



Effect of Replacement of Natural Sand by Artificial Sand on Strength of Concrete

Prof.S.R.Band¹, Prof.S.D.malkhede²

¹Assistant Professor, P.R.M.I.T and R, Badnera-Amravati, 444701

²Assistant Professor, P.R.M.I.T and R, Badnera-Amravati, 444701

ABSTRACT:- Concrete is the most widely used composite material today. The constituents of concrete are coarse aggregate, fine aggregate, binding material and water. Rapid increase in construction activities leads to acute shortage of conventional construction materials. So it's time to find any alternative to the conventional construction materials. Artificial sand can be used as a replacement to natural conventional sand. Quarry dust can be used as an artificial sand to minimize the environmental impact and to solve the problem of scarcity of natural sand. Natural sand can be replaced by definite interval to obtain the desired result. Also the compressive strength of concrete is also enhanced by using artificial sand.

Keywords: Composite material, artificial sand, compressive strength.

I. INTRODUCTION

Concrete is the most widely used composite material today. The constituents of concrete are coarse aggregate, fine aggregate, binding material and water. Rapid increase in construction activities leads to acute shortage of conventional construction materials. It is conventional that sand is being used as fine aggregate in concrete.

The function of the fine aggregate is to assist in producing workability and uniformity in the mixture. The river deposits are the most common source of fine aggregate. Now-a-days the natural river sand has become scarce and very costly. Hence we are forced to think of alternative material. The quarry dust or artificial sand may be used in the place of river sand fully or partly. A comparatively good strength is expected when sand is replaced fully or partially with or without admixtures.

II. PROBLEMS FACED BY CIVIL ENGINEERING COMMUNITY REGARDING NATURAL SAND

The huge quantity of concrete is consumed by construction industry all over the world. In India, the conventional concrete is produced by using natural sand, cement, coarse aggregate and water. One major challenge facing the civil engineering community is to involve the use of high performance, environmental friendly materials produced at reasonable cost. In the context of concrete, which is the predominant building material, it is necessary to identify less expensive substitutes.

Now-a-days sand is not readily suitable, it should be transported from long distance. Those resources are also exhausting very rapidly. With natural sand deposits the world over drying up, there is an acute need for a product that matches the properties of natural sand in concrete.

In the last few years, it has become clear that the availability of good quality natural sand is decreasing. With few local exceptions, it seems to be a global trend also dwindling sand sources poses the environmental problem and hence government restrictions on sand quarrying resulted in scarcity and significant increase in its cost. So it is need of the time to find some substitute to natural river sand.

III. SUITABILITY OF ARTIFICIAL SAND i.e. QUARRY DUST IN CEMENT CONCRETE

Sand is a major material used for preparation of mortar and concrete and plays a most important role in mix design. In general consumption of natural sand is high, due to the large use of concrete and mortar. Hence the demand of natural sand is very high in developing countries to satisfy the rapid infrastructure growth. The developing country facing shortage of good quality natural sand and particularly in India, natural sand deposits are being used up and causing serious threat to environment as well as the society.

Rapid extraction of sand from river bed causing so many problems like losing water retaining soil strata, deepening of the river beds and causing bank slides, loss of vegetation on the bank of rivers. Due to shortage of river sand in India so therefore the need to find an alternative concrete and mortar aggregate material to river sand in construction works has assumed greater importance now a days. Researcher and Engineers have come out with their own ideas to decrease or fully replace the use of river sand and use recent innovations such as artificial sand.

IV. QUARRY DUST

About 20 to 25 per cent of the total production in each crusher unit is left out as the waste material-quarry dust. The ideal percentage of the replacement of sand with the quarry dust is 55 per cent to 75 per cent in case of compressive strength. The use of artificial sand in concrete is desirable because of benefits such as useful disposal of a byproduct, increased workability, reduction of cement consumption, increased sulfate resistance, increased resistance to alkali-silica reaction and decreased permeability.

In concrete production it could be used as a partial or full replacement of natural sand. Besides, the utilization of quarry waste, which itself is a waste material, will reduce the cost of concrete production. The global consumption of natural sand is too high due to its extensive use in concrete. The demand for natural sand is quite high owing to rapid infrastructural growth which results supply scarcity. Therefore, construction industries are in stress to identify alternative materials to replace the demand for natural sand. On the other hand, the advantages of utilization of by-products or aggregates obtained as waste materials are pronounced in the aspects of reduction in environmental load & waste management cost, reduction of production cost as well as augmenting the quality of concrete. The fine aggregate has been replaced by quarry dust a by-product of stone crushing unit and few admixtures to find a comparative analysis for different parameters which are tested in the laboratories to find the suitability of the replacement adhered to the Indian Standard specifications for its strength.

