# AN EXPERIMENTAL INVESTIGATION ON SELF COMPACTING CONCRETE WITH ARTIFICIAL FINE AGGREGATE AS AN ALTERNATIVE TO THE NATURAL FINE AGGREGATE

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***Abstract-** Concrete can be considered as the most widely used in the construction industry. Concrete is a composite material made up of cement, sand, water and sometimes admixtures. Cement is the most active component and the use of large quantities of cement results in increasing $CO_2$ emissions and as a consequence of the green house effect. On the other hand continuous use of natural aggregates causes environmental problems and it is also necessary to preserve the natural sources. The use of sustainable technologies such as supplementary materials is expected to positively affect the performance of concrete mixtures. Self-compacting concrete (SCC) is an innovative development of conventional concrete, which can be placed and compacted under its self weight with little or no vibration effort. This paper present the Mechanical and Durability properties of self compacting concrete using cementitious materials as a partial replacement of cement like Fly ash(15%), Silica fume(15%) and Metakaolin(5%) ; Artificial fine aggregate as natural fine aggregate having fineness modulus 2.7; Coarse aggregate of size 12mm and* CONPLAST SP337 as Super-plasticizer*. SCC containing different proportion of these mineral admixtures has been tested for slump flow, V-funnel, L-box, U-box and J-ring and found that the values are within the limits prescribed by EFNARC, 2002 method. The properties reported in this paper are the workability properties, Mechanical properties and Durability Properties. The Workability properties were investigated by Slump flow (filling ability), V-Funnel (filling ability) and L-Box test (passing ability). The Mechanical properties were tested for Compressive strength, Splitting Tensile strength and Flexural strength of 7 days, 28 days and 90 days were obtained. The Durability properties were tested for Water absorption and Acid tests.*

***Key words**: SELF COMPACTING CONCRETE, FLY ASH, SILICA FUME, METAKAOLIN, ARTIFICIAL FINE AGGREGATE,* CONPLAST SP337.

## 1. INTRODUCTION

Concrete is the most common material used in the construction. Concrete gives considerable freedom to mould the structural component into desired shape or form. Cement and concrete composites are presently the most economic materials for construction. A new trend in designing complex and heavily reinforced structures showed that compaction of concrete by vibrating may be difficult in some cases and strongly depend on a human factor. It is commonly noticed many times that after the formwork is removed, the fresh concrete had not spread to all the points, uniformly and perfectly. A homogenous property of the structure has thus been adulterated. These reasons prompted to the development of Self Compacting Concrete. Self Compacting Concrete (SCC) is considered as a concrete which can be placed and compacted under its self weight with little or no vibration effort, and which is at the same time it is enough to be handled without segregation or bleeding of fresh concrete. It is able to flow under its own weight, completely filling formwork and achieving full compaction.

Cement is the important active ingredient of concrete. The Indian Standard Code of practice for plain and reinforced concrete recommends the minimum cement content to satisfy the strength and durability. Hence, the utilization of cement is increased. But, the cement production consumes large amount of energy and emits carbon dioxide results in environmental pollution. Hence, one of the solutions to these problems is to reduce the consumption of cement and utilise Pozzolana materials for the preparation of concrete. Previous studies indicates that the use of cementitious materials like Fly ash, Silica fume, Metakaolin and Ground Granulated Blast Furnace Slag (GGBS) as partial replacement of cement, reduces the cement consumption and also increases the strength and durability of concrete.

In SCC, the aggregates generally contribute approximately 2/3 of the total volume. Proper choice of aggregates has significant effect on the fresh and hardened properties of SCC concrete. In general it is observed that the effects of shape and texture of fine aggregate are much more important than the effects of coarse aggregate. It is in practice that river sand is being used as fine aggregate in concrete for many centuries. Most of the construction industries use river sand only as fine aggregate. Investigations are going on due to increase in demand and depletion of river sand, along with restrictions imposed on the exploitation of the river sand. One of the solution for this problems is the use of alternative materials for river sand such as artificial fine aggregate, industrial by products (some forms of slag, bottom ash), recycled aggregates, etc. Among the above materials, artificial fine aggregate is relatively receiving significant attention as a replacement for river sand. The artificial fine aggregate is produced by impact crushing rock deposits to obtain a well graded fine aggregate. It is known that for SCC, high powder (cement, cementitious materials and inert fillers) content is required for achieving the required fresh concrete properties. Since, artificial fine aggregate contains large amount of fines, can be used as an alternative to river sand. Due to high fines content in artificial fine aggregate, the strength and durability properties of the concrete are reported to be considerably improved by using artificial fine aggregate. From the literature, it is observed that artificial fine aggregate is being used as fine aggregate in conventional aggregate and limited applications in SCC.

