INTERNATIONAL ASSOCIATION FOR HYDRAULIC RESEARCH
HYDRODYNAMIC PRESSURES IN CONDUITS DOWNSTREAM
FROM REGULATING GATES

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Knowledge of the pressure in the conduit downstream from regulating gates is necessary in evaluating the discharge through the gate, in investigating the potential for cavitation, and in determining possible adverse flow conditions in the downstream conduit. Since the downstream conduits are usually vented, a detailed knowledge of the laws governing air flow through the vent would result in accurate predictions of the pressures in the downstream conduit. However, these laws have not yet been developed and relationships to scale model results to prototype quantities have not been conclusively established.

Some investigators have indicated that the Froude relationship is the valid scale ratio for interpreting model air demand data, (1), (2). Other investigators assert that the Froude relationship is not valid. Recent tests of the Trinity Dam auxiliary outlet works by the Bureau of Reclamation indicate that the Froude relationship may be valid when the model tests are properly conducted. The outlet works consists of an 84-inch jet-flow gate which discharges into a 274 foot long egg-shaped conduit (see Fig. 1).

To investigate the applicability of using the Froude relationship, a comparison of model data with prototype measurements was made using the parameters discussed in Reference 2 (see Figures 1 and 2). Unfortunately, the lenth-to-diameter ratio of the model and prototype were not identical, so the correct-

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(1) Mura, Y., Ijuin, S. Nakagawa, H., Air Demand in Conduits Partly Filled with Flowing Water, IAHR Proceedings, Vol 2, 1959.

(2) Sikora, A., Zavzdušnenie, Šachtových Priepadov (Air entrainment in shaft spillways), Výskumný Ústav Vodohospodársky, Práce a Štúdie 35, Bratislava, (Cvechoslovakia).

ness of the Froude relationship could not be unequivocally verified.

With the exception of the conduit and air vent lengths, the model was a true representation of the outlet works conduit and jet-flow gate. The model conduit length-to-diameter ratio was 11.2, whereas in the prototype the ratio was 34.5. With this length and a Froude number of 8.8, the model predicted an air demand ratio, ß, equal to .14 and a pressure in the downstream conduit, P/γ, equal to .016 $V^2/2g$. For the same Froude number, the prototype had an air demand ratio, ß, equal to .21 and a pressure in the downstream conduit, P/γ, equal to .032 $V^2/2g$. Longer model conduit lengths resulted in lower pressures and in higher air demand ratios for a given Froude number, Figure 2. These results indicated that a good correlation may exist if the air flow passages are accurately reproduced in the model.

The correlation outlined by Reference 2 seems to hold promise as a method for predicting air demand and conduit pressures in prototype structures from model data. The method is somewhat involved, since curves similar to those used in Figures 1 and 2 must be prepared for each gate opening. Future tests are being planned in which the prototype will be homologously represented by the model. In addition, other parameters to correlate the air demand are being investigated.

