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A Review On the Mechanical Properties of Concrete by Using Copper Slag and Nano Silica

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***Abstract*: This is the era of revolution it can be more revolutionized by Eco friendly material like Copper Slag, Nano-Silica. Concrete is one of the widely used building material across the world. The usage of sand in construction industry leads to the excessive mining, causing depletion of natural resources. Copper Slag waste is most usually made from the copper industry, whereas Silica Fume is a by-product from many manufactures. Chuck out of both copper slag waste and Nano –Silica is one of the major environmental problems worldwide today. Hence the reuse of waste material leads to better sustainability to the environment. Reuse of side effects as in incomplete or full substitution of fine total in development exercise not just decreases the interest for extraction of normal crude material yet in addition spares land fill space. In this review paper deals with study of the Strength properties of concrete by partial replacement of fine aggregate with copper slag and cement with Nano-silica in it. In this review paper different writing concentration done by different writers are discussed.**

***Keywords*: Copper slag, Nano-Silica, Concrete, Compressive Strength.**

1. Introduction

Concrete is a development material comprising of cementitious material, fine aggregate, coarse aggregate also, water. Presently days the cost of these materials are expanded in this way, we have to take a look at an approach to diminish the cost of building materials particularly concrete. One of the ongoing headway in development industry is substitution of materials in concrete. The substitution of materials offers cost decrease, vitality funds and security of condition. Copper slag is a mechanical side-effect material created from the way toward assembling copper. At present about 33 million tonnes of copper slag is generating annually worldwide among that India contributing 6 to 6.5 million tonnes. 50 % copper slag can be used as replacement of natural sand in to obtain mortar and concrete with required performance, strength and durability. More specifically, the cement paste matrix is basically a porous material composed of calcium hydroxide (portlandite), aluminates and unhydrated cement (clinker) embedded into an amorphous nanostructured hydration product, the so-called C–S–H (calcium silicate hydrate) gel. This gel is the dominant hydration product of the cement paste, not only because it is the most abundant component (50–70% by volume), but also because of its exceptionally good mechanical properties.

Nanoparticles have a high surface-area-to volume ratio. In this way, nanoparticles with 4-nm diameter have more than 50% of its atoms at the surface and are thus very reactive. The behaviour of such materials is mainly influenced by chemical reactions at the interface, and by the fact that they easily form agglomerates.

2. Literature review

Byung Sik Chunetal., (2005) conducted several laboratory tests and analyzed by monitoring the stress and ground settlement of clay, sand compaction pile and copper slag compaction pile. Weiwuetal., (2010) observed that when copper slag was used to replace fine aggregate, upto 40% coppers large placement, the strength of concrete was increases while the surface water absorption decreases. Senff et al., (2009) Fresh properties Reduction in initial setting time (IST) and final setting time (FST) of pastes was observed on addition of nano-silica. Also, difference between the IST and FST decreased with increase in nano-silica content (Ltifi et al., 2011; Qing et al., 2007). With regard to the effect of nano-silica on the rheology behaviour of the cementitious mixes' studies on cement paste and mortars, most of the researchers agree in indicating that the addition of nano-silica greatly increases the water demand of cementitious mixes as compared to the control ones. Al-Jabrietal.,(2009,2011)observed that the water demand reduced by about 22% for 100% copper slag replacement. The strength and durability of High Strength Concrete improved with the increase in the content of copper slag of upto 50%. However, further additions of copper slag caused reduction in the strength due to increase in the free water content in the mix. Alnuaimi (2012) [4] results showed that the replacement of upto 40%off in aggregate with copper slag caused no major changes in concrete strength, column failure load, or measured flexural stiffness(EI).

R. R. Chavan & D. B. Kulkarni(2013)[5]concluded that Maximum Compressive strength of concrete increased by 55% at 40% replacement off aggregate by copper slag and flexural strength increased by 14% for 40% replacement. S. Chithra et al (2016) studied the Multiple Regression Analysis (MRA) and Artificial Neural Network (ANN) models are constructed to predict the compressive strength of High Performance Concrete containing nano silica and copper slag as fine aggregate

replacement respectively. Khanzadi et al [2010] reported the influence of NS particles on the mechanical properties and durability of concrete through measurement of compressive and tensile strength, water absorption and the depth of chloride penetration. Min Hong Zhang, Jahidul Islam [2012] has used NS to reduce setting times and increase early strength of concrete with high volumes of fly ash or slag. Based on the experimental results by using NS in pastes, mortars and concretes with about 50% of fly ash. Hou et al. [2012] showed that the pozzolanic activity of colloidal NS (instead of NS powder) was higher than that of SF and its hydration acceleration effect was also higher than SF in the early age, but this effect was comparable to that of SF in the later stage. Nazari and Riahia (2011). The splitting tensile strength assessments, thermal behaviour and microstructure of concrete containing different amounts of ground granulated blast furnace slag and SiO2nano particles as binder.

