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A STUDY ON CONCRETE FOR THE DIFFERENT PERCENTAGES OF SEA SAND REPLACED WITH THE RIVER SAND AS FINE AGGREGATE

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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%.

Keywords: Aggregate, mortar, Compressive strength, Split tensile strength

I. INTRODUCTION

1.1. BACK GROUND:

The development of construction industry now-a-days is increasing rapidly because of that it will reduce the amount of natural resources in our country and many of the natural resources will be sacrificed to obtain a source of materials for construction. To save the environment from this loss because of the developmental activities, we need to think of suitable materials that can be used to replace these materials for pavement construction. Environment must be sustained and protected by us for next generation.

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.

1.2. 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.

So, by using sea sand from the sea shores as a fine aggregate replacement in preparation of concrete will save our earth for a sustainable environment. It also helps to save much of our river sand from being deployed for construction.

1.3. OBJECTIVES OF STUDY:

The objectives of this study are:

- To determine the performance of concrete made with sea sand.
- To determine the feasibility of using sea sand as a fine aggregate in concrete.
- To determine the most economic material that can be suitably replaced for construction.
- To fulfil safe environment by using waste materials.
- To investigate the basic properties such as Flexural Strength, Compressive strength of sea sand replaced concrete in comparison with normal concrete.

1.4. SCOPE OF THE STUDY:

The scope of the study will be focused on the performance of concrete with 20mm nominal maximum aggregate size. All laboratory works were performed at K.V.Subbareddy College.

1.5. SIGNIFICANCE OF STUDY:

From the study, it is crucial to know whether washed sea sand can be used for concrete production. As known, sea sand normally has chloride ion and can influences the steel which become weak since the steel is rusted and corroded depending upon amount of ion chloride composition in sea sand. Relating to this study, ion chloride still can cause the bad action for concrete.

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.

II. LITERATURE REVIEW

2.1. INTRODUCTION:

The river sand still remains the main source of sand for construction industry. The demand for sand has been ever increasing with the development of building industry. As a result, it has been noticed the overexploitation of river sand causing serious environmental problems. One of the main objectives of the study is the identification of potential sources of river sand alternatives. The sea sand is now being recognized as the major alternatives of river sand in this study.

2.2. PREVIOUS STUDIES:

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).

Although sea sand is reportedly used in many countries such as the U.K., Netherlands, India, Seychelles and Singapore, proper documentation regarding its use was found mainly regarding U.K. practice. A distinction must also be made between the use of sea sand and sand deposits in dry coastal areas. The latter would tend to have very high chloride contents resulting from salt spray and evaporation over long periods of time. In particular, the use of such a deposit for concrete construction in the Middle East has led to very early onset of corrosion (Fookes and Higginbottom 1980, Rasheeduzzafar et al.1985).

A study done on SriLankan beach sands has also shown fairly high chloride levels in some samples (Chandrakeerthy1994). The use of sea water for batching or for curing (Rasheeduzzafar et al. 1985, Katwan2001) would also promote corrosion; such practices should not be resorted to.

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).

2.3. ADVANTAGES OF UTILIZING WASTE MATERIALS:

Recycled materials can be a source of good quality, cost effective road materials that also benefit the environment. Using recycled materials can frequently improve materials performance and reduce the rate of natural resources depletion. Using recycled materials may also cut costs because materials costs may be less than new materials; transportation/delivery costs may be less; and disposal costs for job-site materials may be less. Utilization of recycled materials benefits the environment by extending the life of limited natural resources, reducing air and water pollution, and extending landfill life. The use of waste materials (recycling) in the construction of pavements has benefits in not only reducing the amount of waste materials requiring disposal but can provide construction materials with significant savings over new materials. The use of these materials can actually provide value to what was once a costly disposal problem.

2.4. PHYSICAL PROPERTIES:

2.4.1. SEA SAND:

Advantages of sea sand:

1. It is the cheapest form of fine aggregate
2. In contrast to crushed fine aggregate, it is more rounded or cubical like river sand and hence, demand for water and cement is low
3. Price fluctuations are small throughout the year
4. As it is found in natural deposits grading of sea sand is generally good
5. It contains no organic contamination, silt or weak small gravel particles
6. It can be made abundantly available.
7. Seashore mining operation is easy.
8. If chloride content is high, it can be reduced to acceptable limits by washing with even sea water.
9. Grading of sea sand is finer than that of river sand and since local crushed stone coarse aggregate is coarser, it does not show any adverse effects when used in concrete.

III. EXPERIMENTAL STUDIES AND DATA ANALYSIS

3.1. TESTS ON CEMENT:

Checking of materials is an essential part of civil engineering as the life of structure is dependent on the quality of material used. Following are the tests to be conducted to judge the quality of cement.

1. Fineness
2. Consistency
3. Initial And Final Setting Time
4. Soundness
5. Specific gravity
6. Compressive Strength

3.1.1. Fineness of Cement by Dry-Sieving Method :(As Per IS-4031 part 1):

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%.

