Partial Replacement of Sea and Desert Sand in Place of River Sand for Mortar in Construction

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Abstract

As the river sand is widely used in construction industry, the demand for fine aggregate is increasing rapidly. River sand has been the most widely used as fine aggregate around the world and to meet the demand has led to various harmful consequences such as increase in the depth of the river bed, lowering of the water table and salinity intrusion into the rivers. As a result, there was an immediate requirement for alternatives to river sand such as manufacturing sand which is prominently used as alternative material. An experimental study is made on the strength aspects of cement mortar by partially replacing river sand with Sea Sand and desert sand as fine aggregate. This study gives a comparison on the relevant material properties of Sea Sand (SS), Desert Sand (DS) and River Sand (RS).Different fine aggregate materials (SS, DS and RS) were used in 10%, 20%, 30%, 40% and 100% proportion to make cement mortar blocks and tested for compressive strength at 3, 7, 28 and 56 days of curing. The Sea Sand was partially replaced with the River Sand (10% SS and 90% RS) mortar blocks were cast and similarly for desert sand (10% DS and 90% RS). For each proportion of Fine Aggregates (FA) cement mortar blocks were cast and tested for compressive strength at 3, 7, 28 and 56 days of curing. The compressive strength results for both the sets of replacements (SS+RS and DS+RS) were tabulated and graphs were plot for compressive strength v/s curing period.
Keywords- Sea Sand, Desert Sand, River Sand, Cement Mortar, Compressive Strength

I. INTRODUCTION

Sand is loose particles of hard broken rock and it comprises of grains from disintegrated rock. The diameter of grains ranges between 0.06 and 2.0 mm in size and varies in shades of brown and orange in color. Sand provides bonding strength and other properties for the construction materials like mortar and concrete.

A. Fine Aggregates

Aggregates which are have grain size less than 4.75mm from IS 383: 1970 classified as fine aggregates. The presence of fine aggregates in the concrete or mortar greatly increases its strength, surface area, volume and durability. This is a brittle in its pure state. Thus concrete or mortar is a true composite material.

1) Types of Fine Aggregates

1) Natural sand
2) Crushed stone sand
3) Crushed gravel sand

1) Natural sources of Fine Aggregates

Natural occurring sand or fine aggregates are a product of many thousands of years of erosion. Natural fine aggregates are a result of the disintegration of rocks which have been deposited by streams, glacial agencies or sea. The naturally occurring sand particles consist of small grains of silica (SiO2) which are formed by the weathering of rocks. The major weathering agent for sand formation is flowing water. Pit sand, river sand and sea sand are the three sources of fine aggregates occurring naturally.

2) Pit Sand

This sand is found as deposits in soil and it is obtained by forming pits into soils. It is excavated from a depth of about 1m to 2m from ground level. The pit sand consists of sharp angular grains which are free from salts and it proves excellent material for mortar or concrete work. For making mortar, the clean pit sand free from organic matter and clay should only be used. When rubbed between the fingers, the pit sand should not leave any stain on the fingers. If there is ant stain, it indicates the coating of oxide of iron over the sand grains.

3) River Sand

This sand is obtained from banks or beds of rivers around the world. The river sand consists of fine rounded grains probably due to mutual attrition under the action of flowing water. The color of river sand is almost white.

4) Sea Sand

This sand is obtained from sea shores or from off-shore dredging in deep seas. The sea sand, like river sand, consists of fine rounded grains. The color of the sea sand is light brown. The sea sand contains salts that attract moisture from the atmosphere and such absorption causes dampness, efflorescence and disintegration of work. The sea sand also retards the setting time of cement. Due to all such reasons, it is the general rule to avoid the use of sea sand for engineering purposes. It can however be used as a local material after being thoroughly washed to remove the salt.2

Seashells present in the sea sand are a hard material that can produce good quality concrete and mortar, however, higher cement content may be required. Also, due to the angularity of the shells, additional cement paste is required to obtain the desired workability. Aggregate containing complete shells (uncrushed) should be avoided as their presence may result in voids in the concrete or mortar and lower the compressive strength. As per BS 812 part 106 code the shell content (shells of size below 5mm) in the sea sand shall be a maximum of 10%.3

Marine-dredged aggregates often contain primary salts which are sodium chloride and magnesium sulfate and the amount of salt on the aggregate is often not more than about 1% of the mass of the mixing water. The highest salt content occurs in sands located just above the high-tide level. Use of these aggregates with drinkable mix water often contributes less salt to the mixture than the use of seawater (as mix water) with salt-free aggregates.

