International Journal of Civil Engineering and Technology (IJCIET)
Volume 8, Issue 12, December 2017, pp. 332-338, Article ID: IJCIET_08_12_039
Available online at http://www.iaeme.com/ijciet/issues.asp?JType=IJCIET&VType=8&IType=12
ISSN Print: 0976-6308 and ISSN Online: 0976-6316

A STUDY ON CRUSHED SAND AS AN ALTERNATIVE FOR NATURAL SAND IN HIGH PERFORMANCE CONCRETE

T. ShanmugaPriya

Associate Professor

Civil Engineering Department, VIT University, Vellore, Tamil Nadu

A.Punitha Kumar

Assistant Professor,

Civil Engineering Department, VIT University, Vellore, Tamil Nadu, India

ABSTRACT

The main objective of this study is to examine the strength of High Performance Concrete using Crushed Sand (Manufactured sand). The natural sand was replaced by Crushed Sand in the proportion of 0%, 20%, 40%, 60%, 80% and 100%. A series of experiments were conducted in M60 grade HPC concrete to study the compressive strength, flexural strength, splitting tensile and modulus of elasticity. Water cement ratio is 0.32 and 10% of silica is also added. Based on the experimental results the replacement by 60% Crushed Sand exhibited the highest compressive strength.

Key words: High Performance Concrete, Crushed Sand, Natural Sand, Silica fume and strength.

Cite this Article: T. ShanmugaPriya and A.Punitha Kumar, A Study On Crushed Sand As An Alternative For Natural Sand In High Performance Concrete, International Journal of Civil Engineering and Technology, 8(12), 2017, pp. 332-338.
http://www.iaeme.com/ijciet/issues.asp?JType=IJCIET&VType=8&IType=12

1. INTRODUCTION

Concrete is a mixture of cement, fine aggregates, coarse aggregate and water with or without admixtures. Since the development in the construction sector, there has been a rapid depletion of natural resources mainly river sand [1]. The use of crushed stone fine aggregate as substitute for natural sand was studied and it was concluded that there was significant increase in strength and durability properties with crushed sand [2-4]. The crushed stone waste as fine aggregate in concrete leads to increase in compressive strength, Modulus of rupture and split tensile strength. But the workability of concrete decreased with higher percentage of stone dust as this can be increased with the addition of super plasticizer [5].

The usage of silica fumes in HPC has resulted in increased compressive and tensile strengths and also the researchers concluded that the optimum replacement of silica fume in concrete in the range of 5 to 15% [6-8]. The addition of silica fume in concrete improves the durability properties, decreases permeability and reduces dry shrinkage [9-12]. The Manufactured Sand as fine aggregate in concrete slightly increases the compressive strength of concrete [13-17]. Most of the research on Crushed Sand as partial replacement of river sand in concrete, deals with concrete grade up to M40. But limited literatures are available on HPC with higher grade of concrete. As a continuation of previous studies, this paper deals with crushed sand as replacement of natural sand.

2. MATERIALS PROPERTIES

Ordinary Portland cement of grade 53, Elkem micro silica 920 D, river sand, crushed sand, coarse aggregate and super plasticizer Glenium B233 were used in this study. The specific gravity of cement, silica fume, river sand, crushed sand, and coarse aggregate superplasticizer is 3.13, 2.2, 2.68, 2.64, 2.7 and 1.09 respectively. The initial and final setting time of cement was 35 minutes and 380 minutes. The fine aggregate conforming to grading of Zone III of IS 383[18]. Normal portable water, was used for mixing the concrete.

3. MIX DESIGN

ACI 211.4R-08 - Guide for selecting proportions for high strength concrete with portland cement and other cementations materials was used for mix design and the mix was designed for M60 grade concrete. The mix proportion was 1:1.1:1.57, water cement ratio was 0.32 and the dosage of super plasticizer was 2% by weight of water. 10 % of silica fume was also added for making High performance concrete. The control concrete mix is termed M1 and specimen name for crushed sand replaced specimen was 20%, 40%, 60%, 80% and 100% were M-2, M-3, M-4, M-5 and M-6 respectively. Weight batching was adopted for measuring materials and mixture machine was used for mixing. The fresh concrete was casted and was compacted using table vibrator. Demoulding was done after 24 hours and cured the specimen in water until the required date of testing.

