MANTECH Publications

Journal of Ceramics and Concrete Technology
Volume 7 Issue 1
ISSN: 2457-0826 (Online)

# *Investigative Studies on Increasing the Dam Capacity by Dredging of Soil from Dam by Excavation*

***Raisa Jabeen[1], Sanjeev T P[2], Shivaprasad H[3]***

*Environmental Engineer[1], Assistant Professor[2], Business Development Manager[3]*

*Department of Civil Engineering[2]*

*China State Construction, Dubai, UAE[1],Dayananda Sagar College of Engineering, Bengaluru, Karnataka, India[2],Frimline Limited, Bengaluru, Karnataka, India[3]*

***Corresponding Author's Email: -*** *drshivaprasadhias2023@gmail.com[3]*

***Abstract***

*Dam is a structure used to store the water and use it for irrigation, human consumption, Industrial use, Agriculture, Navigability etc during droughts. Objective of the paper is to increase the dam capacity by dredging the soil from Full Tank Level to Dead Storage Level by Excavation and Suction method. The study area focused is Krishna Raja Sagara dam (KRS). The present storage capacity of the KRS is 45.05tmcft.Therefore, by removing the soil from the reservoir the capacity of the dam is increased it's twice and thrice. Trapezoidal method is preferred for calculating the capacity of the dam for excavation purpose. According to the Government regulations, Mother Earth of the dam is not allowed to touch due to seepage problem. If the Government permits to excavate the soil from the mother earth, the cylinder consisting rotor and sieves is placed at the excavating area in the tilted angle. The excavated soil is sent through the funnel and the water is pumped into the rotating cylinder to separate the gravel and sand. The left-out clay is spread as blanket so that to overcome the seepage problem. Gravels remained is used for road and embankment construction, Crushed gravel powder can be used as ingredient in the mortar. This study concludes that instead of constructing new dam or raising the bund height, capacity of the dam can be increased as mentioned above*

***Keywords:*** *Increasing dam capacity, Excavation, Dredging, Seepage, Blanket*


Page 37-47 © MANTECH PUBLICATIONS 2022. All Rights Reserved

## INTRODUCTION

Excavation of soil material from the water environment is called as Dredging. Some of the dredging uses are improvement of existing water features, reshape of the land and water features for alternating drainage system, navigability, commercial usage, construction of dams and recovery of the valuable mineral deposits. Dredged soil consists of mineral phases, organic, gravels etc.

The management of the dredged material today remains an important issue. The quantities of materials dredged from the reservoir can be environment problem. Therefore, it is very important to suggest solution by using the materials for construction purposes. Managing of this dredged material by the excavation activity is challenge with legal, financial, environmental, technical and scientific difficulties.

The methodology of excavation of the soil is based on trapezoidal method. Blanket can be spread by using rotating screen cylinder with different sieve sizes to avoid the seepage problem. The grave ls excavated will be analysed to identify the place of its usage. The result of gravels is used for road construction and embankment construction after their testing in the laboratory.

Results analysed here are related to dredged material of Krishna Raja Sagara dam. The initial storage capacity of this dam is 45.05 tmcft. To increase the dam capacity, excavation of soil from full tank level to dead storage level is the real challenge. The dredging operation is an important phase in recovery and preservation of useful storage volumes of dam.



***Fig: 1KRS Dam***


Page 37-47 © MANTECH PUBLICATIONS 2022. All Rights Reserved

## MATERIALS AND METHODOLOGY

***Volume Calculation (Trapezoidal method)***

Calculation of volume to increase capacity of the dam is done by Trapezoidal method for the excavation purpose at the Krishna Raja Sagara dam (KRS). This dam is located at a distance of 19 kilometres from Mysore. In 1924 KRS was built by Sir Visveswaraya, with surki, instead of cement, brick powder and lime stone mixture was used. Cauvery, Hemavati and Lakshman at hritha rivers were confluence the dam and KRS is 3km long. The area of the reservoir spread is 130Sq.Kms. Using Trapezoidal method area is calculated for the excavation purpose.




