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A Review of the Impact of Manufactured Sand and Quarry Dust on Conventional Concrete's Strength Properties

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ABSTRACT: The study emphasizes how quarry dust can be used to produce mixed concrete in a sustainable way instead of manufactured sand. Because of its well-known ability to withstand heat, mixed concrete can be used in a variety of building applications. Because of the study's emphasis on the depletion of river sand, artificial sand and quarry dust are being investigated as potential alternatives. As a fine aggregate, natural sand is commonly used in concrete. Finding a fine aggregate substitute without compromising strength is necessary since illicit sand mining has decreased the ground water table and increased the price of legal sand. This study's design of concrete mix M30 substitutes synthetic sand and quarry dust for natural sand. To investigate the effects of adding produced sand and quarry dust to concrete, castings were made of cubes with a standard mold size of 150 mm x 150 mm x 150 mm, cylinders with a standard size of 150 mm in diameter and 300 mm in height, and beams with a standard size of 100 mm x 100 mm x 500 mm. Each pair of replacements has been given a casting consisting of three cubes. The compressive, split tensile, and flexural strengths of these specimens were assessed following 7, 14, and 28 days of cure. Control samples were used to compare the results. It was discovered that both replacement types strengthened the concrete.

KEYWORDS: Manufactured sand, Normal sand, Quarry dust, Cement concrete, compressive strength, split tensile strength, and flexural strength

I. INTRODUCTION

Quarry dust and manufactured sand are two alternative materials that can be used in concrete production. Both materials have gained attention due to the increasing demand for natural sand and the environmental concerns associated with its extraction. Understanding their properties, benefits, and applications is crucial for optimizing concrete performance.

Quarry Dust is a byproduct of the crushing process of rocks in quarries. It consists of fine particles that are produced when larger stones are crushed into smaller aggregates. Quarry dust typically contains a high percentage of fines (particles smaller than 4.75 mm) and can vary in composition depending on the type of rock being processed.

Manufactured Sand Also known as crushed sand, this material is produced by mechanically crushing rocks or stones to create fine aggregates suitable for concrete production. The manufacturing process allows for better control over particle size distribution and shape compared to natural river sand.

II. LITERATURE REVIEW

Shilar et al., 2023
manufactured high-quality and ecofriendly geopolymer bricks using granite waste powder (GWS) and iron chips (IC). GWS was added up to 40% of the overall content of the mix fraction, whereas GGBS (Ground Granulated Blast-Furnace Slag) and FA (Fine aggregate) in the FGG1 and FGG2 series changed with a 5% increment or decrement. It

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was determined that GWP and IC in geopolymer bricks are sustainable due to low embodied energy and carbon emissions. Because of the alkaline agent's faster silica dissolving rate, which resulted in greater geopolymer gel formation, each brick had a higher compressive strength, and the 1:3 ratio had the best value.

M. J. Anju, M. P. Sureshkumar, R. K. Manikandan, et al. (2023)
The construction sector consumes a large amount of concrete. Sand accounts for approximately 35% of the volume of concrete. Manufactured sand is a by-product and it is a usable substitute for river sand. The manufactured sand obtained from hard rocks by crushing plant. It is also known as M-Sand, Crushed stone sand, Quarry dust, Rock sand, Crushed dust, and other names. The quite exhaustive research has been carried out on using manufactured sand in concrete. This research review effort focuses on the enhancement of strength of concrete by focusing on strength parameters to improve the strength characteristics of concrete and thereby improving its living standard in terms of Compressive Strength.

Ngayakamo et al., 2021
Substituted granite micronized stone waste for natural clay in the manufacturing of ecofriendly bricks with distinct physical and mechanical qualities.
The batches were then made with different quantities of granite powder and burned at different temperatures of 900, 1000, and 1100°C. The final testing approach has shown that eco-friendly bricks containing up to 30% granite powder with a bulk density of 2.2 g/cm3 and the lowest water absorption value of 9.1% when burned at 1100°C are achievable.

Hamid 2021
used granite sludge waste (GSW) and silica fume (SF) as a replacement for clay in bricks. Five different weight ratios of clay to SF to GSW were tried: (70:5:25), (70:10:20), (70:15:15), (70:20:10), and (70:25 :5). They were burnt at three different temperatures of 700°C, 750°C, and 800°C. The bricks with the highest compressive strength of 18.5 MPa at 700°C burning temperature were created utilizing 70% clay, 25% SF, and 5% granite sludge waste, with a water absorption of 18.2% and a saturation coefficient of 0.9.

