



Effect of Full Replacement of Natural River Sand with Manufactured Sand (M Sand) and Partial Replacement of Granite Slurry with Cement in Concrete

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Abstract: This paper presents the effect of materials Manufactured sand (M sand) and granite slurry used in the production of concrete. In the current growing era, consumption of materials in concrete making has increased extensively, leading to increased environmental pollution. The natural river sand availability is limited so, the need of using alternatives is much in need. M sand as an alternative to natural river sand has been done by many researchers at various proportions to the full replacement and granite slurry at various percentages ranging from 0% to 30%. The mechanical properties such as compressive strength, flexural strength, and split tensile strength were conducted after curing periods of 7, 14, and 28 days. Materials like M sand and waste material granite slurry are eco-friendly, cheaper, and fulfilled the strength requirements.

Keywords – Manufactured sand, granite slurry, waste material, eco-friendly.

1. INTRODUCTION

Construction is the prime need in this era of development and thus concrete is very much utilized for different construction work at various stages of construction. Concrete conventionally consists of four components such as cement, coarse aggregates, fine aggregates(sand), and water. All the materials are natural materials except cement which is man-made. The fast growth of construction creates fast exhaustion of these natural materials and thus creates hazards for the environment in the form of pollution, disturbance to natural habitats, and imbalanced biodiversity. The fine aggregates used in concrete are generally 40 to 45% by volume, which further exploits the natural river sand available in limited quantity and could not meet the requirements and becomes costly. In many areas river, sand mining is banned. Cement use creates pollution by emission of CO₂, which is further an issue to the environmental aspect. So, the replacement of any waste product like granite slurry with cement can help to reduce pollution as well as cost. Concrete with environmentally friendly materials and alternatives to conventional materials is the need of the time.

2. MATERIALS REPLACED IN CONCRETE

Granite slurry and Manufactured sand

In Rajasthan, granite stone is available in rich quantities, around 20% of the total production of granite in India. Granite slurry is a waste produced during the quarrying of granite stone as well as during the cutting process of it. After the quarrying and cutting, this slurry is commonly dumped as waste, which creates land pollution as there is no process used to reduce this waste. But it is found by researchers that granite stone has pozzolanic properties just like cement and has cementitious properties. Using this material for concrete manufacturing is eco-friendly because there is no carbon dioxide gas emission while using granite slurry.

So, in this research work, the granite slurry was replaced partially with cement in different percentages of 0%, 5%, 10%, 15%, and 20% of different grades of concrete M20, M25, and M30 and natural river sand is also replaced fully to meet the alternate requirement and utilization of locally available material.

Properties of granite slurry and M sand:**Table.1. Properties of Granite Slurry**

S. No.	Properties	Values obtained
1.	Specific gravity	2.779
2.	Fineness modulus	2.49
3.	Colour	Grey

Table.2. Properties of M sand

S. No.	Properties of M sand	Values obtained
1.	Specific gravity (g/cc)	2.517
2.	Water absorption (%)	5.534
3.	Silt content (%)	7.50
4.	Grading zone	Zone-I
5.	Fineness Modulus	2.770

3. MIX PROPORTIONS

Different mix proportions of concrete grade were prepared and mentioned below.

Table.3. Mix proportions

Mix Designation	Replacement of granite slurry (G.S.) with cement	Concrete grade	Replacement of manufactured sand (M sand) with natural river sand
CM	0%	M20, M25, M30	0%
MS1	0%	M20	100%
MS2	5%	M20	100%
MS3	10%	M20	100%
MS4	15%	M20	100%
MS5	20%	M20	100%
MS6	0%	M25	100%
MS7	5%	M25	100%
MS8	10%	M25	100%
MS9	15%	M25	100%
MS10	20%	M25	100%
MS11	0%	M30	100%
MS12	5%	M30	100%
MS13	10%	M30	100%
MS14	15%	M30	100%
MS15	20%	M30	100%

4. RESULTS AND DISCUSSION

Slump test results

To find out the workability of different mixes slump tests were performed and the test results received are as mentioned in fig.1, fig.2, fig.3.

