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Issues Problems of Sedimentation in Reservoir Siazakh Dam Case Study

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***Abstract*—**Sedimentation in reservoirs lowers the quality of consumed water, reduce the volume of reservoir, lowers the controllable amount of flood, increases the risk of water overflow during possible floods and the risk of reversal and reduction of dam's useful life. So in all stages of dam establishment such as cognitive studies, phase-1 studies of design, control, construction and maintenance, the problem of sedimentation in reservoir should be considered. What engineers need to do is examine and develop the methods to keep effective capacity of a reservoir, however engineers should also consider the influences of the methods on the flood disaster, functions of water use facilities and environmental issues.This article first examines the sedimentation in reservoirs and shows how to control it and then discusses the studies about the sedimens in Siazakh Dam.

***Keywords*—**Sedimentation, Reservoir, Sediment Control, Dam

I. Introduction

UNDER natural conditions, sediment is transported from land to water in runoff. The increased rate of delivery of sediment can cause stream sedimentation problem [6]. Therefore sedimentation in reservoir is a natural process. However, sedimentation can ca**u**se can be enhanced by anthropogenic activities such as deforestation and mismanagement of riparian area [7]. Dam on a river affects the flow regime of waterways and its sedimentation transference. As for the sedimentation transference, dam on a river accumulate the sedimentary materials in reservoir and decreases the useful volume of reservoir and in critical conditions the water varieties behind the dam exceeds the crest varieties and water overflows from the crest. Another destructive phenomenon from the accumulation of sedimentary materials in the reservoir is the reduction the stability of dams. Thus in analyzing the stability of structure like dams, stone reversal which occurs due to the accumulation of sedimentary materials behind the dam should be considered.

II. Sedimentation in Reservoirs

When a particle of sediment enters a river's system, its transfer is determined by the transfer equations or measurement from the river. Comparing the incoming sediments to the reservoir and their sedimentation indicates that the amount of sedimentation in reservoir always is less than their incoming sediments. In other words some percentage of suspensions deposits at the reservoir and also some comes out of it. This percentage is called trapping coefficient. The volume of sedimentary deposits depends on two parameters:

1) Trapping coefficient
2) Sedimentary materials density

The trapping coefficient, in general, decreases over time and it should be considered during the useful life of reservoir. Thus the useful of reservoir should be evaluated every five years. The sedimentary deposits in reservoir should be converted from weight to volume unite in order to determine the how much sediments occupy the reservoir, thus it is required to have the have the sediment density. Predicting the sediment load of a river is one the hardest stages in hydraulics of a river. It is examined through hydrological or hydraulic methods. The hydraulic method included field measurement of sediment load or estimation of erosive elements in catchment area or both of them. It gives a good estimation but at least it needs the annual hydraulic mean data statistics to be available. The hydraulic method has been based on the capacity of river load assuming the flow being saturated which is necessarily may not be the case. The most parts of river's sediment load occurs at flood stage when the water flow is variable. According to the ICOLD, the average loss of reservoir capacity is 1% in a year which is considerable. T he sedimentation in reservoirs is related to the water resource management.

The suspended sediments don't preserve in the catchment. These suspended loads enter the reservoir. The entrance flow to the reservoir besides the water included the suspended load and bed load. The load sediments are often higher than the bed load. The bed load particles gradually deposit in the entrance flow to the reservoir and engage in delta formation and development. The sediments suspended are deposited near the delta. The smaller particles go into the reservoir and deposit more at the stagnant water. When the flow enters the reservoir, the water velocity reduces due to enlargement of reservoir level and the suspended materials are deposited. The water of river has two main differences to the water reservoir: it is muddier and colder. These two properties make the water of a river heavier than the water of reservoir. Thus when the flow enters the reservoir moves at the lower part under the water extending the slope. As it is shown in Fig 1, the layers occurs in the reservoir. The underneath muddy water once reaches the end of reservoir comes up vertically and returns backward again and as Fig (1) shows it flows in oval shape.

The sediments are deposited over time but the sedimentation has a complicated process. First the coarse sedimentary materials and then fine sedimentary materials are deposited. The part filled by sedimentation during the life of

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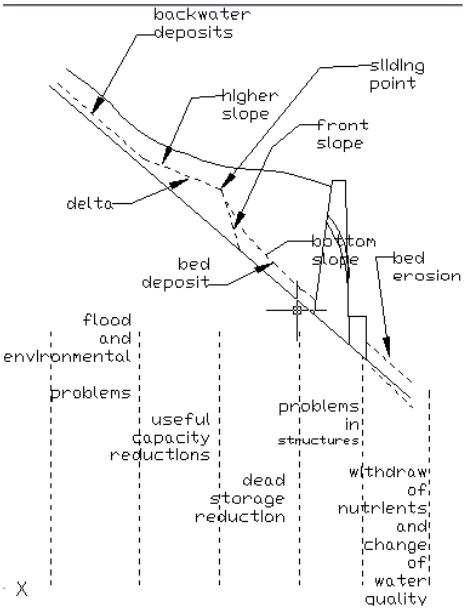

Fig. 1 Deposition of sediments in the reservoir

dam is known as dead volume. The upper part is called useful volume. The empirical area reduction method is one of the practical methods used to predict how the reservoir fills by sediments. The sedimentation transference from reservoir depends on the preservation of useful volume and performance of lower discharge or both.

III. Strategies to Reduce Sedimentation to the Reservoir

The methods used to reduce the sedimentation in reservoirs, in general, are

1) Gravel basin
2) Front basin
3) Dredging
4) Releasing sediments

A secondary dam may be built in the front basin for reducing sedimentation in reservoir to maintain the bed load in the entrance area. The gravel basin is placed at the upstream and could be designed as a reserved area. It usually should be cleaned every year or after a big flood. In case in which the water surface reaches its maximum in the main dam, this dam is flooded completely and gravel may deposit like sand effectively.

