

## International Journal of Innovative Research in Science, Engineering and Technology

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# Effect of Manufactured Sand on Durability Properties of Concrete

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**ABSTRACT:** Currently India has facing a great demand to natural river sand due to its excessive cost and depletion of these natural sources causes major environmental problems. Nowadays in the construction industry, major projects such as construction of power plants, silos, dams, bridges, highway projects etc., meet more demand in the building materials. The utilization of manufactured sand has been accepted as one of the building materials. The above study presents the usage of manufactured sand in concrete at various replacement proportions. The real estate and infrastructure sectors are experiencing sand shortage, which has halted numerous building projects across the city. It has affected all building projects, including government ones like the Metro Rail. The sand shortage and its volatile price escalation is a major cause for concern in the real estate and infrastructure sectors which posed a massive drawback. Due to the growth of construction industry and major infrastructure projects, there is a huge demand for sand as a building material. This leads to acute shortage of river sand for the construction purpose. Excessive Sand Mining has adversely affected the environment. This led to ban on mining of river sand. To check durability of concrete various tests are conducted.

**KEYWORDS:** Durability, Manufactured Sand, Rapid Chloride Penetration Test, Impact resistance, Acid attack.

### I. INTRODUCTION

Concrete is the most widely used building material in the world. Aggregates are the major component of concrete. The sand mining in rivers had gone up to such an extent that in many countries there is ban on sand mining. With the recent ban on river sand mining in India alternate sources are looked into. Attention has turned to how we can use manufactured sands as an alternative to natural sands. Making manufactured sands by crushing rock boulders to sand granules came into practice. The artificial sand produced by proper machines can be a better substitute to river sand. Demand for manufactured fine aggregates for making concrete is increasing day by day. So, now rock mining had also turned out as an environmental problem in many cases. Though Manufactured sand is used in a great manner, it requires to study its characteristics for a better and durable construction material. The durable concrete should require very less or no maintenance and it should remain its original form for maximum life span. To determine the durability Rapid chloride Penetration Test, Impact Resistance and Acid Attack test are conducted.

### II. LITERATURE REVIEW

B. Vijaya and S. Senthil Selvan have shown the durability of M-sand concrete under acid is higher inferior to that of conventional concrete at the same time results of rapid chloride penetration test shows that chloride ion penetrability is high for concrete with natural sand while it is reduced using manufactured sand.

Vijaya Bhaskar Reddy Suda and P.Srinivasa Rao have shown the variation results between M-sand and River sand for Impact Resistance.

They suggest that 70% of manufactured sand in concrete is the optimum replacement for natural sand for better results. Experimental results of M.G. Shaikh et al. suggest that the sharp edges of the particles in artificial sand provide better bond with the cement than the rounded part of the natural sand. Both concrete made using artificial sand and natural sand are moderate to chloride permeability.

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### III. METHODOLOGY

The Methodology adopted is comprised of both preliminary investigation and experimental investigation

**Preliminary investigation:** It includes physical analysis such as specific gravity, water absorption, density etc. and to determine whether the aggregates, manufacturing sand and cement are according to standards which we are using

**Experimental investigation:** The Experimental program will be designed to investigate manufacturing sand as partial replacement and full replacement of natural sand in concrete. The replacement levels of manufacturing sand will be selected as 50% and 100%.

**Durability Tests on Concrete:** Durability is the ability of concrete to resist weathering action, chemical attack and abrasion while maintaining its desired engineering properties. The nature, intensity and mechanism implied in each of these different attacks could vary considerably. No standardized method exists for measuring the durability of concrete in general. Similarly, there are no units in which to evaluate the durability of the concrete.

Following are the test conducted to determine durability of concrete,

1. Rapid chloride ion penetration
2. Impact resistance
3. Acid attack

### IV. MIX DESIGN

Concrete mix design in this investigation was designed as per the guidelines specified. The Table 1 shows the mix proportions of Concrete (kg/m<sup>3</sup>). Concrete mixtures with different proportions of manufactured sand for natural sand ranging from 0% to 100% were casted.