3.1.2. Standard Consistency of Cement:

Normal or standard consistency of any given cement sample is that water content which will produce a cement paste of standard cons instance. Consistence is determined by the Vacate apparatus, which measures the depth of penetration in paste of a 10 mm diameter plunger under its own weight. Normal or standard consistency is expressed as that percentage of water, by mass of dry cement, corresponding to which a specified depth of penetration in paste is achieved. For Portland cements, the normal consistency varies from 26 to 33%.

Normal consistency of cement is determined for the purpose of determining the water to cement ratios for preparing the specimens to be used for other quality tests such as times of set, compressive and tensile strengths, and soundness tests, on the same cement.For finding out initial setting time, final setting time and soundness of cement and strength a parameter known as standard consistency has to be used. The object of conducting this test is to find out the amount of water to be added to the cement to get a paste of normal consistency i.e., the paste of a certain standard solidity, which is used to fix the quality of water to be mixed in cement before performing tests for setting time, soundness and Flexural Strength. The test is required to be conducted in a constant temperature (27^0 c ± 2^0 c) and constant humidity (90%).

Scope:

Specific Gravity is the ratio of the weight of a given volume of aggregate to the weight of an equal volume of water. Water, at a temperature of 73.4°F (23°C).Specific Gravity is important for several reasons. Some deleterious particles are lighter than the “good" aggregates. Tracking specific gravity can sometimes indicate a change of material or possible contamination. Differences in specific gravity may be used to separate the deleterious particles from the good using heavy media liquid. Specific gravity is critical information for the Hot Mix Asphalt Design Engineer. This value is used in calculating air voids, voids in mineral aggregate (VMA), and voids filled by asphalt (VFA). All are critical to a well performing and durable asphalt mix. Water absorption may also be an indicator of asphalt absorption. A highly absorptive aggregate may result in a low durability asphalt mix. In Portland Cement Concrete the specific gravity of the aggregate is used in calculating the Percentage of voids and the solid volume of aggregates in computations of yield. The absorption is important in determining the net water-cement ratio in the concrete mix. Knowing the specific gravity of aggregates is also critical to the construction of water filtration systems, slope Stabilization

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projects, railway bedding and many other applications.

Theory and Scope:

The Flexural Strength of cement mortar is determined in ordered to verify whether the cement conforms to IS specifications (IS: 269-1976) and whether it will be able to develop the required Flexural Strength of concrete.

TABLE: 3.1.1. Physical Test results of cement

SL. NO.	PHYSICAL TESTS	OBTAINED RESULTS	REQUIREMENTS AS PER IS CODES
1	Fineness	3%	Not>10% as per IS 4031 part 1
2	Standard Consistency	32%	IS 4031 part 4
2	Initial Setting time	42mm	Not less than 30 minutes as per IS 4031 part 5
3	Final setting time	265 min	Not more than 600 minutes as per IS 4031 part 5
4	Soundness	2 mm	Not>10mm as per IS 4031 part 3
5	Specific gravity	3.10	IS 2720 part 3 (3.15 is generally assumed)

3.2. TESTS ON AGGREGATE:

There are many tests which are conducted to check the quality of aggregates. Aggregates are very important components of concrete, so the quality really matters when it comes to aggregates.

Various tests which are done on aggregates are listed below.

1. Sieve analysis for fine aggregate
2. Sieve analysis for Coarse Aggregate
3. Aggregate impact Value
4. Specific gravity and water absorption of Aggregate

3.2.1. Grain Size Distribution of Fine Aggregate:

To study the particle size distribution of given fine aggregate by doing sieve analysis, we need to draw the grading curve and determine the fineness modulus of the given fine aggregate sample. We have used a set of sieves consist the sizes of 4.75 mm, 2.36 mm, 1.18 mm, 600 µ, 300 µ, 150µ and pan. Sample should be taken for which the sample is thoroughly mixed and spread over a clean surface. If any further reduction of quantity is required the process may be repeated. Weight retained on each sieve shall not exceed the limits specifies IS code.

3.2.2. Grain Size Distribution of Coarse Aggregate:

To study the particle size distribution of given coarse aggregate by doing sieve analysis, we need to determine the fineness modulus of the given coarse aggregate sample. We have used a set of sieves consist the sizes of 40 mm, 20 mm,12.5 mm, 4.75 mm,2.36 mm and pan. Sample should be taken for which the sample is thoroughly mixed and spread over a clean surface. If any further reduction of quantity is required the process may be repeated. Weight retained on each sieve shall not exceed the limits specifies IS code.

Scope:

This method of test covers a field procedure for the determination of particle size distribution of fine and coarse aggregates, using sieves with square openings.

Significance and Use: The gradation of fine and coarse aggregate samples must be tested to determine compliance with the specifications for these materials.

3.2.3. Aggregate Abrasion value:

Abrasion testing of aggregate is of more direct application to the testing of stone aggregate for wearing. It has been found that the aggregate which shows a low loss in this test will general be hard, tough, resistant to abrasion and strong which are the desirable and necessary qualities for durability of concrete. The abrasion test on aggregate is found as per IS-2386 Part IV. The sieving operation should be conducted by mass of a lateral and vertical motion of the sieve, accompanied by the jarring action so as to keep the sample moving continuously over the surface of the sieve. In no case shall the fragments of the sample be turned or manipulated through the sieve by hand. Use a coarse sieve first in order to minimize wear of 1.7 mm IS sieve.