***Fig: 2 Trapezoidal***

Diagram MDDL+74.00ft= 8.379TMC FRL+124.80ft=49.452TMC

**Salient Features of Krishna raja Sagara Dam**

| | | |
|---|---|---|
| **1.** | **Name of the River:** | **Cauvery** |
| 2. | Location of Dam: | Near Kannambadi village in Srirngapatnataluk, Mandya district. |
| 3. | Longitude1 | 760’34’30” E |
| 4. | Latitude: | 12025’30”N |
| 5. | Purpose: | Multipurpose |
| 6. | Catchment Area: | 10880.63sq.km |
| 7. | Mean Annual Rainfall: | 160.96 cm(63.37”) |
| 8. | Gross storage capacity: | 1400 MCM (49.452TMC) O&M Manual for Krishna raja sagara Dam December201912 |
| 9. | Dead storage capacity: | 124.62 MCM (4.401TMC) |
| 10. | Live storage capacity: | 1275.38 MCM (45.051TMC) |


Page 37-47 © MANTECH PUBLICATIONS 2022. All Rights Reserved

| | | |
|---|---|---|
| 11. | Maximum water spread area: | 129.24 sq.km (49.90 sq.miles) |
| 12. | Lowest River bed level RL: | 714.45m |
| 13. | FRLRL752.48m | |
| 14. | Top of Dam RL: | 754.32m |
| 15. | Type of Dam: | Gravity dam constructed in stone masonry with surki mortar |
| 16. | Length of Dam: | 2620 m |
| 17. | Top width: | 4.12m |
| 18. | Lowest foundation level RL: | 709.66m |

***Table: 1 Calculation of area in Cubic Feet***

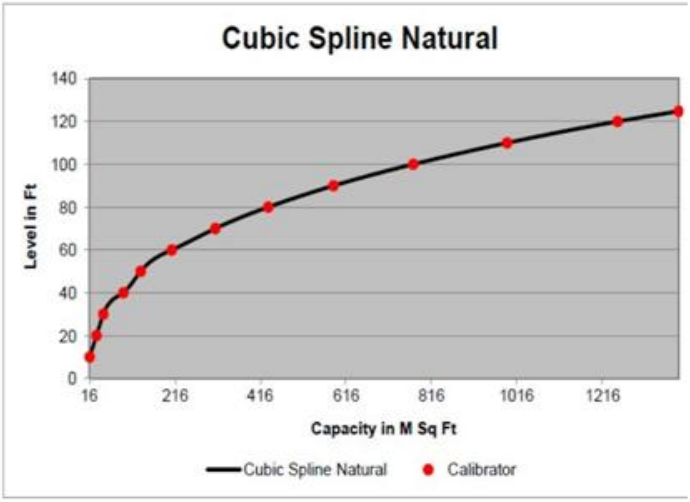
| Area in Msqft | Level in ft | Cubic ft (a)(area*10/2) | Cubic ft(b)(b+a) |
|---|---|---|---|
| 0 | 0 | | 0 |
| 19 | 10 | 95 | 95 |
| 47 | 20 | 470 | 565 |
| 55 | 30 | 550 | 1115 |
| 97 | 40 | 970 | 2085 |
| 139 | 50 | 1390 | 3475 |
| 211.5 | 60 | 2115 | 5590 |
| 316 | 70 | 3160 | 8750 |
| 441 | 80 | 4410 | 13160 |
| 595.5 | 90 | 5955 | 19115 |
| 783.5 | 100 | 7835 | 26950 |
| 1005.3 | 110 | 10053 | 37003 |
| 1266 | 120 | 12660 | 49663 |
| 1410 | 124.8 | 14100 | 63763 |

***Table: 2 Reservoir capacity calculations***

| Height in ft | Reservoir Capacity in Mcft | |
|---|---|---|
| 74 | 3978 | 0 |
| 75 | 4347 | 369 |
| 80 | 6384 | 2406 |


Page 37-47 © MANTECH PUBLICATIONS 2022. All Rights Reserved

| | | |
|---|---|---|
| 90 | 11535 | 7557 |
| 100 | 18407 | 14430 |
| 110 | 27318 | 23340 |
| 120 | 38642 | 34664 |
| 124.8 | 45050 | 41073 |




