Research Article

Journal of Environmental Nanotechnology

Workability and Compressive Strength of Mortar with Manufactured Sand

Brajesh Kumar Suman*
Department of Civil Engineering, UCER Prayagraj, UP, India
Received: 10.09.2018 Accepted: 14.11.2018 Published: 30-12-2018
*bs270790@gmail.com

ABSTRACT

Sand obtained from the river stream is broadly utilized as fine aggregate in the making of ordinary mortar. Because of extraction in abundance, characteristic sand has turned into a scarce material, and it must be protected. Sand obtained from the crushing of stone has better particle shape, size and surface textures than natural river sand due to the controlled degradation of natural rocks and has a very high potential to replace natural sand in the preparation of cement mortar. The effect of manufactured sand in mortar, in terms of workability and compressive strength, has been investigated in this work. River sand was replaced with manufactured sand in mortar at different percentages, at an interval of 10 and investigations were carried out. Results have shown that the trials of replacement resulted in substantial strength gain.

Keywords: Compressive strength; Manufactured sand; River sand; Workability.

1. INTRODUCTION

Cement mortar is a composite material commonly used for the jointing of bricks, stones, blocks, etc. It consists of binding materials like cement, fine aggregate and water. Sand obtained from the river stream is broadly utilized as fine aggregate in the manufacturing of ordinary mortar. Because of extraction in abundance, characteristic sand has turned into a scare material, and it must be protected. The only way to protect the environment and continued construction is to search for alternate materials which can be partially or fully replaced naturally available material, and manufactured sand may be one of them. This is obtained from the crushing of stone chips in the crushing plant. Crushed sand performed better than natural sand as the property of crushed sand is better than natural sand (Rameshwar et al. 2017). Stone dust can be used in place of fine aggregate upto 60 percent for enhancing the strength of concrete (Suman et al. 2015). The present study aimed to utilize manufactured sand in place of natural river sand as partially or fully in mortar. An experiment was conducted to determine the suitability and possible application of processed sand as a substitute for river sand in mortar. To do so, specimens were cast for various substitution levels at a 10% interval to assess the workability and compressive strength of mortar at various levels of river sand versus processed sand. The percentage of processed sand in a mortar was steadily improved, and the impact on workability and compressive strength was investigated. The study found that the compressive strength of mortar made with manufactured sand as a river sand substitute was higher than that of mortar made with river sand, but that the workability of mortar declined steadily as the amount of manufactured sand in the mortar increased. That may be attributed to processed sand's uneven surface quality and lack of surface moisture.

2. MATERIALS AND METHODS

2.1 Cement

In this analysis, Portland Pozzolana Cement (fly ash-based) conforming to IS 1489 (Part 1) - 1991 was used under the brand name Prism. Table 1 lists the characteristics of cement.

Table 1. Physical properties of Cement

S. No.	Properties	Findings
1.	Fineness	6%
2.	Consistency	32 %
3.	Initial setting time	215
4.	Final setting time	320
5.	Specific gravity	2.8
6.	Soundness	5 mm

2.2 Fine Aggregate

Locally available river sand in Prayagraj, India, confirming to IS 383-1970, Zone III, was used in the study. It was completely passed through 4.75 mm IS sieve. The physical properties of fine aggregate are shown in Table 2.

Table 2. Physical properties of Fine aggregates

S. No.	Properties	Natural Sand	Manufactured Sand
1.	Specific gravity	2.60	2.62
2.	Moisture content	0.3%	0.2%
3.	Fineness modulus	2.9	3.42

2.3 Manufactured Sand

Manufactured sand was obtained by the grinding of locally available stone chips and sieved with different sizes of sieve to maintain the same grade as fine aggregate conforming to IS 383-1970, Zone III. The physical properties of manufactured sand are presented in Table 2.

2.4 Water

Potable water was used for mortar mixing having a pH of 8.4 and total dissolved solids (TDS) of 450 mg/l. Mortar mix 1:5 (1 part of cement and 5 parts of sand in volume) with a water-cement ratio of 0.6 was used as a benchmark for the investigation. The grading of river sand and manufactured sand were approximately equal and conforming to the same zone according to IS 383-1970. 56 specimens of size 70.6 mm x 70.6 mm x 70.6 mm were cast during the study with different percentages of manufactured sand in the mortar. The percentage of manufactured sand in mortar was increased gradually from 0 to 100% in an interval of 10%. After the mortar mix, the workability of the mix was measured by a flow table test and the desired specimens were cast. On the other day, the specimens were de-moulded and water cured for 28 days. The water-cured specimens were tested for compressive strength at 7 days and 28 days.

