Experimental Investigation of Self-compacting Concrete Using M-Sand

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ABSTRACT

Self-Compacting Concrete is also referred to as Self-Consolidating Concrete, is able to flow and consolidate under its own weight and is desecrated almost completely while flowing in the form work. It is cohesive enough to fill the spaces of almost any shape and size without segregation or bleeding. This makes SCC particularly useful for placing in difficult conditions, such as in heavily-reinforced concrete members or in complicated work forms. The objectives of this research is to compare the Splitting Compressive strength values of Self-Compacting Concrete and normal concrete specimens and to examine the bonding between the coarse aggregate and the cement paste using the scanning electron microscope. Compressive strength at 28 days of standard curing, of Self-Compacting Concrete has show an increase in this strength and a better bonding between aggregate and cement paste, compared to normal concrete. The mix design used for making the concrete specimen was based on previous research work from literature. The water cement ratio is taken as 0.5, while the rest of the components kept same except the chemical admixture, which were adjusted for obtaining the self-compatibility of the concrete. The Split Compressive strength increased approximately 60% greater. In addition, the SCC Compressive strength after 28 days were almost as high as those obtained.

KEY WORDS: Concrete, sand, water, consolidate.

1. INTRODUCTION

Self-Compacting Concreteis a concrete which compact itself, there is no further Compaction required for self-compacting concrete. Making concrete structures without vibration have been done in the past. Self-compacting concrete has been described as "the most revolutionary development in the concrete construction for several decades". Originally developed in Japan to offset a growing shortage of skilled labour, it has proved to be beneficial from the following points.

Historical Development of Self–Compacting Concrete: Self-compacting concrete, in principle, is not new. Special applications such as underwater concreting have always required concrete, which could be placed without the need of compaction (Bartos, 2000). In such circumstances vibration was simply impossible. A very important aspect was that each of the large contractors also developed their own testing devices and test methods (Bartos, 2000). In the early 1990's there was only a limited public knowledge about SCC, mainly in Japanese 2 languages. The fundamental and practical know-how was kept secret by the large corporations to maintain commercial advantage.

Objective: To find the material properties of the ingredient of the concrete, To obtain Mix proportions of control concrete by IS 10262- 2009, To obtain the self-compacting concrete by replacing with granite sand by 25, 50, 75, 100% of fine aggregate, To check SCC by L box Test and J- ring Test, To determine the compressive strength of self-compacting concrete in comparison with nominal concrete.

Scope: This recommendation shall apply to construction of concrete structures using self-compacting concrete.

Material testing:

Cement: Ordinary Portland cement of 53 grades available in local market is used in the investigation. The cement has been tested for various proportion as per IS 4031-1988 and found to be confirming to various specifications of IS 12269-1987. The specific gravity was 3.14 and fineness was 3200cm^2/gm.

Coarse Aggregate: Crushed angular granite metal of 10mm size from a local source was used as coarse aggregate. The specific gravity of 2.68 and fineness modulus 2.6 was used.

Fine Aggregate: River sand used as fine aggregate. The specific gravity of 2.43 and fineness modulus 3.54 was found in the investigation.

Chemical Description (Super Plasticizer): "CONXL-PCE8860" is a new generation polycarboxylate based concrete super plasticizer developed for using in pre-cast industry for the production of high strength concrete& Self-compacting concrete. This has high plasticizing effect and acts as a high range water reducer for concrete.

Mix design:

Concrete Mix Design: The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible is termed the concrete mix design.The proportioning of ingredient of concrete is governed by the required performance of concrete in 2 states namely the plastic and the hardened states. If the plastic concrete is not workable it cannot be properly placed and compacted. The property of workability therefore becomes of vital importance.

Requirements of Concrete Mix Design: The requirements which form the basis of selection and proportioning of mix ingredients are:

- The minimum compressive strength required from structural consideration
- The adequate workability necessary for fill compaction with the compacting equipment available.
- Maximum water-cement ratio and/or maximum cement to give adequate durability for the particular site conditions
- Maximum cement content to avoid shrinkage cracking due to temperature cycle in mass concrete.

Types of Mixes: a) Nominal Mixes, b) Standard Mixes, c) Designed Mixes.

