#110

Released by the U.S. Department of Agriculture for official use

Fiberglass-coated wooden weirs for runoff measurements

JOSEPH B. MURPHEY

BROADCRESTED V-notch weirs have been used for many years to gather discharge data on experimental watersheds. In the 1930s the Soil Erosion Service built these weirs 24 inches thick. Later the thickness was reduced to 16 inches (*1*), and more recently Virginia V-notch weirs were designed with a thickness of 12 inches (*6*).

Until recently these weirs were made of concrete (usually reinforced) at considerable expense for formwork, materials, etc. A departure from conventional concrete construction was prompted in 1965 by dewatering problems at an Iowa construction site, where Minshall and Spomer (*4*) used steel sheet piling and preformed steel crest. More recently, DeCoursey and Blanchard (*3*) and Yates (*10*) capped steel sheet piling with a concrete V-notch crest. Unfortunately, in an area where site accessibility is limited, all of the above construction methods entail at least one of three serious complications: (1) considerable cost, (2) need for heavy equipment, or (3) extreme site disturbance.

If a structure does not need to last for more than a few years, the heavy construction methods of the past can be ignored and the weir can be built of any material which fulfills mandatory considerations in the construction of any weir, the configuration of the control section, its suitability for the site in question, and sufficient strength to withstand the flows expected.

In 1967, problems of cost, accessibility, time, and policy (requiring any

Joseph B. Murphey is a geologist, Southwest Watershed Research Center, 442 East Seventh Street, Tucson, Arizona 85705. This article is a contribution from the Soil and Water Conservation Research Division, Agricultural Research Service, U. S. Department of Agriculture.

Reprinted from the Journal of Soil and Water Conservation
September - October 1972, Volume 27, Number 5

constricting modification of channels to be temporary in nature) motivated the development of a fiberglass-coated wooden weir which could be affixed to an existing grade stabilization structure in a channel. Barsby (2) had successfully used wood before. About the same time, Smith and Lavis (8) were working on a wooden flat-vee weir, and Wright (9) and Replogle (7) were experimenting with fiberglass for small trapezoidal flumes. However, at the scale for which they were designed, these structures did not have the strength or the capacity needed for the expected flows from the 345- to 2000-acre watersheds in question.

The 16-inch broadcrested V-notch was chosen for the five sites in coastal southern California because of available rating tables (1) and suitable discharge capacity ranges. These temporary weirs were built from wooden timbers attached to existing concrete grade-control structures with masonry anchor bolts. A fiberglass-coated crest section was then bolted to the base section.

Several factors enhanced the use of wood for these weirs. First, there was a tremendous savings in total cost. A comparable reinforced concrete structure was estimated to cost from 3 to 10 times as much as the wooden one, depending on location. Second, wood building materials were easy to transport to the relatively inaccessible sites. Third, precise dimensional control of the crest was assured. Such a crest was easy to repair or, if badly damaged, to replace. Speed of construction and dismantling also was considered. Each weir can be removed in less than half a day by one man with only a socket wrench and hammer.

Construction

The weirs consist of two parts, a base section and crestboard (Figure 1). The base section was made with 2-inch × 12-inch redwood timbers fastened together with lag screws and anchored to the grade control structure with masonry anchor bolts. Redwood was chosen because it is both

