Influence of Silica Sand as Fine Aggregate in Fibre Reinforced Concrete

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ABSTRACT

The usage of alternative fine aggregate like silica sand is a natural step in solving a part of depletion of river sand. The research on alternative material for concrete making commenced earlier than half a century. Concrete made from silica sand as fine aggregate was studied for workability, compressive strength. Silica sand is made from crushing of quartz stone. Similarly, observe of its durability will make sure more dependability in its utilization. So here on this assignment, silica sand were used as substitute of fine aggregate for making concrete of M-20, with w/c ratio 0.45. The proportion substitute could be 100% with natural fine aggregates. For making M20 concrete opc-53 grade cement is used. Cubes has been casted and tested compressive strength.

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1. Introduction

Every year lots of tones of waste substances are disposed at the valuable land which ends within the occupation and degradation of valuable land. Reducing of natural assets is a common phenomenon in developing countries like India because of fast urbanization & industrialization regarding construction of infrastructures.

Silica sand is acquired from the raw material (locally available in industries). After washing the raw material the silica sand is separated by sieve size 1.18 of raw material. Raw material is washed for taking away the clay material that's beneficial in making the tiles. Within the raw material approximately 10% is clay that's provided to the ceramic factories. From the raw material unique size of silica sand are separated by means of various size of sieve. Sand size of 30 mesh to 80 mesh (500 micron) is used in inside the glass industries. Sand size 1.18mm to 600 micron can be utilized in making concrete blend as the partial substitute of fine aggregate. Almost about 200 tones of silica sand is acquired day by day after washing the raw material. Once in a while it's far used within the glass factories in any other case they unload them returned into the mines.

1.1 Steel Fiber Reinforced Concrete (SFRC):

Steel fiber reinforced cement is a composite material having filaments as the more fixings, scattered constantly at abnormal in little charges, i.e. Within the location of 0.3p.cand 2.5% by means of volume in plain cement sfrc items are produced by means of including steel filaments to the elements of cement inside the blender and by means of replacing the green cement into molds. The item is then compacted and cured by the standard techniques. Isolation or balling is one of the issues skilled amid mixing and compacting sfrc. This should be maintained a strategic distance from for uniform appropriation of strands. The power required for mixing, passing on, putting and completing of sfrc is marginally better. Utilization of container blender and fiber gadget to useful resource higher mixing and to lessen the arrangement of fiber balls is fundamental. Extra fines and proscribing maximum intense length of totals to 20mm sometimes, bond substance of 350kg to 550kg for every cubic meter are meter are commonly required.

In a big part of the sector applications experimented with thus far, the span of the filaments shifts among 0.25 mm and 1.00mm in breadth and from 12 mm to 60 mm lengthy, and the fiber content went from zero.3 to two.5 percentage by way of quantity. Better demanding situations of fiber up to 10% have likewise been examined. Growth of steel filaments up to 5% by way of extent increased the flexural quantity to around 2.5 times that of plain concrete.

Innovation for this produce of sfrc light, medium and massive duty sewer vents covers has been created in India by way of structural engineering research center, Chennai. Area explores extraordinary avenues concerning 2% of fiber content material confirmed that sfrc runway chunks may be around one a big part of the thickness of plain solid sections for the same wheel stack scope.

1.2 Advantages of Steel Fiber Reinforced Concrete

- Reinforcing concrete with steel fibers outcomes in durable concrete with a excessive flexural and fatigue flexural strength, advanced abrasion, spelling and effect resistance.
- The removal of traditional reinforcement, and in a few cases the reduction in phase thickness can make contributions to some substantial productivity enhancements. Steel fibers can supply substantial price financial savings, collectively with decreased fabric quantity, extra rapid construction and decreased labor charges.
- The random distribution of steel fibers in concrete guarantees that crack free pressure accommodation happens all through the concrete. As a result micro cracks are intercepted earlier than they increase and impair the overall performance of the concrete.
- Steel fibers are a far more most economical design opportunity.

