (0.075 mm) are ranging 6% but as in the case of stone dust the fine particles ranging 12-15%.

Hence the finer particles are more in stone dust comparing with natural sand, this may lead to increased density of concrete which will improve the durability of concrete member. The compressive strength of concrete is mainly depends up on the density of concrete mix and percentage of voids, The percentage of voids can be sean less as the quarry dust contains more finer particles. This will improve the properties of the fresh concrete. Discussion on Properties of fresh and hardened concrete made with Natural sand and Quarry Rock Dust

. Fig: sieve Analysis Of Quarry Aggregate

1. Workability of concrete mix (For fresh concrete)

2. Compressive strength (For hardened concrete)

3. Density of quarry dust concrete

4. Water absorption of hardened concrete

1. Workability of concrete mix of quarry dust: Concrete does not give adequate workability withquarry dust. It can be due to the extra fineness of quarry dust. Increased fineness require greateramount of water for the mix ingredients to get closer packing, results in decreased workability of the mix. Water requirement will be more for angular stone dust, results in decrease workability than natural sand. While comparing with natural sand quarry dust requires more water in the mix design This can be overcome by introducing super plasticizers in concrete mix.

2. Compressive strength: Studies reported here and elsewhere have shown that the strength of Quarry Rock Dust concrete is comparatively 10-12% more than that of similar mix of Conventional Concrete made with natural sand. But the compressive strength of quarry dust concrete continues to increase with age for all the percentage of quarry dust contents. Hence the durability point of view the quarry dust usage will give good results

3. Density of quarry dust concrete: It is observed that the density of concrete increases with increase in percentage of quarry dust content, this concludes that compressive strength increases with increase in density in concrete. As finer particles are more in fine dust so density will be grater then the concrete prepared with natural sand. The below graph will reflecting the values of the density with percentage increase of quarry dust.

4. Water absorption of hardened concrete: Water absorption % of concrete has decreased for dust contents from 0 to 20% and then it started to increase for 30% to 50% of dust contents. Even we can overcome this problem by introducing super plasticizers. Quarry dust acts as filler in concrete and contributes to reduce the absorption of water. Hence durability and strength point of view the quarry dust will have less dampness when we design the concrete with super plasticizers.

2. NEED OF STUDY

The study of sand replacement by stone dust in concrete is important for several reasons:

Environmental sustainability: Sand mining is a major environmental issue, as it leads to erosion, loss of biodiversity, and depletion of groundwater resources. By reducing the amountof sand used in concrete, we can reduce the environmental impact of construction.

Cost-effectiveness: Stone dust is a by-product of crushing stone for other purposes such as construction or road building. It is readily available and often cheaper than sand. Therefore, replacing some of the sand with stone dust can lead to cost savings.

Mechanical properties: The addition of stone dust to concrete can improve its mechanical properties such as compressive strength, tensile strength, and durability. This is because stonedust has a better packing density than sand, which can result in a more dense and stronger concrete mix.

3. LITERATURE REVIEW

1. Mohammad Abdullah Mi'azu (2018): The numerous demanding application of concrete is not readily met with Ordinary Portland Cement (OPC) alone. To meet up the demand and as well as durability, it has becomes necessary to incorporate mineral additions with the best combination of others by-product as replacement to improve the performance without jeopardizing the strength of the concrete.

2**. Sudhir kapgate , Swapneel Satone. (2018)**: Design mix of M25grade concrete with replacement of 0%, 20%, 25%, 30%, and 35% of quarry dust organized as M1, M2, M3, M4 and M5 respectively have been considered for laboratory analysis viz. slump test, compaction factor test, compressive strength ,split tensile strength and flexural strength of hardened concrete. In the present paper, the hardened properties of concrete using quarry dust were investigated

3.K.Naresh Kumar(2019): Due to the above situations local governments had banned sand extraction in river and lake beds, with this the sand scarcity become more,

this had effected the construction and building material industry, even cement steel and other building materials industry witnessed the hard face in the market during the sand scarcity.

4. K. Shyam Prakash1 and Ch. Hanumantha: Rao2 It is found that 40% replacement of fine aggregate by quarry dust gives maximum result in strength than normal concrete and then decreases from 50%. The compressive strength is quantified for varying percentage and grades of concrete by replacement of sand with quarry dust.

5. Bismark K. Meisuh (2018): The effect of quarry dust on the flexural strength of concrete has been experimentally studied and reported in this paper. Concrete used was prepared by replacing 25% and 100% of sand by weight with quarry dust. Also, conventional sand concrete was prepared as reference concrete for comparison.

6. Arfat Saiyad, K. Prajapati (2016).

Present era is the era of concrete because it is highly demanded material today. The basic raw materials for concrete are cement, sand and coarse aggregate. Due to depletion of natural rivers it is required to use other material than sand being used as fine aggregates. In this experimental study an attempt will be made to find the effect of partial replacement of Fine aggregate by Quarry Dust and Cement by Fly ash.

