NOTES

PRECALIBRATED FIBREGLASS FLOW MEASUREMENT STRUCTURES FOR EXPERIMENTAL BASINS.

H. Drost*

MEASUREMENT PROBLEM

In Experimental Basins the problem is often to measure very low flows to a high degree of accuracy. These flows are often in he range of 0.15 cusecs with an average flow of a few hundredths of a cusec. The choice of structures to measure this flow may be restricted owing to existing channel configuration, slope, sediment movement, and access.

In the Otutira Experimental Basin on the northern shores of Lake Taupo all these problems had to be faced. With the basin in scrub a temporary 80 degree V-notch weir indicated a mean flow of approximately 0.02 cusecs with a maximum about 5 cusecs, from 787 acres. The same area when developed into grass could produce an estimated peak flow of 300 cusecs. The weir silted up completely after every storm owing to the highly erodible pumice soil.

The main measuring structure was sited in a deep gully with no vehicular access. In addition four structures were required on sub-catchments, 20 to 30 acres, having intermittent flow.

A single precalibrated structure to cope with all ranges of flow from a few hundredths of a cusec, when the area is in scrub, to 300 cusecs when developed, while at the same time maintaining a high degree of accuracy in the low flow range, was found to be impracticable. Hence, it was decided to base the initial design on the basin in scrub and, if necessary, redesign the structure after development of the basin.

With this in mind the procedure was to look for a prefabricated structure, which if necessary could be removed and re-installed elswhere. Hence the material used had to be light but at the same time of sufficient strength.

SOLUTION

The most favourable material investigated was laminated fibreglass bonded by a polyester resin which at 3/16in thickness has an impact strength of 5,000 p.s.i.

* District Hydrologist, Ministry of Works, Hamilton.

To cope with the large sediment yield an H-flume would be most suitable but this type of structure would not give sufficient accuracy in the extremely low-flow range. Hence a combination of flume and weir appeared to be the answer.

DESIGN

The structures now under construction consist of:

(a) Fibreglass approach boxes of approximately 8ft length; depth and width depending on H-flume size.

(b) H-flumes made of 1/8in steel plate.

(c) Fibreglass weir boxes 4ft long, 2ft wide and 16in deep with, in one end, a stainless steel weir plate having a 45 degree V-notch 8in deep.

(d) Two separate stilling wells inside one recorder house.

Water from the H-flume discharges through a wire mesh into the weir box. An adjustable baffle in the box acts as an energy dissipator to ensure smooth flow over the crest of the weir. To obtain instantaneous response to flow the level in the weir box is kept to notch level at all times.

At sites with intermittent flow a 44-gallon drum will be placed under the spouting of the recorder house to provide water for topping up and flushing of the weir box when desilting is required.

The fibreglass approach channel has a 1 in 8 sloping floor to prevent silt from accumulating in the channel.

CALIBRATION

Since over 90% of the flow will be measured through the 45 degree V-notch, accurate rating of the weir box was necessary Being a self-contained unit in which water could be poured under the same conditions as in the field, precalibration was found to be extremely easy.

One of the recently completed weir boxes was placed level about 5ft above the ground. Water was tapped from a fire hydrant which could be accurately regulated to simulate inflow at different rates. Volumetric measurements were made using a standard 1,000 cc measuring glass for flows below 0.001 cusecs. Subsequently an accurately calibrated bucket was used and for the higher flows a 44-gallon drum.

Some difficulty was encountered in catching the nappe for flows below 0.001 cusecs because the head is insufficient to make the nappe spring clear of the plate. A bitumen compound and spout had to be stuck to the plate to guide the flow into the measuring glass. The adhering of the water to the weir plate would also account for the break in the rating curve. Above 0.001 cusecs the nappe springs clear of the plate when not disturbed by wind.