1.3 Disadvantages

- Steel fibers will not float on the surface of a properly finished slab, however, rain damaged slabs allow both aggregate and fibers to be exposed and will present as aesthetically poor whilst maintaining structural soundness.
With the software of SFRS the dearth of fabric during the laying segment is reduced by means of 1/2 of in comparison with shotcrete with out fibers. The utility of SFRS permits one to keep away from those technological troubles and extra over creates an opportunity of creating thinner sprayed layers, which concurrently are greater proof towards cracks.

1.7 Objectives of Study

Nowadays it is steel fiber that is for the maximum element used to strengthen cement and defeat the problem of weak point. This paper portrays the maximum charming usage of steel fibers fortified cements (SFRC) anywhere during the sector. Right off the bat, the creator reveals the improvement of steel filaments and SFRC. Additionally the paper covers the current importance of SFRC in structural constructing.

2. Literature Review

1)Vishnumanohar A (2015), carried out an experimental investigation on use of “Finely graded silica” (Eco sand, i.e. waste material from cement manufacturing process) as partial replacement of fine aggregate in concrete. Tests were carried out to find out the physical and chemical properties of finely graded silica and this finely graded silica was replaced with fine aggregate partially (15%,30%,45% & 60%). A mix of M25 and M40 concrete was selected for the replacement. The result obtained for M40 grade of concrete was 56.1 N/mm2 at 28th day and for M25 concrete was 32.07 N/mm2 at 28th day on 15% replacement of fine aggregate by eco sand. This shows that the maximum strength was achieved by 15% of fine aggregate replacement with eco sand in concrete. While increasing the percentage of eco sand the compressive strength value was getting decreased. From the SEM analysis, it was inferred that at a 15% replacement the mix remains homogeneous as the micro pores are filled and the transition zone was densified.

2) Sudhahar A (2012), carried out an investigation of extracted silica sand (EDS) wastes as fine aggregate in concretes and mortars. M25 grade of concrete has been used for study and it has been concluded that 15.5% of increase in compressive strength has been achieved with 50% replacement of fine aggregate with EDS on 28th day. Also the use of EDS is found to improve the packing quality inside the concrete and thus improves its permeability and durability.


They had studied on the use of fine recycled aggregates to partially or globally replace natural fine aggregates in the production of structural concrete. Six concrete mixes containing various contents of the fine recycled concrete 0, 10, 20, 30, 50, and 100% as a replacement to the fine sand were prepared. The results of the following tests are reported: compressive strength, split tensile strength, modulus of elasticity and abrasion resistance. From the result, it is reasonable to assume that the use of fine recycled concrete aggregates does not jeopardize the mechanical properties of concrete, for the replacement ratios up to 30%.

4) Rafat Siddique, Geert De Schutter, (2009):

They had studied on the use of used foundry sand in large volume; research is being carried out for its possible large-scale utilization in making concrete as partial replacement of fine aggregate. They evaluate the mechanical properties of concrete mixtures in which fine aggregate was partially replaced with used foundry sand. Fine aggregate was replaced with three percentages 10, 20 and 30% by weight. Compressive strength, splitting, flexural strength and modulus of elasticity were determined at 28, 56, 91 and 365.
days. Increased in compressive strength varied between 8% and 19% depending upon UFS percentage and testing age, whereas it was between 6.5% and 14.5% for splitting tensile strength, 7% and 12% for flexural strength and 5% and 12% for modulus of elasticity.

5) Her-Yung Wang, (2009): They had studied the use of LCD glass as the Partial replacement of fine aggregate in concrete. The different mix designs were regulated by the ACI method with 0, 20, 40, 60 and 80% LCD glass sand replacements investigation: their engineering properties were determined. Test results revealed that, when compared to the design slump 15cm, the 20% glass sand concrete for the three different mix designs kept good slump and slump flow. Furthermore, a slump loss ranging from 7 to 11 cm was observed for specimens with 60% and 80% glass sand replacements were higher of 28 and 35 MPa. The test results indicate that the addition of 20% LCD glass sand to concrete satisfies the slump requirements and improves the strength and durability of concrete.