TABLE: 3.2.1 Physical Tests of Aggregates which were used in sea sand used Concrete Mix.

Sl. No	Physical Tests	Obtained results	Requirements as per IS 383
1	Impact Test	19.74%	Not more than 45% (other than wearing surfaces)
2	Los Angeles Abrasion Test	9.89%	Not more than 50% (other than wearing surfaces)
3	Specific gravity		
	a) Coarse Aggregates	2.72	2.6-2.9
	b) Fine Aggregates	2.61	2.6-2.8
4	Water absorption		Not<2%as per IS:2386-Part 3
	a) Coarse Aggregates b) Fine aggregate	1% 0.5%	

Table 3.2.2 Sieve Analysis of Coarse Aggregate:

S. NO	Sieve Size	Weight retained(kg)	%(Retained)	%Cumulative Retained	% Cumulative Passing
1	80	0	0	0	100
2	40	0	0	0	100
3	20	4128	41.28	41.28	58.752
4	10	5546	55.46	96.74	44.54
5	4.75	309	3.09	99.83	96.91
6	Pan	16	0.16	99.99	99.84

Confirming to table 4 of IS 383-1970

3.3. TESTS ON FINE AGGREGATE:

Various lab tests which were done in lab includes

1. Sieve Analysis
2. Specific gravity and Water Absorption

Table 3.3.1 Sieve Analysis of Fine Aggregate (River sand):

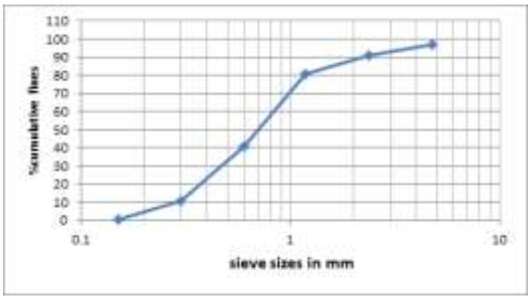
Sieve Size	Weight retained(kg)	%(Retained)	%Cumulative Retained	% Cumulative Passing
4.75 mm	0.032	3.2	3.2	96.8
2.36 mm	0.058	5.8	9	91
1.18 mm	0.101	10.1	19.1	80.9
600 micron	0.398	39.8	58.9	41.1
300 micron	0.306	30.6	89.5	10.5
150 micron	0.099	9.9	99.4	0.6
Pan	0.006	0.6		
Total	1	100		

Fineness modulus = Sum of cumulative percentage retained on standard sieves/100

= 279.1/100

= 2.79

From the sieve analysis of table the river sand is conforming to zone-II.



Graph-3.2.1.Shows the gradation curve for River sand

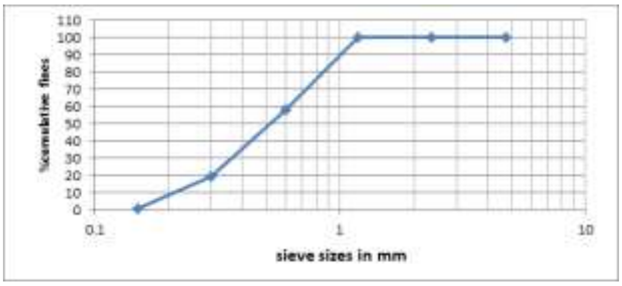
Sieve Size	Weight retained(gm)	%(Retained)	%Cumulative Retained	% Cumulative Passing
4.75 mm	0	0	0	100
2.36 mm	0	0	0	100
1.18 mm	0	0	0	100
600 micron	0.418	41.8	41.8	58.2
300 micron	0.389	38.9	80.7	19.3
150 micron	0.185	18.5	99.2	0.8
Pan	0.008			
Total	1000			

Table 3.3.2 Sieve Analysis of Fine Aggregate (Sea sand):

Fineness modulus = Sum of cumulative percentage retained on standard sieves/100

= 221.7/100

= 2.22



Graph-3.3.1. shows the gradation curve for Sea sand

The different physical properties of Sea sand is given below

3.4. Specific Gravity and Water Absorption:

Table 3.4.1 Physical properties of Sea sand:

Material	Specific gravity	Water absorption in %
Sea sand	2.31	1.2%

IV. CONCRETE MIX DESIGN

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4.1. INTRODUCTION:

4.1.1. 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.

4.1.2. Concept of mix design:

It will be worthwhile to recall at this stage the relationships between aggregate and paste, which are the two essential ingredients of concrete. Workability of the mass is provided by the lubricating effect of paste and influenced by the amount of dilution of paste. The strength of concrete is limited by the strength of paste, since mineral aggregate with rare exception, are stronger then the paste compound. Essentially the permeability of concrete is the governed by the quality and continuity of the paste, since little water flows through aggregate either under pressure or by capillarity. Further, predominate contribution to drying shrinkage of concrete is that of paste. Since the properties of concrete are governed to a considerable extent by the paste, it is helpful to consider more closely the structure of the paste. The fresh paste is a suspension, not a solution of cement in water.