M20 Mix design:			
	Aggregate		

Table 1: Mix Design

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- **Replacement of Manufactured Sand:**

The replacement of manufactured sand is used as shown in Table 2

**Table 2: Replacement of M-Sand**

50 %	MS	0.135 cum	369.68kg/cum
	FA	0.135cum	375kg/cum
100%	<b>MS</b>	0.27cum	739.36kg/cum
	FA	0 cum	0kg/cum

## V. EXPERIMENTAL TESTS ON CONCRETE AND RESULTS

- **Compressive Strength:**

Compressive strength is the ability of material or structure to carry the loads on its surface without any crack or deflection. A material under compression tends to reduce the size, while in tension, size elongates. The measured compressive Strength of specimen should be calculated by dividing the maximum load applied to the specimen during the test by the cross-sectional area, calculated from the mean dimensions of the section and should be expressed to nearest kg/sq.cm. An average of three values should be taken as the representative of the batch, provided the individual variation is not more than 15% of the average. Otherwise repeat tests should be done. Compressive strength of blocks for both grades is shown Table 3.

**Table 3: Compressive strength**

Average Strength of M40 Design Blocks:			
Days	100% N.S.	50% M.S.	100% M.S.
3	30.20	42.07	32.73
7	37.74	49.56	43.31
28	45.09	57.57	53.58
Average Strength of M20 Design Blocks:			
Days	100% N.S.	50% M.S.	100% M.S.
3	25.03	26.06	24.10
7	27.01	28.46	27.94
28	32.99	44.78	40.52

The following graph shows the variation of compressive strength for M20 and M40 grade concrete.

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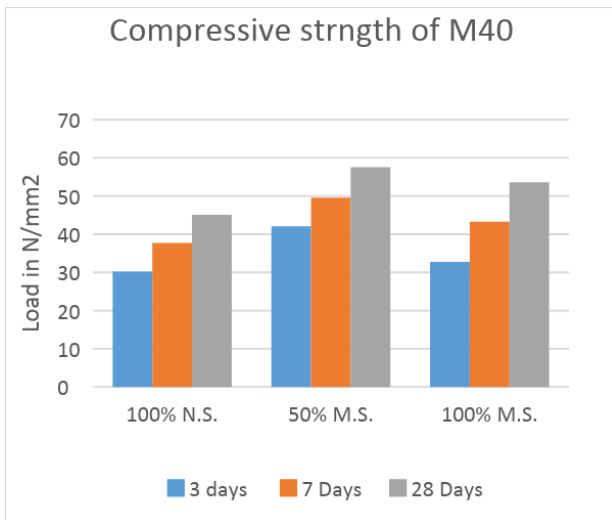


Figure 1: Compressive Strength of M40 Grade Concrete

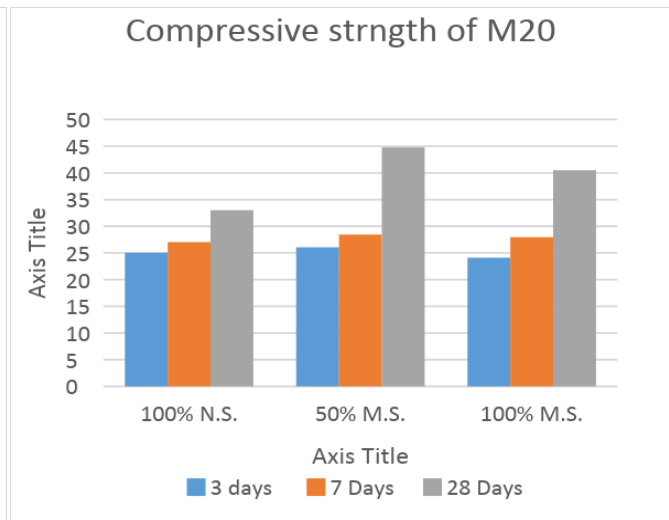


Figure 2: Compressive Strength of M20 Grade

## VI. DURABILITY TESTS ON CONCRETE

- Rapid Chloride Penetration Test**

In the AASHTO T277 (ASTM C1202) test, a water-saturated, 50 mm thick, 100 mm diameter concrete specimen is placed in one reservoir contains 3.0 % NaCl solution and another reservoir contains 0.3 M NaOH solution and subjected to a 60 V applied DC voltage for 6 hours. The total charge passed is determined and this is used to rate the concrete. Table 4 shows the final results of RCPT achieved in terms of Coulombs.