## 2. LITERATURE REVIEW

**Nan Su et al. (2001)** proposes a simple design mix method for Self-compacting concrete. Primarily, required quantities of aggregates are evaluated and binder paste is then poured in to space of aggregates to make sure that concrete attained flowability, its own compactability and other properties of SCC. To observe the behavior of SCC compressive test were carried out. Obtained result indicates this method could produce successfully high quality of self-compacting concrete. As compare to the Japanese Ready-Mixed Concrete Association this method is easier, simple for execution, time consumption is less and cost effective.

**Jian-Tong Ding et al. (2002)** experimentally found out the effects of Metakaolin and Silica fume on the properties of concrete. Experimental investigation with seven concrete mixtures of 0,5,10 and 15% by mass replacement of cement with high reactivity Metakaolin or Silica fume on the workability, strength, shrinkage and resistance to chloride penetration of concrete was investigated. The incorporation of both Metakaolin and Silica fume in concrete was found to reduce the free drying shrinkage and restrained shrinkage cracking width. It is also reported that the incorporation of Metakaolin or Silica fume in concrete can reduce the chloride diffusion rate significantly. The performance of Silica fume was found to be better than Metakaolin.

**Pacheco Torgal.F et al. (2011)** determined the effect of Metakaolin and Fly ash on strength and durability of concrete. The durability was found by three methods namely water absorption, oxygen permeability and concrete resistivity. They reported that partial replacement of Portland cement by 30% Fly ash leads to serious decrease in early age compressive strength than the reference mix made with 100% Portland cement. The use of hybrid of them at 15% Fly ash and 15% Metakaolin based mixtures resulted in minor strength loss at early stages but showed outstanding improvement in durability.

**Benchaa Benabed et al. (2012)** had used different types of sand as replacement of fine aggregate like crushed sand, river sand, dune sand and mixture of all sand. Different inert fillers and supplementary cementitious materials they have added. The slump flow, V- funnel flow time and viscosity measurement tests were used to study the rheological properties. The experimental results indicate that the rheological properties and strength imp rove with mixtures of crushed and river sands but decrease with mixtures of crushed and dune sands especially for higher dune sand content. The slump flow time decreased with the increase in limestone fines content whereas V-funnel flow time increased. The V-funnel flow time has a direct relationship with viscosity as the increase in V- funnel flow time increases the viscosity of mortar.

**Ganeshwaran.P.A et al. (2012)** had evaluated the Mechanical Properties of Self Compacting Concrete with Manufactured Sand and Fly Ash. SCC containing different proportion of fly ash have been tested for Slump flow, V-funnel, U-Box, L-box and J-ring and found that the values are within the limits prescribed by EFNARC. Mechanical properties such as compressive strength, split tensile strength have been evaluated as per Bureau of Indian Standards. It is observed from the studies that the compressive strength and split tensile strength decreases with the increase in replacement of cement by fly ash. It was concluded that SCC with manufactured sand and fly ash can be used for all applications in the construction sector.

## 3. OBJECTIVE

The main objective of this investigation is to use of Fly ash (15%), Silica fume (15%) and Metakaolin (5%) as a partial replacement of cement and Artificial fine aggregate as a fully replacement of natural fine aggregate in SCC. Characterization of all ingredients of SCC has been performed. Mechanical and Durability properties have been evaluated.

## 4. EXERIMENTAL PROGRAMME

### 4.1 Materials

**Cement**: In this investigation Ordinary Portland cement (OPC) of 43 Grade confirming to IS specifications was used. The properties of cement are shown in Table 1.

