Characterization of Construction Sand from South Pennar, Palar and Cauvery Rivers, Tamilnadu

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***Abstract*— River sand is a product of natural weathering o rocks over a period of millions of years. Sand production, movement and deposition are of great concern to the engineering geologist and to the Geomorphologies, especially those cones med with river basin management, shore erosion and harbour development. A better understanding of the sand budget is necessary if the problems of river and coastal environments are to be solved. The present study mainly focused to assess the textural characterization of construction sand from the study area (South Pennar, Palar and Cauvery Rivers). Also to study the Mineralogy, Geochemistry and sedimentology of the construction sand in selected river systems and compare the geological qualities of the construction sand from various river systems in Tamil Nadu.**

INTRODUCTION

Naturally river sand is the most preferred choice as a fine aggregate material for construction industry. Sand mining is the process of removal of sand and gravel where this practice is becoming an environmental issue as the demand for sand increases in industry and construction. Grain size is the most basic physical property of sand like sedimentary deposits (McManus, 1988; Poppe et al., 2000). Grain size studies provide important clues to the sediment provenance, transportation history and depositional conditions (Folk and Ward, 1957; Friedman, 1979; Bui et al. 1990, Ganesh et al. 2012). The rivers worldwide transport about 15-16 × 109 tonnes per year of sediments to the oceans (Milliman and Meade, 1983; Walling and Webb, 1983). Subramanian et al. (1987) has reported that the Indian rivers transport about 1.2 × 109 tonnes of sediments per year.

STUDY AREA

Palar River

Palar River is a river of southern India. (12°28’04”N:80°09’16”E) rises in Nandidurg hills in Kolar District of Karnataka state, and flows 93 km in Karnataka, 33 km in Andhra Pradesh and 222 km in Tamil Nadu before its confluence into the Bay of Bengal at Vayalur about 100 Km South of Chennai. Cheyyar, Poonai and Malatar are the main tributaries to this river Palar. The shape of the basin is rhombus and lies approximately between 12º 15′ and 13º 38′ north latitudes.

SOUTH PENNAR RIVER

The Ponnaiyar is a river in southern India. It rises on the hill of Nandidurg in Chikkaballapur District of Karnataka state, and flows south and then east for 400 km (250 mi) through Karnataka and Tamil Nadu, emptying into the Bay of Bengal at Cuddalore.

CAUVERY RIVER

The river Cauvery rises at Talakaveri on the Brahmagiri hill range in the Western Ghats, Coorg district, Karnataka at an elevation of about 1, 341 m, flows for about 800 km before its outfalls into the Bay of Bengal and drains a total of 81,155 km² area of which 34, 273 km² lies in Karnataka, 43, 856 km² in Tamil Nadu, 2, 866 km² in Kerala and 160 km² in the Pondicherry. The Cauvery River system consists of 21 principal tributaries each with catchment area exceeding 250 km². The important tributaries joining the Cauvery are the Harangi, Hemavati, Lakshmanatirtha, Kabini, Suvarnavathi, Sihmsa, Arkavati, Bhavani, Noyil and Amaravathi.

