ON THE APPLICATION OF THE ELECTRICAL ANALOGY METHOD TO PRESSURE DISTRIBUTION UNDER WEIRS WITH CAVITIES

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An exhaustive study of the distribution of uplift pressure under weirs constructed on permeable foundations had been carried out by the electrical method at this Institute.* The results of these investigations were applicable to the cases of weirs where there were no cavities in the foundation. If, however, a cavity occurred in the subsoil under the weir, there would be a redistribution of pressure. The object of the present investigation is to find out if the electrical method can also be applied to the study of pressure distribution under a weir with cavities. This required experiments both in hydraulic and electrical models. These experiments have been done with a simple flush floor.

The Hydraulic Model.—Experiments in a sand model were carried out in an iron tank 50 inches long, 8 inches broad and 30 inches deep with a glass front. Sand was packed under water to a height of 22 inches in the tank. A glass plate 12 inches long, 8 inches broad and 1 inch thick was placed on sand with sound contact between the glass and sand. This glass plate corresponded to the impervious floor and was provided with twelve suitably spaced glass tubes passing right through its thickness for measuring pressure at various points just under the floor. Water-tight partitions were built at both ends of the floor for maintaining desired levels of water on the upstream and downstream sides. The lower boundary was kept elliptical in shape to correspond to the infinite depth of the pervious stratum as derived from theoretical considerations.

For the sake of practical convenience the experiments have been carried out with a cavity semi-cylindrical in shape 8″ long and 2″ in diameter. The cavity was scooped out in the sand foundation each time in the desired position and its form was maintained in the course of the experiment by fitting a perforated brass sheet into it. A diagrammatic sketch of the tank with the cavity in the centre of the floor is shown in Fig. 1.

* Gurdas Ram and V. I. Vaidhianathan, *Proc. Ind. Acad. Sci.*, 1940, **12 A**, 245 and earlier papers.

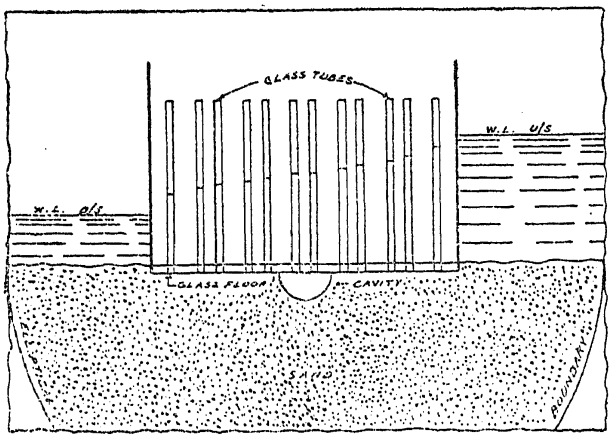

FIG. 1

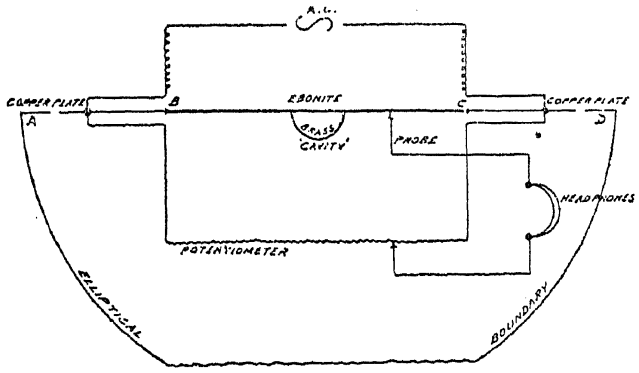

FIG. 2

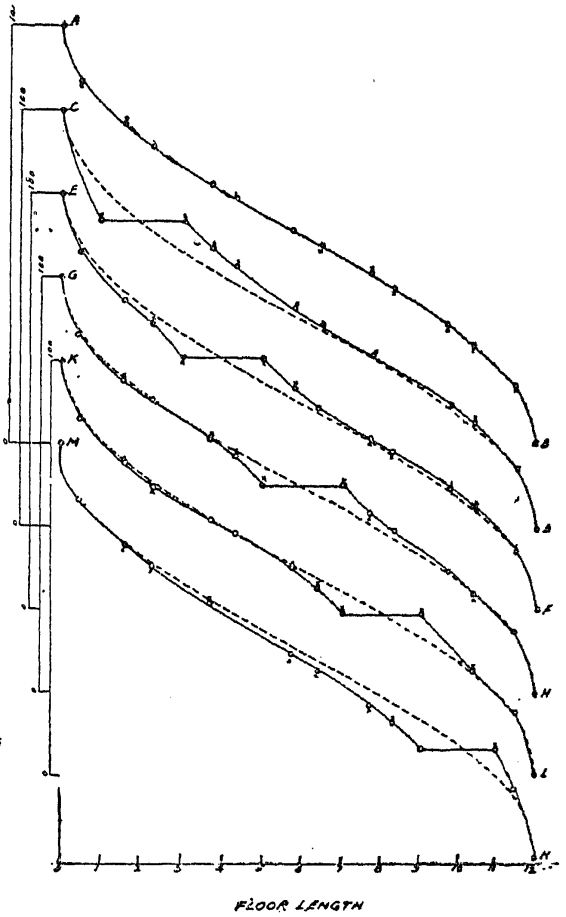

FIG. 3

Observations of pressure distribution under the floor were taken with 7 cm. and 4 cm. heads of water. The effect of the cavity in five different positions has been investigated.

Having obtained the pressure distribution in the hydraulic model an analogous electrical model was set up.

The Electrical Model.—It consists of a shallow elliptical tray 50″ long and about 3″ deep provided with ground glass bottom. The electrical analogue of the upstream and downstream levels is given by two thick copper plates AB and CD shown in Fig. 2.

These plates are maintained at an electrical potential difference corresponding to the hydraulic head of water. The portion BC is made up of an ebonite strip placed flush with the face of the copper strips AB and CD. BC is 12″ long and corresponds to the impervious floor. The cavity in the electrical case is provided by a semi-cylindrical piece of solid brass 2″ in diameter and about 2·5″ long. The cavity was fixed against the ebonite plate in exactly similar positions as was done in the hydraulic model. In order to measure the potential distribution, the tray was filled with water

to serve as an electrolyte. A neon tube oscillator with a valve amplifier was employed as the source of A.C. Potential along the floor was measured on a potentiometer by means of a probe and a headphone as shown in Fig. 2.

Results

The percentage pressure distribution obtained both by the hydraulic model experiments and by the electrical method are plotted and shown in Fig. 3. Curve AB gives the pressure distribution for a flush floor without any cavity. The other curves CD, EF, GH, KL, and MN give the pressure distribution with five different positions of the cavity. The dotted curves superposed on CD, EF, etc., are the same as AB and enable a ready comparison of the change of pressure caused by the cavities in different positions. The position of the cavity is indicated by the portions of the curves which are parallel to the abscissa, because there is practically no fall of pressure or potential within the cavity.

It will be noticed that the curves of the electrical and hydraulic methods almost coincide, thus establishing the applicability of the electrical analogy method to the determination of pressure distribution under weirs with cavities.

The hydraulic method is very laborious and liable to errors whereas the electric method is quick and capable of greater facility and accuracy.

The weirs in the Punjab are provided with pressure pipes which are regularly observed. A departure from the normal pressure distribution in the pressure pipes is taken to indicate some abnormality such as a cavity in the subsoil. It is thus possible by comparing the pressures obtained in the prototype with the potentials obtained in an electrical model to determine the nature of the cavities under the floor.