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Experimental Investigation of Sea Sand for Construction Purposes

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Abstract

Objectives: This project is dealt with the usage of sea sand in the construction field with the removal of salt content from the sand. **Methods/Statistical Analysis:** An experimental setup with Sea Sand has been made suitable for construction purpose by reducing the salt content to equalize its properties similar to the River Sand. **Findings:** By removing the salt from sand by washing with ample water the purified sea sand exhibited better strength than the unpurified sea sand and river sand. Hence, it is proved that the corrosion is controllable. **Applications/Improvement:** The removal of salt content from water is mandatory and hence improves the workability and durability of any construction works.

Keywords: River Sand, Salt Content, Strength Properties, Sea Sand

1. Introduction

In this modern era, demand for sand increases and the cost also rise. The continuous grabbing of sand from the beds also leads to scarcity. To overcome this problem, the use of Sea Sand in construction field may be an alternative remedy. The history of using Sea Sand in our country is very short. When Sea Sand is mixed with cement in place of normal River Sand to make concrete for buildings, the high content of chloride in Sea Sand leads to defects in the structure.

This composition absorbs humidity which causes erosion and rusting in the steel rods used in reinforced concrete. With the invention of precision instruments, it may be possible in the future to modify the properties of Sea Sand concrete to make it suitable for construction[1]. An experimental setup is been set up for making Sea Sand suitable for construction purpose by reducing the salt content to equalize its properties similar to the River Sand. The removal of salt content present in the Sea Sand is mandatory because, it affects the durability and workability of the structure.

The scope of the projects is to utilize Sea Sand for the replacement of demand of River sand and to improve the high strength for the concrete. Thus, this study mainly focused on study the strength variations in concrete before and after the removal of salt content from the Sea Sand with respect to compression and compare the different test results on water to determine the hardness.

2. Materials and Methods

2.1 Sea Sand

An extensive assemblage of sand dunes of several types in an area where a great supply of sand is present;

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characterized by an observer of travel lines are directional indicator and by a wavelike appearance of dunes separated by troughs[1].

2.2 Properties of Sea Sand

Physical properties of coastal soils are scarce in number. Usually, these properties are studied together with the other soil characteristics. The texture of coastal soils may vary in a wide range from loose sandy deposits to heavy soils. The distribution of size fractions along the profiles of coastal soils is very uneven and rather random. As a rule, sandy layers of coastal soils are structure less and loose, sometimes they are somewhat compacted or rather even dense. Sandy horizons are characterized by a high water and air permeability. Therefore, the aeration of sandy soils is rather good; they are not so strongly affected by water logging as clayey soils.

The bulk density of sandy soils is somewhat higher than 1 g/cm[3]. The water content does not exceed 10-20 %. The bulk density of coastal soils generally decreases from sandy to clayey soils, from mineral to organic soils. Simultaneously, increase in the water holding capacity is observed. The Physical and Chemical properties of sea sand are determined using granular size, pH test, chloride test.

2.3 Properties of River Sand

The colour of the sand is Orange yellow and brown. Granular size of river sand is less than 4.75 mm.99.5 % of SiO_2 is pure in condition. Al_2O_3 and Fe_2O_3 are the impurities present (0.5%). Melting point is (1722 °C) with flux agent it reduces to 1290C[2]. River sand is uniform in size and also offered in various particle sizes. It has the property of reducing the shrinkage cracks.

2.4 Comparison of Sea Sand and River Sand

Sea sand is more stable (high SBC - Safe Bearing Capacity) than river sand. It is due to the fact that sea sand, which is brought by travelling water either pushed by sea shore or by river during the continuous rolling in between water layers in rivers and sea shore (which can be assumed as infinite time process) bigger stone particles continuously decaying during travelling towards sea and dissociates into as small as possible[3]. Remaining dissociate particles at beach will be of much strength than any other sand on earth surface.

2.5 Sand Test

Different tests were carried out on Sea Sand to determine its properties.

2.6 Specific Gravity Test

Specific gravity of solids, G_s is defined as the ratio of the weight of a given volume of solids to weight of an equivalent volume of water at 4C.