**Table 1.Properties of Cement**

| S. No | Property | Test results |
|---|---|---|
| 1 | Normal consistency | 30% |
| 2 | Specific gravity | 3.15 |
| 3 | Initial setting time | 90 minutes |
| 4 | Final setting time | 330 minutes |

**Artificial Fine Aggregate:** In this paper, artificial fine aggregate is totally replaced as fine aggregates which is procured from Hyderabad, with different sizes that passing through 4.75mm, 2.36mm, 1.18mm, 600µ, 300µ and 150µ. The properties of Artificial Fine Aggregate are shown in Table 2.

**Table 2.Properties of Artificial Fine Aggregate**

| S. No | Property | Test results |
|---|---|---|
| 1 | Fineness Modulus | 2.7 |
| 2 | Specific gravity | 2.6 |
| 3 | Bulk density | 1600 $kg/m^3$ |
| 4 | Grading zone | II |

**Coarse aggregate:** In this investigation coarse aggregate of size 12 mm used and obtained from the local quarry confirming to IS specifications was used. The properties of coarse aggregate are shown in Table.3.

**Table 3.Properties of Coarse Aggregate**

| S.NO | PROPERTY | VALUES |
|---|---|---|
| 1 | Specific Gravity | 2.58 |
| 2 | Water Absorption | 0.3% |

**Chemical Admixture**: CONPLAST SP337 is using as a Super-plasticizer (chemical admixture) in this work. The main reason of utilizing super-plasticizer in SCC it gives good flowability with very high slump that is to be used in heavily reinforced structural member.

**Fly ash:** Fly ash used in this present experimental study is obtained from ASTRRA chemicals, Chennai. Properties of fly ash as given by the supplier are given in the following table 4 and table 5.

**Table 4.Physical Properties of Fly Ash**

| | |
|---|---|
| Colour | White grey |
| Specific gravity | 2.12 |
| Bulk Density | 0.994 gm/cc |

**Table 5.Chemical Properties of Fly Ash**

| Constituents | Values |
|---|---|
| $SiO_2$ | 59.00% |
| $Al_2O$ | 21.00% |
| $Fe_2O_3$ | 3.70% |
| CaO | 6.90% |
| MgO | 1.40% |
| $SO_3$ | 1.00% |
| $K_2O$ | 0.90% |
| LOI | 4.62% |

**Silica fume:** Silica fume is a by-product resulting from the reduction of high quantity quartz with coal in electric arc in the manufacture of silicon or ferrosilicon alloy. And it is obtained from ASTRRA chemicals, Chennai. Properties of silica fume as given by the supplier are given in the following Table 6 and Table 7.

**Table 6.Physical Properties of Silica Fume**

| S.No. | Properties | Results |
|---|---|---|
| 1 | Physical State | Micronised Powder |
| 2 | Odour | Odourless |
| 3 | Appearance | White Colour Powder |
| 4 | Colour | White |
| 5 | Pack Density | 0.76 Gm/Cc |
| 6 | Ph Of 5% Solution | 6.90 |
| 7 | Specific Gravity | 2.63 |
| 8 | Moisture | .058% |
| 9 | Oil Absorption | 55 Ml / 100 gms |

**Table 7.Chemical Properties of Silica Fume**

| S.No. | Properties | Results |
|---|---|---|
| 1 | Silica ($SiO_2$) | 99.886% |
| 2 | Alumina ($Al_2O2$) | 0.043% |
| 3 | Ferric Oxide ($Fe_2O_3$) | 0.040% |
| 4 | Titanium Oxide ($TiO_2$) | 0.001% |
| 5 | Calcium Oxide (CaO) | 0.001% |
| 6 | Magnesium Oxide (MgO) | 0.000% |
| 7 | Pottasium Oxide ($K_2O$) | 0.001% |
| 8 | Sodium Oxide ($Na_2O$) | 0.003% |
| 9 | Loss On Ignition | 0.015% |

**Metakaolin:** Metakaolin, used in this present experimental study is obtained from ASTRRA chemicals, Chennai. Specification, physical and chemical properties of the Metakaolin as given by the supplier are given in the following Table 8 and Table 9.