4. TEST PROGRAM

A compression testing machine of capacity 3000 kN was used for determining the compressive load and split tensile strength. The loading rate of 140 kg/sq.cm/min was maintained for compression test and split tensile test as per IS: 516 [19]. The specimen dimensions for compression testing were 150 mm cubes. 150 mm diameter and 300 mm long specimen was used for split tensile test. For determining flexural strength beams of size 100 mm X 100 mm X 500 mm were tested using 1000 kN capacity Flexure Testing Machine (FTM). Cylinders of size 150mm diameter and 300mm long cylinders were used to determine the young's modulus.

5. RESULTS AND DISCUSSIONS

5.1. Compressive Strength

The compressive strength experimental results are tabulated in Table 1 and the graphical representation of experimental results are shown in Figure 1. It is observed M4 specimen achieved higher strength that is 60% of fine aggregate replaced with M sand. The strength enhancement of M4 specimen is 11.54% than control specimen. The compression test on cube specimen is shown in Figure 2.

Table 1 Compressive strength of High Performance Concrete

Mix ID	Compressive strength in N/mm^2		
	3 days	7 days	28 days
M1	33	45	69
M2	33	48	70
M3	36	49	72
M4	37	48	78
M5	34	43	72
M6	29	40	68

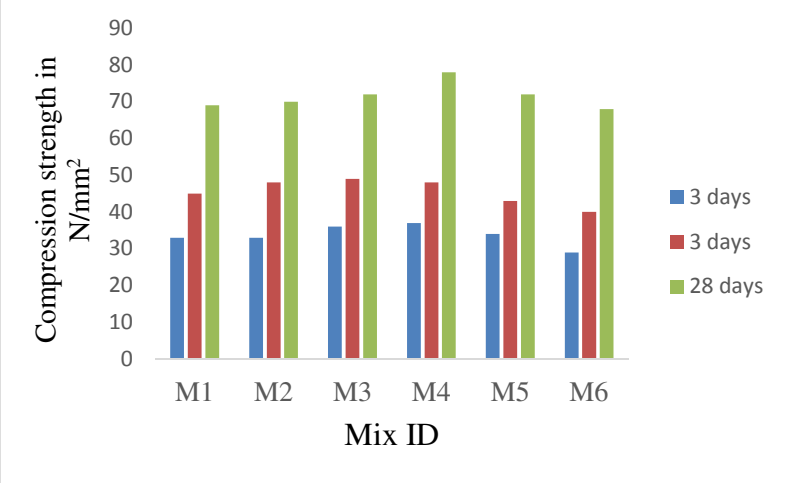

Figure 1 Compressive Strength of High Performance Concrete

Figure 2 Compression test Setup

The increase in the compressive strength is due to the presence of high fines in Crushed Sand fines increases the water demand. However, the Crushed Sand fines contribute to an increase in paste volume which is strengthened by the incorporation of silica fume and Super plasticizer. The above observations are supported by the work of other researchers who studied the influence of manufactured sand as fine aggregate on the strength of concrete [20, 21].

5.2. Split tensile strength

The 28 days split tensile strength of various specimens are given in Table 2. The graphical representation of tensile strength of various specimens are shown in Figure 3. The tensile strength values range of 6.5 N/mm^2 and 7.2 N/mm^2 and also it is seen that tensile strength value is about 10 % of its compressive strength. The M4 specimen achieved higher strength that is 60% of fine aggregate replaced with M sand. The strength enhancement of M4 specimen is 10.77% than control specimen. . The split tensile test on cylindrical specimen is shown in Figure 4.

Table 2 Split Tensile strength of High Strength Concrete

MIX ID	SPLIT TENSILE STRENGTH IN N/MM^2
	28 DAYS
M1	6.50
M2	6.55
M3	6.80
M4	7.20
M5	7.00
M6	6.40

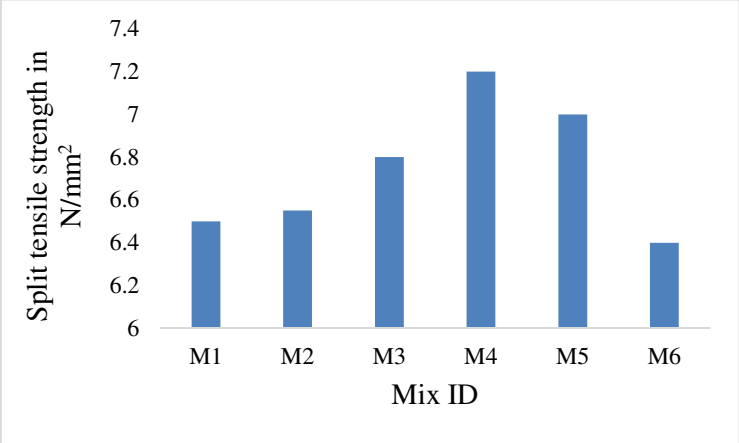

Figure 3 Split Tensile Strength of High Performance Concrete

Figure 4 Tensile strength test Setup

5.3. Flexural strength

The flexure strength of concrete at the age of 28 days is tabulated in Table 3. The graphical representation of flexural strength of various specimens are shown in Figure 5. The tensile strength values range between 6.3 N/mm^2 and 8.6 N/mm^2. The M4 specimen has achieved higher strength. The strength enhancement of M4 specimen is 16.27% higher than control specimen.

