RESERVOIR SEDIMENTATION SURVEYS--OBJECTIVES AND METHODS

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Discussion – Horizontal Control

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The objectives of reservoir sedimentation surveys have been presented in an excellent manner by the author, and he has very ably described the method currently employed by his agency in the conduct of the surveys. Mr. Murray and Mr. Morrison have contributed greatly to the subject by describing other methods with particular reference to echo-sounding equipment.

Considerable thought should be devoted to one paragraph in the original paper, particularly, by individuals who are concerned with conducting reservoir sedimentation surveys.

> "Considering the large number and importance of reservoirs both large and small throughout the country, the over-all magnitude of reservoir sedimentation determinations is sufficient to justify the development and use of methods which will give desired results both accurately and economically."

In other words, the problem is of such magnitude that it merits the concerted cooperative effort of all concerned, even to the extent of joint purchase of equipment.

Further development of presently employed methods is dependent upon improvement of present equipment, production of new equipment, and the possibility of adapting to the problem equipment designed for other uses.

Hydrographic surveys are three dimensional. A sounding represents a vertical dimension which must be located in the horizontal plane by two coordinates. Hence, in addition to the sounding, there must also be position finding, or horizontal control of the survey. In recent years, depth measurements have been made with supersonic equipment. The operation of this equipment has been described previously. The continuous graphical recording of depth by electronic sounders has greatly increased the need for some means of automatically determining position. However, the development of such equipment has not been consistent with the development of sounding devices.

Cross-Reference "Proceedings of the Federal Inter-Agency Sedimentation Conference" (Held at the Bureau of Reclamation Laboratories, Denver Colo., May

Horizontal control for hydrographic surveys now being generally employed, may be divided into two categories, (1) established methods utilizing mechanical survey and navigation instruments, and (2) experimental methods employing electronic equipment. The positioning of soundings is ordinarily accomplished by a direct, or indirect measurement of angles and distances, using instruments normally employed in topographic surveys, or navigation. The methods of application have necessarily been modified.

The electronic methods of horizontal control now being used to a limited extent in hydrographic survey work were designed principally for war, or aeronautical use, but the basic principles upon which they operate permits conversion to civil use. Since applications to war effort differ from peace-time applications, new procedures must be established for securing and interpreting the data. These procedures have been established to a limited extent, and preliminary applications indicate greater accuracy may result than that attained by purely mechanical means.

Methods of position finding, depending on visual means, are not operational during inclement weather and periods of poor visibility. This causes considerable loss of time to survey parties working in coastal areas, but should be a somewhat lesser problem on reservoirs located inland. One particular advantage of the electronic devices is that they will remain operational in fog and during other periods of low visibility.

Essentially, all of the electronic position finders now applied to hydrographic surveys are still in the development stage, although Shoran and search-type radar are being employed extensively by the major oil companies on underwater geologic surveys. The cost of such equipment, although justifiable on large surveys, would probably be out of proportion for our ordinary reservoir sedimentation surveys.

Among the electronic systems being used at present is the SCR-584 radar developed by the Army for detecting and tracking hostile aircraft. This equipment has a certain degree of mobility but is mounted on trucks and trailers; hence, is heavy and bulky and not adaptable to movement over rough terrain. It was used on the hydrographic surveys in Galveston Harbor very successfully and accurate results were obtained. The system employs ultra-high frequencies and, therefore, operates on "line-of-sight." The bulk of the equipment is located on shore and a target, or radar beacon, is mounted on the survey boat. The cost of the equipment is approximately $150,000. The availability is questionable, since all radar equipment has been frozen for the needs of the Army. However, it may be possible for Federal agencies to arrange for a loan of the necessary apparatus for experimental purposes. Trained crews are prerequisite for successful operation.

Another type of equipment that has been used on off-shore surveys conducted for oil exploration, is the SO8 Navy radar. This equipment is mounted on the survey vessel. The location of the vessel is accomplished

by resection from previously located points as viewed on the PPI scope. The accuracy is somewhat less than the shore-based radar, but the equipment is not bulky and is easily installed. This apparatus is available only from Navy surplus, or War Shipping Administration, and the cost varies considerably depending on the condition of the equipment. Highly trained operators are not required.

Shoran, a war development for the control of airborne aircraft, is being used for off-shore surveys and other similar work where relatively long distances are involved. This equipment consists of two or more fixed stations and one mobile station normally located on the airplane or ship. It employs radar frequencies and accomplished measurement of distance by timing the signal for the round trip over the course from craft to ground station. The equipment is very compact and well designed. The accuracy is excellent for long distances. The percentage of error is greater when measuring short distances being in the order of 15 yards. The cost of the equipment, two ground stations and one airborne station, is approximately $30,000.

The British Decca system is, generally speaking, suitable only for large bodies of water. The fixed stations are more of a permanent nature, but the mobile station is quite simple and readily moved about. The cost, including duty, is approximately $160,000.

Other methods employed to a lesser degree are variations of the radio direction finding principle. This type of equipment was not designed to give a high degree of accuracy, but further development might permit adaptation to reservoir surveys.

Photogrammetric methods of position finding are undergoing rapid development, and some system based on this principle may be available in the future.

Probably the most promising equipment for use on reservoir surveys is a recently developed electronic device known as "Raydist." This equipment was developed for determining ground speed of aircraft in flight. It is a highly accurate and sensitive electronic distance measuring system and is applicable to many problems requiring precise determination of position. The system measures relatively short distances accurately and is capable of detecting a 1-inch movement of a small transmitter. It is also capable of measuring the longer distances and is not limited to line-of-sight measurements.

The method accomplishes the equivalent of setting up standing radio waves in space and enables the number of these waves set up within a given distance to be counted. In setting up for the measurement of linear distance between any two points, equipment is placed at two stations located conveniently adjacent to the distance to be measured. A continuous wave transmitter is then moved over any convenient path from a point at one end of the distance to be measured to a point at the other end. A second transmitter heterodynes the moving transmitter and is held at a

fixed point in such a way that the heterodyned signals can be received at both ends of the distance to be measured. The signal received at one receiver is then retransmitted to the other point so that the two signals can be mixed. Each beat between these two signals represents a distance traveled by the moving transmitter equal to one-half wave length of its transmitted frequency.

For sedimentation surveys, the pure range system of Raydist may be utilized. In this system, two instruments are required and a continuous indication of distance between the two sets is obtained. If one instrument were located on the end of the range line and the recording instrument carried in the craft, continuous indication of distance along the line could be had.

The contemplated accuracy of this system is 1 inch in a mile, a little better than one part in 50,000. Actual measurements have been made where the error was consistently less than 1 foot in a mile.

The equipment is completely housed in suitcase-type cabinets. The heaviest single unit weighs 32 pounds. The cost of the presently developed Raydist is approximately $20,000, but this should be somewhat less after exact needs are known and production increases.

In closing, I wish to again point out that there is a definite need for an accurate continuous means of position finding. I have reviewed briefly some of the methods of effecting this position finding by electronic devices.