Experimental Investigation of Self - Compacting Concrete Using Copper Slag

E. Sureshkumar [1], T. Suresh [2], V. Vijayan [2], T. Sathanandham [2], K. Sivanesan [3], S. Rathinamoorthy[3]

[1]Assistant Professor, Civil Engg.., Jay Shriram Group of Institutions, Tamilnadu, India

[2]PG student.., RVS College of Engineering, Tamilnadu, India

[3]UG student,, Civil Engg.., Jay Shriram Group of Institutions, Tamilnadu, India

ABSTRACT:

The paper examines the possibility of using copper slag as partial replacement of sand and Nano Silica as partial replacement of cement and super plasticizer and Viscosity Modifying Agent are used in self compacting concrete, in order to overcome problems associated with cast-in-place concrete. Self compacting concrete does not require skilled labours. The percentage of copper slag to be added is 10%, 20%, 30% of total weight of sand. The percentage of Nano Silica to be added is 2%, 4%, 6%, and 8% of total weight of cement. According to ACI: 211.4R code of practice, control specimen is casted for M_{40} . Finally the workability and strength characteristics of concrete have been compared with conventional concrete.

INTRODUCTION:

Development of self-compacting concrete (SCC) is a desirable achievement in the construction industry in order to overcome problems associated with cast-in-place concrete. Self compacting concrete is not affected by the skills of workers, the shape and amount of reinforcing bars or the arrangement of a structure and, due to its high-fluidity and resistance to segregation it can be pumped longer distances. The concept of self-compacting concrete was proposed in 1986 by Professor Hajime Okamura, but the prototype was first developed in 1988 in Japan, by Professor Ozawa (1989) at the University of Tokyo. Self-compacting concrete was developed at that time to improve the durability of concrete structures. Since then, various investigations have been carried out and SCC has been used in practical structures in Japan, mainly by large construction companies. Investigations for establishing a rational mix-design Method and self-compact ability testing methods have been carried out from the viewpoint of making it a standard concrete. Fine aggregate is an essential component of concrete. The most commonly used fine aggregate is natural river sand. The global consumption of natural river sand is very high due to the extensive use of concrete. In particular, the demand of natural river sand is quite high in developed countries owning to infrastructural growth. The non-availability of sufficient quantity of ordinary river sand for making cement concrete is affecting the growth of construction industry in many parts of the country. Recently, Tamilnadu government has imposed restrictions on sand removal from the river beds due to unsafe impacts threatening many parts of the state. On the other hand, the copper slag was generated by the industry has accumulated over years. Only insignificant quantities have been utilized and the rest has been dumped unscrupulously resulting in environment problem. In the present work, it is aimed at developing a new building material from the copper slag, an industrial waste as a replacement material of fine aggregate in concrete. By doing so, the objective of reduction of cost of construction can be met and it will help to overcome the problem associated with its disposal including the environmental problems of the region.

ADVANTAGES OF THE SELF-COMPACTING CONCRETE:

- It reduces the cost of labours needed for curing and compacting the concrete
- It holds well in the place of large buildings and in complicated areas where curing and compaction process is difficult and costly.
- Marked improvement in durability on account of better compaction
- Extremely suitable for slim and complicated moulds.
- Covers the reinforcement area effectively.
- Construction process is very faster.

INGREDIENTS USED:

Cement : Ordinary Portland cement 53 grade (OPC)

Fine aggregate : Natural river sand

Coarse aggregate: Maximum stone size of 10mm – 12.5 mm is used

Water : Ordinary potable water

Mineral admixtures: Nano silica

Self-compacting admixtures **:** Super plasticizer (SP CONPLAST 430, 1%), Viscosity Modifying Agent (0.8%)

MATERIAL PROPERTIES

Table: 1. Test Results for Fine Aggregate

S No	Sand type	Name of the Test	Zone III
1.	River Sand	Specific gravity	2.74
2.		Fineness modulus	2.62

Table: 2. Test Results for Coarse Aggregate

S.NO	NAME OF THE TEST	RESULT OBTAINED
1.	Specific gravity	2.71
2.	Impact strength	9.415%
3.	Crushing strength	22.57%

S.NO	NAME OF THE TEST	RESULT OBTAINED
1.	Specific gravity	3.83
2.	Hardness	6 to 7 Mohr's Scale
3.	Bulk density	1.87 (Kg/l)
4.	Granulated	Black in color