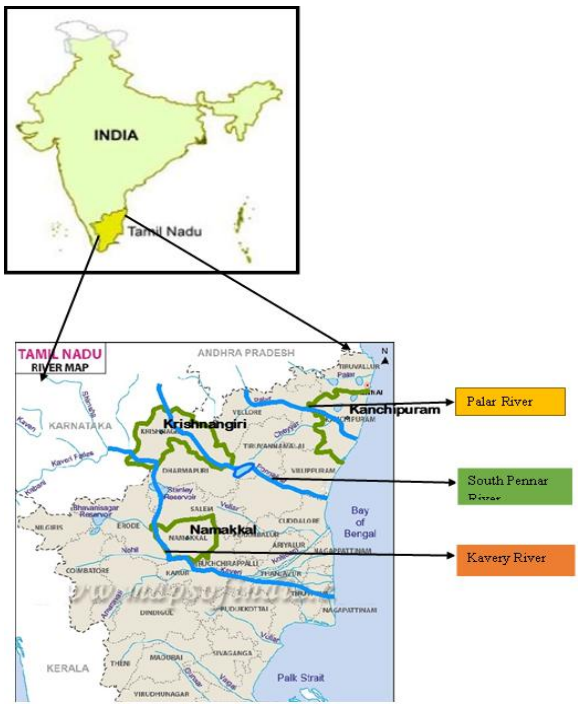

Fig.1. Study area

For the present study the about 1 kg of construction grade sand sediments (i.e. medium size) were collected from three river basins viz, Palar river (P1), South Pennar river (SP1-SP10) and Kavery river (K1). The sample location details as follows,

Table Sample location details

Sample No.	Latitude	Longitude
P1	12°47'45.20"N	79°42'8.39"E
SP1	12°26'44.1"N	78°12'58.9"E
SP2	12°25'01.1"N	78°13'06.1"E
SP3	12°24'04.0"N	78°14'48.5"E
SP4	12°23'33.7"N	78°14'49.1"E
SP5	12°22'58.4"N	78°15'41.5"E
SP6	12°20'23.6"N	78°16'38.4"E
SP7	12°18'21.9"N	78°17'22.0"E
SP8	12°17'53.0"N	78°17'35.2"E
SP9	12°15'55.2"N	78°18'19.3"E
SP10	12°15'53.0"N	78°18'28.7"E
K1	11°2'22.67"N	78° 8'33.10"E

MINERALOGY AND SAND GRAIN TEXTURE STUDIES

To find out the minerals present in the river sand, cleaned unconsolidated 35 and 60 ASTM size of construction grade sand grains were taken. These sand grains were studied under petrological microscope and the textural studies were carried out under Leica M 205A Stereo binocular microscope. Both mineral identification and surface textural studies were carried out.

XRF Studies on sand grains

To assess the geochemical nature of the sand the XRF analysis were carried out. For the present study homogenized fine grounded sample has been analysed under X-MET3000TXS+ handheld elemental analyzer.

STRENGTH ANALYSIS

COMPRESSIVE STRENGTH TEST

Compressive strength of concrete blocks was assessed following the guidelines of IS 2250 code. Concrete blocks were prepared using different river sand materials. Compressive strength test of concrete blocks were carried out after 7 days settling of the blocks. The paver block specimen of size 200 mm ×100 mm × 80 mm were cast for each mix proportion. After curing for required period the specimen were placed in the compressive testing machine in such a manner that the load applied.

RESULT AND DISCUSSION

Carbonate material in construction grade sand

Result of various studies on the construction grade sand is described in this chapter. As per the given procedure of, the carbonate material in sand samples were estimated. In the three rivers and samples the Kaveri river sand consist of moderate amount of carbonate material (2.52 %) like shells, shell fragments and carbonate mineral grains. Palar river sand have 2.11% of carbonate material and Pennar river sand have minimum of 0.1% and maximum of 5.48%.

Table. 4.1. Acid soluble carbonate material in construction sand

S.No	Sample wt (g)	Carbonate material wt (g)	% of Carbonate	% of sand
P1	25	0.528	2.11	97.89

SP1	25	0.3823	1.53	98.47
SP2	25	0.7323	2.93	97.07
SP3	25	0.1847	0.74	99.26
SP4	25	0.3247	1.30	98.70
SP5	25	0.025	0.10	99.90
SP6	25	0.528	2.11	97.89
SP7	25	0.3468	1.39	98.61
SP8	25	0.2868	1.15	98.85
SP9	25	0.6297	2.52	97.48
SP10	25	1.3697	5.48	94.52
K1	25	0.6297	2.52	97.48