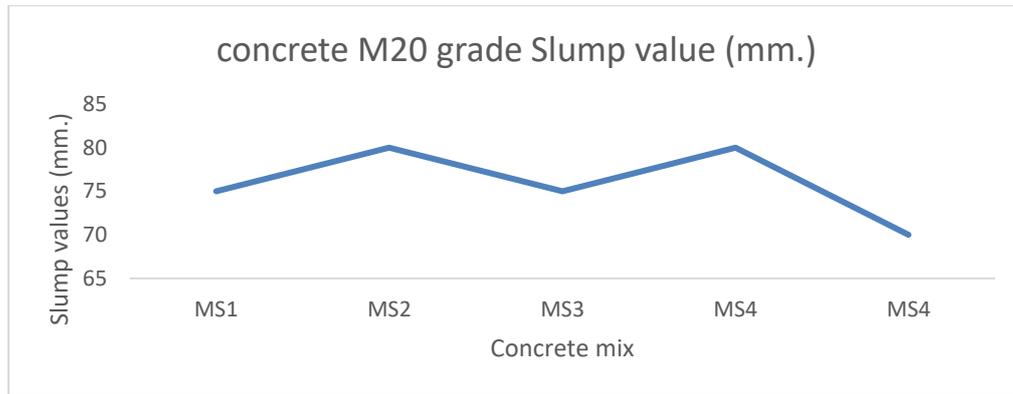


Fig.1. Slump value of concrete mixes of M20 grade

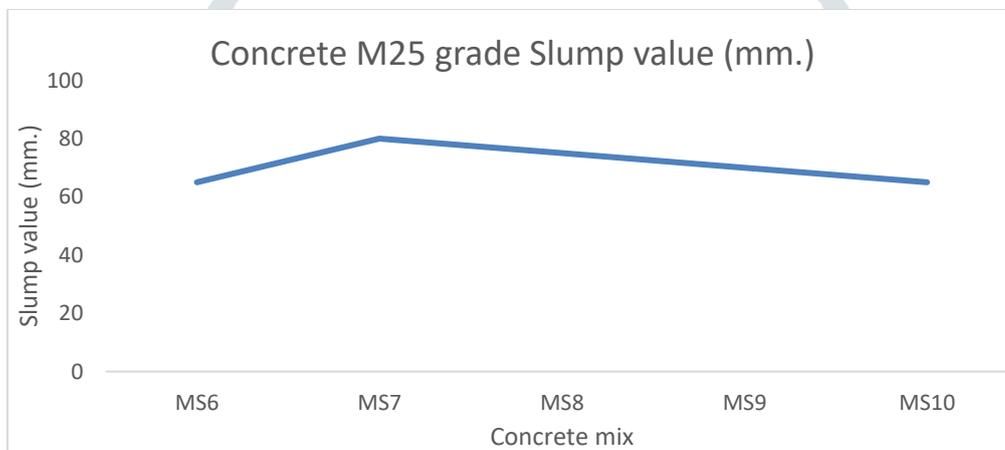


Fig.2. Slump value of concrete mixes of M25 grade

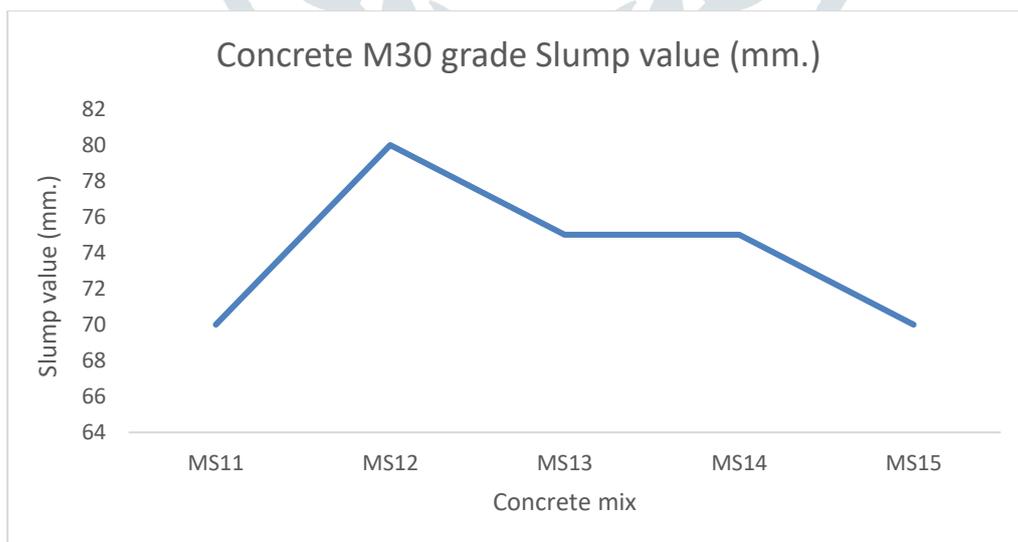


Fig.3. Slump value of concrete mixes of grade M30

Compressive strength test

To determine the behavior of different concrete mixes having varying percentages of granite slurry from 0% to 20% and fully replaced fine aggregate with manufactured sand. The results of compressive strength are as follows.

Table.4. Compressive strength test results for M20 grade after 7 and 28 days

Mix	Replacement of cement with granite slurry (%)	Compressive strength (N/mm ²), after 7 days	Compressive strength (N/mm ²), after 28 days	The difference in compressive strength with conventional concrete (%) after 28 days
CM	-	16	26.60	-
MS1	0	20.15	27.93	5
MS2	5	23.55	32.15	20.86
MS3	10	22.81	31.52	18.49
MS4	15	21.48	31.15	17.10
MS5	20	21.1	28.23	6.12

The test values for CM, MS1, MS2, MS3, MS4, and MS5 after 7 days are 16, 20.15, 23.55, 22.81, 21.48, and 21.1 N/mm² and after 28 days are 26.60, 27.93, 32.15, 31.52, 31.15, and 28.23 respectively. These results showed an increase in compressive strength in comparison to the control mix CM (after 28 days) for mixes MS1, MS2, MS3, MS4, and MS5 are 5%, 20.86%, 18.49%, 17.10%, and 6.12% respectively.

Table.5. Compressive strength test results for M25 grade after 7 and 28 days

S. No.	Mix	Compressive strength (N/mm ²), after 7 days	Compressive strength (N/mm ²), after 28 days	The difference in compressive strength with conventional concrete (%) after 28 days