Marine aggregates are appreciable source of chlorides. The presence of these chlorides may affect the concrete by altering the time of set, increasing drying shrinkage, significantly increasing the risk of corrosion of steel reinforcement and causing efflorescence.1

5) Crushed Stone Sand

Fine aggregates produced by crushing hard stones like granite and basalt. Manufactured sand and quarry dust are examples for this type of sand.

6) Manufactured Sand

As the decreasing quantity of river sand, now the use of manufactured sand as a replacement is increased. M sand is having the properties similar to river sand and it it is obtained by the manual crushing of parent rock for required size.

B. Qualities of Good Fine Aggregates

Should not contain impurities like Silt, Clay and salts. These impurities can affect physical and chemical properties of fine aggregates.

- It should be free from organic matter.
- It should contain clean, coarse and well graded angular grains in suitable proportions.
- Grains of the fine aggregates should be hard, strong and durable.
- It should be free from hygroscopic moisture.
- It should be chemically inert.

C. Functions of Fine Aggregates in Mortar or Concrete

1) Bulking: Fine aggregates help in increasing the volume of concrete or mortar there by resulting in its cost reduction.
2) Setting: If binding material is lime, the carbon dioxide should be absorbed through the voids of fine aggregates and setting of lime should occur effectively.
3) Shrinkage: Fine aggregates should prevent excessive shrinkage of the mortar in the course of drying and hence the cracking of mortar during setting is avoided.
4) Strength: It should help in the adjustment of strength of mortar or concrete by variation of its proportion with cement or lime. It should also increase the resistance of mortar against crushing.
5) Surface Area: It should subdivide the paste of the binding material into a thin film and thus more area should be offered for its spreading and adhering.

II. OBJECTIVES

- To reduce the scarcity of river sand for construction.
- Replacement of Sea sand and Desert sand as fine aggregate.
- To reduce the river sand mining.
- To use sea sand and desert sand in construction for plastering purpose.
- To determine the compressive strength of cement mortar containing Sea sand and Desert sand.

III. EXPERIMENTAL PROGRAM

The aim of this experimental program is to compare the properties of normal cement mortar with sea sand mortar and desert sand mortar. The basic tests and its properties carried out on materials like cement, River sand, Sea sand and desert sand. The values are listed for all samples are discussed in Table 1 and 2 given below.

Table 1: Summary of the various testes conducted on cement are as under given below in table

Sl. No	*Characteristics*	*Values obtained*	*Standard values*
1.	*Normal consistency*	*32%*	*26 – 34%*
2.	*Initial setting time*	*30 min*	*Not be less than 30 min*
3.	*Final setting time*	*600 min*	*Not to be greater than 600 min*
4.	*Fineness*	*5%*	*<10*
5.	*Specific gravity*	*3.0*	*2.9 – 3.15*

Table 2: Properties of Fine aggregates

Sl. No	*Characteristics*	*Obtained Values*			*Reference codes*
		River Sand	*Sea Sand*	*Desert Sand*	
1.	*Specific Gravity*	*2.4*	*2.6*	*2.65*	*IS: 2386 (Part III) 1963*
2.	*Silt Content*	*4%*	*0%*	*0.8 to 1%*	*IS: 2386 (Part III) 1963*
3.	*Fineness*	*1.7% by weight of aggregate*	*0%*	*0%*	*IS 2386: (Part I) 1963*
4.	*Total Water Absorption*	*1.3% by weight of aggregate*	*0%*	*0%*	*IS: 2386 (Part III) 1963*
5.	*Bulking Of Sand*	*5.2%*	*14.2%*	*10%*	*IS: 2386 (Part III) 1963*
6.	*Sieve Analysis*	*Zone II*	*50 -200 mm*	*200 mm and above*	*IS 373: 1970 IS: 2386 (Part I) 1963*

IV. METHODOLOGY

The cement mortar of ratio 1:6 is calculated as per IS: 4031-PART 6-1988 and the following data was required for producing a masonry mortar. (Field testing masonry mortar)

1) Cement used is OPC (According to IS 1489: 1991(part 1) Table 1 as given the properties of Cement mentioned above.
2) River sand, Sea sand and Desert sand are used as fine aggregates and there properties are mentioned in Table 2.

