ABSTRACT- Self-Compacting Concrete is an innovative concrete that doesn't need vibration for placing and compaction. It is able to flow underneath its own weight, completely filling formwork and achieving full compaction, even within the presence of engorged reinforcement. One various to cut back the price of self-compacting concrete is that the use of mineral admixtures appreciate oxide fume, ground granulated furnace scum and fly ash, that is finely, divided materials further to concrete throughout mixture procedure and chemical admixture like high range water reducers (HRWR or super plasticizer) and viscosity modifying admixtures (VMA). This paper presents an experimental investigation on strength aspects like compressive, flexural and split tensile strength of self-compacting concrete containing totally different mineral admixtures and workability tests for various mineral admixtures (slump, L-box, V-funnel, U-box and T50) are carried out. The methodology adopted is “Nan–Su” method of mix design as per “EFNARC” specifications (i.e., 55, 56, 57, 58 percentages) that satisfies the fresh properties and additionally the hardened properties of SCC confine the water/powder ratio is constant. The influence of mineral admixtures on the workability, compressive strength, and flexural strength of self-compacting concrete was investigated. The mix proportion is obtained as per the rules given by European Federation of producers and contractors of special products for structure. As a result, overall improvements within the flow ability, filling ability and segregation resistance of the self-compacting concrete were determined.

1. INTRODUCTION
Self compacting concrete (SCC) has been represented as “the most revolutionary development in concrete construction for many decades”. The most advantage of the Self compacting concrete is to shorten construction period and to assure compacting within the structures particularly within the confined zones wherever vibration and compaction is difficult.

The Self compaction concrete developed by professor, Hajime Okamura of Japan in 1986, however the prototype was initial developed in 1988 in Japan by Professor Ozawa at the University of Tokyo.

The specifications and guidelines for testing fresh-compacting concrete contained during this document are taken from “Specification and guidelines for Self-compacting concrete” published by EFNARC in February 2002. EFNARC is that the European federation dedicated to specialist construction
chemicals and concrete systems. to induce engineering properties and smart performance, it need high quality of cementitious material, mineral admixtures like ash, silicon oxide fume, GGBFS, stone powder and chemical admixture like high vary water reducers (HRWR or super plasticizer) and consistence modifying admixtures(VMA). It needs restricted aggregate concretes have aggregate contents of roughly 59 by volume.

The roles of those additives are as follows

- It will increase the hydration products and reduces the porosity of the concrete.
- It fills and closes the pores or adjusts the kind of pore structure.
- It increases hydration products in addition to the filling effect of micro aggregate.

In Nan-Su technique of combine style the quantity magnitude relation of fine combination to total aggregates ranges from 50 you are going to 58 you are going to achieve the fresh properties of SCC. And as per “EFNARC” specifications the coarse aggregate content normally ranges from 28th to 35 you interested in volume of mix to achieve the fresh properties of SCC.

2. LITERATURE REVIEW

Domone et al has done research on the effect on fresh properties of mortar phase of Self compacting concrete of four different types of super plasticizer and various combinations of powder, including Portland cement, GGBS, fly ash, micro silica and lime stone powder. He concluded that many of important parameters that influence the performance Self Compacting concrete can be assessed by testing on mortars.

Gram et al (1999) has focused their research on the properties of Self compacting concrete especially early age and long term shrinkage and salt frost resistance. The heat of hydration for Self compacting concrete is bigger and the time for when the maximum heat liberation is reached is shorter compared to ordinary concrete.

Kazumasa ozawa (1988) completed the first prototype of Self-compacting concrete using materials already on the market. By using different types of super plasticizers, he studied the workability of concrete and develops a concrete which was very workable.

Nan-Su et al proposed a simple mix design method for self-compacting concrete the amount of aggregates required is determined, and the paste of binders is then filled into the voids of aggregates to ensure that the concrete thus obtained has flow ability, self-compaction ability and other desired SCC properties.

A. Su, J.K. (7) in his studies the effect of sand ratio (Fine aggregate volume / total aggregate volume) on the elastic modulus of SCC: various SCC mixes with differing sand and admixtures (S/A) ratio were cast and tested.