3. RESULTS AND DISCUSSION

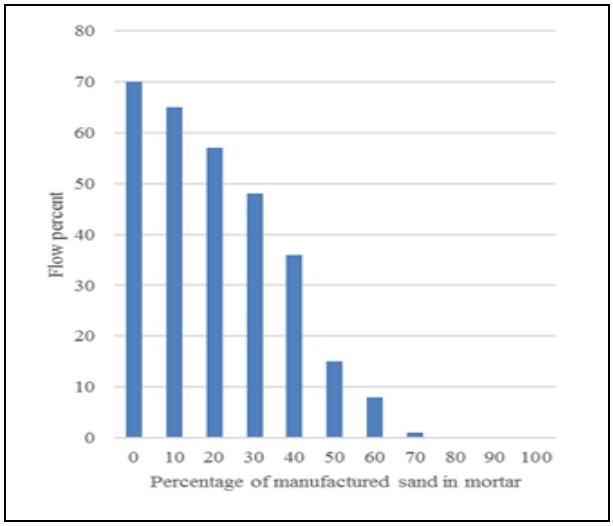
3.1 Workability

The workability of the fresh mortar mix was measured by Flow table test. The flow table test indicates the flowing behavior of the mix in terms of increase in average base diameter of the mortar mass, expressed as a percentage of the original base diameter. The flow percentage for the different mixes are presented in Table 3 and graphically shown in Fig. 1. The results have shown that an increment in the percentage of manufactured sand in mortar led to decrement in flow percentage, i.e., a decrement in workability gradually. Mortar with 70% manufactured sand and above did not show any noticeable flow. Only distortion in shape was noted.

Table 3. Workability of Mortar mix

S. No.	Percentage of Manufactured sand in mortar	Flow %
1.	0	70
2.	10	65
3.	20	57
4.	30	48
5.	40	36
6.	50	15
7.	60	8
8.	70	1
9.	80	0
10.	90	0
11.	100	0

Fig. 1: Workability of Mortar mix



3.2 Compressive strength

The average compressive strength of three specimen samples was used for strength calculations. The average compressive intensity of mortar mix was tested for 7 and 28 days and presented in Table 4 and graphically represented in Fig. 2. The results have shown that the compressive strength of specimens with manufactured sand is always greater than the mortar with natural sand. Maximum strength was obtained at 100% replacement level and the strength varied gradually from 0 to 100%, with a maximum variation at 73.33% with respect to the mortar with river sand.

Table 4. Compressive strength of Mortar mix

S. No.	Percentage of Manufactured sand in mortar	Compressive Strength of mortar	
		7 days	28 days
1.	0	4.88	7.50
2.	10	5.07	7.80
3.	20	5.30	8.15
4.	30	5.66	8.70
5.	40	6.11	9.40
6.	50	6.37	9.80
7.	60	6.63	10.20
8.	70	7.02	10.80
9.	80	7.48	11.50
10.	90	7.80	12.02
11.	100	8.45	13.00

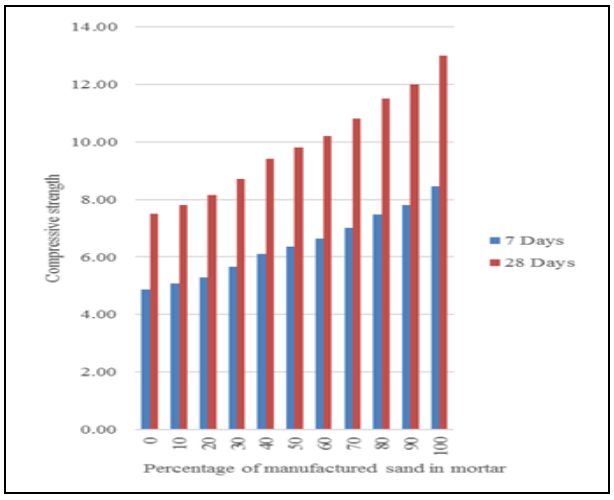


Fig. 2: Compressive strength of Mortar mix

4. CONCLUSION

The following conclusions can be drawn based on experimental findings:

- The workability of mortar decreases rapidly with the partial replacement of natural sand with manufactured sand.
- The strength of mortar made using manufactured sand is higher at all replacement levels, in comparison with natural sand.
- The mortar with manufactured sand can be used in masonry work with a high water-cement ratio.
- The workability of the mix can be managed by using a dose of super-plasticizer in the mix.

FUNDING

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

REFERENCES

IS 4031(Part 5)–2000 Method of physical tests of hydraulic cement Part 5 Determination of initial and final setting times, Bureau of Indian Standards, New Delhi.

IS 4031(Part 6)–2005 Method of physical tests of hydraulic cement Part 6 Determination of compressive strength of hydraulic cement other than the masonry cement, Bureau of Indian Standards, New Delhi.

IS 1489 (Part 1) - 1991 Specification for Portland Pozzolana cement, Part 1: Flyash based, Bureau of Indian Standards, New Delhi.

IS 383–1970 Specification for coarse and fine aggregate from natural sources for concrete, Bureau of Indian Standards, New Delhi

IS 2250-1981 Code of Practice for Preparation and Use of Masonry Mortars, Bureau of Indian Standards, New Delhi

Rameshwar, S. Ingalkar and Shrikant M. Harle, Replacement of Natural Sand by Crushed Sand in the Concrete, Landscape Architecture and Regional Planning, 2(1), 13-22 (2017) https://doi.org/10.11648/j.larp.20170201.12

Suman, Brajesh Kumar and Srivastava Vikas, Utilization of stone dust as fine aggregate replacement in concrete, Journal of Multidisciplinary Engineering Science and Technology, 2(4), 704-708 (2015).