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AN EXPERIMENTAL INVESTIGATION ON CONCRETE WITH PARTIALLY OR FULLY REPLACEMENT OF TREATED SEA SAND AS FINE AGGREGATE

G.PRANAY KUMAR[1], A. BALAJI[2], N.SIVA[3], U.BHARATH KUMAR[4]

[1]*Assistant Professor, Dept. of Civil Engineering, Sree Venkateswara College of Engineering, Nellore,*
[2,3,4] *B. Tech Student, Dept. of Civil Engineering, Sree Venkateswara College of Engineering, Nellore,*

Abstract— The concrete is the most popular building material in the world. It is composed of cement, fine aggregate[sand], and coarse aggregate mixed with water. Sand is the one of the material in concrete, it mostly used in all construction purposes. In current situation river sand has been most popular choice for the fine aggregate component of concrete, but overuse of the material has lead to depleting of securable river sand deposits and inconvenient transportation rises the cost of river sand resources. Therefore, it is desirable to obtain cheap, eco-friendly substitutes for river sand that is partial preferably sea sand. This project deals with the usage of sea sand in the construction field with the removal of salt content and organic matter from the sand. An experimental setup for boiling and number of washes with ample water are made suitable for reducing the salt content. And for removal of micro organic matter, wash the sea sand with water along chemical solution. To equalize its properties similar to the river sand. This study gives a comparison on the M25 grade conventional concrete properties and the partially replacement of sea sand as fine aggregate in concrete was used in gradually increasing proportion to make concrete blocks and test the compression and tensile tests at 7, 14, 28 days of curing. The test results for both the sets of concrete were tabulated and plot the graphs. Compare the test results evaluate the which percentage gives the best result.

Keywords— concrete, river sand, sea sand, salt content, matter and organic

I. INTRODUCTION

1.1 GENERAL

Concrete is the most widely used man-made product in the world. It occupies second place, only to water as the world's most utilized substance. Fundamentally, concrete is economical, strong, and durable. Concrete has an exceptionally important role in such densely populated developing countries as India and China. The overall demand of concrete per year is 11.5 billion tons. This means that, in addition to 1.5 billion tonnes of cement, the concrete industry is consuming annually 9 billion tonnes of sand and rock together with one billion tonne of mixing water. Sand is a unique raw material for the construction industry at present, but contractors have to spend more allocations for obtaining bulk loads of sand for their construction work. Especially during monsoons the sources of river sand are unpredictable due to the rise in river water table. Also governments have imposed norms on the mining and utilization of river sand for construction purposes According to the industry sources, the price level of the river sand has become skyrocketed. The continuous grabbing of sand from the beds also leads to scarcity. In many other countries the situation is similar; several have turned to alternative materials such as ROBO sand, glass powder and stone dust etc. But the cost of the concrete was increased. To overcome this problem, the use of Sea Sand in construction field may be an alternative remedy. An experimental setup is been set up for making Sea Sand suitable for construction purpose by reducing the salt content by boiling and number of washes with ample water are made suitable for reducing the salt content. And for removal of micro organic matter, wash the sea sand with water along chemical solution. To equalize its properties similar to the river sand.

1.2 OBJECTIVES

- To study the practical utilization of sea sand as fine aggregate partially or completely.
- To reduce the scarcity of river sand for construction.
- Replacement of Sea sand as fine aggregate.
- To reduce the river sand mining.
- To determine the compressive strength and spilt tensile strength of concrete with different percentages of sea sand as fine aggregate as partial replacement.

II. TESTS ON MATERIALS

2.1 TESTS ON CEMENT

Cement is a grey colour fine powder which is a mixture of calcareous and argillaceous material used for binding between the materials of concrete. In this project ordinary Portland cement (OPC) of 53 grade of specific gravity 3.15 and that confirms in accordance with IS 12269:1987 is used.

Figure 1: showing the Cement

LABORATORY TESTS

The following are the laboratory tests which are carried on cement

1) Fineness test
2) specific gravity test
3) Setting time test
4) Strength test

1. FINENESS OF CEMENT

Accurately weigh 100 gm of cement sample and place it over the test sieve No. 9 (90 microns). Gently break down the air set lumps if any with fingers. Hold the sieve with pan in both hands and sieve with gentle wrist motion, in circular and vertical motion for a period of 3 to 4 minutes without any spilling of cement.

