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STUDY ON USE OF MANUFACTURED SAND AS FULL REPLACEMNT OF RIVER SAND

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Abstract

Due to the high expense of transporting from natural sources, common river sand is pricey. Environmental issues are also brought on by the widespread depletion of these sources. Finding an alternative or replacement product for the concrete industry is necessary because river sand is less readily available and less desirable to use due to environmental, transportation, and other factors.

In all areas of the country, there is a severe shortage of river sand, which is utilized as fine aggregate in the manufacturing of concrete. Regarding its supply, cost, and environmental impact, continued usage of this has begun to pose major issues. In this case, manufactured sand (M. Sand) may be a more affordable option than river sand. When rocks are extracted and processed into tiny particles smaller than 4.75 mm, the residue, tailing, and other non-valuable debris are together referred to as manufactured sand.

Manufactured sand is widely utilized in construction projects, as a surface finishing material for highways, and in the production of hollow blocks and light-weight prefabricated concrete components. **Researchers and investigators are paying attention to the use of manufactured sand in concrete.**

The viability of using manufactured sand in place of natural sand in concrete is presented by Manufactured Sand's study. **Using design codes like the IS codes for both conventional concrete and precast concrete,** several mix designs have been created for various grades. The strength of concrete created of Manufactured Sand was investigated in this research by a number of experiments on cubes strength. The results were compared to those of concrete made with natural sand. It was discovered that concrete constructed with manufactured sand has virtually identical more compressive and tensile strength compared to normal concrete.

Keywords: *Manufactured Sand, River Sand, Environment, Researchers, Compressive Strength, Flexural Strength, Tensile Strength.*

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1. INTRODUCTION

Concrete is now the most widely and often used construction material in the entire world due to the rapid growth of infrastructure on a worldwide scale. In order to meet the increased need for infrastructure development, this has put tremendous pressure on the concrete industry to produce massive quantities of concrete. The price of the raw elements that make up concrete, namely cement, aggregates (both coarse and fine), and water, determines the cost of making concrete in the main. The Natural River sand, one of the constituent raw materials, accounts for around 35% of the volume of concrete and is crucial in determining the price of concrete. The concrete industry has increasingly turned its focus toward a suitable fine aggregate replacement for the currently employed natural river sand due to the diminishing sources of natural river sand and tight environmental regulations on mining. **Natural River sand**. Crushed rock sand has surfaced as a viable alternative to Natural River sand and is being now used commonly throughout the world as fine aggregate in concrete.

1.1 Environmental Effects of Excessive Sand Mining:

For thousands of years, people have used concrete in ground-breaking construction projects. The de-mand for concrete is rising very quickly around the world as a result of the ongoing housing boom and other growth efforts in the construction industry. According to a research released by the United Nations Environment Program, almost 12 billion tonnes of concrete are produced annually through-out the world. Large amounts of natural resources are needed to produce such volumes of cement and aggregate. For instance, the consumption of cement increased three-fold during the past 20 years, from 1.37 billion tonnes in 1994 to 3.7 billion tonnes in 2012, primarily as a result of Asia's rapid economic development. It's interesting to note that in 2012, China accounted for around 58 percent of global cement consumption.

1.2. Alternatives for Natural Sand:

Fine aggregate made from crushed stone, known as crushed sands, has grown in popularity in loca-tions where natural sand is in short supply or is not widely accessible. The Mumbai-Pune expressway was a project where getting natural sand proved challenging. This led the building company to em-ploy crushed sand to produce the roughly 20 lakh cubic meters of concrete essential for the infra-structure work. The high concentration of micro-fines, or particles smaller than 75 microns, in this type of sand, however, Might negatively impact the nature of concrete. As a result, when using crushed sand in concrete, the proportioning of different raw materials is essential during the mix de-sign process.

Broken Stone Sand is the term for the leftovers, tailings, or waste products left over after the removal and processing of rocks at a quarry's crushing plant. It is sometimes referred to as rock dust, stone dust, and quarry debris. The primary goal of rock crushing and sizing in quarries has often been to generate coarse graded aggregates of various sizes and road construction materials that adhere to par-ticular norms and specifications. A certain fraction of the rock is ground down throughout the course of a quarry's routine production procedures to a size that prevents it from being used as a component of coarse aggregates. It is sometimes referred to as rock dust, stone dust, and quarry debris.