***Graph: 1 Capacity Graph***

***Table: 3 Area Calculations***

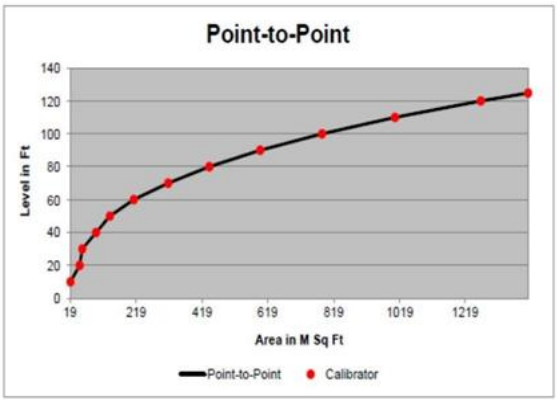
| **Height in ft** | **Area in MCFT** | | |
|---|---|---|---|
| 75 | 378.5 | 28387.5 | 28.3875 |
| 80 | 441 | 33075 | 33.075 |
| 90 | 595.5 | 44662.5 | 44.6625 |
| 100 | 783.5 | 58762.5 | 58.7625 |
| 110 | 1005.3 | 75397.5 | 75.3975 |
| 120 | 1266 | 94950 | 94.95 |
| 124.8 | 1410 | 105750 | 105.75 |
| Total Volume=77.3625*39.8 | | | 77.3625<br>3,079.02 |

**Rotating Screen Drum**

Mainly Powder handling is done with this rotating screen drums. Basically the usage of this equipment is for separating the various granular material sizes. In this study, this equipment is set up at the excavation place in the inclined manner at few degrees. The pilot rotating screen


Page 37-47 © MANTECH PUBLICATIONS 2022. All Rights Reserved

drum is composed of two sieves to separate three fractions: fine, medium and large aggregates. Water can be easily pumped to the drum as the equipment is set up at the reservoir. Excavated soil is sent through the large funnel to the rotating drum, Sievers will sieve the soil, Clay particles will be dropped at the reservoir itself to act as a blanket for avoiding seepage problem at mother earth dam. The separated gravels and fine aggregate is collected and used for different purposes i.e. road construction, Embankment construction and can be used as material in the mortar after crushing the gravels in the crusher.




***Graph: 2 Level graph***

The rotating screens are normally less expense for taking, equipment is very simple for operating with low cost and also it is maintenance free. This equipment mainly consists of cylindrical perforated drum that rotates to separate the sizes. The minute particles are dropped out while the drum rotates through the small holes in the cylinder. The remaining particles will travel on wards to the subsequent screening rings for separation due the inclination of the drum. At the beginning of the process, fine particles will be separated first, over-sized particles will be passed by rotating screen drum equipment. Particles are flown through the or if ice. This is caused due to the particle combination with mobility by rotating the screen drum. By controlling the product flow, driving speed and inclination angle of rotational axis, the rotating cree drum equipment can be easily managed.

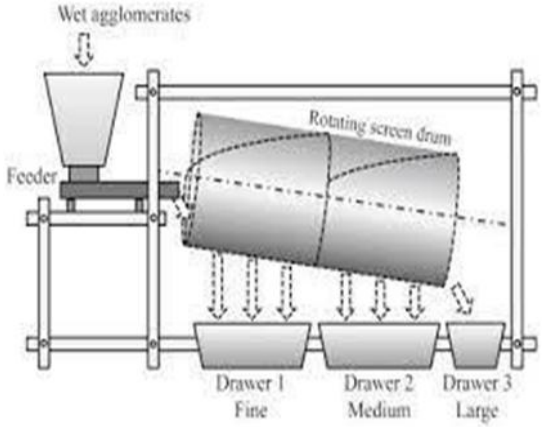



***Fig: 3 Rotating Screen Drum***

***Raw materials***

Here, the excavated soil itself will be used as the raw material throughout the process. Dumped out soil is sent through the large funnel for the screening purpose. Water will be easily pumped to the rotating drum


Page 37-47 © MANTECH PUBLICATIONS 2022. All Rights Reserved

from the dam reservoir itself. The clay particles will be dropped out so that this layer acts as blanket for the dam reservoir as this layer is impervious and avoids the seepage. The separated gravels can be used for the further usages.

