Broad-Crested Weirs

A weir approximately rectangular in cross section is termed a broad-crested weir. Unless otherwise noted, it will be assumed to have vertical faces, a plane level crest, and sharp right-angled corners. Figure 5.6 represents a broad-crested weir of breadth b. The head H should be measured at least $2.5H$ upstream from the weir. Because of the sharp upstream edge, contraction of the nappe occurs. Surface contraction begins at a point slightly upstream from the weir.
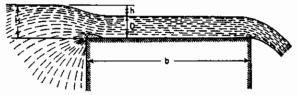

FIGURE 5.6 Broad-crested weir.

The discharge over broad-crested weirs is usually expressed by the equation

$$Q = CLH^{3/2} \qquad (5.10)$$

Experiments on broad-crested weirs have been performed by Blackwell, Bazin, Woodburn, the U.S. Deep Waterways Board, and the U.S. Geological Survey. These experiments cover a wide range of conditions as to the head, breadth, and height of the weir. Considerable discrepancy exists in the results of the different experiments, especially for heads below 15 cm. For heads from 15 to about 45 cm the coefficient becomes more uniform, and for heads from 45 cm to the point at which the nappe becomes detached from the crest, the coefficient as given by the different experiments is nearly constant and equals approximately 1.45. When the head reaches one to two times the breadth of the weir, the nappe becomes detached and the weir becomes essentially sharp-crested. The effect on discharge of the roughness of the crest can be computed by applying the principles of flow in open channels.

In order to put the results of the various experiments in a form convenient for use, Table 5.1 has been prepared by graphically interpolating the results of all experiments, giving more weight to those of the U.S. Geological Survey. This table should give values of C within the limits of accuracy of the original experiments.

The effect of rounding the upstream corner of a broad-crested weir is to increase the discharge for a given head. Table 5.2 lists experiments on this type of weir. The effect of rounding the upstream corner on a radius of 10 cm is to increase the coefficient C by approximately 9 percent. Coefficients by Woodburn[19] for flat weirs with rounded upstream corners and gently sloping crests are given in Table 5.3a.

Blackwell experimented with three weirs 90 cm broad, having a slightly inclined crest. Inclining the crest appears to increase the coefficient of discharge slightly. The results of these experiments are rather inconsistent, especially for low heads. Table 5.3b has been compiled from Blackwell's experiments. Sloping the top of a broad-crested weir makes it similar to a triangular weir with the upstream face vertical. The coefficients given in Tables 5.4 and 5.5 will therefore be helpful in selecting coefficients for broad-crested weirs with sloping crests.

If the upstream corner of a weir is so rounded as to prevent contraction entirely, and if the slope of the crest is as great as the loss of head due to friction, flow occurs at critical depth, and discharge is given by the rational formula

TABLE 5.1   Values of C in Formula $Q = CLH^{3/2}$ for Broad-Crested Weirs

Measured head, m	Breadth of crest of weir, m										
	0.15	0.20	0.30	0.45	0.60	0.75	0.90	1.20	1.50	3.00	4.50
0.10	1.61	1.55	1.50	1.46	1.44	1.44	1.43	1.40	1.38	1.41	1.49
0.20	1.70	1.60	1.52	1.46	1.44	1.44	1.48	1.49	1.49	1.49	1.49
0.30	1.83	1.73	1.65	1.52	1.47	1.46	1.46	1.48	1.48	1.48	1.45
0.40	1.83	1.80	1.77	1.61	1.53	1.48	1.46	1.46	1.46	1.48	1.46
0.50	1.83	1.82	1.81	1.70	1.60	1.52	1.48	1.47	1.46	1.46	1.45
0.60	1.83	1.83	1.82	1.67	1.57	1.52	1.50	1.48	1.46	1.46	1.45
0.80	1.83	1.83	1.83	1.81	1.70	1.60	1.55	1.50	1.48	1.46	1.45
0.90	1.83	1.83	1.83	1.83	1.77	1.69	1.61	1.51	1.47	1.46	1.45
1.0	1.83	1.83	1.83	1.83	1.83	1.76	1.64	1.52	1.48	1.46	1.45
1.2	1.83	1.83	1.83	1.83	1.83	1.83	1.70	1.54	1.49	1.46	1.45
1.4	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.59	1.51	1.46	1.45
1.5	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.70	1.54	1.46	1.45
1.7	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.59	1.46	1.45

TABLE 5.2   Values of C in Formula $Q = CLH^{3/2}$ for Models of Broad-Crested Weirs with Rounded Upstream Corner

Experimenter	Radius of curve, m	Breadth of weir, m	Height of weir, m	Head H, m								
				0.10	0.20	0.30	0.45	0.60	0.75	0.90	1.20	1.50
Bazin	0.10	0.80	0.75	1.62	1.64	1.66	1.68					
Bazin	0.10	2.00	0.75	1.49	1.56	1.60	1.61					
U.S. Deep Waterways	0.10	0.80	1.40		1.53	1.56	1.61	1.66	1.70	1.75	1.85	1.93
U.S. Deep Waterways	0.10	2.00	1.40			1.56	1.56	1.56	1.56	1.56	1.56	1.55