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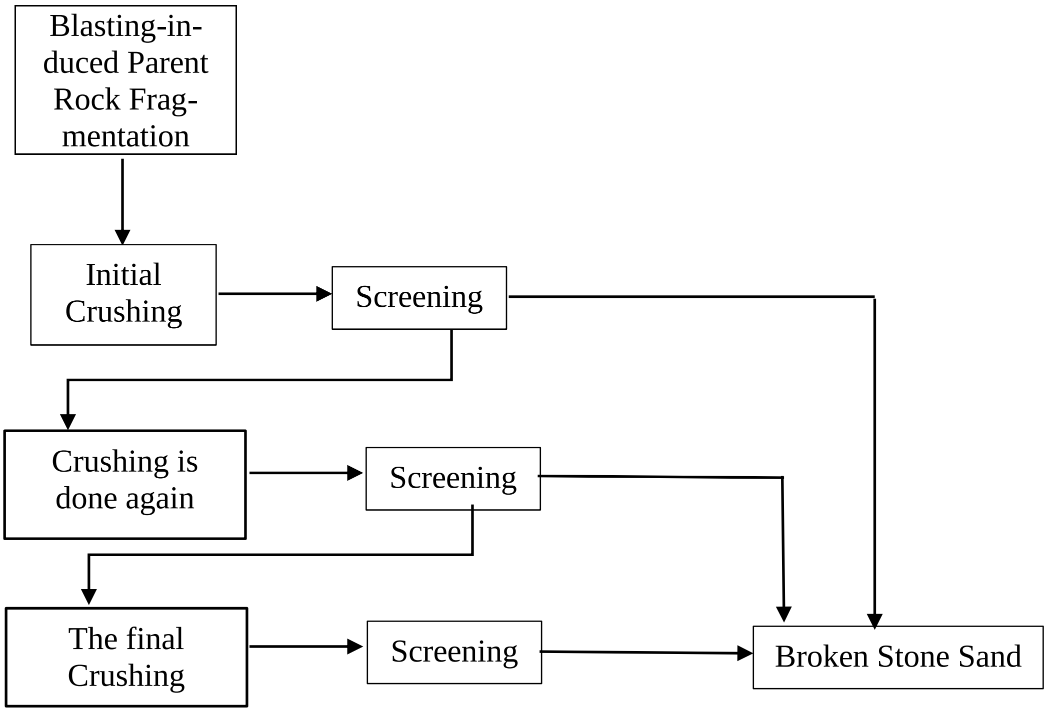

Figure 1. Flow Chart Demonstrating Broken Stone Sand Production

Stone dust or quarry dust is created during the coarse grade aggregate quarrying procedures of blast-ing, crushing, and screening. This quarry by-particle product's size is typically less than 5 mm or var-ies depending on the size of the smallest used screening. It comprises of clay/silt fraction that is finer than 75 microns in size as well as considerable amounts of coarse, medium, and fine sand particles

2. LITERATURE REVIEW

This study's objective is to determine the current state of knowledge on the use of crushed stone sand in mortar and concrete in place of natural or river sand. In this literature review, a thorough analysis of the most recent research studies and current research articles on the use of crushed stone sand as a complete replacement of river sand is undertaken. The assessed fresh qualities, toughened properties, and durability properties of studies are investigated. The major findings from the literature review are discussed in relation to properties. Workability, compressive strength, and Young's modulus of elasticity are some of the other characteristics covered in the lit-erature review.

(1) Raman et al. (2011) [1] looked at the impact of using crushed stone sand in place of natural sand on the ability of high strength rice husk ash concrete to be worked. To get the desired strengths of 60 MPa and 70 MPa, respectively, two series of concrete, C60 and C70, were created. Quarry dust was substituted for natural sand in each series in amounts of 10%, 20%, 30%, and 40%. For all mixes, 10% of the cement was made from rice husk ash.

(2) Singh et al. (2016) [2] studied the impact of substituting crushed stone sand for natural sand at replacement levels ranging from 0% to 40% on the workability of concrete. They noticed that as more natural sand is replaced with granite cutting waste, the workability of concrete significantly decreases. They came to the conclusion that the increased friction between concrete particles caused by more angular and rough-surfaced crushed stone sand roughness than river sand was the cause of the deterioration in concrete's workability.