**Table 4: Rapid Chloride Penetration Test**

Proportion	M20			M40		
	100% N.S.	50% M.S.	100% M.S.	100% N.S.	50% M.S.	100% M.S.
Specimen 1	3313.30	1715.90	1033.60	1062.20	686	988.20
Specimen 2	3186.40	1452.60	1356.20	1201.30	791.40	798.50
Average(Coulombs)	3249.85	1584.25	1194.90	1131.75	738.70	893.35

The below graph shows the total charge passed in concrete and the rate of passed charge is in coulombs.

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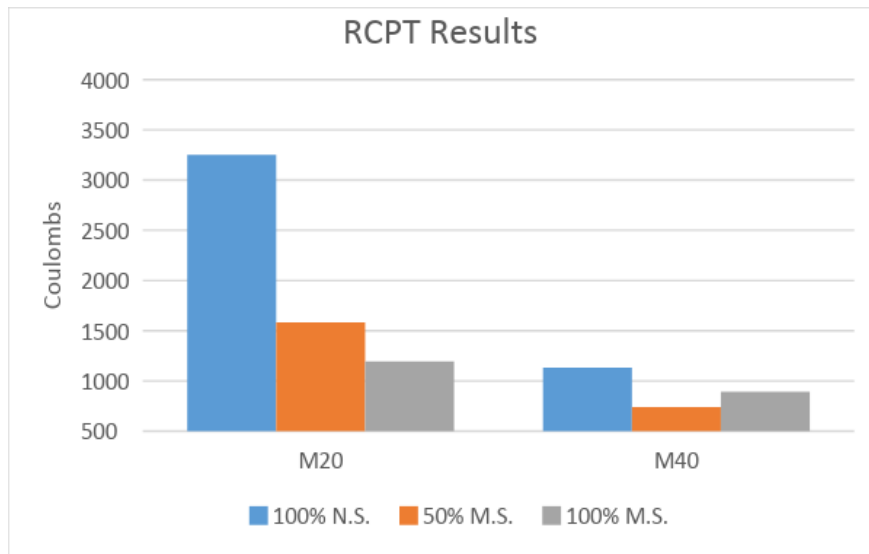


Figure 3: RCPT results.

- Impact Resistance**

Impact resistance energy was measured by using drop weight hammer test recommended by ACI committee 544.2R-89. The concrete specimen of 150mm diameter and 64mm thickness was placed on the base plate and four positioning lugs were put in at the periphery of the base plate. A cylindrical sleeve was placed over the test specimen. Hardened steel ball was placed within the sleeve on the top of the specimen. The steel ball was free to move vertically within the sleeve. A drop hammer was used to apply the impact load. The weight of the hammer was 45N. The number of blows required by dropping the hammer through a height of 457mm to cause the first visible crack and to cause the ultimate failure was recorded. Ultimate failure is defined in terms of number of blows required to open the crack in the specimen to enable the fractured pieces to touch three or four positioning lugs on the base plate. Each blow of the hammer represents 20.2Nm of energy. The results of first visible crack and the ultimate failure of specimen for impact test are shown in table 5 and 6 respectively.

**Table 5: Impact Resistance Results For First Visible Crack**

First Visible Crack:						
Proportion	M20			M40		
	100% N.S.	50% M.S.	100% M.S.	100% N.S.	50% M.S.	100% M.S.
Specimen 1	505	585.80	545.40	2262.40	2626	2666.40
Specimen 2	424.20	686.80	505	2525	2444.20	2888.60
Specimen 3	585.80	545.40	545.40	2343.20	2666.40	2747.20
Average(N-m)	505	606	531.93	2376.86	2578.86	2767.40

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Ultimate Failure:						
Proportion	M20			M40		
	100% N.S.	50% M.S.	100% M.S.	100% N.S.	50% M.S.	100% M.S.
Specimen 1	1131.20	1353.40	1131.20	2525	3030	3211.80
Specimen 2	990	1313	1454.40	2747.20	3151.20	3110.80
Specimen 3	1171.60	1232.20	1313	2706.80	2969.40	3070.40
Average(N-m)	1097.60	1299.53	1299.53	2659.67	3050.20	3131

**Table 6: Impact Resistance Results For Ultimate Failure**

The Following figure shows the increasing impact load value for M20 and M40 grade concrete.

