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Parametric study ofself-compacted concrete (SCC) by using industrial waste (copper slag, ceramic waste)

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Abstract: *self-compacted concrete is high performance concrete which has high fluidity without segregation which does not required vibration and able to flow by own weight for filling purpose of mold. SCC first develop in 1988 in japan to make standard recommendation and manuals for SCC. Now a days concrete has no long just cement, fine aggregate, coarse aggregate and water. Technology undergone from macro to micro study which improve performance of concrete. But use of expansive admixture and very large quantity of cement and its give low strength and difficult to obtain. India has serious challenge for disposing industrial waste as land filling which result in high cost and environmental problem. Utilize treated and untreated industrial waste as raw material in concrete is give clean and greener environment. Industrial waste like copper slag and construction & demolition (C&D) waste replacing by fine aggregate and coarse aggregate in different proportion is economical. Copper slag is by product of matte smelting and retaining copper.Which can replace by fine aggregate in concrete and in C&D wastes major part ceramic waste can replace by coarse aggregate to improve workability and strength of concrete. The test conducted for finding workability of SCC conducted are slump test, U-tube test, V-funnel test and L bar test.*

Keywords: *scc, industrial waste, copper slag, ceramic waste, fine aggregate, coarse aggregate, workability.*

I. INTRODUCTION

Self-compacting concrete (SCC) can be defined as a fresh concrete which possesses superior flow ability under maintained stability (i.e. no segregation), thus allowing self-compaction— that is, material consolidation without addition of energy.
The three properties that characterize a concrete as self-compacting are

1. flowing ability—the ability to completely fill all areas and corners of the formwork into which it is placed (e.g. Fig. 1)
2. Passing ability—the ability to pass through congested reinforcement (e.g. Fig. 2) without separation of the constituents or blocking.
3. Resistance to segregation—the ability to retain the coarse components of the mix in suspension in order to maintain a homogeneous material. In general, the hardened properties of SCC are similar or superior to those of equivalent conventional concrete. Provided the self-compacting properties are verified on site, a less variable and denser concrete is achieved. It could also be said that the compaction, and therefore durability, of the concrete is more guaranteed with the use of SCC as it reduces the potential for human error (in the form of poor compaction).

Fig 1

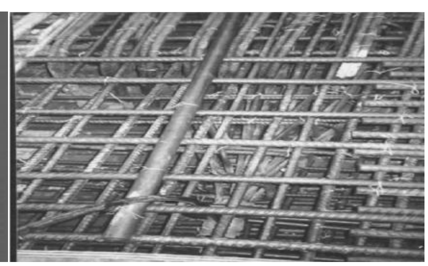

Fig 2

Self-compacting concrete (SCC) was first developed in Japan as a mean to create uniformity in the quality of concrete by controlling the ever present problem of insufficient compaction by a workforce that was losing skilled labor and by the increased complexity of designs and reinforcement details in modern structural members.

The concept of Self-compacting concrete was firstly presented in 1986 by Okamura, a scholar from the University of Tokyo. He pointed out that the reduction of Japanese skilled workers has a negative impact on the durability of the concrete structure, and proposed developing self-compacting concrete which can avoid the impact of construction quality. Self - compacting concrete is a kind of concrete which is characterized by high – workability Soon after, Ozawa, a scholar from the University of Tokyo, carried out the study of self-compacting concrete, and make up self - compacting concrete successfully in 1988.
Industrial revolution brought many changes in human lifestyle with various industries giving employment to people. On the other hand, numerous amount of industrial solid waste is generated from the industrial sectors. The disposal of this solid waste is a tedious process causing various threats to the environment.
The Indian construction industry alone consumes approximately 400 million tons of concrete every year and the relative amount of mortar too. Therefore the demand of the concrete and the required raw materials are very high. This causes the hike in the costs of cement, fine and coarse aggregates. Quite often the shortage of these materials is also occurred. To avoid the problems like cost hike and cuts in supply of concrete and mortar, the alternate material or the partial replacements for the cement and aggregate should be developed by recycling of waste materials. This provides us the low cost, lightweight and eco-friendly construction products. Use of the waste materials also reduces the problem of land-filling, environmental and health concern.
A fine example of use of waste material in concrete would be Copper slag, which can replace either cement or aggregate partially or completely. Although studies indicate use of Copper slag as aggregate influences the performance of concrete, not much research has been done regarding its use as fine aggregate in SCC. Cooper slag is a by-product in the manufacture of copper. For every ton of copper produced, roughly 3 tons of copper slag gets generated. The Tuticorin plant of Sterlite has a capacity of 400,000 ton of copper per annum and generates roughly 1.2 million ton of copper slag. This polluting material needs to be properly disposed. This waste material is used for many purposes, mostly for land filling to grid blasting.
The second one is ceramic waste. Much research has been conducted worldwide on the usage of ceramic wastes as an additive in structural and non-structural concrete. The study was also conducted in specialized concrete such as high performance concrete and sulphate resistant concrete. Positive results were obtained from these studies.