**Table 8.Physical Properties of Metakaolin**

| Properties | Value |
|---|---|
| Density ($gm/cm^3$) | 2.17 |
| Bulk density ($gm/cm^3$) | 1.26 |
| Particle shape | Spherical |
| Colour | Half-white |
| Specific gravity | 2.6 |

**Table 9.Chemical Properties of Metakaolin**

| Constituents | Values |
|---|---|
| Silica | 53% |
| Alumina | 43% |
| Iron Oxide | 0.5% |
| Calcium Oxide | 0.1% |
| Sulphate | 0.1% |
| Sodium Oxide | 0.05% |
| Potassium Oxide | 0.4% |

**Water:** The water used for casting and curing of concrete test specimens was free from acids, organic matter, suspended solids and impurities which when present can adversely affect the strength of concrete. The local drinking water free from such impurities has been used in this experimental programme for mixing and curing.

### 4.2 Evaluation fresh properties of SCC

The proportioning of the quantity of cement, cementitious material like Fly ash, Silica fume and Metakaolin, artificial fine aggregate and coarse aggregate has been done by weight as per the mix design. Water and super plasticizer were measured by volume. All the measuring equipments are maintained in a clean serviceable condition with their accuracy periodically checked. The mixing process is carried out in electrically operated concrete mixer. The materials are laid in uniform layers, one on the other in the order – coarse aggregate, artificial fine aggregate and cementitious material. Dry mixing is done to obtain a uniform colour. The Fly ash, Silica fume and Metakaolin is thoroughly blended with cement before mixing. Self Compacting characteristics of fresh concrete are carried out immediately after mixing of concrete using EFNARC specifications. In order to study the effect on fresh concrete properties, the SCC containing different proportion of Fly ash, Silica fume and Metakaolin have been tested for Slump flow, V-funnel and L-box. The results of various fresh properties tested by slump flow test (Filling ability), V-funnel test (Filling ability), L-box test (Passing ability) for various mix compositions in the present study conform to range given by EFNARC, 2002 method standards which are given in following Table 10.

**Table 10: Workability properties of SCC (EFNARC, 2002)**

| Method | Property | Typical range |
|---|---|---|
| **Slump flow** | Filling ability | 650-800mm |
| **$T_{50cm}$ slump flow** | Filling ability | 2-5 seconds |
| **V-funnel test** | Filling ability | 6-12 seconds |
| **L-box test** | Passing ability | $h_2/h_1$ = 0.8-1.0 |

The Slump flow test is done to assess the horizontal flow of concrete in the absence of obstructions. It is a most commonly used test and gives good assessment of filling ability. It can be used at site. The test also indicates the resistance to segregation.

**Fig.1.Slump Flow Test**

The procedure for $T_{50}$ slump flow test is same for Slump flow test. When the slump cone is lifted, start the stop watch and find the time taken for the concrete to reach 500mm mark. This time is called $T_{50}$ time. This is an indication of rate of spread of concrete. A lower time indicate greater flowability.

The V-funnel test is used to determine the filling ability (flowability) of the concrete with a maximum size of aggregate 20mm. The funnel is filled with about 12 litre of concrete. Find the time taken for it to flow down.

Fig.2.V-funnel Test

The L-box test assesses the flow of concrete, and also the extent to which the concrete is subjected to blocking by reinforcement. This test is used to determine the passing ability of the concrete.

Fig.3.L-box Test

Test results of this investigation indicated that all SCC mixes meet the requirements of allowable flow time. Maximum size of coarse aggregate is kept as 12 mm in order to avoid blocking effect in the L-box. The gap between rebars in L-box test is 35 mm. As a whole, it is observed that all the fresh properties of concrete values are found to be in good agreement to that of the values provided by European guidelines.

Table 11 presents the mix proportion for Self compacting concrete. These proportions are finalized by keeping all ingredients constants and by adjusting the w/p ratio and superplasticizer.