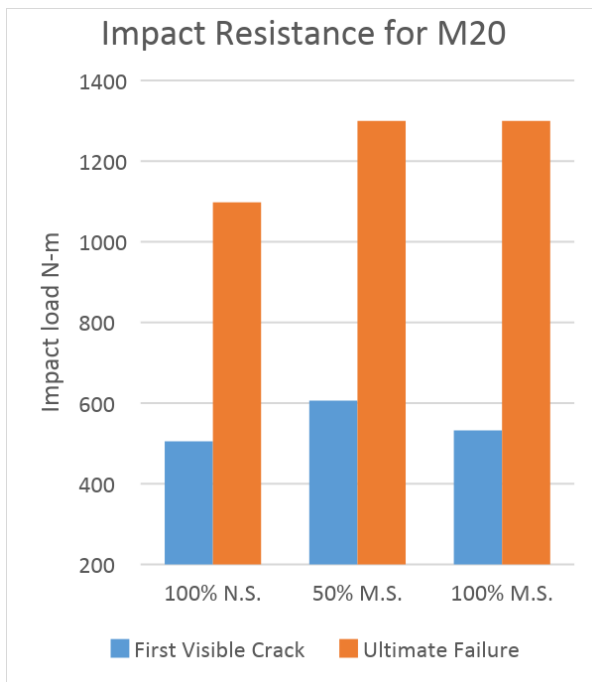


Figure 4: Impact Resistance result for M20

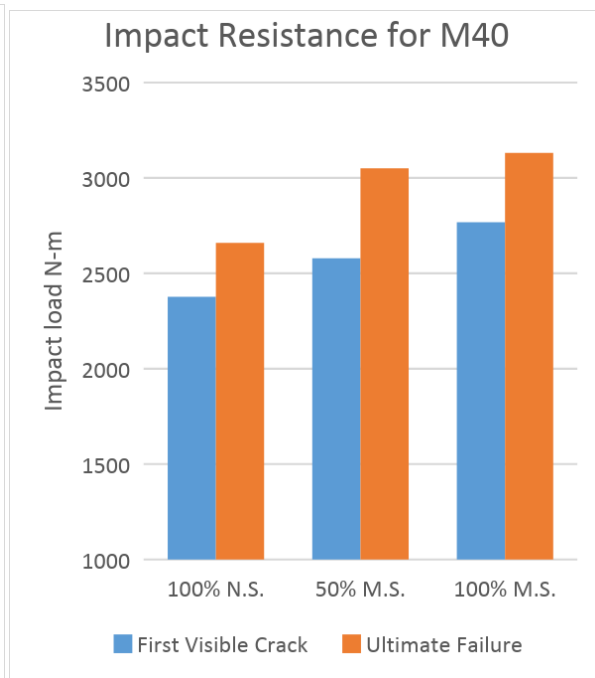


Figure 5: Impact Resistance result for M40

- Acid Attack**

The acid attack has been one of the primary causes of chemical deterioration of concrete for many years. Concrete is not a chemically stable material under the condition of acidic environment. It is susceptible to acid attack because of its alkaline nature. So, it is necessary to study the deterioration effect on concrete due to sulphuric acid.

In the present study, the deteriorating effects of 0.1 normality of sulphuric acid solution on concrete had been assessed. The standard cube samples of size 150mm x 150mm x 150mm were immersed in the 0.1 normality of sulphuric acid solutions with PH value kept between 1.9 and 3.2. The changes in weight and strength of the concrete samples were found at 28 days of immersion. The results are shown in table 7.