(3) The effect of utilizing granite dust in place of natural sand on mortar's compressive strength was examined by Jeyaprabha et al. in 2016 [3].They looked studied the effects of using crushed stone sand in place of natural sand at ages of 3, 7, 14, and 28 days after curing. They discovered that using granite dust in place of natural sand at all ages significantly increases the compressive strength of mortar. The compressive strength of crushed stone sand mortar is increased over river sand mortar by 48, 57, 61, and 43 percent for curing times of 3, 7, 14, and 28 days, respectively. They came to the conclusion that the granite dust's higher fineness compared to natural sand may have a filling effect, increasing the compressive strength of mortar when used in place of natural sand.

(4) At ages of 7, 28, 90, and 180 days of curing, Bonavetti and Irassar (1994) [4] examined the compressive strength of mortar made by replacing natural sand with quartz dust, granite dust, and limestone dust, respectively, at replacement levels of 0 to 20 percent.

3. OBJECTIVE OF STUDY

The project's main objective is to look into the possibility of using crushed stone sand in place of natural sand in concrete. In this study, concrete mixes made with 100 percent manufactured sand are prepared, and their various qualities are contrasted with those of the control concrete mix made with 100 percent natural sand.

- ❖ To contrast the control concrete workability mix's and the gradation of aggregate mixes that incorporate crushed stone sand in place of natural sand.
- ❖ To contrast the specific gravity, compressive strength, water absorption and density of concrete mixes using crushed stone sand in place of natural sand with the control concrete mix.

4. MATERIALS AND METHODS

Cement:

OPC 43, manufactured by UltraTech Cement Limited, was used in the creation of all concrete com-positions. The cement had a uniform color and was free of any sharp lumps. Table 4.1 lists the physi-cal characteristics of cement.

Coarse Aggregate:

Concrete with coarse aggregate uses a mixture of aggregates with nominal sizes of 20mm and 10mm. Both varieties of coarse aggregate were bought locally and met the requirements of BIS 383:1970's Indian Standard Specifications. Table 4.2 lists the different physical qualities of both forms of coarse aggregate.

Crushed (Manufactured) Sand:-

Dust from a nearby crushing mill was gathered from a crushed stone sand. According to the process outlined in BIS 2386(Part 1):1963, crushed stone sand was sieved through a series of sieves to pro-vide sieve analysis, which allowed researchers to compare the particle size distribution of the dust to that of natural sand. The grading specifications for crushed sands provided in BIS 383:1970 were also compared to the sieve analytical results of crushed stone sand. Zone and fineness modulus of crushed stone sand were calculated, same like with natural sand.

Natural Sand:

Nearby available natural sand was used as the fine aggregate in the creation of concrete. Natural sand's physical characteristics are evaluated using procedures defined in the Bureau of Indian Guide-lines standards, such as sieve analysis, specific gravity, water absorption, and bulk density. Accord-ing to the technique outlined in BIS 2386(Part 1):1988, natural sand was sieved through a number of sieves to provide sieve analysis, which was then compared to the specifications outlined in BIS 383:1970. Zone of the sand was identified, and fineness modulus was computed in accordance with BIS 383:1970 standards.

Preparation of Samples

In steel moulds, all of the concrete examples were cast. Before the components for the concrete were mixed, all the moulds were thoroughly cleaned and lubricated. Before casting processes, they were appropriately tightened to the proper dimensions. Care was taken to make sure there would be no gaps to allow slurry to slip through. Using a vibrating table, concrete sample were crushed into two layers. After the casting procedures, concrete samples were demolded and put in the curing tank after being kept in the casting room for around 24 hours. Below is information about the samples used to conduct various tests;

1. Concrete's compressive strength was tested using cube-shaped specimens with dimensions of 150 mm x 150 mm x 150 mm.
2. Concrete's Water Absorption: To test the concrete's water absorption, cubic specimens of 70.6 mm x 70.6 mm x 70.6 mm were cast.

Workability Test:

Concrete's workability refers to how easily it can be correctly mixed, transported, compacted, and finished with the least amount of homogeneity loss. The Slump Test is the test that is most frequently used to assess the workability of concrete in the construction industry worldwide. Slump testing was used to assess the concrete's workability in accordance with Indian Standard Specifications found in BIS 1199:1959.