Weight of the cement taken = 100 gm.

Weight of cement retained after sieving = 8 gm.

Fineness of the given sample is = 8%.

Figure 2: Showing the Sieves For Fineness

2. SPECIFIC GRAVITY OF CEMENT:

Weight of empty flask W1 = 30gm

Weight of empty flask+cement W2 = 95gm

Weight of empty flask+cement+kerosene W3 = 154gm

Weight of empty flask +kerosene W4 = 110gm

Specific gravity of cement = $(W2 - W1)/(W2 - W1) - (W3 - W4)$

= (95−30)/(95−30)−(154−110)

= 3.15

3. SETTING TIME TESTS

i. **NORMAL CONSISTENCY**

The objective of conducting the 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 certain solidity which is used to fix the quantity of water to be mixed to cement for the tests for tensile strength,compressive strength, setting time and soundness of cement as standard for comparing various cements, as it is the water cement ratio that decides the characteristics of cement water paste.

Figure 3: Showing the Vicats Apparatus

Table 1 : Results Of Normal Consistency

Amount Of Water (%)	Initial Reading	Final Reading	Depth of penetration from bottom (mm)
28	40	31	31
30	40	21	21
32	40	9	9
34	40	6	6

RESULT

Normal consistency of the given cement sample is 34%.

ii. INITIAL SETTING TIME OF CEMENT

Figure 4: Showing the Vicat Apparatus

RESULT

The initial setting time of the given cement sample = 45minutes

2.2. TESTS ON AGGREGATES

2.2.1. TESTS ON FINE AGGREGATE

2.2.1.1 SIEVE ANALYSIS

a) SIEVE ANALYSIS FOR ZONING OF RIVER SAND

Zone of sand is determined by comparing values obtained from sieve analysis.

Table 2 : Specifications Of Is: 383-1970 For Zoning Of Sand

SIEVE SIZE	ZONE – I	ZONE - II	ZONE - III	ZONE – IV
10mm	100	100	100	100
4.75mm	90-100	90-100	90-100	95-100
2.36mm	60-95	75-100	85-100	95-100
1.18mm	30-70	55-90	75-100	90-100
0.6mm	15-34	35-59	60-79	80-100
0.3mm	5-20	8-30	12-40	15-50
0.15mm	0-10	0-10	0-10	0-15
Fineness Modulus	4.0 – 2.71	3.31 – 2.1	2.78-1.71	2.25-1.35

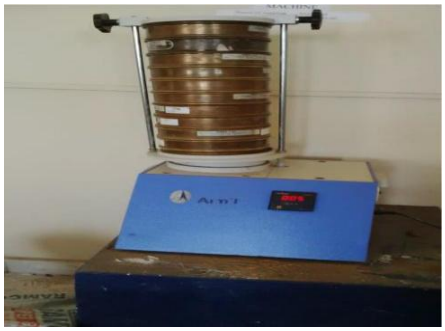


Figure 5: Showing the Sieve Analysis For River Sand

Table 6 : Results OnRiver Sand Sieve Analysis

SIEVE SIZE	WEIGHT RETAINED	% PASSING
4.75mm	0	100
2mm	0.76	99.924
1mm	244.75	75.449
0.6mm	280.75	47.37
0.425mm	162.7	31.1
0.3mm	134.29	17.671
0.15mm	132.27	4.444
0.075mm	0.19	4.425
Pan	34.24	1.001

Total percentage passing = 381.384

Fineness modulus = total percentage passing/100 = 381.384/100 = 3.81

From the results, the sand is conforming to Zone – II

b) SIEVE ANALYSIS FOR ZONING OF SEA SAND

Table 7 : Results OnSea Sand Sieve Analysis

SIEVE SIZE	WEIGHT RETAINED	% PASSING
4.75mm	0	100
2mm	3.09	99.691
1mm	59.78	93.713
0.6mm	216.72	72.051
0.425mm	211.99	50.852
0.3mm	252.10	25.642
0.15mm	241.56	1.486
0.075mm	0	1.486
Pan	11.12	0.374

Total percentage passing = 445.295
Fineness modulus = total percentage passing/100 = 445.295/100 = 4.45
From the results, the sand is conforming to Zone – I.