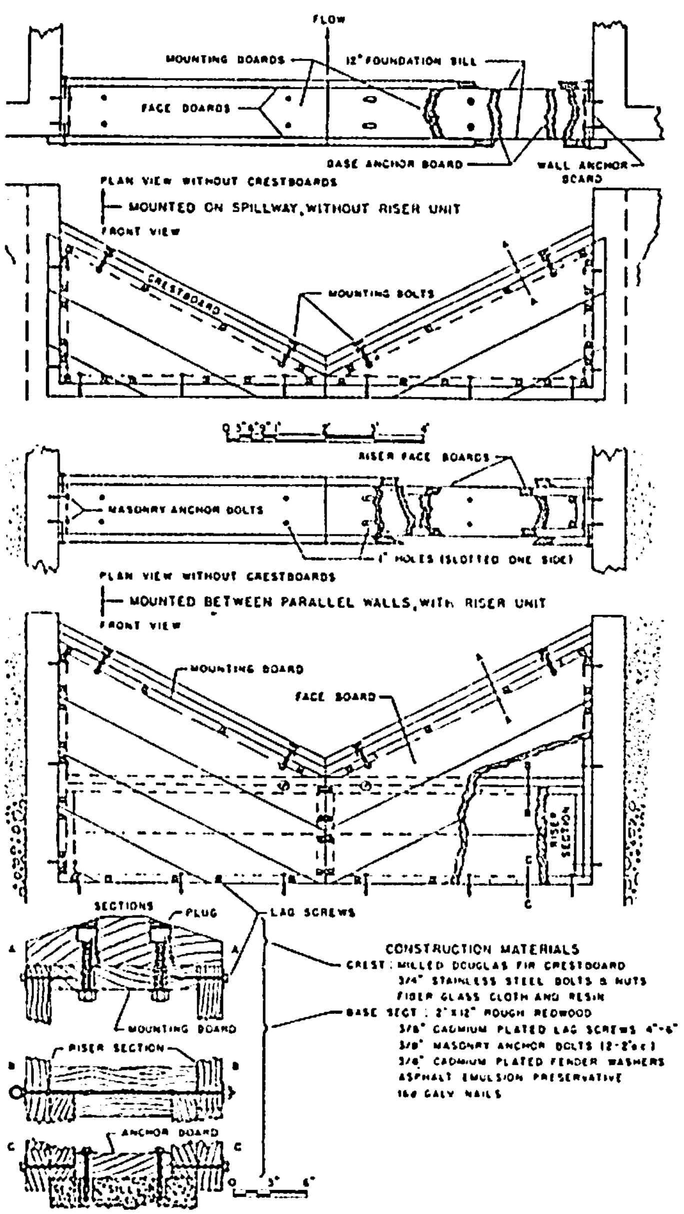

Figure 1. Generalized construction plans for fiberglass-coated wooden, 16-inch, broadcrested V-notch weirs.

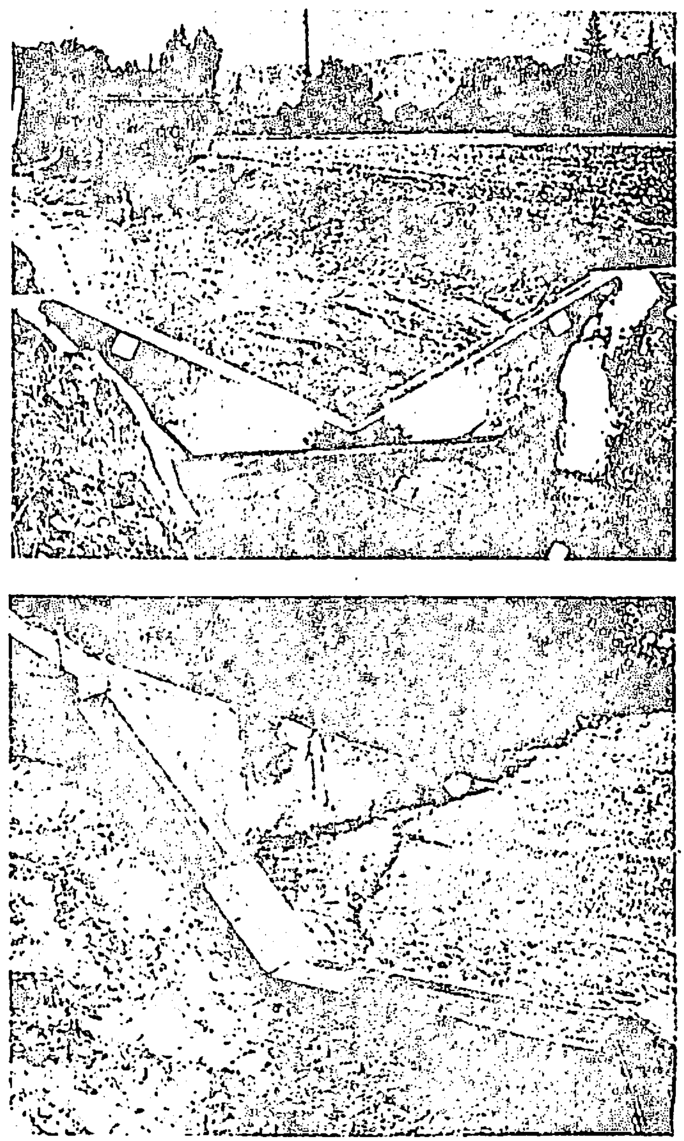

Figure 2a (above). Completed weir with a 2-to-1 fiberglass crest at a 1934 Las Posas pilot watershed gaging site in Ventura County, California. 2b (below). View of completed weir with 3-to-1 compound fiberglass-steel crest on a drop spillway constructed in 1956, Ventura County.

water-tolerant and naturally toxic to insects. Any wood having similar or greater strength could be substituted if properly impregnated with a solution of pentachlorophenol. The sections were caulked with an asphalt compound and treated with an asphalt emulsion preservative.