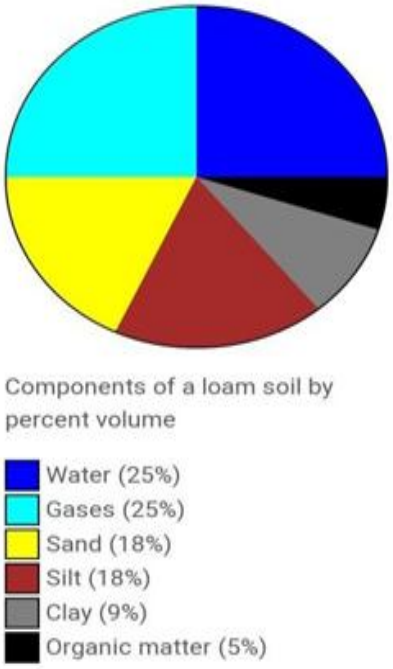



***Fig: 4 Composition of Soil***

**Rolling Process**

This experiment is done using the rotating screen drum. This setup mainly consists of a stainless-steel cylinder which is used as screening device that is rotated for separating the sizes of the aggregates.

Central axis is fixed for the support purpose and it is rotated with the help of a electric mortar along with the belt and This equipment includes 2 successive combined screening cylinders, having 0.5 m height each with a 0.44mm screening length effectively. Sieves with round holes of 0.075 mm and 4.75 mm diameter.

Experimental condition ranges can be determined regarding to the experimental equipment capacities, industry used values. Various inclination degreessuchas5.1, 6.2, 7.4, 9.7, and 12.0° also with comparing angular Speeds of the drum: 0.21, 0.79, 1.36, 2.09, and 2.72 rad.s $^{-1}$, which respectively corresponds to: 2, 7.5, 13, 20, and 26 rpm, of the drum were tested. Excavated material will be continuously fed in the drum which is in rotation manner; tangentially the first screening at the bottom.10-15 minutes is taken for the complete process depending on the operating conditions.

**Reservoir storage capacity**

Based on the useful purposes of the reservoir, this storage capacity is divided to various zones. Fig shown below gives a clear picture about various storage zones of reservoir. Bottom zone is the dead storage of a reservoir. More storage space is taken by conservation zone.

**Dead Storage Capacity**

The River, while it flows to the reservoir, it takes up some amount of sediment/silt/organic materials and carry it


Page 37-47 © MANTECH PUBLICATIONS 2022. All Rights Reserved

along to suspend load. As soon the water enter to the reservoir, the flow velocity comes virtually to nil and it losses its carrying capacity. So the carried material settles at the bottom and keeps accumulating.

Hence this accumulation effects the storage capacity. In Dead storage zone settling of the material take on. So by this experiment we excavate the soil from the Full Tank Level to the Dead storage level so as to increase the capacity of the reservoir instead of constructing the new dam or by increasing the Bund height. This technique may reduce the cost compared to the other techniques.

**Dredged materials**

Soil is commonly referred to as earth or dirt. The excavated material consists of organic matter, clay, silt, sand water, gravels etc. Clay particles are dropped out at the reservoir itself so that it acts as a blanket which covers the reservoir to avoid the seepage. As the clay is an impervious material, laying this material avoids the seeping of water into the mother earth of the reservoir. Separated gravels can be used for the road construction and embankment as it meetsll the values obtained by various laboratory tests as recommended in the Standard IRC codes.

Gravels can also be crushed using the crusher and use the crushed powder as a material in the mortar for the construction purpose. So by this method the excavated materials are not wasted and blindly dumped at a place instead it is used for some useful purposes.

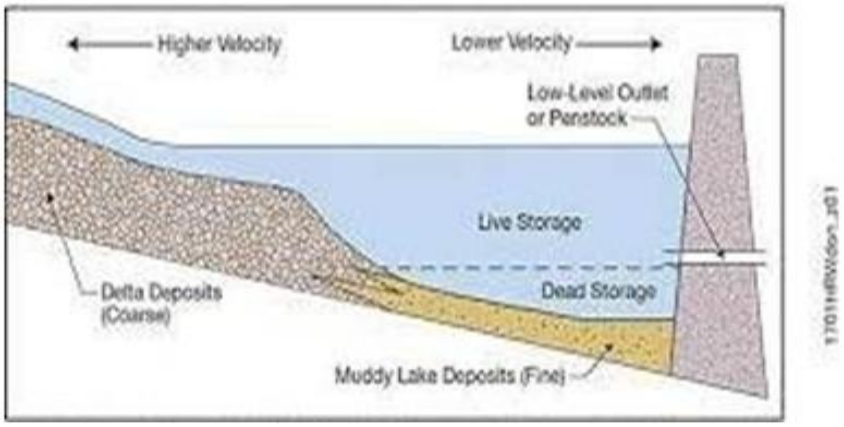



***Fig: 5 Different Zones of Dam***


Page 37-47 © MANTECH PUBLICATIONS 2022. All Rights Reserved



***Fig: 6 Blanket Covered to avoid Seepage***

## RESULTS AND DISCUSSION

Area from the Full tank level to the Dead storage level is calculated in the table.4. The area of the reservoir is estimated and shown the increase of the storage area of the dam.