2.2.1.2. SPECIFIC GRAVITY OF FINE AGGREGATE

Figure 6 : Showing the Pycnometer

CALCULATION

M_1= mass of empty pycnometer = 0.62kg
M_2= mass of pycnometer and dry aggregate = 0.905kg
M_3= mass of pycnometer, aggregate and water = 1.665kg
M_4= mass of pycnometer filled with only water = 1.495kg

Specific gravity, $G = (M_2-M_1)/ ((M_2-M_1)-(M_3-M_4))$
$= (0.905– 0.620)/((0.905 – 0.620) – (1.665 – 1.495))$
$= 2.47$

2.2.2 TESTS ON COARSE AGGREGATE

2.2.2.1. SPECIFIC GRAVITY AND WATER ABSORPTION

Observations &calculations :

Weight of the saturated aggregates along with basket in water (A) = 2920 g
Weight of the empty basket in water (B) =1610 g
Weight of the surface dried saturated saturated aggregates (C) =2010 g
Weight of oven dried sample (D) =2000 g
Specific gravity = $D/C-(A-B)$
Water absorption = $100*(C-D)/D$
Specific gravity = $2000/ 2010-(2920-1610)$
= 2.86
Water absorption = $100*(2010-2000)/ 2000$
= 0.5%

Table 8 : Characteristics Of Coarse Aggregate

S.no	Characteristics	Value
1	Specific gravity	2.86
2	Water absorption	0.5%

2.3 MIX PROPORTION

Table 9 : Mix Proportion

WATER	CEMENT	FINE AGGREGATE	COARSE AGGREGATE
191.6Lit	436kg	436kg	872kg
0.44	1	1	2

2.4 PREPARATION OF SPECIMENS

2.4.1. BATCHING

Batching is the process of measuring concrete mix ingredients either by 'volume or by mass' and introducing them into the mixture. Traditionally batching is done by volume but most specifications require that batching be done by mass rather than volume. Percentage of accuracy for measurement of concrete materials as follows.

Figure 7: Showing the Volume Batching

2.4.2. MIXING

Mixing concrete is simply defined as the "complete blending of the materials which are required for the production of a homogeneous concrete". This can vary from hand to machine mixing. The materials of concrete should be mixed thoroughly so that there is uniform distribution of materials in the mass of concrete. The thorough mixing also ensures that cement water paste completely covers the surfaces of aggregates. The mixing of materials of concrete can be done either with hand or with the help of a cement mixer machine.

- **Hand Mixing**
- **Machine mixing**

Figure 9: Mixing

2.4.3. MOULDS PREPARATION

Test specimens cubical in shape shall be 15 × 15 × 15 cm as shown in figure 6.2 Cylindrical test specimens shall have a length equal to twice the diameter as shown in Figure 6.3

Iron type of moulds with proper size and shape are used for casting which free from dust particles, applying oil to the moulds properly inside every corner of the mould before concrete is spill in the moulds, level the top surface with trowel. This mould is positioned in levelled surface on the ground to maintain unique shape.

Figure 10: Showing the Moulds Preparation

2.4.4CASTING OF SPECIMENS

Placing and Compaction of Concrete

The operation of placing and compaction are interdependent and are carried out simultaneously. They are most important for the purpose of ensuring the requirements of strength, impermeability and durability of hardened concrete in the actual structure. As for as placing is concerned, the main objective is to deposit the concrete as close as possible to its final position so that segregation is avoided and the concrete can be fully compacted. The aim of good concrete placing can be stated quite simply.

Figure 11: Casting Of Specimens

2.4.5 DEMOULDING OF SPECIMENS

Test cubes should be demoulded between 16 and 24 hours after they have been made. If after this period of time the concrete has not achieved sufficient strength toenable demoulding without damaging the cube then the demoulding should be delayedfor a further 24 hours. When removing the concrete cube from the mould, take themould apart completely. Take care not to damage the cube because, if any cracking iscaused, the compressive strength may be reduced.

