Workability Characteristics of Crushed Granite Sand (CGS) in Cement Mortar

Manu A S[1], Madhushree K J[2], Swapnagowda R[3]

[1,2] Assistant Professor, Civil Engg, BNM Institute of Technology, Bangalore, India.
[3]Post graduation student, Civil Engg, UVCE college of Engineering, Bangalore, India.

Abstract - *This paper investigates the possibility of utilizing Crushed Granite Sand (CGS) as a sand substitute in cement mortar, in order to reduce the environmental problem. In this investigation, cement mortar mix 1:3 and CGS at 100% replacement to natural sand for constant w/c ratio of 0.5 is considered. The work is extended to 100% replacements of natural sand with CGS for w/c ratios of 0.4 and 0.6. The flow characteristics of the various mixes are studied. From this study, it is observed that CGS could be utilized as an alternative construction material for natural sand in mortar applications. Reduction in workability expressed as flow can be compensated by adding suitable percentage of Super Plasticizer*.

Key words: Crushed Granite Sand (CGS), Workability, Super Plasticizer (SP)

1. INTRODUCTION

Aggregates have a significant influence on both rheological and mechanical properties of mortars and concrete. In India, natural river sand (fine aggregate) is traditionally used in mortars and concrete. However, growing environmental restrictions to the exploitation of sand from riverbeds have resulted in a search for alternative sand, particularly near the larger metropolitan areas. This has brought in severe strains on the availability of sand forcing the construction industry to look for an alternative construction material. Thus manufactured fine aggregates appear as an attractive alternative to natural fine aggregates for cement mortars and concrete. 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. Venkatarama Reddy et al, [1] conducted experimental work by replacing natural sand by manufactured sand and found that the manufactured sand exhibits better bonding, workability and water retentivity characteristics and also the compressive strength and flexure strength at the age of 28 days is better when compared with the mortar and concrete made by river sand. It was concluded that strength can achieve 20% more than that of river sand. 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. Elavenil et al. [3] Based on experimental results, replacing natural sand by manufactured sand found that, the fresh properties of concrete are certainly affected by the use of manufactured sand, but the hardened properties such as flexural strength & compressive strength do not seem to be greatly affected by the gradation. It was concluded that, compared to concrete made from river sand, high fines concrete generally had higher flexural strength, improved abrasion resistance, and higher unit weight & lower permeability due to fillings the pores with micro fines. 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 (OPC43 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 and CGS. NS confirms to grading zone II 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.

Table1: Properties of Fine Aggregates

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

2.3 Flowability of cement mortar

Flowability of mortar was measured using a flow table method modified from, 'IS: 5512, Indian standard code of practice for determining the flow of cement mortar'. As the finer material increases, more is the surface area and hence more water is required for wetting the surface. For the given fixed quantity of water as the finer material increases the workability decreases. The workability can be increased by adding optimum dosage of chemical admixture. The horizontal spread of the mortar for different combination is measured as percentage spread for 15, 30 and 45 blows.

3. TEST RESULTS AND DISCUSSIONS

The result of the investigation for the replacement of NS with CGS was discussed. The replacement was taken as 100% for 1:3 mortar mixes proportions for 0.4, 0.5 and 0.6 water- cement ratio (w/c) with different dosages of super plasticizer.

3.1 Effect of CGS on Flowability of cement mortar

Natural sand **CGS with SP**

Fig -1: Variation of Flowability of mortar with different types of sand

The results indicated that the use of Crushed Granite Sand (CGS) for replacement of Natural Sand (NS) as a fine aggregate in cement mortar will significantly reduce the flowability of cement mortar. It was observed that by adding 0.5% of super plasticizer by weight of cement for the mortar made with CGS, it was possible to get workability closer to that of reference mix. Chart 1 to 3 showing variation of flowability of mortar for NS and CGS at water cement ratio of 0.4,0.5 and 0.6 respectively. Figure 4 showing variation of flowability of mortar for CGS by adding 0.5% and 1% super plasticizer at constant water cement ratio of 0.5.

