

Examining the Properties of Concrete by Partial Replacement of Natural Sand with Crushed Sand

Anup K. Chitkeshwar¹, Chaitali A. Chitkeshwar², Mohammad Abdul Rehman³, Rashmi G. Lonkar⁴

Assistant Professor, Department of Civil Engineering, P.R. Pote CoE & M, Amravati, Maharashtra, India¹

Assistant Professor, Department of Civil Engineering, DRGIT&R, Amravati, Maharashtra, India²

Assistant Professor, Department of Civil Engineering, P.R. Pote CoE & M, Amravati, Maharashtra, India³

U.G. Student, Department of Civil Engineering, P.R. Pote CoE & M, Amravati, Maharashtra, India⁴

ABSTRACT: Depletion of river sand which is excavated from the river bed leads to environmental problem. Due to this government has restricted the excavation of river sand and it has become a scarce commodity. Hence it is needed to replace the river sand. Therefore the present work has initiated to make the concrete useful by replacing the natural sand by crushed sand in the concrete. Concrete is the most used construction material having basic ingredients as binding material, fine aggregate, coarse aggregate and water in predetermined proportion all the ingredients are homogeneously mixed to obtain resulting mixed of desired strength. For the mix design of M25 grade IS 10262:2009 is used. Various test has been performed to examine the parameters such as compressive strength, workability of concrete with crushed sand as replacement to natural sand. The Replacement of the sand with stone dust shows an improved in the compressive strength of the concrete. As the replacement of the sand with stone affected workability of the concrete is decreasing due to the absorption of the water by the stone dust. In this study, conventional mix (M25) with water to binder ratio is maintained as 0.4, 0.45, 0.5 is used. Here the River Sand is partially replaced with Manufacturing Sand with different percentages like 0%, 25%, 30%. Also fly ash is used in this study as a replacement for cement in 20%.

KEYWORDS: Manufacturing Sand

I. INTRODUCTION

In India, the natural sand which excavated from river bed is used to produced conventional concrete. Conventionally concrete is mixture of cement, sand and aggregate. Properties of aggregate affect the durability and performance of concrete, so fine aggregate is an essential component of concrete. Depletion of natural sand cause the environmental problem and hence sand excavating is restricted by government which resulted in shortage and drastically increase in its cost. The use of manufactured sand as an effort towards viable development in India. It will help to find viable solution to the diminishing availability of natural sand to make eco-balance. The M sand is obtained by crushing the rocks. Environmental concern are also been rising against uncontrolled extraction of natural sand. The argument is mostly in regards of protecting the natural river bed against erosion and importance of having natural sand as a filter for ground water. The global consumption of natural sand is very high, due to the extensive use of concrete. Particularly in India, Natural sand deposits are being depleted and causing serious threat to environment as well as the society. In general, the demand of natural sand is quite high in developing countries to satisfy the rapid infrastructure growth, in this situation developing country like India facing shortage in good quality natural sand. In today's competitive world the demand of natural sand is not going to decreasing, the only best possible way to reduce its extraction is find another alternative for it.

II. OBJECTIVES

- To study the influence of manufacturing sand on the compressive strength of Concrete.
- To study the influence of manufacturing sand on the workability of concrete.
- To make our structure in an economical cost without compromising the strength.
- To investigate the optimum replacement of river sand with stone dust for concrete in term of compressive strength performance.



III. LITERATURE REVIEW

Sakthivel et al. [1]:- Studied replacement of sand used in concrete as fine aggregates made by the crush sand. This study made an attempt to partially replace artificial sand in place of sand in M20 grade concrete. It was found that the partial replacement of sand with 10% of artificial sand has given the optimum results and concluded that if partial replacement of sand with artificial sand up to 10% in M20 grade of concrete is done. According to Sakthivel. al. study the replacement of natural sand with crush sand is economical and use of crush sand is possible without affecting the strength of structure.

Sahu Kumar and Sachan [2]:- Investigated the suitability of crushed stone dust waste as fine aggregate for concrete. Test results indicated that crushed stone dust waste can be used effectively to replace natural sand in concrete. Concrete made with this replacement can attain the same compressive strength, comparable tensile strength, modulus of rupture and lower degree of shrinkage as the control concrete.

