An Experimental Analysis For Evaluation Of Compressive Strength Of Concrete Cube By Using Foundry Sand, Silica Fume And Metakaolin As An Admixture

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Abstract: Due to the rapid increase in construction activities use of sand become more these days. However, the querying of sand has become more costly to the people. Due to this, the total cost of construction is getting increasing. In the present study, an investigation is done with Foundry sand waste, Silica fume and Metakaolin as an admixture. The use of admixtures becomes quite common in construction materials like Cement. Sand to replace the content of conventional material with subsequent material. The various researchers all over the world still working on experimental studies by using Flyash, Jute, GGBS, Geosynthetic material, Rice husk ash and other materials as admixtures. In the present investigation, an attempt made on M25 grade of concrete 28days compressive strength. In the first stage of the study, fine aggregates are replaced with Foundry sand. The replacement of Foundry sand increased to a maximum of 50% and from the results, it is observed that in the compressive strength of concrete 38.27 N/mm² is the maximum strength achieved at 40% Foundry sand in the fine aggregates for 28days. And in the second stage of the study, by maintaining the same 40% replacement Foundry sand in fine aggregates, Cement content has been replaced with the Silica fume and Metakaolin with different percentage levels. And then comparative analysis was done for 28 days compressive strength between 40% replaced fine aggregates with Foundry sand and Silica fume and Metakaolin content in the cement. The compressive strength results showed that the at 10% Silica fume in the cement with 40% Foundry sand in fine aggregates gives better compressive strength with respect to Metakaolin for the same 28days period.

Index Terms: Foundry sand, Silica fume, Metakaolin, Fine aggregates, Cement, Compressive strength.

1. INTRODUCTION
On-demand and supply basis the requirements of the public become increasing in all the aspects. Especially the construction field is involved with many industries like Cement, Mining, Timber and many others. To meet the public demand the industries are also updating according to the new techniques. In this scenario, on conventional concrete many experimental studies done by adding admixtures to achieve the required strength, durability and safety. [15, 16] Due to the high competition between the industries in providing the best quality materials to the public the industries are performing their own experimental studies on materials to gain good strength. During this, the industries are also concentrated on strength, productivity, environmental problems. Hence, the use of substitution products in the manufacturing of constructional material became quite common. Use of external products like Foundry sand, Silica fume and Metakaolin and some other quite common in the industries in recent days. [19] The second largest industry in the field of construction is quarrying after the cement industry.

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The use of aggregates in the construction will start from the foundation level so that the consumption of aggregates is more in the field of construction. At the same time getting aggregates into the site is quite expensive. [14] Due to the increase in charges of worker's daily wages, blasting materials, machinery and transportation the aggregates cost getting increasing. Use of machinery and blasting techniques to quarry the aggregates causes disrupted land even so the aggregates by industrial waste products are certainly not simply incorporating further aggregate resources towards the pure and man-made aggregate but keep environmental polluting of the environment. The main problem with used sand is disposal and the other one is environmental issues. The environmental problems may occur due to the mixed concrete. After multiple uses, the sand loses its strength and even though if you use it in the construction it won't give the excepted strength. It means that once used sand no longer useful in the construction. Used sand as designated as waste foundry sand (WFS). [17,18] In recent days the use of WFS used in the casting of pre-cast moulded structures and in proving stones. The present study directed in the compressive strength point of view by replacing the cement and aggregates with Silica fume Metakaolin and Foundry sand as admixtures. During the pre-casting process in the foundry industries, a huge amount of by-product materials will produce. In general, the different ferrous metals like cast Iron and Steel will be produced the preparation of moulds in the foundry industries. [5] A maximum of 70% of casting in the foundry industry is only with moulding sand only, due to the easy in availability and high in resistance in the destruction of heat. [20] Over the years lot waste-producing in the foundry industries during casting with waste sand. Some times in the foundry industries itself the same sand, which is getting from the primary casting of moulds is using again for the next time casting purpose and it is treated as used foundry sand (UFS) and some UFS also referred as spent foundry sand (SFS) and waste foundry sand.
(WFS). Generally, the color of UFS is black and it contains a huge amount of fine particles in its total mass. The physical and chemical properties of UFS are depending on the type of material used in the casting process.[13] In the present investigation to compare the compressive strength between conventional concrete with mixed concrete. The word mixed concrete used in this study for the concrete mix with admixtures, the admixtures as external material used may be in the fine aggregates or may in the cement.