3. EXPERIMENTAL PROGRAM

A. Cement

Ordinary Portland cement (Ultra-tech cement) of 53 grades conforming to IS: 12269 were used.
B. Fine aggregate

Locally available natural sand was used. Specific gravity and fineness modules were found to be 2.56 and 2.73 respectively.

C. Coarse aggregate

Crushed granite stone chips (angular) of 12mm and maximum size 20mm were used. Specific gravity and fineness modulus were found to be 2.62 and 7.61 respectively.

D. Super plasticizer

High range water reducing admixture called as super plasticizers are used for improving the flow or workability for decreased water cement ratio without sacrifice in the compressive strength. In the present work water-reducing admixture Glenium B233 conforming to ASTM C494 types F. EN934-2 T3.1/3.2, IS 9103: 1999 is used.

E. Viscosity modifying agent (VMA)

The use of viscosity modifying admixture (VMA) gives more possibility of controlling segregation. In the present work Stream2VMA is used.

F. Fly ash

The fly ash used in the investigation was procured from Kakatiya Thermal Power Station. This is collected from electrostatic precipitator. The specific gravity of fly ash was found to be 1.95.

Mix design procedure by Nan-Su method

The principal consideration of the proposed method is to fill the paste of binders into voids of the aggregate framework piled loosely. The loose unit weight of the aggregate is according to the shoveling procedure of ASTM C29, except discharging the aggregate at a height of 30 cm above to the top of the measure. The volume ratio of aggregate is about 52–58%, in other words, the void in the loose aggregate is about 42–48% according to ASTM C29.

The procedures of the proposed mix design method can be summarized in the following steps.

Step 1: Calculation of coarse and fine aggregate contents

Step 2: Calculation of cement content

Step 3: Calculation of mixing water content required by cement

Step 4: Calculation of fly ash (FA) and ground granulated blast-furnace slag (GGFS) contents

Step 5: Calculation of mixing water content needed in SCC

Step 6: Calculation of SP dosage

Step 7: Adjustment of mixing water content needed in SCC

Step 8: Trial mixes and tests on SCC properties

Step 9: Adjustment of mix proportions

Casting and curing of test specimens

The specimens of standard cubes (150mm x 150mm x 150mm), Standard prisms (100mm x 100mm x 500mm) and standard cylinders (150mm diameter x 300mm height) were casted.
Mixing

Measured quantities of coarse aggregate and fine aggregate were spread out over an impervious concrete floor. The mixture over and over until uniformity of color was achieved the time of mixing shall be 10-15 minutes.

Placing and compacting

The sections of mould were coated with mould oil and a similar coating of mould oil was applied between the contact surfaces of the bottom of the moulds and the base plate in order to ensure that no water escapes during the filling.

Curing

The test specimen cubes, prisms and cylinders were stored in a place, free from vibration, in most air at 90% relative humidity and at a temperature of 27 ±2c for 24 hours± ½ hour from the time of addition of water to the dry ingredients.

4. EXPERIMENTAL RESULTS

![Fig. 1](image1) Variation of (M60-Grade) passing ability for FA/TA ratios

![Fig. 2](image2) Flexural strength for M-40 grade on prisms at (7 and 28 days)

![Fig. 3](image3) Compressive strength for M-60 grade on cubes at (7 and 28 days)

![Fig. 4](image4) Split tensile strength for M-40 grade on cylinders at (7 and 28 days)

Table 1 Test results for Compressive strength of concrete (7 and 28 days)

<table>
<thead>
<tr>
<th>FA/TA ratios</th>
<th>M60</th>
<th>M40</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 days</td>
<td>51.13</td>
<td>39.53</td>
</tr>
<tr>
<td>28 days</td>
<td>70.88</td>
<td>54.19</td>
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</tbody>
</table>
Table 2 Test results for Flexural strength of concrete (7 and 28 days)

<table>
<thead>
<tr>
<th></th>
<th>Flexural Strength (N/mm²)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>For 58%</td>
<td>7 days</td>
<td>28 days</td>
</tr>
<tr>
<td>M60</td>
<td>3.06</td>
<td>4.27</td>
</tr>
<tr>
<td>M40</td>
<td>2.11</td>
<td>3.05</td>
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</table>