Table 3 Tensile strength of High Strength Concrete

Mix ID	Flexural strength in N/mm^2
	28 days
M1	7.2
M2	7.5
M3	8
M4	8.6
M5	7.4
M6	6.3

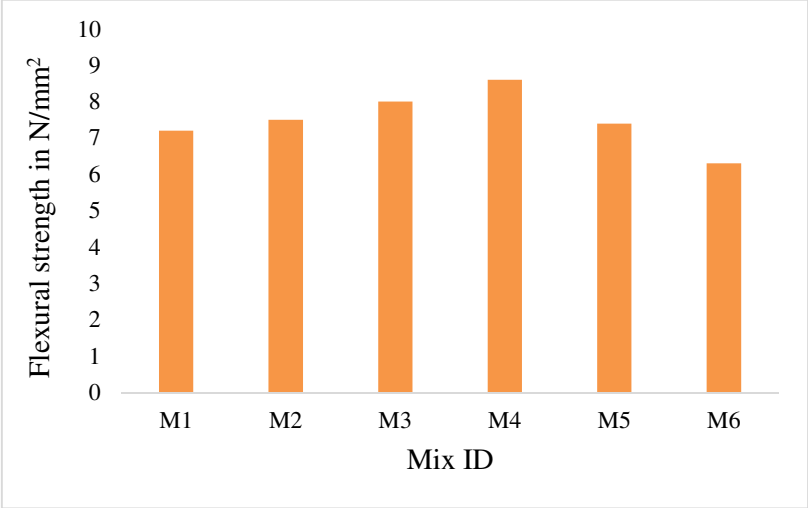

Figure 5 Flexural Strength of High Performance Concrete

Figure 6 Flexural Strength Test Set up

5.4. Modulus of Elasticity

The graphical representation of Young modulus of various specimens are shown in Figure 7. The modulus of elasticity values range between 41 kN/mm^2 and 45 kN/mm^2

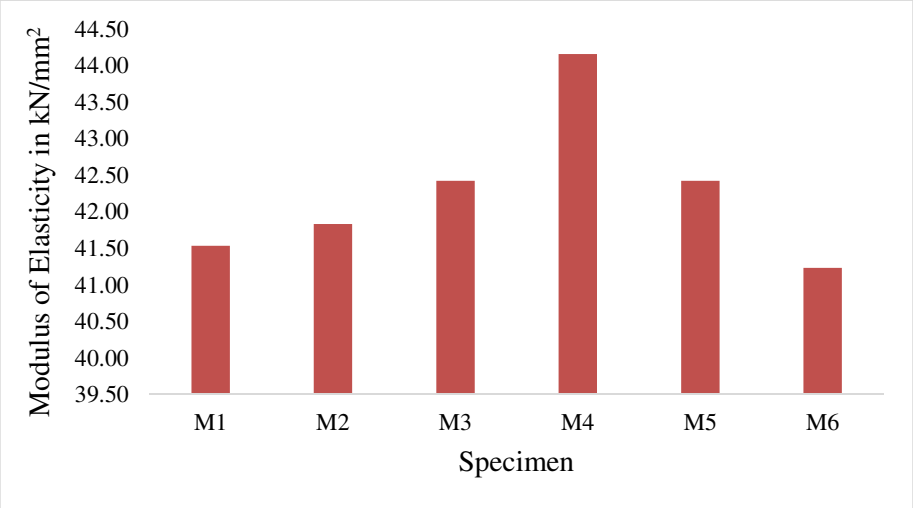

Figure 7 Modulus of Elasticity of High Performance Concrete

6. CONCLUSION

This study deals with High Performance Concrete with Crushed Sand used as substitute material to natural sand. The concrete mix was designed to attain the strength of 60 N/mm^2. In compression testing all the specimens reached more than 60N/mm^2. Thus it is proved that crushed sand can also be used as fine aggregate of concrete. Based on the experimental results it is evident that the optimum percentage of crushed sand replacement is 60%.