Kumar et al., 2020.
During their experiment, they attempted to create bricks from industrial waste using fly ash (FA), granite waste (GW), and black cotton soil (BS). The FA and GW proportions in the block cotton soil (BS) brick mixture were varied by adding 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, and 100%. The highest compressive strength value was BS60:A20:W20. In all cases, water absorption was less than the standard value of 22%. Furthermore, the weight of these bricks was around 30% to 50% less than that of regular bricks. In all studies, the efflorescence test findings were negative.

Shilar et al., 2019.
The study included an experimental investigation of the impacts of different amounts of granite waste powder and lime in the fly ash while creating a fly ashbased interlocking brick to examine the attributes of interlocking bricks such as compressive strength and water absorption. . For 72% fly ash, 18% granite powder, and 10% lime mix the compressive strength was 3.96 N/mm2 for 7 days and 8.59 N/mm2 for 21 days, for 72% fly ash, 16% granite powder, and 6% lime mix the compressive strength was 3.98 N/mm2 for 7 days and 8.96 N/mm2 for 21 days and for 72% fly ash, 18% granite waste powder, and 10% lime mix the compressive strength was 3.78 N/mm2 for 7 days and 8.32 N/mm2 for 21 days. 15.20%,16.10%, and 16.50 % was the percentage of water absorption for all three mix proportions respectively.

III. OBJECTIVE OF VIEW

Objective of View Quarry Dust & M sand with PPC cement

1. To understand the objective of using Quarry Dust M sand with PPC cement, it is essential to consider the properties and benefits of each component in construction.
2. Quarry Dust is a byproduct of granite stone processing and is often used as a substitute for sand in concrete mixtures. It is known for its durability, strength, and abrasion resistance, making it a suitable material for

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construction applications. When used in concrete mixes, quarry Dust can enhance the strength and durability of the concrete due to its mineral composition.
3. M Sand (Manufactured Sand) is a fine aggregate produced by crushing hard stones or rocks. It is free from impurities and has consistent particle size distribution, making it an ideal alternative to river sand in construction. M sand helps improve the workability and strength of concrete while reducing the environmental impact associated with sand mining.
4. A study reviewing past research on replacing sand with Quarry Dust (QD), and M Sand (MS). Their review showed that Quarry Dust (QD), and M Sand (MS) has increased the mechanical properties of concrete and has the potential to produce durable concrete.

IV. STATEMENT OF THE PROBLEMS

The study on the effect of quarry Dust and M sand on concrete aims to address several key issues related to the use of these materials in concrete production. Some of the main problems that this research may seek to investigate include:

- Strength and Durability: One primary concern could be how the inclusion of quarry Dust and M sand affects the compressive strength, tensile strength, and overall durability of concrete. Understanding whether these materials enhance or compromise the structural integrity of concrete is crucial.
- Workability and Consistency: Another important aspect to consider is how the addition of quarry Dust and M sand influences the workability and consistency of concrete mixes. It is essential to assess if these materials improve or hinder the handling and placement of concrete during construction.
- Chemical Interactions: Investigating any potential chemical interactions between granite dust, M sand, cement, and other components in concrete is vital. Understanding how these materials react with each other can provide insights into long-term performance and stability.
- Environmental Impact: Assessing the environmental impact of using quarry Dust and M sand in concrete production is also significant. This includes evaluating any reduction in carbon footprint, energy consumption, or waste generation associated with incorporating these materials.
- Cost-Effectiveness: Analyzing the cost-effectiveness of utilizing quarry Dust and M sand in concrete mixes compared to traditional ingredients is essential for practical implementation in construction projects.
- Health and Safety Concerns: Addressing any potential health hazards or safety risks associated with handling, processing, or using quarry Dust in concrete production is paramount to safeguarding workers' well-being.

V. MATERIALS USED

***Portland Pozzolana Cement* (PPC)**

Portland Pozzolana Cement (PPC) is a type of blended cement that consists of Portland clinker, pozzolana particles, and gypsum in specific proportions. It is produced by either intergrading OPC clinker with pozzolanic materials or grinding OPC clinker, gypsum, and pozzolanic materials separately and blending them thoroughly. Pozzolana is a material containing reactive silica that can chemically react with calcium hydroxide to form compounds with cementitious properties. PPC is suitable for various construction applications such as hydraulic structures, marine works, mass concreting, masonry mortars, and plastering.

