RESEARCH PAPER | Engineering | Volume : 5 | Issue : 3 | March 2015 | ISSN - 2249-555X

Experimental Study on Properties of Granite Waste in Self Compacting Concrete

KEYWORDS: self compacting concrete; workability; hardened concrete test; granite waste.

M. Manikandan
Research Scholar, Department of Civil Engineering, St. Peter's University, Chennai, India

Dr. T. Felixkala
Professor and Head, Department of Civil Engineering, Dr. M. G. R. Educational and Research Institute, University, Chennai, India

ABSTRACT *The main objective of this study utilizes the granite waste in self-compacting concrete. The effect of using granite powder and granules as constituents of fines in mortar or concrete by partially reducing quantities of cement as well as other conventional fines in self compacting concrete. The mixtures are prepared based upon cement or sand substitution by the granite waste and their properties are evaluated both in fresh state and in hardened state of self-compacting concrete. The possibility of using granite powder as replacement of sand and partial replacement of cement with fly ash, silica fume, slag and superplasticiser in concrete. The percentage of granite powder added by weight was 0, 25, 50, 75 and 100 as a replacement of sand used in concrete and cement was replaced with 7.5% silica fume, 10% fly ash, 10% slag and 1% superplasticiser. The workability test is conducted on fresh concrete using Slump – Flow test, L- Box test, and V – Funnel test. In the further study hardening test are Compressive Strength, Flexural Strength, Split Tensile Strength are conducted and compared for different proportions of granite waste at different curing periods on hardened concrete specimens.*

Introduction

Self – compacting concrete (SCC) is a fluid mixture, which is suitable for placing difficult conditions and also in congested reinforcement, without vibration. The study of granite powder as fine aggregate and partial replacement of cement with admixtures in the production of High performance concrete.1 Compared with conventional concrete of similar mechanical properties, the material cost of SCC is more due to the relatively high demand of cementation materials and chemical admixtures including high – range water reducing admixtures (HRWRA) and viscosity enhancing admixtures (VEA). Proper selection of finely ground materials can enhance the packing density of solid particles and enable the reduction of water or HRWRA demand required to achieve high deformability. It can also reduce viscosity for a given consistency; especially in the case of SCC made with relatively low Water – Binder ratio.2 The mixture proportioning of SCC to simultaneously meet the various performance requirements at minimum cost involves the optimization of several mixture constituents that have a marked influence on performance. This process is quite complex and can be simplified by understanding the relative significance of various mixture parameters on key properties of SCC. This includes deformability, passing ability, filling capacity and segregation resistance. As with any new technology, there was clearly a learning curve to overcome, and refinement of the materials and mix proportions used took care to finally achieve optimum performance.

Materials and Methods

Cement:

Ordinary Portland cement (53 Grade) was used and its properties are

- Specific gravity of cement - 3.15
- Initial setting time of cement - 45 min
- Final setting time of cement - 360 min
- Consistency - 36 %

Fine aggregate:

River sand (maximum size 4.75) was used and its properties are

- Specific gravity of FA - 2.63
- Water absorption - 1.25 %

Coarse aggregate:

Natural crushed stone (size – 12.5mm) was used and its properties are

- Specific gravity of CA - 2.68
- Water absorption - 0.45%

Both fine aggregate and coarse aggregate are conformed to Indian Standard Specifications IS: 383 – 1970.

Fly ash

- Class C fly ash was used and specific gravity is 2.15.

Silica fume:

- Specific gravity is 2.25

Ground Granulated Blast Furnace slag:

- Specific gravity of (GGBS) : 2.95

Superplasticizer:

Master Glenium Sky 8233 is an admixture of a new generation based on VMA and polycarboxylated ether superplasticizer was used as per code EN 934-2

Mix Design

Mix Design for M30 Grade of SCC:

The mix design done as per code IS 10262:2009 and given in Table.1.