The quarry dust is the by-product which is formed in the processing of the granite stones which broken downs into the coarse aggregates of different sizes. The dust is selected from the nearest source as raw materials without any processing of the dust from the quarry. It is a crushed form of aggregate available in quarries. It is easily available and in large quantity.

V. PHYSICAL AND CHEMICAL PROPERTIES

The physical and chemical properties of quarry dust obtained by testing the sample as per the Indian Standards are listed in table 1 and table 2

Table 1- Physical properties of quarry dust and natural sand

Property	Quarry Dust	Natural Sand	Test Method
Specific Gravity	2.54-2.60	2.60	IS2386(Part-III)1963
Bulk density(Kg/M ³)	1720-1810	1460	IS2386(Part-III)1963
Absorption (%)	1.20 – 1.50	Nil	IS2386(Part-III)1963
Moisture Content (%)	Nil	1.5	IS2386(Part-III)1963
Fine particles less than 0.075 mm (%)	12-15	6	IS-2386(Part-III)1963
Sieve analysis	Zone-II	Zone-II	IS-383-1970

Table 2- Chemical properties of quarry dust and natural sand

Constituents	Quarry Dust (%)	Natural Sand (%)	Test Method
SiO ₂	62.48	80.78	IS 4032- 1968
Al ₂ O ₃	18.72	10.52	
Fe ₂ O ₃	6.54	1.75	
CaO	4.83	3.21	
MgO	2.56	0.77	
Na ₂ O	Nil	1.37	
K ₂ O	3.18	1.23	
TiO ₂	1.21	Nil	
Loss of ignition	0.48	0.37	

The comparison between natural sand and artificial sand with respect to some basic parameter is given in table 3.

Table 3 - Comparison between natural sand and artificial sand

Sr.No	Natural Sand	Artificial Sand
1	The material which is obtained from natural river bed.	The material obtained from stone crusher after sieving the crushed stones.
2	The excessive use of natural sand will affect the natural sand which affects the river basin and its path.	The use of artificial sand protects the environment system.
3	It contains mainly impurities like silt, clay etc.	It is free from impurities
4	It is available in limited extent.	It is available in considerable extent.
5	It may contain chemical impurities.	It is chemically inert in nature.
6	It is of smooth texture.	It has rough texture, hence gives more compressive strength.
7	Its cost is very high.	It is economical as compared natural sand.
8	It can absorb water to some extent.	Water absorption is less than Natural Sand.

VI. EXPERIMENTAL WORK

In this paper summarized concept of mix design, different types mix design , factor affecting selection of mix design and nominal mix design. The tables are shown in which compressive strength of M15 , M20 and M25 at 7 N/mm² and 28 N/mm².The replacement is clearly showed 0%,20%,40%,60%,80%, 100% and graph is drawn showing the results.Nominal Mix design is done for M₁₅, M₂₀, M₂₅ and weights of materials are calculated. The natural sand is replaced by artificial sand in systematic interval and strength is calculated which is given in table

Table 4 - Relation of compressive strength and percentage of replacement for M₁₅ grade at 7 days and 28 days in N/mm²

% Replacement	Nature Sand Kg	Artificial Sand Kg	7 Days strength in (N/mm) ²	28 Days strength in (N/mm ²)
0%	2.815	0	20.44	22.22
20%	2.252	0.563	24	24.88
40%	1.689	1.126	28.88	30.22
60%	1.126	1.689	33.77	35.11
80%	0.563	2.252	28.44	28
100%	0	2.815	22.22	25.77

Table 5 - Relation of compressive strength and percentage of replacement for M₂₀ grade at 7 days and 28 days in N/mm²

% Replacement	Nature Sand Kg	Artificial Sand Kg	7 Days strength in (N/mm) ²	28 Days strength in (N/mm ²)
0%	2.686	0	26.667	28
20%	2.1488	0.5372	28	32
40%	1.6116	1.0744	34.22	35.55
60%	1.0744	1.6116	36.44	37.77
80%	0.5372	2.1488	33.33	34.22
100%	0	2.686	31.11	28.88

Table 6 - Co-relation of compressive strength and percentage of replacement for M₂₅ grade at 7 days and 28 days in N/mm²

% Replacement	Nature Sand Kg	Artificial Sand Kg	7 Days strength in (N/mm) ²	28 Days strength in (N/mm ²)
0%	2.462	0	36.44	37.778
20%	1.9696	0.4924	37.33	39.55
40%	1.4772	0.9848	38.22	40.88
60%	0.9848	1.477	40	43.11
80%	0.4924	1.9696	38.667	38.22
100%	0	2.162	37.778	36.88

VII. RESULTS AND DISCUSSION

After performing tests on various grade of concrete by replacing natural sand by artificial sand, the results are obtained and the variation in strength of grade M₁₅, M₂₀ and M₂₅ at replacement of 0%,20%,40%,60%,80% and 100% are plotted.