The Mortar is manually mixed in the ratio of 1:6 (cement and sand) and water is depend on normal consistency value of cement i.e. 32% mentioned in the Table 3 given below, here the River sand is partial replaced by Sea and Desert sand for 10%, 20% and 30% with the cement weight and mould of 7 cm X 7 cm X 7 cm is casted and tested for 7, 14, 28 and 56 days strength for mortar cubes.

Depending on Normal consistency value the water content is calculated as mentioned in Table 3 below

Normal Consistency = P =32%

Water content = (P/4+3) % *(wt. of cement + sand)

= (32/4+3) % *(200+1200) = 154ml

Table 3: Quantity of Cement, River sand, Sea Sand and Desert Sand for 1:6 Mortar cubes at 0, 10 %, 20 %, 30 %, 40% and 100% variations

Sl No	*Percentage*	*Cement gms*	*River Sand gms*	*Sea Sand gms*	*Desert Sand gms*	*Water ml*
1	*0%*	*200*	*1200*	*-*	*-*	*154*
2	*10%*	*200*	*1080*	*120*	*120*	*154*
3	*20%*	*200*	*960*	*240*	*240*	*154*
4	*30%*	*200*	*840*	*360*	*360*	*154*
5	*40%*	*200*	*720*	*480*	*480*	*154*
6	*100%*	*200*	*-*	*1200*	*1200*	*154*

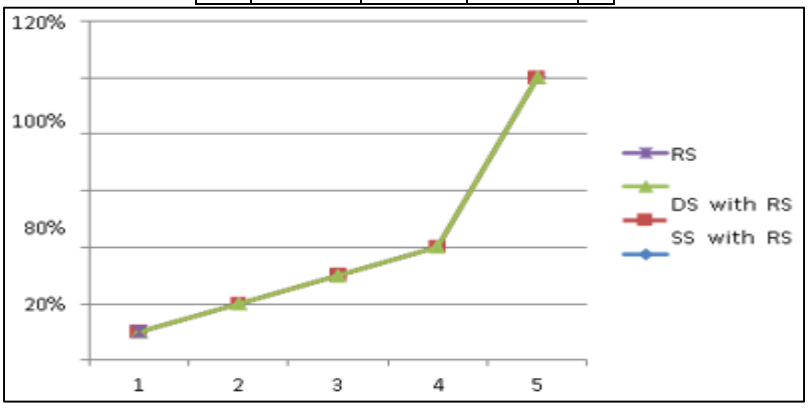
V. RESULTS AND DISCUSSIONS

A cement mortar cubes are prepared for 1:6 ratios, the water is calculated for the normal consistency value 32 % depend on IS: 4031-PART 6-1988. The fine aggregates are partial replaced by the amount of 0%, 10%, 20% and 30% by the weight of cement in the mortar mix with the river sand.

For the fresh mortar the flow table test is carried out, the results are given as in Table 4

Table 4: Results of Flow table test for Sea sand with River Sand and Desert Sand with River Sand

Sl No	*Percentage*	*SS with RS*	*DS with RS*	*RS*
1	*10%*	*55 mm*	*45 mm*	*20 mm*
2	*20%*	*65 mm*	*50 mm*	
3	*30%*	*67.5 mm*	*55 mm*	
4	*40%*	*69.2mm*	*58mm*	
5	*100%*	*73 mm*	*82 mm*	



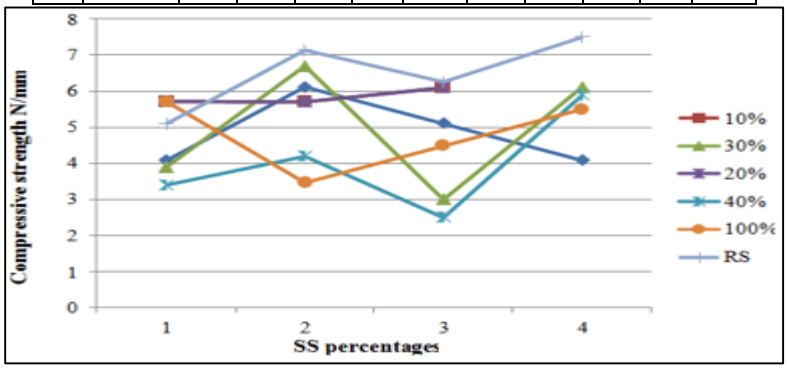
Graph 1: Flow Table test results for RS, SS and DS

