Indexed in
Scopus Compendex and Geobase Elsevier,
Geo-Ref Information Services-USA, List B of Scientific
Journals, Poland, Directory of Research Journals

International Journal of Earth Sciences and Engineering

www.cafetinnova.org

ISSN 0974-5904, Volume 09, No. 03

June 2016, P.P.579-583

# Experimental Investigation on Self Compacting Concrete with Foundry Sand and Tile Powder

**P YAZHINI, A VENNILA, R VENKATASUBRAMANI AND V SREEVIDYA**
*Cafet Innova Technical Society, Hyderabad, Andhra Pradesh, INDIA*
***Email:*** *yazhparamasivam@yahoo.com, vnilaa.21@gmail.com, rvs_vlb@yahoo.com, v.sreevidya@skct.edu.in*

**Abstract:** Self compacting concrete was conceptualized by Prof.Okamura at Ouchi University, Japan in 1986. Self-compacting concrete requires no consolidation work which improves the durability and uniformity of the concrete.It is a highly flowable and non-segregating concrete filling the formwork easily. This paper explores the strength and durability studies of self-compacting concrete using Foundry sand and tile powder. The parameters like protection of natural resources, environmental consciousness are the present construction field requirements. Environmental pollution a major problem faced by mankind, mainly in the construction industry the production of Portland cement causes the emission of pollutants that causes serious threat to the environment. The pollution effects on environment due to cement production can be reduced by increasing the usage of waste products in our construction industry. Usage of Foundry sand and tile powder is such a remedial measure and in the present study, sand is being replaced with Foundry sand and Tile powder is choosen as powder in binder (cement + powder). The percentage replacement of foundry sand with sand includes 10%, 15%, 20%, 25%, 30%. The binder is 70% of cement and 30% of tile powder. The Mix design for SCC was arrived as per the guidelines of EFNARC (European Federation of National Associations Representing for Concrete). As per the results from the strength tests carried out the strength was found to be achieved with 30% replacement of foundry sand. The Flexural strength of beam (structural member) is investigated using the optimal value (30% replacement of foundry sand). The flexure strength of the beam was carried out using two point loading. The experimental results were compared with the results from ANSYS (Finite element analysis software).

***Keywords:*** *Self Compacting concrete, EFNARC, Tile Powder, Durability Studies, Hardened properties*

## 1. Introduction

The Problem of durability of concrete was a major topic of interest in Japan in the year 1983. Due to the Lack of uniformity and complete compaction of concrete by vibration researches at the University of Tokyo started to develop SCC. A self-compacting concrete is a unique type of concrete which can be compacted into every corner of a formwork purely by its own self weight, without any vibrating compaction. Several European countries recognized the significance of SCC developed in Japan and led to the development of European Federation and Natural trade Associations representing producers and applicators of specialist building products (EFNARC).Self Compacting Concrete is defined as a type of concrete that is able to flow and consolidate under its own weight, completely fill the formwork even in the presence of dense reinforcement, albeit maintaining homogeneity without any additional compaction. This type was also named as High Performance Concrete. “It is considered as the most revolutionary development in concrete construction for several decades”. The three stages of the concrete include,

i) Fresh : Self-compactable
ii) Early age : Avoids initial defects
iii) After Hardening: Protects from external effects.

## 2. Material properties

### 2.1 Cement

Ordinary Portland cement of 43 grade confirming to IS 8112-19890 was used. The Physical Properties are given in the Table 1.

***Table 1.****Physical Properties of cement*

| S.No. | Properties | Values |
|---|---|---|
| 1. | Specific gravity | 3.14 |
| 2. | Initial setting time | 95min |
| 3. | Final setting time | 320min |

### 2.2 Fine Aggregates

The sand (Fine Aggregate) sieved through 4.75 mm sieve is used. It is defined by size being finer than gravel and coarse than silt. Sand can also refer to a textural class of soil or soil type.

