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Textural Characteristics and Distribution of Sediments in Gundaru Reservoir, Tirunelveli District, Tamil Nadu

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Abstract— ***Sediments carried into a reservoir may deposit throughout its full length, thus gradually raising the bed elevation and causing aggradations. To address this,a detailed investigation carried out on sedimentation process and sediment characteristic studies of reservoir sediments. The present study focused to understand the size distribution and textural characteristics of sediments in a reservoir site and to understand the sedimentation model of the reservoir. The study area Gundaru Reservior is Located (N 8º 56' 55", E 77º 13' 14") at the foot of the Western Ghats. Three types of sampling have been done for this proposed study. Granule sediments were collected along the upstream channel in the reservoir site. Sand sized sediments collected along the periphery of the reservoir and finer materials were collected at the centre part. Textural studies including pebble size analysis, sieving analysis for sand sized sediments and wet sieving analysis for finer material were done. Pebble analysis revels that the samples are spherical in nature and are transported by rolling mode of transportation. Heavy mineral assemblage of the Gundaru reservoir sand is suggestive of their derivation from the rock type of the regions such as gneiss, charnockite gneiss and charnockite, garnet biotite gneiss belonging to Archean Complex.***

I. INTRODUCTION

Reservoir sedimentation is a complex process that varies with watershed sediment production, rate of transportation, and mode of deposition. Reservoir sediment depends on the river regime, flood frequencies, reservoir geometry and operation, flocculation potential, sediment consolidation, density currents, and possible land use changes over the life expectancy of the reservoir. Sedimentation reduces reservoir storage capacity for flow regulation and with it all water supply and flood control benefits, plus hydropower, navigation, recreation, and environmental benefits that depend on release from storage. Besides storage loss, many types of sediment-related problems can also occur both upstream and downstream of dams. The combination of sediment trapping and flow regulation also has dramatic impacts on the ecology, water transparency, sediment balance, nutrient budgets, and river morphology (Morris G.L. and Fan J., 1997). The fundamental physical properties that controlling the hydraulics and the channel morphology of the stream will be exhibited by the sediments (Di Stefano and Ferro, 2002; Surian, 2002). Sedimentation is actually caused by erosion of soil in the catchment areas, its transportation by flow of water and deposition in the reservoirs. All reservoirs formed by dams on natural rivers are therefore subjected to some degree of sedimentation. The present study has been carried out to understand the size distribution and textural characteristics of sediments in a reservoir site also to understand the sedimentation model of the reservoir.

II. STUDY AREA

The study area GundaruReservior is Located (N 8º56' 55", E 77º13' 14") at the foot of the Western Ghats. Gundaru is one of the tributary of Chittaru.The reservoir is near the towns of Courtallam and Shencottai. The main Purpose of Dam is constructed for irrigation around the region. The site is falling under the Seismic Zone-III. It is an Earthen/ Gravity Type of Dam and the total length of dam is 389.9m. Max Height above foundation is 14.66m. Total volume content of dam (CM) is 73 and Spillway Capacity (cumec) is 265.

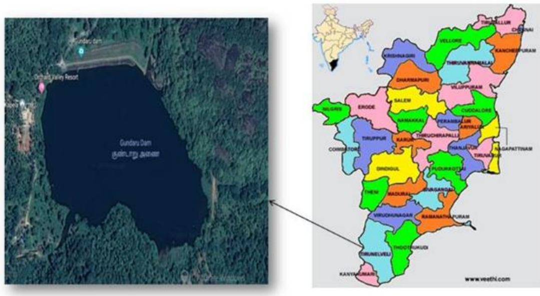

Fig.2.1 Study Area (Gundaru Reservoir)

III. MATERIALS AND METHODS

Twelve surface samples were collected from periphery of reservoir and twelve samples collected from the channel bar deposit and nine samples are collected from the Inner part of the reservoir. Samples were collected in clean dry polythene bags for laboratory analysis. The sample locations are noted with the help of Global Positioning System (GPS) (Tab.3.1). Quantitative measures of shape of pebble sized materials has been made on two-dimensional images or projections of particles or on the three-dimensional shape of individual particles. Sieving wascarried out in ASTM at ½ 4 interval. Using graphic (Folk &Ward, 1957) and moment methods (Friedman, 1961, 1967,1979) Weight percentages, mean, and various statistical parameters like standard deviation, skewness and kurtosis were determined. From the mounted slidesthe individual (>300 grains) minerals were counted by usingthe line method described by Galehouse (1969). Variousdiagnostic properties of heavy minerals provided in theMilner (1962), Rothwell (1989), are utilized for easier identification.

