

Australian Standard[®]

Measurement of water flow in open channels

Method 4.4: Measurement using flow gauging structures—V-shaped broad-crested weirs



This Australian Standard® was prepared by Committee CE-024, Measurement of Water Flow in Open Channels and Closed Conduits. It was approved on behalf of the Council of Standards Australia on 12 July 1991.
This Standard was published on 23 September 1991.

The following are represented on Committee CE-024:

- Association of Consulting Engineers, Australia
 - Australian Water and Wastewater Association
 - Board of Works, Melbourne
 - Department of Water Resources, N.S.W.
 - Engineering and Water Supply Department of South Australia
 - Forestry Commission, N.S.W.
 - Institute of Instrumentation and Control
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Standards Australia wishes to acknowledge the participation of the expert individuals that contributed to the development of this Standard through their representation on the Committee.

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First published as AS 3778.4.4—1991.
Reconfirmed 2009.

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Published by Standards Australia GPO Box 476, Sydney, NSW 2001, Australia

ISBN 0 7262 7062 8

PREFACE

This Standard was prepared by the Standards Australia Committee on Measurement of Water Flow in Open Channels and Closed Conduits. It is identical with and has been reproduced from ISO 8333:1985, *Liquid flow measurement in open channels by weirs and flumes—V-shaped broad-crested weirs*.

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This Standard is one of a series which deals with methods of measurement of water flow in open channels. The series when complete will consist of the following parts:

- Part 1: *Vocabulary and symbols*
- Part 2.1: *General—Guidelines for the selection of methods of measurement*
- Part 2.2: *General—Establishment and operation of a gauging station*
- Part 2.3: *General—Determination of the stage-discharge relation*
- Part 2.4: *General—Estimation of uncertainty of a flow-rate measurement*
- Part 2.5: *General—Guidelines for the selection of flow gauging structures*
- Part 3: *Velocity-area methods*
- Method 3.1: *Measurement by current-meters and floats*
- Method 3.2: *Measurement by moving-boat method*
- Method 3.3: *Measurement by slope-area method*
- Method 3.4: *Collection and processing of data for determination of errors in measurement*
- Method 3.5: *Investigation of total error*
- Method 3.6: *Measurement of flow in tidal channels*
- Method 3.7: *Measurement by ultrasonic (acoustic) method*
- Method 3.8: *Electromagnetic method using a full-channel-width coil*
- Part 4: *Measurement using flow gauging structures.*
- Method 4.1: *Thin-plate weirs*
- Method 4.2: *Rectangular broad-crested weirs*
- Method 4.3: *Round-nose horizontal broad-crested weirs*
- Method 4.4: *V-shaped broad-crested weirs (this Standard)*
- Method 4.5: *Triangular profile weirs*
- Method 4.6: *Flat-V weirs*
- Method 4.7: *Rectangular, trapezoidal and U-shaped flumes*
- Method 4.8: *Trapezoidal profile weirs*
- Method 4.9: *Parshall and Saniiri flumes*
- Method 4.10: *End-depth method for estimation of flow in rectangular channels with a free overfall*
- Method 4.11: *End-depth method for estimation of flow in non-rectangular channels with a free overfall (approximate method)*
- Part 5: *Dilution methods*
- Method 5.1: *Constant-rate injection method for the measurement of steady flow*
- Method 5.2: *Integration method for the measurement of steady flow*
- Part 6.1: *Measuring devices, instruments and equipment—Rotating element current-meters*
- Part 6.2: *Measuring devices, instruments and equipment—Direct depth sounding and suspension equipment*
- Part 6.3: *Measuring devices, instruments and equipment—Calibration of rotating element current-meters in straight open tanks*
- Part 6.4: *Measuring devices, instruments and equipment—Echo sounders for water depth measurements*
- Part 6.5: *Measuring devices, instruments and equipment—Water level measuring devices*
- Part 6.6: *Measuring devices, instruments and equipment—Cableway system for stream gauging*
- Part 6.7: *Measuring devices, instruments and equipment—Ultrasonic (acoustic) velocity meters*
- Part 6.8: *Measuring devices, instruments and equipment—Position fixing equipment for hydrometric boats*

For the purposes of this Australian Standard, the ISO text should be modified as follows:

- (i) Wherever the words 'International Standard' appear, referring to this Standard, they should be read as 'Australian Standard'.
- (ii) Wherever the word 'fluid' appears, it should be read as 'water'.
- (iii) Substitute a full point (.) for a comma (,) as a decimal marker.
- (iv) The references to other publications should be replaced by references to Australian Standards as follows:

<i>Reference to International Standard</i>		<i>Australian Standard</i>	
ISO		AS	
		3778	Measurement of water flow in open channels
772	Liquid flow measurement in open channels—Vocabulary and symbols	3778.1	Part 1: Vocabulary and symbols
5168	Measurement of fluid flow—Estimation of uncertainty of a flow-rate measurement	3778.2.4	Part 2.4: General—Estimation of uncertainty of a flow-rate measurement
4374	Liquid flow measurement in open channels—Round-nose horizontal broad-crested weirs	3778.4.3	Part 4: Measurement using flow gauging structures Method 4.3: Round-nose horizontal broad-crested weirs
4373	Measurement of liquid flow in open channels—Water level measuring devices	—	

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Measurement of water flow in open channels

Part 4: Measurement using flow gauging structures

Method 4.4: 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

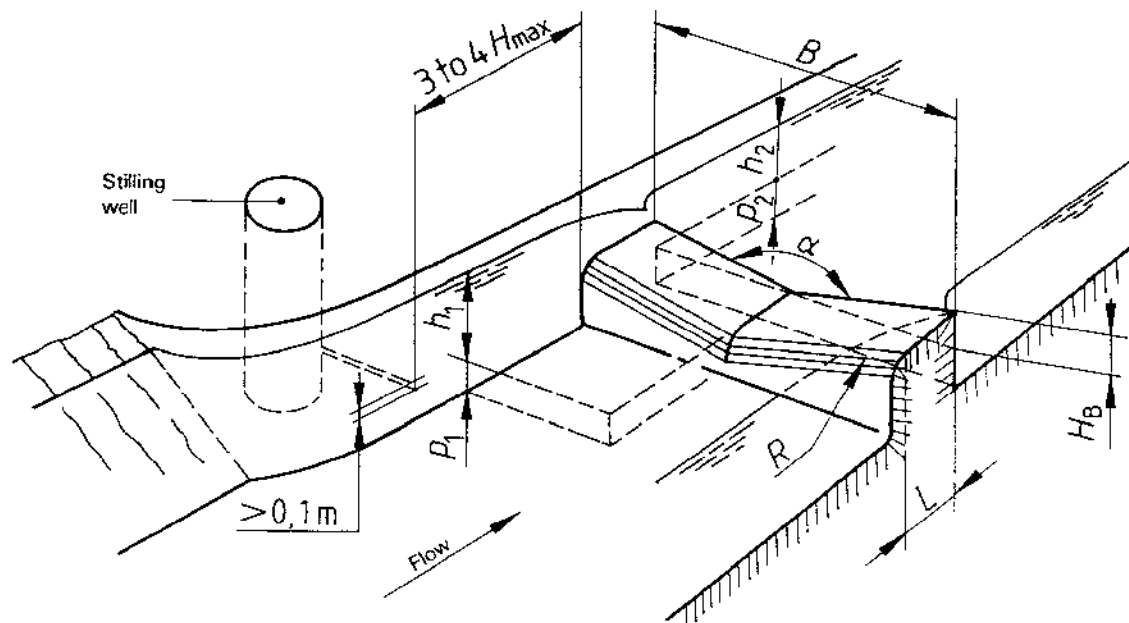


Figure 1 – V-shaped broad-crested weir

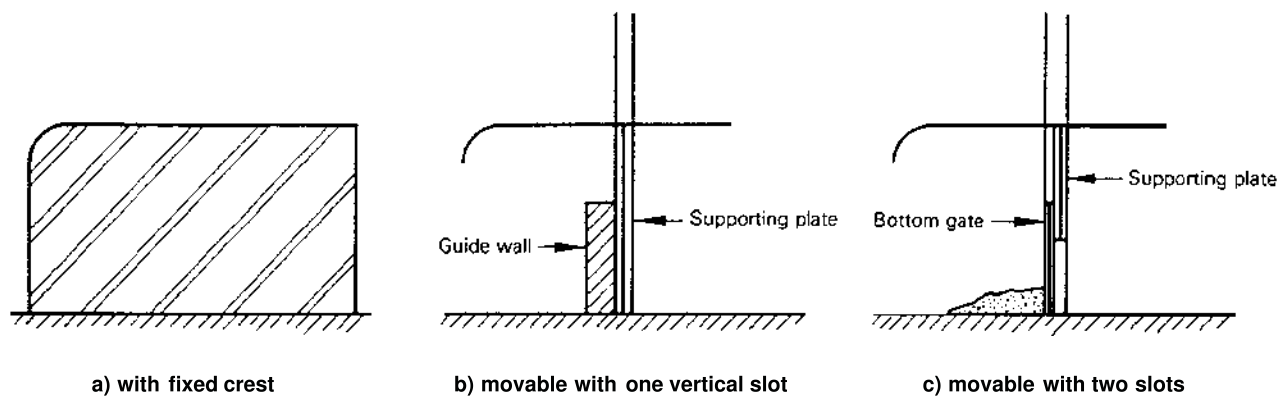


Figure 2 – Longitudinal section of three types of construction