***Table 2.****Physical Properties of Sand*

| S.No. | Properties | Values |
|---|---|---|
| 1. | Specific gravity | 2.55 |
| 2. | Fineness modulus | 2.20 |

### 2.3 Foundry Sand

Foundry sand consists of clean, uniformly sized, high quality silica sand that is bonded to form molds of both ferrous and nonferrous metal castings. This can be used in many ways as natural and manufactured sands.

***Table 3.****Physical Properties of Foundry Sand*

| S.No. | Properties | Values |
|---|---|---|
| 1. | Specific gravity | 2.40. |
| 2. | Colour | Reddish. |

**2.4 Coarse Aggregate**

The coarse aggregate obtained from the locally available crushing plant is used. The physical properties are given in Table-4.

***Table 4.****Physical Properties of Coarse Aggregate*

| S.No. | Properties | Values |
|---|---|---|
| 1. | Size | 10-12.5 mm |
| 2. | Fineness modulus | 60. |
| 3. | Specific Gravity | 2.65. |

**2.5 Tile Powder**

There are certain circumstances (eg: during demolishing buildings) were broken tiles are being wasted; instead they were powdered and replaced for cement.

***Table 5.****Physical Properties of Tile Powder*

| S.No. | Properties | Values |
|---|---|---|
| 1. | Specific gravity | 2.85. |
| 2. | Colour | Creamy white |

**2.6 Admixture**

Conplast SP430 DSI (Sulphonated Naphthalene Formaldehyde based super plasticizer) was used. The Dosage is about 1% of cementations material.

***Table 6.****Physical Properties of Conplast*

| S.No. | Properties | Values |
|---|---|---|
| 1. | Specific gravity | 1.145 |
| 2. | Colour | Dark brown liquid |

**2.7 Water**

Potable water was used for mixing and curing.

**2.8 Mix Proportion**

The mix proportion was chosen in order to satisfy all the criteria for the concrete in both fresh and hardened state. Since there is no particular method for SCC mix design many academic institutions, precast and contracting companies have developed their own proportioning methods. The use of ultrafine materials and chemical admixture is a must in case of SCC. The components are better coordinated one by one preventing segregation, bleeding and sedimentation.

The EFNARC guidelines are used for developing a mix proportion for $M_{25}$ grade. The EFNARC guidelines are

- W/B ratio :- 0.25-0.4
- Sand content should be greater than 50%of total aggregate volume.
- Free water < 200 litres
- Powder content :- 400-600 Kg/m$^3$

**3. Experimental investigation**

The hardened properties of self-compacting concrete for various replacement percentages of Foundry Sand and Tile Powder are determined.

**3.1 Hardened Properties**

The mechanical properties are determined by conducting Compressive strength tests at 7 and 28 days of cube (150 x 150 x 150 mm) specimens. Two specimens were tested for each combination. The results are discussed below,

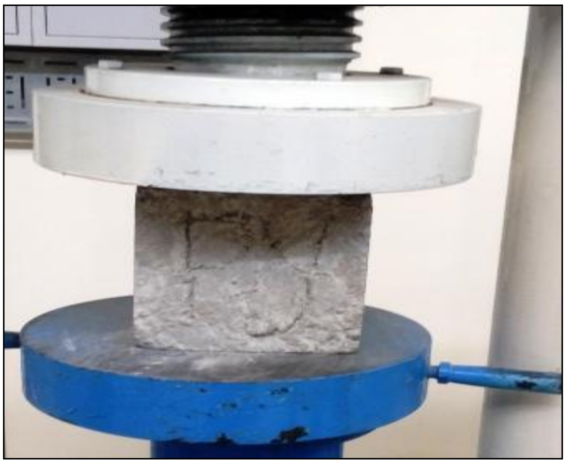

***Figure 1.****Compression strength Test*

***Table 7.****Compressive strength of SCC with Foundry Sand and Tile Powder (7 days)*

| S.No. | Percentage replacement of materials | | | 7 days Compressive strength (N/mm$^2$) |
|---|---|---|---|---|
| | Foundry Sand | Tile Powder | *SP* | |
| 1. | 0 | 0 | 0 | 18.44 |
| 2. | 10 | 30 | 0.7 | 13.33 |
| 3. | 15 | 30 | 0.7 | 12 |
| 4. | 20 | 30 | 0.7 | 13.78 |
| 5. | 25 | 30 | 0.7 | 16 |
| 6. | 30 | 30 | 0.7 | 23.56 |

