Subject: Hydraulic model studies for the design of the Boca Dam Spillway—Truckee Storage Project—Nevada-California.

PROBLEM

Early in 1937 the hydraulic laboratory was authorized to construct a model of the Boca Dam Spillway, Figure 1, for the purpose of studying the entrance conditions to the gate section; the flow through the gate section and the chute leading to the stilling pool; the energy dissipation in the stilling pool; and for obtaining head-discharge and coefficient curves for the spillway.

THE PROTOTYPE

Boca Dam is located on the Little Truckee River in California, approximately 20 miles west of Reno, Nevada, Figure 2. The structure is an earth embankment having a maximum height of 110 feet and a crest length of 1,650 feet. The spillway, in the left abutment of the dam, is a concrete-lined open channel terminating in a concrete-lined stilling pool, and will have a total length of approximately 555 feet. The maximum capacity of the spillway is 8,000 second-feet. Flow over the spillway will be controlled by two radial gates each 19 feet long and 16 feet high, installed at the crest of the spillway.

MODEL TESTS

The person who conducted the model study on the Boca Dam Spillway is no longer with this Bureau and the writer was not present when the
tests were conducted. The data and drawings received by him for the purpose of writing the report were meager, therefore many of the desirable details have been omitted rather than to make vague or unsupported statements concerning them. The information presented is believed to be the correct interpretation of the available data.

Initial model tests indicated that a few refinements should be made on the original design. The spillway design as first tested is shown on Figure 1. Photographs of the entrance transition of this design are shown in Figure 3A and B. Four transitions were tested simultaneously with two different shapes of overflow section. There was no information to indicate the undesirable features of the various entrance transitions but the fourth one, Figure 3C and D, and Figure 4, was recommended for prototype construction. The jet did not follow the surface of the original overflow section. The surface of the section immediately downstream from the crest axis was raised slightly by changing it to a parabolic shape, Figure 5. The resulting design proved satisfactory and was recommended. The coefficient curves for both the original and the recommended entrances and overflow sections are shown on Figure 6 for the gates fully open.

Observations were made of the flow conditions in the chute connecting the gate section with the stilling pool. The most adverse conditions appeared to be for a discharge of 4,380 second-feet passing through one gate fully open and the other one open 1.5 feet. These conditions were not considered of a serious nature, particularly since there was still ample freeboard. Water-surface profiles along the chute walls for two discharges are shown on Figure 7. Figure 8A and B are views looking upstream toward the spillway crest and gate section.

Several runs were made using various combinations of channel and stilling pool floor elevations to determine the proper elevation of the stilling pool floor with respect to the channel bottom to keep the tailwater from sweeping out, and at the same time to keep the velocities from becoming excessive as the water passed from the stilling pool to the channel. The original sill was included in each of these runs. The most satisfactory combination, averaging hydraulic performance and economy of construction, was with the pool floor at elevation 9487 and the channel floor at elevation 5498.
The remaining problems were to determine the necessary height of the stilling pool walls and to investigate the possibilities of improving the energy dissipation in the stilling pool. Approximately 30 different tests were made, using various types and arrangements of dentates and end sills. From these tests two schemes of almost equal satisfaction were evolved. One was the original Lehbock sill at the downstream end of the horizontal pool floor, and the other was a solid sill at the same location, accompanied by a set of dentates on the horizontal floor, a distance of 10 feet upstream from the solid sill. Both of these schemes were accompanied by a set of dentates at the upstream end of the pool on the toe of the 2:1 sloping apron. Photographs 9A and B show the two arrangements of the teeth and sills in the stilling pool. Photographs C and D in Figures 8 and 9 show flow conditions in the pool for the two sill arrangements. The water surface in the pool was smoother and the scour downstream from the riprap was less severe when using the dentates and solid sill in the stilling pool. However, the Lehbock sill was recommended because; (1) the scouring of the channel could not damage the spillway structure; (2) the designers had intended for the channel to be scoured to some extent; and (3) the Lehbock sill was the same one already designed for the prototype.

The model indicated that there was about 1.5 feet of difference between the normal channel water surface for a satisfactory jump and the water surface at which the tailwater swept out of the pool when using the Lehbock sill. Rather than operate on such a narrow margin the channel bottom was raised to elevation 5500. The tops of the stilling pool walls were set at elevation 5516. Figure 4, revised November 8, 1940, shows the elevations of the stilling pool floor and walls to be 5487 and 5516 respectively, as was indicated by the model tests. Figure 10, revised September 12, 1941, shows the elevations of the stilling pool floor and walls to be 5489 and 5514 respectively. These changes were made subsequent to completion of the model tests. The writer was unable to obtain information pertaining to the reason for the changes and has assumed that they were the result of either construction or economic problems encountered in the field subsequent to the laboratory work.
BOCA DAM SPILLWAY
DESIGN AS ORIGINALLY CONSTRUCTED
ON A 1:48 SCALE HYDRAULIC MODEL
A. Original spillway approach.
   Q=4000 sec.-ft. One gate open.

C. Recommended spillway approach.
   Model dry.

B. Original spillway approach.
   Q=8000 sec.-ft. Two gates open.

D. Recommended spillway approach.
   Q=8000 sec.-ft. Two gates open.
Assumed rock line. 3' Min. info rock or impervious material as received.

SECTION B-B

Drain line. Rock screened gravel.

SECTION C-C

Drain line. Rock screened gravel.

SECTION D-D

Transverse sewer pipe drain in rock.

SECTION E-E

LONGITUDINAL SEWER PIPE DRAIN

SECTION F-F

Transverse sewer pipe drain in earth.

NOTE
Excavation for cutoff and drain trenches not shown. Before drawing.

This drawing supersedes fig. 296-10-37.

RECORD DRAWING
THIS DRAWING IS PART OF THE PROJECT.

Boca Dam Spillway Excavation Plan and Sections.
Figure 6

Boca Dam Spillway
Coefficient and Discharge Curves
As Determined from AI-48 Hydraulic Model
A. Looking upstream towards spillway crest and gate section.

C. Denticates and solid sill in pool. Discharge of 8000 sec.-ft. passing through two gates T.W. elevation = 5568.0.

B. Looking upstream. Discharge of 8000 sec.-ft. passing over crest.

D. Rehbook sill in pool. Discharge of 8000 sec.-ft. passing through two gates T.W. elevation = 5568.0.

BOCA DAM SPILLWAY OVERFLOW SECTION AND STILLING POOL
1:48 Model
A. Looking downstream into pool. Rebhokk sill in place.

B. Looking downstream into pool. Solid sill and dentates in place.

C. Looking upstream into pool with Rebhokk sill. Discharge = 4000 s.f. T.W. elev. = 5503.0.

D. Looking upstream into pool with solid sill and dentates. Discharge = 4000 s.f. T.W. elev. = 5503.0.

BOCA DAM SPILLWAY STILLING POOL
1:48 MODEL