Figure 2. Slump Test of Concrete

Compressive Strength Test:

It is believed that the most significant characteristic of hardened concrete is its compressive strength. The procedures described in BIS 516:1959 were used to carry out compression strength testing in compliance with Indian Standard Specifications. Concrete's compressive strength was evaluated at ages of 3 days, 7 days, and 28 days using standard cube specimens with dimensions of 150mm x 150mm x 150mm.

Figure 3. Compressive Testing Machine Test for Compressive Strength

Concrete Density and Water Absorption Test:

The Concrete's density is a crucial factor consideration since it has a significant impact on how a structure's dead weight is determined. The mass of three random cubes was determined using the fol-lowing formula while demoulding cubical specimens of 150mm x 150mm x 150mm used for com-pressive strength testing on a weighing scale with a 10 kg capacity and an accuracy of 1.0g:

Figure 4. Water Absorption Test on Curing Tank of Standard Size Cube and Curing Process

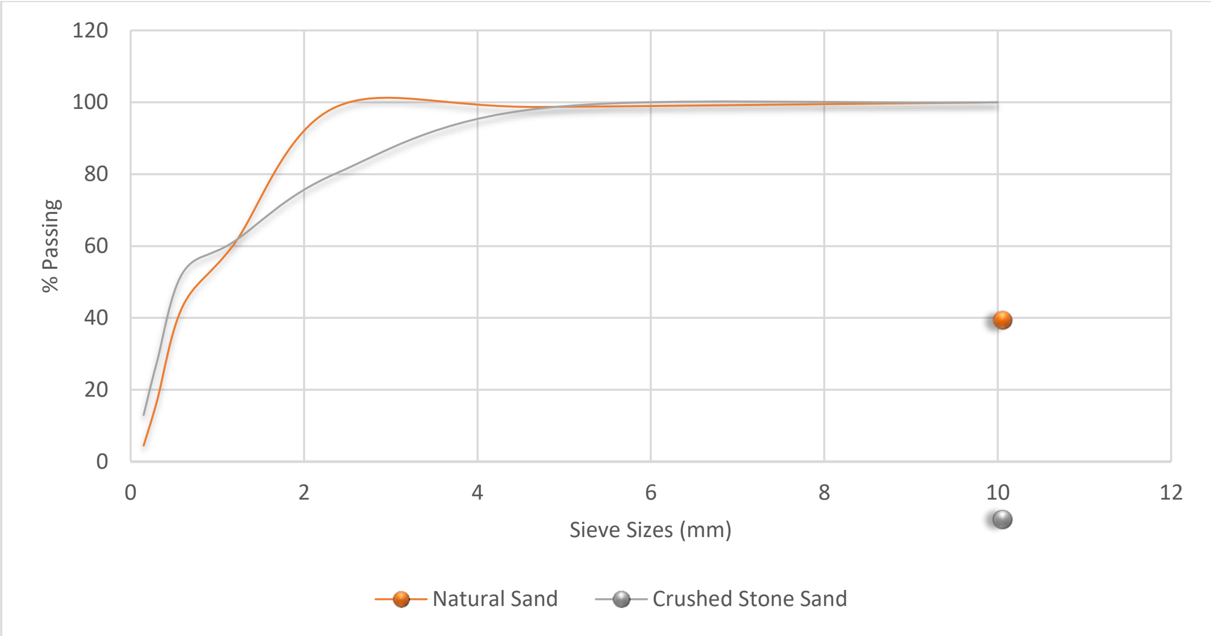

Figure 5. Particle size distribution of natural sand and crushed stone sand is compared.

5. RESULTS AND DISCUSSIONS

This chapter presents and analyses the results of several experimental experiments. The first section contains the physical testing findings for cement, coarse aggregate, natural sand, and quarry dust. Spe-cific gravity, compressive strength, starting and final setting times, standard uniformity, soundness, and fineness of the cement cubes were all measured physically. For coarse aggregates, sieve analysis, bulk density, specific gravity, and water absorption of aggregates with nominal diameters of 20 mm and 10 mm were all computed. One of the tests performed on fine aggregate was a sieve analysis. Oth-er tests included checking for silt content, bulk density, specific gravity, and water absorption. Crushed Stone Sand was put through physical testing. The next part includes mix design information for M20 grade concrete as well as mix proportioning for various concrete mixes. As an all-in aggregate, blended aggregate is also graded. Crushed stone sand was used in place of natural sand in M20, M25, M30, and M35 grade concrete entirely to determine how it affected the concrete's workability, density, compressive strength, and water absorption. Later, a number of trials were run.