Specific Gravity = $W_2 - W_1 / (W_4 - W_1) - (W_3 - W_2)$

where,

W_1 = Weight of empty bottle (kg)

W_2 = Weight of soil dried in oven and cooled in a desiccators (300g) and bottle (kg)

W_3 = Weight of soil, water and bottle (kg)

W_4 = weight of water and bottle (kg)

2.7 Sieve Analysis

According to Indian Standard Code IS: 460-1962 (Revised), the sieve number is the mesh width expressed in mm for large sizes and in microns for small sizes. The set of I.S. sieves for fine sieve analysis consist of 2 mm, 1mm, 600µ, 425µ, 212µ, 150µ and 75µ sieves[4]. In the dry sieve analysis, dry soil (sea sand) of 1 kg is taken and is sieved through a selected set of sieves arranged according to their sizes, with the largest aperturized sieve at the top and the smallest aperturized sieve at the bottom. A receiver is kept at the bottom and a lid is placed on the topmost sieve of the stack. Shaking is done by the mechanical shaker. The amount of soil retained on each sieve is weighed to the nearest 0.1 g. On the basis of total weight of the sample taken and the weight of soil retained on each sieve, the percentage of the total weight of the soil passing through each sieve (also termed as finer per cent finer than) can be calculated. The sieve analysis results are presented in Table 1.

When the same above given tests are repeated for the purified sea sand taken from the experimental setup will produce the similar specific gravity and sieve analysis values. Hence the properties will remain the same for the normal and purified sea sand only the salt content will be reduced on the purification whereas the water along with salt content remains at the top. This water with the salt content is removed through the outlet. The sand is separated from the cylinder. The fresh sand is obtained in which nearly 75% to 80% of the salt is taken out after the repeating the process several times. The sand is wet and is dried in natural sunlight for hours.

Table 1. Sieve Analysis

S.No	Is Sieve	Weight retained (g)	Cumulative weight retained (g)	% Retained on a particular Sieve	Cumulative % retained	%Finer than the sieve under reference
1	2 mm	0	0	0	0	100
2	1 mm	0	0	0	0	100
3	600µ	0	0	0	0	100
4	425µ	0.016	0.016	0.0016	0.0016	99.9984
5	212µ	0.45	0.466	0.045	0.0466	99.9534
6	150µ	0.49	0.956	0.049	0.0956	99.044
7	75µ	0.044	1	0.0044	0.1	99.9

3. Test Result

3.1 Experimental Setup

The Experimental setup is shown in Figure 1. It has three main components like cylinder, steel rod and suction pump.

Figure 1. Experimental setup.

3.1.1 Cylinder

The material used in the cylinder is Acrylic. The dimensions of the cylinder are as follows. The height of the cylinder is 60.5 cm, Inner Diameter is 10 cm, and Outer Diameter is 10.8 cm. Normal tap water is supplied through the inlet at the bottom at a general velocity. The uplift pressure of water increases the water level. The sea sand is filled in the cylinder with the help of the opening present at the top of the cylindrical setup. The sand poured at the top mixes with the water supplied from the bottom.

3.1.2 Steel Rod

The rod is made of steel. The diameter of the rod is 8 mm and the height is 66 cm. Total no of rods placed in the steel rod is 9. The mixing of sand and supplied water is done with the help of the steel rod provided at the middle of the cylinder. The steel rod is connected with an AC motor which rotates at 200 rpm with the power of 1200 W. The rotation of steel rod helps in blending the sea sand and water. During the mixing of sea sand and water removal of salt content from the sea sand takes place. Separation process is done by using sedimentation method. Sedimentation method is the one in which heavier particles settle down at the bottom and lighter particles remains at the top of the container. By this process the mixed sea sand and water is separated.

3.1.3 Suction Pump

The discharge is 900 rpm. The voltage is 240 V and the capacity is 10 of 440 Volt. The Power Input is 0.80 KN. Head is 30 m and the size is 25 x 25 m. The sea sand which is heavier than the water settles down at the bottom at the top, with the help of the suction pump.

The dried sand is subjected to test to determine the strength of the Sea Sand after the removal of the salt content with the help of the experimental setup. The water along with the salt content which is removed through the outlet with the help of the suction pump after the sedimentation process is tested to examine the level of purification done on the Sea Sand and the measure of salt content in the water[5]. The cement and fine aggregate properties are presented in Table 2 and Table 3 respectively.

