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DISCUSSION OF PAPER TO BE GIVEN BY MR. ERNEST B. LIPSCOMB  
AT FIFTH HYDRAULICS CONFERENCE OF THE  
IOWA INSTITUTE OF HYDRAULIC RESEARCH

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by

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Mr. Lipscomb has given us an excellent discussion and some good examples of the use of hydraulic model studies involving movable beds. I commend the Waterways Experiment Station for utilizing the movable bed model as a tool in assisting the solution of river sedimentation problems.

Too often we see someone tackling a problem involving sediment deposition and movement on the basis of an engineer's or construction man's best guess only to find he has gotten into trouble which could be avoided by use of a model study.

The movable bed model is by no means fool proof for solving hydraulic problems involving sediment transportation and deposition, but when it is used wisely the movable bed model is invaluable in the solution of sedimentation problems.

It has been said very aptly by someone "the construction and use of movable bed models demands considerable care, great skill, and the patience of Job."

The movable bed models Mr. Lipscomb has described are river models in which the length and width of the water section under study is usually great with respect to the depth, and for this reason the model scale is usually distorted in order to cause movement of the bed material and to have the gravity force the controlling force in the model. Where depths are very small, surface tension forces become of comparatively great magnitude and turbulence is not reproduced.

A second kind of movable bed model is that involving a structure such as a diversion dam with a comparatively small headworks and sluiceway compared to the entire structure or river width. In this case it is possible to model the headworks and sluiceway and a portion of the dam in order to study sediment distribution at the headworks and sluiceway. On the streams where sediment load is comparatively heavy, the problem is usually one of trying to keep the sediment intake into the canal as low as possible or low enough to have equilibrium sediment movement in the canal. In which case the same amount of sediment is brought into the canal at any section

as is moved out at the same section. In most cases it is difficult to reduce the sediment inflow to this quantity.

For a model of this kind, it is impossible to utilize the verification principle because the answer is needed before the diversion dam is constructed. Where a structure is part of the model, it is best not to use a distorted scale in order to not upset the flow distribution and velocity distribution of the prototype. In a distorted model the lateral velocity distribution, as well as the energy distribution, is changed from what it is in the prototype.

It is impossible to reduce the model sediment on the same scale as the model because sediment which moves as bed load in the prototype would move as suspended load in the model. In other words, the type of movement of sediment would not be the same in the model as it is in the prototype. One method of overcoming this difficulty is to use the scale ratio of the settling velocities between model and prototype sediment as the scale criteria. Within quite wide limits of the scale ratios, sediment chosen on this basis for a model study, will have the same type of movement as the prototype bed sediment. The selection of sediment is usually limited to sand, coal, plastics, etc., so it is possible to choose the sediment first and then set the scale ratios to fit the sediment. This relationship of using settling velocities as the scale ratio criteria is usable for both undistorted and distorted models.

An important feature of movable bed models is maintaining a continuous sediment feed with the least amount of man handling. A special device which was developed in the hydraulic laboratory of the Bureau of Reclamation for providing a uniform supply of sediment to a movable bed model consists of a sheet metal hopper mounted so the opening in the bottom is just above a pan on a vibratory-type feeder. The feeder is a trough or pan mounted on flexible leaf springs supported in a frame and vibrated at 60 cycles per second by an electromagnet. The magnet, which is energized by pulsating current, pulls the trough sharply down and back, then when the current is broken with a rectifier, the leaf springs return the pan up and forward to its original position. The return is not as sharp as the downpull and the resulting motion causes material on the pan to move forward even when the pan is sloped upward.

The feeder is equipped with a separate control box which contains the operating switch, a rheostat for controlling speed of flow of material, and an electronic valve or rectifier that converts alternating current into sharp pulsating current. The pulsating current activates the magnet intermittently and thus causes the

vibratory motion of the feeder. The hopper and feeder can be arranged so that either dry or damp sand can be fed satisfactorily.

At the present time we are operating a model in which we feed sand with the type of feeder described, and we are able to run it continuous day and night which speeds up the time of reaching equilibrium and hence cuts the time needed for the study considerably.

To study the scour or deposition of the bed and banks, on a movable bed model similar to those described by Mr. Lipscomb, it requires the measuring and recording of many elevations. The larger the model usually the larger the number of elevations are required. An apparatus developed in the Neyerpic Laboratory at Grenoble, France, utilizes an electronic circuit and a recording stylus to increase the speed of taking these bed and bank elevations. The apparatus is a new development and shows promise of greatly reducing the time for measuring scour and deposition in movable bed models. A description of the apparatus is given in the April 1952 issue of La Houille Blanche, the magazine published by the Neyerpic Laboratory.