It is interesting to note that British Standard 3680, Part 4A, 1965: "Thin Plate Weirs and Venturi Flumes", states that the head on these weirs shall not be less than 2 inches (0.015 cusecs). This confirms our observation that below this head one cannot be sure that the nappe is fully aerated. However, since the weir box will be completely covered once installed, wind should have little effect on the rate of flow and we regard this rating to be accurate within 1 or 2 per cent.

For discharges above 0.015 cusecs, the volumetric measurements made by using the 44-gallon drum were compared with the British Standard rating and found to plot on the same curve (see Fig. 1).

INSTALLATION

Since writing the above the first structure has been installed (Fig. 2). This was set into a shallow, dished-shape channel with intermittent flow from an 11-acre grassed catchment. The first step was to dig a narrow trench for the cut-off wall. Since pumice soils in general are highly erodible, especially when stripped of vegetation, every effort was made to disturb a minimum amount of ground up-stream of the cut-off wall. An 8ft x 4ft x $\frac{3}{8}$in fibrolite sheet was used for the cut-off wall. After completion of the trench the cut-off wall, approach box and flume were lowered into position and the holes for the flange-bolts marked out. The three parts of the flume structure were then lifted and bolted together on the bank. To waterproof the joins $\frac{1}{4}$in Neoprene gaskets were used. Subsequently the structure as a whole was gently lowered into its final position after which back-filling of the cut-off trench was done. The back-fill was mixed with bentonite and water for improved sealing.

To prevent any puddling up stream of the cut-off wall the bed of the channel was lined with a concrete approach apron.

To reduce the chance of breaking the large fibrolite sheet during installation, the rectangular piece forming the opening to the approach box was cut out after installation was completed.

The channel down stream of the flume had to be dug out to place the weir box in position and lead the water away on a gradual gradient.