IV. SYSTEM DEVELOPMENT

Conventionally concrete is mixture of cement, sand and aggregate. Properties of aggregate affect the durability and performance of concrete, so fine aggregate is an essential component of concrete. The most commonly used fine aggregate is natural river. Now-a-days good sand is not available it is transported from one place to another so it is need of the time to find substitute to natural river sand. Because of limited supply the cost of natural river sand has sky rocketed and its consistence supply cannot be guaranteed. For the purpose of experimentation concrete mix are designed for M25 grade by replacing natural sand with artificial sand at different replacement levels of 0%, 25%, 30%. After the Mix design following Tables are prepared for Making the Concrete.

WATER CONTENT	CEMENT	FINE AGGREGATE	COARSE AGGREGATE
0.4	1	1.29	2.126
0.45	1	1.505	2.463
0.5	1	1.71	2.8

Table 4.1 For 30% Crushed Sand (Fly ash =0)

WATER CONTENT	CEMENT	FINE AGGREGATE	COARSE AGGREGATE
0.4	1	1.299	2.126
0.45	1	1.505	2.46
0.5	1	1.71	2.8

Table 4.2 For 25% Crushed Sand, 5% Dust (Fly ash=0)

WATER CONTENT	CEMENT	FINE AGGREGATE	COARSE AGGREGATE
0.4	1	1.59	2.61
0.45	1	1.853	3.033
0.5	1	2.11	3.454

Table 4.3 For 30% Crushed Sand And Fly ash 20% With Admixture

WATER CONTENT	CEMENT	FINE AGGREGATE	COARSE AGGREGATE
0.4	1	1.59	2.61
0.45	1	1.853	3.033
0.5	1	2.11	3.454

Table 4.4 For 25% Crushed Sand 5% Dust And Fly ash 20% With Admixture

V. RESULTS AND DISCUSSIONS

The cubes of size 150 X 150 X 150 mm are to be casted as per mix design for the compression tests. After conducting tests and determining compressive strength of concrete. Following result are obtained as shown below.

Mix	Mix proportion	Water content ratio	Avg. Compressive strength of concrete (28 days) (N/mm ²)
100% river sand	1:1.234:2.194	0.4	31.70
	1:1.43:2.542	0.45	31.55
	1:1.625:2.89	0.5	31.03
30% crushed sand	1:1.299:2.126	0.4	33.25
	1:1.505:2.46	0.45	32.15
	1:1.71:2.8	0.5	31.95
25% crushed sand	1:1.299:2.126	0.4	32.65
	1:1.505:2.46	0.45	32.15
	1:1.71:2.8	0.5	31.95
30% CS 20% fly ash (admixture)	1:1.59:2.61	0.4	35.60
	1:1.853:3.033	0.45	35.25
	1:2.11:3.45	0.5	34.00
25% CS 20% fly ash (admixture)	1:1.59:2.61	0.4	34.90
	1:1.853:3.033	0.45	34.55
	1:2.11:3.45	0.5	33.98

