International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 04 | Apr -2017 www.irjet.net p-ISSN: 2395-0072

Strength characteristics of different types of manufactured sand in cement mortar

Manu A S[1], Swapnagowda R[2]

[1]*Assistant Professor, Civil Engg, BNM Institute of Technology, Bangalore, India.*

[2]*Post graduation student, Civil Engg, UVCE college of Engineering, Bangalore, India.*

Abstract:*This paper reports the results of experimental studies on the use of different types of manufactured sand in cement mortar. Copper Slag (CS) is a by-product obtained during the matte smelting and refining of copper and Crushed Granite Sand (CGS) obtained from vertical cone crusher are considered. CS and CGS as a sand substitute in cement mortar is considered for present work. In this present work, cement mortar mix 1:3 and the replacement of Natural Sand (NS) by CS and CGS at various percentages is considered at a constant water cement ratio of 0.5. The strength characteristics of different types of manufactured sand are studied. The manufactured sand exhibited better strength due to good bond characterises. From this study, it is observed that the manufactured sand is a good alternative for the natural river sand in mortar, In spite of this, manufactured sand is quite economical. In addition, workability and durability studies are necessary for making concrete conclusions*.

Key words: Copper Slag (CS), Crushed Granite Sand (CGS), Compressive strength.

1. INTRODUCTION

Copper slag is a by-product obtained during the matte smelting and refining of copper. Major constituents of a smelting charge are sulphides and oxides of iron and copper. The charge also contains oxides such as SiO2, Al2O3, CaO and MgO, which are either present in the original concentrate or added as flux. It is iron, copper, sulphur, oxygen and their oxides which largely control the chemistry and the physical constitution of the smelting system. A further important factor is, the oxidation/reduction potential of the gases which are used to heat and melt the charge. As a result of this process, copper-rich matte (sulphides) and copper slag (oxides) are formed as two separate liquid phases. The addition of silica during smelting process forms strongly bonded silicate anions by combining with the oxides. This reaction produces copper slag phase, whereas sulphides form matte phase due to low tendency to form the anion complexes. Silica is added directly for the most complete isolation of copper in the matte which occurs at near saturation concentration with SiO2. The slag structure is stabilized with the addition of lime and alumina. The molten slag is discharged from the furnace at 1000–1300° C. When liquid slag is cooled slowly, it forms a dense, hard crystalline product, while as quick solidification by pouring molten slag into water gives granulated amorphous slag. Crushed Granite Sand (CGS) is manufactured by crushing stone making use of the cone crusher. Due to the use of this technology the sand particles can be shaped similar to that of the naturally available fine aggregate.

Significant research work has been reported in the field making of cement mortar or concrete using industrial by products as ingredients. Meenakshi and Ilangovan [1] investigated that the replacement of natural sand by copper slag(CS) and ferrous slag(FS) yielded higher compressive strength of concrete compared to that of the reference mix. Also, they concluded that at higher levels of replacements (100%) there was a slight bleeding tendency and it is recommended that up to 80% of CS and FS can be used as replacement of sand. The studies show that total replacement of sand by CS and FS is not advisable. Khalifa et al. [2] conducted experimental work by using copper slag as fine aggregate in cement mortar and concrete. From the results, they concluded that copper slag can be used as alternative for natural sand. Mahzuz et al [3] investigated that the use of stone powder in concrete and mortar as an alternative for natural sand and they concluded that use of sand stone instead of NS in concrete increases the compressive strength by 15%. Kanmalai et al [4] conducted an experimental work on mechanical properties of high performance concrete incorporating granite powder as fine aggregate and they concluded that granite powder can be utilised partially as a fine aggregate in cement mortar for making high performance concrete.

2. MATERIAL PROPERTIES

2.1 Cement

Ordinary Portland cement (OPC 43 grade) confirming to IS: 8112-1989 was used. The properties are determined as per relevant IS standards and the test results obtained are satisfying code requirements.