Table: 3. Test Results for Copper Slag

Table: 4. Trial – I MATERIAL QUANTITY

AS PER EUROPIAN STANDARD	
Cement	398 kg/m^3
Fine aggregate	1000 kg/m^3
Coarse aggregate	1108.13 kg/m^3
Water	139 ml
Super plasticizer	4.68 lit/m^3
VMA	3.64 lit/m^3

Table: 5 Trials – II MATERIAL QUANTITY

AS PER ACI: 211.4R	
Cement	504.21kg/m^3
Fine aggregate	683.24 kg/m^3
Coarse aggregate	1108.13 kg/m^3
Water	146.61ml
Super plasticizer	3.79 lit/m3
Viscosity Modifying Agent	3.35 lit/m3

The maximum result should be obtain in the 2nd trial, so it will taken as a final mix proportion

WORKABILITY:

Table: 6. Workability test result

Trials	L-Box (h2/h1) mm	V-Funnel (Sec)	Slump flow mm	U-Box (h2 - h1) mm
1	0.85	9	680	18
2	0.90	8	710	20
3	0.9	10	700	20

SPECIMENS CASTING AND TESTING

The cubes of size 150mm, cylinder of size 150mm diameter and 300mm height and prism of size 150mm length, 50mm depth, 50mm breadth of both conventional and self-compacting concrete were cast. The strength related tests were carried out for hardened conventional concrete and self-compacted concrete at the age of 7 days and 28 days to ascertain the strength related properties such as compressive strength, split tensile strength and flexural strength.

Fig 1. Casting of Specimens

Fig 2. Testing of Specimens

RESULTS AND DISCUSSION:

The compressive strength of cube, split tensile strength of cylinder and flexural strength of prism are given below.

Table 7. Compressive Strength of Conventional Cubes

	Compressive strength(N/mm^2)		
Conventional	3 days	7 days	28 days
	17.21	28.39	48.625

