
International Standard



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Liquid flow measurement in open channels by weirs and flumes — V-shaped broad-crested weirs

Mesure de débit des liquides dans les canaux découverts au moyen de déversoirs et de canaux jaugeurs — Déversoirs à seuil épais en V

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 8333 was prepared by Technical Committee ISO/TC 113, *Measurement of liquid flow in open channels*.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Liquid flow measurement in open channels by weirs and flumes — V-shaped broad-crested weirs

1 Scope and field of application

This International Standard specifies a method for the measurement of subcritical flow in small rivers and artificial channels using V-shaped broad-crested weirs.

The advantages of this type of weir are described in clause 8.

NOTE — A comparison of the different types of weirs and flumes will form the subject of a future International Standard.

2 References

ISO 772, *Liquid flow measurement in open channels — Vocabulary and symbols*.

ISO 4373, *Measurement of liquid flow in open channels — Water level measuring devices*.

ISO 4374, *Liquid flow measurement in open channels — Round-nose horizontal crest weirs*.

ISO 5168, *Measurement of fluid flow — Estimation of uncertainty of a flow-rate measurement*.

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 772 apply.

4 Units of measurement

The units of measurement used in this International Standard are SI units.

5 Installation

5.1 Selection of site

A preliminary survey shall be made of the physical and hydraulic features of the proposed site to check that it conforms (or may be made to conform) to the requirements necessary for measurement using the weir.

Particular attention shall be paid to the following features in selecting the site of the weir :

- a) the availability of an adequate length of channel of regular cross-section;
- b) the existing velocity distribution;
- c) the avoidance of channels having gradients greater than 1 in 250;
- d) the consequential effects of any increased upstream water level due to the measuring structure;
- e) the consequential conditions downstream, including such influences as tides, confluences with other streams, sluice gates, mill dams and other controlling features which might cause drowning;
- f) the impermeability of the ground on which the structure is to be founded, and the necessity for piling, grouting or other sealing in river installations;
- g) the necessity for flood banks to confine the maximum discharge to the channel;

- h) the stability of the banks, and the necessity for trimming and/or revetment in natural channels;
- j) the clearance of rocks or boulders from the bed of the approach channel;
- k) the effects of wind (wind can have a considerable effect on the flow in a river or over a weir, especially if these are wide and the head is small and when the prevailing wind is in a transverse direction).

If the site does not possess the characteristics required for satisfactory measurements, it shall be rejected unless suitable improvements are practicable.

If a survey of a stream shows that the existing velocity distribution is regular, then it is assumed that the velocity distribution will remain satisfactory after the weir has been built.

If the existing velocity distribution is irregular and no other site for a gauge is feasible, due consideration shall be given to checking the distribution after the weir has been installed and to improving it, if necessary.

Several methods are available for obtaining more precise indications of irregular velocity distribution; velocity rods, floats or concentrations of dye can be used in small channels, the latter being useful in checking conditions at the bottom of the channel. A complete and quantitative assessment of velocity distribution may be made by means of a current-meter.

5.2 Installation conditions

5.2.1 General

The complete measuring installation consists of an approach channel, a measuring structure and a downstream channel. The parameters of each of these three components affect the overall accuracy of the measurements.

Installation requirements include such features as weir finish, the cross-sectional shape of the channel, channel roughness and the influence of control devices upstream or downstream of the gauging structure.

The distribution and direction of velocity have an important influence on the performance of a weir, these factors being determined by the features mentioned above.

Once an installation has been designed, the user shall eschew any changes which could affect the discharge characteristics.

5.2.2 Approach channel

For all installations, the flow in the approach channel shall be smooth, free from disturbance and shall have a velocity

distribution as normal as possible over the cross-sectional area. This can usually be verified by inspection or measurement. In the case of natural streams or rivers, this can only be attained by having a long, straight approach channel free from projections into the flow. Unless otherwise specified in the appropriate clauses, the approach channel shall comply with the general requirements outlined below.

The altered flow conditions due to the construction of the weir may have the effect of building up shoals of debris upstream of the structure, which in time may affect the flow conditions. The likely consequential changes in the water level should be taken into account in the design of gauging stations.

In an artificial channel, the cross-section shall be uniform and the channel shall be straight for a length equal to at least 10 times its width.

In a natural stream or river, the cross-section shall be reasonably uniform and the channel shall be straight for such a length as to ensure regular velocity distribution.

If the entry to the approach channel is through a bend or if the flow is discharged into the channel through a conduit of smaller cross-section or at an angle, then a longer length of straight approach channel is required to achieve a regular velocity distribution.