6) Farid Debieb, Said Kenai, (2008): They had studied recycling and reuse of building rubble present interesting possibilities for economy on waste disposal sites and conservation of natural resources. Either natural sand, coarse aggregates or both were partially replaced 25, 50, 75 and 100% with crushed brick aggregates. Compressive and flexural strengths up to 90 days of age were compared with those of concrete made with natural aggregates. Porosity, water absorption, water permeability and shrinkage were also measured. The result indicates that it is possible to replace 25% of coarse aggregate and 50% of fine aggregate gives results similar to natural aggregate.

3. Methodology

The details of number of be tested while the experimentation process is given in the below table:

<table>
<thead>
<tr>
<th>S.NO</th>
<th>% OF FIBRES</th>
<th>COMPRRESSIVE STRENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>FINE AGGREGATE</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

In each batch 3cubes, were casted. Totally 72 cubes, were casted during entire experimentation.

3.1 Materials

The materials used this experimental work are cement, sand, water, steel fiber, and super plasticizer.

3.1.1 Cement

Ordinary portland cement of 53 grade was used in this experimentation conforming to IS-12269-1987.

3.1.2 Fine Aggregates

Locally open sand zone with specific gravity 2.65, water absorption 2% and fineness modulus 2.92, changing in accordance with I.S.-383-1970. It is the aggregate the lion’s share of which passes 4.75mm IS sifter and contains simply such an extraordinary measure of coarser as is permitted by detail.

3.1.3 Silica Sand

Silica sand is one of the most common varieties of sand found in the world. It is used for a wide range of applications, and can be purchased from various suppliers throughout the world. Silica sand is used in industrial processing, to make glass, as fill, and to create molds and castings.

Sand is the general term for broken down granules of minerals or rocks, technically between about one-sixteenth of a millimeter to two millimeters in diameter, falling between silt and gravel in the spectrum of sizes. There are many varieties of sand in the world, each with their own unique composition and qualities. The white sandy beaches of iconic tropical destinations, for example, are made up primarily of limestone that has been broken down, while many black sands are either volcanic in origin or contain magnetite. Other sands have high levels of iron in them, and so are rich and yellow in color.

The most common mineral in the Earth’s continental crust is quartz, and most silica sand is made up of broken down quartz crystals. Silica is another name for silicon dioxide, SiO2, of which quartz is a specific latticed structure. So silica sand is quartz that over the years, through the work of water and wind, has been broken down into tiny granules. These granules can be used for many different purposes, and can be found in most non-tropical regions of the world.

3.1.4 Coarse Aggregate

Squashed shake stones of 10mm measures having specific gravity of 2.70, fineness modulus of 2.73, conforming to IS383-1970 Aggregates are idle granular material, for instance, sand, shake or pounded stone that are a last out come in their own right. They are moreover the unrefined materials that are a fundamental settling in concrete. For a nice strong mix, aggregates ought to be
spotless, hard, strong particles free of expended chemicals or coating of soil and other fine materials that could cause the rot of concrete.

3.1.5 Water
By and large consumable water should be utilized. This is to ensure that the water is shoddy loosened from such pollutions as suspended solids, natural depend and broke down salts, which may furthermore antagonistically influence the home of the solid, particularly the setting, solidifying, vitality, solidness, pit expense, and numerous others.

3.1.6 Steel Fibre
Stainless steel wire of 0.5mm distance across has been utilized as a part of the arrangement of SFRC. The steel fiber of length 40mm and of perspective proportion 80 has been utilized as a part of this exploratory work. All the steel filaments are tied down, snared, disintegrated fit as a fiddle.

4 Results
4.3 Compressive Strength Of Concrete:
4.3.1 Normal Fine Aggregate
Table 4. Compressive strength of concrete (fine aggregate).