Table.3.1.Sample locations

S. No	Sample Location	Latitude	Longitude
1	S1	N 8° 56´34.11”	E 77° 12’46.56”
2	S2	N 8° 56´35.10”	E 77° 12’44.42”
3	S3	N 8° 56´38.82”	E 77 °12’43.22”
4	S4	N 8° 56´42.70”	E 77° 12’44.40”
5	S5	N 8° 56´41.65”	E 77° 12’56.35”
6	S6	N 8°56´39.07”	E 77° 12’58.36”
7	S7	N 8 °56´37.08”	E 77° 12’59.74”
8	S8	N 8 °56´32.82”	E 77° 3’00.00”
9	S9	N 8 °56´32.15”	E 77 °2’58.48”
10	S10	N 8 °56´31.74”	E 77 °12’56.63”
11	S11	N 8 °56´31.84”	E 77 °12’54.74”
12	S12	N 8 °56´32.86”	E 77° 12’57.74”

IV. RESULTS AND DISCUSSION

4.1 PEBBLE ANALYSIS

In order to understand the size, dimension, textural significance of the granule size sediments in the reservoir site, about 15 samples were analysed and the results of DI/DL and DS/DI were plotted in the Zingg’s plot.

Tab.4.1 Pebble analysis data

Sample	DL	DI	DS	DI/DL	DS/DI
1	3.86	3.56	2.69	0.9222	0.9222
2	5.48	3.91	2.85	0.7135	0.7135
3	3.31	2.85	1.69	0.861	0.861
4	3.83	2.58	2.45	0.6736	0.6736
5	3.91	3.88	2.35	0.9923	0.9923
6	4.43	2.85	2.09	0.6433	0.6433
7	3.61	2.62	2.09	0.7257	0.7257
8	3.5	2.96	2.15	0.8457	0.8457
9	3.91	3.03	2.27	0.7749	0.7749
10	4.32	3.77	2.52	0.8726	0.8726
11	3.64	2.71	1.88	0.7445	0.7445
12	5.1	3.98	1.61	0.7803	0.7803
13	3.88	3.07	1.97	0.7912	0.7912
14	2.85	2.13	1.7	0.7473	0.7473
15	3.37	2.54	1.45	0.7537	0.7537

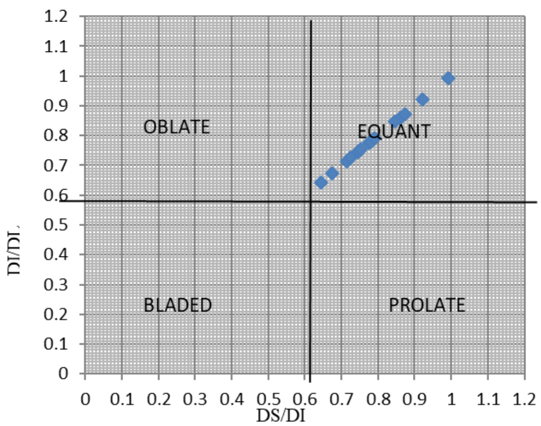

Fig.4.1. Zinggs classification plot for the pebble samples

Based on the results it is found that all the samples are falling in the equant plot, revels that the samples are spherical in nature and are transported by rolling mode of transportation.

4.2 GRAIN SIZE STUDIES

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.

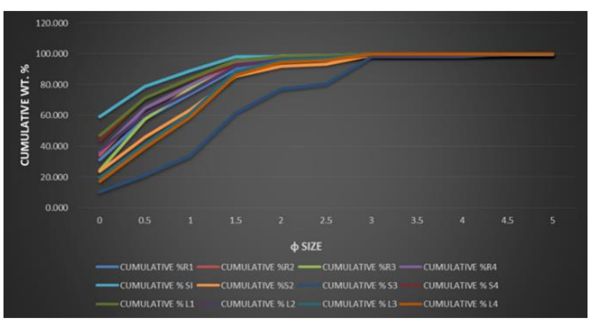

Fig 4.2.Phi Vs Cum.Wt% curve for All Sample

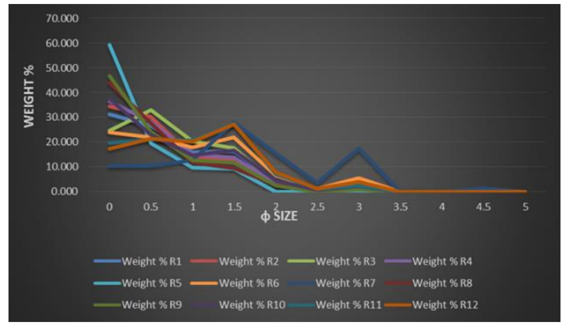

Fig 4.3.Phi Vs Wt% curve for All Sample

The determination and interpretation of particle grain-size has a fundamental role in sedimentology. The study of textural parameters of the sediments is of principal utility in differentiating various depositional environments and thereby interpreting the origin of ancient clastic deposits. The size frequency distribution of various grain-size parameters of Gundaru Reservoir sediments are presented in the figures. The mean size of the Gundaru Reservoir sediments varies between 0.24 to 0.76 Φ. It is found that in the Reservoir mouth region. From the Φ Vs Wt% plots, it is observed that in the Reservoir mouth region initially sorting becomes well sorted The well sorted sediments show high positive skewness are found to be associated with high values of kurtosis (platykurtic). The abrasion and progressive sorting of sediments are the main reasons for a downstream decrease in phi mean and gradual enhancement of the fining of sediments (Riyaz and Jeelani, 2015; Allen 1970).

