Properties Of Concrete By Replacement Of Natural Sand With Artificial Sand

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ABSTRACT

Concrete is considered to be the most widely used and versatile material of construction all over the world. In recent years, concrete technology has made significant advances which have resulted in economical improvements in strength of concretes. This economical development depends upon the intelligent use of locally available materials. One of the important ingredients of conventional concrete is natural sand or river sand, which is expensive and scarce. In India, the conventional concrete is produced by using natural sand obtained from riverbeds as fine aggregate. However, due to the increased use of concrete in almost all types of construction works, the demand of natural or river sand has been increased. To meet this demand of construction industry excessive quarrying of sand from river beds is taking place causing the depletion of sand resources. The dwindling sand resources have not only posed the environmental problems but also have caused the rivers to change their flow direction. This fact has forced the Government to lay down restrictions on sand quarrying process resulting in the scarcity and significant increase in its cost. Thus the scarcity of natural sand has forced to find the suitable substitute. The cheapest and the easiest way of getting substitute for natural sand is by crushing natural stone to get artificial sand of desired size and grade which would be free from all impurities. The promotional use of artificial sand will conserve the natural resources for the sustainable development of the concrete in construction industry.

In the present an attempt has been made to discuss the properties such as workability and compressive strength of concrete prepared by replacing natural sand with artificial sand at different replacement levels (0%, 20%, 40%, 60% and 100%). The development of cracks and their measurement is also studied. The results have shown that the natural sand can be replaced with artificial sand up to a maximum replacement level of 60% in order to produce concrete of satisfactory workability and compressive strength and also with cracks of lesser areas.

Key words: Natural sand, artificial sand, compressive strength, crack pattern.

1.0 INTRODUCTION:

Concrete is the most widely material of construction all over the world. A huge quantity of concrete is consumed by construction industry all over the world. In India, the conventional concrete is produced by using natural sand obtained from the riverbeds as fine aggregate. One of the important ingredients of conventional concrete is natural sand or river sand, which is expensive and scarce. However, due to the increased use of concrete in almost all types of construction works, the demand of natural or river sand has been increased. To meet this demand of construction industry, excessive quarrying of sand from river beds is taking place causing the depletion of sand resources. The scarcity of natural sand due to such heavy demands in growing construction activities have forced to find the suitable substitute. One of the cheapest and the easiest ways of getting substitute for natural sand is by crushing natural stone to get artificial sand of desired size and grade **[1]**. The promotional use of artificial sand will conserve the natural resources for the sustainable development of the concrete in construction industry **[2]**.

Artificial sand is a process controlled crushed fine aggregate produced from quarried stone by crushing or grinding and classification to obtain a controlled gradation product that completely passes the 4.75 mm sieve. Artificial sand generally contain more angular particles with rough surface textures and flatter face than natural sand that are more rounded as a result of weathering. Over the time some investigations have shown that angular particles, rough surface of artificial sand influences the workability and finish ability in fresh concrete. The artificial sand have to satisfy the technical requisites such as workability, strength and durability of concrete and hence it has become necessary to study these properties in order to check the suitability and appropriate replacement level of artificial sand in comparison with the natural sand for producing concretes in an economical way **[3]&[9].**

In the present paper an attempt has been made to experimentally study the strength of concrete cubes and cracking patterns of concrete slab panels by replacing the natural sand with artificial sand at various replacement levels of 20%, 40% 60% 100%. The results have shown that the natural sand can be replaced with the artificial sand upto a maximum replacement level of 60% in order to produce concrete of satisfactory strength. The results have also indicated that concrete slab panels showed minimum area of cracks on its surfaces thus improving the durability property.

2.0 EXPERIMENTAL WORK:

2.1.1 Materials Used:

The properties of various materials used in making the concrete (M20) are discussed in the following sections.

Cement:

Ordinary Portland cement of 53 grade satisfying all the requirements of IS12269-1987 [4] was used in making the concrete slab panels and cubes in the experimental work.

Natural (River) Sand:

The natural sand having fineness modulus of 2.9 and conforming to zone II as per IS: 383-1970 **[5]** was used for the experimentation after washing it with clean water. The specific gravity of this natural sand was found to be 2.7. The water absorption and moisture content values obtained for the sand used was found to be 6% and 1.0% respectively.

Artificial sand (Crushed sand):

The crushed sand having fineness modulus of 2.84 and conforming to zone II as per IS: 383-1970 **[5]** was used for the experimentation after washing it with clean water. The specific gravity of this artificial sand was found to be 2.97. The water absorption and moisture content values obtained for the sand used was found to be 6.5% and 1.0% respectively.

Coarse Aggregate

Crushed stone aggregates of 20mm size obtained from local quarry site were used for the experimentation. The fineness modulus of coarse aggregates was found to be 6.3with a specific gravity of 2.75 The water absorption and moisture content values obtained for the sand used was found to be 2.5% and 0.5% respectively.

