# ECO FRIENDLY SELF COMPACTING CONCRETE FOR WHITE TOPPING

**Suma paralada[1]**

[1] Assistant professor, Civil engineering Department, NHCE, Bangalore, Karnataka, India

---***---

***Abstract*** *- The production of SCC can be achieved by varying the mix proportion of concrete with super plasticizer in order to make concrete flow while keeping the coarse aggregate in suspension.*

*SCC has gained importance worldwide. Many major structures were built in short interval of time. Research on SCC has been carried out using Fly ash & Ground granulated blast furnace slag as the main filler material and very few studies have been carried out using granite powder as filler material. The present study is one such attempt in which granite powder as been used as the filler material.*

*In this study, a number of mixes have been tried out initially to develop a mix which could satisfy the fresh properties of Self Compacting Concrete. Once the suitable mixes have been developed, the water & cement is fixed at 160kg/m³& 375kg/m³ and different volume of paste namely, 0.36, 0.38, 0.40 & 0.42 has been kept as variable to ascertain the properties of SCC. For each variation in volume of paste only the granite powder content is increased. For each volume of paste 5 different mixes have been developed by keeping variation in coarse aggregate: fine aggregate ratio namely 60:40, 55:45, 50:50, 45:55, and 40:60. One best CA:FA ratio based on slump flow value and compressive strength is opted from each volume of paste for further strength test . Final 4 optimal mixes are tested for 28 days compressive strength, flexure strength, split tensile strength and density test.*

*The results show that, SCC can be successfully developed using granite powder as the filler material. Initial and final compressive strengths are good and also flexure strength value is more than 4.5MPa for all mixes.*

## 1. General Introduction

Reinforcing old flexible pavements with concrete layers is called as whitetopping. It is a technique that deserves to be divided under to major's procedures.

Construction of normal thickened slabs over the old pavement and the application of thin cement concrete layers (about 100 mm) with more closed joints, defining square shaped slabs.

There are three types of whitetopping:

1.11. Ultra-thin whitetopping (UTW).

Typically 100mm or less thick, with joint spacing ranging from 2 to 6 feet (ft), this type of whitetopping is used primarily for urban intersections, city streets, and overall low-volume roads. UTW relies on its bond to the existing asphalt pavement for performance.

1.12. Thin whitetopping (TWT).
This type is greater than 100mm and less than 200mm thick with joint spacing from 4 to 12 ft. Like UTW, TWT relies on the bond with the underlying asphalt pavement for good performance. TWT is the most prevalent type of whitetopping overlay highway agencies use.

1.13. Conventional whitetopping.
More than 200mm thick, this type of whitetopped pavement follows the behavior of a concrete pavement in terms of performance.

UTW solutions for reinforcing old flexible pavements can require concrete flexural strengths ranging from conventional concretes (4.5 to 5 MPa) to very high strength concretes (more than 10 MPa). This great variance will be found depending on the kind of road and on the heavy traffic volume.

Durability is considered to be one of the important aspects for any structure. The durability of concrete is directly related to the degree and quality of consolidation efforts. Using conventional placing and vibration techniques, the resulting concrete can have considerable honey combing due to development of voids. This problem occurs predominantly in reinforced structures with congested reinforcement. Many parts of the world are experiencing this problem.

There are no practical means by which compaction of concrete on a site ever be fully guaranteed. Vibrating the concrete in congested location also causes some risk to labors. There are also doubts about strength and durability. The lack of uniform and complete compaction had been identified as the primary factor responsible for poor performance of concrete structure.

As a result, research have been conducted in different parts of the world which led to the development of a new type of concrete known as SELF COMPACTING CONCRETE (SCC), which could be a solution to most of these problems.

Self-compacting concrete plays a major role in increasing the use of industrial byproducts like slag, fly ash, silica fume and granite dust obtained during sawing process of granite rocks. SCC offers possibility for utilization of dusts which are currently waste products demanding with no practical applications and which are costly to dispose off.

## 1.1 Need for this study

Granite powder is a waste product obtained during the process of sawing of granite rocks in granite industries. As this granite dust is creating many environmental hazards, its disposal is a great problem. Self-compacting concrete contains a large quantity of powder materials which is required to maintain sufficient yield value of the fresh mix and hence reducing bleeding, segregation and settlement. Hence, it is worthwhile to investigate the influence of **granite powder** in SCC as filler.

.

## 1.2Proportioning of self-compacting concrete

Absolute volume method is adopted for mix proportioning in this study, where cement and water contents are fixed so that self compactability can be achieved by varying granite powder, coarse aggregate and fine aggregate contents.