Pozzolana in PPC cement

Pozzolana refers to natural or artificial materials containing reactive silica that can react with calcium hydroxide to form cementitious compounds. Natural pozzolans include volcanic ash, pumicite, shales, clay, while artificial pozzolans consist of burnt clay, silica fume, fly ash from coal-fired power plants, and blast furnace slag.

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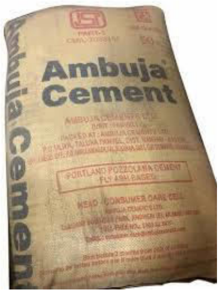

Figure no.1 Portland Pozzolana Cement (PPC Cement)

Fine Aggregate
Fine aggregate, also known as fine aggregates, is a crucial component of concrete used in construction. It can be granular material or crushed stone and plays a significant role in determining the quality and density of concrete. The selection of fine aggregate based on factors like grading zone, particle geometry, surface characteristics, wear resistance, and moisture absorption can greatly impact the durability, strength, and cost-effectiveness of the concrete mixture.

Size of Fine Aggregate
The size of fine aggregate is defined as particles equal to or less than 4.75 mm in diameter. Fine aggregates are materials that can pass through a sieve with a mesh size of 4.75 mm, including clay, silt, sand, crushed gravel, and crushed stone.

Role of Fine Aggregate in Concrete Mix
Fine aggregate serves as the structural filler in concrete mixes, occupying a significant volume. It influences various properties of concrete such as dimensional stability, elastic properties, damage tolerance, proportions of the mixture, hardening capabilities, and shrinkage behavior.

Figure no.2 Fine Aggregate

Coarse Aggregates
Coarse washed aggregates are a type of coarse aggregate that has been cleaned through a washing process to remove impurities such as clay, dirt, and debris. These aggregates are typically used in concrete production and drainage systems due to their cleanliness and quality. The washing process ensures that the aggregates are free of fine materials that could potentially affect the performance and durability of concrete.

Coarse Aggregate Characteristics:
Several key characteristics define the quality and suitability of coarse aggregates for concrete production:
Size: The size of coarse aggregates should be selected based on the intended use of the concrete.
Aggregate Shape: The shape of the aggregate influences workability, with angular, cubical, or spherical shapes being common options.
Water Absorption: Excessive water absorption can negatively impact concrete workability and durability.
Specific Gravity: Coarse aggregates with higher specific gravity tend to be stronger and more durable.

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Impurities: Impurities like dust, clay, or organic matter can weaken the bond between aggregates and cement.
Durability: Coarse aggregates must withstand environmental conditions and loads over time.
Surface Texture: A rough and porous surface texture enhances bonding with cement or bitumen.

Figure no.3 Coarse Aggregates

Quarry dust

Quarry dust, also known as stone dust, is a fine gray crushed stone that is produced as a byproduct during the crushing of larger stones. When stones are processed through a crushing machine, the larger pieces are separated from the smaller particles. The smaller particles that fall through the screens of the machine are what we refer to as quarry dust. Its texture can range from coarse to fine, depending on the size of the holes in the screening equipment used during production.

Figure no. 4 Granite Dust

Manufactured Sand (M-Sand)

Manufactured Sand (M-Sand) is a substitute for river sand, primarily used in concrete construction. It is produced by crushing hard granite stone into sand-sized particles, typically less than 4.75 mm in size. The manufacturing process involves several steps to ensure that the final product meets the required specifications for construction use.
Manufacturing Process of M-Sand
Crushing: Rocks or quarry stones are blasted and then subjected to multiple crushing cycles. This reduces the larger aggregates into smaller particles that resemble natural sand.
Sieving: After crushing, the material is sieved to separate it into different sizes, ensuring that only particles below 4.75 mm are included in the final product.
Washing: The crushed sand is washed to remove impurities such as clay, silt, and dust. This step is crucial as these impurities can negatively affect the quality of concrete.

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Quality Testing: Before being deemed fit for construction use, M-Sand undergoes various quality tests including sieve analysis and checks for particle shape and workability.

Figure no. 5 Manufactured Sand (M-Sand)

VI. CONCLUSION

In conclusion, both quarry dust and manufactured sand present viable alternatives to natural sand in construction applications when properly processed and tested for quality assurance. Their use not only supports sustainable building practices but also addresses economic challenges associated with traditional material sourcing. However, careful consideration must be given to their properties, potential challenges, and adherence to regulatory standards for successful implementation.

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