SEDIMENTATION ANALYSIS USING EMPIRICAL FORMULA

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Abstract - Trapping of sediment in reservoirs, dams interrupt the flow of sediment transport through rivers and dams, causing in loss of reservoir storage and reduce it's usable life, and disposing downstream reaches of sediments crucial for channel form and aquatic habitation. The pace of newly constructed dam globally, these phenomena are rising ubiquitous. To pass sediments there are proven techniques for reservoirs, so as to conserve reservoir capacity and to diminish downstream impacts, but they are applicable in limited situations where they would work effective. This paper summarizes collective experience from Jayakawadi dam in calculating dam sediments. Favourable geometry often gravitate detour sediment round the reservoir, it favours keep away reservoir sedimentation and supplies sediment to downstream stick out with rates and timing similar to predam conditions.

***Key Words*: Sedimentation, Reservoir, Dam, Silting, Sustainable**

1. INTRODUCTION

One of the paramount element is water, all living needs water to sustain. Socio economic and primary health development directly relies on water, suction in poverty and maintaining equality. The well being of the improvised sector with with expenses of urbanization, high demand for drinking water. The Forthcoming years are crucial for hydropower stations, the demandingly maximum food production at cheaper rate of water consumption, expansion of Industrial and Agriculture sector and the economical waste water treatments. Water Resources Management aims at optimizing the naturally available water flows and engaging needs. Summing uncertainty, changing climate will rise in the complexity of management of water resources. Due to demand of water supply there are various challenges, it has became necessary to utilize all the available storage in minimum rate. It is well known fact that sedimentation occurs at reservoirs constructed on rivers. A reservoir sedimentation is a natural phenomena. The objective of paper is to estimating the methods to find sedimentation rate in the reservoir.

Our case study is Jayakwadi dam which is an earthen dam located on Godavari river at the site of Jayakwadi village in Paithan taluka of Aurangabad district in Maharashtra, India. The harsh project is one of the largest irrigation projects in the Indian state of Maharashtra. It is a multipurpose project. The water is mainly used to irrigate agricultural land in the drought-prone Marathwada region of the state. It also provides water for drinking and industrial usage to nearby towns and villages and to the municipalities and industrial areas of Aurangabad and Jalna districts. The surrounding area of the dam has a garden and a bird sanctuary.

In the past we have built enormous construction projects keeping several safety measures in mind. The Jayakawadi reservoir is one such example. The need of study is to evaluate current sedimentation rate in dam. In this paper we shall found out the current condition of dam.

It is observed from the some studies that the different storage zones of the Jayakwadi reservoir are silting up rapidly where reduced life storage is expected to be available around 100 MCM by the year of 2060-70. So, it is definitely required to evacuate the silt from the reservoir to increase its operation life Now, it is a great question that how it may be achieved. In this study we will be discussing some the empirical methods we can use for silt calculation.

2. Related work

2.1. STUDY AREA

Our case study is Jayakwadi dam which is an earthen dam located on Godavari river at the site of Jayakwadi village in Paithan taluka of Aurangabad district in Maharashtra, India. Located at geographically 19°29′8.7″N 75°22′12″E. Our site is located at one of the fastest growing area in Maharashtra.