- Cement content is fixed to 375kg/m$^3$
- Water content is fixed to 160ltr.
- W/C ratio is fixed as 0.43, whereas water to powder ratio is varying because granite powder content is varying.
- Granite powder used in this study has water absorption 23% - 25%, thus the same amount of water is added to granite powder before mixing.
- The super plasticizer dosage and the final water-powder ratio are determined so as to ensure self-compatibility.

The powder is reported to contain large amount of very fine particles which are inert in nature. Since they are inorganic in nature they can be used in concrete without any durability issues.

## 1.4 Objective of the study

The main objective of this experimental investigation is to study

- Physical properties of granite powder waste for its possible use as powder in SCC.
- The influence of Granite powder on fresh and hardened properties of SCC.

## 1.5 Scope of the work

The scope is limited to the materials used for the experiments, which are

- OPC 53 grade cement (Birla Super)
- Natural river sand conforming to zone two
- Coarse aggregate of size 20mm down
- Granite powder (collected from JAI AMBE STONES, Granite industry, jigni industrial Area, anekal taluk, Bangalore 562106)
- Superplasticizers (Glenium B233)

# 2. Experimental programme

Concrete was first designed by absolute volume batching method, which assumes that the volume of compacted concrete is equal to the sum of the absolute volumes of all ingredients.

The mix is designed for M40 grade concrete with a w/c ratio of 0.43 to get a minimum slump of 550mm. In this study trial mixes are done for different paste volumes to achieve SCC and also to get an ideal mix with good strength. Superplasticizer is used to achieve good slump. In this study granite powder is used as filler for good bonding in concrete. In each varying $V_P$ (Volume of Paste) the cement and water is kept constant but only the granite powder is varied. Use of GP help to achieve SCC easily and also arrests segregation and bleeding in this process

## 2.1 Materials used

Materials used in the study are tested as per relevant IS Standards.

- OPC 53 grade cement
- Granite powder
- Poly carboxylated ether based admixture (Glenium B233)
- Aggregates
- Portable water

Granite powder

It is obtained from JAI AMBE STONES, Granite industry, jigni industrial Area, anekal taluk, Bangalore. It is a waste product obtained during sawing process of granite rocks. This dust is creating great problems due to disposal, as it is creating environmental hazards. Table 1 shows some of the properties and details of granite powder.

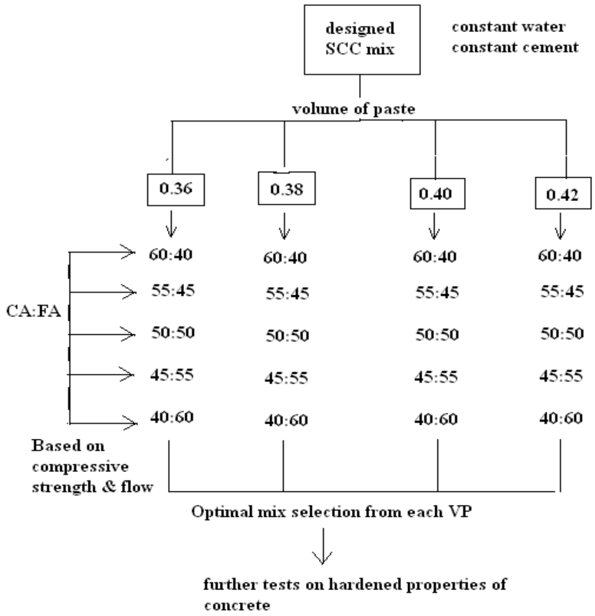
Granite rock cutting process

Granite waste dumped

Table 1: Properties of granite powder

| Sl. No. | Properties | Values | Permissible limits as per IS 456 |
|---|---|---|---|
| 1 | Specific gravity | 2.64 | |
| 2 | Water absorption | 23% - 25% | |
| 3 | Fineness | 88% passing through 45 micron sieve | |
| 4 | Chloride content | 0.0098% | less than 0.025% |
| 5 | Sulphate content | 0.052% | less than 0.2% |

**2.2** flow diagram for experimental scheme




Stage 1: Concrete mix design was done by using absolute volume method. In this, cement and water contents are kept constant where as granite powder and aggregate contents are varied. After trial and error method superplasticizer content is fixed to 0.75%

Volume of paste's = 0.36, 0.38, 0.4, 0.42

CA:FA ratio's = 60:40, 55:45, 50:50, 45:55, 40:60

Stage 2: Slump test is carried out for each mix and its slump is noted. Each mix is cast in 100mm cubes and tested for 3 day and 7 day compressive strength. Based on its flow ability and compressive strength optimal CA:FA ratio is selected from each $V_P$.