***Table 8.****Compressive strength of SCC with Foundry Sand and Tile Powder (28 days)*

| S.No. | Percentage replacement of materials | | | 28 days Compressive strength (N/mm$^2$) |
|---|---|---|---|---|
| | Foundry Sand | Tile Powder | *SP* | |
| 1. | 0 | 0 | 0 | 23.11 |
| 2. | 10 | 30 | 0.7 | 18.67 |
| 3. | 15 | 30 | 0.7 | 17.78 |
| 4. | 20 | 30 | 0.7 | 15.56 |
| 5. | 25 | 30 | 0.7 | 18.22 |
| 6. | 30 | 30 | 0.7 | 31.11 |

The graph indicates the compressive strength variations for 7 days and 28 days.

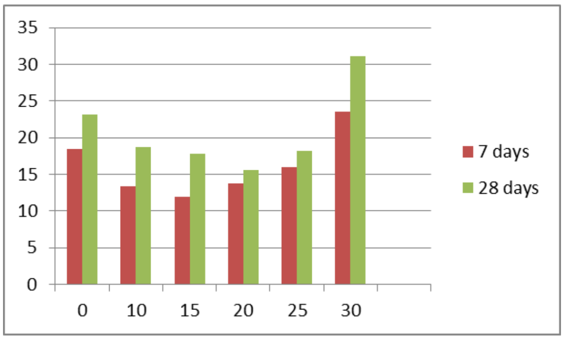


***Figure 2****Chart for Compressive Strength of SCC with Foundry Sand and Tile Powder*

The split tensile strength of concrete was determined by testing cylinders (150 x 300 mm) for 7 and 28 days. Two specimens were tested for each combination. The results are discussed below,

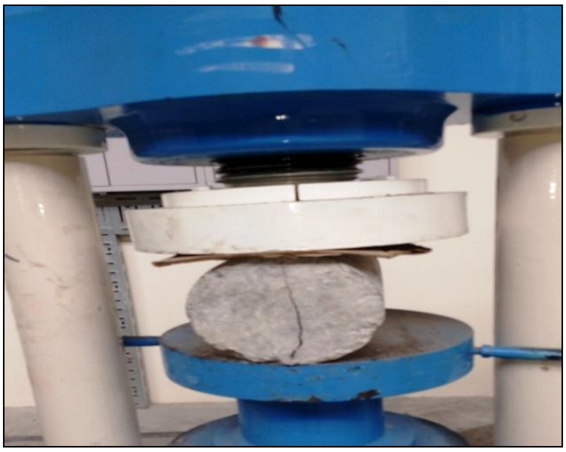

***Figure 3.****Split Tensile strength Test*

***Table 9*** *Split tensile strength of SCC with Foundry Sand and Tile Powder (7 days)*

| S.No. | Percentage replacement of materials | | | 7 days split tensilestrength ($N/mm^2$) |
|---|---|---|---|---|
| | Foundry Sand | Tile Powder | SP | |
| 1. | 0 | 0 | 0 | 2 |
| 2. | 10 | 30 | 0.7 | 1.84 |
| 3. | 15 | 30 | 0.7 | 1.69 |
| 4. | 20 | 30 | 0.7 | 1.98 |
| 5. | 25 | 30 | 0.7 | 2.12 |
| 6. | 30 | 30 | 0.7 | 2.40 |

***Table 10.****Split tensile strength of SCC with Foundry Sand and Tile Powder (28 days)*

| S.No. | Percentage replacement of materials | | | 28 days split tensilestrength ($N/mm^2$) |
|---|---|---|---|---|
| | Foundry Sand | Tile Powder | SP | |
| 1. | 0 | 0 | 0 | 2.4 |
| 2. | 10 | 30 | 0.7 | 1.98 |
| 3. | 15 | 30 | 0.7 | 1.55 |
| 4. | 20 | 30 | 0.7 | 2.12 |
| 5. | 25 | 30 | 0.7 | 2.4 |
| 6. | 30 | 30 | 0.7 | 2.82 |

The graph indicates the split tensile strength variations for 7 days and 28 days.