The more dilute the paste, the greater the spacing between cement particles, and thus the weaker will be the ultimate paste structure. The other conditions being equal, for workable mixes, the strength of concrete varies as an inverse function of the water by cement ratio. Since the quantity of water that is as little paste as possible should be used and hence important for grading.

4.1.3. VARIABLES IN PROPORTIONING:

With the given materials, the four variable factors to be considered in connection with specifying a concrete mix are:

a) Water –cement ratio
b) Cement content or cement – aggregate ratio
c) Gradation of the aggregates
d) Consistency

4.1.4. VARIOUS METHODS OF PROPORTIONING

a) Arbitrary proportion
b) Fineness modulus method
c) Maximum density method
d) Surface area method
e) Indian road congress, IRC 44 method
f) High strength concrete mix design
g) Mix design based on flexural strength
h) Road note No. 4 (Grading curve method)
i) ACI committee 211 method
j) DOE method
k) Mix design for pump able concrete
l) Indian standard recommended method IS 10262-198

Out of the above methods, some of them are not very widely used these days because of some difficulties or drawbacks in the procedures for arriving at the satisfactory proportions.

4.2. CONCRETE MIX DESIGN AS PER INDIAN STANDARD CODE (IS: 10262-2009):

4.2.1. Introduction:

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.

The Flexural Strength of hardened concrete which is generally considered to be an index of its other properties, depends upon many factors, e.g. quality and quantity of cement, water and aggregates; batching and mixing; placing, compaction and curing. The cost of concrete is made up of the cost of materials, plant and labour. The variations in the cost of materials arise from the fact that the cement is several times costly than the aggregate, thus the aim is to produce as lean a mix as possible. From technical point of view the rich mixes may lead to high shrinkage and cracking in the structural concrete, and to evolution of high heat of hydration in mass concrete which may cause cracking.

The actual cost of concrete is related to the cost of materials required for producing a minimum mean strength called characteristic strength that is specified by the designer of the structure. This depends on the quality control measures, but there is no doubt that the quality control adds to the cost of concrete. The extent of quality control is often an economic compromise, and depends on the size and type of job. The cost of labor depends on the workability of mix, e.g., a concrete mix of inadequate workability may result in a high cost of labor to obtain a degree of compaction with available equipment.

4.2.2. Requirements of Concrete Mix Design

The requirements which form the basis of selection and proportioning of mix ingredients are:

a) The minimum Flexural Strength required from structural consideration
b) The adequate workability necessary for full compaction with the compacting equipment available.
c) Maximum water-cement ratio and/or maximum cement content to give adequate durability for the particular site conditions
d) Maximum cement content to avoid shrinkage cracking due to temperature cycle in mass concrete.

4.3. TYPES OF MIXES

4.3.1. Nominal Mixes

In the past the specifications for concrete prescribed the proportions of cement, fine and coarse aggregates. These mixes of fixed cement-aggregate ratio which ensures adequate strength are termed nominal mixes. These offer simplicity and under normal circumstances, have a margin of strength above that specified. However, due to the variability of mix ingredients the nominal concrete for a given workability varies widely in strength.

4.3.2. 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.

4.3.3. Designed Mixes

In these mixes the performance of the concrete is specified by the designer but the mix proportions are determined by the producer of concrete, except that the minimum cement content can be laid down. This is most rational approach to the selection of mix proportions with specific materials in mind possessing more or less unique characteristics. The approach results in the production of concrete with the appropriate properties most economically. However, the designed mix does not serve as a guide since this does not guarantee the correct mix proportions for the prescribed performance. For the concrete with undemanding performance nominal or standard mixes (prescribed in the codes by quantities of dry ingredients per cubic meter and by slump) may be used only for very small jobs, when the 28-day strength of concrete does not exceed 30 N/mm^2. No control testing is necessary reliance being placed on the masses of the ingredients.

4.4. FACTORS AFFECTING THE CHOICE OF MIX PROPORTIONS

The various factors affecting the mix design are:

4.4.1. Compressive Strength

It is one of the most important properties of concrete and influences many other describable properties of the hardened concrete. The mean Flexural Strength required at a specific age, usually 28 days, determines the nominal water-cement ratio of the mix. The other factor affecting the strength of concrete at a given age and cured at a prescribed temperature is the degree of compaction. According to Abraham's law the strength of fully compacted concrete is inversely proportional to the water-cement ratio.

4.4.2. Workability

The degree of workability required depends on three factors. These are the size of the section to be concreted, the amount of reinforcement, and the method of compaction to be used. For the narrow and complicated section with numerous corners or inaccessible parts, the concrete must have a high workability so that full compaction can be achieved with a reasonable amount of effort. This also applies to the embedded steel sections. The desired workability depends on the compacting equipment available at the site.