Baffles shall not be installed closer to the points of measurement than 10 times the maximum head to be measured.

Under certain conditions, a standing wave may occur upstream of the gauging device, for example if the approach channel is steep. Provided this wave is at a distance of not less than 30 times the maximum head upstream, flow measurement is feasible, subject to confirmation that a regular velocity distribution exists at the gauging station.

If a standing wave occurs within this distance, the approach conditions and/or gauging device shall be modified.

5.2.3 Measuring structure

The structure shall be rigid, watertight and capable of withstanding flow conditions without distortion or fracture. It shall be at right angles to the direction of flow and shall have the dimensions specified in the relevant clauses (see also figure 1).

The V-shaped broad-crested weir may be constructed with either a fixed crest or a movable one with vertical slots (see figure 2).

5.2.4 Movable measuring structure

The movable V-shaped broad-crested weir can be constructed with one vertical slot in which the supporting plate of the weir

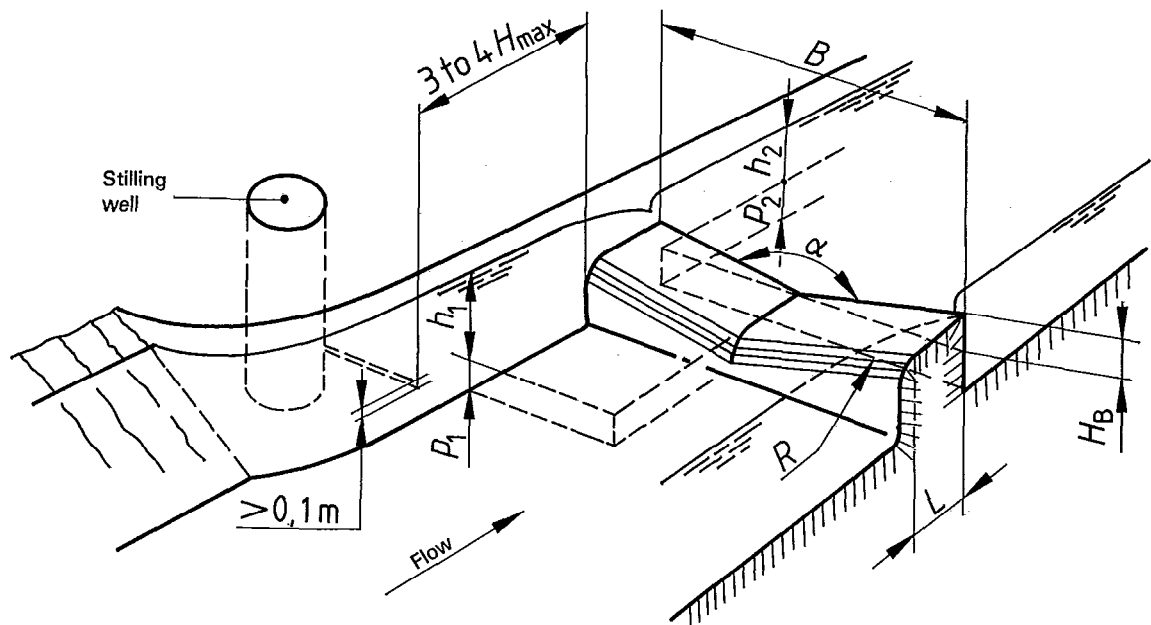


Figure 1 — V-shaped broad-crested weir

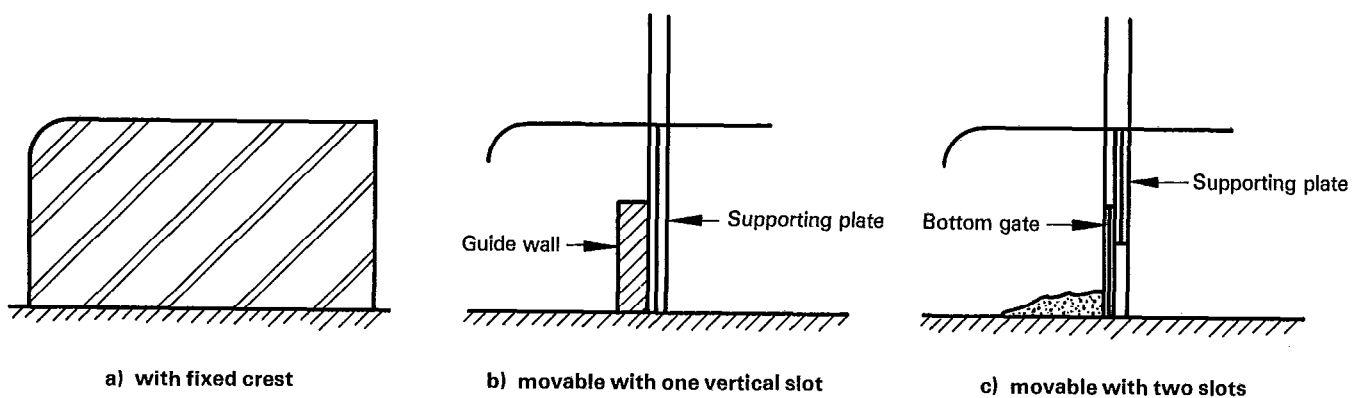


Figure 2 — Longitudinal section of three types of construction

crest can be raised or lowered according to the desired crest level. A vertical guide wall founded at the channel bottom and parallel to the supporting plate acts as a watertight barrier for the movable weir.

If regular flushing of sediment is expected to be necessary, the weir can be constructed with two slots. The movable weir can be operated in the downstream slot while a bottom gate is placed in the upstream slot. During measurement of flow, the gate is closed at the bottom. To flush sediment that has settled upstream of the weir, the gate can be opened by connecting it to the movable weir and raising the weir and gate together.

5.2.5 Downstream channel

The channel downstream of the structure is usually of no importance as such, provided that the weir has been designed so that the flow is modular under the operating conditions.

The altered flow conditions due to the construction of the weir may have the effect of building up shoals of debris immediately downstream of the structure, which in time may raise the water level sufficiently to drown the weir. Any accumulation of debris downstream of the structure shall therefore be removed.

6 General requirements for maintenance

Maintenance of the measuring structure and the approach channel is important to ensure accurate continuous measurements.

It is essential that the approach channel to weirs be kept clean and free from silt and vegetation as far as practicable for at least the distance specified in 5.2.2. The float well and the entry from the approach channel shall also be kept clean and free from deposits.

The weir shall be kept clean and free from clinging debris and care shall be taken in the process of cleaning to avoid damage to the weir crest.

7 Measurement of head

7.1 General

