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USE OF GRANITE WASTE AS POWDER IN SELF COMPACTING CONCRETE

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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.

I. INTRODUCTION

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 is considered to be a concrete which can be placed and compacted under its own self weight with little or no vibration effort and which is at the same time cohesive enough to be handled without any segregation or bleeding.

SCC got its initiation in JAPAN. It was first developed at THE UNIVERSITY OF TOKYO by Prof .H.OKAMURA and OZAWA (31) and has since generated significant interest worldwide. Its innovative aspects lie in its fresh properties and the potential benefits to construction practice.

SCC plays a major role in precast concrete, where the speed of placing and removal of the elements from forms at the earliest are essential requirements, at the same time having defect free surface. SCC is a solution that solves most of the challenges and problems, which come across the concrete industries.

The SCC has gained wide use in many countries for different application and structural configurations. SCC requires a high slump, which can easily be achieved by incorporating several chemical admixtures. In particular, Superplasticizer and Viscosity Modifying Agent (V.M.A).

The superplasticizer influences the rheological behavior, the viscosity and the yield value of the fresh concrete are reduced in certain concrete mix. The super plasticizer ensures high fluidity and reduces water-powder ratio. Superplasticizer greatly improves the pump ability and the slump value can be greatly increased.

The use of Viscosity Modifying Agent increases the segregation resistance of concrete and increases the deformability without segregation and then to lead high optimum self-compatibility.

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.

1.2 Proportioning 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/m3
- 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.

1.3 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.

1.4 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)

II. 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 VP (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.

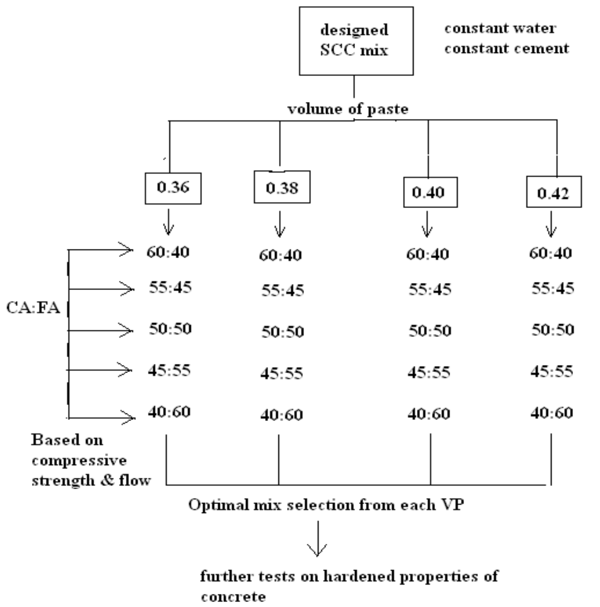
Granite rock cutting process

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 VP.

Stage 3: Six numbers of beams of size 150*150*700mm are cast from each VP. 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/m3, water – 160 kg/m3 are fixed)

Mix no.	V_P	CA:FA	Granite powder (kg/m^3)	Coarse aggregate (kg/m^3)	Fine aggregate (kg/m^3)
M1		60:40		1036.8	691.2
M2		55:45		950.4	777.6
M3		50:50	208	864	864
M4	0.36	45:55		777.6	950.4
M5		40:60		691.2	1036.8
M6		60:40		1004.4	669.5
M7		55:45		920.7	753.3
M8		50:50	260	837	837
M9	0.38	45:55		753.3	920.7
M10		40:60		669.5	1004.4
M11		60:40		972	648
M12		55:45		891	729
M14		45:55	312	729	891
M15	0.40	40:60		648	972
M16		60:40		940	626
M17		55:45		861.3	704.7
M18		50:50	364	783	783
M19	0.42	45:55		729	891
M20		40:60		626	940

