

USE of M-SAND in Conventional Concrete- A Review

Er. Hitpal Singh^{1*} and Er. Aiwant Chandaliya²

¹MTech, Civil Engineering Department, Pacific University, Udaipur

²Assistant Professor, Civil Engineering Department, Pacific University, Udaipur

DOI: <https://doi.org/10.51244/IJRSI.2023.10805>

Received: 25 June 2023; Revised: 01 August 2023; Accepted: 08 August 2023; Published: 05 September 2023

ABSTRACT

M-sand (Manufactured sand) is a byproduct created when granite or basalt stone is crushed and screened. The investigation of substitute materials such as M-sand for construction has been prompted by the depletion of available natural sand resources and the environmental issues related to sand mining. In order to replace natural sand in concrete in a sustainable manner, this study intends to provide a thorough overview of the relevant literature. We have reviewed the consequences of using M-sand in place of natural sand on the workability, strength, and durability of concrete. The outcomes of the published experiments show that M-sand has the potential to be a workable replacement for natural sand, exhibiting equivalent or even greater performance in a number of areas. The assessment highlights the significance of taking into account M-sand as a sustainable choice for making concrete, helping to lessen the negative effects that sand extraction has on the environment and encouraging the effective use of available resources.

INTRODUCTION

Fine Aggregate is a key component in the creation of concrete, one of the most often used building materials globally. Sand is a component of many construction products. In the past, riverbeds have been the main source of natural sand for making concrete. Natural sand resources are now scarce due to the rising demand for sand, environmental concerns, and strict laws on sand mining. Due to the recent global economic slowdown, production costs for concrete are consequently rising. According to Karthik et al. (2017), traditional building materials are getting more expensive.



Figure 1: Problems leading to environmental imbalance

As a result, the construction industry is under pressure to research substitutes for or additions to natural sand in the manufacture of concrete. M-sand is one such possible substitute.



Figure 2: Manufacturing process of CRSs

The manufacturing sand is prepared from hard rocks such as granite or basalt. The rocks are crushed and screened to produce m-sand as a byproduct. It is created by mechanically crushing and sifting the stone aggregates to produce particles that are similar to natural sand in terms of size and shape. Due to its potential advantages and sustainability considerations, M-sand use in concrete has recently attracted a lot of interest.

The research of M-sand as a substitute for natural sand in concrete is driven primarily by the need to protect natural resources, which prevent sand mining and lessen the negative effects on the environment. Natural sand mining frequently results in ecological problems such as habitat loss, erosion, and modifications to water flow patterns. Utilizing M-sand will lessen the need for natural sand, minimizing the harm that sand mining does to the environment.

Numerous research projects have been carried out to assess the viability and effectiveness of M-sand-based concrete. These studies have looked at the workability, strength, durability, and sustainability of M-sand concrete, among other qualities. The findings of these investigations indicate that M-sand has a promising future as a workable replacement for natural sand in the manufacturing of concrete.

Concrete's workability is a key factor that affects how simple it is to install, compact, and finish. Through tests like slump, flowability, and compatibility, researchers have evaluated the workability of M-sand concrete. The results show that M-sand can offer similar workability to natural sand, ensuring best practices for building.

Fundamental markers of concrete performance are strength qualities. Numerous studies have compared the compressive and flexural strengths of concrete made using M-sand to concrete made with natural sand. The findings show that, depending on variables like M-sand quality, mix proportions, and curing circumstances, M-sand can produce concrete with equivalent or even greater strength properties. Another important factor that affects concrete's long-term performance and service life is its durability. Studies on the endurance of M-sand concrete have looked at its resistance to freeze-thaw cycles, alkali-silica reaction (ASR), sulphate assault, chloride penetration, and carbonation. According to these investigations, M-sand concrete demonstrates equivalent or improved durability attributes in comparison to natural sand concrete.