**Table 11.Mix Proportions of SCC**

| Type of mix | Cement ($Kg/m^3$) | Fly ash | Silica fume | Metakaolin | Artificial fine aggregate | Coarse aggregate | Water | W/P | SP | VMA | Paste ($litre/m^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **SCC** | 410 | 72.5 | 72.5 | 25 | 865 | 720 | 175 | 0.36 | 7.75 | 0 | 375 |

## 4.3 Evaluation of Mechanical Properties of SCC

In this investigation various Mechanical properties such compressive strength, split tensile strength and flexural strength has been evaluated.

To evaluate these properties the following specimens were required to cast.

1. For compressive strength cubes with the dimension of 150 x 150 x 150 mm is casted and the tests were performed at the age of 7, 28 and 90 days.
2. For split tensile strength cylinder with dimension of 150mm diameter and 300mm height is prepared. Tests were carried out at the age of 7, 28 and 90days.
3. For flexural strength, beams with dimension of 150 x 150 x 700 mm are prepared and tests were conducted at the age of 7, 28 and 90 days.

## 4.4 Evaluation of durability properties of SCC

The durability of a concrete structure is closely associated to the permeability of the surface layer, the one that should limit the ingress of substances ($CO_2$, Chloride, Sulphate, Water, Oxygen, Alkalis, Acids, etc.) that can initiate or propagate

Possible deleterious actions. For durability characteristics, several tests are used to evaluate the performance of the concrete in different aggressive environment.

In this investigation, the durability properties such as Water absorption and Acid resistance were investigated.

### 5.0 Results and Discussions

### 5.1 Fresh properties of SCC

Results obtained by fresh concrete testing are presented in Table 12. SCC mix showed horizontal slump flow without any bleeding at the periphery which indicates good deformability and segregation resistance.

### 5.2 Mechanical properties

The strength parameters of SCC are presented in the Table 13. Fig.4 represents the compressive strength of SCC. From the figure it can be observed that at 28days strength, an increment of 12.3% can be achieved for SCC compared to controlled mix.

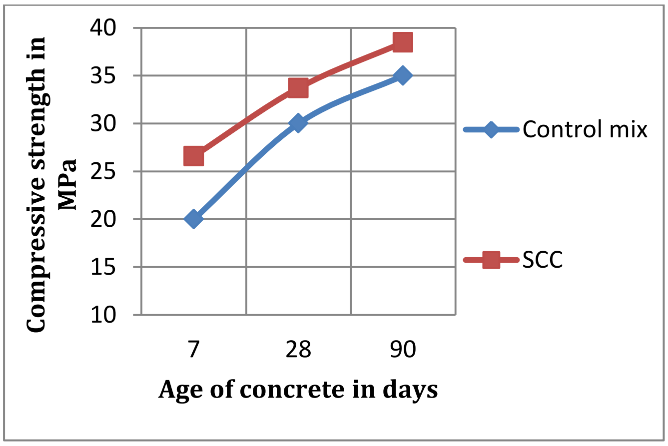


**Fig.4.Compression Strength of SCC**

Fig.5 represents the split tensile strength of SCC. From the figure it can be observed that at 28days strength, an increment of 12.5% can be achieved for SCC compared to controlled mix.

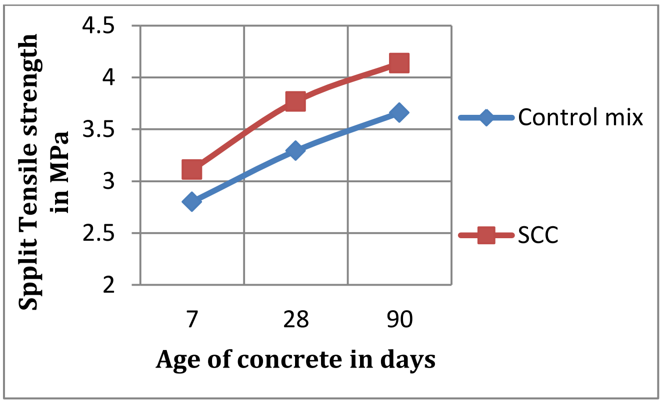


**Fig.5.Spit Tensile Strength of SCC**

Fig.6 represents the Flexural strength of SCC. From the figure it can be observed that at 28days strength, an increment of 11.4% can be achieved for SCC compared to controlled mix.