2.2 Fine Aggregate

The fine aggregates used in the present work are NS, CS and CGS. NS confirms to grading zone II, CS and CGS confirms to grading zone III as per IS: 383-1970. The physical properties of sand such as sieve analysis, specific gravity, bulk density, etc. are determined as per IS:2386-1963 and presented in Table 1.

Table 1: Properties of Fine Aggregates

Fine Aggregates	Natural Sand (NS)	CS	CGS
Specific Gravity	2.67	3.74	2.82
Bulk density , Kg/m^3	1685	2015	1830
Fineness Modulus	2.74	3.05	3.10

2.3 Methodology for Mortar cubes

Cement mortar was cast in 70.6mm×70.6mm×70.6mm moulds. Mixing has been carried out at room temperature (27±2^{0}C). Potable/distilled water was used for preparing the cement mortar cubes. Compaction of fresh cement mortar in the moulds was carried out for two minutes. Mortar cubes were cast for the proportion of 1:3(1 part of cement and 3 parts of sand) for a water cement ratio of 0.5. The ratio of natural sand replaced with manufactured sand for constant water cement ratio of 0.5 was 0%, 20%, 40%, 60%,80 and 100%. Three sets of cubes were casted to determine the compressive strength of cement mortar at ages of 7, 28 and 120 days. The proportions of constituent materials used for mortar works is shown in Tables 2 and 3.

Table 2: Proportions of constituent materials used for cement mortar

Combination	Cement (g)	NS (g)	CS (g)	CGS (g)	Water (ml) (W/C-0.5)
Reference mix (0% replacement)	200	600	0	0	100
100% replacement of NS with CS	200	0	600	0	100
100% replacement of NS with CGS	200	0	0	600	100

Table 3: Proportions of constituent materials for different replacement levels

Combination	Cement (g)	NS (g)	CS (g)	CGS (g)	Water (ml) (W/C-0.5)
20% replacement of NS with CS	200	480	120	0	100
40% replacement of NS with CS	200	360	240	0	100
60% replacement of NS with CS	200	240	360	0	100
80% replacement of NS with CS	200	120	480	0	100
20% replacement of NS with CGS	200	480	0	120	100
40% replacement of NS with CGS	200	360	0	240	100
60% replacement of NS with CGS	200	240	0	360	100
80% replacement of NS with CGS	200	120	0	480	100

3. Test results and Discussions

The result of the investigation for the replacement of NS with CS and CGS was discussed. The replacement was taken as 0, 20, 40, 60,80 and 100% for 1:3 mortar mixes proportions for 0.5 water- cement ratio (w/c).

3.1 Effect of CS and CGS on compressive strength of cement mortar

The variations of compressive strength of cement mortar at 7, 28 and 120 days for 100% NS, CS and CGS at w/c of 0.5 are shown in table 4. Tables 5 and 6 showing compressive strength at 7, 28 and120 days for different replacement of NS by CS and CGS at constant w/c of 0.5. From chart 1 it can be observed that, the compressive strength of cement mortar made with manufactured sand (CS and CGS) is high when compared with mortar strength of reference mix (made with NS). The increased in strength of mortar made with manufactured sand is mainly because of good bond characterise.

Charts 2 and 3 showing variation of compressive strength of cement mortar at 7, 28 and 120 days for different replacement (0%, 20%, 40%, 60%, 80% and 100%) of NS by CS and CGS at constant w/c of 0.5. From Figures 2 and 3 it can be observed that, the compressive strength of cement mortar for replacement of NS by manufactured sand at any level will give higher strength than that of reference mix.

Table 4: Compressive strength at 7, 28 and 120 days for NS, CS and CGS at different w/c of 0.50.

Combination	Water-cement ratio (w/c)	Compressive strength, N/mm²		
		7 days	28 days	120days
Cement +100% NS	0.5	28.13	37.84	46.89
Cement +100%CS	0.5	39.41	50.17	64.87
Cement+100%CGS	0.5	42.87	54.68	67.45

Table 5: Compressive strength at 7,28 and 120 days for different replacement of NS by CS sand at w/c of 0.50.

