Calculation of Life of Reservoir by Reducing the Silt

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Abstract - *We know that due to sedimentation of silt in the reservoir reduce the life of reservoir. So reducing silt upcoming in reservoir at it's source by various method improves life of reservoir. The most important practical and critical problem related to performance of reservoir is the estimation of storage capacity loss due to sedimentation process. The problem to be addressed is to estimate the rate of sediment deposition and period of time at which the sediment would interfere with the useful functioning of reservoir. Fairly large number of methods and models are available for the estimation, analysis and prediction of reservoir sedimentation process. However, these method and models differ greatly in terms of their complexity, input and computational requirements.*

***Key Words*: Silting (clogging), Desilting, Forecasting methods, Mitigation measures of silting (clogging)**

1. INTRODUCTION

The water cycle, also known as the hydrological cycle or the hydrologic cycle, describes the continuous movement of water on, above and below the surface of the Earth. The mass of water on Earth remains fairly constant over time but the partitioning of the water into the major reservoirs of ice, fresh water, saline water and atmospheric water is variable depending on a wide range of climatic variables.

1.1 Silt

Silt is granular material of a size between sand and clay, whose mineral origin is quartz[1] and feldspar. Silt may occur as a soil (often mixed with sand or clay) or as sediment mixed in suspension with water (also known as a suspended load) and soil in a body of water such as a river. It may also exist as soil deposited at the bottom of a water body, like mudflows from landslides. Silt has a moderate specific area with a typically non-sticky, plastic feel. Silt usually has a floury feel when dry, and a slippery feel when wet. Silt can be visually observed with a hand lens.

1.2 Different Types of Silt

The soil is basically classified into three types: Sand, Silt, Clay.

Figure-1. Types of silt

1.3 Eutrophication

In designing reservoirs, silting problem plays an important role because their operating mode and period depend on this phenomenon. Annual sediment load in a lake is 2-3 or even 4 times higher than the one required by design.

The process of eutrophication can be both natural and human induced. Natural eutrophication where the basin gradually fills in from nutrient and sediment inputs. Occurs over long time period on the order of centuries. Human induced or cultural eutrophication, occurs on a much shorter time scale(decades) as a result of human disturbance and nutrient inputs.

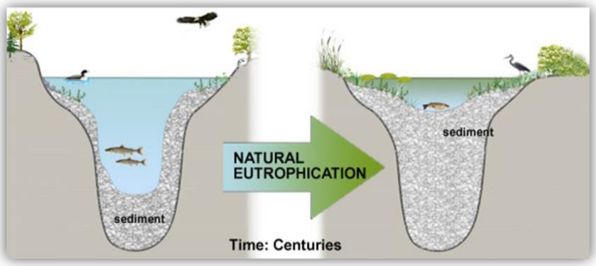

Figure-2 Natural Eutrophication

2. STDUY AREA

1. Location:-

Padale is a small Village/hamlet in Murbad Taluka in Thane District of Maharashtra State, India. It comes under Padale Panchayath. It belongs to Konkan region . It belongs to Konkan Division. It is located 77 KM towards East from District head quarters Thane. 9KM from Murbad. 89KM from State capital Mumbai. It is located on bhamkori river at the site od padale village in murbad taluka of thane district in Maharashtra state of India.

2. Dam:-

Padale dam built on bhamkhori river and kalu river in the drought prone padale, khutarvadi, dheheriand milhe region. Padale dam is one of the largest earthen dam in murbad district. It's length is 720m (0.72km) and height is 26.66m with total gross storage capacity of 7.857 mcum and effective live storage is 7.277 mcum. The total catchment area of dam is 20.73 sq.km.

3. Purpose:-

Padale dam is a multipurpose project. The main purpose was to irrigate land for agriculture in the drought prone murbad region of thane district. Other important purpose was to provide water for drinking and industrial usage to nearby towns and villages and to muncipalties and industrial area of kalyan and thane. The 80% of water of dam is meant for irrigation 5-7% for drinking water and the rest for industrial purpose. Maximum flood discharge is 682.95 m3/sec.

4. Irrigation

Padale dam is one of the largest irrigation project in murbad. Padale dam irrigate cultivable area of 759 hectares. The canal capacity(head) of left bank canal is 0.96m3/sec and right bank canal is 0.122 m3/sec. The commanded area is the 850 hectares.