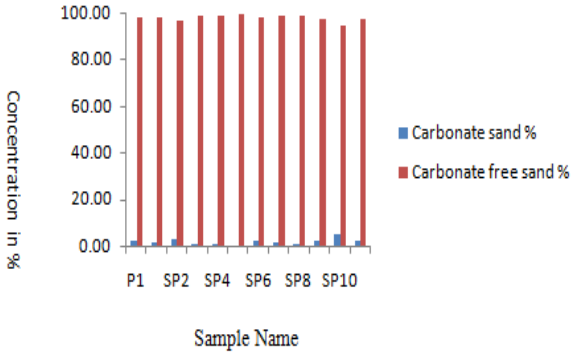

Fig.4.1. Carbonate free sand concentration in the samples

Coarse Fraction Analysis

To understand the grain size distribution and sediment settling in the study area, detailed grain size analysis has been carried out. In 100g dry sample, the sand sized sediments were separated and different fraction of sand materials separated. Individual weight of each fraction has been measured. Weight % and cumulative weight % calculated. The Φ size Vs Weight% and Φ size Vs Cumulative weight% calculations made. All the plots have prepared and the grain size characteristics discussed.

The sand samples collected from Palar,, South Pennar and Kavery rivers were compared by the samples weight % Vs φ value to understand the sediment source. The curves show unimodal for P1 and SP5 sand. That indicate the sand sediments might derived from single source of origin. The bimodal curve for K1 sample indicates two different source of the sediment.

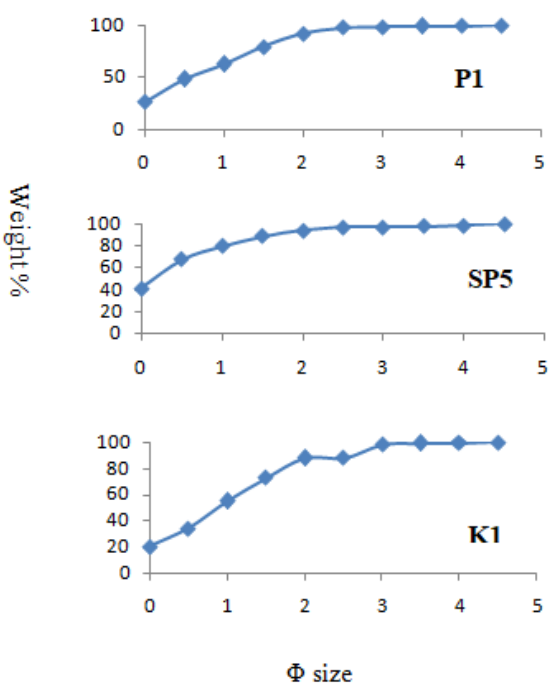

Fig.4.2. Grain size distribution curve of P1, S5 and K1 sand sediments

Mean			Skewness		Kurtosis	
Sample no	Value	Description	Value	Description	Value	Description
P1	0.674	Coarse sand	0.238	Fine Skewed	0.768	Platykurtic
SP1	0.524	Coarse sand	0.494	Very Fine Skewed	0.885	Platykurtic
SP2	0.738	Coarse sand	0.412	Very Fine Skewed	0.801	Platykurtic
SP3	0.133	Coarse sand	0.571	Very Fine Skewed	1.306	Leptokurtic
SP4	0.106	Very Coarse sand	0.373	Very Fine Skewed	1.375	Leptokurtic
SP5	0.348	Coarse sand	0.458	Very Fine Skewed	1.059	Mesokurtic
SP6	0.063	Very Coarse sand	0.368	Very Fine Skewed	1.063	Mesokurtic
SP7	0.470	Coarse sand	0.170	Fine Skewed	0.905	Mesokurtic
SP8	0.230	Coarse sand	0.529	Very Fine Skewed	0.746	Platykurtic
SP9	0.547	Coarse sand	0.237	Fine Skewed	0.697	Platykurtic
SP10	0.392	Coarse sand	0.447	Very Fine Skewed	0.756	Platykurtic
K1	0.881	Coarse sand	0.114	Fine Skewed	0.936	Mesokurtic

Table.4.3.Class variation of statistical parameters of Palar, South Pennar, Kavery river sands