Table No. 5.1 Results of compressive test made for various mixes

5.1 Compressive Strength for Various Mix for W/C Ratio as 0.40

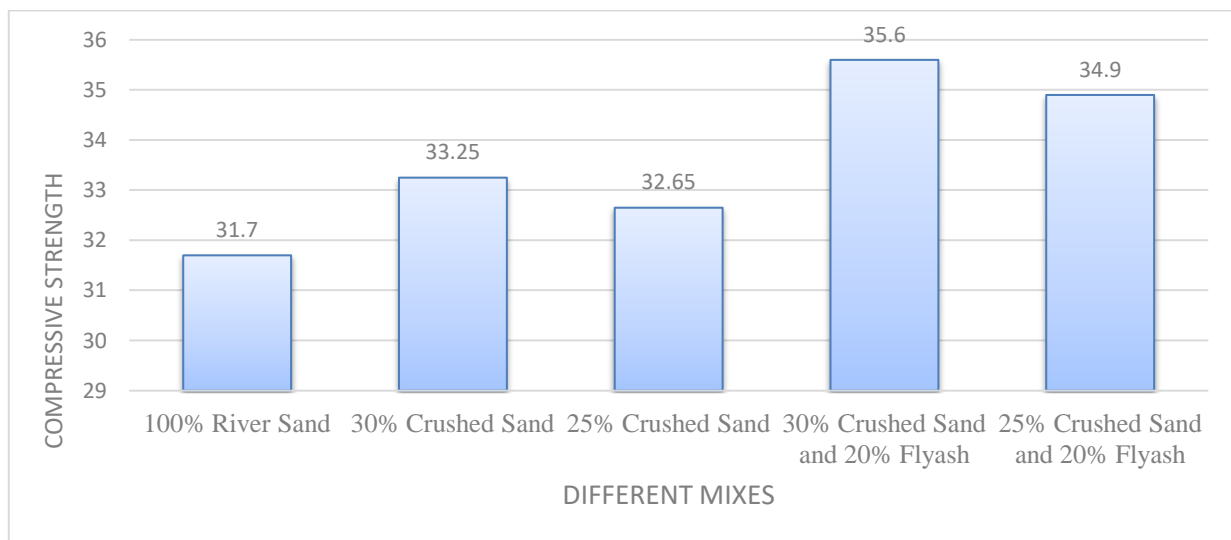


Fig No. 5.1 Compressive Strength for Various Mix for W/C Ratio as 0.40

From Above Chart, It can be seen that for concrete made using 30% Crushed Sand and 20% Fly ash with W/C Ratio as 0.40, has shown highest compressive strength of 35.60 N/mm² followed by concrete made using 25% Crushed Sand and 20% Fly ash showing compressive strength as 34.90 N/mm²

5.2 Compressive Strength for Various Mix for W/C Ratio as 0.45

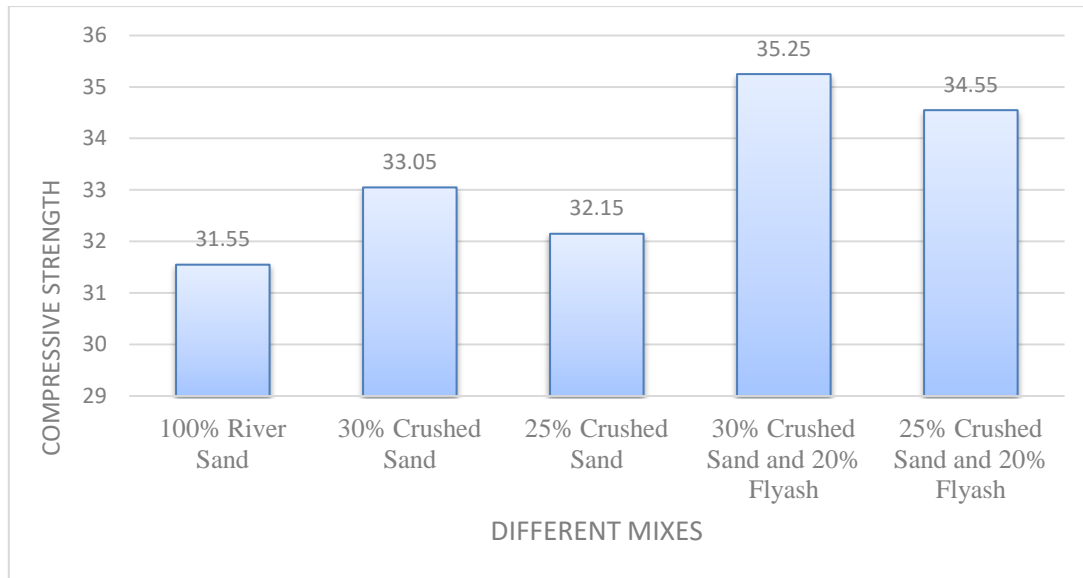


Fig No. 5.2 Compressive Strength for Various Mix for W/C Ratio as 0.45

From Above Chart, It can be seen that for concrete made using 30% Crushed Sand and 20% Flyash with W/C Ratio as 0.45, has shown highest compressive strength of 35.25 N/mm² followed by concrete made using 25% Crushed Sand and 20% Flyash showing compressive strength as 34.55 N/mm²