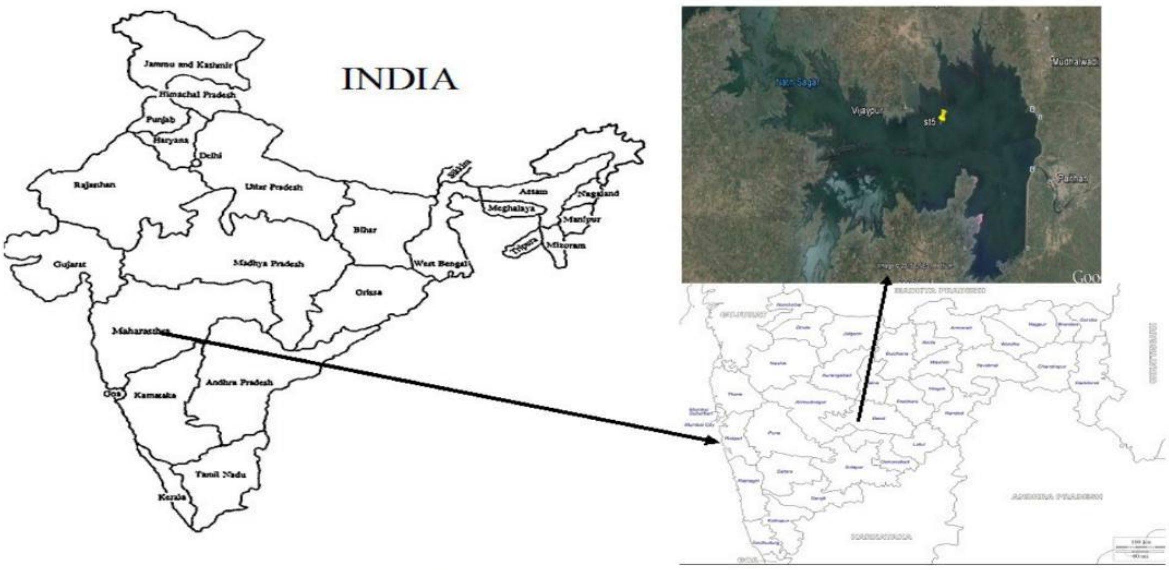

Fig-1: Location of Jayakawadi Dam

2.2. DATA COLLECTION

Various types of data are needed to calculate the Sedimentation rate. it includes site map, soil map, area of dam, map, life of dam etc. The sources of data are department of hydrology, Indian meteorological department (IMD) for , Maps for satellite maps. Dam geography details.

2.2.1 Site map

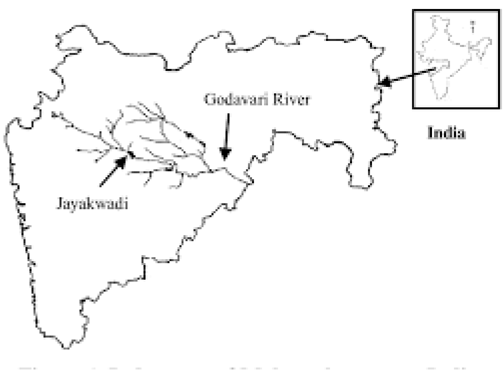

FIG - 2: Site Map Of selected site

Site map helps identifying geographical location of site selected. Weather conditions, streams merging on site, type of soil strata etc.

2.2.2 AREA OF DAM

- The salient features of the Jayakawadi dam Project Planning are as given below.
    - Catchment Area : 21750 Sq.kms. (8400 Sq.Miles)
    - Gross Storage : 2909 Mm3 (10272 Mcft)
    - Live Storage : 2171 Mm3
    - Type of Dam : Earthen • Length of Dam : 10.20 kms.
    - Maximum height of dam above River Bed : 37 meters (120 ft.)
    - Area under submergence : 35000 Ha.

The above area are taken from department of hydrology. This numbers will be used for empirical calculation of dam.

2.2.3 LIFE OF DAM

- Commencement of the Project: Oct. 1965
- Year of first impoundment: 1974
- Year of commencement of Irrigation: 1976

The Jayakawadi dam project started at 1965 which commenced at 1976. The current life of Jayakawadi dam is 44 years. Our calculations will be based on current life of dam

3. Methods

Calculation methods for total sedimentation yield

1. **BATHYMETRIC SURVEY**

Water depths can be measured using a portable sounder connected to a GPS. The GPS records both the location coordinates and the depth measurement of the sounder. DGPS is often used, which allows for rapid collection of bathymetric data in open areas, so this is suitable for reservoirs as well. Fish-finder is also a useful low-cost device to measure the bathymetry in easy way. Usually they are used to find fish. Since they record water depth also, it is possible to use them for measuring bathymetry of rivers and reservoirs other methods are water depth soundings using single or multi-beam eco-sounders, which are rather commonly used these days as it produces fast and high resolution mapping of bathymetry. Such bathymetry measurement provides clear feature of the reservoir bed. The bathymetric feature shows that the area near the dam is deeper. Besides, there is a deep channel in the reservoir, which appears to be the old river course. There are some situations when reservoirs with fine sediment deposition appear to fill from the dam towards the backwater and no delta forms at the upstream area.