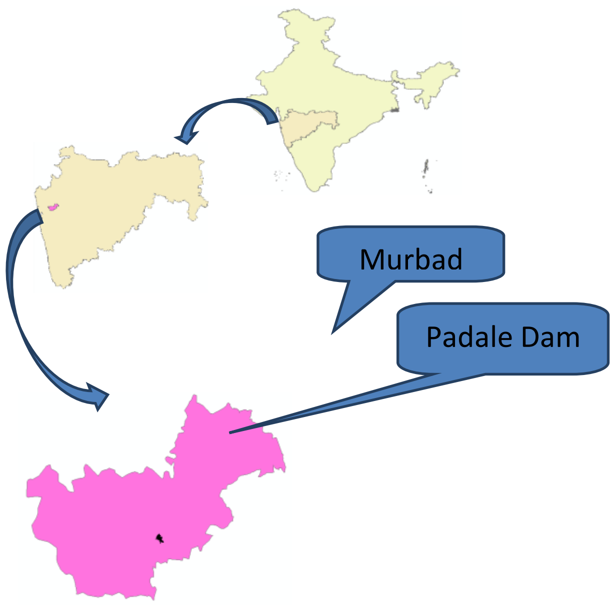

Figure-3 Location of Study area

3. METHODOLOGY

3.1Useful life estimation

The period up to which the reservoir can serve the defined purpose is called usable life, the period after which the cost of operating the reservoir exceeds the additional benefits expected from its continuation is called economic life, design life is generally the useful life, full life period is that when no capacity is available in the reservoir for useful purpose (Murthy, 1980; Kulkarni et al. 1994). Useful life is the period during which the sediment collected does not affect the intended primary use of the reservoir (Arora and Goel, 1994; Kulkarni et al. 1994, Agrawal and Singh, 1994). In most of the developed countries full life said to be arrived, when half of the total capacity of reservoir is depleted. While in case of Trinity River basin reservoirs (Texas), it was considered as the period when the useful storage would be completely destroyed (Arora and Goel, 1994). Useful life is an important design parameter of a reservoir which may affect the economic feasibility and sustainability of a water resources project (Gill, 1979).

Then we use the method by given formula:-

Primarily Highly Flocculated and Coarse Grained Sediments:

$$T_L=\left(\gamma'\frac{I}{G}\right)\left(0.49735\frac{C}{I}+0.3\times10^{-5}\times\frac{C}{I}+0.00436\right)$$

Median Curve (for Medium Sediments):

$$T_L=\left(\gamma'\frac{I}{G}\right)\left(0.008+0.51\frac{C}{I}\right)$$

Primarily Colloidal and Dispersed Fine-grained Sediments:

$$T_L=\left(\gamma'\frac{I}{G}\right)\left(0.51328\frac{C}{I}-0.133\times10^{-5}\times\frac{I}{C}+0.153\times10^{-5}\times\left(\frac{I}{C}\right)^2+0.018167\right)$$

Trap Efficiency

Primarily Highly Flocculated and Coarse Grained Sediments:

$$T_L=\left(\gamma'\frac{I}{G}\right)\left(0.49735\frac{C}{I}+0.3\times10^{-5}\times\frac{C}{I}+0.00436\right)$$

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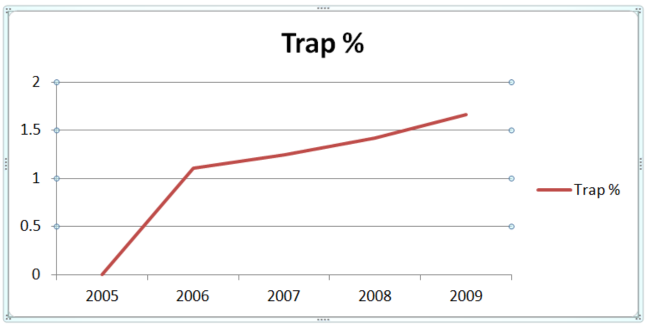

CALCULATION:-

- I = 2507 mm = 2.507 m
- Inflow = Annual rainfall × Cathment area.
- Co = Dead storage + Live storage