5.3 Compressive Strength for Various Mix for Same W/C Ratio as 0.50

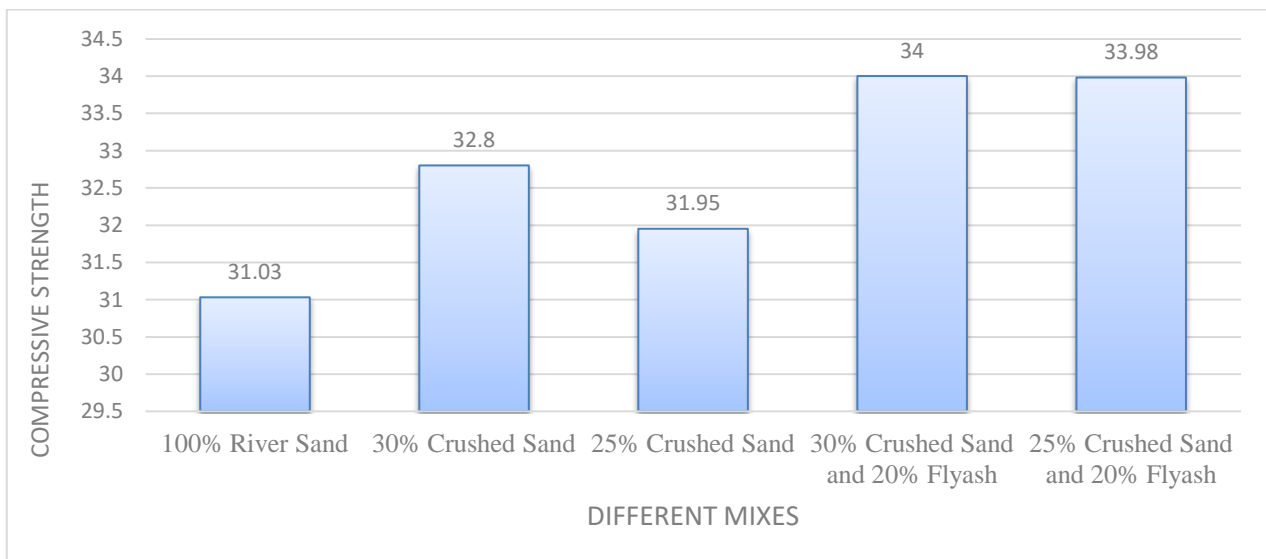


Fig No. 5.3 Compressive Strength for Various Mix for Same W/C Ratio as 0.50

From Above Chart, It can be seen that for concrete made using 30% Crushed Sand and 20% Flyash with W/C Ratio as 0.50, has shown highest compressive strength of 34.00 N/mm² followed by concrete made using 25% Crushed Sand and 20% Flyash showing compressive strength as 33.98 N/mm².

5.4 Compressive Strength for Various Mix for different W/C Ratio

Compressive strength for every mix with different materials and different water – cement ratio is graphical represented as below.