1.	CM	21	31.60	-
2.	MS6	20.15	34.00	7.59
3.	MS7	24.75	37.93	20.03
4.	MS8	23.51	36.45	15.34
5.	MS9	22.73	34.08	7.84
6.	MS10	21.05	29.89	-5.41

The test results showed the values for CM, MS6, MS7, MS8, MS9, and MS10 after 7 days are 21, 20.15, 24.75, 23.51, 22.73, and 21.05 N/mm² and after 28 days values are 31.60, 34, 37.93, 36.45, 34.08, and 29.89 N/mm² respectively. From test results, it is clear that the increase in compressive strength (after 28 days) by percentage concerning to CM was 7.59%, 20.03%, 15.34%, and 7.84% for mixes MS6, MS7, MS8, and MS9 respectively.

Table.6. Compressive strength of cubes of M30 grade (after 7 and 28 days)

S.No.	Mix	Compressive strength (N/mm ²), after 7 days	Compressive strength (N/mm ²), after 28 days	The difference in compressive strength with conventional concrete (%) after 28 days
1.	CM	24	36.60	-
2.	MS11	30.52	36.72	3.27
3.	MS12	32.30	39.94	9.12
4.	MS13	29.56	36.04	-0.56
5.	MS14	28.07	34.34	-6.17
6.	MS15	25.90	32.26	-11.85

Table.6 listed the results of different concrete mixes of M30 grade. The mixes CM, MS11, MS12, MS13, MS14, and MS15 compressive strength after 7 days are 24, 30.52, 32.30, 29.56, 28.07, and 25.90 respectively, and after 28 days are 36.60, 36.72, 39.94, 36.04, 34.34, and 32.26 respectively. Mixes MS11 and MS12 showed an increase in CM values of 3.27% and 9.12% respectively but mixes MS13, MS14, and MS15 values are decreasing in comparison to CM by 0.56%, 6.17%, and 11.85% respectively.