Stage 3: Six numbers of beams of size 150*150*700mm are cast from each $V_P$. They are cured for 28 days in curing tank. These beams are subjected to flexure test using third point loading method. These are also tested for 28 day compressive strength using 100mm moulds.

Stage 4: The same mixes taken for flexure test were under taken for split tensile test & non destructive ultrasound pulse velocity test.

## 2.3 Mix design

Table 2: Mix proportioning of SCC for all mixes. (Cement – 375kg/m$^3$, water – 160 kg/m$^3$ are fixed)

| Mix no. | $V_P$ | CA:FA | Granite powder (kg/m³) | Coarse aggregate (kg/m³) | Fine aggregate (kg/m³) |
|---|---|---|---|---|---|
| M1 | 0.36 | 60:40 | 208 | 1036.8 | 691.2 |
| M2 | | 55:45 | | 950.4 | 777.6 |
| M3 | | 50:50 | | 864 | 864 |
| M4 | | 45:55 | | 777.6 | 950.4 |
| M5 | | 40:60 | | 691.2 | 1036.8 |
| M6 | 0.38 | 60:40 | 260 | 1004.4 | 669.5 |
| M7 | | 55:45 | | 920.7 | 753.3 |
| M8 | | 50:50 | | 837 | 837 |
| M9 | | 45:55 | | 753.3 | 920.7 |
| M10 | | 40:60 | | 669.5 | 1004.4 |
| M11 | 0.40 | 60:40 | 312 | 972 | 648 |
| M12 | | 55:45 | | 891 | 729 |
| M14 | | 45:55 | | 729 | 891 |
| M15 | | 40:60 | | 648 | 972 |
| M16 | 0.42 | 60:40 | 364 | 940 | 626 |
| M17 | | 55:45 | | 861.3 | 704.7 |
| M18 | | 50:50 | | 783 | 783 |
| M19 | | 45:55 | | 729 | 891 |
| M20 | | 40:60 | | 626 | 940 |

## 3. RESULTS AND DISCUSSION

**3.1** Relationship between % of coarse aggregates and slump flow.

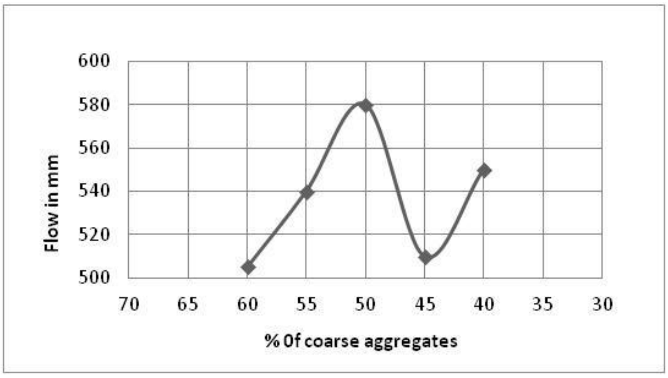



Fig 1: slump flow v/s % of CA (Vp0.36)

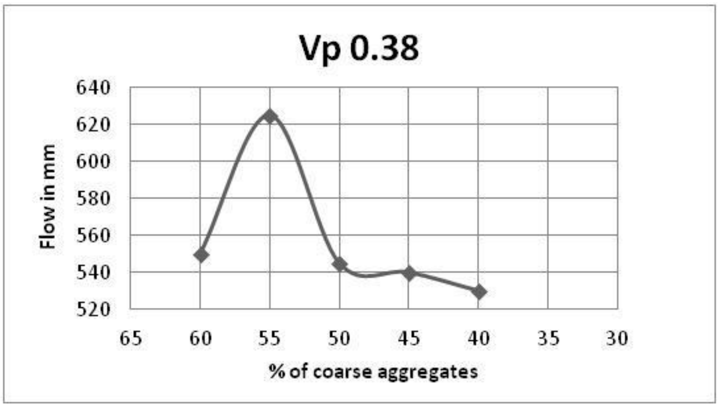



Fig 2: slump flow v/s % of CA (Vp0.38)