4.4.3. Durability

The durability of concrete is its resistance to the aggressive environmental conditions. High strength concrete is generally more durable than low strength concrete. In the situations when the high strength is not necessary but the conditions of exposure are such that high durability is vital, the durability requirement will determine the water-cement ratio to be used.

4.4.4. Maximum Nominal size of Aggregate

In general, larger the maximum size of aggregate, smaller is the cement requirement for a particular water-cement ratio, because the workability of concrete increases with increase in maximum size of the aggregate. However, the Flexural Strength tends to increase with the decrease in size of aggregate.

IS 456:2000 and IS 1343:1980 recommend that the nominal size of the aggregate should be as large as possible.

4.4.5. Grading and Type of Aggregate

The grading of aggregate influences the mix proportions for a specified workability and water-cement ratio. Coarser the grading leaner will be mix which can be used. Very lean mix is not desirable since it does not contain enough finer material to make the concrete cohesive. The type of aggregate influences strongly the aggregate-cement ratio for the desired workability and stipulated water cement ratio. An important feature of a satisfactory aggregate is the uniformity of the grading which can be achieved by mixing different size fractions.

4.4.6. Quality Control

The degree of control can be estimated statistically by the variations in test results. The variation in strength results from the variations in the properties of the mix ingredients and lack of control of accuracy in batching, mixing, placing, curing and testing. The lower the difference between the mean and minimum strengths of the mix lower will be the cement-content required. The factor controlling this difference is termed as quality control.

4.4.7. Mix Proportion Designations

The common method of expressing the proportions of ingredients of a concrete mix is in the terms of parts or ratios of cement, fine and coarse aggregates. For e.g., a concrete mix

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of proportions 1:2:4 means that cement, fine and coarse aggregate are in the ratio 1:2:4 or the mix contains one part of cement, two parts of fine aggregate and four parts of coarse aggregate. The proportions are either by volume or by mass. The water-cement ratio is usually expressed in mass.

4.5. FACTORS TO BE CONSIDERED FOR MIX DESIGN

1. The grade designation giving the characteristic strength requirement of concrete.
2. The type of cement influences the rate of development of Flexural Strength of concrete.
3. Maximum nominal size of aggregates to be used in concrete may be as large as possible within the limits prescribed by IS 456:2000.
4. The cement content is to be limited from shrinkage, cracking and creep.
5. The workability of concrete for satisfactory placing and compaction is related to the size and shape of section, quantity and spacing of reinforcement and technique used for transportation, placing and compaction.

4.6. ADVANTAGES OF 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.

V. TESTS ON CONCRETE

5.1. INTRODUCTION:

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. The tests methods should be simple, direct and convenient to apply. One of the purposes of testing hardened concrete is to confirm that the concrete used at site has developed the required strength.

The basic tests to be conducted in the field as well as in the lab based on its state of concrete are given below.

1. Tests on Fresh concrete
2. Tests on Hardened concrete

5.1.1. Tests on Fresh Concrete:

Fresh concrete or plastic concrete is a freshly mixed material which can be mould into any shape. Strength of concrete primarily depends upon the strength of cement paste. In other words, the strength of paste increases with cement content and decreases air and water content. Abrams water/cement ratio law states that the strength of concrete is only dependent upon water/cement ratio provided the mix is workable. Hence it can be clearly understood that the water/cement ratio required from the point of view of workability.

Hundred percent compaction of concrete will result in air voids whose damaging effect on strength and durability is equally or more predominant than the presence of capillary cavities. To enable the concrete to be fully compacted with given efforts, normally a higher a higher water/ cement ratio than that calculated by theoretical considerations may be required

5.1.2. Tests Conducted To Check Quality of Concrete:

The quality of concrete satisfying the above requirements is termed as workable concrete. The word workability or workable concrete signifies much wider and deeper meaning than the other terminology consistency often used loosely for workability. Consistency is general terms indicate the degree of fluidity or degree of mobility.

Concrete is most important construction material which is manufacture at the site and is likely to have variability of strength from batch to batch and also within the batch. The magnitude of this variation depends on several fain factors, such as, the variation in the quality of constituent materials, variations in mix proportions due to batching and mixing equipment available, the quality of overall workmanship and supervision at the site, and variation due to sampling and testing of concrete specimens.

The grading and shape of aggregates even from the same source vary widely. Considerable variations occur partly due to quality of plant available and partly due to efficiency of operation. There are no unique attributes to define the quality of concrete in its entirety. Under such a situation the concrete is generally referred to as being of good, fair or poor quality. This interpretation is subjective. It is therefore necessary to define the quality in terms of desired performance characteristics, economics, aesthetics, safety and other factors. Due to large number of variables influencing the performance of concrete, the quality control is an involved task. However, it should be appreciated that the concrete has mainly to serve the dual needs of safety (under ultimate loads) and serviceability (under working loads) including durability. These needs vary from one situation and one type of construction to another. Therefore, uniform standards valid for general application to all the works may not be practical. It should be noted that the usual 28 day cube tests are not the quality control measures in the strict sense; they are in fact the acceptance tests. In situations of site production and placing, the quality of the concrete is to be controlled way ahead of the stage of testing cubes at 28days.

