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RESEARCH ARTICLE

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AN EXPERIMENTAL INVESTIGATION ON CONCRETE PARTIAL REPLACEMENT OF RIVER SAND WITH SEA SAND

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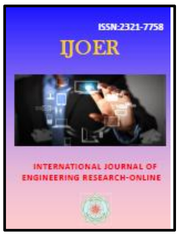

ABSTRACT

The rapid growth in development of construction industry is leading to an increase in utilization of natural resources like river sand due to which there has been a much scarcity in availability for construction. This overuse should be balanced by introducing certain abundantly available other natural materials which can be replaced to the river sand. The sea sand seems to have certain similar properties and can be used as a constituent of concrete. This can reduce the river sand replenishment and decrease various ecological imbalances.

The fast growth in industrialization has resulted in tonnes and tonnes of by product or waste materials, which can be fly ash, crushed stone dust, silica fume, and granulated blast furnace slag, steel slag etc. The use of these byproducts not only helps to utilize these waste materials but also enhances the properties of concrete in fresh and hydrated states. In the present work a series of tests were carried out to make comparative studies of various mechanical properties of concrete mixes prepared by using Sea Sand and. If some of the materials are found suitable in concrete making, cost of construction can be cut down. So in the present study, an attempt has been made to assess the suitability of Sea sand in concrete making. Cubes and beams were cast and tested for compressive strength and flexural strength after 7 days and 28 days. The Sea sand is replaced in percentages of 0%, 20%, 40%, 60%, 80%, and 100%.

Key Words: Aggregate, mortar, Compressive strength, Split tensile strength

1. INTRODUCTION

Now- a- days, there are so many researches that has been done to improve and upgrade the materials for concrete properties to be enhanced. The utilization of various natural and waste materials as a replacement for producing the concrete can give a lot of benefits to the humans and environment. Sea sand is some of the alternative that can be used to replace with river sand in the preparation of concrete. As major natural resource Sea sand can be obtained from the sea shores abundantly at free of cost.

1.1 Problem Statement

Now–a-days, the use of river sand for concrete production has increased rapidly due to increase in number of construction industries. The increase in rate of production of concrete leads to increase in demand for raw materials which in turn leads to price hike of raw materials. Also this demand may be due to scarcity in availability of raw materials mostly the river sand. This problem of importing river sand from other places at a higher price has brought the idea of using the locally available natural material in the place of this river sand. So, by using the sea sand which is abundantly available at the sea shores for the low volume road construction, much of the economy of construction could be saved.

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1.2 **Significance of Study**

There are many materials in the world that can be categorized as excessive materials including sea sand. Sea sand will accommodate the lack of river sand and this should be a crucial step in the development of construction industry to be more realistic and flexible. Beneficial uses of industrial by products, in general promote sustainable development, green building and environmental responsibility by reducing the quality of materials such as natural aggregates that must be mined. Natural aggregates are becoming increasingly scarce and their production is environmentally disruptive.

2. LITERATURE REVIEW

This literature review will focus on the use of sea sand in concrete, since sea sand is arguably the most promising alternative to river sand, as stated before. It is also the alternative that poses the greatest concerns, primarily with respect to its chloride content (known to promote corrosion of reinforcement and suspected of enhancing efflorescence) and shell content (which in early days was suspected of having negative effects on workability and permeability).

In the U.K. around 11% of its aggregate extraction is from sea sources. In South East England and South Wales, this figure is as high as 30% and 90% respectively (Marine2002). While much of the aggregate is processed (inclusive of washing), it is largely unprocessed sand (together with land based coarse aggregate) that is used on the West Coast and the Bristol Channel (GuttandCollins1987).

The use of such aggregate in concrete has not caused any major durability problems in the U.K. during the past 60 years of its use. In fact, chloride related durability problems in the U.K. have largely been due to the use of Calcium chloride as an accelerator (up to a dosage of 0.15% by weight of cement),a practice that had been permitted up to 1977 (Gutt and Collins 1987).

3. EXPERI MENTAL STUDIES & DATA ANALYSIS

3.1. Fitness of cement by Dry-Sieving Method

Fineness of cement is a measure of size of particle of cement. It is expressed as specific surface of cement (in sq. cm /gm.).The fineness of cement is an important factor in determining the rate of gain of strength and uniformity of quality. It is measured in terms of specific surface of the cement and can be calculated from the particle size distributions are determined by one of the air permeability. We have used IS sieve No.9 (90 microns), as per Indian standards(IS :269- 1975), the percentage of residue left after sieving a good Portland cement through IS sieve number 9, should not exceed 10%.