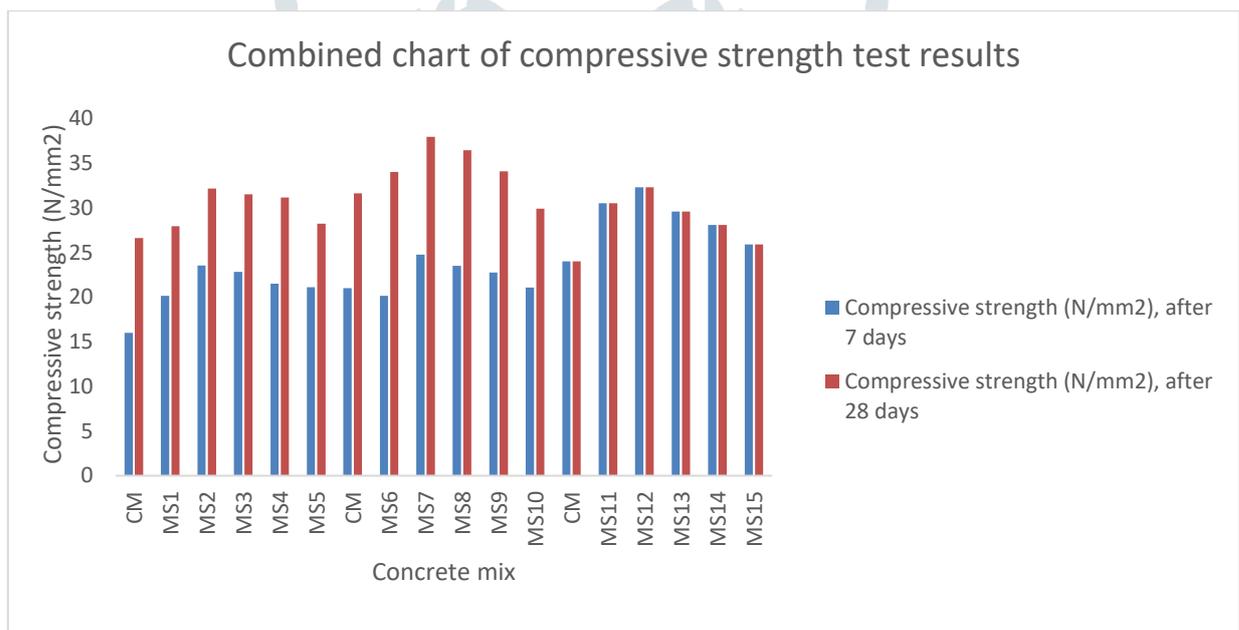
**Fig.4. Comparison of compressive strength between different grade concrete mixes**

Fig. 4 shows the behavior of different mixes of M20, M25, and M30 grades of concrete. It was observed after investigations that compressive strength increases from 0 to 5 % granite slurry replacement and after those values decreased.

Flexural strength test

To find out the flexural strength of concrete grades with different concrete mixes, flexural tests were performed after 28 days of making beam specimens. The results are shown in table 7 below.

Table.7. Flexural strength test results of M20 grade

S. No.	Mix	Flexural strength after 28 days(N/mm ²)
1.	CM	3.10
2.	MS1	3.15
3.	MS2	3.50
4.	MS3	3.33
5.	MS4	3.26
6.	MS5	3.20

Flexural strength of different concrete mixes of grade M20 (after 28 days) was obtained after testing and values are such that for mix MS1, MS2, MS3, MS4, and MS5 are 3.15, 3.50, 3.33, 3.26, and 3.20 N/mm² respectively.

Table.8. Flexural strength of cubes of M25 grade

S.No.	Mix	Flexural strength after 28 days(N/mm ²)
1.	CM	3.6
2.	MS6	3.85
3.	MS7	3.95
4.	MS8	3.82
5.	MS9	3.75
6.	MS10	3.45