2. **EMPIRICAL MODEL**

I. Khosla's equation

$$\boxed{Qs = 0.323 (A)^{(-0.28)}}$$

$$\boxed{Y = Qs \times \text{life of dam}}$$

a. Qs = Annual sedimentation yield rate (meter cube/100 sq. km of catchement)
b. Y = Sedimentation Rate (ha.m/ 100 sq Km / year)
c. A= Catchement area (sq. Km)

II. Joglekar Equation

$$\boxed{Qs = 0.59 (A)^{(-0.24)}}$$

$$Y = Qs \times \text{life of dam}$$

a. Qs = Annual sedimentation yield rate (meter cube/100 sq. km of catchement)
b. Y = Sedimentation Rate (ha.m/ 100 sq Km / year)
c. A= Catchement area (sq. Km)

iii. Varshny equation

$$Qs = 1.534 (A)^{(-0.264)}$$

$$Y = Qs \times \text{life of dam}$$

a. Qs = Annual sedimentation yield rate (meter cube/100 sq. km of catchement)
b. Y = Sedimentation Rate (ha.m/ 100 sq Km / year)
c. A= Catchement area (sq. Km)

iv. Froehlich formula

$$\hat{Y} = K\, Ac^{\alpha}\, Ar^{\beta}\, C0^{\gamma}\, T^{\varphi}$$

Where,

$\hat{Y}$ = expected value of reservoir capacity loss (Mm3), Ac = catchment area(km2), Ar = surface area of the reservoir atFRL (km2), C0 = initial storage capacity of the impoundment (Mm3), T= time since the initial filling of the reservoir (years), K,α, β, γandφ = empirical constants, which is proposed to be 0.0067, 0.1, 0.05. 0.8 and 0.9 respectively for the reservoirs on eastward flowing rivers, while 0.03, 0.15, 0.3, 0.5 and 0.65 respectively for the reservoirs on westward flowing rivers.

4. Experimental results

The data used for last ten years shows trend in sedimentation using different empirical formula.

1. Khosla's equation

Year	CALCULATED SEDIMENTAION RATE (ha.m/ 100 sq Km / year)
2011	0.6848
2012	0.7095
2013	0.7293
2014	0.7490
2015	0.7687
2016	0.788
2017	0.8081
2018	0.8278
2019	0.8475
2020	0.8697

The average sedimentation for last ten years is found out to be 0.79824 ha.m/100 sq Km/ year

2. Joglekar equation

Year	CALCULATED SEDIMENTAION RATE (ha.m/ 100 sq Km / year)
2011	1.8788
2012	1.93248
2013	1.98616
2014	2.03484
2015	2.09352
2016	2.1472
2017	2.20088
2018	2.25456
2019	2.30824
2020	2.36192

The average sedimentation for last ten years is found out to be 2.111986 ha.m/100 sq Km/ year

3. Varshny equation

Year	CALCULATED SEDIMENTAION RATE (ha.m/ 100 sq Km / year)
2011	3.84405
2012	3.95388
2013	4.06371
2014	4.17354
2015	4.28337
2016	4.3932
2017	4.5030
2018	4.61286
2019	4.722
2020	4.832

The average sedimentation for last ten years is found out to be 4.338161 ha.m/100 sq Km/ year

4. Froehlich formula

The current sedimentation is found to be 2.6175 % loss/year

5. Conclusion

To provide sustainable, economic , social and safe environment practices sedimentation analysis is essential. This can be achieved by calculating sedimentation over time. The rate of sedimentation should be controlled if found more has to be make preventive measures. Using different empirical formula we have found sedimentation rates in this paper.

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