II. COPPER SLAG AND ITS MIX PROPORSION

Approximately 24.6 million tons of slag is generated from world copper production. Dumping or disposal of this slag causes wastage of metal values and leads to environmental problems. Rather than disposing, these slags can be used taking full advantage of its physico-mechanical properties. The major slag producing regions with quantities is given in Table 1. Slag containing <0.8% copper are either discarded as waste or sold as products with properties similar to those of natural basalt (crystalline) or obsidian(amorphous). Utilization and recovery of metal depend on the type of slag. Current options of management of this slag are recycling, recovering of metal, production of value added products and disposal in slag dumps or stockpiles. Processed air-cooled and granulated copper slag has number of favorable mechanical properties for aggregate use, including excellent soundness characteristics, good abrasion resistance and good stability. Since copper slag has a low content of CaO, granulated copper slag exhibits pozzolanic properties (Deja and Malolepszy, 1989; Douglas and Mainwaring, 1985).

Table 1. Copper slag generation in various regions

Regions	Copper slag generation/annum in million ton
Asia	7.26
North America	5.90
Europe	5.56
South America	4.18
Africa	1.23
Oceania	0.45

Fig 3

Mix proposion
According to the studies by Brindha and Nagan (2011) the mix proportion considered is1:1.66:3.76 with w/c = 0.45 and 0 to 60% (CC, S20, S40 and S60) of natural sand was replaced bycopper slag by weight. The four concrete mixtures with different proportion of copper slag are asshown in Table 2.

Table 2 Χονχρετε μιξτυρεσ ωιτη διφφερεντ προπορτιον οφ χοππερ σλαγ

Μιξ ματεριαλσ	ΧΧ Κγ/μ^3	Σ20 Κγ/μ^3	Σ40 Κγ/μ^3	Σ60 Κγ/μ^3
Cement	340	340	340	340
Copper slag (CS)	0	113.4	226.8	340.2
Water	153	153	153	153
Fine aggregate	567	453.6	340.2	226.8
Coarse aggregate	1278	1278	1278	1278
Τοταλ ψιελδ (Κγ/μ^3)	2338	2338	2338	2338

Ιν τηε αβοωε μιξ δεσιγν, τηε τοταλ ψιελδ ισ λεσσ τηαν ονε χυβιχ μετε.

Ταβλε 3: Μοδιφιεδ χονχρετε μιξτυρεσ ωιτη διφφερεντ προπορτιον οφ χοππερ σλαγ

Μιξ ματεριαλσ	ΧΧ Κγ/μ^3	Σ20 Κγ/μ^3	Σ40 Κγ/μ^3	Σ60 Κγ/μ^3
Cement	340	340	340	340
Copper slag (CS)	0	172.36	344.77	517.1
Water	153	153	153	153
Fine aggregate	567	453.6	340.2	222.6
Coarse aggregate	1278	1278	1278	1278
Τοταλ ψιελδ (Κγ/μ^3)	2338	2338	2338	2338

III. ΧΕΡΑΜΙΧ ΩΑΣΤΕ ΑΝΔ ΙΤΣ ΜΙΞ ΠΡΑΠΟΡΤΙΟΝ

The term ceramics is a general term used to refer to ceramic products. Common manufactured ceramics include wall tiles, floor tiles, sanitary ware, household ceramics and technical ceramics. In essence, ceramic is a term used to describe inorganic materials (with possibly some organic content), made up of non-metallic compounds and made permanent by a firing process.