2. OBJECTIVES OF THE PRESENT STUDY
The present research work designed in the direction to achieve the maximum strength and to estimate the cost of how much can we reduce by using admixtures in the concrete mix. The objectives of the present investigation have been summarised below in two-points.

- To assess the maximum compressive strength of concrete block with foundry sand as an admixture in fine aggregates.
- To identify the best material to reduce the cement content in the concrete mix out of Silica fume and Metakaolin.

3. METHODOLOGY

3.1 MATERIALS USED
Various materials like Cement, aggregates (fine/coarse), foundry sand, Silica fume[1] and Metakaolin [2] are used in the present investigation.[7] Before applying materials into the casting process, the properties (physical/chemical) of the material are identified and maintained as per the recommended IS codes. [11] The details of the materials is used for the present study has given below briefly. Due to the high preference in using 53-grade cement in real-time, the present experimental study also directed with 53-grade cement only.[12] The basic tests like initial setting, final setting, fineness test and specific gravity tests are conducted on the cement as per the IS code: 8112-1989. The fineness value of the obtained cement is 4.9% and the value of specific gravity is 3.13. The ingredient compositions like percentages of lime (60-67), silica (17-25), alumina (3-8), iron oxide (0.47-6), magnesium(0.1-4), alkali (0.4-1.3) and sulphur (1.3) are maintained throughout the testing.

3.2 FOUNDRY SAND
The Foundry sand is the main admixture used to find the compressive strength of the cube by replacing the aggregates.[3,4] The foundry sand the collected from the industries. The industry located in Hyderabad, Telangana state. As usual, to evaluate the basic characteristics of foundry sand the physical properties and some other parameters, basic tests like specific gravity, relative density and sieve analysis was conducted on the collected the foundry sand. The nature of the foundry sand is non-plastic and the value of specific gravity is obtained 2.2 and bulk density of foundry sand is 2589 kg/m3 achieved during the testing.[6] And from the sieve analysis, the fineness modulus of foundry sand is obtained as 1.89.

3.3 EXPERIMENTAL STUDY
In the present investigation, the experimental study planned in 12 stages, and each stage has been designated as trial no 1 to 12. In each trial, the content of fine aggregates replaced with the foundry sand up to 50% to trial no 6, and after that by keeping 40% foundry sand common in fine aggregates, the cement content has been replaced with Silica fume and Metakaolin. In the first stage, the cement replaced with Metakaolin of percentages of 10, 15 and 20 with respect to trial numbers 7,8 and 9, and then again without disturbing the foundry sand content (40%) in the fine aggregates in the second stage the conventional cement replaced with Silica fume of percentages of 5.7.5 and 10 with respect to trial numbers 10,11 and 12. The compressive strength testing on concrete cube is shown in figure1. The mix design method adopted in the present study as per IS 10262-2009 for M25 grade, total there are 3 different shapes (cubes) of moulds prepared within the considerable design mix. Before casting the moulds cleaned with oils to overcome permanent settlements in the moulds. [8] The mixed concrete was placed in the moulds layer by layer and a top surface of the mould maintained even. Then the prepared moulds allowed within the recommended room temperature for about 24 hours after that the complete moulds allowed the curing for 28 days. The compressive testing machine of capacity 100KN, used in this study for crushing samples. There are other samples tested in between the days (14 and 21) but the results in this study considered only for 28 dyas.

