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Effect of use of Waste Silica Sand as Fine Material in Concrete

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ABSTRACT

This study aims to explore the potential benefits and challenges associated with incorporating silica sand as a fine material in concrete mixtures. Silica sand, known for its abundance and consistent particle size distribution, presents an opportunity to enhance concrete properties while potentially reducing costs. Through a series of laboratory experiments, this research will examine the impact of varying silica sand proportions on concrete's mechanical properties, durability, workability, and sustainability aspects. The findings will provide insights into optimizing concrete mix designs to leverage the advantages of silica sand, paving the way for more efficient and sustainable construction practices.

The use of alternative aggregate like silica sand is a natural step in solving part of depletion of natural aggregates. The investigation on alternative material for concrete making started before half a century. Concrete made from silica sand waste as fine aggregate was studied for workability, compressive strength, Split tensile strength and Flexural strength. Further, study of its durability will ensure greater dependability in its usage. So here in this project, Silica sand had been used as replacement of fine aggregate by different percentage for making concrete of M-20, with w/c ratio 0.50 &
0.45. The percentage replacement will be 0%, 10%, 20%, 30%, 40%, 50% with natural fine aggregates. For making concrete OPC-53 grade cement is used. Cubes and beams will be casted and tested compressive strength, Split tensile strength, and flexural strength as well as for durability properties. Optimum replacement of silica sand can be used in structural concrete. Keywords: Silica sand, Workability, Compressive strength, Tensile strength & Flexural strength

This research investigates the effect of incorporating silica sand as a fine material in concrete mixtures. Silica sand, with its abundant availability and consistent particle size distribution, presents a promising alternative to conventional sand in concrete production. The study aims to assess the influence of varying silica sand proportions on concrete's mechanical properties, workability, durability, and sustainability aspects. Through laboratory experiments and analysis, the research seeks to provide insights into optimizing concrete mix designs to maximize the benefits of silica sand utilization while addressing potential challenges. The findings contribute to advancing sustainable construction practices by enhancing the understanding of silica sand's role in concrete technology.

INTRODUCTION

Silica Sand

Silica sand, also known as quartz sand, is a type of sand that contains a high percentage of silicon dioxide (SiO_2). It is distinguished by its purity and consistency, typically composed of well-rounded grains of quartz. The key characteristics of silica sand include its high silica content (usually over 95%), chemical inertness, hardness, and its ability to withstand high temperatures.

Composition of Silica Sand

1. **Silicon Dioxide (SiO_2)**: The primary component, which gives silica sand its high melting point and strength.
2. **Other Minerals**: Minor amounts of other minerals and impurities like feldspar, clay, and iron oxide might be present.
3. **Grain Size and Shape**: The grains are usually well-rounded, which influences the sand's properties and suitability for various applications.

Significance of Silica Sand in Civil Engineering

1. **Concrete Production**:
2. **Glass Manufacturing**
3. **Foundry Sand**
4. **Mortar and Grout**
5. **Asphalt Mixtures**
6. **Filter Media Recreational Uses**
7. **Chemical Stability and Durability**
8. **Construction and Landscaping**

Replacement of recycled silica sand with regular sand in concrete

Recycled silica sand in concrete is an innovative and sustainable approach that aligns with modern practices of reducing waste and promoting resource efficiency. Foundry sands, primarily silica-based, are used extensively in metal casting processes. After multiple cycles, these sands can no longer be used for casting but can still be valuable as a fine aggregate in concrete production. This practice not only mitigates environmental impact but also provides cost benefits.

SILICA SAND

Benefits of Using Recycled Silica Sand in Concrete

1. **Environmental Impact**:
   - Waste Reduction**:**
   - Resource Conservation**:**
2. **Energy Savings**
3. **Economic Advantages**:
   - Cost Savings
   - Availability
4. **Performance Enhancements**:
   - High Strength and Durability:
   - Improved Workability

<u>Objectives of Study</u>:-

1. Partially Replacement of fine aggregate with silica sand by volume.

2. To investigate the fresh and hardened properties (slump test, compressive strength, Tensile strength & Flexural strength) of concrete for M20-M30 grade of concrete mix.

3. To investigate the hardened properties of concrete made with partial replacement of fine materialwith silica sand −

4. The properties of silica sand and silica sand concrete is examined and the use of silica sand inconstruction is tested. −

5. Use of waste silica sand as the fine material in concrete can reduced the demand of natural sand.

Materials Used

Material specification for concrete preparation has been discussed below

Cement:
Cement is produced by burning together, in a definite proportion, a mixture of siliceous (containing silica), argillaceous (containing alumina) and calcareous (containing lime) material in a partial fusion, at a temperature of 1400 to 1450°C. By doing so, a material called clinker is obtained. It is cooled and then grounded to the required fineness to get cement. Different types of cement are obtained by varying the proportions of the raw materials and also adding small percentage of other chemicals.