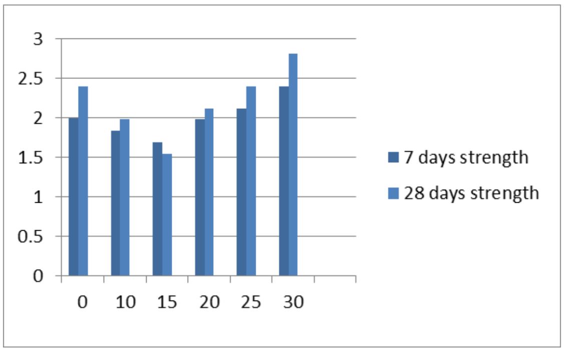


***Figure 4****.Chart for Split Tensile Strength of SCC with Foundry Sand and Tile Powder*

### 3.2 Durability Tests

Durability tests were conducted at 14days to find out the resistance to acid resistance, sulphate attack and Corrosion resistance.

### Acid Resistance

This test was carried out with a cube (150mm size) at the age 28 days of curing. The Specimen was weighed and immersed in water which is being diluted with 1% by weight of sulphuric acid for 14 days. After the specimens are removed from the acid water the surface is well cleaned, weighed and compressive strength is determined. Finally the average percentage loss of weight and Compressive strength is calculated.

***Figure 5.****Acid Resistance Test*

### Sulphate Attack

Sulphate attack is conducted by choosing a well cured specimen, which is again cured in 5% Sodium Solution for 14 days. This test indicates the performance of particular concrete mix to sulphate attack on concrete. The degree of sulphate attack is determined from the weight losses of the specimen.

***Figure 6*** *Sulphate Attack Test*

### 3.3 Flexure strength test

The Flexure strength test of Self Compacting Concrete using the optimal percentage value of foundry sand and tile powder was conducted. The strength test was conducted using Beam (1000 x 200 x 100 mm)specimens for 28 days.As expected, the flexural cracks are initiated in the pure bending zone. As the load increased, existing cracks propagated and new cracks developed along the span. In the case of beams with larger tensile reinforcement ratio some of the flexural cracks in the shear span turned into inclined cracks due to shear effect of shear force. Near peak load the beam deflected significantly, thus loading that the tensile steel must have yielded at failure. The final failure of the beams occurred when the concrete in the compression zone crushed, accompanied by buckling of the compressive steel bars. The failure mode was typical of that an under reinforced concrete beam.

The table below shows the results,

***Table 11*** *Flexure strength results*

| *Load (kN)* | *Deflection (mm)* | *Load (kN)* | *Deflection (mm)* |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 10 | 0.18 | 10 | 0.25 |
| 20 | 1.33 | 20 | 1.8 |
| 30 | 2.52 | 30 | 3.05 |
| 40 | 3.25 | 40 | 3.56 |
| 50 | 4.02 | 50 | 4.7 |
| 55 | 4.55 | 58 | 5.55 |
| 52 | 12.3 | 55 | 10.5 |

The graph below shows the flexural variations,

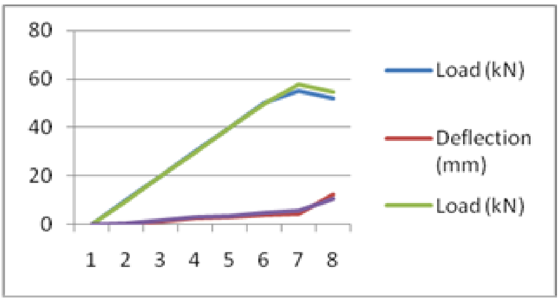


***Figure 7*** *Flexure strength graph*

### 4. Conclusion

- The use of Foundry Sand at a particular percentage increases the hardened properties of Self Compacting concrete (say 30%-50%).
- Usage of Tile Powder at a percentage of about 30% has controlled the strength characteristics.
- Tile Powder when preferred above 30% reduces the hardened properties of SCC.
- Use of Naphthalene based superplasticizer (Conplast) improved the flowability of the concrete.
- The result was better achieved with 30% replacement of Foundry Sand with Sand and 30% usage of Tile powder as a binder along with cement.