After demoulding, each cube should be marked with a legible identification on the top or bottom using a waterproof crayon or ink. The mould must be thoroughly cleaned after demoulding the cube. Ensure that grease or dirt does not collect between the faces of the flanges, otherwise the two halves will not fit together properly and there will beleakage through the joint and an irregularly shaped cube may result.

Figure 12: Showing the Demoulding Of Specimens

2.4.6. CURING OF SPECIMENS

Cubes must be cured before they are tested. Unless required for test at 24 hours, the cube should be placed immediately after demoulding in the curing tank or mist room. The curing temperature of the water in the curing tank should be maintained at 27-30°C. If curing is in a mist room, the relative humidity should be maintained at no less than 95%. Curing should be continued as long as possible up to the time of testing.

In order to provide adequate circulation of water, adequate space should be provided between the cubes, and between the cubes and the side of the curing tank. If curingis in a mist room, there should be sufficient space between cubes to ensure that allsurfaces of the cubes are moist at all times.

Figure 13: Showing the Curing Of Specimens

III. TREATMENT OF SEA SAND

3.1 PROCESS OF REMOVING CHLORIDE CONTENT IN SEA SAND:

The sea sand contains a high amount of chloride content. This makes the corrosion when it is used in the reinforcement. So to remove this chloride content there are threeprocess:

1. Hypo treatment and washing
2. Soaking and
3. Boiling process

3.1.1. HYPO TREATMENTAND WASHING

In this process some amount of sea sand say 1kg is weighed and poured into a drum with 1 litre of water, add 8 ml of hypo solution with 0.1 normality, mix evenly entire the sea sand. And this is mixed for 2 to 3 minutes. After then, wash with fresh water.

Normality:

$$\text{Normality} = \frac{weight\ of\ substance}{gram\ equivalent\ weight} X \frac{1000}{V}$$

$$0.1 = \frac{weight\ of\ substance}{248.18} X \frac{1000}{1000}$$

$eight\ wof\ substance$ = 24.818 grams/lit

3.1.2. SOAKING PROCESS

In this process some amount of sea sand say 50kg is weighed and poured into a drum with some water. And this is soaked for 1 week. During this one week we have to stir the sand with water. After this one week the sand is taken from the drum and dried in an oven.

FIGURE 15: Showing the Soaking Of Sea Sand

3.1.3.BOILING PROCESS

In this process the soaked sea sand which is dried in an oven is taken. So the sea sand is taken in a vessel with some water and is heated up to when it reaches a temperature of 100°c. And this temperature is measured by using thermometer. After this entire process the sea sand is again dried in an oven and the remaining water is tested for chloride test.

FIGURE 16: Showing the Boiling Of Sea Sand

IV. RESULTS ON THE EXPERIMENTAL INVESTIGATION

5.1 TESTS RESULTS OF CEMENT

OPC 53 Grade cement of KCP Company

Table 10: Showing the Cement tested in Concrete technology Laboratory

S NO	Property	Result
1	Fineness	8 %
2	Normal consistency	34%
3	Initial setting time	45 Min
4	Final setting time	500 min

5.2 TESTS RESULTS OF FINE AGGREGATE

1. Specific gravity river sand = 2.47
2. Fineness modulus of river sand = 3.81
3. It confirms to Zone 2 of IS 383-1970.
4. Fineness modulus of sea sand =4.45
5. It confirms to Zone 1 of IS 383-1970.