  $= 0.807\ m^3 + 7.08\ m^3$

  $= 7.887\ m^3$

- Cathment Area = 20.73 sq.km =20730000 sq.m
- Gross Storage =96.54 ha. = 965400 sq.m
- γ' = 90 lbs =14163.77 $\frac{KN}{M^3}$
- G =12% of sedimentation deposite from storage

  $= 965400 \times \frac{12}{100}$

  = 115848 m.cum / 20 years

Primarily Highly Flocculated and Coarse Grained Sediments:

$$T_L = \left(\gamma' \frac{I}{G}\right)\left(0.49735 \frac{C}{I} + 0.3\times10^{-5} \times \frac{C}{I} + 0.00436\right)$$

$$= 37.25\ \frac{KN}{M^3}$$

Primarily Colloidal and Dispersed Fine-grained Sediments:

$$T_L = \left(\gamma' \frac{I}{G}\right)\left(0.51328 \frac{C}{I} - 0.133\times10^{-5} \times \frac{I}{C} + 0.153\times10^{-5} \times \left(\frac{I}{C}\right)^2 + 0.018167\right)$$

$$= 1527.24\ \frac{KN}{M^3}$$

Median Curve (for Medium Sediments):

$$T_L = \left(\gamma' \frac{I}{G}\right)\left(0.008 + 0.51 \frac{C}{I}\right)$$

$$= 118.349\ \frac{KN}{M^3}$$

Primarily Highly Flocculated and Coarse Grained Sediments:

$$T_L = \left(\gamma' \frac{I}{G}\right)\left(0.49735 \frac{C}{I} + 0.3\times10^{-5} \times \frac{C}{I} + 0.00436\right)$$

$$= 37.25\ \frac{KN}{M^3}$$

Primarily Colloidal and Dispersed Fine-grained Sediments:

$$T_L = \left(\gamma' \frac{I}{G}\right)\left(0.51328 \frac{C}{I} - 0.133\times10^{-5} \times \frac{I}{C} + 0.153\times10^{-5} \times \left(\frac{I}{C}\right)^2 + 0.018167\right)$$

$$= 1527.24\ \frac{KN}{M^3}$$

Annual Rates of Silting of Reservoirs

The earlier designs of reservoirs in India were based on the silting rate of $0.036 Mm^3$ per 100 sq.km of catchment area as suggested by Dr. Khosla, Application of Dr.Khosla's recommendations to Indian reservoirs had limitations, firstly because only 5 points out of 38 points on which he developed his enveloping curve pertained to data of Indian reservoirs and secondly the catchment areas of these reservoirs were very big but reservoirs of very small capacities. Dr. Khosla equation is,

$$Y = 0.323/A^{0.2},$$

Where,

Y is sedimentation rate (ha m/100 sq.km /year)
A is catchment area (sq.km).

$$Y = \frac{0.323}{A^{0.2}} = \frac{0.323}{(20.73)^{0.2}} = 0.176 \text{ ha.m / 100 sq.km / year}$$

$$= 17.6\ m^2 / \text{sq.km.}$$

For Total cathment area (20.73 $km.m^2$) = 17.6 × 20.73 = 366.848 m^2

Total Life of Dam = 60 years

Hence,
Total Sediment Deposition = 60 × 366.848 = 22010.88 m^2

3. RESULT

As we know that silt is deposited in the reservoir. In our project we calculate the silt deposition per year is **3.66km²** and after 60 year it is **20.73 km²**

If we provide the Gambian then this deposition silt quantity is reduce. This Gabion provide by following :-

- **Step Gabion** :- In step gabion the upward portion is vertically straight and downward portion steps is provided. For construction of this gabion stones and wire mesh is used. In flood condition water level rises at that time the amount of silt contain in water is maximum. By providing thid type of gabion silt is deposited at the bottom of upwrd site which helps to reduce the silt deposition in the reservoir.

- **Incline step gabion :-** Incline step gabion is same as step gabion. Step gabion is provided in normal region where as incline step gabion is provided in hilly region. Incline step gabion is more suitable and effctive than step gabion in hilly region.

3. CONCLUSIONS

In our project we conclude that the silt in the reservoir coming from sources is getting reduced due to the provision of gabion as compared to the silt directly deposited in the reservoir which will indirectly increase the life of reservoir.

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