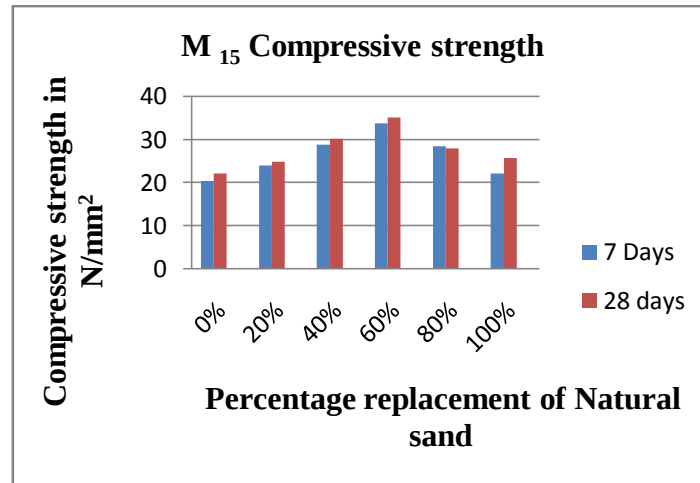


Figure1- Co-relation Between Percentage Peplacement of Natural Sand by Artificial Sand and Compressive Strength of Concrete at 7 and 28 Days for M₁₅.

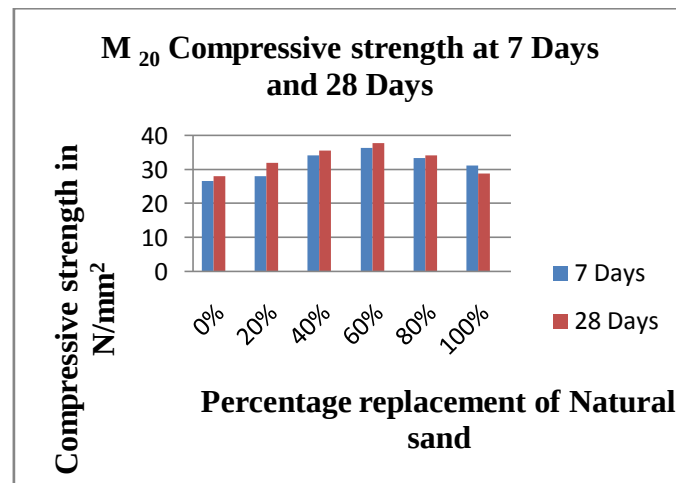


Figure2- Relation between percentage replacement of natural sand by artificial sand and compressive strength of concrete at 7 and 28 days for M₂₀.

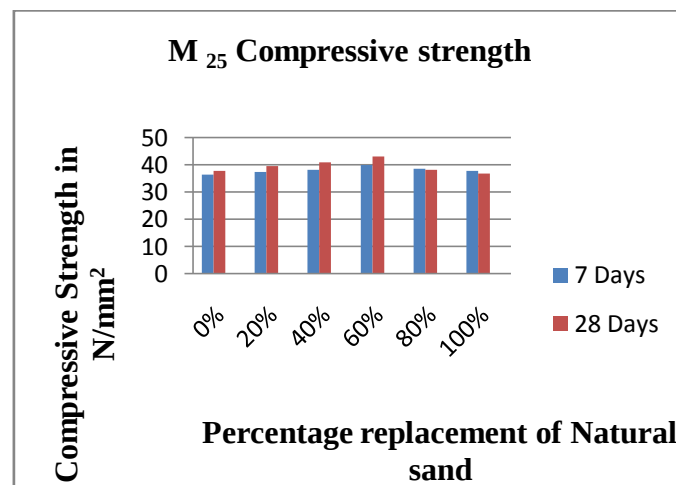


Figure3- Co-relation Between Percentage Replacement of Natural Sand by Artificial Sand And Compressive Strength of Concrete at 7 and 28 Days for M₂₅.

The figures 1,2 and 3 shows comparison between 7 and 28 days compressive strength for M10,M15 and M25 of standard size of cube. It clearly shows that 100% replacement of natural sand by artificial sand gives more strength than 0% replacement.It shoes maximum strength in between 40% – 60 %in every case. Hence it is observed that it is more economical and eco-friendly to use artificial sand.

VIII. CONCLUSION

- This experiment shows that the concreting can be done economically eco-friendly.
- The results prove that the compressive strength of 100% replacement natural sand is higher than 0% replacement.
- The compressive strength is maximum at 60% replacement.
- The compressive strength increases upto 60% variation and then it decreases up to 100% , But still at 100% strength is more than 0% replacement of natural sand.

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