2.1.2 Mix Proportions Adopted:

The concrete of M20 grade was designed using the IS Code method (IS: 10262-1982) **[6]** of mix design and proportions were obtained after applying necessary corrections to suit field conditions. The final mix ratio expressed as parts of water: cement: fine aggregate: coarse aggregate was 0.50:1:1.583:3.275.

2.1.3 Casting of Concrete specimens:

The mix proportion as obtained by following the guidelines of IS: 10262-1982**[6]** was used in making the concrete mixes in the form of cubes and slab panels for study of compressive strength and crack patterns. The required quantities of all the ingredients were taken by weigh batching. The concrete cubes of 150mm side and slab panels of 500x300x50mm size were cast by replacing the natural sand at replacement levels of 0%, 20%, 40%, 60% and 80% using artificial sand. The mixing of all the ingredients of concrete was done by taking their appropriate contents on a water-tight platform. The mixture was turned twice in dry state and then the required quantity of water was added to it and again the entire mixture was turned twice till a homogenous mass of concrete was obtained. The workability of the concrete so prepared was studied by conducting slump test as per the standard procedure given in IS: 1199–1959**[7]**. The results of the slump test are presented in the Table 1.

Table 1: Workability values of Concrete for diff.% replacement of natural sand

% replacement of natural sand by artificial sand	Workability Tests		
	Slump (mm)	Compaction factor	Flow (%)
0	40	0.91	27.16
20	48	0.92	25.70
40	50	O.90	9.32
60	**56**	**0.90**	**11.33**
80	54	0.90	7.68
100	45	0.87	9.12

Standard cube specimens were cast using the procedure described in IS: 516–1959 and were immediately covered with wet cloths and kept there for 24 hours and then released in water tank for 28 days curing. The concrete slab panels were also prepared by following the same procedure. However, the slab panels at each replacement level of natural sand with artificial sand were observed to see the development of cracks after 7 hours of casting. The cracks appeared on the surface of slab panels were marked on the transparent paper by keeping it over the surface of slab panels for finding the area of crack. The measurement of cracks for its width was done with help of a microscope of 0.001mm least count as shown in figure 3. The cracks were also measured for their spacing on the surface of slab panels. The areas of the cracks worked out from the dimensions of cracks are presented in the Table 2.

Table 2: Workability values for different % replacement of natural sand by artificial sand

% replacement of natural sand by artificial sand	0	20	40	60	80	100
Area of crack (mm2)	13.33	2.59	2.22	1.21	3.23	5.22

Testing of Specimens:

After 28 days curing period, the concrete cube specimens cast by replacing natural sand with artificial sand at different replacement levels were tested under a compression testing machine (Figure 4) following the procedure given in IS:516–1959 **[8]**.

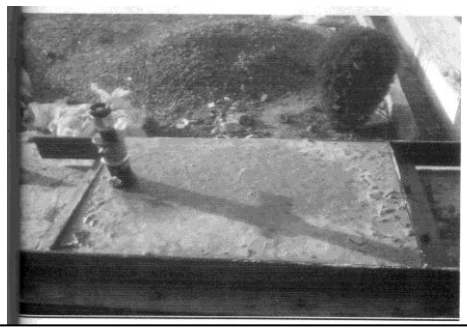

Figure 3: Measurement of cracks using microscope

Figure 4: Compression Test on Cube Specimen

The crushing loads were noted and the average compressive strength of three specimens was determined. The compressive strength values of all the specimens are presented in Table 3.

Table 3: Comp. St. for different % replacement of natural sand by artificial sand

% replacement of natural sand by artificial sand	0	20	40	60	80	100
Area of crack Compressive strength (N/mm^2)	23.48	27.12	31.38	35.16	33.28	33.27

RESULTS AND DISCUSSIONS:

From the results of workability tests (slump, compaction factor and flow) a relationship between slump, compaction factor and flow value for different percentage replacement of natural sand by artificial sand is plotted and is shown in figure 5. From this relationship it is observed that the concrete mixes provide better workability in terms of slump, compaction factor and flow values for 60% replacement of natural sand by artificial sand.