REFERENCES

[1] Suresh,G., Ramasamy,V., Meenakshisundaram,V., Venkatachalapathy, R & Ponnusamy, V, A relationship between the natural radioactivity and mineralogical composition of Ponnaiyar river sediments, Indian Journal of Environmental Radioactivity, 102, 2011, 370–377.

[2] Ahmed E. Ahmed, Properties of concrete incorporating Natural and Crushed Stone very fine Sand , ACI material Journal, 1989,86(4),417-424.

[3] Priyanka A and D.K.kulkarni, An Experimental Investigation on the properties of concrete containing Manufactured Sand, 3(2), 2012, 101-104.

[4] P.M.Shanmugavadivu and R.Malathy, Effects of chloride attack with the replacement of Natural sand by manufactured sand as fine aggregate", Journal of Structural engineering, 39(5), 2012, pp 564-573.

[5] B.Balapgol, S A Kulkarni and K M Bajoria Strength and Durability of concrete with crushed sand, proceedings of 27th conference on Our world in concrete & structures: 2002, 1-7.

[6] Bayasi, Z and Zhou, J., Properties of silica fume concrete and mortar, ACI Materials Journal, 90(4), 1993, 349-356.

[7] Duval. R and Kadir. E.H, Influence of silica fume on the workability and compressive strength of High Performance Concrete, Cement and Concrete Research, 28(4), 1998533-547.

[8] Hooton, R.D, Influence of silica fume replacement of cement on physical properties and resistance to sulphate attack, freezing and thawing and alkali –silica reactivity, ACI Materials Journal, 90(2), 1993,143-151.

[9] Mazloom, M., Ramezanianpour, A.A., and Brooks.J.J., Effect of silica fume on mechanical properties of High strength concrete, Cement and concrete Composites, 26, 2004, 347-357.

[10] Mohammad Iqbal Khan and RafatSiddique., Utilization of silica fume in concrete: Review of durability properties, Resources, Conservation and Recycling, 57, 2011, 30-35.

[11] Santanu Bhanja and Bratish Sengupta, Investigation on tensile strength of High Performance Concrete incorporating silica fume , International conference Structural Mechanics in Reactor Technology, 2005, 2222-2226.

[12] Santanu Bhanja and Bratish Sengupta, Optimum silica fume content and its mode of Action on concrete, ACI material Journal, 100(5), 2003, 407-412.

[13] Elavenil, S and Vijaya B. Manufactured Sand, A Solution and an Alternative to River Sand and in Concrete Manufacturing, Journal of Engineering, Computers and Applied Sciences, 2(2), 2013, 20-24.

[14] Amnon, K., and Hadassa, B., Effect of high levels of fines content on concrete properties, ACI Material Journal, 103, 2006, 474-481.

[15] Sahu, A. K., Kumar Sunil & Sachin, A. K , Crushed Stone Waste as Fine Aggregate for Concrete. The Indian Concrete Journal, 77(1), 2003, 845-847.

[16] Balapgol, B, Kulkarni, S A&Bajoria, K M, Strength and Durability of concrete with crushed sand. proceedings of 27th conference on Our world in concrete & structures, 2002, 1-7.

[17] Guney, Y., Sari, YD., Yalcin M., Tuncan, A.,& Donmez, S , Re-usage of waste foundry sand in high strength concrete. Waste Management, 30, 2010, 1705–13.

[18] IS 383- 1970 , Indian standards specification for coarse and fine aggregate from natural source for concrete , 2002.

[19] IS: 516-1959. Indian standard code of practice- methods of test for strength of concrete. Bureau of Indian Standards, New Delhi, India.

[20] Balapgol, B, Kulkarni, S A& Bajoria, K M, Strength and Durability of concrete with crushed sand.proceedings of 27th conference on Our world in concrete & structures: 2002, 1-7.

[21] M. Vijaya Sekhar Reddy, Dr.I.V. Ramana Reddy and N.Krishna Murthy, Experimental Evaluation Of The Durability Properties Of High Performance Concrete Using Admixtures, Volume 4, Issue 1, January- February (2013), pp. 96-104, International Journal of Advanced Research in Engineering and Technology.

[22] D. Maruthachalam, P. Saravanakumar, K. Divya Darshini and S. Rajeswari, Experimental Investigation On The Flexural Behaviour of Polyolefin Macro-Monofilament Fibre Reinforced High Performance Concrete Beams. International Journal of Civil Engineering and Technology, 8(6), 2017, pp. 436–449

[23] Guney, Y., Sari, YD., Yalcin M., Tuncan, A.,& Donmez, S , Re-usage of waste foundry sand in high strength concrete, Waste Management, 30, 2010, 1705–13.