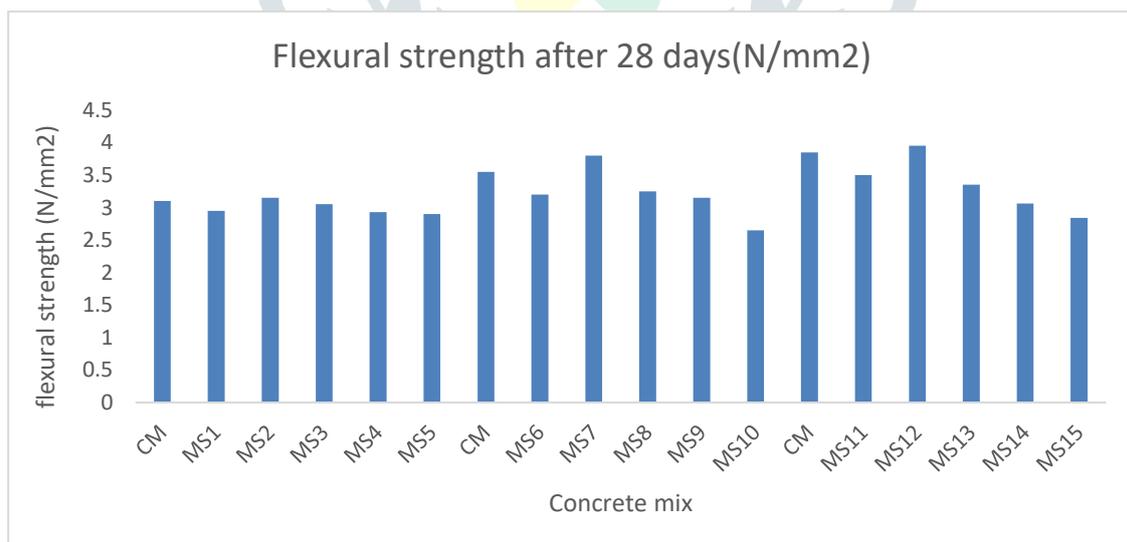
The flexural strength of the control mix was 3.60 after 28 days of curing period for M25 grade and the flexural strength of mixes MS6, MS7, MS8, MS9, and MS10 were 3.85, 3.95, 3.82, 3.75, and 3.45 respectively.

Table.9. Flexural strength of cubes of M30 grade

S.No.	Mix	Flexural strength after 28 days(N/mm ²)
1.	CM	4.10
2.	MS11	4.15
3.	MS12	4.25
4.	MS13	4.05
5.	MS14	3.75
6.	MS15	3.65

The flexural strength value for the control mix (CM) after 28 days was 4.10. The mixes MS11, MS12, MS13, MS14, and MS15 values were 4.15, 4.25, 4.05, 3.75, and 3.65 respectively.

A comparison of flexural strength of all concrete mixes of different grades is shown in Fig.5.

**Fig 4.17. Comparison of flexural strength**

The figure shows that flexural strength is increased for 5% granite slurry replacement mixes of all concrete grades and after that as the granite proportion increased the flexural strength values decreased from 10 to 20% for all grades of concrete.

5. CONCLUSION

The final conclusions which are drawn from the investigation of this research work are as follow

1. M20 grade concrete mixes for different proportions of granite slurry (0% to 20%) were tested for the workability of fresh concrete and mechanical properties of hardened concrete. All mixes of this grade have slump values between 60mm to 90mm indicating sufficient workability for the modified concrete of M20 grade.
2. For the concrete of M20 grade having different mixes, values of compressive and flexural strength for 7 and 28 days showed a considerable increase in the control mix.
3. The early strength achieved by the concrete mix is significantly higher than the strength of the control mix (CM) due to the increased hydration process because of granite slurry.
4. Test results of different mixes of M25 grade concrete showed an increase in compressive strength after 7 days for all mixes having granite slurry 0%, 5%, 10%, 15%, and 20% and test results after 28 days showed also increase for mixes MS6, MS7, MS8, and MS9. The mix MS10 showed a decrease in compressive strength in comparison to CM.
5. The observed values of flexural strength of M25 grade showed an increase for mixes of the above-mentioned concrete having granite slurry from 0% to 15% replacement with cement but mix MS10 having granite slurry and 20% replacement with cement showed a decreased result.
6. All different mixes of concrete M30 grade showed improvement in compressive strength after 7 days than CM but after 28 days, the compressive strength increased for mixes having 0% and 5% G.S. replacement and it got decreased for mixes having 10%, 15%, and 20% G.S. replacement comparing to CM. The flexural strength of mixes MS11 and MS12 increased (after 28 days) but flexural strength for mixes MS12, MS13, MS14, and MS15 showed decreased values.
7. Across all the mixes of M20, M25, and M30 concrete grades with different granite slurry percentages (0% to 20%), it was observed that values of concrete mixes MS2, MS7, and MS12 of all three grades M20, M25, and M30 respectively having the partial replacement of granite slurry (5%) with cement showed maximum increased values of mechanical properties like compressive and flexural strength than CM of respective concrete grades.

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