5.3 TESTS RESULTS OF COARSE AGGREGATE

• Locally Available 20mm Coarse Aggregate

Table 11: Showing the Coarse Aggregate tested in Concrete technology Laboratory

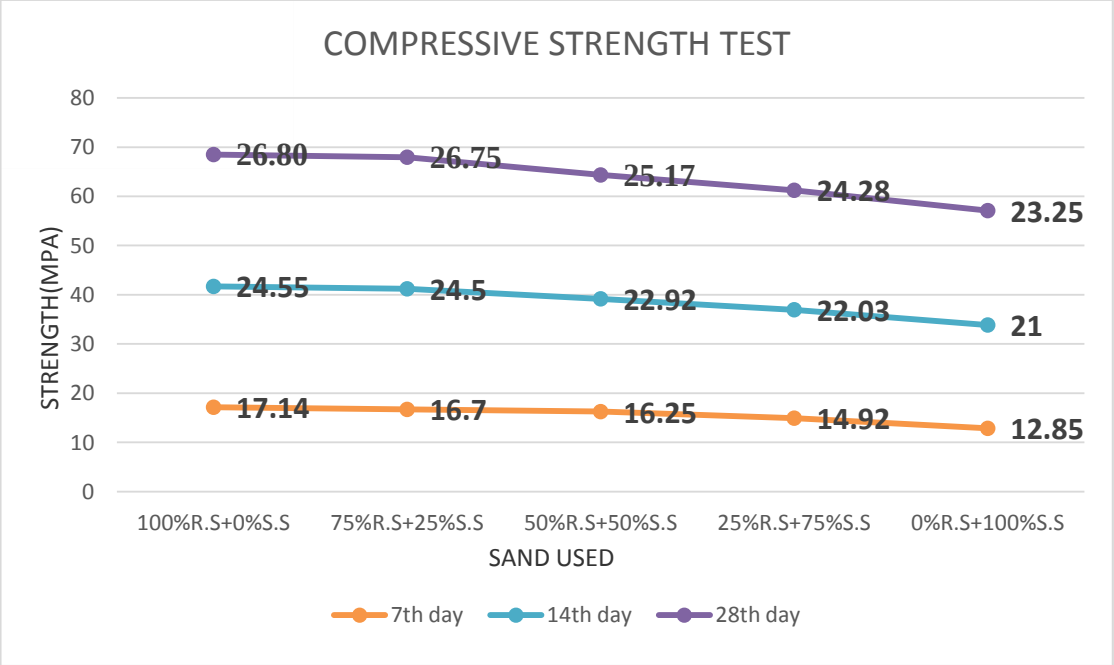
S.no	Characteristics	Value
1	Specific gravity	2.86
2	Water absorption	0.5%

5.4 TEST RESULTS ON CONCRETE SPECIMENS (cubes and cylinders):

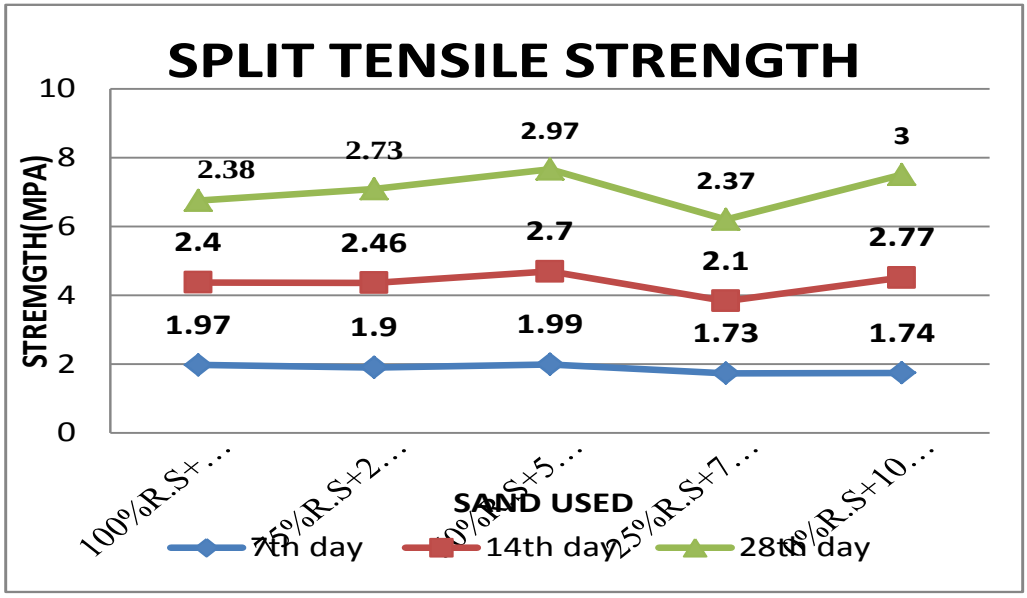
5.4.1 CYCLE 1 (NORMAL RIVER SAND AND SEA SAND)