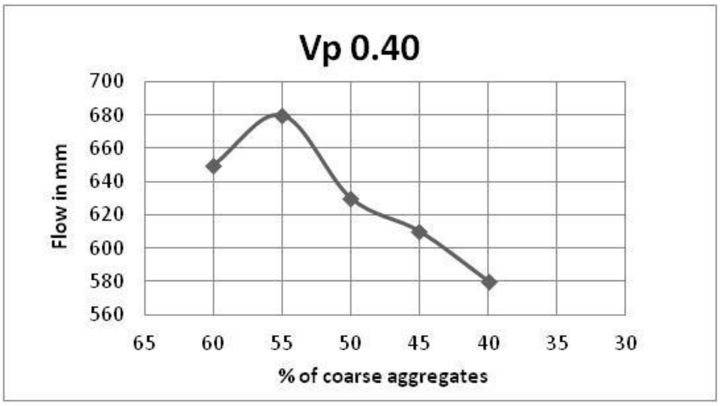



Fig 3: slump flow v/s % of CA (Vp0.40)

International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 07 | July-2016 www.irjet.net p-ISSN: 2395-0072

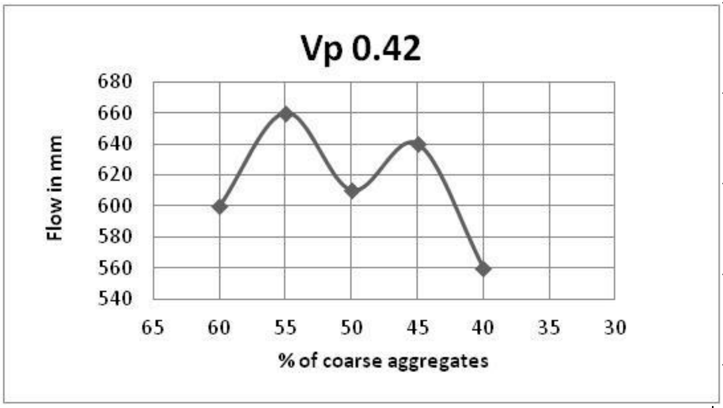



Fig 4: slump flow v/s % of CA (Vp0.42)

Table 3: Compressive strength of trial mixes

| Mix no. | $V_P$ | CA:FA | Flow (mm) | 3-day compressive strength(Mpa) | 7-day compressive strength(Mpa) |
|---|---|---|---|---|---|
| M1 | 0.36 | 60:40 | 505 | 26.0 | 30.1 |
| M2 | | 55:45 | 540 | 21.9 | 26.2 |
| M3 | | 50:50 | 580 | 29.5 | 31.1 |
| M4 | | 45:55 | 510 | 22.0 | 27.6 |
| M5 | | 40:60 | 550 | 16.5 | 21.2 |
| M6 | 0.38 | 60:40 | 550 | 25.6 | 29.4 |
| M7 | | 55:45 | 625 | 23.8 | 30.0 |
| M8 | | 50:50 | 545 | 24.5 | 29.0 |
| M9 | | 45:55 | 540 | 21.3 | 29.6 |
| M10 | | 40:60 | 530 | 19.8 | 28.0 |
| M11 | | 60:40 | 650 | 13.8 | 16.1 |
| M12 | 0.40 | 55:45 | 680 | 22.3 | 27.1 |
| M13 | | 50:50 | 630 | 19.8 | 26.2 |
| M14 | | 45:55 | 610 | 19.1 | 26.9 |
| M15 | | 40:60 | 580 | 20.1 | 28.2 |
| M16 | 0.42 | 60:40 | 600 | 23.2 | 29.2 |
| M17 | | 55:45 | 660 | 21.1 | 26.4 |
| M18 | | 50:50 | 610 | 19.8 | 25.5 |
| M19 | | 45:55 | 640 | 18.6 | 21.3 |
| M20 | | 40:60 | 560 | 21.3 | 27.0 |

From the table , it is observed that, compressive strength at 3, 7 days are higher generally for those mixes which have shown higher workability. Fig 1 to 4 shows the optimal workability for a particular percentage of CA. Based on these results, it appears that in SCC, the role of CA is important beyond a percentage of CA say about 55%, in mixes having lower paste contents ($V_P$ 0.38). However, in higher paste contents the role of CA is limited as paste content dominates the flow and strength of the matrix.

However, for further investigation in this study, values of CA:FA determined experimentally have been used.