<table>
<thead>
<tr>
<th>S.NO</th>
<th>% OF FIBRES</th>
<th>COMPRESSIVE STRENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>7 DAYS</td>
</tr>
<tr>
<td>1</td>
<td>0%</td>
<td>21.96</td>
</tr>
<tr>
<td>2</td>
<td>1%</td>
<td>24.219</td>
</tr>
<tr>
<td>3</td>
<td>2%</td>
<td>26.42</td>
</tr>
<tr>
<td>4</td>
<td>3%</td>
<td>25.04</td>
</tr>
</tbody>
</table>

4.3.2 Silica Sand
Table 5. Compressive strength of concrete (silica sand).

<table>
<thead>
<tr>
<th>S.NO</th>
<th>% OF FIBRES</th>
<th>COMPRESSIVE STRENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>7 DAYS</td>
</tr>
<tr>
<td>1</td>
<td>0%</td>
<td>36.4</td>
</tr>
<tr>
<td>2</td>
<td>1%</td>
<td>37.2</td>
</tr>
<tr>
<td>3</td>
<td>2%</td>
<td>38.69</td>
</tr>
<tr>
<td>4</td>
<td>3%</td>
<td>38.72</td>
</tr>
</tbody>
</table>

4.1 Workability of Concrete with Normal Fine Aggregate
Table 2. Results on workability tests.

<table>
<thead>
<tr>
<th>Sl.no</th>
<th>Test</th>
<th>Results</th>
<th>IS code used</th>
<th>Acceptable limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Slump cone test</td>
<td>10 cm</td>
<td>AASHTO T 119</td>
<td>Less than 20 cm</td>
</tr>
<tr>
<td>2</td>
<td>Compaction factor test</td>
<td>0.911</td>
<td>IS 5515</td>
<td>Medium</td>
</tr>
<tr>
<td>3</td>
<td>Vee bee consistency test</td>
<td>20.45 sec</td>
<td>IS:1199</td>
<td>Medium</td>
</tr>
</tbody>
</table>

4.2 Workability of Concrete With Silica Sand & Normal Fine Aggregate:
Table 3. Results on workability tests with silica sand & Normal Fine Aggregate.

<table>
<thead>
<tr>
<th>Sl.no</th>
<th>Test</th>
<th>With SILICA SAND</th>
<th>With NORMAL FINE AGGREGATE</th>
<th>IS code used</th>
<th>Acceptable limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Slump cone test</td>
<td>10 cm</td>
<td>10 cm</td>
<td>AASHTO T 119</td>
<td>Less than 20 cm</td>
</tr>
<tr>
<td>2</td>
<td>Compaction factor test</td>
<td>0.81</td>
<td>0.911</td>
<td>IS 5515</td>
<td>Medium</td>
</tr>
<tr>
<td>3</td>
<td>Vee bee consistency test</td>
<td>24.6 sec</td>
<td>20.45 sec</td>
<td>IS:1199</td>
<td>Medium</td>
</tr>
</tbody>
</table>
4.3.3. Graph Results:
- 7 days Compressive Strength Graph Variations Of Normal Fine Aggregate And Silica Sand:

Fig 10. 7 days compressive strength graph variations.

- 14 Days Compressive Strength Graph Variations Of Normal Fine Aggregate And Silica Sand:

Fig 11. 14 days compressive strength graph variations.

- 28 Days Compressive Strength Graph Variations of Normal Fine Aggregate And Silica Sand:

Fig 12. 28 days compressive strength graph variations.

4. Conclusion

Based totally on experimental studies for concrete made with complete replacement of fine aggregate by means of silica sand are performed, the test outcomes display certainly that quartz sand as a partial replacement of fine aggregate has useful consequences of the mechanical properties concrete & the subsequent conclusions are drawn at 28 days.
- The workability of silica sand is acceptable when compared to normal fine aggregate.
- As the % of fibres are increasing the compressive strength of silica sand concrete also increasing when compared to normal fine aggregate.
- Economically silica sand and normal fine aggregate are almost same.
- Silica sand can be used as fine aggregate which will act as good fillery material.
- Finally we can conclude that the replacement of silica sand with normal fine aggregate in concrete will give the beneficial results.

References