A. Compressive Strength Test Results

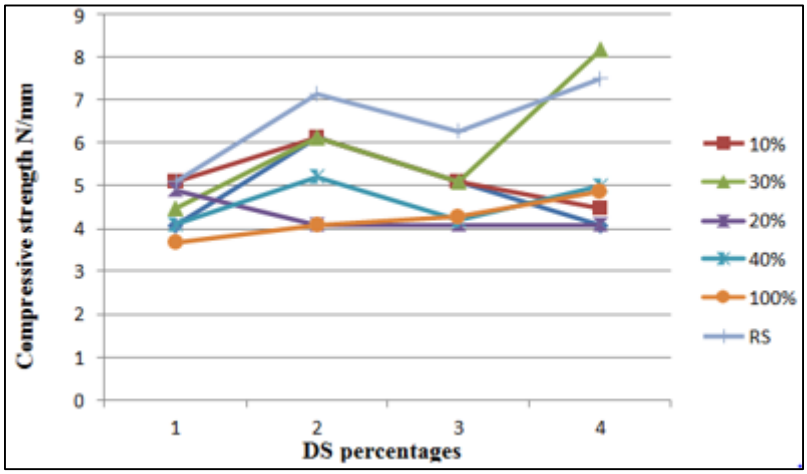
Table.5 presents the Compressive strength of cement mortar with partial replacement of Sea and desert sand with River sand, where 0% is RS it is a normal cement mortar of 1:6 ratio, SS 1 with sea sand of 10% and DS 1 of with Desert sand of 10%, SS 2 with sea sand of 20% and DS 2 of with Desert sand of 20%, SS 3 with sea sand of 30% and DS 3 of with Desert sand of 30%, Graph 2 shows the graphical representations of compressive strength of all mixes SS1, SS2, SS3 and DS1, DS2, DS3 for 7, 14, 28 and 56 days.

Table 5: Compressive Strength test results at varying % of River sand, Sea and Desert sand after curing of 7, 14, 28 and 56 Days of curing.

Days	*RS 100 %*	*Compressive Strength N/mm^2 (SS WITH RS)*					*Compressive Strength N/mm^2 (DS WITH RS)*				
		10 %	*20 %*	*30 %*	*40%*	*100%*	*10 %*	*20 %*	*30 %*	*40%*	*100%*
7	*5.1*	*4.08*	*5.71*	*3.9*	*3.4*	*5.71*	*5.1*	*4.89*	*4.48*	*4.1*	*3.67*
14	*7.14*	*6.12*	*5.7*	*6.7*	*4.2*	*3.46*	*6.12*	*4.08*	*6.12*	*5.2*	*4.08*
28	*6.26*	*5.1*	*6.1*	*3.0*	*2.5*	*4.48*	*5.1*	*4.08*	*5.1*	*4.2*	*4.28*
56	*7.5*	*4.08*	*6.12*	*5.7*	*5.9*	*5.5*	*4.48*	*4.08*	*8.16*	*5.0*	*4.87*



Graph 2: Compressive strength N/mm^2 gained in number of days for SS with RS



Graph 3: Compressive strength N/mm2 gained in number of days for DS and RS

VI. CONCLUSIONS

Following are the conclusions can be made based upon the studies made by various researches:

1) The sea sand sample obtained from Malpe beach was found to be very fine in nature while all other relevant properties of it being within the limits.
2) The Desert sand sample from Talkadu is very loose and it has less silt content and fine and all the parameters are within the limit.
3) By comparing above results with Normal cement mortar with river sand which is replaced with sea and desert sand The compressive strength values of all mix tend to decrease below the values for the reference normal mortar mixes. This may attribute to the decrease in the adhesive strength between the materials.
4) The compressive strength obtained by the partial replacement of sea sand and desert sand is very less compare to normal cement mortar
5) The optimized proportion of this sea sand and desert sand as replacement in fine aggregates (River sand) was found out from the results obtained for compressive strength of cement mortar blocks to be 30% SS in RS and 30% DS in RS.
6) As the strength is increasing for number of days (56) for both sea and desert sand it can be used for light weight structures and plastering purposes.

VII. FUTURE WORK

- As it is sea sand it consist of salt content the durability parameters should be tested for future work.
- The durability parameters for desert sand are tested for further use.
- The concrete blocks are casted for both sea and desert sand for minimum 28 days of curing and compressive strength is calculated for future works.

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