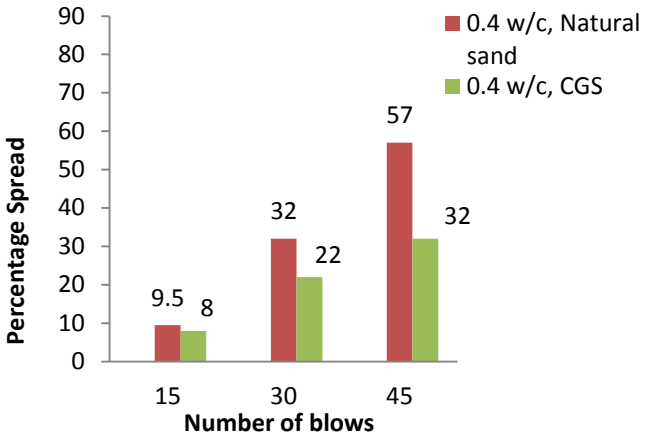

Chart1- Variation of Flowability of mortar for different types of sand at 0.4 w/c

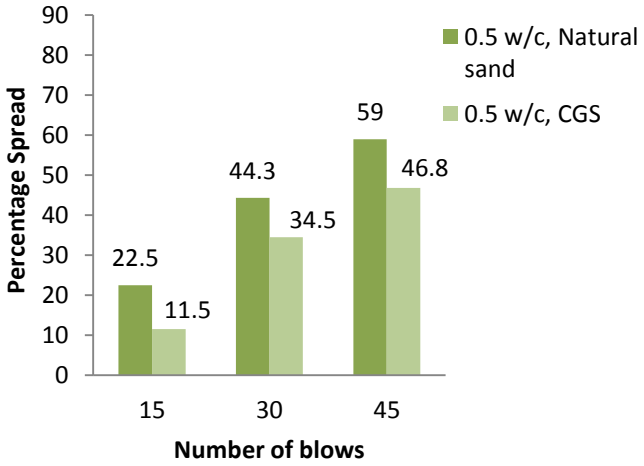

Chart 2- Variation of Flowability of mortar for different types of sand at 0.5 w/c

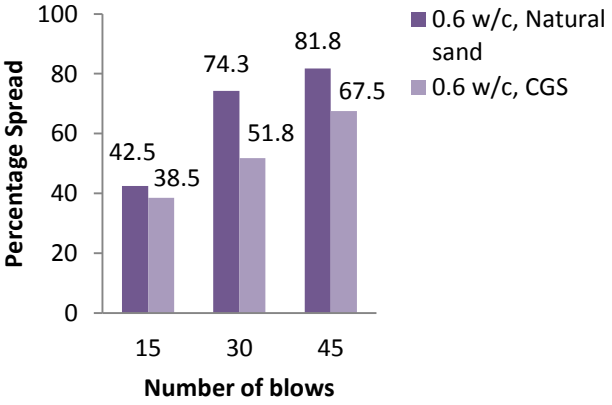

Chart 3- Variation of Flowability of mortar for different types of sand at 0.6 w/c.

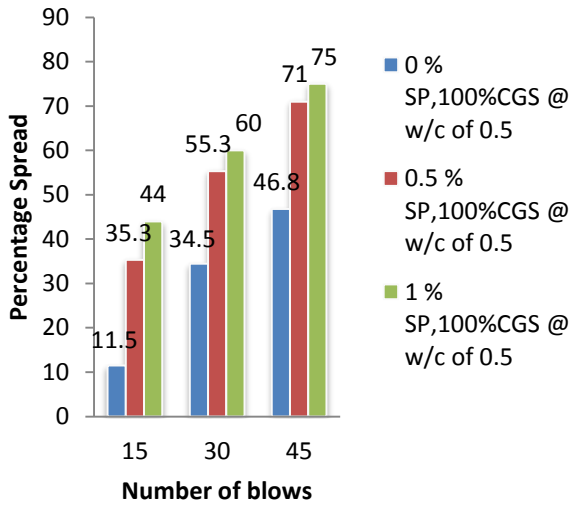

Chart 4-Variation of Flowability of mortar for CGS at different dosages of Super Plasticizer (SP) at constant w/c ratio of 0.5.

4. CONCLUSION

The data obtained shows that the replacement of Natural Sand (NS) by Crushed Granite Sand (CGS) will reduce the workability. By adding suitable dosage of Super Plasticizer (SP), the workability of mortar can be improved. Finally we can conclude that Crushed Granite Sand (CGS) is good alternative for Natural Sand in cement mortar application. In spite of this, CGS is quite economical. Also strength and durability studies are necessary for making concrete conclusions.

5. REFERENCES

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BIOGRAPHY

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.