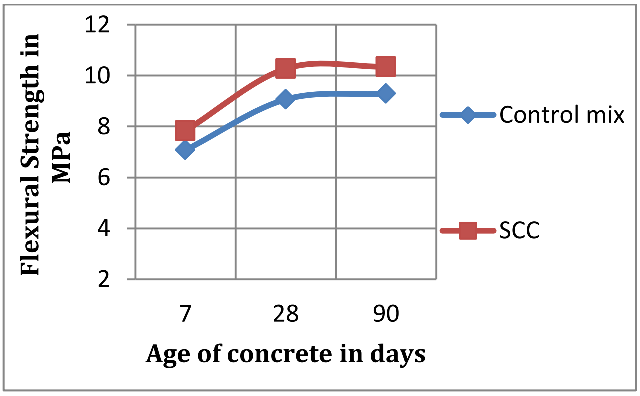


**Fig.6.Flexural Strength of SCC**

**Table 12.Fresh Properties of SCC**

| Method | Property | Typical range (EFNARC, 2002) | Obtained values |
|---|---|---|---|
| **Slump flow** | Filling ability | 650-800mm | 710mm |
| **$T_{50cm}$ slump flow** | Filling ability | 2-5 seconds | 3 seconds |
| **V-funnel test** | Filling ability | 6-12 seconds | 8 seconds |
| **L-box test** | Passing ability | $h_2/h_1 = 0.8$-$1.0$ | 0.8 |

Table 13.Strength Parameters of SCC

| Type of concrete | Compressive strength (MPa) | | | Split tensile strength (MPa) | | | Flexural strength (MPa) | | |
|---|---|---|---|---|---|---|---|---|---|
| Age (days) | 7 | 28 | 90 | 7 | 28 | 90 | 7 | 28 | 90 |
| Control Mix | 20 | 30 | 35 | 2.80 | 3.29 | 3.66 | 7.08 | 9.07 | 9.29 |
| SCC | 26.59 | 33.70 | 38.46 | 3.11 | 3.76 | 4.14 | 7.84 | 10.27 | 10.35 |

### 5.3 Durability properties

#### 5.3.1 Water absorption

Water absorption is the indicator of permeability of concrete. The obtained results are shown in following Table 14.

Table 14.Water Absorption Test

| Age (days) | Water absorption (%) |
|---|---|
| 28 | 1.20 |
| 56 | 1.54 |
| 90 | 1.72 |

#### 5.3.2 Acid resistance

The acid resistance test was conducted by immersing the specimens in HCl and $H_2SO_4$ solution and measuring the loss in weight and compressive strength of the specimens. The obtained results are shown in the following Table 15.

Table 15.Acid Resistance Test

| Age (days) | Loss in weight (%) | |
|---|---|---|
| | HCl | $H_2SO_4$ |
| 28 | 2.58 | 6.67 |
| 56 | 3.63 | 14.50 |
| 90 | 4.83 | 20.12 |

### 6.0 A simple tool for SCC mix Design

Table 16.Material Properties

| Material data | | | |
|---|---|---|---|
| Material | Specific gravity | % Absorption | % Moisture |
| Cement | 3.15 | N/A | N/A |
| Fly ash | 2.6 | N/A | N/A |
| Silica fume | 2.63 | | |
| Metakaolin | 2.6 | | |
| Coarse aggregate | 2.58 | 0.3 | 0 |
| Artificial Fine aggregate | 2.6 | 1.0 | 0 |

Table 17.Input parameters section

| Input parameters | |
|---|---|
| Dry Rodded Unit Weight ($kg/m^3$) | 1600 |
| % of CA in DRUW | 45.1 |
| % of Artificial Fine aggregate in Mortar | 46.1 |
| % of fly ash | 15 |
| % of silica fume | 15 |
| % of metakaolin | 5 |
| Water/Binder ratio | 0.36 |
| Binder($kg/m^3$) | 483 |
| SP (%wt. of binder) | 1.6 |
| VMA (% wt. of binder) | 0 |
| % of Air | 2 |
| % of dry material in SP | 40 |
| % of dry material in VMA | 0 |