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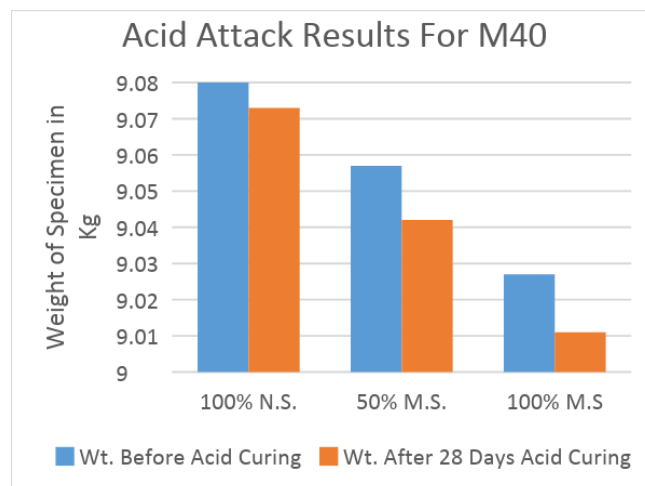
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**Table 7: Acid Attack Results for M40 and M20 Grade Concrete**

<b>For M40:</b>						
	<b>100% N.S.</b>		<b>50% M.S.</b>		<b>100% M.S.</b>	
	<b>Wt. Before Acid Curing</b>	<b>Wt. After 28 Days Acid Curing</b>	<b>Wt. Before Acid Curing</b>	<b>Wt. After 28 Days Acid Curing</b>	<b>Wt. Before Acid Curing</b>	<b>Wt. After 28 Days Acid Curing</b>
<b>Specimen 1(Kg)</b>	9.140	9.128	9.082	9.065	9.298	9.282
<b>Specimen 2(Kg)</b>	8.885	8.867	9.023	9.010	9.243	9.228
<b>Specimen 3(Kg)</b>	9.240	9.224	8.960	8.946	9.289	9.871
<b>Avg. (Kg)</b>	9.088	9.073	9.057	9.042	9.027	9.011
<b>For M20:</b>						
	<b>100% N.S.</b>		<b>50% M.S.</b>		<b>100% M.S.</b>	
	<b>Wt. Before Acid Curing</b>	<b>Wt. After 28 Days Acid Curing</b>	<b>Wt. Before Acid Curing</b>	<b>Wt. After 28 Days Acid Curing</b>	<b>Wt. Before Acid Curing</b>	<b>Wt. After 28 Days Acid Curing</b>
<b>Specimen 1(Kg)</b>	8.624	8.614	8.928	8.913	9.261	9.250
<b>Specimen 2(Kg)</b>	8.868	8.859	9.351	9.340	9.467	9.451
<b>Specimen 3(Kg)</b>	8.810	8.793	9.160	9.148	9.910	9.894
<b>Avg. (Kg)</b>	8.767	8.755	9.146	9.133	9.546	9.531

The results of acid attack for M20 and M40 grade concrete are represented in below graph.

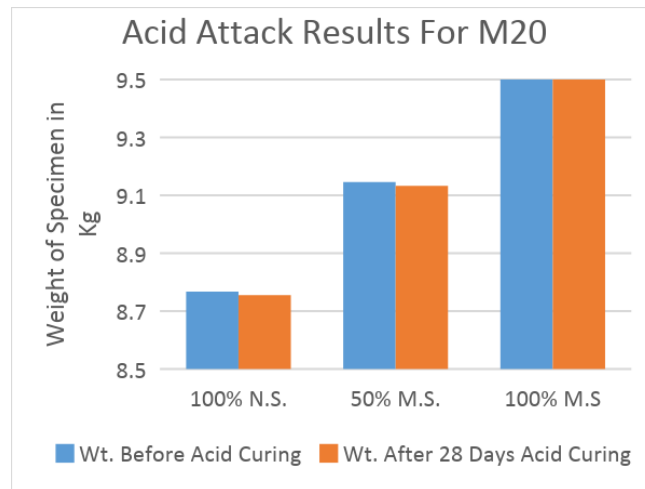


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### VII. CONCLUSION

- The results of the present research work conclude that the compressive strength of concrete is significantly improved by partial replacement of M-sand for fine aggregate.
- The RCPT test results reveals that M40 grade concrete shows lower permeability when compared to M20 for conventional concrete and concrete with partial replacement of M-sand. It is found that the chloride ion penetrability is high for concrete with natural sand and it is reduced while using manufactured sand. This may be due to the grain size of the manufactured sand is coarser and the better packing is developed. Due to the better packing the permeability of the concrete is reduced.
- The durability of M-sand concrete under acid is higher inferior to that of conventional concrete.
- Hence this research work concludes that, M-sand can be used as an alternative material for river sand and thereby the sustainability can be achieved.

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