Table 2. Cement properties

Specific gravity of cement	3.15
Standard Consistency of cement	33%
Initial Setting Time of cement	125 min.
Final Setting Time of Cement	230 min.
Fineness modulus cement	7%

Table 3. Fine aggregate properties

Bulk density	**1615.38 kg/m^3**
Specific gravity	2.70
Fineness modulus	4.9

For a tolerance factor of 1.65 and using Table 1 of IS: 10262-1982, the target mean strength for the specified characteristic cube strength is 20 + (4.6x1.65) = 27.6 N/mm^2. From Figure 1 of IS: 10262-1982, the free water - cement ratio required for the target mean strength of 27.6 N/mm^2 is 0.50. This is lower than the maximum value of 0.65 prescribed for 'mild' exposure in Appendix A of IS : 456-1978[6].

From Table 4, for 20 mm nominal maximum size aggregate and sand conforming to grading zone 2, water content per cubic meter of concrete is 186 kg and sand content as percentage of total aggregate by absolute volume is 35 %. For change in values in water - cement ratio, compacting factor and sand belonging to Zone 3, the required adjustment[7] is given in Table 4.

Table 4. Mix ratio

Water	**Cement**	**Fine Aggregate**	**Coarse Aggregate**
191.6 l	383 g	546 g	1187 g
0.50	1	1.42	3.09

3.2 Compressive Strength

The compressive strength of concrete is one of the important and useful properties of concrete. In most structural applications concrete is employed primarily to resist compressive stresses. In those cases, where strength in tension or in shear is of primary importance, the compressive strength is frequently used as a measure of these properties. Therefore the concrete making properties of various ingredients of mix are usually measured in terms of the compressive strength. The compressive strength is determined using concrete cube 150 x 150 x 150 mm. The test results of various proportions for 7, 14, 28 days are presented as follows:

3.2.1 Composition of Concrete Cube

- Sea sand, Ordinary Portland cement, Aggregate passing through 20mm and retained on 10 mm, water – (A)
- Partial river and sea sand, Ordinary Portland cement , Aggregate passing through 20 mm and retained on 10 mm, water – (B)
- River sand, ordinary Portland cement, Aggregate passing through 20 mm and retained on 10 mm, water – (C)

4. Results and Discussion

4.1 Compressive Strength of Concrete Cubes

The sea sand which is taken from the Nagapattinam Region is used in the entire process. The sea sand is tested for compressive strength without the removal of salt content. The compressive strength of concrete (full replacement of river sand by sea sand and partially replaced river sand) has increased at 7, 14, and 28 days is presented in Table 5. Even though the sea sand attains high compressive strength the usage is not as frequent as River sand since, it leads to corrosion and the durability of the structure is not long lasting.

Table 5. Compressive Strength of Concrete Cubes

Sample		**Area (mm^2)**	**Load (kN)**			**Compressive strength (N/mm^2)**		
			7 days	**14 days**	**28 days**	**7 days**	**14 days**	**28 days**
A	A1	22500	202	328	452	8.97	14.57	20.0
	A2		203	330	455	8.98	14.66	20.22
B	B1	22500	170	248	446	7.61	11.02	19.80
	B2		172	250	448	7.64	11.11	19.91
C	C1	22500	208	337	455	9.23	14.98	21.10
	C2		209	338	456	9.28	15.02	20.26

4.2 Compressive Strength of Mortar Cube

After the removal of salt content by using our Experimental Setup the compressive strength of the mortar cube is determined. The test result shows the Purified Sea sand has more strength than the unpurified Sea Sand and River Sand. Hence, it is proved that the corrosion is controllable.

4.3 Other Test Results

The EDTA test, Chloride test carried out on various water samples (Potable Tap Water, Distilled Water, Rinsed Water in Sea Sand) shows the salt content.

5. Conclusion

This work deals with the usage of sea sand in the construction field with the removal of salt content from sand. After the purification of the sea sand using the experimental setup many tests are conducted on the sand and water is removed from the apparatus after the rinse mechanism. Partial mixing of purified sea sand and the river sand attains adequate strength at 28 days. The replacement of river sand by sea sand overcomes the future demand in the requirement of the river sand in construction. The purified sea sand has more strength than the unpurified sea sand and river sand. Hence, it is proved that the corrosion is controllable. This this project concluded that the removal of salt content from sea sand is mandatory for improving the workability and durability of any construction works.

6. References

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