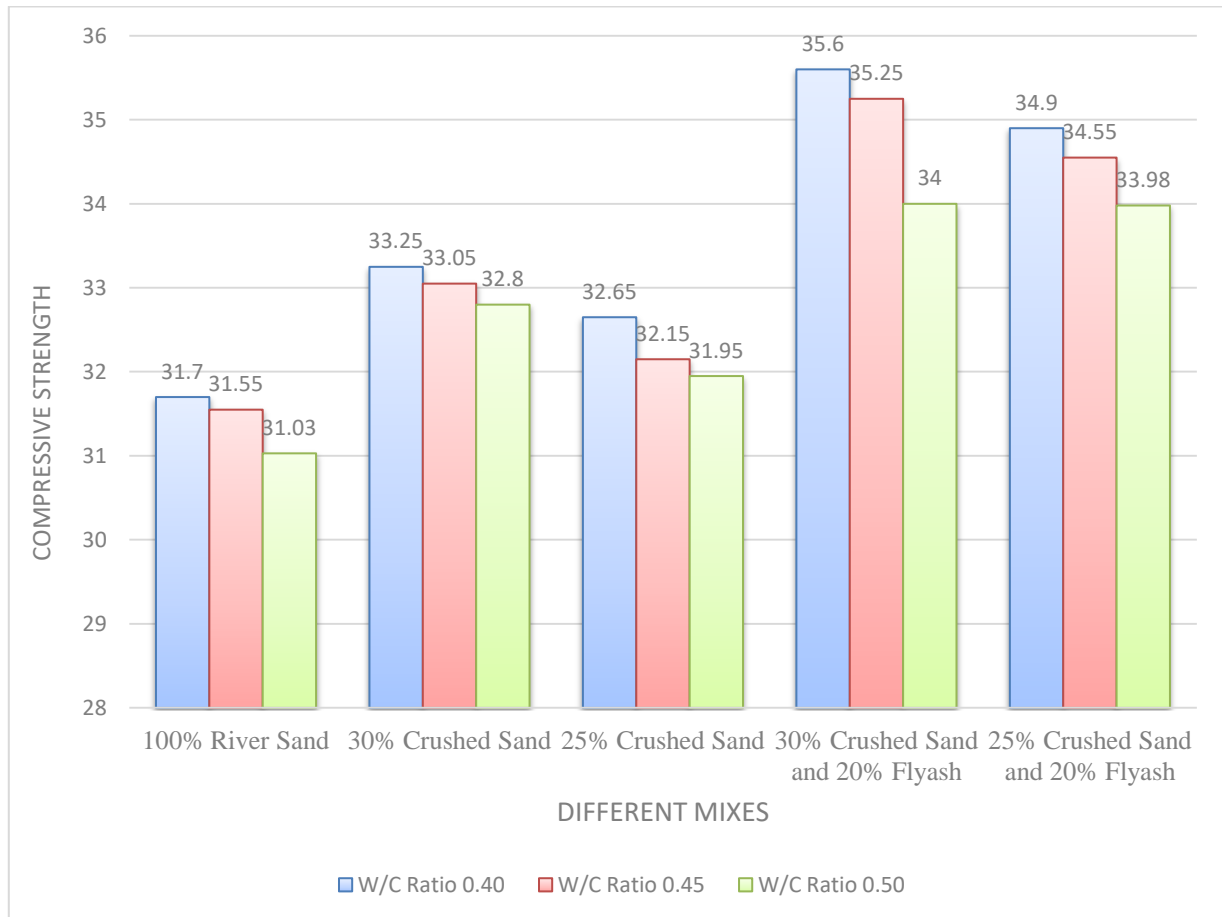


Fig No. 5.4 Compressive Strength for Various Mix for Different W/C Ratio

5.5 Comparison between Workability and Compressive Strength of Concrete

After carrying out Slump cone test for determining workability of concrete following results are obtained and are compared with obtained compressive strength for various mixes respectively

Mix	Mix proportion	Water content ratio	Slump Value (mm)	Compressive strength of concrete (28 days) (N/mm ²)
100% river sand	1:1.234:2.194	0.4	95	31.70
	1:1.43:2.542	0.45	100	31.55
	1:1.625:2.89	0.5	125	31.03
30% crushed sand	1:1.299:2.126	0.4	60	33.25
	1:1.505:2.46	0.45	65	32.15
	1:1.71:2.8	0.5	75	31.95

25% crushed sand	1:1.299:2.126	0.4	65	32.65
	1:1.505:2.46	0.45	68	32.15
	1:1.71:2.8	0.5	75	31.95
30% CS 20% fly ash (admixture)	1:1.59:2.61	0.4	45	35.60
	1:1.853:3.033	0.45	50	35.25
	1:2.11:3.45	0.5	58	34.00
25% CS 20% fly ash (admixture)	1:1.59:2.61	0.4	55	34.90
	1:1.853:3.033	0.45	58	34.55
	1:2.11:3.45	0.5	62	33.98

Table 5.5 Comparison between Workability and Compressive Strength of Concrete

VI.CONCLUSION

From the acquired result after caring out test for determining Compressive strengths of concrete. Followings conclusions are made

