CASTOR: Simplified Dam-Break Wave Model [a]

Discussion by Janice M. Lewis [3]

The discusser has several comments regarding the validity of statements in the paper. The author concluded that the National Weather Service (NWS) SMPDBK model "was not precise enough for engineering purposes" when routing a flood hydrograph from a small dam through a single valley with no city downstream. A study comparing the results of the NWS Simplified Dambreak model (SMPDBK) to results obtained by solving the Saint-Venant equations (DAMBRK) was done previously by Westphal and Thompson (1987) with a different conclusion. Applying the two models to six dams in the State of Missouri (41 points) resulted in an average absolute error in peak depth along the channel of about 11 percent with a standard deviation of 9 percent. The absolute error is computed as follows.

$$\text{absolute error} = \frac{|Y_{SMPDBK} - Y_{DAMBRK}|}{Y_{DAMBRK}} * 100\%$$

The discusser also used six other dams (in the United States as well as in other countries) which have properties that fall within the range specified by the author (46 points), applied the DAMBRK and SMPDBK models to them, and compared the results. It was found that the average absolute depth error was 11 percent with a standard deviation of 10 percent. The results of the two studies are shown in Figure A. Using the author's statistics (average ratio of the depth computed by the Saint-Venant equations to SMPDBK), the average for all sections was 1.06 with a standard deviation of 0.21 (Figure B). The travel times computed by the SMPDBK model were also compared with the results of the DAMBRK model (Figure C). The average absolute error was 10 percent with a standard deviation of 8 percent. Using the peak discharges computed by the DAMBRK model, travel times were computed using the author's technique. When compared with the travel times generated by the DAMBRK model, an average absolute error of 18 percent with a standard deviation of 16 percent was determined. Based on the NWS data, it is shown in Figure C that the SMPDBK model performs as well as the CASTOR technique for travel times. Although the author used the six French dams to determine the effectiveness of the simple modeling techniques, it is not evident that the CASTOR method was used on these dams. It would be useful to know how well the CASTOR method modeled the six French dams.

Although the author states that the SMPDBK model produced errors of >100 percent in water depths, no information was given to corroborate the statement (e.g., description of the datasets used in the test or actual model results). As stated previously, the SMPDBK model had an overall error of 6 percent when applied to 12 dams in two different studies. Although it may not be applicable in all situations, the SMPDBK model may be used with confidence to model dam failure analy-

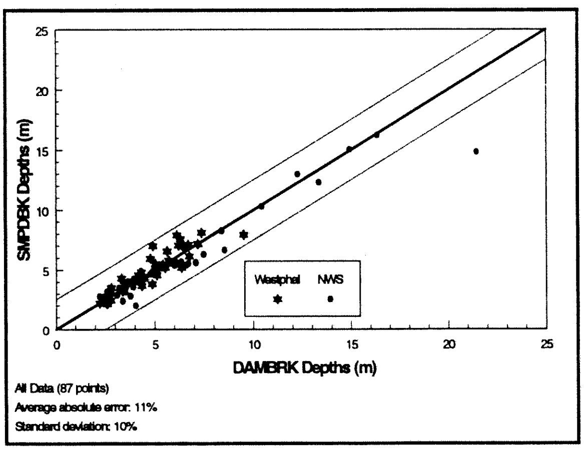

Figure A. Depth comparison of SMPDBK model vs. DAMBRK model using Westphal data and NWS data.

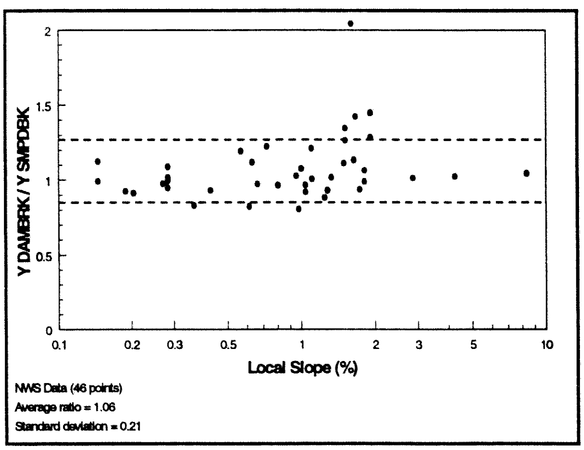

Figure B. Depth ratio of DAMBRK model to SMPDBK model using NWS data.