Factors Affecting the Choice of Mix Proportions: The various factors affecting the mix design are a) Compressive Strength, b) Workability, c) Durability, d) Maximum Nominal Size of Aggregate, e) Grading and Type of Aggregate, f) Quality Control.

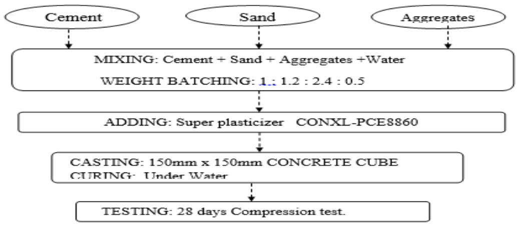

Fig 1: Flow Chart of Sequence of Concrete Mixing

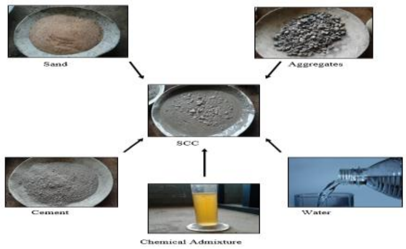

Fig 2: Mixing Sequence of Concrete Using Admixtures

Table 1: Trial Mixes of Self Compacting Concrete

Contents	Trail Mix1		Trail Mix 2		Trail Mix 3		Trail Mix 4		Trail Mix 5	
Cement (kg)	5.45	1	6.3	1	10.12	1	10.12	1	10.12	1
FlyAsh (kg)	2.25	0.41	1.05	0.16	0.533	0.052	0.053	0.052	0.533	0.052
Sand (kg)	12.03	2.2	11.7	1.85	16.7	1.65	16.7	1.65	16.7	1.65
Aggregate(12mm) (kg)	11.11	2.03	10.03	1.73	15.4	1.52	15.4	1.52	15.4	1.52
Water (ltr)	3.07	0.4	2.46	0.33	3.5	0.32	3.5	0.32	3.5	0.32
SuperPlasticizer (ml)	385	5%	367	5%	532	5%	639	6%	745	7%
Inference	L–Box run - ok T10 - not ok J ring - did not cross D 500		L–Box run -ok T10 - not ok J ring - did not cross D 500		L–Box run - ok T10 - not ok J ring - did not cross D 500		L–Box run - ok T10 - not ok J ring – crossed D 500		L–Box - ok T10 - ok J ring - crossed D 500	