Figure shows the blanket covered at the reservoir. By using the Rotating Screen Drum Equipment at the Excavation area, Blanket layer is created to avoid the Seepage problem. Excavated material is used at various purposes (Road Construction, embankment, material in the mortar) instead of dumping it as a waste.

## CONCLUSION

Due to the settlement of the sediments at the reservoir, the storage capacity of the water body reduces which effects during the drought times. So, the reservoirs must be maintained regularly. By taking up some innovative ideas we must increase the storage capacity performance.

In conclusion, Dam storage capacity is increased by the area calculation. Blanket is covered by the impervious layer in order to avoid the seepage problem. Finally, the excavated materials are used for various purposes.

## REFERENCES

1. Banoune (2016) Treating the riverse dements using hydraulic binders for valorization in road construction Bulletin of


Page 37-47 © MANTECH PUBLICATIONS 2022. All Rights Reserved

Engineering Geology and the Environment pp75

2. Daniel Levacher (2016 ) Behaviour of sediment from the dam FERGOU Gin road construction, Advances in Concrete Construction volume 4 (1):15-26

3. ZEHOURLABIOD(2014),Experim ental investigation of mixtures of bentonite and dredged sediments from Chorfa dam in Algeria, Turkish JEarthSci23:330-338

4. Nikolaos Voulvoulis, Environmental management for dredging sediments, Journal of Environmental Management (2015),Pp 338-348.

5. A. Larouci, Y. Senhadji, L. Laoufi, A. Benazzouk (2020),Valorization of Natural Waste: Dam Sludge for Road Construction, Nature Environment and Pollution Technology, Vol.19,pp. 1075-1083

6. Shigekazu (2007).Conservation of reservoir water Storage: An economic appraisal, Water ResourcesResearch, Vol.43.

7. M. A. Dekker (2003),Numerical and experiment Investigation of Head cutter Dredging Flows, J. Waterway, Port, Coastal, OceanEng,pp203-209

8. N. Belmokhtar (2017), Valorize of port dredged sediments in cement mortars, Journal of Materials and Environmental Sciences, vol-8, Issue-9, pp3347-3352.

9. N. Abou Bekr, S.Taibi (2010), Geotechnical characterization of dredging sediments for valorization in road embankments. Cas of the Cheurfasdam (Algeria), Advances in Analysis, Modeling and Design.

10. S W. Lee daniels (2014), Beneficial Use of Dredge Materials For soil Construction and Development of Dredge Screening Protocols, Journal of Environmental Quality, Vol45, Issue1, Pp.62-73.

11. T. Thuy Minh Nguyen (2018), Stabilizing of Silty Clayey Dredged Material, Journal of Materials in Civil engineering, Vol.30, Issue.9.


Page 37-47 © MANTECH PUBLICATIONS 2022. All Rights Reserved

12. FiJhon CHANG (2001),Physical Modeling of Hydraulic Desiltation in Tapu Reservoir, International Journal of Sediment Research, Vol.16,pp.363-379.

13. A Casagrande (1948). Classification and identification of soils. TransactionsASCE113:901–930.

14. Verstraeten G (2005). The application of semi quantitative methods and reservoir sedimentation rates for the prediction of basin sediment yield in Spain. J Hydrol305:63–86.

15. Francingues NR, Reible D, Vorhees DJ, Wolfe JR (2008).Evaluating the effectiveness of contaminated sediment dredging. Environ Sci Technol 42:5042–5047.

16. Krizek RJ (1970).Properties of slightly organic top soils. J Construct Div.-ASCE96:29–43. Manesh AN, Hoseini SMR (2008). Optimum water content and maximum dry unit weight of clayey gravels at different compactive efforts.EJGE13:1–14.


Page 37-47 © MANTECH PUBLICATIONS 2022. All Rights Reserved