Table 4: Compressive strength values of optimal mixes for different volume of paste.

| Mix no. | VP | CA:FA | Granite powder (kg/m$^3$) | Flow (mm) | Compressive strength in MPa | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | 1-day | 3-day | 7-day | 28-day |
| Mix A | 0.36 | 50:50 | 208 | 580 | 22.1 | 29.5 | 31.1 | 45.4 |
| Mix B | 0.38 | 55:45 | 260 | 625 | 20.3 | 23.8 | 30.0 | 52.4 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Mix C | 0.40 | 55:45 | 312 | 680 | 19.0 | 22.3 | 27.1 | 40.0 |
| Mix D | 0.42 | 55:45 | 364 | 660 | 17.2 | 21.1 | 26.4 | 42.8 |

Table 5: Results of flexure strength, split tensile strength & pulse velocity for different volume of paste

| VP | CA:FA | Flexure strength (MPa) $0.7\sqrt{f_{ck}}$ (IS 456-2000) | Flexure strength (MPa) $\Sigma = PL/bd^2$ (Experimental) | Split tensile $T = \frac{2P}{\pi DL}$ (MPa) | Pulse velocity (Km/s) |
|---|---|---|---|---|---|
| 0.36 | 50:50 | 4.7 | 5.0 | 2.76 | 4.6 |
| 0.38 | 55:45 | 5.1 | 5.4 | 2.76 | 4.3 |
| 0.40 | 55:45 | 4.4 | 4.8 | 2.35 | 4.0 |
| 0.42 | 55:45 | 4.5 | 5.4 | 2.34 | 4.0 |

Table 6: Test results of abrasion test for different volume of paste

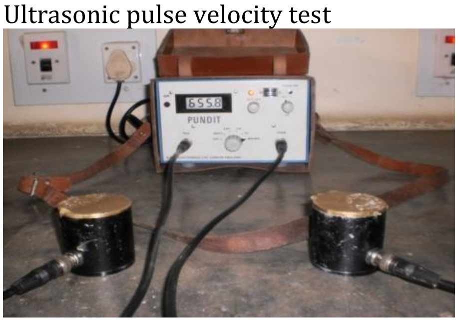
| Volume of paste | Weight W1-gm (before testing) | Weight W2 gm (after Testing) | Length L in mm | Breadth B in mm | Thickness T1 mm (before testing) | Thickness T2 mm (after testing) | $t=\frac{(W1-W2)T1}{W1\times A}$ in mm |
|---|---|---|---|---|---|---|---|
| 0.36 | 338.9 | 317.0 | 64.5 | 64.5 | 34 | 32 | 2.19 |
| 0.38 | 335.7 | 314.2 | 64.5 | 64.5 | 32.5 | 32 | 2.08 |
| 0.40 | 340 | 320 | 64.5 | 64.5 | 33.5 | 32 | 1.97 |
| 0.42 | 337.6 | 317.4 | 64.5 | 64.5 | 34.5 | 32 | 2.06 |

According to the table 6 the average wear for the heavy duty floor tiles is 2 mm. All the mixes show similar abrasion value ranging from 1.97 to 2.19mm which is acceptable value for flooring

Flexure strength test

Split tensile test

Ultrasonic pulse velocity test



## 4. CONCLUSIONS

1. The available waste product from granite industry i.e. granite powder can be used successfully to achieve SCC properties in fresh state. As it is a finer material helps in avoiding segregation and promotes sustainability of natural resources.

2. Increase in granite powder content beyond a certain limit is likely to increase the viscosity of the mixes and hence less flowable.

3. There is a significant increase in strength at 1 & 3days when granite powder is used as filler. This is very helpful to early opening of roads to traffic and can be explored to produce SCC.

4. An optimum content of 260kg/m$^3$ of granite powder gives maximum strength than higher content, as it is evident from compressive strength, flexure strength and split tensile strength results.

5. Among the volume of pastes examined, paste of 0.38 appears to be optimal and gives superior performance both in fresh and hardened state.

6. From the study, we can conclude that among the CA:FA ratios, 55:45 appears to be an optimal ratio for the characteristics of aggregates used.

**ACKNOWLEDGEMENT**

I would like to extend my most profound gratitude and deepest thanks to my Guide, Professor**Dr. R V RANGANATH**, Professor and Head of Department of Civil Engineering, B.M.S.C.E, for his guidance, commitment and encouragement throughout the entire period of the research project . His Dedication and continuous guidance enabled me to remain focused on the research investigation from the beginning of the project to the very end for all the time spent on coordinating and supervising the whole thesis.

## REFERENCES

[1] A.M. Neville., text "Properties of Concrete" pearson education publishing company ltd., fourth and final edition

[2] C. Selvamony, M. S. Ravikumar, S. U. Kannanand S. Basil Gnanappa., "Investigations on self-compacted self curing concrete using limestone powder and clinkers" ARPN Journal of Engineering and Applied Sciences, VOL. 5, NO. 3, March 2010.

[3] M. Ramegowda, M.C.Narasimhan, Karisddappa and S.V.Rajeeva., "study of the properties of SCC with quarry dust" , The Indian Concrete Journal, August 2009, pp 54.