The 4-inch × 16-inch crestboards were milled from solid Douglas fir timbers to the proper crest configuration, covered with fiberglass cloth, and treated with fiberglass yacht resin. The timbers may be laminated or of one solid piece if free of heartwood. The crestboard is bolted to the base section with studs embedded in the timbers prior to their resin treatment. In streams having heavy, coarse sediment loads, the lower section of the notch may be easily protected from abrasion with thin stainless steel sheeting (.080-inch sheets were used here). Figure 2 shows views of two completed weirs.

Performance

The durability of these structures was illustrated during the January and February 1969 storms in southern California which produced unusually heavy flows at all the wooden structure stations. None of the weirs failed structurally, although they were all topped one or more times by the flows, which in a few instances exceeded the design discharge of the weirs by more than 500 percent. At these locations the weir occupied only a portion of the total opening depth between the grade stabilization structure wing walls. The compound weir incurred minor abrasion damage to the fiberglass coating 3 to 4 inches above the sheathed portion. No other damage was noted.

The coefficient of friction for the finished fiberglass surface — determined at the Agricultural Research Service Water Conservation Structures Laboratory in Stillwater, Oklahoma — is the same as for stainless steel used by Minshall and Spomer. Thus a complete model study to prepare a rating table was unnecessary since the same rating table would apply to steel crests, fiberglass crests, and crests combining both materials.

The precision of these weirs is governed by the same conditions that control the precision of the concrete 16-inch V-notch weir (*1*), that is, the crest configuration must be known at all stages, adequate freeboard must be maintained, and the configuration of the approach must be monitored if siltation is occurring in the channel.

These temporary weirs were designed for and first used to measure ephemeral stream outflow in southern California on the above-mentioned 345- to 2000-acre watersheds. However, this type of construction may also be used in perennial streams. The existing structure to which the wooden weir is attached may be a grade stabilization drop structure, such as the Soil Conservation Service uses (*5*), a box road culvert, an irrigation canal wall, or any other structure with a suitable foundation. In the absence of any of these, buried creosoted pilings or railroad crossties would probably suffice as a foundation.

Because wood is the most commonly available light construction material throughout the world, it is, in most cases, the most economical and practical building material. Although hard fiberglass resin was used in this application because of the relative softness of fir, practically any hard sealant could be applied to a hardwood crestboard. Teak, for example, which is available in the Orient, would be ideal for the crest.

The performance of the five weirs was highly satisfactory. Their use is recommended wherever temporary measurements of runoff are desired. Additionally, in an area where channel stabilization structures or box-type road culverts exist, many may already have the same dimensions, and a weir could readily be moved from site to site. Susceptibility to fire is the only known hazard to these weirs.

Cost

The total cost of a concrete weir, a steel sheet-piling weir, or one combining both materials, including cutoff walls, stilling pool, splash aprons, etc., often runs close to $5,000 (*1, 4*). The five fiberglass-coated wooden weirs were constructed at an average cost of $400 each, including labor.

This wooden weir is recommended where short-term or temporary runoff measurements are needed and where hand construction is necessary or desirable. If no coarse, abrasive sediment load exists in a channel, the life expectancy of the structure should exceed 10 years. Applications in developing countries should be especially promising.

REFERENCES CITED

1. Agricultural Research Service, U. S. Department of Agriculture. 1962. *Field manual for research in agricultural hydrology.* Agr. Handbook No. 224. Washington, D. C.
2. Barsby, A. 1963. *A wooden flume.* Tech. paper no. 28. Water Research Assn., United Kingdom.
3. DeCoursey, D. G., and B. J. Blanchard. 1970. *Flow analysis of large triangular weir.* Am. Soc. Civil Eng. 96 (HY-7): 1435-1454.
4. Minshall, N. E., and R. G. Spomer. 1965 *New type weir construction for small watersheds.* Am. Soc. Civil Eng. 91(IR-1): 11-15.
5. Morris, B. T., and D. C. Johnson. 1943. *Hydraulic design of drop structures for gully control.* Am. Soc. Civil Eng. Trans. 108:887-940.
6. Ree, W. O., and W. R. Gwinn. 1959. *The Virginia V-notch weir.* ARS 41-10. U. S. Dept. Agr., Washington, D. C.
7. Replogle, J. A. 1969. *Flow measurement with critical-depth flumes.* R. 15, question 24. Seventh Cong., Int. Comm. on Irrigation and Drainage, Mexico City, Mexico. pp. 24.215-24.235.
8. Smith, K., and M. E. Lavis. 1969. *A prefabricated flat-vee weir for experimental catchments.* J. Hydrol. 8(2): 217-226.
9. Wright, C. E. 1967. *Glass fiber trapezoidal flumes.* The Surveyor and Municipal Eng., United Kingdom. pp. 23-27.
10. Yates, Paul. 1970. *V-notch weir for submerged flow measurement.* Agr. Eng. 51(3): 132-133. □