International Standard

ISO 19234

Hydrometry — Low cost baffles to aid fish passage on triangular profile gauging weirs

Hydrométrie — Chicanes à faible coût pour faciliter le passage des poissons par les déversoirs à profil triangulaire

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 113, *Hydrometry*, Subcommittee SC 2, *Flow measurement structures*.

This first edition cancels and replaces (ISO/TR 19234:2016), which has been technically revised.

The main changes are as follows:

— this document has been restructured;

— low-cost baffles on flat-V weirs have been included.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Flow gauging structures such as triangular profile weirs are commonly used for the measurement of open channel flows. This document applies to weirs operating under modular flow conditions, with flow passing through critical depth. To operate under these conditions, such weirs require a sufficient head difference to be generated between upstream and downstream. At structures operating in the modular flow range, flow rate is solely a function of the upstream head.

In recent years, greater emphasis has been placed on environmental issues, including the free migration of fish in watercourses. It is acknowledged that the head drop required to achieve modular flow can inhibit the movement of fish. It has become important, therefore, to consider ways of aiding fish migration without significantly affecting flow measurement accuracy.

Applied research has shown that baffles of suitable form and placement on the downstream face of triangular profile weirs can partially mitigate fish passage impacts while retaining the gauging function.

NOTE The coefficient of discharge of the weir would normally remain the same although it is an option to recalibrate the coefficient to take into account the placement of baffles.

The baffle system described in this document was adapted from an optimal solution for aiding fish passage[1][2] on non-gauging sloping weirs commonly used for other purposes (e.g. abstraction, flow diversion, power generation, navigation).

The following Excel[1)] spreadsheet tools can be used to design the layout of the baffles according to this document:

— Crump weir spreadsheet (LCB placement sheet for Crump weirs 2023.xlsm);

— Flat-V weir spreadsheet (LCB placement sheet for flat-V weirs 2023.xlsx).

The spreadsheet tools are available at: https://standards.iso.org/iso/19234//ed-1/en/

1) Excel is the trademark of a product supplied by Microsoft. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named. Equivalent products may be used if they can be shown to lead to the same results.

Hydrometry — Low cost baffles to aid fish passage on triangular profile gauging weirs

1 Scope

This document specifies how to integrate baffles to aid the passage of fish on the downstream face of triangular profile weirs that conform to ISO 4360 (including Crump weirs) and ISO 4377 (flat-V weirs).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 772, *Hydrometry — Vocabulary and symbols*

ISO 4360, *Hydrometry — Open channel flow measurement using triangular profile weirs*

ISO 4377, *Hydrometric determinations — Flow measurement in open channels using structures — Flat-V weirs*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 772 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
anguillid
eel and lamprey
long and cylindrical body-shaped species including eel (*Anguilla anguilla*) and lamprey (*Lampetra fluviatillis* and *Petromizon marinus*)

3.2
non-migratory salmonid
fish of the family Salmonidae that migrates solely in freshwater including brown trout (*Salmo trutta*) and grayling (*Thymallus thymallus*)

3.3
coarse fish
non-salmonid fish found in freshwater habitats

3.4
Crump weir
weir with a triangular profile in the streamwise direction and a horizontal crest in the transverse direction used for gauging

Note 1 to entry: This weir was named after the inventor E.S. Crump. The upstream slope is 1:2 and downstream slope is 1:5 (see ISO 4360).

3.5
anadromous
living and migrating between the sea and freshwater

3.6
flat-V weir
triangular profile weir (3.15) with a transverse V-shaped crest used for gauging

Note 1 to entry: The upstream slope is 1:2 and downstream slope is 1:5 (parallel to the centreline). The cross-slopes can be between 1:10 and 1:40 (see ISO 4377).

3.7
low-cost baffle
LCB
low-cost deflector attached to the downstream face of the structure to aid fish passage

Note 1 to entry: These are low-cost baffles in comparison to having to incorporate a formal fish pass in a gauging weir.

Note 2 to entry: These are perpendicular to the downstream slope of the weir. The geometry of the baffle is precisely described in Figure 4.

3.8
migratory salmonid
fish of the family Salmonidae that migrates between the sea and fresh water including salmon (*Salmo salar*) and sea trout (*Salmo trutta*)

3.9
modular flow
flow that is independent of variations in tailwater level

3.10
plunging flow
flow passing an obstruction that is directed towards the floor and defined as

$$H_2/H_1 \leq 0{,}50$$

where

H_1 is the depth of water on the upstream side of baffle relative to the base of the baffle;

H_2 is the depth of water on the downstream side of baffle relative to the base of the baffle.

Note 1 to entry: Unstable flow conditions can occur for ratios of H_2/H_1 between 0,51 to 0,59.

3.11
potamodromous
living and migrating solely in freshwater

3.12
reflection
change in direction of the position of the gaps in the baffles

3.13
streaming flow
flow passing an obstruction that remains at or near the surface and defined as

$$H_2/H_1 \geq 0{,}60$$

where

H_1 is the depth of water on the upstream side of baffle relative to the base of the baffle;

H_2 is the depth of water on the downstream side of baffle relative to the base of the baffle.

Note 1 to entry: Unstable flow conditions can occur for ratios of H_2/H_1 between 0,51 to 0,59.

3.14
structural head difference
SHD
difference in elevation (in metres) between the invert (lowest level) of the crest of the *triangular profile weir* (3.15) and the downstream water surface at a flow exceeded 95 % of the time

Note 1 to entry: See Figure 3 an illustration of structural head difference.