3. Materials and their properties

A. Cement

Ordinary Portland Cement of 53 grade confirming to IS: 12269-1987(9) will use in the future study. The properties of cement are shown in Table 1.

Table 1
Properties of Cement

Sr. No.	Property	Result
1.	Normal Consistency	32%
2.	Colour	grey
3.	Specific Gravity	3.15
4.	Fineness of cement	4. 5%

B. Fine Aggregate

Natural sand as per IS: 383-1987 will use in future research (Locally available River sand having bulk density 1800-1860 kg/m^3). The properties of fine aggregate are shown in Table 2.

Table 2
Properties of fine aggregate

Sr. No.	Property	Result
1.	Specific Gravity	2.57
2.	Shape	irregular
3.	Grading zone	II

C. Coarse Aggregate

Crushed aggregate confirming to IS: 383-1987 was used. Aggregates of size 20mm and 12.5 mm of specific gravity 2.74.

D. Copper Slag

Copper slag is a by-product obtained during matte smelting and refining of copper. One of the greatest potential applications for reusing copper slag is in cement and concrete production. Many researchers have investigated the use of copper slag in the production of cement, mortar and concrete as raw materials for clinker, cement replacement, coarse and fine aggregates. The use of copper slag in cement and concrete provides potential environmental as well as economic benefits for all related industries, particularly in areas where a considerable amount of copper slag is produced. This paper reviews the characteristics of copper slag and its effects on the engineering properties of cement, mortars and concrete.

Table 3
Properties of copper Slag

Sr. No.	Physical Properties	Physical Component
1.	Bulk Density	2.08 g/cc
2.	Shape of Particle	Irregular shape
3.	Type	Air cooled type
4.	Voids	42 %
5.	Plausibility	Glassy & Black
6.	Fineness modulus	3.46
7.	Size of particle	0.077 mm to 4.75 mm

Table 4
Composition of Copper Slag

Sr. No.	Component	Percentage
1.	Fe_2O_3	68.29
2.	CaO	0.15
3.	SiO_2	68.29
4.	TiO_2	0.41
5.	Na_2O	0.58
6.	Al_2O_3	0.22
7.	So_3	0.11
8.	CuO	1.20
9.	K_2O	0.23
10.	Mn_2O_3	0.22
11.	Insoluble Residue	14.87
12	Sulphide Sulphur	0.25

E. Nano Silica (nS)

Due to rapid Urbanization infrastructure projects are increased at a very swift rate. A huge amount of solid waste is produced in forms of copper slag, silica fume and recron fiber which can be use sustainable building material. Concrete is matrix of aggregates, sand, cement and water.

Table 5
Properties of Nano-Silica

Sr. No.	Physical Properties	Physical Component
1.	Bulk Density	2.4 g/cc
2.	Colour	White
3.	Specific Surface Area	200-210
4.	Sieve residue	<0.04
5.	pH value	3.7-4.5
6.	Moisture content	<0.15
7.	Size of particle	5nm-100nm

F. Super Plasticizer

Super plasticizer- CONPLAST-SP 430 in the form of sulphonated Naphthalene polymers complies with IS: 9103-1999 and ASTM 494 type F will use to improve the workability of concrete. The properties of super plasticizer are shown in Table 6.

Table 6
Properties of super plasticizer

Sr. No.	Property	Result
1.	Specific Gravity	1.220-1.225
2.	Chloride content	NIL
3.	Air entrainment	Approximately1%additionalairis entrained

4. Experimental methodology

Concrete mix design in experiment will designe as per the guidelines specified in ACI234R – 96 “Guide for the use of Copper slag in concrete” by ACI committee 234(7) and nano silica(ns). All the samples will prepare using design mix. M 25 grade of concrete for the future investigation. Mix design on the bases of I.S 10262-1982 will use. The copper slag will be replaced by 8 %, 16 %, 24 % ,32 % and 40% with fine aggregates and partially replacement of cement by nano silica content (upto 5%).

5. Conclusion

In India a study has been carried out by the Central Road Research Institute (CRRI) shown that copper slag may be used as a partial replacement for river sand as fine aggregate in concrete up to 50 % in pavement concrete without any loss of compressive and flexural strength and such concretes shown about 20 % higher strength than that of conventional cement concrete of the same grade. A new nano-silica (nS) can be produced in high quantities and for low prices that allows for a mass application in concrete. It may replace cement in the mix, which is the costliest and environmentally unfriendly component in concrete. The use of nS makes concrete financially more attractive and reduces the CO_2 footprint of the produced concrete products. It was repeatedly shown that NS can enhance the properties of cement-based materials from many aspects. NS can enhance the mechanical properties of concrete, accelerate cement hydration by means of nucleation effect, and reduce porosity of cement paste through the filler action. However, further research is needed to enhance our understanding of mechanisms of concrete mechanical properties enhancements involving copper slag and nano silica(nS).

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