The head upstream of the measuring structure may be measured by a hook-gauge, point-gauge or staff-gauge where spot measurements are required or by a float-operated recording gauge where a continuous record is required, and, in many cases, it is preferable to measure heads in a separate stilling well to reduce the effects of surface irregularities. Other head-measuring methods (for example bubble tubes) may be used, provided sufficient accuracy is obtainable.

The discharges given by the working equation are volumetric figures, and the liquid density does not affect the volumetric discharge for a given head provided the head is calibrated in liquid of identical density.

If the gauging is carried out in a separate well, a correction for the difference in density may be necessary if the temperature of

the liquid in the well is significantly different from that of the flowing liquid. However, it is assumed herein that the densities are equal.

It shall, however, be ensured that the gauge is not located in a pocket or still pool, but measures the piezometric head.

7.2 Stilling or float well

Where provided, the stilling well shall be vertical and shall extend at least 0,6 m above the maximum water level estimated to be recorded in the well.

It shall be connected to the approach channel by an inlet pipe or slot, large enough to permit the water in the well to follow the rise and fall of the head without significant delay. The level of the inlet pipe shall be at least 0,1 m below the lowest point of the crest (vertex).

The connecting pipe or slot shall, however, be as small as possible insofar as is consistent with ease of maintenance, or, alternatively, it shall be fitted with a constriction to damp out oscillations due to short amplitude waves. This will be necessary, for example, if the chart of the recorder cannot be read to within ± 6 mm.

The well and the connecting pipe or slot shall be watertight. If provided for the accommodation of the float of a level recorder, the well shall be of adequate diameter and depth for that purpose.

The well shall also be sufficiently deep to ensure that any sediment which may enter does not lead to grounding of the float. The float well arrangement may include an intermediate chamber, between the stilling well and the approach channel, of similar proportions to the stilling well, to enable sediment to settle.

Additional specifications for stilling wells are given in ISO 4373.

7.3 Head-gauge datum

Accuracy of head measurements is critically dependent upon the determination of the head-gauge datum or gauge zero, which is the gauge reading corresponding to the level of the vertex — lowest point — of the V-shaped weir.

The gauge zero shall be determined with great care and shall be checked regularly.

7.3.1 Determination of head-gauge datum for weirs with a fixed crest

An acceptable method of determining the head-gauge datum for V-shaped broad-crested weirs with a fixed crest height is specified in 7.3.1.1 to 7.3.1.6 (see also figure 3).

The advantage of this method is that it relates the head-gauge datum to the geometrical vertexline which is defined by the sides of the weir.