Table 1: Details of concrete mix

Volume : 5 | Issue : 3 | March 2015 | ISSN - 2249-555X

Mix Designation	Weight in kg per m^3 of concrete								
	Cement	Fly Ash (10%)	Silica fume (7.5%)	Slag (10%)	Super Plasticizer (1%)	Water	Coarse Aggregate	Fine aggregate	
								Granite power	Sand
GP0	343	48	36	48	5	182	1071	0	701
GP25	343	48	36	48	5	182	1071	175.25	525.75
GP50	343	48	36	48	5	182	1071	350.5	350.5
GP75	343	48	36	48	5	182	1071	525.75	175.25
GP100	343	48	36	48	5	182	1071	701	0
NA	480	-	-	-	-	182	1071	714	0
CC	480	-	-	-	-	182	1071	-	701

Note: GP-Granite powder, NA-Nominal aggregate, CC-Control concrete

Test Method for fresh SCC

Slump Flow Test[3]

Slump flow is one of the most commonly used SCC tests at the current time. This test involves the use of slump cone used with conventional concretes as described in ASTM C 143(2002).The main difference between the slump flow test and ASTM C 143 is that the slump flow test measures the "spread" or "flow" of the concrete sample once the cone is lifted rather than the traditional "slump" (drop in height) of the concrete sample.

L – Box Test

The L-box value is the ratio of levels of concrete at each end of the box after the test is complete at each end of the box after the test is complete. The L-box consists of a "chimney" section and a "trough" section after the test is complete, the level of concrete in the chimney is recorded as H1,the level of concrete in the trough is recorded as H2. The L-box value(also referred to as the "L-box ratio", "blocking value", or "blocking ratio")is simply H2/H1.Typical acceptable values for the L-box value are in the range of 0.8 to 1.0. If the concrete was perfectly level after the test is complete, the L-box value would be equal to 1.0. Conversely, if the concrete was too stiff to flow to the end of the trough the L-box value would be equal to zero.

V-Funnel Test and – Funnel Test at T_5 Minutes[4]

V-funnel test is used to determine the filling ability (flow ability) of the concrete with a maximum aggregate size of 20 mm. The funnel is filled with about 12 liters of concrete and the time taken for it to flow through the apparatus is measured .After this the funnel can be refilled concrete and left for 5 minutes to settle .If the concrete shows segregation then the flow time will increase significantly, The acceptance criteria for Self compacting concrete has been given in Table 2.

Table 2: Acceptance criteria for SCC

S. No	Method	Unit	Typical range of values	
			Minimum	Maximum
1.	Slump flow test	mm	650	800
2.	T_{50} cm slump flow	sec	2	5
3.	V-funnel test	sec	6	12
4.	V-funnel at T_5 minutes	sec	6	15
5.	L-box test	H2/H1	0.8	1.0

Test for Hardened SCC

- **Compressive strength test[5]**
- **Split tensile strength test**
- **Flexural strength**

Results and Discussion:

Fresh Concrete Properties:

Slump Flow Test

Mix	Trial 1	Trial 2	Trial 3	Average
GP 0	640	650	645	645
GP 25	650	660	660	657
GP 50	660	670	665	665
GP 75	680	675	670	675
GP 100	690	685	680	685

Note: Flow ability of SCC should be 650 to 800 mm

L - Box Text

Mix	Trial 1	Trial 2	Trial 3	Average
GP 0	1.20	1.3	1.5	1.30
GP 25	1.30	1.1	1.2	1.20
GP 50	0.8	0.8	0.9	0.83
GP 75	0.6	0.6	0.7	0.63
GP 100	0.6	0.7	0.8	0.70

Note: L- Box value should be 0.8 to 1.0 cm/sec

V – Funnel Test and Funnel Test at T_5 Minutes

Mix	Initial in sec				T_5 min in sec			
	Trial 1	Trial 2	Trial 3	Average	Trial 1	Trial 2	Trial 3	Average
GP 0	12.00	11.00	13.00	12.00	22	23	21	22.00
GP 25	13.00	12.00	13.00	12.67	19	18	20	19.00
GP 50	12	12	11	11.67	14	15	16	15.00
GP 75	10	11	11	10.67	15	15	15	15.00
GP 100	8	9	8	8.33	17	17	16	16.67