In general, there are two methods including the sediment retention in the gravel basin including soil protection and sediment maintenance in special places through adjustable dams.

Dredging reservoir depends upon the depth of sediments and their place of accumulation in reservoir, quality of sediments and transference systems. The sedimentary deposits can't be discharged using simple suction due to their high adhesion. It is required to use looser tools such as jet nozzles or rotating tools and then transfer the sediments through a pipeline to the outlet nozzle. The hydraulic transference is carried out by siphon. There is no need any pump for discharging sedimentary materials because the load is enough between the reservoir and outlet level for hydraulic transfer of sedimentary materials.

IV. Research Records

In a research that has been done in Japan, operated or test operated methods of sediment control around dam reservoirs are as flow [1]:

1) Sediment flushing

Draw down operation is executed for flushing large amount of sediments. Partially draw down operation is also executed to control released sediment volume or recover store water.

2) Sediment bypassing

There are both cases. Bypassing wide range of grain size and fine sediment only.

3) Excavating and dredging

60% of removal sediment is effectively used. Some dams have tried to resettle in river area of dam downstream for flushing during the flood.

4) Discharge turbid water

Outlet conduits, selective withdrawal facilities or special structures to release turbid bottom water are used.

5) Empty dam

Gateless bottom outlets are placed near riverbed elevation if a dam is planed only flood control.

Main purpose of the operation or test operation is different by each example. Result of the operation or test operation, however, have various phases such as countermeasures of sedimentation, sediment supply method to the areas downstream, influential activity on river eco-system conditions and so on. They had to find the position of the activity in the sediment transport system. That must be obtained the concept of integrated sediment system management.

In another research, three case studies of sediment impact and control management have been down in swiss [2]. in these cases, some sediment flushing is performed for security purpose (mainly to maintain an access to the emergency drain). In other reservoirs, periodic flushing of sediments is carried out. Discrete sampling of suspended matter upstream and downstream of the reservoir was carried out in 2005, during both normal and flood conditions [3]. Result show that about 50% of the sediment load is stored in the reservoir during normal flow, whereas this proportion rises to 90% during flood conditions. In addition, the sediment load during flood conditions was 4,000 times higher than during normal flow. This enormous difference emphasized the importance of rate events in the sediment dynamics of a reservoir. In a research have shown that sediments deposited between the 1960s and the early 1970s are located with contaminates [3].

In a research that has been down in wonogiri reservoir in Java Island [4]. Some strategies have been done for sedimention control as bellow;

Excavation of sediment and cleaning up of garbage, sediment flushing, land conservation, construction small reservoirs and sabo dams were carried out effectively outside reservoir. However, flushing in reservoir was not

recommended since it will cause flooding on the downstream of reservoir which are densely populated and may cause degradation of water quality. Moreover, sedimentation control related to erosion control and hence, it is necessary to:

1) Prevent hillside erosion by means of reforestation
2) Manage riparian zone along rivers
3) Establish the possibility of bypassing from keduang river to the downstream
4) Conduct reservoir sound periodically

For complement of pervious research that has been down in wonogiri reservoir, sedimentation in the reservoir resulted in decreasing storage capacity of 19 years faster than designed. Flushing, sand mining and dreading that carried out inside the reservoir were effective in controlling sediment and directly improve the storage capacity. However, the present measures such as check dams, small reservoir, short-cut and land conservation offer more detailed research on technical, social and environmental approach [5].

V. Studies on Sediment Entering the Reservoir Siazakh Dam

Since there is no sampling statistics on sedimentary material concentrations at the river of Siazakh Dam, the plan used the sedimentation statistics at the local stations to analyze the sedimentation area in order to determine the erodible of catchment. According to the regional results , it has been estimated that the average fine sediments carried by the river to the recommended place is about 442,583 tons a year equaling 418 tons a year by square kilometer of special sedimentation up to this place or 2.6 kg of suspended sediment per cubic meter water. After 50 years of operation to measure the occupied volume the weight of coarse sediments or slope bed load considered about 25% of suspended sediments weight and also trapping coefficient of suspension materials considered based on the reservoir volume, entrance flow, operation of dam and finally lower discharge maneuver at the bottom outlet tunnel three times every year at least about 97% and accounting for 1.3 ton/m^3density for the suspended sediments and 1.6 ton/ $m^3$for the bed load , the total volume of entrance sediment after 50 years of operation estimated 20 million m^3. So it would be expected that the average annual entrance volume of sediments into the siazakh dam is about 0.4 million m^3. As it is defined by the National Committee of Big Dams the loss of reservoirs is 1% of reservoir volume for entrance sediments that is after 50 years the useful life of dam is practically over unless the deposition methods are well. According to the estimation by the Abniro Consultation Engineers after 50 years of plan the sediment accumulation in the reservoir would be 20 million m^3 which the reservoir reserved volume (230 million m^3), the sediment accumulation in reservoir is (20/230)*100 =8.7% and it differs so much with the defined percentage by ICOLD.

Recommendation

Since the Ghazal Ozen river is one of the river that is constantly exposed to serve spring floods due to its location and climate conditions around the dam and has high average of rainfalls and also observing the river at these times it seems necessary to do more complementary studies about fine and coarse sediments and implement sedimentation control methods in catchment of siazakh dam and deposit the accumulated sediments according to the presented methods.

From the view point of the integrated sediment management, dam reservoirs are expected to have functions of sediment flow monitoring facilities and as large check dams. Annual measurement of sedimentation volume should be continued for a monitoring facility.

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