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Study on experimental behaviour of concrete using sea sand as an aggregate in reinforced concrete Elements

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ABSTRACT

India is a developing economy and the development of India is one the fastest in the world. The growth of the nation inhibits the growth in infrastructure development. This development creates a huge demand for the raw materials of construction. The river sand is generally used as the fine aggregate in concrete, the over exploitation of which results in several serious hazardous problems to the environmental cycle. This project aims to replace the usage of river sand with the sea sand after reducing the chloride content with the feasibility of using the sea sand with reinforced concrete. On satisfactory results of the total salinity content the sand is used in the reinforced concrete.

Key words : *Sea sand, River sand, Salinity, Chloride content, Feeder*

Introduction

The river sand is competitive in the market. Nearly 90% of total sand usage inconstructions industry are from river bed and banks which leads to river erosion (Sai Deepak and Tirupathi Naidu, 2015). To subside this issue, consumption of sea sand in construction field might be an alternative remedy. Sea sand is enriched in high-chloride content. This project aims to find the replacement for the river sand on thinking about the environmental point of view. In current situation, the Manufacturing sand (M-Sand) is the onlyoption that is widely replaced inconcrete in the place of river sand (Xiao *et al.*, 2017). That indirectly result in exploiting process of M-Sand (granite rocks). This project aims to use sea sand after minimizing the salt content by certain procedures. The development of this project will enables the mankind to use sea sand in plain cement concrete, mortar and also in the reinforced concrete. The salinity of the sand is planned to be reduced within the permissible limit by successive washing of sea sand. The sand which is obtained from sea beds is made to dry for 2 days in laboratory condition without any traces of water. The sea sand in contains higher percentage of slit content (Mahalakshmi *et al.,* 2017). The sea sand possesssilts in the range of 6%–7%. These particles are removed by the process of sieving. The sea sand which is used in this project is obtained from sea beds which are around 1.5 km from sea shore in the area near Kasaragod, Kerala, India. The preliminary tests have been carried out for the sea sand and those are tabulated below in the Table 1.

Experimental Program

Thesea water is taken and it is tested in the laboratory and thelevel of chlorides in sea water is 1.98%

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Table 1. Properties of the sea sand

Property	Results
Specific gravity	2.5
Voids Ratio	0.7
Bulk Density	1.45g/cm
Silt Ratio	0.4

of its own weight. Next, the sand is made to dry in laboratory condition for a period of 48 hours. The sand is taken and it is tested in the laboratory to find its saline content. Five set of samples was tested and the range of the salinity varies from 0.32% to 0.37 %. Instead of taking the average, to be in safer side we have opted for the maximum value which is found to be 0.37%. As per Codal provisions BS: 5328 Part-1: 1997, the total chlorides for plain cement concrete shall be maximum of 0.4% of its own weight. BS 882: 1992 states the chloride limit for the pre-stressed and reinforced concrete was observed to be 0.1% of its own weight. Thepreliminary plan of this project is to reduce the chloride content below the specified maximum value by considerable amount specified by the codal provisions. The apparatus consists of four levels namely A, B, C and D. The dried sea sand is made to feed into the feeder from the opening in the LevelA. The pure water is fed into the chamber and made to stir. The levels in the feeder are to take the samplesfor the salinity test. In our case, the sea sand is washed with water in the ratio 1:1, water is added by half, twice. Then it is allowed to dry for 48 hours inside the feeder. The samples are taken from the Levels A, B and C simultaneously and tested. The results show a positive sign; the value of chloride varies from 0.034% to 0.086%. The lower value is observed from the samples which are obtained from the Level A and the maximum value is obtained in the Level C. The value which is obtained is much less than the maximum permissible amount of chloride allowed as per the standards. The feeder is made up of galvanised steel and the epoxy resin is coated over that to avoid corrosion of the feeder. The typical diagram of the feeder is shown in figure1.