3.2. Initial Setting and Final Setting

In order that the concrete may be placed in position conveniently, it is necessary that the initial setting time is not too quick and after it has been laid, hardening should be rapid so that the structure can be made use of as early as possible. The initial set is a stage in the process of hardening after which any crack that may appear will not re-unite. The concrete is said to be finally set when it has obtained sufficient strength and hardness.For Portland cement, the initial setting time should not be less than 30 minutes and final setting time should not be more than 600 minutes. For quick cement, Initial setting time should not be less than 5 minutes and final setting time should not exceed 30 minutes. The setting time is influenced by temperature, humidity fair and quantity of gypsum in the cement.

3.3. Soundness of Cement

This test indicates the liability of cement to expand sometimes after setting and causes severe cracking of failure of concrete. The chief test for soundness is the “Le-Chatelier” test.

To decide the suitability of given cement sample. The cement is said to be sound when the percentage of free lime and magnesia is within specified limits. These materials expand in the structure and thus the concrete or mortar also expands, causing unequal expansion of paste. Disintegration of cement compound is determined by Le- Chatelier apparatus.

3.4. Specific gravity of Cement

Specific gravity is normally defined as the ratio between the mass of a given volume of material and mass of an equal volume of water. One of the methods to determining the specific gravity of cement is by the use of a liquid such as water-free kerosene which does not react with cement. A specific gravity bottle may be employed or a standard Le-Chatelier flask may be used.

3.5. Specific gravity of Water Absorption

S.NO	**Material**	Specific gravity	Water absorption in %
1	Sea Sand	2.31	1.2%

4. CONCRETE MIX DESIGN

Mix design can be defined as the process of selecting suitable ingredients of concrete and determining their relative propositions with the object of producing concrete of certain minimum strength and durability as economically as possible.

4.1. Concrete Mix Design as per Indian Standard Core(TS:10262-2009)

1. The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible, is termed the concrete mix design. The proportioning of ingredient of concrete is governed by the required performance of concrete in 2 states, namely the plastic and the hardened states. If the plastic concrete is not workable, it cannot be properly placed and compacted. The property of workability, therefore, becomes of vital importance.

4.2. Standard Mixes

The nominal mixes of fixed cement-aggregate ratio (by volume) vary widely in strength and may result in under- or over-rich mixes. For this reason, the minimum Flexural Strength has been included in many specifications. These mixes are termed standard mixes.

IS 456-2000 has designated the concrete mixes into a number of grades as M10, M15, M20, M25, M30, M35 and M40. In this designation the letter M refers to the mix and the number to the specified 28 day cube strength of mix in N/mm^2. The mixes of grades M10, M15, M20 and M25 correspond approximately to the mix proportions (1:3:6), (1:2:4), (1:1.5:3) and (1:1:2) respectively.

4.3. Procedure for Mix Design

Determine the mean target strength f_t from the specified characteristic Flexural Strength at 28-day f_{ck} and the level of quality control.

$f_t = f_{ck} + 1.65\ S$

Where S is the standard deviation obtained from the Table of approximate contents given after the design mix. Obtain the water cement ratio for the desired mean target using the empirical relationship between Flexural Strength and water cement ratio so chosen is checked against the limiting water cement ratio. The water cement ratio so chosen is checked against the limiting water cement ratio for the requirements of durability given in table and adopts the lower of the two values.

4.4. Procedure for Mix Design

Mix design aims to achieve good quality concrete at site economically.

1. Quality concrete means

• Better strength
• Better imperviousness and durability
• Dense and homogeneous concrete.

2. Economy

a. Economy in cement consumption:

It is possible to save up to 15% of cement for $M_{30\ grade}$ of concrete with the help of concrete mix design. In fact higher the grade of concrete more are the savings. Lower cement content also results in lower heat of hydration and hence reduces shrinkage cracks.

b. Best use of available materials:

Site conditions often restrict the quality and quantity of ingredient materials. Concrete mix design offers a lot of flexibility on type of aggregates to be used in mix design. Mix design can give an economical solution based on the available materials if they meet the basic IS requirements. This can lead to saving in transportation costs from longer distances.

c. Other properties:

Mix design can help us to achieve form finishes, high early strengths for early shuttering off, concrete with better flexural strengths, concrete with pump ability and concrete with lower densities.

5. TESTS ON CONCRETE

Testing of concrete plays an important role in controlling and conforming the quality of cement concrete works. Systematic testing of raw materials, fresh concrete and hardened concrete are inseparable part of any quality control program for concrete, which helps to achieve higher efficiency of the material used greater assurance of the performance of the concrete with regard to both strength and durability.

5.1. Slump Test

The slump test is the most well-known and widely used test method to characterize the workability of fresh concrete. The inexpensive test, which measures consistency, is used on job sites to determine rapidly whether a concrete batch should be accepted or rejected.