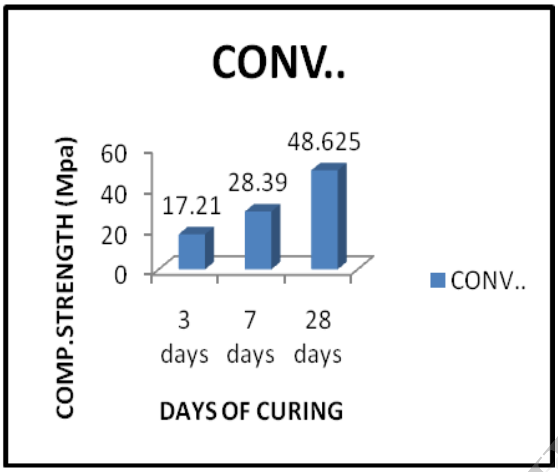


Fig. 4 Comp. Strength of Conventional Cubes

Table 8.Split tensile Strength of Conv..Cylinder

	Split tensile strength(N/mm^2	
Conventional	7 days	28 days
	1.39	4.58

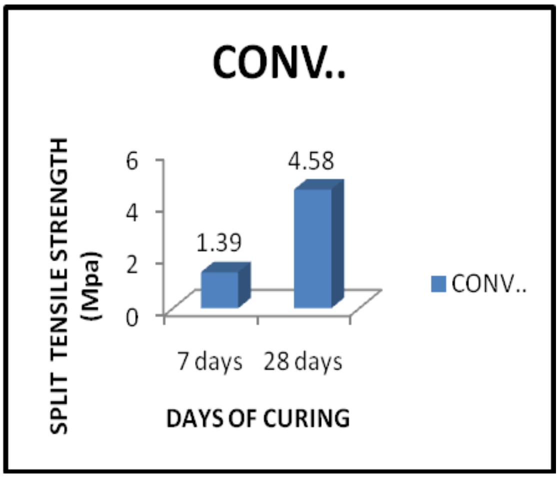


Fig. 5 Split Tensile Strength of Conv... Cylinder

Table 9. Flexural Strength of Conventional Prism

	Flexural strength(N/mm^2)	
Conventional	7 days	28 days
	1.56	3.95

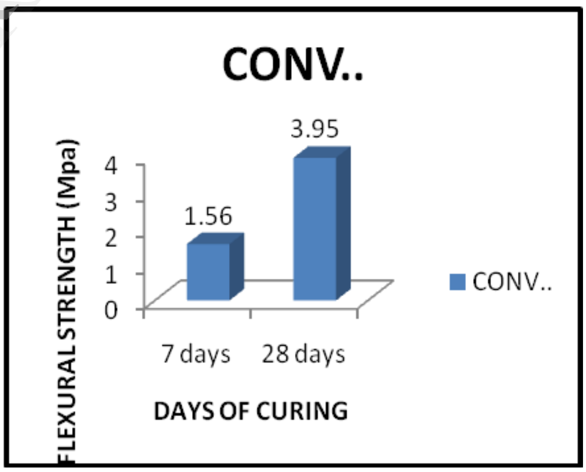


Fig. 6 Flexural Strength of Conv... Prism

Table 10. Compressive strength of SCC cubes

	Compressive strength N/mm^2		
SCC	3 days	7 days	28 days
	14.43	26.46	46.136

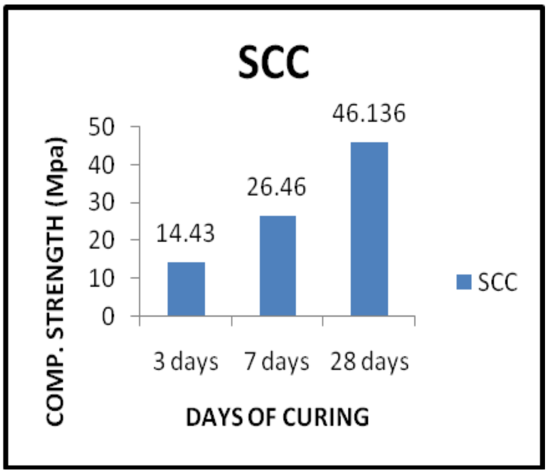


Fig. 7 Comp. Strength of SCC Cubes

Table 11. Split tensile strength of SCC cylinder

	Split tensile strength N/mm^2	
SCC	7 days	28 days
	7.72	10.15

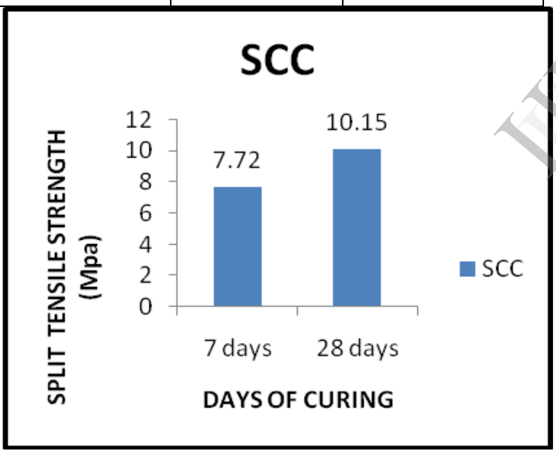


Fig. 8 Split tensile strength of SCC cylinder

Table 12. Flexural strength of SCC prism

	Flexural strength N/mm^2	
SCC	7 days	28 days
	4.52	6.98

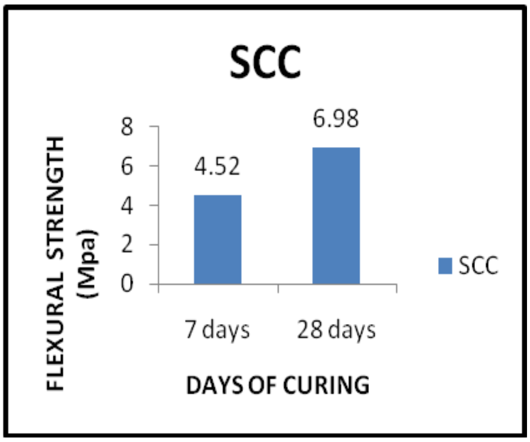


Fig.9 Flexural Strength of SCC Prism

Fig.10 Comparison chart for NC and SCC cubes

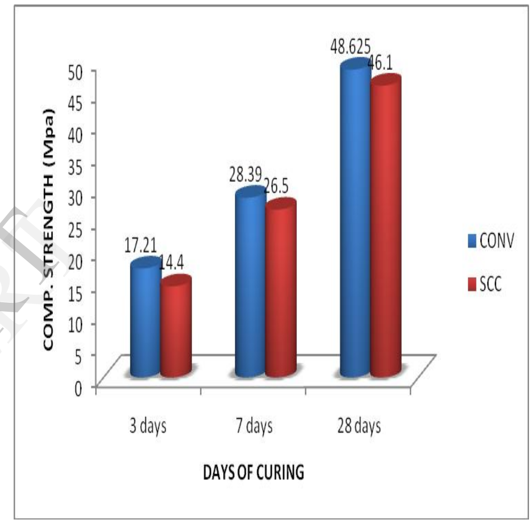


Fig.11 Comparison chart for NC and SCC cylinder

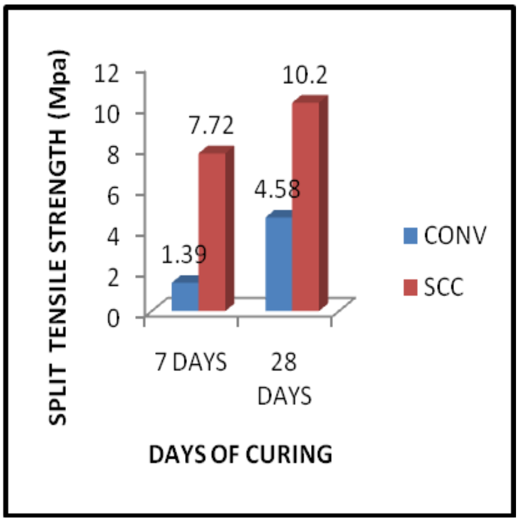
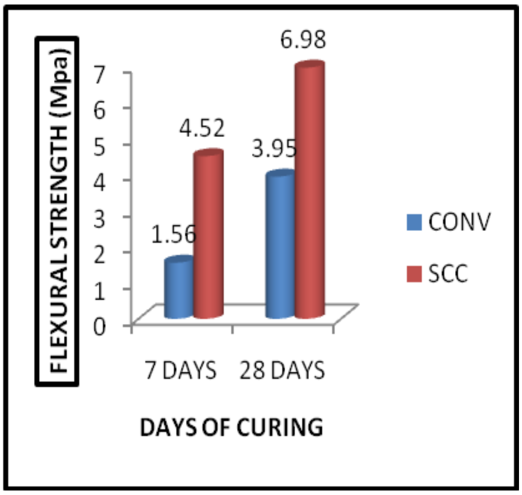


Fig.12 Comparison chart for NC and SCC prism



CONCLUSION:

After testing, the following results should be made.

- The strength of the conventional concrete has attained the target strength in 7days and 28 days
- The self compacting concrete has obtained the grade of strength, but it does not meet the target strength