TABLE 12: COMPRESSIVE AND SPLIT TENSILE STRENGTH OF NORMAL RIVER SAND AND SEA SAND

SNO	SAND USED	SPECIMEN NO	COMPRESSIVE STRENGTH (MPA)			SPLIT TENSILE STRENGTH (MPA)		
			7^{th} day	14^{th} day	28^{th} day	7^{th} day	14^{th} day	28^{th} day
1.	**100%R.S+0%S.S**	**1.**	17.44	24.44	26.69	1.95	2.09	2.36
		2.	17.88	24.11	26.36	2.01	2.17	2.44
		3.	16.11	25.44	27.69	1.95	2.09	2.36
		AVG	**17.14**	**24.55**	**26.80**	**1.97**	**2.11**	**2.38**
2.	**75%R.S+25%S.S**	**1.**	17.44	24.55	26.80	1.95	2.26	2.53
		2.	16.55	23.44	25.69	1.95	2.59	2.86
		3.	16.11	24.56	26.81	1.98	2.52	2.79
		AVG	**16.70**	**24.50**	**26.75**	**1.96**	**2.46**	**2.73**
3.	**50%R.S+50%S.S**	**1.**	16.11	23.67	25.92	1.87	2.66	2.93
		2.	16.55	23.67	25.92	2.12	1.77	2.04
		3.	16.11	21.44	23.69	1.98	2.68	2.95
		AVG	**16.25**	**22.92**	**25.17**	**1.99**	**2.7**	**2.97**
4.	**25%R.S+75%S.S**	**1.**	15.67	22.33	24.58	1.70	2.09	2.36
		2.	13.89	22.78	25.03	1.78	2.19	2.39
		3.	15.22	21.00	23.25	1.73	2.09	2.36
		AVG	**14.92**	**22.03**	**24.28**	**1.73**	**2.10**	**2.37**
5.	**0%R.S+100%S.S**	**1.**	12.56	21.89	24.14	1.73	2.77	3.04
		2.	13.00	21.00	23.25	1.73	2.66	2.93
		3.	13.00	20.11	22.36	1.78	2.77	3.04
		AVG	**12.85**	**21.00**	**23.25**	**1.74**	**2.73**	**3.00**



Graph 1: Compressive Strength Of Normal River Sand & Normal Sea Sand



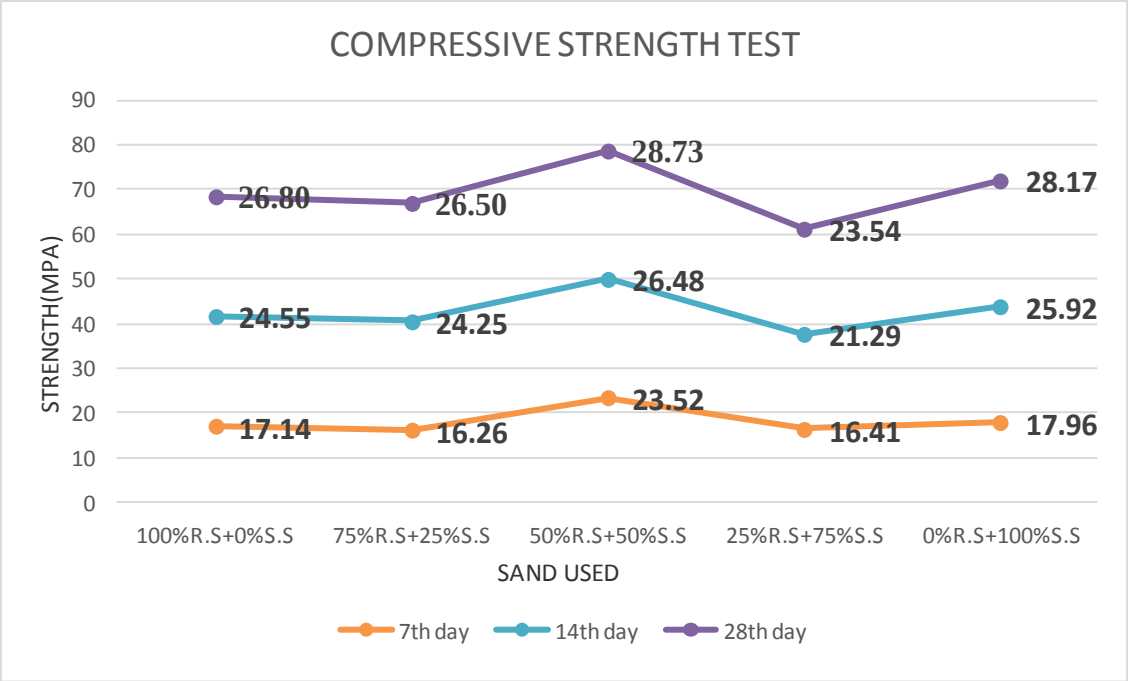
Graph 2: Split Tensile Strength Of Normal River Sand & Normal Sea Sand