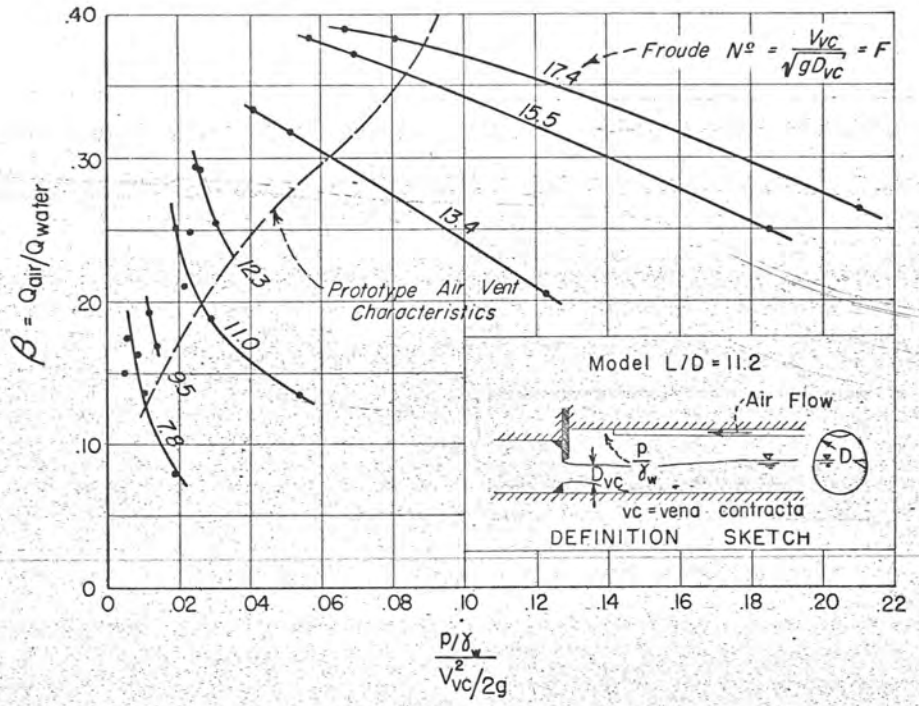
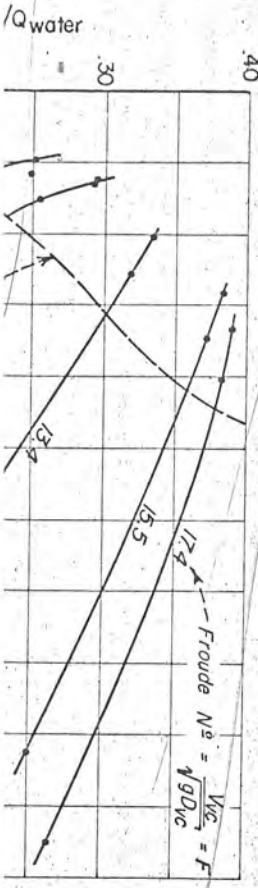


Figure I. Model Data with Gate 100% Open

S3.3



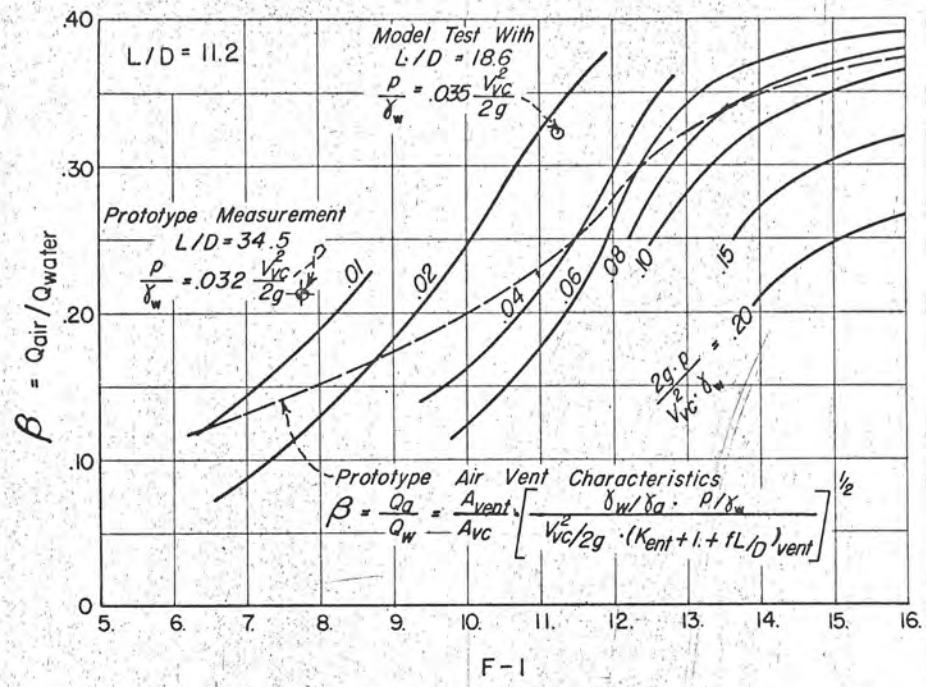


Figure 2. Comparison of Model Data with Prototype Measurement