Three types of cement are available in Indian Market. They are:
1. Ordinary Portland Cement (OPC) may be used in normal conditions
2. Portland Pozzolona Cement (PPC) may be used in normal condition but after checking the mortar setting
3. High-early-strength Cement (quick setting cement) may be used in cold climate zones and also in places where early setting and strength gaining is desirable.

In the project we have used Ordinary Portland Cement.

Aggregate: A mixture of only cement and water is costly and possesses low strength and shrinks unacceptably on drying shrinkage. In order to reduce the cost and modify such properties as the strength and drying shrinkage of the hardened mass, it is usual to introduce insoluble non cementitious particles described as aggregates. Such aggregates usually constitute between 50 to 80% of the volume of conventional concrete and may thus greatly influence its properties.
Aggregate should not contain any constituent which affects the hardening of the cement and durability of the hardened concrete adversely. It should be free from organic matter which reduces the hydraulic activity of cement and affects its normal setting and hardening. It should also be free from occupies which decompose or change significantly in volume on exposure to atmosphere, or react adversely with the hardened cement paste.

Classification of aggregate: Aggregates are classified based upon their size as
a) Coarse aggregate and
b) Fine aggregate

a. Coarse aggregate: Coarse aggregate is material which passes through 80 mm sieve and retained on a 4.75 mm sieve.
b. Fine aggregate: Fine aggregate is material which passes through 4.75 mm sieve and retained on 75 micron sieve.

In the project we have used river sand and crushed C&D wastes [4,5] as fine aggregate.

Water: Water used for making and curing concrete should be free from injurious substances such as oil, acid, alkali, sugar, salt, organic materials or other elements deleterious to concrete or steel. Portable water is suitable for making concrete. Sea water containing up to 35000 ppm of sodium chloride and other salts is generally suitable as mixing water for plain concrete work. It is not fit for making reinforced concrete as the chlorides present in it may corrode reinforcement and produce efflorescence.

Tests Conducted

In this project we are going to compare the results of concrete with crushed C&D wasted, with normal concrete by conducting following tests.