1. It can be concluded that under laboratory conditions with accurate measurements of quantity strictly following mix designs, replacement of sand by 30% Crushed sand along with 20% Flyash has shown increase in strength as compared to the concrete made using 100% River Sand but the workability has decreased by 50%, 50%, 46.4% for w/c 0.4, 0.45, 0.5 respectively.
2. For W/C Ratio of 0.40, Around 12% increase in strength is shown by using 30% crushed sand along with 20% Flyash. While for W/C Ratio of 0.45 and 0.50, around 11.50% and 9.50% increase in strength is shown respectively.
3. Also for the Mix of 25% Crushed sand and 20% Flyash as a replacement for sand, when compared with the mix of 100% river sand an increase in compressive strength of around 10.00%, 9.50% and 9.00% is shown for W/C Ratio of 0.40, 0.45 and 0.50 respectively where the workability has decreased as 57.89%, 58% ,49.6% for w/c ratio 0.40 , 0.45 and 0.5 respectively.
4. Also, for the Mix of 30% Crushed sand as a replacement for sand, when compared with the mix of 100% river sand an increase in compressive strength of around 4.50%, 4.70% and 5.70% and decrease in workability as 63.16%, 65%, 60% is shown for W/C Ratio of 0.40, 0.45 and 0.50 respectively.
5. And At Last, for the Mix of 25% Crushed sand as a replacement for sand, when compared with the mix of 100% river sand an increase in compressive strength of around 3.00%, 3.40% and 3.00% and decrease in workability as 68.42%, 68%, 60% is shown for W/C Ratio of 0.40, 0.45 and 0.50 respectively.
6. It can be concluded that after replacing natural sand with crushed sand compressive strength of concrete is comparatively increased. Also, Use of fly ash with crushed sand in concrete will show much better results, but the workability of concrete decreases, so need to use admixture to maintain workability.

REFERENCES

- (1) **B Balapgol, S A Kulkarni, K M Bajoria**, "Strength and durability of concrete with crushed sand", 27th Conference on OUR WORLD IN CONCRETE & STRUCTURES: 29 - 30 August 2002, Singapore, pp179-184.
- (2) **Sahu A. K., Kumar S. and Sachan A. K.** 'Crushed Stone waste as Fine Aggregates for concrete', Indian concrete Journal.
- (3) **Ahmed, A. E. and El. Kourid A. A. (1989)**, 'Properties of concrete incorporating natural sand and crushed stone very fine sand', American Concrete Journal, 86 (4), 417-424.
- (4) **Ilangovana, R. Mahendrana, N. and Nagamanib, K. (2008)**, 'Strength and durability properties of concrete containing crush sand as fine aggregates', ARPN Journal of Engineering and Applied Science, Vol.3 (5),pp 2026.
- (5) **M. L. Gambhir, (2006)**, Concrete technology, Tata McGraw Hill Publishing Co. Ltd, India.
- (6) **Shaikh, M. G., Daimi, S. A. (2011)**, Durability studies of concrete made by using artificial sand with dust and natural sand, International Journal of Earth Sciences and Engineering (ISSN 0974-5904), Vol. 04, No. 06 SPL, pp 823-825.



- (7) **Nimitha Vijayaraghavan and A. S. Wayal** "Effect of manufactured sand on compressive strength and workability of concrete"International Journal of Structural and Civil Engineering Research, Vol 02, No 04, Nov 2013., pp229-232.
- (8) **Ilangovan, R.; Nagamani, K., and Kumarasamy, K.,** "Studies on strength and behaviour of concrete by using crushed rock dust as fine aggregate," Civil Engineering and Construction Review, October 2006, pp. 924-932.
- (9) **Ahmed, A. E. and El. Kourid A. A. (1989),** 'Properties of concrete incorporating natural sand and crushed stone very fine sand', American Concrete Journal, 86 (4), 417-424.
- (10) **Dan Ravina** 'Fly Ash to Improve the Workability of Structure Concrete made with Crushed sand as Fine Aggregate', National Building Research Institute, Technion – Israel Institute of Technology.
- (11) **Indian Standard code of practice for Methods of Test for Strength of Concrete. I. S. 516-1959, Bureau of Indian Standards, New Delhi.**