Along with its technological advantages, M-sand has important sustainability advantages. By using it, the need for natural sand is lessened, riverbeds and coastal regions are preserved, and the environmental damage caused by sand extraction and transportation is reduced. Additionally, the manufacture of M-sand can make use of some industrial byproducts, enhancing their efficient utilization and lowering waste output. This essay seeks to give a thorough review of the use of M-sand in place of natural sand in concrete. It will explore the body of research on the topic and discuss a number of topics, including workability, strength, durability, and sustainability. This review aims to provide useful insights into the possibilities and restrictions of M-sand in concrete production, supporting informed decision-making for sustainable building practices. It does this by synthesizing the data from earlier investigations.

LITERATURE REVIEW

Ding et al. presented data on 262 groups of compressive strength tests of M-Sand at 28 days and 186 groups of compressive strength tests of concrete using M-Sand at various curing ages. The test data was cubic compressive strength at 28 days ranged from 25.0 MPa to 84.6 MPa with a water/cement ratio (W/C) as 0.30-0.70, the sand ratio of 30-46%, P.O.32.5, P.O.42.5 and P.O.52.5 cement in the density of 2871-3134 kg/m³, coarse aggregate with a maximum particle size of 20- 31.5 mm, M-Sand with limestone powder content of 0-20% and fineness modulus of 2.60-3.40.

Karthik et al. used Bamboo strips were used as reinforcement in concrete that included additional cementitious ingredients and M-sand in place of some of the river sand. A mixture of admixtures, including fly ash and ground granulated blast furnace slag (GGBS), was used to replace 25% of the cement. The following conclusions were looked at after concrete cubes, cylinders, and beam samples were manufactured and tested in accordance with standard specifications.

1. According to the morphological (FTIR and SEM) characteristics of the bamboo dust examined, bamboo is a flexible reinforcing material with some evident rigidity, making it suitable as an alternative for steel. Bamboo can be a good material for parts subjected to compression and bending due to its strongly reinforced particles.
2. In concrete made entirely of M-Sand as fine aggregate, partial cement replacement with fly ash and GGBS produced a promising compressive strength. It can make a good material for some structural applications even though their values were poor in comparison to the reference concrete. In terms of split tensile strength, however, the materials outperformed the reference concrete.
3. In comparison to BRC manufactured using reference materials, the performance of BRC made with alternative materials (fly ash, GGBS, and m-sand) under flexural stress was noticeably worse. Because bamboo has strong strength and ductility on its own, a poor bonding of bamboo with concrete with an alternate material may be a contributing factor. Additionally, BRC produced using reference materials produced SRC with a 6.5% greater strength gain in terms of flexural strength.

Pilegis et al. presented a laboratory investigation in which the physical and mineralogical characteristics of manufactured sand produced in an industrial-sized crushing plant were assessed. Artificial neural networks (ANN) were used to research and estimate the effects of these properties on the workability and strength of concrete when synthetic sand totally replaced natural sand in the mix. The findings demonstrated that, due to the manufactured sand particles' increased angularity, manufactured sand concrete generally needs a higher water/cement (w/c) ratio to be as workable as natural sand concrete. If the created sand doesn't contain any dirt particles, water-reducing admixtures can be used to make up for this. The compressive and flexural strengths of manufactured sand concrete are greater than those of natural sand concrete at a similar w/c percentage.

Yamei and Lihua examined the particle form characteristics of both natural and man-made limestone sand. According to the findings, manufactured sand was more 19.0% longer than natural sand, less 11.5% flatter, more than 0.3% convex, more than 0.2% fuller, less 19.3% less in particle shape characteristics, and less 14.8% less spherical. As a result, the natural sand was more rounded and smooth, whereas the M-Sand was more slender, flat, and uneven. Natural sand concrete had a higher compressive strength than manufactured sand concrete when slump and cement dosage were both present at the same time. However, manufactured sand concrete required more water and less air.