III. RESULTS AND DISCUSSION

3.1 Relationship between % of coarse aggregates and slump flow.

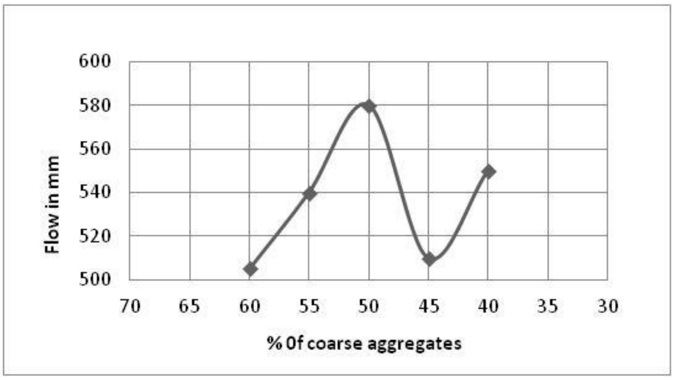


Fig 1: slump flow v/s % of CA (Vp0.36)

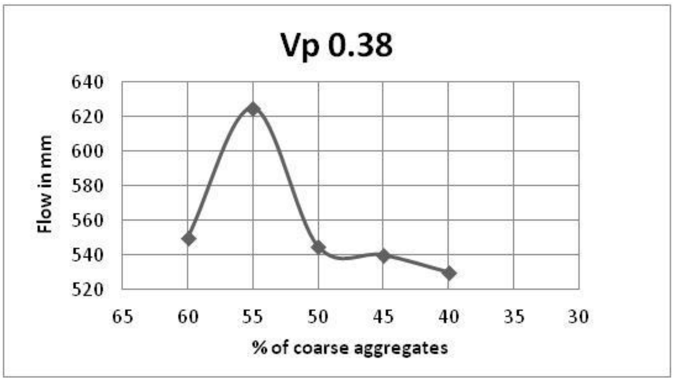


Fig 2: slump flow v/s % of CA (Vp0.38)

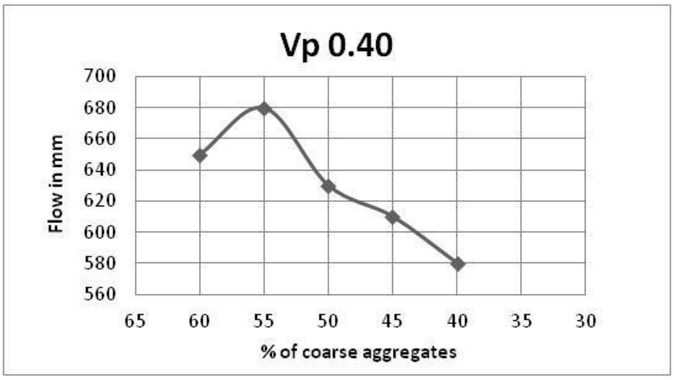


Fig 3: slump flow v/s % of CA (Vp0.40)

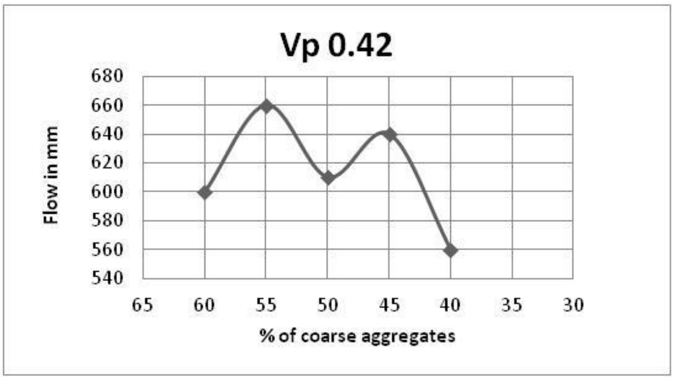


Fig 4: slump flow v/s % of CA (Vp0.42)

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	23.0	32.3
M2		55:45	540	21.9	26.2
M3		50:50	580	27.5	31.8
M4		45:55	510	22.0	27.6
M5		40:60	550	16.5	21.2
M6	0.38	60:40	550	26.6	30
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	20	28.3
M11		60:40	650	14.8	16.6
M12		55:45	680	22.3	27.1
M13	0.40	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	24.2	31.2
M17		55:45	660	22	27
M18		50:50	610	20	26.1
M19		45:55	640	19.1	23
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 (VP 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/m³)	Flow (mm)	Compressive strength in MPa			
					1-day	3-day	7-day	28-day
Mix A	0.36	50:50	208	580	22.1	27.5	31.8	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	22	27	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

Flexure strength test

Split tensile test

Ultrasonic pulse velocity test

IV. CONCLUSION

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/m3 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.

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V. 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.