Table 1. Individual gradation of 20 mm aggregate

Sieve Size(mm)	% Passing										Avg
	Sample 01	Sample 02	Sample 03	Sample 04	Sample 05	Sample 06	Sample 07	Sample 08	Sample 09	Sample 10	
40.00	100	100	100	100	100	100	100	100	100	100	**100**
20.00	93.24	94.22	95.21	91.89	94.12	93.21	94.53	92.12	95.62	93.24	**93.24**
10.00	4.36	3.89	4.12	3.36	3.12	4.26	4.26	4.06	3.78	3.39	**3.86**
4.75	0.87	0.92	1.02	0.78	0.68	0.89	0.88	0.88	1.12	0.94	**0.90**

Table 2. Individual gradation of 10 mm aggregate

Sieve Size(mm)	% Passing										Avg
	Sample 01	Sample 02	Sample 03	Sample 04	Sample 05	Sample 06	Sample 07	Sample 08	Sample 09	Sample 10	
12.5	100	100	100	100	100	100	100	100	100	100	**100**
10.00	89.32	87.86	90.12	89.42	88.74	88.24	90.24	91.26	88.92	92.32	**89.64**
4.75	10.26	8.98	10.12	8.98	10.24	9.74	9.78	8.98	10.24	10.26	**9.26**
2.36	3.12	2.91	3.26	2.28	3.02	2.46	2.86	2.12	3.26	2.63	**2.79**

Table 3. River sand sieve analysis

Sieve Size (mm)	Weight Retained (gm)	% Retained	Cum. % Retained	% Passing	Limits for Zone II as per BIS 383-1970
10	0	0	0	100	**100**
4.75	1.3	1.3	1.3	98.7	**90-100**
2.36	1	0.1	1.4	98.6	**75-100**
1.18	38.5	38.5	39.9	60.1	**55-90**
0.600	16.9	16.9	56.8	43.2	**35-59**
0.300	26.7	26.7	83.5	16.5	**8-30**
0.150	12.0	12.0	95.5	4.5	**0-10**

Table 4. Individual gradation of classified crushed stone sand

Sieve Size (mm)	% Passing										Avg
	Sample 01	Sample 02	Sample 03	Sample 04	Sample 05	Sample 06	Sample 07	Sample 08	Sample 09	Sample 10	
10.00	100	100	100	100	100	100	100	100	100	100	**100**
4.75	98.26	98.12	98.56	96.78	98.88	99.12	97.863	98.24	98.68	99.12	**98.36**
2.36	81.26	79.63	80.12	82.12	80.34	78.32	79.32	81.26	78.34	80.34	**80.11**
1.18	61.34	60.26	61.34	62.34	58.36	61.26	61.54	60.34	61.24	62.48	**61.05**

0.600	52.28	50.34	56.72	53.29	49.26	53.46	52.25	54.62	51.36	51.39	**52.50**
0.300	27.32	26.98	29.12	26.12	25.92	27.62	26.32	28.32	28.32	28.28	**27.43**
0.150	12.02	13.24	13.52	12.84	13.38	12.92	13.34	12.66	13.24	12.76	**12.99**

Table 5. Mix proportion (m20 to m35 grade of concrete) with natural sand

Mix Name	Cement (kg)	Fly Ash (kg)	Coarse Aggregate(kg)		Natural Sand (kg)	Manufactured Sand (kg)	Water (kg)	Admixture CHRYSO (kg)
			20 mm	10 mm				
M-20	220	93	655	435	780	0	175	2.580
M-25	240	101	645	430	770	0	170.6	2.814
M-30	270	110	635	425	760	0	170	2.987
M-35	300	100	630	420	750	0	167	3.200

Table 6. Mix proportion (m20 to m35 grade of concrete) with manufactured sand

Mix Name	Cement (kg)	Coarse Aggregate(kg)		Natural Sand (kg)	Manufactured Sand (kg)	Water (kg)	Admixture CHRYSO (kg)
		20 mm	10 mm				
M-20	320	620.81	620.81	0	737.18	172.80	3.20
M-25	350	625.97	625.97	0	743.30	157.50	3.50
M-30	360	623.39	623.39	0	757.86	158.40	3.60
M-35	375	615.67	615.67	0	748.46	161.25	3.75