Clay, which is the most abundant material in the making of most ceramics, is naturally not a pozzolanic material. This is because it does not have silicate properties, which can react with water to form calcium hydroxide in the production of concrete. Research conducted by on the possibility of waste clay materials being used as pozzolanic additions indicated that the activation of clay to become pozzolanic begins during dehydration process, which initiates when heating clay from around 500ºC, and the separation of amorphous and very active aluminum oxide. The temperature required to reach maximum concentrations of the aluminum oxide depends on the type of minerals in the clay. During the making of ceramics, clay is heated at relatively high temperatures, the exact temperature depending on the type of ceramic being produced. For instance, the study at hand focuses on ceramic wall tile wastes, which are reject tiles, which went through the full firing process. The ceramic wall tiles are fired at around 1150ºC. Deducting from that, it is logical to say wastes from the ceramic industry (ceramic waste) possess characteristics suitable for use as pozzolanic materials and thus are suitable for use in the making of concrete.

Mix proposion

Here sixtype of different mixes of concrete were prepared by keeping water cement ratio, fine aggregate contain constant. Ceramic coarse aggregate used with different sizes of 7, 12 and 20mm. fly ash used to replaced cement binder. The mix properties showed inTABLE 4.

Materials		**Size**	**M1**	**M2**	**M3**	**M4**	**M5**	**M6**
Binder Kg/m^3	**Cement**		520	520	520	365	365	365
	Fly ash		-	-	-	155	155	155
Aggregate Kg/m^3	**Fine**		895	895	895	895	895	895
	Coarse	7	765					
		12		765				
		20			765			
	Ceramic	7				765		
		12					765	
		20						765
Water/Binder			0.48	0.4	0.48	0.48	0.48	0.48
Water,liter			250	250	250	250	250	250
SP,%weight cement			-	-	-	1.5	1.5	1.5

Table 4:

SP,% weight		-	-	-	1.5	1.5	1.5

Μοδιφιεδ χονχρετε μιξτυρεωιτη χεραμιχ ωαστε.

III. TESTING METHOD FOR SELF COMPACTION ON SOFT CONCRETE

Method for finding the SCC properties are slump flow test, U – flow test, V – flow time, L – Box test.
Recommended limitations for various properties of SCC are given in table 5.

Table 5: recommended values for different method

Sr. no	methods	unit	Typical range of values	
			minimum	Maximum
1	Slump flow	mm	600	800
2	U-flow test	h_2-h1	0	30
3	V-funnel test	Sec	6	12
4	L-box test	h_2/h_1	.8	1.0

3.1 SLUMP FLOW TEST

This is a test method for evaluating the flowability. of SCC, where the slump flow of SCC with coarse aggregates having the maximum size of less than 40 mm is measured

This is simple, rapid test procedure, though two people are needed if the T50 time is to be measured. It can be used on site, though the size of the base plate is somewhat unwieldy and level ground is essential. It is most commonly used test, and gives a good assessment of filling ability. It gives no indication of the ability of the concrete to pass between reinforcement without blocking, but may give some indication of resistance to segregation. It can be argued that the completely free flow, unrestrained by any boundaries, is not representative of what happens in practice in concrete construction, but the test can be profitably be used to assess the consistency of supply of ready-mixed concrete to a site from load to load.

Fig 4

3.2 U- FLOW TEST

These are methods for testing flowability of SCC through an obstacle with coarse aggregates having the maximum size of less than 25 mm (Fig. 5). Time and height to be filled in the chamber B and amount of aggregate passed through the obstacle are measured for self-compatibility.

This is a simple test to conduct, but the equipment may be difficult to construct. It provides a good direct assessment of filling ability-this is literally what the concrete has to do-modified by an unmeasured requirement for passing ability.The 35 mm gap between the sections of reinforcement may be considered too close. The questioner mains open of what filling height lessthan 30 cm.is still acceptable.

