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Deposition at the Heads of Reservoirs

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INTRODUCTION
Scope

Experience has shown that there are two characteristic types of sediment deposits in reservoirs along alluvial rivers: (1) those occurring generally over the reservoir bottom, mostly composed of the finer fractions of the river sediment load - the silts and clays; and (2) those occurring in a characteristic delta formation at the head of the reservoir, including all the coarser fractions of the river sediment load - the sands and gravels - but which may also include large quantities of the silts and clays. This paper will be limited to a discussion of the headwater delta deposits, with some reference to deposits which have occurred upstream of reservoirs, but are not necessarily associated with them.

Purpose

The analytical procedure for predicting delta formation will be discussed in a general way and some conclusions which have resulted from observations at the heads of existing reservoirs will be offered. It is the purpose of this paper to suggest some of the factors which must be taken into account in an engineering estimate of future deposition at the heads of exisiting or proposed reservoirs, so that action for the control or alleviation of problems which could arise therefrom can be planned before the problems become serious.

The Engineer's Interest in the Problem

It is well known that delta deposits can progress in two directions. They build downstream into the reservoir and, unless the riverbed is degrading, as it would below a dam, they extend themselves upstream, progressively aggrading the river channel above the limit of reservoir backwater. Upstream aggradation of the river channel could under some circumstances cause the reservoir backwater effect to progress upstream, increasing flood heights. The growth of the delta into the reservoir lessens the reservoir capacity, affecting its economic life. In Lake Texoma above Denison Dam (1), 49.5% of the deposition between 1940 and 1948 occurred in the delta area, large portions of which were silt and clay. Consideration of downstream delta building is also important when allocating areas for docks and recreation on a new reservoir. An example is a privately owned fishing camp located on the upper end of Possum Kingdom Reservoir in Texas. When the pool was filled in 1941, there was deep water at the camp. By 1951, a delta had progressed downstream past the camp, creating a two-foot muddy channel, and endangering the campowner's livelihood.

Consideration of these extraneous effects point to the possibility of controlling reservoir sedimentation by inducing upstream deposition deliberately. The Bureau of Reclamation estimates that the vegetative screen above Lake McMillan intercepts over eighty percent of the sediment inflow, prolonging the useful life of the reservoir for many years. Naturally, if upstream valley lands are well developed, the prevention of extra upstream deposition is the problem; and the remedy is to maintain a clear channel through the length of the delta, to eliminate any man-made local contractions, and to keep the channel free of encroaching vegetation if possible.

CONCLUSIONS

A search for information through a great number of reservoir surveys reveals that reliable information on the delta portion of reservoirs is sparse. (Notable exceptions are Conchas Reservoir, Lake Texoma, and Lake Mead.) Because most surveys were conducted primarily for the determination of storage loss, only the portion of the reservoir effects upstream to the limit of backwater were not taken into account. If there is to be a better understanding of the way a delta is formed, the following information should be obtained from some reservoirs:

1. Water-surface profiles along the delta, during both high and low discharges.
2. Bed-surface samples taken along the channel from the head to the foot of the delta, during high discharges if possible.
3. Borings to determine the distribution of material within the delta.
4. Cross sections of the delta surface.
5. Surveys or aerial photographs of the channel alignment.
6. Reconnaissance of the delta after major inflows to note general disposition of new deposits on the delta surface.

This dicussion of the various factors which must be considered in predicting future delta formation has pointed to the need for more information on some of the basic phenomena involved. In the opinion of the writer, the analytical tools which will enable predominantly sand deltas to be computed are on hand or are being developed; but for deltas which contain large amounts of clay the problem is still indeterminant because of the lack of knowledge of the criteria for deposition of fine materials. A computation of delta formation due to reservoir backwater is, in itself, inadequate as an engineering estimate in many cases. Consideration must be given to the possibility of vegetation and other extraneous effects altering the deposition pattern.

DISCUSSION

Mr. Lane, discussing Mr. Harrison's paper, commented that engineer dealing with sediment problems have in recent years become aware that the position at which the sediment coming into a reservoir deposits is very important. Some years ago, a common assumption was that the sediment deposited in the lowest part of the reservoir, with a level upper surface. It is now widely known that this does not occur and under the large range of conditions which is found in reservoirs, it is difficult to predict just what will occur. Mr. Harrison's paper is very valuable as an aid in such a prediction.