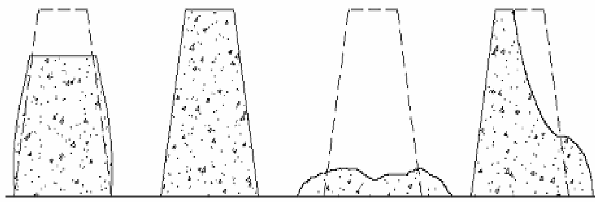


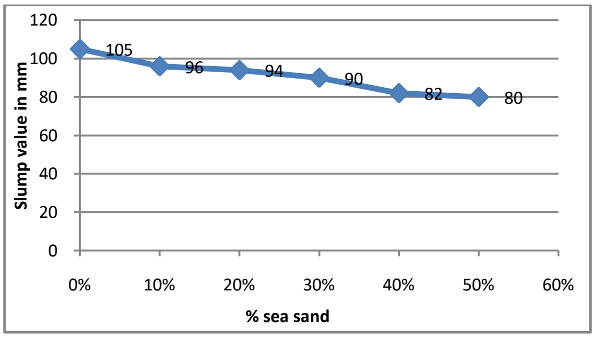
Fig -1: Fout Types of slump

The slump test is not considered applicable for concretes with a maximum coarse aggregate size greater than 1.5 inches.

Table -1: Slump Values of a Sea Sand Mix

S.I.No	Percentage addition of Sea Sand to concrete	Slump Values in mm.
1	0%	105
2	20%	96
3	40%	94
4	60%	90
5	80%	82
6	100%	80

As per IS requirements the slump value for medium workability of concrete should be 50-100.



Graph 1. Represnts the Variations in Slump.

5.2. Compaction Factor Test

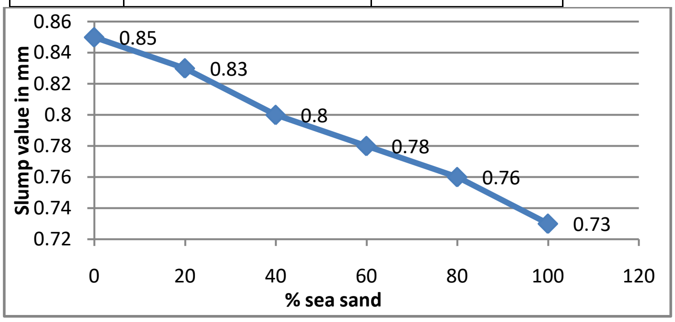
The compaction factor test measures the degree of compaction resulting from the application of a standard amount of work. Compaction factor test is adopted to determine the workability of concrete, where nominal size of aggregate does not exceed 20 mm. It is based upon the definition, that workability is that property of the concrete which determines the amount of work required to produce full compaction. The test consists essentially of applying a standard amount of work to standard quantity of concrete and measuring the resulting compaction.

Fig -2: Compaction Factor Test

The results of the compaction factor test can be correlated to slump, although the relationship is not linear. Table 5 relates the results of the compaction factor test to slump and the sample's degree of workability.

Table -2: Compaction Factor Values of Sea Sand

S.I.No	Percentage addition of Sea Sand to concrete	Compaction Factor Value
1	0%	0.85
2	20%	0.83
3	40%	0.80
4	60%	0.78
5	80%	0.76
6	100%	0.73



Graph 2. Represnts the variations in compaction Factor.

5.3. Preparation of Test Specimens

The preparation of test specimen including sampling of materials, preparation of materials, proportioning, weighing, mixing, testing for workability, choice of the size of test specimens, compacting, and capping of specimen shall be in accordance with IS: 516-1959*, if tests are intended to draw correlation curve between the results from Flexural Strength tests on specimens cured by normal curing method and accelerated curing method.

5.4. Curing Method Followed

All specimens will be moist cured for one day and after moist curing the specimens will be water cured for required days. Testing will be done after required days.In the Traditional curing the cubes moulded with the cement concrete is subjected to curing in the water Tank and then check the strengths achieved by the cubes and beams for every 7 days and 28 days from this we can get the Flexural Strength from cubes and Flexural strength from Beams, split tensile strength for cylinders.

Fig -3: Curing of Specimens

5.5. Compression Strength for Specimens

Table -3: Specimens Dimensions

Serial No	Specimens	Dimensions in mm
1	Cube	150 X 150 X 150
3	Beam	500X100X100

Table -4: Number of specimens required for the 7,28 days strength tests

S.No	% of sea sand replaced	No. of cubes for Compression test	No. of beams for flexural test
1	0	6	3
2	20	6	3
3	40	6	3
4	60	6	3
5	80	6	3
6	100	6	3
Total	**54**		