Testing Results—Preliminary

The concrete mix design is done for M-40 grade of concrete with W/C ratio of 0.4. The experimental testing is done in two categories: first comprise of cube, cylinder and prismand the second comprises the reinforced concrete beam. The results are compared with that of conventional concrete. The increase in the compressive strength in sea sand is about 6.25 %, which is a positive sign. Whereas in case of tensile strength, sea sand have a slight increase in about 3.22% of average results of river sand. The test results witnessed that sea sand is eminent to use in the place of river sand.

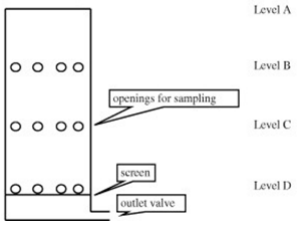

Fig. 1. Typical diagram of feeder to purify sea sand.

Results and Discussion of Conventional &RC beams with sea sand

The Reinforced concrete (RC) Beam is tested in loading frame with two point loading condition. Theload and the deflection are noted simultaneously and those data are manipulated in the form of the graph. The graph of the conventional beam (100 % river sand as the fine aggregate) and beam with dechlorinated sea sand as fine aggregate is given in figure 2 and 3, respectively.

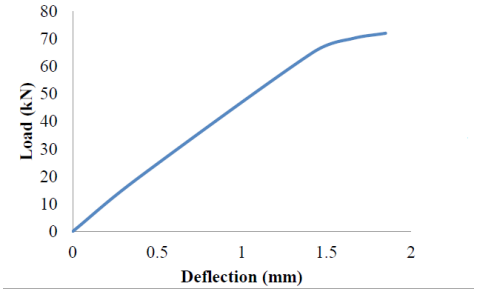

Fig. 2. Load vs defection curve of the conventional beam

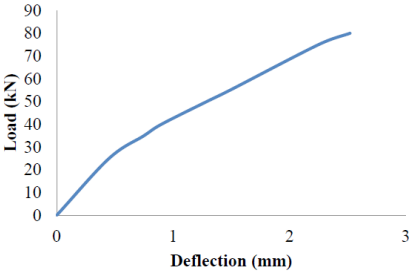

Fig. 3. Load vs defection curve of beam (sea sand as the fine aggregate)

Table 2. Comparison of structural behaviour

1.	Initial crack load	: 27 kN	Initial crack load	: 32 kN
2.	Ultimate load	: 72 kN	Ultimate load	: 80 kN
3.	Maximum deflection	: 1.85 mm	Maximum deflection	: 2.52 mm
4.	Ductility	: 2.64	Ductility	: 5.6
5.	Stiffness	: 40.6 kN/mm	Stiffness	: 44.4 kN/mm
6.	Energy absorptioncapacity	: 220 kN- mm	Energy absorption capacity	: 187 kN-mm
7.	Weight of the beam	: 54.13 Kg	Weight of the beam	: 55.95 Kg
8.	Unit wt of concrete	: 2405 Kg/m^3	Unit wt of concrete	: 2487 Kg/m^3

The comparison of structural behaviour is given in Table 2.

The results give stamp of approval, actually in terms of compression strength, flexural strength and tensile strength and overall behaviour in stiffness, ductility and the ultimate load. The self-weight of the beam gets increased in the case of the beam with sea sand as the aggregate is due to the fact that the particle size distribution of the sea sand thus increasing the dead load. The check of the unit weight has been found that falls within the standard value of 2500Kg/m^3.

Conclusions

The test sample reveals that the chloride content of the sand falls well below and the observed value was from 0.034% to 0.086%. This limit was well under the maximum permissible limit specified by the codal provisions. The behaviour like ductility, energy absorption, stiffness and ultimate loads are studied, those also shows similar results like the conventional. Thus, it is concluded that sea sand gives efficient result after washing of chlorine content from sea sand and could be even used in reinforced cement concrete.

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