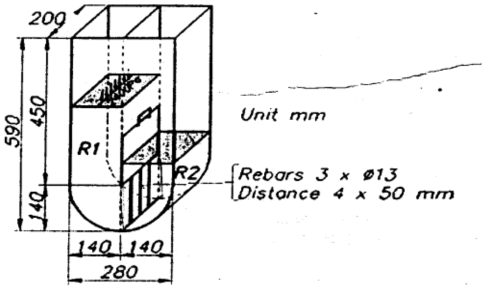

Fig 5

3.3V-FUNNEL TEST

The described V-funnel test is used to determine the filling ability (flow ability) of the concrete with a maximum aggregate size of 20mm.The funnel is filled with about 12 liter of concrete and the time taken for it to flow through the apparatus

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.
About 12 liter of concrete is needed to perform the test, sampled normally. Set the v-funnel on firm ground. Moisten the inside surfaces of the funnel. Keep the trap door open to allow any surplus water to drain. Close the trap door and place a bucket underneath. Fill the apparatus completely with concrete without compacting or tamping; simply strike off the concrete level with the top with thetrowel. Open within 10 sec after filling the trap door and allow the concrete to flow out under gravity. Start the stopwatch when the trap door is opened, and record the time for the discharge to complete (the flow time). This is taken to be when light is seen from above through the funnel. The whole test has to be performed within 5 minutes.

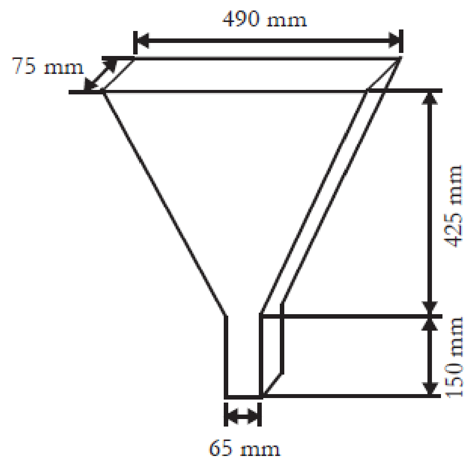

FIG 6

3.4 L- BOX TEST

This test, based on a Japanese design for underwater concrete, has been described by Peterson. The test assesses the flow of the concrete, and also the extent to which it is subjected to blocking by reinforcement. The apparatus is shown in figure.
The apparatus consists of a rectangular section box in the shape of an 'L', with a vertical and horizontal section, separated by a moveable gate, in front of which vertical lengths of reinforcement bars are fitted.
The vertical section is filled with concrete, and then the gate lifted to let the concrete flow into the horizontal section. When the flow has stopped, the height of the concrete at the end of the horizontal section is expressed as a proportion of that remaining in the vertical section (H2/H1 in the diagram). It indicates the slope of the concrete when at rest. This is an indication passing ability, or the degree to which the passage of concrete through the bars is restricted.
The horizontal section of the box can be marked at 200 mm and 400 mm from the gate and the times taken to reach these points measured. These are known as T20 andT40 times and are an indication for the filling ability.

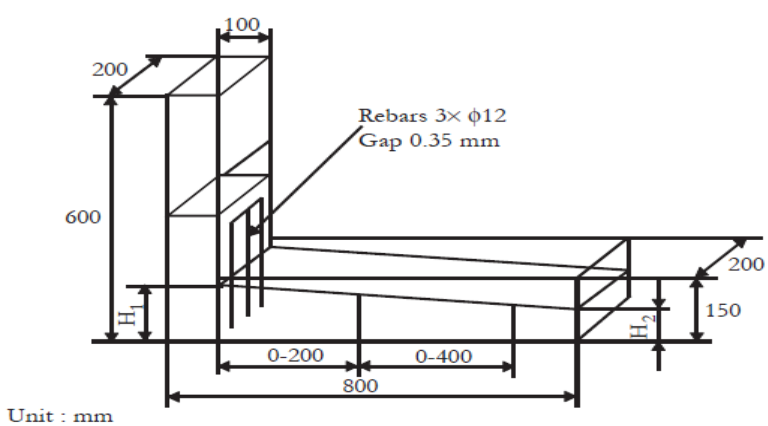

Fig 7

IV. TESTING METHOD FOR SELF COMPACTION ON HARDEN CONCRETE

4.1 Compressive Strength

SCC compressive strengths are comparable to those of conventional vibrated concrete made with similar mix proportions and water/cement ratio. There is no difficulty in producing SCC with compressive strengths up to 60MPa\

Fig 8

4.2Tensile Strength

Tensile strengths are based on the indirect splitting test on cylinders. For SCC, the tensile strengths and the ratios of tensile and compressive strengths are in the same order of magnitude as the conventional vibrated concrete.