4.3. SAND- SILT- CLAY ANALYSIS IN SURFACE SAMPLE

In surface sediments, sand shows its maximum concentration along the periphery of the reservoir. Silt concentration shows maximum in the western part and minimum in the Eastern part of the study area. Clay size particles are showing less percentage along the periphery.

Tab.4.3.1 Table for Sand Silt Clay % of periphery surface sample

Sample No	Sand	Silt	Clay
1	88.8	10	1.2
2	62.8	20	17.2
3	68.8	20	11.2

4	70.6	20	9.4
5	80.8	13	6.2
6	72.4	26	1.6
7	63.2	23	13.8
8	73.7	17	9.3
9	67.9	10	22.1
10	80.4	11	8.6
11	75.7	16	8.3
12	76.1	14	9.9

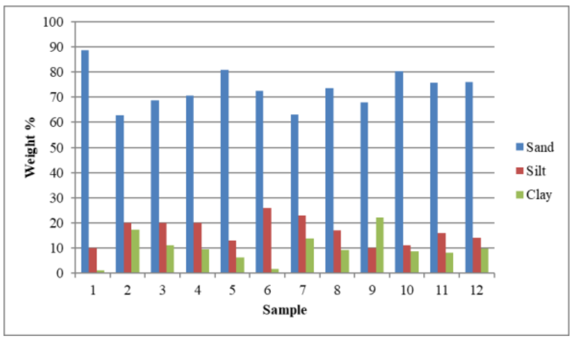

Fig.4.3.1 Sand-silt-clay analysis results of periphery surface sample

In surface sediments, silt shows maximum in the inner part of the reservoir followed by Sand concentration shows moderate and Clay size particles are showing the minor amount present along the inner part of the reservoir.

Tab.4.3.2 Table for Sand Silt Clay % of center part surface sample

Sample	Sand %	Silt %	Clay %
1	23.88	67.19	0.89
2	45.20	39.94	14.85
3	19.85	62.15	17.99
4	21.69	58.46	19.84
5	30.25	42.95	26.78
6	20.20	56	23.79
7	29.91	54.16	15.9
8	18.35	56.83	24.80
9	25.14	50.97	23.87

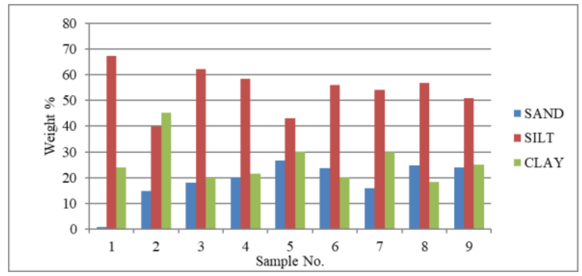

Fig.4.3.2 Sand-silt-clay analysis results of center part surface sample

4.4. RESERVOIR SEDIMENTATION MODEL

On basis of the textural analytical results, it is understood the various sized sediments and its distribution within the reservoir. With respect to the field observations and laboratory analysis, a sedimentation model has been prepared. This shows the inlet part of the reservoir contains granule sized sediments. The sand sized particles settled along the periphery and muddy materials found in the centre part of the reservoir.

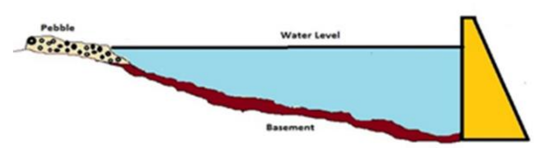

Fig.4.4.1. Model of Reservoir sedimentation in the inlet channel

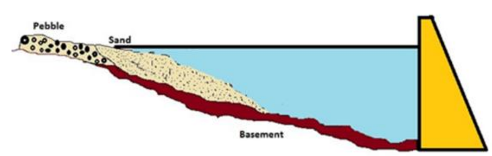

Fig.4.4.2. Model shows the sedimentation along the periphery of the Reservoir.

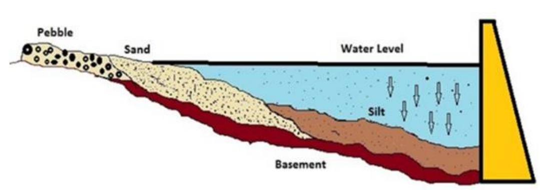

Fig.4.4.3. Model shows the ultimate sedimentation in the reservoir

V. CONCLUSION

The reservoir receives variable sizes of sediments. The granule sized materials found in the upstream channel were transported by mainly traction mode and rolling mode.The sediment deposition pattern begins with a deltaic formation, mainly composed of coarser sediments in the reservoir headwater area. Density currents may transport finer sediment particles down to the dam. Reservoir mouth region initially received sortedto well sorted sediments. The well sorted sediments show high positive skewness are found to be associated with high values of kurtosis (platykurtic).The sand sized materials deposited along the periphery of the reservoir and also contain many heavy minerals. The finer sediments settles from the centre to the out let of the reservoir. From the sedimentation model the reservoir deltaic sedimentation process is understood.

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