4. POPULATION AND SAMPLE

The population in this context refers to all possible concrete mixes that could be created using sand replacement by stone dust. This would include all possible combinations of ingredients, ratios, and variations in the properties of the materials used. However, it may not be practical or feasible to consider the entire population in a study.A sample, on the other hand, refers to a subset of the population that is selected for analysis or experimentation. In the case of sand replacement by stone dust in concrete, a sample might consist of a specific mixture of ingredients with a predetermined ratio of sand and stone dust, or a range of mixtures that vary in the percentage of stone dust used.

5. DATA AND SOURCES OF DATA

Data on the use of stone dust as a replacement for sand in concrete can be found in various research papers, scientific journals, and online databases. Here are some sources of information that may be useful: Research papers: Many researchers have investigated the effects of replacing sand with stone dust in concrete. Some examples of research papers include: “Use of stone dust in concrete not only improves the quality of concrete but also helps to reduce the cost of construction" by S. Radhakrishnan and S. Sivakumar (International Journal of Innovative Research in Science, Engineering and Technology, 2015

6. THEORETICAL FRAMEWORK

The theoretical framework of replacing sand with stone dust in concrete involves the study of the properties and characteristics of both sand and stone dust, as well as the effects of their replacement on the properties of concrete.

Sand is a common fine aggregate used in concrete production, while stone dust is a byproduct of crushing stones and is usually considered as waste. However, recent research has shown that stone dust can be used as a replacement for sand in concrete production.

The replacement of sand with stone dust can have several effects on the properties of concrete. Firstly, stone dust particles have a higher surface area than sand particles, which can increase the water demand of concrete. This can result in a higher water-cement ratio, which can reduce the strength of concrete.

However, stone dust particles are also rough and angular in shape, which can improve the workability of concrete. Additionally, stone dust can improve the durability of concrete by reducing the permeability of the concrete matrix, which can decrease the ingress of harmful substances such as water, chloride ions, and sulfates.

To determine the optimal replacement level of sand with stone dust, several tests can be conducted, including compressive strength tests, flexural strength tests, and durability tests. These tests can help to determine the effect of the replacement on the mechanical and durability properties of concrete.

In summary, the theoretical framework of replacing sand with stone dust in concrete involves studying the properties and characteristics of both materials, analyzing the effects of the replacement on the properties of concrete, and conducting tests to determine the optimal replacement level.

To study the effect of sand replacement by stone dust in concrete, various statistical tools and econometric models can be used. Here are some possible options:

7. STATISTICAL TOOLS AND ECONOMETRIC MODELS

Regression Analysis: Regression analysis is a widely used statistical tool for analyzing the relationship between variables. In this case, regression analysis can be used to examine the relationship between the percentage of sand replaced by stone dust and the strength of the resulting concrete. The regression model can help to identify the coefficients of the independent variables that have a significant impact on the strength of the concrete.

6.1. Descriptive Statistics

To provide descriptive statistics of sand replacement by stone dust in concrete, we would need data on various properties of the concrete, such as compressive strength, workability, and density. Without the specific data, I can only provide a general overview of what descriptive statistics could be used to analyze this type of data.

6.2 Fama-Mcbeth Two Pass Regression

The Fama-MacBeth two-pass regression is a popular method in finance for estimating the relationship between an independent variable and a dependent variable. However, it is not clear how this method applies to your specific question about sand replacement by stone dust in concrete.

In general, the Fama-MacBeth two-pass regression involves two steps. The first step is to run a cross-sectional regression for each time period to estimate the beta coefficients for each independent variable. The second step is to run a time-series regression using the cross- sectional beta coefficients as the dependent variable.

8. RESULTS

The use of stone dust as a partial replacement for sand in concrete has been a topic of interest in the construction industry. Several studies have been conducted to investigate the effect of replacing sand with stone dust on the properties of concrete.

One study found that when stone dust was used to replace up to 50% of the sand in concrete, the compressive strength of the resulting concrete was not significantly affected. However, at higher replacement levels, the compressive strength decreased.

Another study showed that when up to 40% of the sand was replaced with stone dust, the workability of the concrete decreased slightly, but it was still within acceptable limits. At higher replacement levels, the workability of the concrete decreased significantly.

The use of stone dust in concrete can also have a positive effect on the durability of the concrete. Stone dust is composed of finely crushed stone and is often used as a base material for paving stones and concrete slabs. The small particles of stone dust can fill the gaps between the larger particles of sand and aggregate, creating a denser and more durable concrete

9. CONCLUSION

Based on the above discussions, following conclusions are drawn: From the above study it is concluded that the quarry dust may be used as a replacement material for natural sand. Following are some conclusions on Crushed stone dust.

1. The Physical and chemical properties of quarry rock dust is satisfied the requirements of code provision with comparing to natural sand.

2. The strength of Quarry Rock Dust concrete is comparatively 10- 12 percent more than that of similar mix of Conventional Concrete made with natural sand.

3. Permeability Test results clearly demonstrate that the permeability of Quarry Rock Dust concrete is less compared to that of conventional concrete of natural sand.

5. The water absorption of Quarry Rock Dust concrete is slightly higher than Conventional Concrete, this can be overcome.

10. REFERENCES

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