[a]August 1997, Vol. 123, No. 8, by A. Paquier and O. Robin (Technical Note 9582).

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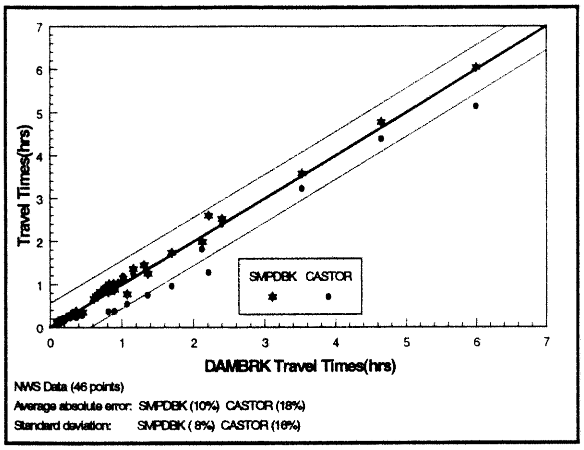

Figure C. Comparison of travel times analyzed by NWS SMPDBK and CASTOR with NWS DAMBRK.

ses on the type of dams described by the author. The reference cited by the author (Wetmore and Fread, 1983) indicates that the latest SMPDBK model was not used. The most recent version of the model (Fread et al., 1991) contains several enhancements, including the use of the Manning equation, to compute the depth for a known discharge, allowing cross sections to have both active flow widths and inactive (dead storage) widths, a better way to handle submergence effects at the dam, and the use of the energy slope instead of the channel bottom slope when computing the maximum depth to account for the dynamic effects. The SMPDBK model, which computes the outflow hydrograph through the dam as well as the peak discharge and water surface elevation along the routing reach, has been used successfully for many dam studies throughout the United States and in several other countries for over 15 years. It was not developed to handle complex situations (e.g., backwater due to downstream control structures; spillway and gate flow, although it may handle dam overtopping; non-rectangular breach shapes, although an adjusted average breach width may be used) or very long reservoirs for which storage routing techniques are not applicable and dynamic routing is necessary (Fread, 1993). When used within the confines of its limitations, the discusser believes that the SMPDBK model is a very useful tool for doing the type of dam studies described by the author.

Although it was stated that a simple relation is used to determine the peak discharge at the dam, the author does not state the relation that is used. It is also unclear as to whether the CASTOR model computes this peak flow or if it is an input parameter. The outflow from the dam, which is a key parameter in determining the peak depth downstream of the dam, is dependent upon several parameters including the breach parameters, reservoir characteristics, and downstream topography because of submergence effects on the weir outflow due to very high tailwater. Care must be taken when computing this parameter, and the author should describe the model for obtaining the peak outflow and explain its limitations.

The limitation of the technique to handle "regular valleys" with no significant changes in the storage may be too restrictive. The dimensionless graph in Step two of the model description (which has two parameters that are a function of bottom slope; Manning's coefficient; distance; and reservoir volume) appears to be a reasonable approach in which to determine the peak flow along the routing reach; however, it is not apparent how the channel-valley storage is represented in the dimensionless curve. Although the reservoir volume may be similar to that of the channel valley in many cases, there are many other situations where the storage behind the reservoir may be disproportionate to the storage represented by the channel valley even though it may be considered a "regular valley"; therefore, a relationship between the the channel valley and the reservoir volume would be necessary.

Another concern with the limitation of "regular valleys" relates to the computation of the travel time. The average velocity determined by the author to compute the travel time may not be adequate to model this situation since the technique uses only the dam and most downstream section to compute the velocity. It is not uncommon for the channel valley below dams to have irregular topography wherein the storage areas may strongly modify the flow. An average cross section which reflects the true storage volume between the dam and the end section would better represent the average velocity through routing reach.

APPENDIX 1. REFERENCES

Fread, D.L. (1993). "Chapter 10, Flow Routing," Handbook of Hydrology, editor D.R. Maidment, McGraw-Hill Book Co., New York.

Fread, D.L., Lewis, Janice M., and Wiele, Stephen M. (1991). "The NWS Simplified Dam-Break Flood Forecasting Model," HRL-286, Hydrologic Research Laboratory, Silver Spring, Maryland.

Westphal, Jerome A. and Thompson, David B. (1987). "NWS Dambreak or NWS Simplified Dam Breach," Proceedings, Computational Hydrology '87, Lighthouse Publications First International Conference (Hromadka and McCuen, Eds.), Anaheim, California.