5.4.2. CYCLE 2 (NORMAL RIVER SAND AND TRATED SEA SAND)

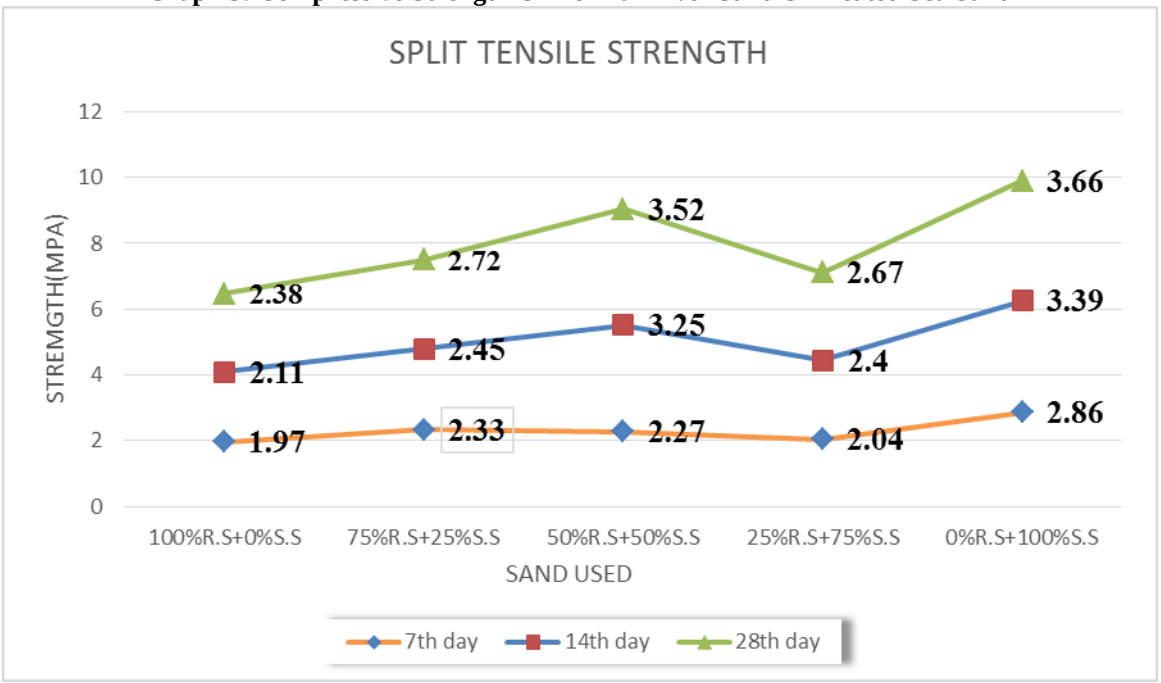
TABLE 13: COMPRESSIVE AND SPLIT TENSILE STRENGTH OF NORMAL RIVER SAND AND TREATED SEA SAND