MINERALOGICAL AND TEXTURAL ANALYSIS

Palar River Sand

The sand consists of both light and dark colored minerals. The minerals are quartz, garnet, illmenite, zircon, and magnetite, etc. Generally the grains are subrounded in 35ASTM size and subangular to subrounded in 60 ASTM size. Grains are semi pitted and elongated in nature. The various parameters namely, mean size; sorting, skewness and kurtosis are used to evaluate cumulative frequency distribution (Trask, 1932; Otto, 1938; Inman, 1952; Mc common, 1962). The values of the textural parameters and grain size distribution of the samples were computed by the formulae suggested by Folk and Ward (1957).

South Pennar River Sand

The sand grains in this river consist of dark colored minerals compare to other two river sands. The darker mineral grains are magnetite, biotite and zircon. Quartz and feldspar are the common light colored minerals. Individual sand grains are generally angular to sub angular.

Kavery River sand

Kavery River sand predominantly consists of light color minerals like quartz and other minerals. The individual grains are generally sub rounded and to sub angular.

XRF ANALYSIS

Oxide elements

Sample no	SiO_2 %	Al_2O_3 %	FeO %	MnO %	K_2O %	CaO %
S 3	75.06	2.13	9.98	0.09	8.25	4.49
S 8	74.31	0.90	11.05	0.09	6.18	0.00
P 1	80.54	0.00	6.65	0.06	6.95	9.12
K1	78.31	0.90	11.04	0.09	7.18	7.12

In the oxide elements SiO_2 is high in Palar river have 80.54% compare to other river sediments. In Cauvery river sediments it is 78.31% and in South Pennar river contains 74.31-75.06 % of SiO_2.

Trace elements

Sample no	Zr (ppm)	Sr (ppm)	Rb (ppm)	Zn (ppm)	Mo (ppm)	Nb (ppm)
S 3	0.024	0.04	0.007	0.005	0.016	0.024
S 8	0.019	0.039	0.004	0.007	0.018	0.027
P 1	0.008	0.032	0.004	0.005	0.011	0.022
K1	0.022	0.031	0.012	0.003	0.019	0.032

In the trace elements, Sr (strontium) is present abundantly than the other elements. It is high in South Pennar river location 8 records 0.39 ppm. 0.32 ppm of Sr reported in Palar sample and Cauvery river sand is contains 0.31ppm of Sr. Concentration of other trace elements are listed above table.

Strength analysis

The result of the compressive strength for the concrete blocks which are prepared using the sand materials from three rivers and is described below. The sample was taken or this test after settling of the concrete for 7 days. The variation of compressive strength of the paver blocks with various replacement level of slag up to 100% is shown in table and figure.

Table 4.1 Compressive Strength Results (after 7 days settling of blocks)

S.No	Sample Name	Load(kN)	Compressive Strength (MPa)
1	P1	49.5	10.1
2	K1	61.2	12.5
3	S 8	44.1	9.0

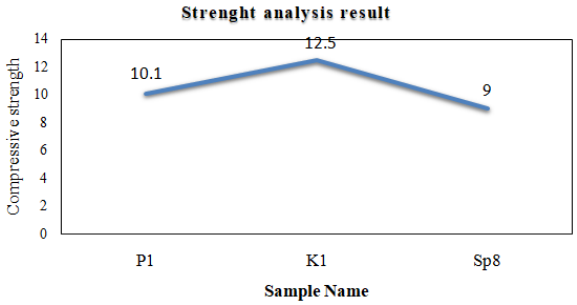

Figure 4.1 Compressive Strength (MPa) Results

Based on the results of the Compressive Strength test, the paver block which was prepared using Kavery river sand shows the maximum Compressive Strength (12.5 MPa). The paver block made using South Pennar river sand have the minimum Compressive Strength of 9.0 MPa.

CONCLUSIONS

Compressive strength of the paver block is determined on the basis of its mineralogy, texture of the mineral, chemical composition of the sand, etc. In this contest Kavery River sand have the suitable qualities than the other two river sands.

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