Zhao et al. showed 755 groups dividing concrete with M-Sand tensile strength test results for a range of cure times from 1 day to 388 days. The basic silicate cement, the admixture of fly ash, slag, and silica fume, and the crushed stone were the ingredients for M-Sand. At 28 days, the cement's compressive and tensile strengths varied between 35.5 and 63.4 MPa and 6.9 and 10.8 MPa, respectively. The crushed stone's

maximum grain size ranged from 12 to 120 mm. The fineness modulus ranged from 2.25 to 3.55 for produced sand. Due to the fact that these experiments were conducted using various codes, differing maximum particle sizes of 0.075 mm and 0.160 mm for stone powder in produced sand were established. Stone powder with a particle size of 0–0.075 mm ranged in composition from 0–21.8%, while powder with a particle size of 0–0.160 mm varied in content from 0–40%. While the water-cement ratio $MW/mc = 0.30-1.43$, the water-binder ratio W/B is 0.24-1.00. The percentage of sand was 24-54%. M-SAND's compressive strength at 28 days ranged from 10.1 to 96.3 MPa, its slump ranged from 10 to 260 mm, and the specimens' curing times ranged from 1 day to 388 days.

Kumars and Kotian With a complete replacement of river sand and M sand, the compressive strengths of the two materials were evaluated. According to the findings, M Sand offers the same property as River Sand. The different tests, including those for specific gravity, compression strength, flexure, and split tensile strength, also gave river sand the same or superior value.

Thivya and Aarthi (2019) combined M-Sand and Quarry Dust as sand and contrasting it with the standard mix, researchers were able to determine the concrete's strength and endurance. In the study of M40 grade concrete, a wide range of 28 days of healing was taken into consideration for the design mix, with full replacement of M-Sand and Quarry Dust, respectively, having been considered for investigation. concrete is tested for its compressive strength (cube), split tensile strength (cylinder), and flexure strength (beam). The following findings have been looked at.

1. It was more cost-effective to replace the fine aggregate with M-Sand and Quarry Sand.
2. The compressive strength of M40 concrete after 28 days, with 100% of the river sand replaced by M-sand, is 63.56 N/mm².
3. Where there was a modest requirement for workability, 100% replacement was feasible. Additionally, when a high level of workability was required, a partial replacement can be made while taking into account strength and economy.
4. Huge projects like motorways require a lot of fine aggregate, creating a factory benefits the economy.

CONCLUSION AND FUTURE WORK

Conclusion

Several important implications about the use of M sand in the making of concrete can be drawn based on the findings and analyses reported in this study.

1. It is more cost-effective to replace fine aggregate with M-Sand instead of river sand.
2. The strength requirements can be fully established with a 100% substitution of natural sand with manufactured sand.
3. For big projects like highways, establishing a plant leads to economy as they require large amount of fine aggregate so M sand is the best alternative for it.

Future work

Future Work

1. The compressive and split elasticity are enhanced by M-Sand. In this way, M sand can be successfully used in construction as an alternative to river sand, to safeguard waterbodies for the future, and to advance environmentally friendly development practices.
2. The physical, Mechanical, and chemical characteristics of various raw materials for manufacturing sand, which were gathered from various crushing plants, will be studied.

ACKNOWLEDGMENT

My sincere appreciation and thanks to Er. AiwantChandaliya (Assistant Professor of Civil Engineering Department, Pacific University, Udaipur). His constructive suggestions, patience, and continuous encouragement are highly acknowledged throughout this research. My sincere thanks also go to Dr. Tanveer Ahmad Kazi (Professor of Civil Engineering Department, Pacific University, Udaipur) as all the success is the result of his affectionate encouragement.