SNO	SAND USED	SPECIMEN NO	COMPRESSIVE STRENGTH (MPA)			SPLIT TENSILE STRENGTH (MPA)		
			7^{th} day	14^{th} day	28^{th} day	7^{th} day	14^{th} day	28^{th} day
1.	100%R.S+0%S.S	1.	17.44	24.44	26.69	1.95	2.09	2.36
		2.	17.88	24.11	26.36	2.01	2.17	2.44
		3.	16.11	25.44	27.69	1.95	2.09	2.36
		AVG	**17.14**	**24.55**	**26.80**	**1.97**	**2.11**	**2.38**
2.	75%R.S+25%S.S	1.	16.56	26.78	27.69	2.15	2.46	2.73
		2.	15.67	26.33	24.14	2.43	2.46	2.76
		3.	16.56	26.33	27.69	2.43	2.40	2.67
		AVG	**16.26**	**26.48**	**26.5**	**2.33**	**2.45**	**2.72**

3.	**50%R.S+50%S.S**	**1.**	22.33	26.78	29.03	2.18	2.60	2.87
		2.	24.55	26.33	28.58	2.37	3.79	4.02
		3.	23.67	26.33	28.58	2.26	3.37	3.64
		AVG	**23.52**	**26.48**	**28.73**	**2.27**	**3.25**	**3.52**
4.	**25%R.S+75%S.S**	**1.**	17.59	21.00	23.25	1.53	2.21	2.48
		2.	15.67	21.00	23.69	2.23	2.49	2.76
		3.	15.67	21.44	23.69	2.38	2.49	2.76
		AVG	**16.41**	**21.29**	**23.54**	**2.04**	**2.40**	**2.67**
5.	**0%R.S+100%S.S**	**1.**	17.89	28.11	30.36	2.46	3.08	3.35
		2.	17.89	23.67	25.92	3.20	3.59	3.86
		3.	18.11	24.56	26.81	2.94	3.51	3.78
		AVG	**17.96**	**25.92**	**28.17**	**2.86**	**3.39**	**3.36**



Graph 3: Compressive Strength Of Normal River Sand & Treated Sea Sand



Graph 4: Split Tensile Strength Of Normal River Sand & Treated Sea Sand

V. COST COMPARISON

6.1 DIMENSIONS AND COST

Size of tractor truck = 12 x 4 x 2 = 96 ft

=29.26 m^3 = 30 m^3

The one truck = 1 unit

Cost of one unit river sand = Rs 1900

Cost of one unit 20 mm aggregate = Rs 3400

Cost of one unit sea sand = Rs 800

Cost of one bag of cement = Rs 380

[1 bag = 0.03472 m^3 ; 30 m^3 = 864.05 kgs]

6.2 1M^3 COST OF CONVENTIONAL CONCRETE AND SEA SAND CONCRETE

table1 14: cost of concretes

S.NO	MATERIAL	RIVER SAND CONCRETE	SEA SAND CONCRETER
1	CEMENT	3313.6	3313.6
2	FINE AGGREGATE	13.71	5.77
3	COARSE AGGREGATE	49.68	489.68
4	CHEMICALS	0	16.05
	TOTAL	3386.109	3385.1

VI. CONCLUSION

7.1 COMPRESSIVE STRENGTH

❖ **CONVENTIONAL**

- The compressive strength for 0% normal River Sand+100% normal Sea Sand at the age of 7days of curing is **13.25% strength decreased.**
- **The Strength Continuously Fall Due To Increasing Of Sea Sand, So Is Not Possible To Use In The Construction**

❖ **REPLACEMENT OF TREATED SAND**

- The compressive strength for 0% normal River Sand+100% treated Sea Sand at the age of 28days of curing is **5.11% strength increased.**
- **The Strength After Treatment Is 5.11% Increased Abnormally In A Gradual Way.**

7.2 SPLIT TENSILE STRENGTH COMPARISSION

❖ **CONVENTIONAL CONCRETE**

- The highest split tensile strength for 0% normal River Sand+100% treated Sea Sand the age of 28days of curing is **26.05% strength increased.**
- **The Split Tensile Strength Is Increased In Non Treated Sand In A Fluctuated Manner**

❖ **REPLACEMENT OF TREATED SAND**

- The highest split tensile strength for 0% normal River Sand+100% treated Sea Sand the age of 28days of curing is **53.78% strength increased.**
- **The Split Tensile Strength Is Increased In Treated Sand In A Fluctuated Manner.**
- **In the cost point of view the sea sand concrete is slightly 0.03% strength less than river sand concrete.**
- **So, the eco- friendly point of view this concrete is safe.**

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