**Table 18.Concrete Mix proportion by Volume**

| | | | |
|---|---|---|---|
| Coarse aggregate (kg/m³) | 720 | | |
| % of CA in concrete volume | 30 | | |
| Concrete Mix Proportions by Volume (litre/m³) | | | |
| CA | Mortar | Fine aggregate | Paste |
| 280 | 720 | 335 | 390 |
| Sand (kg/m³) | 865 | | |
| Total aggregates (kg/m³) | 1585 | | |

**Table 19.Paste Composition**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Volume of water/powder | | | | | | | 1.299152 |
| Paste Composition | | | | | | | |
| kg/m³ | | | | | | | litre/m³ |
| Cement | Fly ash | Silica fume | Metakaolin | Water | SP | VMA | Paste |
| 315 | 72.5 | 72.5 | 25 | 175 | 7.75 | 0 | 375 |

**Table 20.Constituent Materials for SCC**

| Constituent Materials for Concrete | | | | |
|---|---|---|---|---|
| Material (kg/m³) | Initial | Adjusted | Required (m³) 0.0142 | g/ml |
| Cement | 315 | 315 | 4.46 | 4458.09 |
| Fly ash | 72.5 | 72.5 | 1.03 | 1028.79 |
| Silica fume | 72.5 | 72.5 | 1.03 | 1028.79 |
| Metakaolin | 25 | 25 | 0.34 | 342.93 |
| Coarse aggregate | 720 | 720 | 10.25 | 10246.72 |
| Artificial Fine Aggregate | 865 | 865 | 12.26 | 12259.77 |
| Water | 175 | 180 | 2.47 | 2469.10 |
| SP (lit) | 7.75 | 7.75 | 0.11 | 109.77 |
| VMA (lit) | 0 | 0 | 0 | 0 |
| Unit weight | 2252.75 | Total (kg) | 32 | 31960 |
| | | Liters | 15 | |

**Table 21. Constituent Material for SCM**

| Constituent material for mortar | | | | |
|---|---|---|---|---|
| Material (kg/m³) | Initial | Adjusted | Required (m³) 0.0008 | g/ml |
| Cement | 315 | 315 | 0.25116 | 251.16 |
| Fly Ash | 72.5 | 72.5 | 0.05796 | 57.96 |
| Silica Fume | 72.5 | 72.5 | 0.05796 | 57.96 |
| Metakaoline | 25 | 25 | 0.02 | 19.32 |
| Artificial | 865 | 865 | 0.69 | 142.30 |

| | | | | |
|---|---|---|---|---|
| **Fine Aggregate** | | | | |
| **Water** | 175 | 175 | 0.14 | 690.69 |
| **VMA (lit)** | 7.75 | 7.75 | 0.01 | 6.18 |
| **Unit Weight** | | **Total (kg)** | **1.15** | **1150** |
| | | **liters** | **0.52** | |

**Table 22.Aggregate Proportions by Volume and by Weight**

| Aggregate Proportions | | |
|---|---|---|
| **Material** | **% by Volume** | **% by Weight** |
| **Coarse Aggregate** | 45.72 | 45.53 |
| **Fine Aggregate** | 54.28 | 54.47 |
| **Total** | 100 | 100 |

**7.0 Conclusions**

1. Based on this study, it concludes that, the required fresh properties of SCC by fixing the fineness modulus of artificial fine aggregate to 2.7 is within the limits of EFNARC, 2002 method.
2. SCC mix showed horizontal slump flow without any bleeding at the periphery which indicates good deformability and segregation resistance.
3. By replacing the limited amount of cement content in SCC with the cementitious materials like Fly ash, Silica fume, Metakaolin in fixed basis resulting mechanical properties increasing manner with respect to age of the concrete.
4. The investigation reveals that, by utilizing the super-plasticizer as chemical admixture in SCC to get required fresh properties in economical way.
5. From the experimental results, it can be concluded that the SCC has higher mechanical properties than control mix.
6. The percentage increase in compressive, split and flexural strength of SCC at 28 days is 12.3%, 14.3% and 13.2% respectively more compared to the control mix.
7. The evaluated durability properties of SCC showing minimal effect of Water absorption and Acid resistance with respect to performance.

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