Review of Sedimentation Removal Technique in Dam

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Abstract — This study explores a novel sedimentation removal technique in dams using a pipe system. The conventional challenges associated with sediment build-up in dam reservoirs are addressed through the implementation of strategically placed pipes. These pipes facilitate the controlled release of sediments, preventing excessive accumulation and maintaining optimal reservoir capacity. The proposed technique aims to enhance the overall efficiency of dam operations by minimizing sediment-related issues and ensuring sustainable water management. The study provides insights into the design, implementation, and effectiveness of the pipe system as an innovative solution for sedimentation removal in dam environments.

Keywords: Sedimentation Removal Technique, Dam

I. INTRODUCTION

- Dams play a crucial role in water resource management, providing vital functions such as flood control, water storage, and hydroelectric power generation. However, over time, sedimentation poses a significant challenge, reducing a dam's capacity and efficiency. Sedimentation removal techniques are essential to maintain optimal dam performance, and one innovative approach involves the use of pipe systems.
- Sedimentation is the natural process by which particles settle out of water and accumulate at the bottom. In dam reservoirs, this phenomenon leads to the gradual build-up of sediment, impacting the dam's functionality. Traditional sediment removal methods often involve costly and environmentally intrusive dredging processes. To address these challenges, engineers and researchers have turned to advanced pipe systems as a sustainable and efficient solution.
- The use of pipe systems for sedimentation removal in dams introduces a novel and streamlined approach. These systems are designed to strategically transport sediment-laden water from the reservoir to designated areas, preventing the accumulation of particles within the dam structure. The pipes are strategically positioned to create a controlled flow that optimally removes sediment while minimizing the disturbance to aquatic ecosystems.
- One key advantage of pipe systems is their adaptability to various dam configurations. Engineers can customize the design based on the specific sedimentation patterns and dam requirements. This flexibility allows for the implementation of targeted solutions, ensuring that the removal process is efficient and tailored to the unique challenges posed by each dam.
- Additionally, pipe systems contribute to sustainability by reducing the environmental impact associated with traditional sediment removal methods. By minimizing the need for extensive dredging operations, these systems protect aquatic habitats, preserve water quality, and mitigate disruption to the surrounding ecosystem.
- This paper explores the principles and applications of sedimentation removal techniques in dams through the innovative use of pipe systems. By delving into the design considerations, operational mechanisms, and environmental benefits of this approach, we aim to highlight the potential of pipe systems to enhance dam efficiency and sustainability.

II. METHODOLOGY:

A. Site Assessment:

- Conduct a thorough assessment of the dam and its sedimentation buildup.
- Identify the location and depth of sedimentation within the reservoir.

B. Hydrological Study:

- Perform a hydrological study to understand the flow patterns, water levels, and sedimentation rates.
- Analyze the sediment composition to determine the appropriate removal method.

C. System Design:

- Design a pipe system that can effectively transport sediment-laden water from the dam to a designated discharge area.
- Consider the size, material, and layout of the pipes based on the sediment load and flow rates.

D. Sedimentation Basin:

- Construct a sedimentation basin or settling tank at the discharge area where sediment-laden water will be released.
- Ensure the basin has sufficient capacity to allow sediment to settle before releasing water.

E. Pipe Installation:

- Install the pipe system in the dam, connecting it to the sedimentation zone.
- Place intake structures at strategic locations to capture sediment-laden water.

F. Pump System (if needed):

- If the dam water level is not sufficient to rely on gravity flow alone, install pumps to assist in transporting water through the pipe system.

G. Monitoring and Control:

- Implement a monitoring system to track water flow, sediment concentration, and overall system performance.
- Include control mechanisms to adjust flow rates and address any issues promptly.

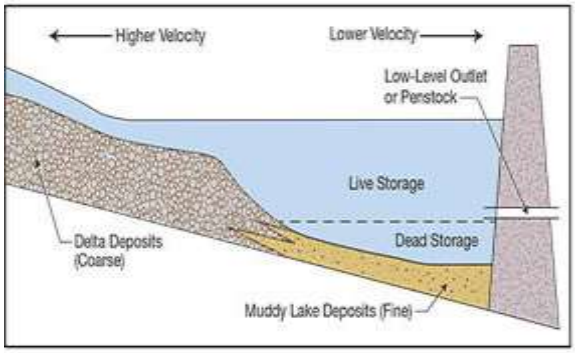

Fig. 1: Typical Reservoir Sediment Profile

Fig. 2: Example of Dam

Fig. 3: Sediment Removal, reduction, and flushing

III. Effects of Reservoir Sedimentation

A. Sediment Impacts on Discharge Capability:-

Sediments will often block low-level outlets designed to allow for reservoir drawdown. As sedimentation continues, clogging of spillway tunnels or other conduits may occur. Reduction of spillway capacity can occur as a result of the loss of approach depth when the sediment front reaches the dam. The reservoir becomes a delta-filled valley that takes a meandering course such that a flood wave does not spread out to allow flood routing.

B. Sediment Impacts on Equipment:-

Sediment can damage turbines and other mechanical equipment through erosion of the oxide coating on the blades, leading to surface irregularities and more serious material damage. Sustained erosion can lead to extended shutdown time for maintenance or replacement.

C. Sediment Impacts on the Environment:-

Any dam will cause some degree of sediment starvation downstream. Plant and animal species are sensitive to alteration of both the sediment supply and flow regime. Increases in sediment concentration can create turbid waters with a smaller zone. This decreases plant productivity, negatively impacting fish and bird species and causing abrasion of fish gills, thus increasing the potential for disease or mortality.

D. Other effects include the following:-

1) Reduced storage capacity.
2) Retrogressive deposition.
3) Reduced availability of water for irrigation.
4) Shortening of life of a reservoir.

E. Silting control in a reservoir:-

To increase the life of a reservoir, it is necessary to control the deposition of sediments. Various measures are undertaken to achieve this aim. The various methods which are adopted can be divided into two parts:

1) Pre-constructing measures and
2) Post- constructing measures

IV. Other Mitigation Methods are Below:

A. Reduce Sediment Inflow:

Sediment delivery to the reservoir can be reduced by techniques such as erosion control and upstream sediment trapping.

B. Route Sediments:

Some of the entire inflowing sediment load may be hydraulically routed beyond the storage pool by techniques such as drawdown during sediment-laden floods, off-stream reservoirs, sediment bypass, and venting of turbid density currents.

C. Sediment Removal:

Deposited sediments may be periodically removed by hydraulic flushing, hydraulic dredging, or dry excavation.

V. Advantages

1) Mitigate impacts to hydraulic structures and equipment which may reduce the likelihood of repairs and downtime.
2) Easier to perform and less prone to technical error.
3) Reduce sediment yield from upstream.
4) Effective removal of solids.

VI. Conclusion

Sedimentation can affect hydropower production due to loss of the reservoir storage and/or damage to the facility's mechanical components. Sediments deposited in reservoirs may affect the safety of dams and, without proper management, negatively impact the environment.

Methods of managing reservoir sedimentation problems fall under three general categories: those that divert sediment around or through the reservoir, those that remove deposited sediments, and those that minimize the amount of sediment reaching the facility in the first place. A variety of sediment management strategies have been used around the world, with many successful implementations documented.

This discussion in essence highlights the need for appropriate sediment management at hydropower facilities and shows how this can be achieved through consideration of sediment concerns from the earliest design phase through to construction and operation. To curb erosion and sedimentation in rivers and reservoirs, there is a need to develop and implement an integrated water resources management plan by all stakeholders.

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