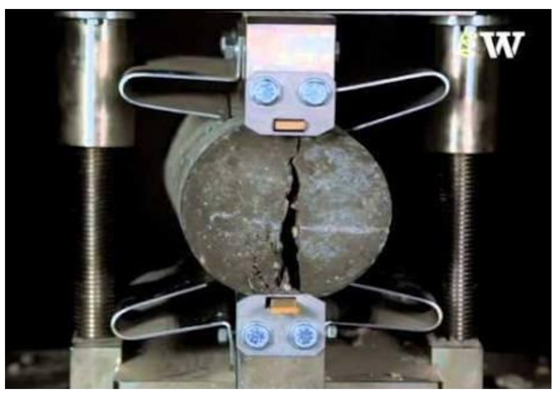

Fig 9

4. CONCLUSIONS

Self-compacting concrete could possibly be developed with utilizing copper slag and ceramic aggregate as was done in this study.

By replacing fine aggregate by copper slag improve the workability and strength of concrete for replacement up to 40% of fine aggregate .further increase in copper slag reduced its strength due to an increase of the water content in the mix content.Hence this paper mention that 40 percentage weight of CS can be used as replacement of river sand (fine aggregate) in order to obtain self-compaction with good properties.

Regarding our research, to attempt compressive and flexure strength, the use of ceramic recycled aggregates for concrete is suitable. After 56 day Self-compacting concrete average compressive strength is higher than normal concrete.The tensile strength of self-compacting concrete [SCC] for beam is less than a comparable behavior to normal concrete beam. However, the self-compacting beam concrete achieves higher ultimate strength and there is significance difference in ductile behavior compared to normal concrete beam. Consequently, it can be reported to the mix (M4) has beneficial effects on both (fresh and hardened) properties of self-compacting compared to the other five mixes in normal and self-compacting concrete

REFERENCES

[1] DhirajAgrawal,PawanHinge,U. P. Waghe,S.P. Raut, "Utilization of industrial waste in construction material – A review" IJIRSET, ISSN: 2319-8753 ,PP 8390

[2] O. Zimbili, W. Salim, M. Ndambuki, "A Review on the Usage of Ceramic Wastes in Concrete Production", International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering Vol:8, No:1, 2014,PP 91-93

[3] Zekong Chen, Mao Yang, "The Research on Process and Application of Self-Compacting Concrete" Int. Journal of Engineering Research and Applications, Vol. 5, Issue 8, (Part - 3) August 2015, pp.12-18

[4] GhasanFahimHuseien,"Performance of Self-Compacting Concrete With Different Sizes of Recycled Ceramic Aggregate", ©2015 IJIRCT | ISSN: 2454-5988 ,PP 264-269

[5] M. C. Nataraja1, G. N. Chandan2, T. J. Rajeeth, "CONCRETE MIX DESIGN USING COPPER SLAG AS FINE AGGREGATE", IJCIET, ISSN 0976 – 6316 Volume 5, Issue 9, September (2014), pp. 90-99

[6] Daniel , Joel Shelton , Vincent Sam Jebadurai , Arun Raj, "STUDIES ON HIGH STRENGTH SELF COMPACTING CONCRETE WITH COPPER SLAG FOR M30 GRADE",IJRET,eISSN: 2319-1163 | pISSN: 2321-7308, PP 74-78

[7] Chris I. Goodier, "Development of self-compacting concrete", GOODIER, C.I., 2003. Development of self-compacting concrete, Proceedings of the ICE- Structures and Buildings, 156 (4), pp. 405-414

[8] PathariyaSaraswati, RanaJaykrushna, Shah Palas, Mehta Jay, Patel Ankit N, "Application of Waste Foundry Sand for Evolution of Low-Cost Concrete:", International Journal of Engineering Trends and Technology (IJETT) – Volume 4 Issue 10 - Oct 2013, PP 4281-4286

[9] PayalPainuly, ItikaUniyal, "LITERATURE REVIEW ON SELF-COMPACTING CONCRETE", International Journal of Technical Research and Applications e-ISSN: 2320-8163,Volume 4, Issue 2 (March-April, 2016), PP. 178-180

[10] Masahiro Ouchi, Sada-aki Nakamura, Thomas Osterberg, Sven-Erik Hallberg, MyintLwin "APPLICATIONS OF SELF-COMPACTING CONCRETE IN JAPAN, EUROPE AND THE UNITED STATES" , 2003 ISHPC ,PP 1-20