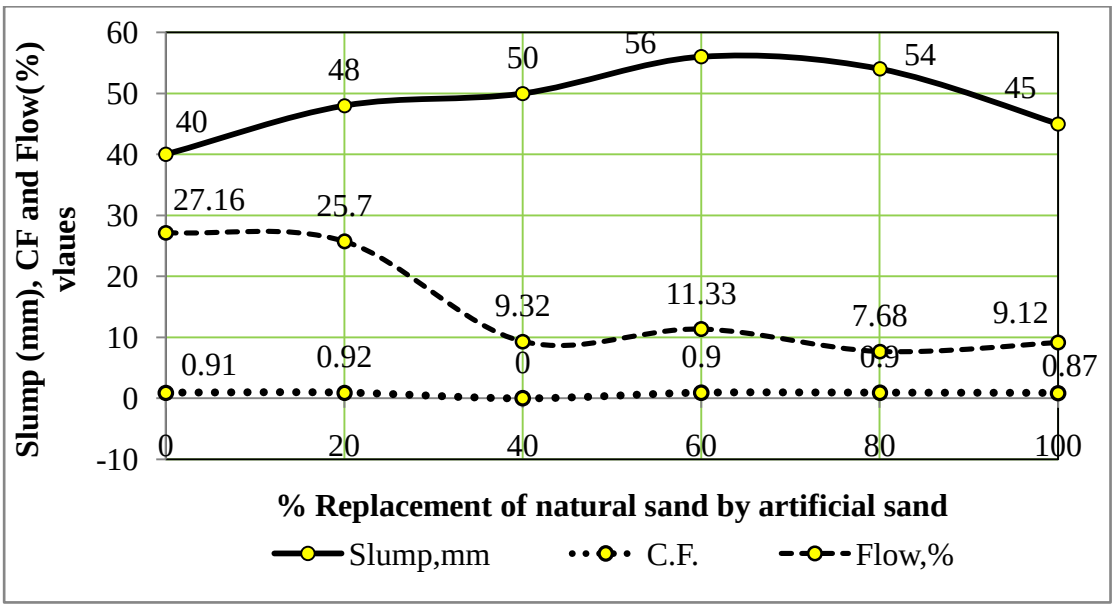

Figure 5: Variation of in workability (slump, CF and Flow) for different % replacement of natural sand by artificial sand

From the results of compressive strength test and measured areas of cracks at different percentage replacement of natural sand a variation in compressive strength and area of cracks for percentage replacement of natural sand is shown in figure 6. From figure 6, it is observed that the concrete mixes at 60% replacement of natural sand by artificial sand gives greater strength and minimum area for cracks but beyond this (60%) replacement level the compressive strength shows a reduction trend while area cracks goes

on increasing. Thus, it is seen that a maximum percentage replacement of natural sand should be limited to 60% so that satisfactory concretes can be produced.

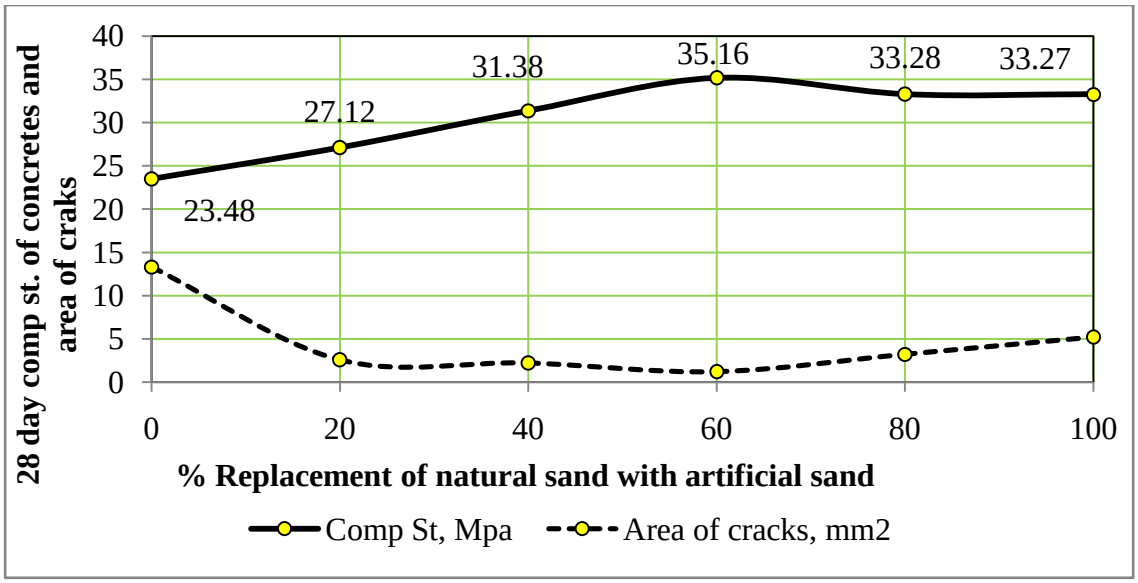

Figure 6: Variation of comp. st. and area of cracks for different % replacement of natural sand by artificial sand

CONCLUSIONS:

1) Replacement of natural sand by 60% artificial sand results in producing the concrete of satisfactory workability and strength properties. It is also possible to minimize the area of surface cracks of concrete, thus achieving the durable concrete. However, for more than 60% replacement of natural sand by artificial sand causes reduction in compressive strength of concrete mixes with increase in the area of cracks.
2) The replacement of natural sand with artificial sand will help in conserving the natural resources of sand and maintain the ecological balance of the nature.

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