2. EXPERIMENTAL STUDIES

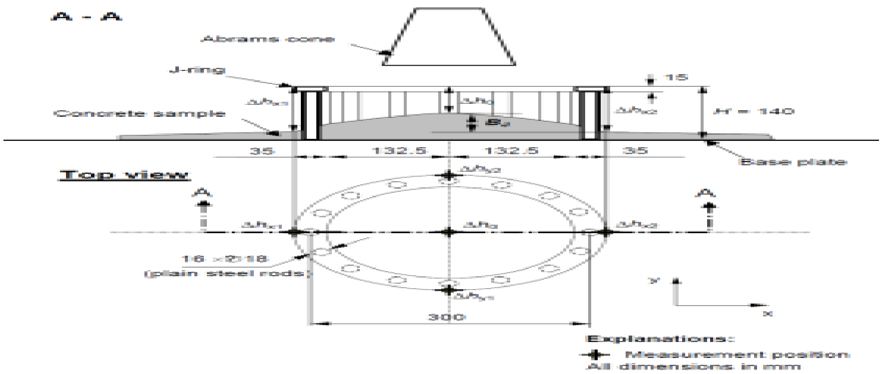

Fig 3: J-Ring Test

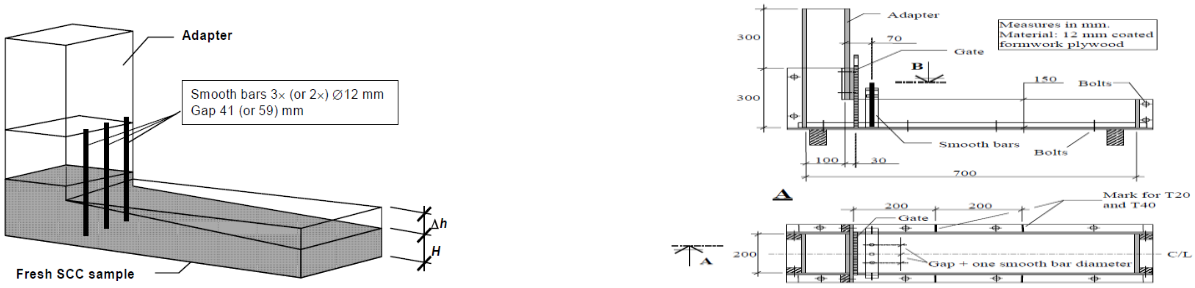

Fig 4: Dimension of L-box

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Dimension of J-Ring:

Table 2: Precisions of the J-Ring flow spread and flow time

J-ring flow spread *SJ* [mm]	**<600**	**600-700**	**>750**
Repeatability *r* [mm]	59	46	25
Reproducibility *R* [mm]	67	46	31
J-ring flow time T50J [sec]	≤3.5	3.5-6	>6
Repeatability *r* [sec]	0.70	1.23	4.34
Reproducibility *R* [sec]	0.90	1.32	4.34
J-ring blocking step *BJ* [mm]	≤20		>20
Repeatability *r* [mm]	4.6		7.8
Reproducibility *R* [mm]	4.9		7.8

L-Box: The l-box, which are shown in Figure 2 measure the filling and passing ability of SCC. In the case of the l-box, concrete is initially placed in the vertical portion of the box.

Cube Casting: Cubes are casted using the moulds of size 150*150*150mm.

Making Test Cubes from Fresh Concrete: Concrete cubes are made on site to check that the strength of the concrete is above the minimum strength which has been specified.

Curing: Curing was performed for duration of 14 days and 28 days. Curing was performed under water and the cast was removed after 24 hours of casting. Shown in fig 5.

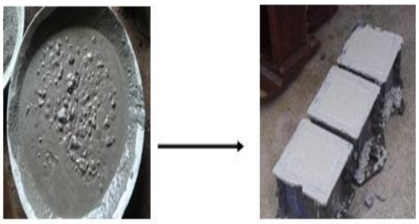

Fig 5: Cube Casting

Fig 6 : Concrete Cubes

Fig 7: Curing process

Fig 8 : Before testing

Fig 9 : After testing

Concrete Cube Testing

3. RESULTS AND DISCUSSION

L – Box Test

Table 3: Passing ratio of L- Box test

L-box	**Partial replacement of M-sand**				
	0%	25%	50%	75%	100%
H1	61	56	53	51	50
H2	50	48	47	48	49
H1/H2	0.81	0.85	0.88	0.94	0.98

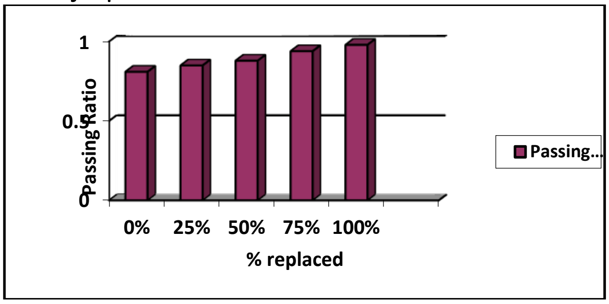

Fig 10: Passing Ratio for L-Box Test

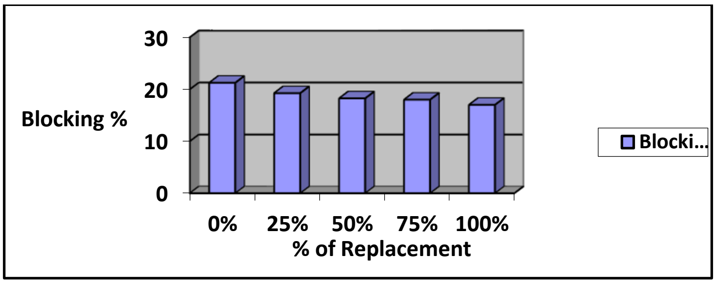

Fig 11: Blocking percentage for L-Box Test

J – Ring Test:

Table 4: Blocking percentage of J- Ring test

S.N	Replacement of Fine Aggregate	Δhx_1	Δhx_2	Δhy_1	Δhy_2	Δhx_0	B_j
1	0%	115	117	118	115	95	21.25
2	25%	121	123	122	123	103	19.25
3	50%	124	123	125	125	106	18.25
4	75%	126	125	126	127	108	18
5	100%	129	128	128	127	111	17

Compressive Strength:

Table 5: Compressive Strength for 28 Days after Curing

S.N	Replacement of Fine Aggregate	Load kN	Compressive Strength N/mm2
1	0%	810	36
2	25%	855	38
3	50%	900	40
4	75%	946	42.044
5	100 %	968	43.022

Table 6: Weight loss and Compressive Strength of 28 days 100% Replaced Concrete Cubes

Weight (Kg)	Average Weight (Kg)	Loss of Weight (%)	Compressive Strength(N/mm^2)
3 Days			
7.900	7.895	1.32	32.15
7.891			
6 Days			
7.700	7.700	3.8	28.35
7.700			
9 Days			
7.850	7.720	4.5	26.52
7.640			

Table 7: Weight Loss and Compressive Strength of 28 days M30Cubes

Weight (Kg)	Average Weight (Kg)	Loss of Weight (%)	Compressive Strength (N/mm^2)
3 Days			
7.310	7.530	1.50	22.32
7.271			
6 Days			
7.156	7.125	3.8	20.15
7.100			
9 Days			
7.085	7.050	5.0	18.78
7.001			

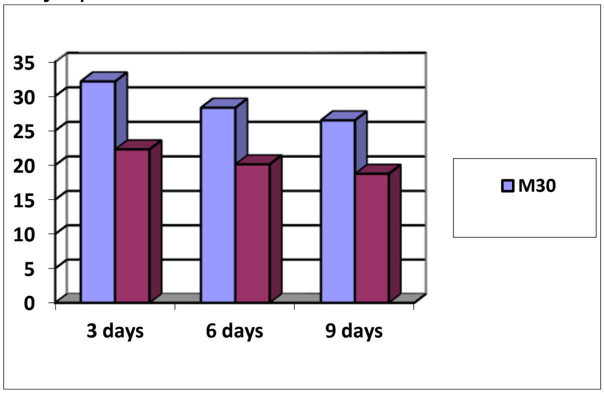

Fig 12: Weight loss and Compressive Strength of 28 days 100% Fine Aggregate Replaced Concrete Cubes

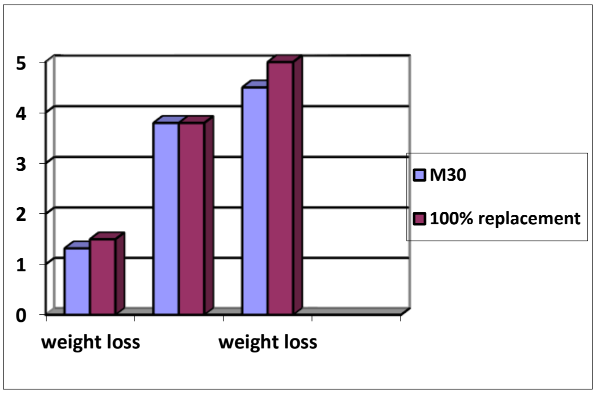

Fig 13: Weight Loss and Compressive Strength of 28 days M_{30} Cubes

4. SUMMARY AND CONCLUSION

Summary of Work: With the information available about the self-compaction of concrete form the literature surveying and from the past researches done on this topic. The mixture proportion was selected so as to have a balanced workability and strength. The mixing was done manually. The compaction did not done in this all cubes casted. Curing was performed to immerse in the water and testing was done to determine the compressive.

Conclusions: In this project, the properties of fine aggregates, coarse aggregates and cement were determined. The Fine aggregate is replaced by 25%, 50%, 75% and 100% by granite dust. The Passing Ratio of L- Box test is 100% replaced fine aggregate by granite sand is increased by 21% more than Nominal concrete. The Blocking Ratio of J- Ring test is 100% replaced fine aggregate by granite sand is increased by 25% more than Nominal concrete. The Compressive strength shows good result for 100% replaced fine aggregate by granite sand and Strength is increased by 19% more than Nominal concrete.

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