REFERENCES

1. Adams, J. M., Maria, R. A. and Brightson, P. 2013. Experimental Investigation on the Effect of M-Sand in High Performance Concrete. *American Journal of Engineering Research* 02: 46-51.
2. Appukutty, P. and Murugesan, R. 2009. Substitution of mortar quarry dust to sand in brick masonry works. *International Journal on Design and Manufacturing Technologies* 03: 59-63.
3. Bhanuprabha. 2003. Studies on use of manufactured sand as Fine Aggregate. M.Tech dissertation, submitted to JNTU, Hyderabad, India.
4. Ding, X.X., Li, C.Y., Xu, Y.Y. and Li, F. 2016. Experimental study on long-term compressive strength of concrete with manufactured sand. *Construction and Building Materials* 06: 959- 964.
5. Dinku, S. B. 2006. The Use of manufactured Sand in Concrete production. M.Tech thesis submitted to the School of Graduate Studies of the Addis Ababa University, Faculty of Technology Dept. of Civil Engineer, Ethiopia.
6. Elavenil, S. and Vijaya, B. 2013. M-Sand, A Solution and an alternative to concrete river sand production. *Journal of Engineering, Computers Applied Sciences (JEC&AS)* 02: 1-20.
7. Ghannam, S., Najm, H. and Vasconez, R. 2016. Experimental study of concrete made with granite and iron powder as partial replacement of sand. *Sustainable Materials and Technologies* 09: 1-9.
8. Hudson, B.P. 1997. Manufactured sand for concrete. *The Indian concrete journal*. 237-240.
9. Ilangoan, R., Mahenfrana, N. and Nagamani, K. 2008. Strength and Durability Properties of Concrete Containing Quarry Dust as Fine Aggregate. *APRN Journal of Engineering and Applied Sciences* 03: 20-26.
10. Jadhav, P.A. and Kulkarni, D.K. 2013. Effect of replacement of natural sand by manufactured sand in the properties of cement mortar. *International Journal and Structural Engineering Technology* 03.
11. Jadhav, P.A. and Kulkarni, D.K. 2012. An experimental investigation on the properties of concrete containing manufactured sand. *International Journal of Advanced Engineering Technology* 03: 101-104.
12. Karthik, S., Rao, R.M.P. and Awoyera, P.O. 2017. Strength properties of bamboo and steel reinforced concrete containing manufactured sand and mineral admixtures. *Journal of King Saud University-Engineering Sciences* 29: 400-406.
13. Kumars, S. and Kotian, S.R. 2018. Comparison study on natural river sand and manufactured sand. *International Journal of Scientific & Engineering* 09.
14. Mahmood, S. 2008. Effect of Crushed and natural sand on the Properties of fresh and hardened concrete. Conference on our world in concrete and structure held at Singapore in August, 2008.
15. Pilegis, M., Gardner, D. and Lark, R. 2016. Influence of manufactured sand characteristics on workability and strength of cement concrete. Ph.D. thesis submitted to Cardiff School of Engineering, Cardiff University, UK.
16. Sahu, A.K., Kumar, S. and Sachin, A.K. 2003. Crushed Stone Waste as Fine Aggregate for Concrete. *The Indian Concrete Journal* 77: 845-848.
17. Shyam, P. V. 2007. Ready mixed concrete utilized manufactured sand as fine aggregate. Conference on our world in concrete and structures held at Singapore during August 28-29, 2007.
18. Thivya, J. and Aarthi, A. 2019. Comparative analysis of river sand, manufactures sand and quarry sand. *International Research Journal of Engineering and Technology (IRJET)* 06: 923-927.

-
19. Yamei, H. and Lihua, W. 2017. Comparative study of limestone manufactured sand and natural sand on concrete. 6 th International Workshop on Performance, Protection & Strengthening of Structures under Extreme Loading held at Guangzhou (Canton), China during December 11-12, 2017.
 20. Zhao, S., Hu, F., Ding, X.X., Zhao, M.S., Li, C.Y. and Pei, S. 2017. Experimental study on tensile strength development of concrete with manufactured sand. *Construction and Building Materials* 11: 469-472.