4. RESULTS AND DISCUSSION
The compressive strength conducted on the prepared moulds after 28days results only considered in this study. Initially, the compressive strength was observed between the conventional cubes and the cubes which replaced fine aggregates with foundry sand of different percentages (10, 20, 30, 40 and
The compressive strength results compared with conventional blocks and the blocks with a minimum percentage of foundry sand. It has been observed in the results of compressive strength up to 40% foundry sand gives better results and immediately at the 50% foundry sand cube results shown decreased values in compressive strength. In the second stage of testing, the other blocks with mixed admixture in cement used, in these cubes, 40% of foundry sand maintained constantly and cement replaced with Silica fume of percentages 5, 7.5 and 10. The maximum compressive strength achieved in these types of cubes is 42.96 KN/M2 at this stage the cement replaced with Silica fume 10%. Next compressive strength conducted on the cubes which constructed with Metakaolin as an admixture in the cement and the concrete blocks with 40% foundry sand. In this type of cube, the maximum compressive strength obtained 35.11 KN/M2 at 10% partial replacement of cement with Metakaolin. The detailed compressive strength test results are presented in table 1. The graphical representation in 2, 3and 4 figures shows a clear difference in the changes of compressive strength in all 3 types of admixtures in conventional concrete.

**Table 1: Compressive strength results after 28days curing period**

<table>
<thead>
<tr>
<th>Trial no</th>
<th>% of UFS</th>
<th>% of Metakaolin</th>
<th>% of Silica fume</th>
<th>Compressive strength in KN/M²</th>
<th>The increased or decreased strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>33.037</td>
<td>0</td>
</tr>
<tr>
<td>T2</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>34.98</td>
<td>5.881</td>
</tr>
<tr>
<td>T3</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>36.6</td>
<td>10.785</td>
</tr>
<tr>
<td>T4</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>37.88</td>
<td>14.659</td>
</tr>
<tr>
<td>T5</td>
<td>40</td>
<td>0</td>
<td>0</td>
<td>38.7</td>
<td>17.141</td>
</tr>
<tr>
<td>T6</td>
<td>50</td>
<td>0</td>
<td>0</td>
<td>33.13</td>
<td>0.282</td>
</tr>
<tr>
<td>T7</td>
<td>40</td>
<td>10</td>
<td>0</td>
<td>35.11</td>
<td>5.214</td>
</tr>
<tr>
<td>T8</td>
<td>40</td>
<td>15</td>
<td>0</td>
<td>33.85</td>
<td>1.438</td>
</tr>
<tr>
<td>T9</td>
<td>40</td>
<td>20</td>
<td>0</td>
<td>31.29</td>
<td>-6.233</td>
</tr>
<tr>
<td>T10</td>
<td>40</td>
<td>0</td>
<td>5</td>
<td>39.82</td>
<td>19.329</td>
</tr>
<tr>
<td>T11</td>
<td>40</td>
<td>0</td>
<td>7.5</td>
<td>40.71</td>
<td>21.996</td>
</tr>
<tr>
<td>T12</td>
<td>40</td>
<td>0</td>
<td>10</td>
<td>42.96</td>
<td>28.738</td>
</tr>
</tbody>
</table>

From the experimental studies, the author concludes this study in 3 points:

I. The compressive strength results of conventional concrete with 40% partial replacement foundry sand in fine aggregates have given the maximum strength, after reaching the maximum it’s started decreasing. So that it means we can replace the 40% fine aggregates with the foundry sand.

II. Due to the partial replacement of cement with 10% Metakaolin as an admixture, the compressive strength gets increased.

III. Another attempt made in cement with Silica fume content as an admixture, in this case, the maximum compressive strength observed at the same 10% of Silica fume.

Finally, with this study, the author concludes that the fine aggregates cost can be reduced near to half. Still, more investigations are required on the admixtures which are used in this study to replace the cement. The WFS can be used in the construction of Retaining walls, slopes, Embankments of Dams, Reservoirs and many other types of constructions. There are two advantages while using WFS.
in construction one we can reduce the total cost in fine aggregates and the other one is we can prevent the area from the disposal.

REFERENCES:
[12].IS:12269-1987 “Specifications for 53-Grade Portland cement”, Bureau of Indian Standards, New Delhi, India