3.15
triangular profile weir
weir with a triangular profile in the streamwise direction

Note 1 to entry: This includes *Crump weirs* (3.6) and *flat-V weirs* (3.8).

3.16
V_{full}
flow that just fills the whole width of a flat-V weir at the crest

4 Symbols

a	baffle width	m
b	breadth of the weir crest perpendicular to the flow direction	m
c	gap offset distance immediately downstream from the reflection (see Figure 6)	m
d	distance between baffles, centre to centre along the slope (see Figure 6) (a * suffix indicates the dimension in plan view)	m
d_L	intermediate variable used in the Crump weir spreadsheet for calculating cutting lengths for the baffles – left-hand-side baffle	—
d_R	intermediate variable used in Crump weir spreadsheet for calculating cutting lengths for the baffles – right-hand-side baffle	—
f	offset distance between the position of gaps in successive baffles (see Figure 6)	m
h	gauged head relative to the crest elevation (upstream head is implied if no subscript is used); for flat-V weirs, the crest elevation is taken from the invert of the V	m
H	total head, energy head, relative to crest elevation; for flat-V weirs, the crest elevation is taken from the invert of the V	m
H_1	depth of water on the upstream side of baffle relative to the base of the baffle	m
H_2	depth of water on the downstream side of baffle relative to the base of the baffle	m
L	for Crump weirs, this is the distance from the crest to the base of the upstream face of the first baffle along the slope (in plane view); for flat-V weirs, this distance is the smallest distance to the base of the upstream face of the first baffle (see Figures 6 and 7 for clarity) (a * suffix indicates the dimension in plan view)	m

L_1	distance from the crest to the centre of the first baffle along the slope (only relevant to Crump weirs)	m
L_2	rounded up value of L_1 (only relevant to Crump weirs)	m
L_a	maximum apron length	m
p	height of the weir crest above the upstream bed level	m
q	gap width	m
Q_{nn}	flow that is exceeded for *nn* % of the time	m^3/s
R	radius	mm
T	height of the first baffle	m
T_s	height of subsequent baffles used in the Crump weir spreadsheet	m
V_{full}	flow that fills the whole width of the flat-V weir at the crest	m^3/s
z_L	intermediate variable used in the Crump weir spreadsheet to determine local coordinates (left-hand-side) for determining the gap location	—
z_R	intermediate variable used in the Crump weir spreadsheet to determine local coordinates (right-hand-side) for determining the gap location	—
Δ_x	axis in the direction of the flow (perpendicular to the crest) used in the Crump weir spreadsheet	—
Δ_y	axis in the direction perpendicular to the face of the crest (vertical upwards) used in the Crump weir spreadsheet	—
Δ_z	axis in the direction along the crest used in the Crump weir spreadsheet	—

5 Principles

5.1 General principles

Baffles are placed in horizontal parallel rows on the downstream sloping face of the weir. There is a gap in each row of baffles that runs at an angle progressively across and down the weir face. This forms an oblique flow path that can be reflected from side to side in narrower channels forming a V-shaped pattern in plan view (as shown in Figures 1 and 2). The baffles retard flow, maintain a consistent depth of water, and substantially reduce the acceleration of the water on the downstream face of the weir. The oblique flow path formed by the gaps provides a passage route for fish with greater flow depth and lower velocities than over the baffles. The baffles also spread the dissipation of flow energy over the length of the downstream slope of the weir, creating a series of small hydraulic jumps and reducing the intensity of a final hydraulic jump at the junction with the tailwater pool.

The solution creates conditions that fish can exploit to find passage over a wide range of flows. Fish can exploit the low velocity flow path, or, when flow tops the baffles, they can swim straight up the slope, taking advantage of the lower velocities created by the baffles. However, if the top baffle is too close to the weir crest, it can affect gauging performance.

For the application of this document, users shall either apply ISO 4360 (including Crump weirs) or ISO 4377 (flat-V weirs).

5.2 Crump weirs — Structures that conform to ISO 4360

Baffles are placed in rows that are parallel to the crest on the downstream sloping face of the weir. See Figure 1.

a) Baffles in the dry (viewed from upstream during construction)

b) Baffles in operation before maintenance has been carried out (viewed from upstream)

NOTE The figure shows Jessops Weir on the River Asker, Dorset, United Kingdom.

Figure 1 — Crump weir

Although the weir in Figure 1 is a Crump weir, it no longer has a gauging function. Therefore, the first baffle has been placed closer to the crest than this document allows. The downstream slope of this crest is sufficiently long for more than one reflection and the flow path of the water where the gaps are located is evident when the baffles are in operation.

The distance from the weir crest to the upstream side of the first baffle is of critical importance. The distance to the first baffle is determined by the range of flow rates for which modular flow is required at the gauge. The distance can be determined by using the low-cost baffle placement tool. The spreadsheet tool is available at: https://standards.iso.org/iso/19234//ed-1/en/

The baffle solution was tested in a laboratory with structures that operate up to a maximum head of 0,49 m at field scale. The dimensions and location of the baffles are determined (see Figure 6) so that they do not reduce the coefficient of discharge of the weir by more than 1 %[3][4].

5.3 Flat-V weirs — Structures that conform to ISO 4377

Baffles are placed in parallel rows on the downstream sloping face of the flat-V weir, along the contours of the weir so that each baffle top is level in the horizontal plane. There are gaps in each row of baffles that run at an angle progressively across and down the weir face. This oblique flow path can be reflected from side to side (see Figure 2).