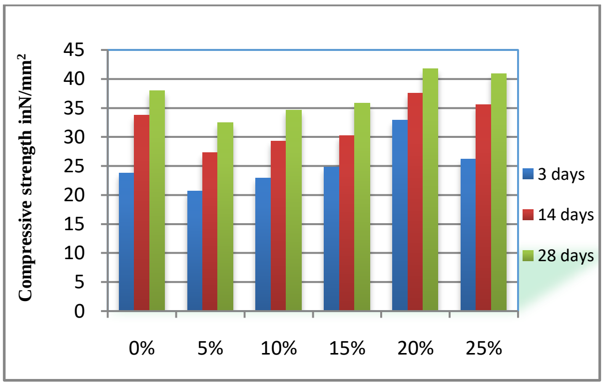
Fig -4: Cube test under Compression

5.6. Test for Flexural Strength of Concrete

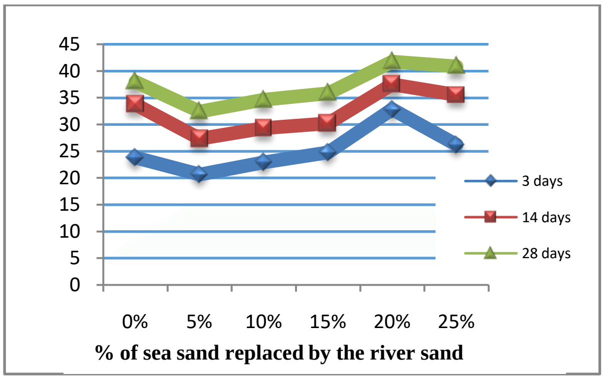
This deals with the procedure for determining the flexural strength of concrete specimens. Tests shall be made at ages of 7, 28 days. Ages of 13 weeks and one year are recommended if tests at greater ages are required. Where it may be necessary to obtain the early strengths, tests may be made at the ages of 24 hours ± ½ hour and 72 hours ± 2 hours. Specimens when received dry shall be kept in water for 24 hours before they are taken for testing.

Fig -5: Beam Under Tension and Beam after Failure

6. RESULTS & DISCUSSIONS

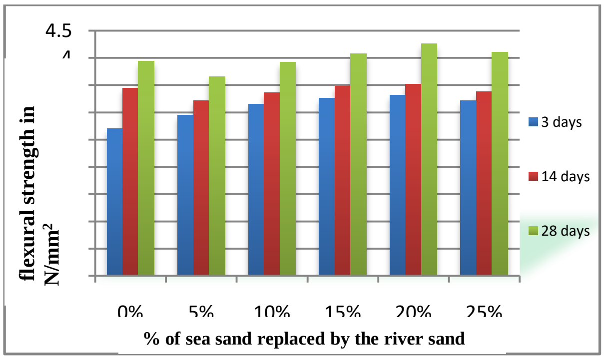


Graph 3. Compression STRENGTH V/S Different Different percentages of sea sand



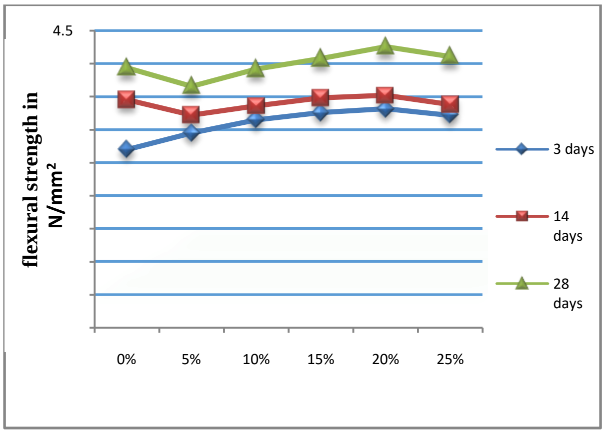
Graph 4. Compression STRENGTH V/S Different

Different percentages of River sand



Graph 5. Flexural STRENGTH V/S Different

Different percentages of sea sand



Graph 6. Flexural STRENGTH V/S Different

Different percentages of River sand

In the present study, the sea sand has been replaced with river sand in concrete mix. The compressive strength and flexural strength for different percentages of sea sand is shown in table. The normal M30 grade with no replacement is used as a reference for compressive and flexural strengths and the increase or decrease in percentage of strength is calculated. For 5% replacement the compressive strength has decreased for 14.6% and gradually increased with increased in percentage of sea sand. The optimum strength achieved is 9% more than the normal strength at 20% of sea sand replaced. The flexural strength behavior is also similar in this case since the strength has decreased for about 15.5% by 5% replacement and increased to 6.4% more than the normal concrete mix strength.

6. CONCLUSION

1. The replacement of sea sand to concrete slightly increases the compressive and flexural strength.
2. By replacing 20% sea sand the compressive strength has increased by 9%
3. By replacing 20% sea sand the Flexural strength has increased by 6.4%.
4. Adoption of waste materials, cost of construction can be reduced to some extent.

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