PERCENTAGE OF INCREASE IN STRENGTH OF SELF – COMPACTING CONCRETE COMPARED TO CONVENTIONAL CONCRETE:

Cube Strength:

Decrease in compressive strength of SCC at 3 days compared with CC =16.32%

Decrease in compressive strength of SCC at 7 days compared with CC =6.79%

Decrease in compressive strength of SCC at 28 day compared with CC =5.13%

Cylinder Strength:

Increase in split tensile strength of SCC at 7 days compared with CC =24.58%

Increase in split tensile strength of SCC at 28 day compared with CC =19.62%

Prism Strength:

Increase in Flexural strength of SCC at 7 days compared with CC =22.39%

Increase in Flexural strength of SCC at 28 day compared with CC =17.42%

REFERENCES:

1) H.Mazaheripour,S.Ghanbarpour, etc All "Construction and Building Materials" vol 25(2011),pp:351-358

2) Gaston Espinoza-Hijazin, Mauricio Lopez "Construction and Building Materials" vol 25(2011),pp:1236-1242

3) Fathollah sajedi,Hashim Abdul Razak "Construction and Building Materials" vol 25(2011),pp:2036-2045

4) Luc Courard,Frederic Michel,Julie Pierard "Construction and Building Materials" vol 25(2011),pp:1356-1361

5) C.Parra,M.Valcuende..Gomez "Construction and Building Materials" vol 25(2011),pp:20.

6) Ming-fang Ba, Chun-xiang Qian, "Construction and Building Materials" vol 25(2011), pp:123-128)

7) Seong-Tae Yi, Sue-Won Pae, Jin-keun Kim "Construction and Building materials" vol 25(2011), pp:1439-1449

8) Eva Vejmelkova,Martin Keppert "Construction and Building Materials" vol 25(2011)pp:1325-1331

9) Shazim Ali Momon,Muhammad Ali Shaikh,Hassan Akbar "Construction and Building Materials" vol 25(2011),pp:1044-1048