The aim of the quality control is to reduce the above variations and to produce uniform material which provides the characteristics desirable for the job envisaged. Thus the quality control is a Co-operate, dynamic program me to assure that all the aspects of materials, equipment and work man ship.

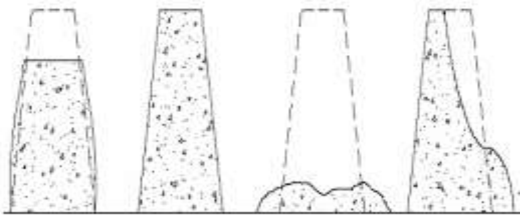
5.1.3. Tests to be conducted on site as well as lab for quality control are

1. Slump Test
2. Compaction Factor Test

5.1.3.1. 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. The test method is widely standardized throughout the world.

The apparatus consists of a mold in the shape of a frustum of a cone with a base diameter of 8 inches, a top diameter of 4 inches, and a height of 12 inches. The mold is filled with concrete in three layers of equal volume. Each layer is compacted with 25 strokes of a tamping rod. The slump cone mould is lifted vertically upward and the change in height of the concrete is measured. Four types of slumps are commonly encountered, as shown in Figure 5.1.3.1(a). The only type of slump permissible under ASTM C143 is frequently referred to as the "true" slump, where the concrete remains intact and retains a symmetric shape. A zero slump and a collapsed slump are both outside the range of workability that can be measured with the slump test. Specifically, ASTM C143 advises caution in interpreting test results less than ½ inch and greater than 9 inches. If part of the concrete shears from the mass, the test must be repeated with a different sample of concrete. A concrete that exhibits a shear slump in a second test is not sufficiently cohesive and should be rejected.



TRUE ZERO COLLAPSE SHEAR

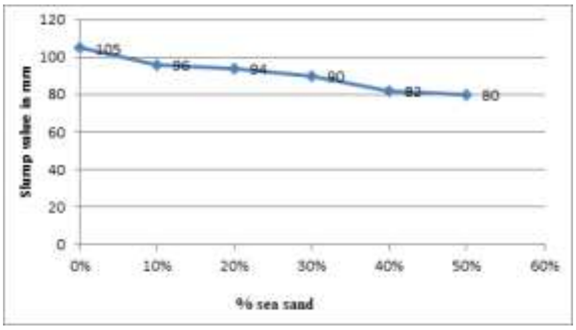
Figure -5.1.3.1(a): Four Types of Slump

The slump test is not considered applicable for concretes with a maximum coarse aggregate size greater than 1.5 inches. For concrete with aggregate greater than 1.5 inches in size, such larger particles can be removed by wet sieving. Additional qualitative information on the mobility of fresh concrete can be obtained after reading the slump measurement. Concretes with the same slump can exhibit different behavior when tapped with a tamping rod. A harsh concrete with few fines will tend to fall apart when tapped and be appropriate only for applications such as pavements or mass concrete. Alternatively, the concrete may be very cohesive when tapped, and thus be suitable for difficult placement conditions. This is a site test to determine the workability of the ready mixed concrete just before it's placing to final position inside the formwork, and is always conducted by the supervisor on site. However in mid of concreting process , should the site supervisor visually finds that the green concrete becomes dry or the placement of concrete has been interrupted , a re-test on the remaining concrete should be conducted in particular of the pour for congested reinforcement area.

Table-5.1.3.1. Slump Values of sea sand mix

SL 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: 5.1.3.1. Shows the variations in slump

5.1.3.2. 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

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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. To find the workability of freshly prepared concrete, the test is carried out as per specifications of IS: 1199-1959. Workability gives an idea of the capacity of being worked, i.e., idea to control the quantity of water in cement concrete mix to get uniform strength. The test should be carried out on a level ground. The top hopper must be filled gently and to the same extent on each occasion and the time between the end of mixing and release of concrete from top hopper must be content, two minutes will be convenient. The outside of mould must be wiped clean before weighing and mass should be recorded to the nearest 10 gm.

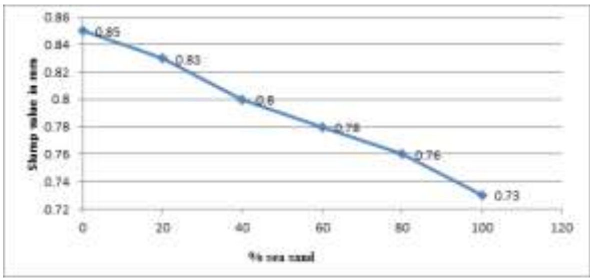
Figure-5.1.3.2: Shows compaction Factor Test

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.

The test has typically been used in precast operations and at large construction sites. Compared to the slump test, the apparatus is bulky and a balance is required to perform measurements. In addition to these practical drawbacks, the test has several flaws that reduce the accuracy of the results. Some of the work imparted into the concrete is lost in friction between the hoppers and the concrete. The magnitude of this friction varies between different concrete mixtures and may not reflect field conditions. Further, the compaction factor test does not utilize vibration, the main compaction method used in the field.