Test for cement

1. Fineness Test
2. Consistency Test
3. Specific Gravity

Test carried out for fine and coarse aggregate

1. Sieve analysis
2. Specific gravity test
3. Fineness modulus
4. Specific Gravity
5. Impact value

Test On Silica Sand

1. **Specific Gravity Test**
2. **Sieve Analysis Test**

Test for workability of concrete

1. Slump cone test

Concrete load bearing capacity test

1. Compressive strength test

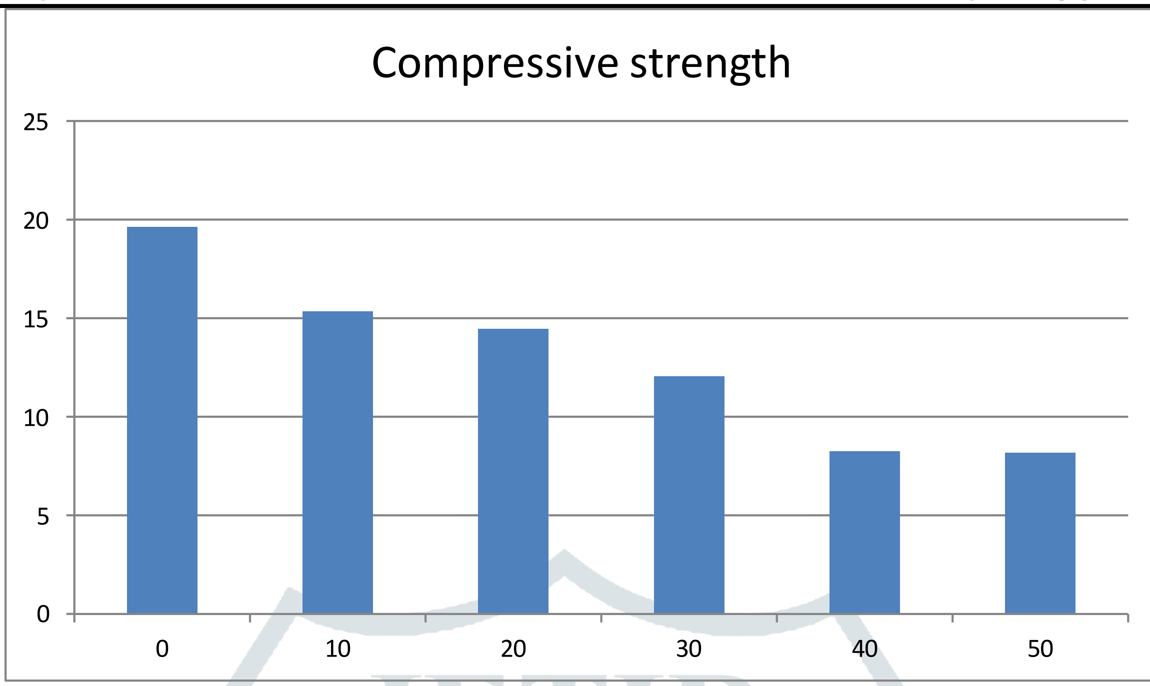
2. Flexural Strength Test

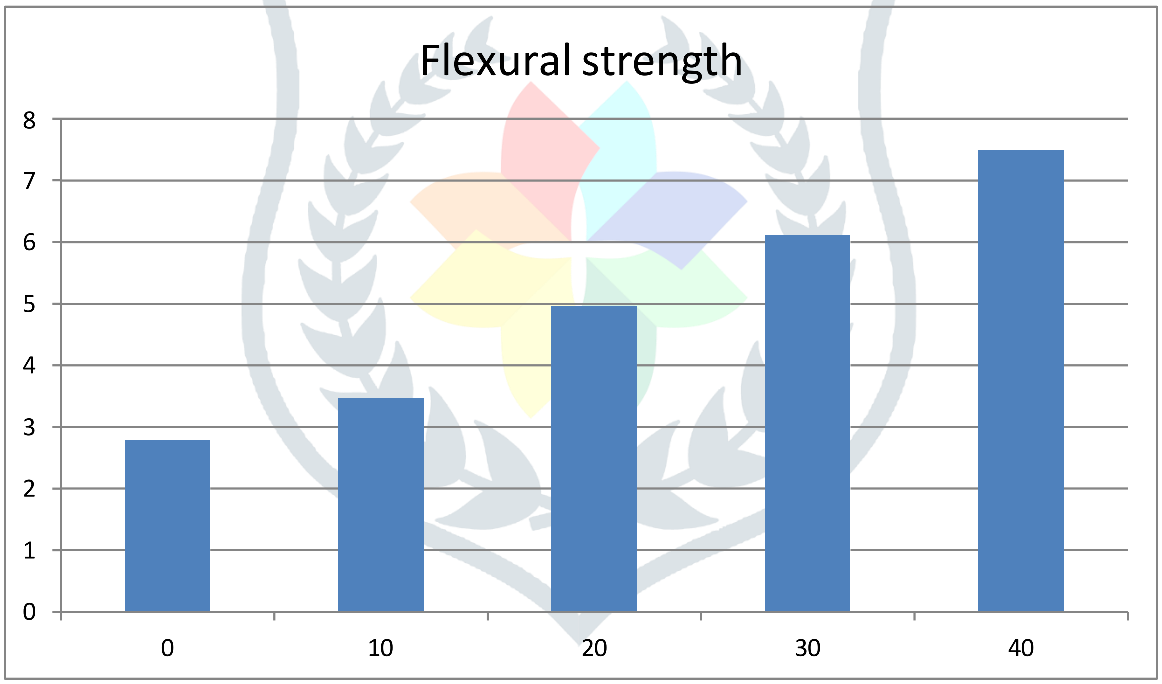
Conclusion:-

From this experimental study, It is observed that there has been improvement in the properties of M- 20 grade of concrete in terms of its compressive strength and flexural strength corresponding to the percentage of waste silica sand by weight of cement.

The experimental results indicated the following features of M-20 Grade concrete with the addition of Waste Silica Sand :-

1. It was found that addition of 10% waste Silica sand in M-20 grade concrete showed approximately equal compressive strength as compared to conventional M-20 concrete after 7 days of curing. Achieved strength was around 20N/mm2.
2. Average compressive strength of M-20 grade concrete was achieved after 7 days of curing when 10% waste Silica sand was added to concrete.
3. The addition of 20% waste Silica sand showed soe decrease in thecompressive strength of silica reinforced concrete when compared to conventional M-20 concrete.
4. Significant decrease in compressive strength was observed when fibers were increased above 30%. It is mainly due to the particle size and shape which reduces the workability of concrete , leading to improper compaction. which makes the sample overall weak.
5. Maximum Flexural Strength was observed when beams of M-20 grade concrete with addition of 40% waste Silica sand was tested for flexure.
6. Significant increase in flexural strength was observed when waste silica sand was mixed from 10% to 40%.
7. The ideal water cement ratio for waste silica sand was observed to be 0.40.
8. The concrete showed some signs of bulking and segregation at higher concentrations of waste silica sand.


Compressive strength
25
20
15
10
5
0
0
10
20
30
40
50


Flexural strength
8
7
6
5
4
3
2
1
0
0
10
20
30
40

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