Table 3 Test results for Split tensile strength of concrete (7 and 28 days)

<table>
<thead>
<tr>
<th></th>
<th>Split tensile Strength (N/mm²)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>For 58%</td>
<td>7 days</td>
<td>28 days</td>
</tr>
<tr>
<td>M60</td>
<td>3.02</td>
<td>4.12</td>
</tr>
<tr>
<td>M40</td>
<td>2.08</td>
<td>3.00</td>
</tr>
</tbody>
</table>

Table 4 Test results for Specific gravity

<table>
<thead>
<tr>
<th>Trial mix</th>
<th>Grade</th>
<th>Specific gravity</th>
</tr>
</thead>
<tbody>
<tr>
<td>T4 (55%)</td>
<td>M40</td>
<td>3.48</td>
</tr>
<tr>
<td>T4 (55%)</td>
<td>M60</td>
<td>4.97</td>
</tr>
<tr>
<td>T4 (58%)</td>
<td>M40</td>
<td>3.45</td>
</tr>
<tr>
<td>T4 (58%)</td>
<td>M60</td>
<td>4.92</td>
</tr>
</tbody>
</table>

Water/ fly ash = 0.45

Quantity:

- Coarse aggregate = 744.12Kg/m³
- Fine aggregate = 1015.59Kg/m³
- Cement = 344.64Kg/m³
- Water = 189.55Lit/m³
- Fly ash volume = 0.002m³
- Fly ash = 3.70Kg/m³
- Water for fly ash = 1.67Lit/m³
- Super plasticizer = 3.48Lit/m³
- Adjustment of water quantity = 189.13Kg/m³

5. CONCLUSION

After the analysis of the results of the experimental program, the subsequent conclusions arrived.

Mix proportions for M40 and M60 grade of self-compacting concrete were developed using the Nan Su methodology of mix design that satisfied the fresh properties of SCC as per “EFNARC” specifications.

The fresh properties of SCC were satisfied once 400th of 20mm and 60 minutes of 12mm size of coarse aggregates were used. As the fine aggregate to total aggregate ratio will increase from 55 to 58, the fresh properties (i.e., filling ability, passing ability and segregation resistance) are satisfied as per “EFNARC” specifications.

ANNEXTURE-I

Mix design for M40 Grade using Nan-Su method (FA/TA=55%)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>W/C ratio</td>
<td>=</td>
<td>0.55</td>
</tr>
<tr>
<td>FA/TA</td>
<td>=</td>
<td>55%</td>
</tr>
<tr>
<td>Air content</td>
<td>=</td>
<td>1.5%</td>
</tr>
</tbody>
</table>
For both grades of concrete (i.e., M40 and M60), the compressive strength, splitting tensile strength and flexural strength of concrete is raised by increase in FA/TA ratio up to 57, on additional increase within the ratio i.e., 58%, the compressive strength, splitting tensile strength and flexural strength for both grades of concrete is reduced.

The compressive strength of concrete is raised by 4.96% for M40 grade of concrete and 4.74% for M60 grade of concrete, once the FA/TA ratio was raised from 55th to 57. The compressive strength of concrete is reduced by 4.89% for M40 grade of concrete and 4.22% for M60 grade of concrete, when the FA/TA ratio was increased from 57 to 58.

The splitting tensile strength of concrete is increased by 12.79% for M40 grade of concrete and 8.30% for M60 grade of concrete, when the FA/TA ratio was increased from 55th to 57. The splitting tensile strength of concrete is decreased by 10.71% for M40 grade of concrete and 9.25% for M60 grade of concrete, when the FA/TA ratio was raised from 57 to 58.

The flexural strength of concrete is increased by 16.50% for M40 grade of concrete and 15.10% for M60 grade of concrete, when the FA/TA ratio was increased from 55th to 57.

The flexural strength of concrete is decreased by 16.10% for M40 grade of concrete and 14.70% for M60 grade of concrete, when the FA/TA ratio was increased from 57 to fifty eight. The mechanical properties of SCC is not considerably affected by increased ratio of fine aggregate to total aggregate up to 57, however it has been reduced when the ratio was further raised to 58.

REFERENCES