Table 7. Compressive strength (MPa) trend comparison

Days	M-20		M-25		M-30		M-35	
	M-Sand	Natural Sand	M-Sand	Natural Sand	M-Sand	Natural Sand	M-Sand	Natural Sand
7 Days	26.25	21.3	32.07	29.5	34.44	28.3	40.00	31.2
28 Days	38.09	29.3	42.60	34.6	46.13	38.4	52.11	44.2

Table 8. Cost comparsion

Grade of Concrete	Cost of Concrete	
	Natural Sand	Manufactured Sand
	(Rupees Per Cum)	
M-20	**4800**	**2600**
M-25	**5400**	**3000**
M-30	**6000**	**3300**
M-35	**6800**	**3600**

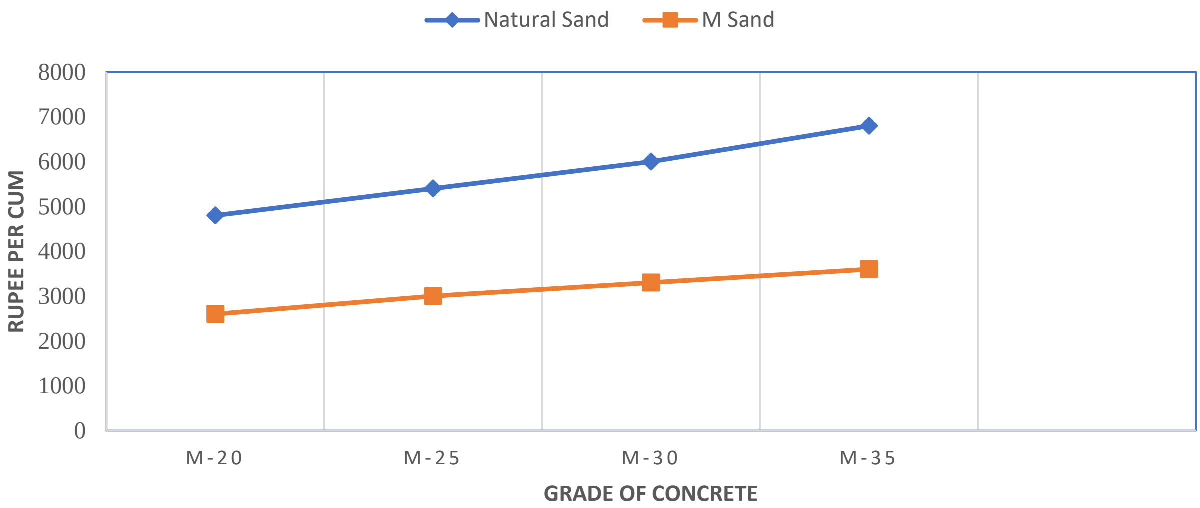

Figure 6. Cost comparison of natural sand vs M-sand

6. CONCLUSION

1. Crushed, artificial, or manufactured sand addition has a considerable impact on concrete's compressive strength. It would be a fantastic chance to produce concrete using crushed sand at a reasonable cost, which would lower construction costs and concrete usage.
2. The aforementioned studies support the strategic objective of the construction industry to con-duct environmental research that will allow manufactured sand (MS) to take the place of natu-ral sand in concrete mixes. Less river dredging and environmental impact result from the use of less natural sand. As already noted, aggregate mining sites can be recovered and developed for brand-new uses like residential, commercial, or recreational ones.
3. Concrete mixes using manufactured sand had better compressive strengths almost at all tested concrete ages, according to results of the mix's hardened properties.
4. At all corresponding mix designs, the compressive strength of concrete made with M sand is somewhat higher than that made with Natural (River) Sand for the M20, M25, M30, and M35 grades of concrete. It is dependable that M Sand may be used in place of natural sand as the fine aggregate in concrete to produce high-quality concrete at a lower cost.

Future Scope of Study

The raw material's source affects M. Sand's mechanical character-istics. So choosing a quarry is crucial if you want to get high-quality fine aggregates. According to this study, M. Sand has a lower void content than natural sand, which results in less drying shrinkage and cavitation in the structure and greater durability for all types of concrete work.

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