Combination	Compressive strength, N/mm²		
	7 days	28 days	120 days
0% CS + 100% NS	28.13	37.84	46.89
20% CS + 80% NS	30.14	40.86	49.48
40% CS + 60% NS	32.08	43.07	53.74
60% CS + 40% NS	35.41	46.87	58.64
80% CS + 20% NS	37.83	48.93	62.11
100% CS + 0% NS	39.41	50.17	64.87

Table 6: Compressive strength at 7, 28 and 120days for different replacement of NS by CGS sand at w/c of 0.5

Combination	Compressive strength, N/mm²		
	7 days	28 days	120 days
0% CGS + 100% NS	28.13	37.84	46.89
20% CGS + 80% NS	32.84	46.41	52.74
40% CGS + 60% NS	35.14	47.08	56.12
60% CGS + 40% NS	37.84	48.14	61.04
80% CGS + 20% NS	39.04	50.91	63.44
100% CGS + 0% NS	42.87	54.68	67.45

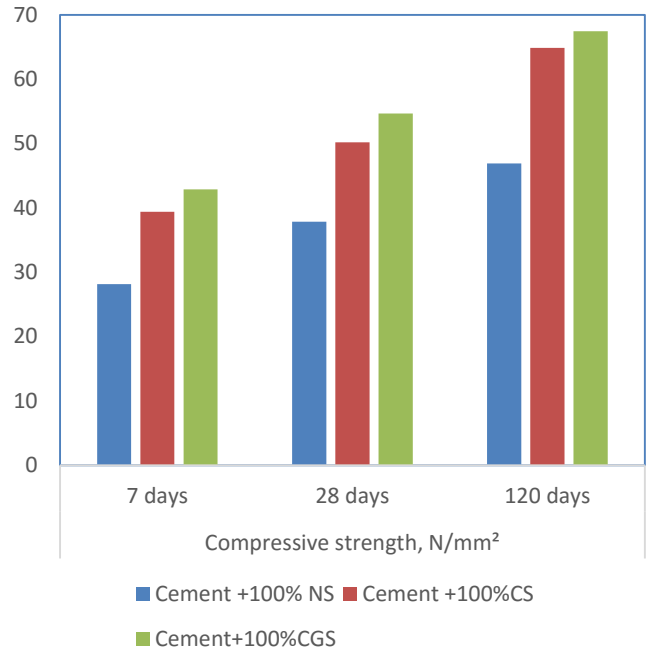

Chart 1- Variation of compressive strength at 7, 28 and 120days for different types of sand at w/c of 0.5.

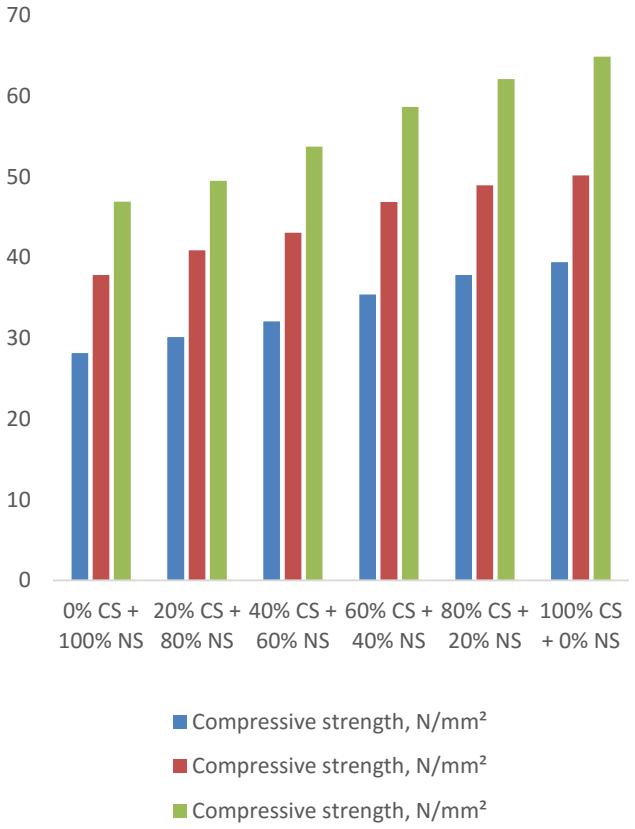

Chart 2- Variation of compressive strength at 7, 28 and 120 days for different replacement of NS by CS at w/c of 0.5