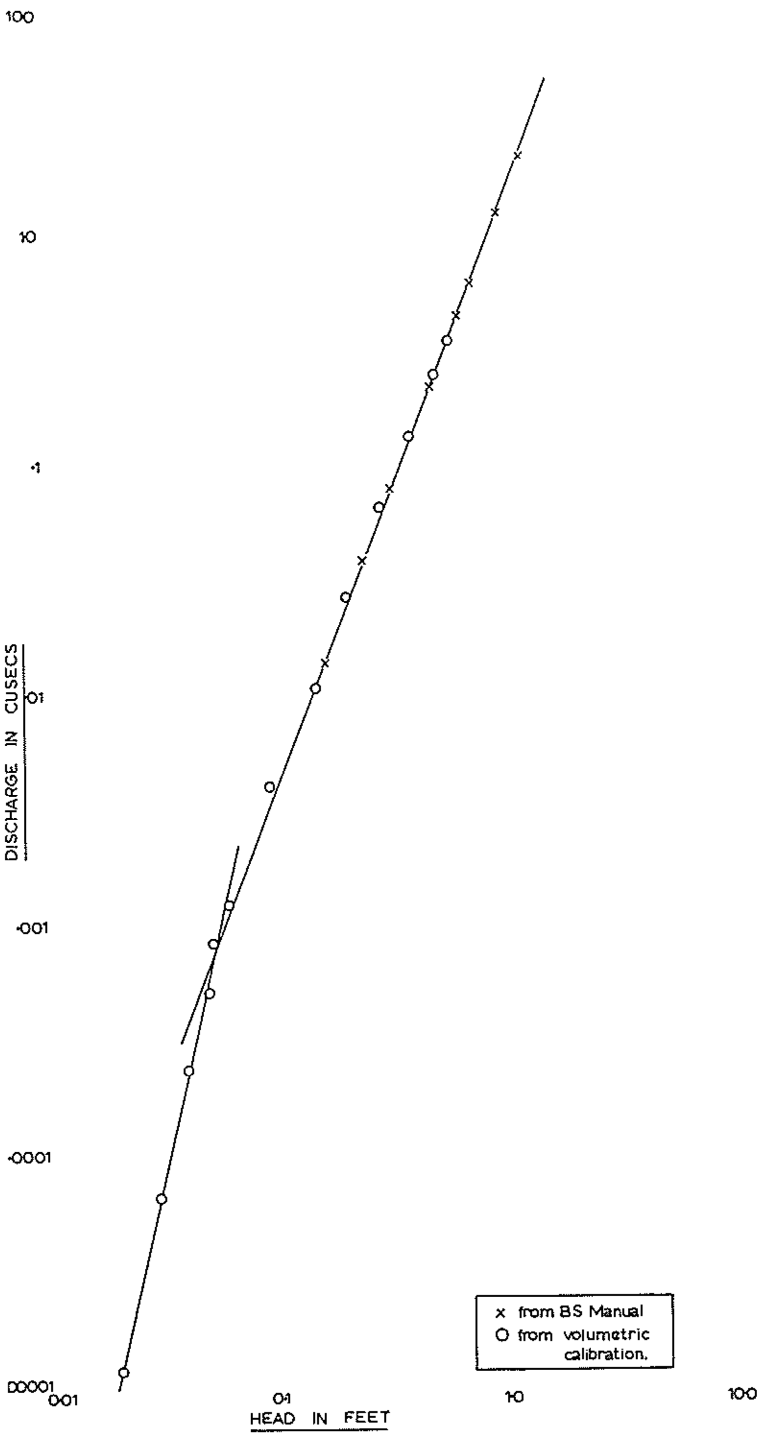

Fig. 1 — RATING SURVE for 4ft x 2ft x 16in deep weir box with a 45-degree weir notch 8in deep.

Under favourable conditions the complete installation is done in one day.

A half-inch storm two days after the structure was installed provêd everything to be working satisfactorily. Some silt was deposited on the level part of the steel flume proper. Further trials to prevent the accumulation of silt in the flume will be made.

The inclined bottom of the approach box kept this part clean and the accumulation of silt in the weir box did not interfere with the discharge rating; the silt could easily be removed through the large drain-hole.

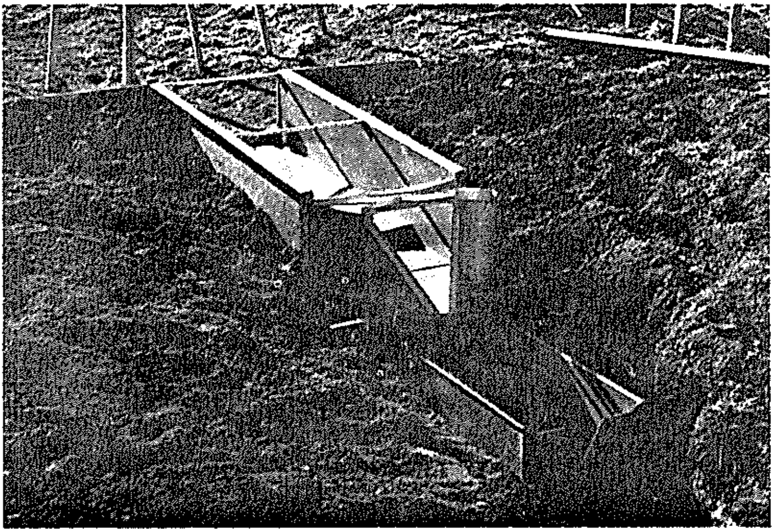

Fig. 2 — INSTALLATION IN OTUTIRA EXPERIMENTAL BASIN, near Taupo, on an 11-acre grassed catchment.

SUMMARY

For Experimental Basins where low flows have to be measured with a high degree of accuracy, the flume-weir combination appears to be the ideal solution. The weir box as a self-contained prefabricated unit has the great advantage of enabling calibration of the structure before installation. It also provides a check on the low-flow range of the flume structure. Fibreglass has many advantages over conventional materials. Since fibreglass can be polished to a smooth finish and requires no maintenance it is intended to fabricate flumes in the same material except that the orifice will be made from stainless steel plate.

Separate recorders for each structure provide an independent check in the critical low-flow range. The weir box can also be used as a sediment measuring device.