Table: 5.1.3.3. COMPACTION FACTOR VALUES OF SEA SAND:

S.NO	% 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: 5.1.3.3. Shows the variations in compaction factor

Advantages:

1. The compaction factor test gives more information (that is, about compact ability) that the slump test.
2. The test is a dynamic test and thus is more appropriate than static tests for highly thixotropic concrete mixtures.

Disadvantages:

1. The large and bulky nature of the device reduces its usefulness in the

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field. Further, the test method requires a balance to measure the mass of the concrete in the cylinder.

2. The amount of work applied to the concrete being tested is a function of the friction between the concrete and the hoppers, which may not reflect field conditions.
3. The test method does not use vibration, the main compaction method used in the field.
4. Although the test is commercially available, it is used infrequently.

5.1.4. CURING METHOD FOLLOWED:

Traditional curing:

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.

Figure-5.1.5: Shows Curing Tank

TESTS ON HARDENED CONCRETE:

For testing concrete in hardened state, it is required to cast the various moulds like cubes and beams. It is cured for the required period after 24 hrs of casting.

5.1.4.1. Introduction:

Compressive strength of hardened concrete is the most important parameter and representative of almost overall quality of concrete. It mainly depends on the water/cement ratio of the mix and curing and age after it is cast. Compressive strength of concrete is determined by testing the cylindrical or cubical specimens of concrete using a compression testing machine, at various ages such as: 7 days, and 28 days. Compressive strength test is conducted during mix proportioning for assessing the quality of concrete cast at site.

Tensile strength of concrete is found to be proportional to its Flexural Strength. It is determined by flexure test on beam specimens. Although the tensile strength of concrete is of no practical relevance, it is determined to show how a brittle material like concrete has very low strength as compared to its very high Flexural Strength. Tensile strength of concrete is determined by testing the concrete beam specimens using a universal testing machine at various ages such as: 7 days, and 28 days.

Table 5.1.6.Dimensions of the Specimens Used for Compressive Strength and Flexural strength:

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

Table 5.1.7.Number of specimens required for the 7, 28 days strength tests

% of sea sand replaced	No. of cubes for Compression test	No. of beams for flexural test
0	6	3
20	6	3
40	6	3
60	6	3
80	6	3

100	6	3
Total	54	

Total number of specimens = 54

Following tests are made by casting cubes, beams and cylinders from the representative concrete samples after, 7 and 28 days.

5.1.6.2. Test for Compressive Strength of Concrete:

This deals with the procedure for determining the Compressive Strength of concrete specimens. Tests shall be made at recognized ages of the test specimens, the most usual being 7 and 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. The ages shall be calculated from the time of the addition of water to the dry ingredients .Specimens stored in water shall be tested immediately on removal from the water and while they are still in the wet condition. Surface water and grit shall be wiped off the specimens and any projecting fins removed. Specimens when received dry shall be kept in water for 24 hours before they are taken for testing. The dimensions of the specimens to the nearest 0.2 mm and their weight shall be noted before testing.

Placing the Specimen in the Testing Machine the bearing surfaces of the testing machine shall be wiped clean and any loose sand or other material removed from the surfaces of the specimen which are to be in contact with the compression platens. In the case of cubes, the specimen shall be placed in the machine in such a manner that the load shall be applied to opposite sides of the cubes as cast, that is, not to the top and bottom. The axis of the specimen shall be carefully aligned with the center of thrust of the spherically seated plate. No packing shall be used between the faces of the test specimen and the steel plate of the testing machine.

As the spherically seated block is brought to bear on the specimen, the movable portion shall be rotated gently by hand so that uniform seating may be obtained. The load shall be applied without shock and increased continuously at a rate of approximately 140 kg/sq. cm/min until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained. The maximum load applied to the specimen shall then be recorded and the appearance of the concrete and any unusual features in the type of failure shall be noted.

It is determined from the expression given below

∴ Compressive Strength = P/A, in Mpa

Where, P = Maximum applied load in KN

A = Area of mould

Fig No: 5.1.6.2 (a)

Fig No: 5.1.6.2 (b)

CUBE UNDER COMPRESSION IN CTM CUBE AFTER CRUSHING

5.1.6.3. 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.

Direct measurement of tensile strength of concrete is difficult. Neither specimens nor testing apparatus have been designed which assure uniform distribution of the pull applied to the concrete. The beam tests are found to be dependable to measure the flexural strength property of concrete.

The value of modulus of rupture depends on the dimensions of the beam and manner of loading. The systems of loading used in finding out the flexural tension are central point loading and third point loading. In the center point loading, maximum fibre stress will come below the point of loading where the bending moments is maximum. The standard size of specimens are 15 x 15 x 70 cm. Alternatively, if the largest nominal size of the aggregate does not exceed 20 mm, specimens 10 x 10x 50 cm may be used.