### 5. Acknowledgements

Authors we wish to express our sincere thanks to Sri Krishna College of Technology, Coimbatore. We also take immense pleasure in thanking our staffs of Civil Engineering Department for extending us their warm support and timely Guidance in performing our Project work.

### References

[1] Anupama.B.S and Dr. H. Eramma , 'Self-compacting concrete with Recycled Traditional Roof Tile Powder',' International Journal of Research in Engineering and Science', Volume no: 2.

[2] Abdullah Anwar, Syed Mohd. Ashraf Husain, Sabih Ahmad, Syed Aqeel Ahmad, 'Replacement of cement by marble dust and ceramic waste in concrete for sustainable development', 'International journal of innovative science, engineering and technology', Volume no: 2.

[3] Bernardinus Herbardiman and Adhi Mulyawan Saptaji,' Self-compacting concrete with recycled Traditional Roof Tile Powder', 'Second International Conference on Rehabilitation and Maintenance in civil Engineering'.

[4] Claus Pade,' Test methods for Self-Compacting Concrete', Danish Technological Institute.

[5] Dhruv Kumar H. Patel, Dixit Kumar D.Patel, Dhaval P. Patel, Vivek A. Patra, Yashasvikumar R. Patel, 'Literature review on Self compacting concrete',' International Journal for technological Research in Engineering', Volume 1.

[6] Dhiyaneshwaran. S, Ramanathan. P, Baskar. I, and Venkatasubramani. R,' Study on Durability characteristics of self-compacting concrete with Flyash',' Jordan Journal of Civil Engineering', Volume 7.

[7] Hajime Okamura and Masahiro Ouchi,' Self Compacting Concrete',' Journal of Advanced Concrete Technology', Volume 1.

[8] Kiran K. Shetty, Gopinatha Nayak, Rahul Shetty K,' Self Compacting concrete using red mud and used Foundry Sand', 'International Journal of

Research in Engineering and Technology', Volume 3.

[9] Ponnapati, Manogna and Sri Lakshmi, 'Tile powder as partial replacement of cement in concrete',' International Research journal of Engineering and technology', Volume 2.

[10] Puertas, Santos, Palacios and Martinez, 'Polycarboxylatesuperplasticizer admixtures: effect on hydration, microstructure and rheological behaviour in cement paste',' Advances in cement Research', 17, No.2.

[11] Rajath and M.R Suresh,' Development of Self Compacting Concrete by Replacing Foundry Sand and Granular Blast Furnace slag for sand', 'International Journal of Research in Engineering and Technology', Volume 3.

[12] Shetty. M.S, 'Concrete Technology Theory and Practice', S. Chand Publications.

[13] 'Specification and guidelines for self-compacting concrete', EFNARC, 'European Federation of Producers and Applicators of Specialist Products for Structures'.

[14] S.N. Tande and P.B. Mohite ,' Applications of Self compacting Concrete'.

[15] Venkatesh. P and S.A. Venkatesh Subramanian ,' Utilisation of used Foundry Sand and waste tyre rubber in Self Compacting Concrete',' International Journal for Innovative research in Science and Technology', Volume 1.

[16] IS 383: 1970 Specification for coarse and fine aggregates from natural sources for concrete, Bureau of Indian Standards.

[17] IS 10262: 2009 Concrete mix proportioning - guidelines, Bureau of Indian Standards.

[18] IS 1489 (part 1): 1991 Portland – pozzolanic cement specification part 1 fly ash based, Bureau of Indian Standards.