The Accessibility, Suitability and Performance of alternatives of natural sand in concrete as an optimization technique in recent construction

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Abstract - *In the present scenario of construction industry, the accessibility of natural sand as fine aggregate is inadequate to assemble the stipulation of speedily emerging construction sector. This experiment is carried out to research suitableness of different fine aggregate such as sea sand, crusher sand and granite waste powder. In this study, more number of fine aggregate is taken into consideration for safeguarding environment and conserving the depletion of natural river sand. On the other hand, the alternatives chosen so far is not procurable at various site of construction. The main rationale of this project is to utilize sea sand existing naturally as well as crusher sand and granite waste powder being produced artificially as a replacement of river sand in different combination .The concrete cubes and beams were casted and cured for 7, 14 and 28 days then subsequently were tested using compression testing machine and universal testing machine for getting compressive strength and flexural strength. Based on the experimental investigation it is concluded that the full replacement as well as partial replacement is a better practice to develop the strength of the M_{30} concrete by alternative means.*

***Key Words*:** River sand, replacement, suitableness, environment, depletion, compressive strength, flexural strength.

1. INTRODUCTION

Today, the world is using concrete at a gigantic scale. Concrete is the most essential component of development. Basically, concrete is composed of cement, fine aggregate, coarse aggregate, water and a suitable admixture. The most commonly used fine aggregate is natural river sand. Sand can also associated with a textural class of soil or soil type. The composition of sand deviate, depending on the parent rock, mineral composition and location of its formation. Sand is a non-renewable resource over human timescale, and thus the sand possessing sound class suitable for making concrete have high demand in the construction sector. Rapid increase in the construction sector leads to critical shortfall of construction materials. The excessive instream sand and gravel mining causes the degradation of river and streams. Mining depletes the stream bottom which depletes the stream bottom and may cause bank erosion. This significantly degrades the ground water table and leads to saline water intrusion from the seashore. In addition to this, excessive sand mining is challenge to bridge, river bank, nearby structures. It also results in the degradation of aquatic life and their habitat.

For the past five years, the acceleration in rate of sand due to governmental restrictions in different states of India. On the other hand, the granite waste created by the industry has been collected over years, the accumulated quantity is utilized only in considerable quantity and the rest is disposed of resulting in pollution problems. The function of fine aggregate is to boost in producing the workability and uniformity of mixture. The river deposits are the most common fine aggregate used in concrete. But, nowadays the natural river sand has become deficient and uneconomic. Hence the time has come to judge and find a suitable alternative so as to prevent the depletion of natural sand. In this study, it is proposed to research on three different fine aggregate such as sea sand occurring naturally as well as crusher sand and granite waste with their full replacement and partial replacement in different combination.

1.1 Study of material and its properties:

The constituents of the concrete I.e. cement, fine aggregate and coarse aggregate are tested before going for its manufacturing. The relevant Indian standard codes were followed for carrying out the test on the materials.

Cement: The cement used in the project work is *Priya* cement of 53 grade (OPC). The properties of cement refereed by IS 1489-1967is tested. Cement used din this study is ordinary Portland cement conforming to IS .The specific gravity of the cement is 3.12.

Table -1: Properties of cement.

SN	Properties	Results
1.	Normal Consistency	31%
2.	Initial setting Time Final Setting Time	32 min 540 min
3.	Specific gravity	3.12
4.	Fineness of Cement	3%

Fine aggregate: River sand is the naturally occurring granular material made up of finely divided rocks and minerals particles. Due to the shortage of good quality river sand for the use construction the use of alternative of fine aggregate is being considered.

Table -2: Properties of Fine aggregate.

SN	Fine aggregate	Properties	Results
1.	River sand	Specific Gravity	2.57
		Fineness modulus	1.9
		Grading zone	IV
2.	Sea sand	Specific Gravity	2.43
		Fineness modulus	1.6
		Grading zone	IV
		pH before washing	8.80
		pH after washing	7.2
		Chloride content(Unwashed)	164.11 gm/l
		Chloride content(Washed)	54.51 gm/l
3.	Crusher sand	Specific Gravity	2.7
		Fineness modulus	2.4
		Grading zone	III
4.	Granite powder	Specific Gravity	2.8
		Fineness modulus	1.4
		Grading zone	IV

As a comparative study, the three alternatives are chosen for the study which are sea sand, crusher sand and granite waste powder. The sea sand was collected from the nearby sea and was washed in wash basin. Similarly, the granite waste powder was collected from the granite cutting industry. Crusher sand is obtained from the crusher where hard granite stone is crushed in to smaller size less than 4.75 mm, the crushed material bearing angular shape with conical edge.

Coarse aggregate: Crushed granite stone of sieve size passing between 20 mm and retaining 10 mm was used for the concrete work. The crushed granite stone was procured from nearest crusher. The specific gravity test for coarse aggregate was done as per the guideline provided by IS 2386 part III 1963.

1.2 METHODOLOGY

In this experimental investigation, the study deals with the suitableness of the different types of alternatives of natural river sand as fine aggregate with full and partial replacement. On the basis of location, cost and ease of availability of materials three alternatives are chosen in this project which are sea sand, crusher sand and Granite waste. The flow sequence of the project work is illustrated in the Chart 1 below.