Note: V funnel value should be 6-12 sec for initial and 6 - 15 sec for T-5 min

Volume : 5 | Issue : 3 | March 2015 | ISSN - 2249-555X

Test Method for Hardened SCC

Compression strength Test

Mechanical behavior of concrete was studies for M30 grade of SCC; Cubes specimens 150 x 150 mm were casted and cured for 7, 14, 28, 56 days and the result obtained are reported

Compressive strength of various mixes

Mix	7 Days	14 Days	28 Days	56 Days
GP 0	20.66	25.92	33.47	42.82
GP 25	24.15	27.13	33.85	43.74
GP 50	21.66	26.06	32.25	43.04
GP 75	20.91	24.73	32.16	41.47
GP 100	18.63	24.01	31.35	38.88
CC100	17.81	23.95	31.02	40.08

Splitting Tensile Strength Test

Mechanical behavior of concrete was studies for M30 grade of SCC; cylindrical specimens 150 mm diameter x 200 mm height were casted and cured for 7, 14, 28, and 56 days, and the result obtained are reported.

Split tensile strength of various mixes

Mix	7 days	14 days	28 days	56 days
GP 0	1.19	3.13	4.05	5.48
GP 25	1.90	2.66	4.17	5.62
GP 50	1.63	2.37	3.99	5.46
GP 75	1.39	2.60	3.68	4.54
GP 100	1.15	2.36	3.41	4.16
CC 100	1.20	2.55	3.36	4.37

Flexural Strength Test[7]

Mechanical behavior of concrete was studies for M30 grade of SCC; Beam specimens 100mm x 100 mm x 500 mm were casted and cured for 7, 14, 28, 56 days and the result obtained are reported

Felxural strength of various mixes

Mix	7 days	14 days	28 days	56 days
GP 0	2.40	4.01	5.03	6.52
GP 25	2.48	4.16	5.94	7.39
GP 50	2.05	3.82	4.97	6.05
GP 75	1.87	3.48	4.65	5.96
GP 100	1.73	3.12	3.93	4.99
CC100	1.78	3.41	4.58	5.91

Conclusion

A study on the performance concrete made with granite powder as fine aggregate and partial replacement of cement with 7.5% Silica fume, 10% fly ash, 10% slag and 1% superplasticiser subjected to water curing is conducted for finding the characteristic mechanical properties such as compressive strength, split tensile, strength and flexural strength of concrete mixtures at 7, 14, 28, and 56 days of curing for 0.40 water-cement ratio. The test results show clearly that granite powder as a partial sand replacement has beneficial effects of the mechanical properties of high performance concrete. Of all the 6 mixtures considered, concrete with 25% of granite powder (GP25) was found to be superior to other mixtures as well as GP0 and CC100 for all operating conditions.

REFERENCE 1. T.Felix Kala, Effect of Granite Powder on Strength properties of concrete, Int J of Eng and Sci, Vol.2, Issue 12 (May 2013), pp. 36-50. | 2. Skarendah, A., Petersson, O, Preceedings of the First International RILEM Symposium (Stockholm, 13-14 September 1999), RILEM Publications S.A.R.L., Cachan Cedex (France), 1999. | 3. Bartos, P.J.M, Sonebi, M, Tamini, A.K, Workability and Rheology of Fresh concrete: Compendium of tests, Report of RILEM Technical Committee TC 145-WSM, RILEM Publications S.A.R.L., Cachan Cedex (France), 1999. | 4. Okamura. H, Ouchi. M, Self-compacting concrete, J of Adv Con Tech, Vol 1, No. 1, 5-15, April 2003. | 5. Roncero J and Gettu R 2002 'Influencia de los superplastificantes en la microestructura de la pasta hidratada y en el comportamiento diferido de los morteros de cement', Cemento Hormigón 832: 12–28 | 6. Nazari A, Riahi S 2010h The effects of limewater on flexural strength and water permeability of Al2O3 nanoparticles binary blended concrete, J. Compos. Mater. doi:10.1177/0021998310378907 | 7. Nazari A, Riahi S 2010d The effects of zinc dioxide nanoparticles on flexural strength of self-compacting concrete, Composites Part B: Engineering, doi:10.1016/j.compositesb.2010.09.001