The Universal Testing machine is used for testing the beam specimens. The specimen is placed in the machine in such a manner that the load is applied to the uppermost surface as cast in the mould, along two lines spaced 20 or 13.3 cm apart. The axis of specimen is carefully aligned with the axis of loading device. The load is applied in such a way that in increasingly manner at a rate of 180 kg/min for 10.0 cm specimen. The load is increased until the specimen fails, and the maximum load applied to the specimen during test is recorded.

The flexural strength of specimen is expressed as the modulus of rupture(f_b) which if ‘a’ equals the distance between the line of fracture and the nearer support, measured on center line of specimen, in cm, is calculated as follows

$$f_b = \frac{P\ x\ l}{b\ x\ d^2}$$

Where b = measured width of cm of the specimen

d = measured depth of cm of the specimen at point of failure

l = length in cm of the span on which the specimen is supported and

P = maximum load in kg applied to the specimen

Fig No: 5.1.6.3 (a)

Fig No: 5.1.6.3 (b)

BEAM UNDER TENSION IN UTM BEAM AFTER FAILURE

VI. RESULTS AND DISCUSSIONS

TABLE: 6.1: Shows the characteristic Compressive and Flexural Strength of the cubes and beams for different percentages of Sea sand

Percentage of sea sand added in concrete mix	Age in days	Compressive strength in Mpa	Flexural Strength in Mpa
0 %	7		
	28		
20 %	7		
	28		
40 %	7		
	28		
60 %	7		
	28		
80 %	7		
	28		
25 %	7		
	28		

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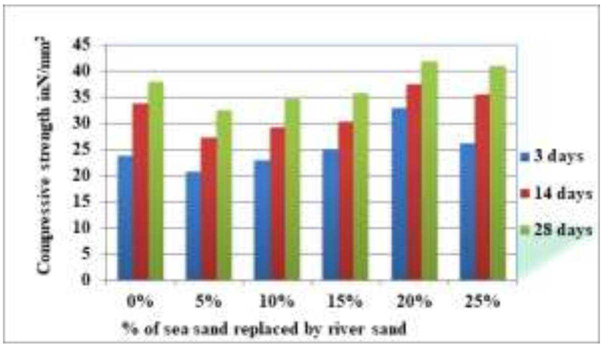
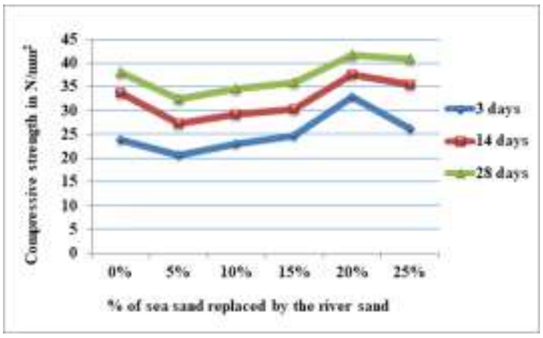
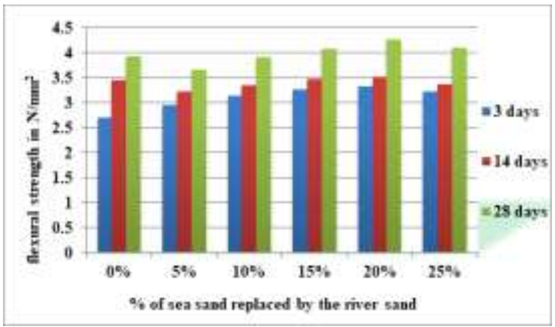


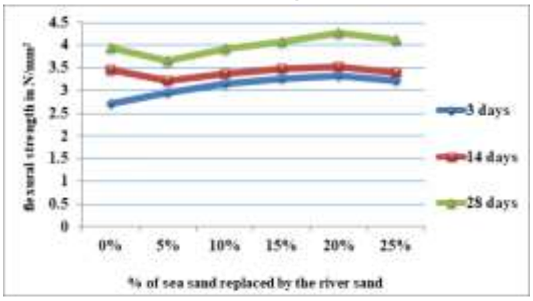
Graph-6.1(a) Compressive Strength v/s Different percentages of sea sand



Graph-6.1(b) Compressive Strength v/s Different percentages of sea sand



Graph-6.1(c) Shows Flexural Strength v/s Different percentages of sea sand



Graph-6.1(d) Shows Flexural Strength v/s Different percentages of sea 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.

VII. CONCLUSIONS AND SUGGESTIONS

Conclusions:

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.

Suggestions for future work:

1. The sea sand from different location can be collected and their properties could be studied.
2. The crusher dust from different quarries is to be added in different percentages instead of Fine aggregate and the strength is checked
3. Stress-strain curve can be plotted and their behaviour can be studied.
4. The crack pattern can be studied using fracture mechanics.
5. The usages of different percentages of other materials instead of river sand and check the variations in the strengths.

6. Some of waste products are fly ash, rice husk, saw dust, and discarded tires, plastic, glass rock, steel slugs and ceramic, can be used in different percentages instead of fine aggregate.
7. Admixture can be added and the properties can be studied.

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