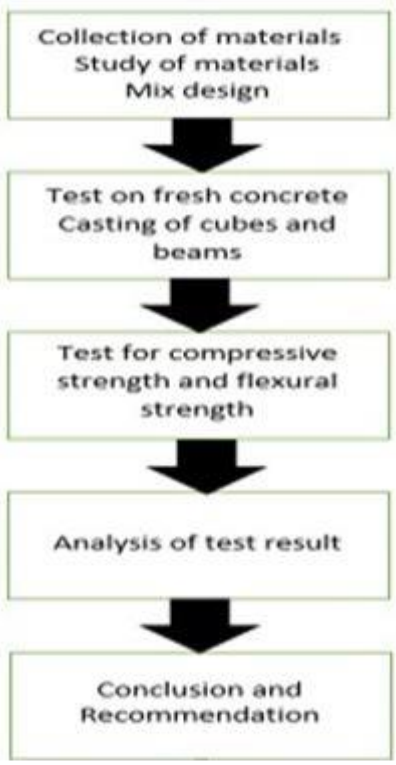

Chart-1: Flowchart of the project.

The different modelling of the combination of fine aggregate is represented in the table below.

Table -3: Modelling of various combination of Fine aggregate.

SN	C	PERCENTAGE OF FINE AGGREGATES			
		RS	SS	CS	GP
1.	C1	100	0	0	0
2.	C2	0	100	0	0
3.	C3	0	0	0	100
4.	C4	0	0	100	0
5.	C5	70	10	10	10
6.	C6	40	20	20	20
7.	C7	25	25	25	25
8.	C8	10	30	30	30
9.	C9	0	33.33	33.33	33.33

Whereas C=combination, RS, SS, CS and GP Represents River sand, sea sand, crusher Sand and granite powder respectively.

The concrete was designed for M30 grade and the mix design was done as per the guideline provided in IS 10262:2009 .The adopted value for water cement ratio was 0.44 and the mix ratio is shown in tabular form. The combination considered is compared in terms of compressive strength and flexural strength.

Table -4: Mix design table for modelling.

SN	C	CEMENT (Kgs)	FA (Kgs)	CA (Kgs)	MIX RATIO
1	C1	447.72	690.5	1155.08	1:1.54:2.57
2	C2	447.72	605.75	1155.08	1:1.35:2.57
3	C3	447.72	697.9	1155.08	1:1.55:2.57
4	C4	447.72	673.05	1155.08	1:1.50:2.57
5	C5	447.72	681.03	1155.08	1:1.52:2.57
6	C6	447.72	671.56	1155.08	1:1.50:2.57
7	C7	447.72	668.26	1155.08	1:1.49:2.57
8	C8	447.72	662.08	1155.08	1:1.47:2.57
9	C9	447.72	652.34	1155.08	1:1.45:2.57

The mixing of the concrete was done on the quantative proportion given by the above mix design table. The Mixing is illustrated as shown in the figure 1.

Fig -1: Mixing of Concrete with different fine aggregate.

The test specimen were casted in the form of cubes and beams whose dimensions are as follows:
Beams: 750*150*150 mm,
Cubes: 150*150*150 mm.

Fig -2: Curing of Cubes and Beams

Compressive strength test: The casted cube specimens for different combination as shown in the above mentioned modelling were casted with proper levelling and finishing the surface. After 24 hours, the specimen were demolded and conveyed to curing tank for 7, 14 and 28 days of curing. In each category three cubes were casted and tested for the average value. After curing for 7, 14 and 28 days the cubes were tested by Using digital compression testing machine (CTM) of 400 KN capacity as per IS 516-1959. The failure load was noted in each sample and the compressive strength was calculated as follows.

Compressive strength (Mpa) = Load at failure/ Base area of the sample.

The data obtained is represented in the tabular form and is presented graphically.

Fig -3: Testing of cubes.

Flexural strength: The casted beams specimens for different combination as shown in the above mentioned modelling were casted with proper levelling and finishing the surface. After 24 hours, the specimen were demolded and conveyed to curing tank for 7, 14 and 28 days occurring. In each category three beams were casted and tested for the average value.

After curing for 7, 14 and 28 days the beams were tested by using two loading point over an effective length of 700 mm using Universal testing machine (UTM) of 400 KN capacity as per IS 516-1959.

Flexural strength (MPa) = $P*L/B*D^2$

Where, P represents load at failure indicates center to center distance between the supports= 700,B is width of specimen=150 and D is depth of specimen=150 mm

The data obtained is represented in the tabular form and is presented graphically.

Fig -4: Testing of Beams

2. RESULT AND DISCUSSSION

From the test result it is observed that the combination C6 having the maximum compressive strength of 28.16, 38.91 and 43.24 for 7, 14 and 28 days of curing. On the other hand, the combination C2 showed a declined compressive strength of 20.42, 28.28 and 31.43 Mpa for 7, 14 and 28 days of curing. While comparing the result of flexural strength combination C6 showed better flexural properties having a value of 9.03,9.93 and 10.38 Mpa for 7,14 and 28 days of curing. On the other hand the combination C2 showed flexural strength of 7.47, 8.21and 8.59 Mpa for 7, 14 and 28 days of curing.