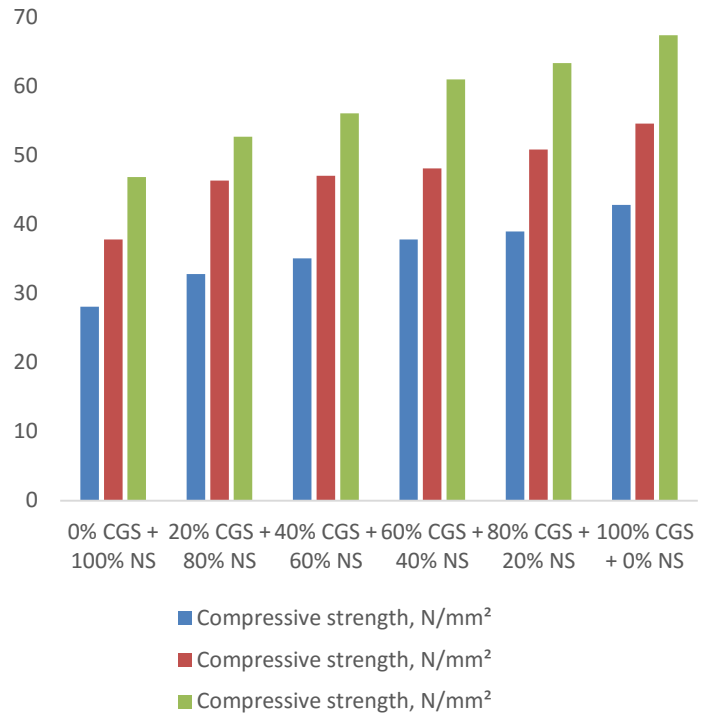

Chart 3- Variation of compressive strength at 7, 28 and 120 days for different replacement of NS by CGS at w/c of 0.5

4. CONCLUSIONS

The results obtained shows that the compressive strength of cement mortar at any level replacement of NS by manufactured sand will give higher strength for all ages. From this experimental study, we can conclude that manufactured sand is good alternative for natural sand in cement mortar application. In addition, workability and durability studies are necessary for making concrete conclusions.

5. REFERENCES

[1] Meenakshi Sudarvizhi. S and Ilangovan. R, "Performance of Copper Slag and Ferrous Slag as Partial Replacement of Sand in Concrete", International Journal of Civil and Structural Engineering, Vol. 1, No. 4, 2011, pp. 918-923.

[2] Khalifa S.Al-jabri, Abdullah H. Al-Saidy, Ramzi Taha, "Effect of Copper Slag as a Fine Aggregate on the Properties of Cement Mortars and Concrete", Construction and Building Materials, Vol. 25, No. 2, 2011, pp. 933–938.

[3] Mahzuz H.M.A, Ahmed A. A. M and Yusuf M. A, "Use of stone powder in concrete and mortar as an alternative of sand", African Journal of Environmental Science and Technology, Vol. 5, No. 5, 2011, pp.381-388.

[4] Kanmalai Williams C., Partheeban P., Felix Kala T, "Mechanical Properties Of High Performance

Concrete Incorporating Granite Powder As Fine Aggregate", International Journal on Design and Manufacturing Technologies, Vol.2, No.1, 2008, pp.67-73.

[5] IS: 383-1970, "Specification for Coarse and Fine Aggregates from Natural Sources for Concrete", Bureau of Indian Standards, New Delhi.

BIOGRAPHIES

Manu A S received his B. E and M. tech from VTU, Belgaum. He is a faculty in the Department of Civil Engineering, BNM institute of Technology and Management, Bangalore. He has presented few papers in international conferences and journals.