Table -5: Average Compressive strength of the cubes.

SN	COMBINATIONS	AVG COMPRESSIVE STRENGTH		
		7	14	28
1.	C1	22.50	31.15	34.62
2.	C2	20.42	28.28	31.43
3.	C3	20.93	28.98	32.2
4.	C4	23.05	31.92	35.47
5.	C5	27.50	38.08	42.32
6.	C6	28.10	38.91	43.24
7.	C7	22.72	31.46	34.96
8.	C8	25.11	34.77	38.64
9.	C9	21.17	29.31	32.57

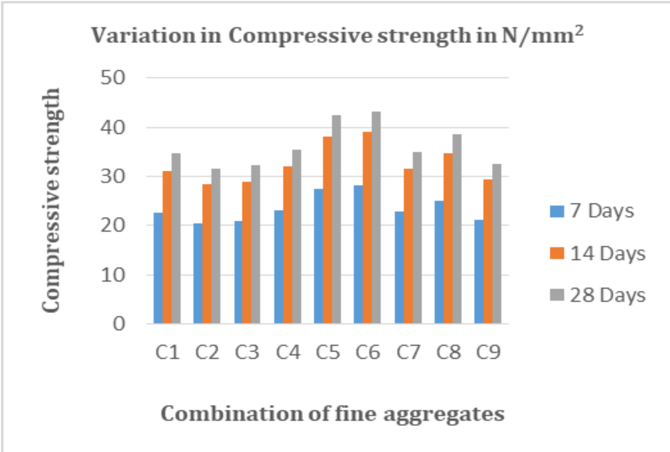

Chart -2: Compressive strength of cubes

SN	COMBINATIONS	AVG FLEXURAL STRENGTH		
		7	14	28
1.	C1	7.94	8.73	9.13
2.	C2	7.47	8.21	8.59
3.	C3	7.16	7.87	8.23
4.	C4	8.09	8.89	9.30
5.	C5	8.72	9.59	10.02
6.	C6	9.03	9.93	10.38
7.	C7	7.78	8.55	8.94
8.	C8	7.47	8.21	8.59
9.	C9	7.94	8.73	9.13

Table -6: Average flexural strength of the Beams.

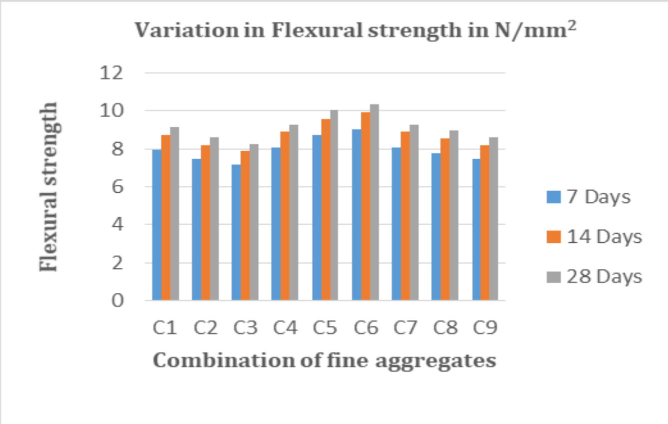

Chart -3: Flexural strength of Beams

3. CONCLUSIONS

In the above test results and discussion the combination so far considered is divided into two subdivision i.e. with full replacement and partial replacement. The following conclusion are withdrawn from the experimental investigation

1. In the first subdivision, it is seen that combination C4 shows maximum compressive strength of 23.055, 31.923, and 35.470 for 7, 14 and 28 days of curing in N/ mm^2. Similarly, it is observed that the same combination has maximum load of 26 KN and flexural strength being 8.09, 8.899 and 9.3035 in N/ mm^2 for 7, 14 and 28 days of curing. The other combination such as C1, C2 and C3 showing the satisfactory result.
2. In the second subdivision, it is seen that combination C6 shows maximum compressive strength of 28.106, 38.916 and 43.24 in N/ mm^2 for 7, 14 and 28 days of curing. Similarly, it is observed that combination C6 has maximum load value of 29KN and flexural strength being 9.03,9.933 and 10.3845 in N/ mm^2 for 7, 14 and 28 days of curing. The other combination such as C1, C2 and C3 showing the satisfactory result.
3. In the above project work, the partial replacement of fine aggregate combination C6 is the most viable combination as observed from the experimental investigation.
4. In 7 days, the compressive strength and flexural strength of conventional river sand concrete is compared to partial replacement increased by 24.86%, 13.62%. Whereas, for 14 days it showed an incremental value by 19.94%, 13.40% for compressive and flexural strength.
5. The compressive and flexural strength showed an incremental value by 24.89%, 13.69% for 28 days curing.
6. From the above Experimental investigation it is recommended to use sea sand, crusher sand and granite waste as fine aggregate for accomplishment of economic feasibility of construction and environmental safeguarding of the nature.

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