TECHNICAL REPORT

# ISO/TR 19234

First edition
2016-12-15

# Hydrometry — Low cost baffle solution to aid fish passage at triangular profile weirs that conform to ISO 4360

*Hydrométrie — Projet de chicane à faible coût pour faciliter le passage des poissons au niveau des déversoirs à profil triangulaire conformes à l'ISO 4360*



Reference number
ISO/TR 19234:2016(E)

ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

# Contents

Page

# 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 documents 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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html



The committee responsible for this document is Technical Committee ISO/TC 113, *Hydrometry*, Subcommittee SC 2, *Flow measurement structures*.



# Introduction

Flow gauging structures are commonly used for the measurement of open channel flows. To operate satisfactorily, these structures require a head difference to be generated between the upstream and downstream water levels. At structures designed to operate in the modular flow range, an upstream head measurement is used to interpret flow rates. At structures designed to operate in both the modular and drowned flow ranges, the upstream head measurement is augmented by a second measurement which senses tailwater conditions. The former type tends to require higher head losses over the structure.

In recent years, greater emphasis has been placed on environmental issues, including the free migration of fish in watercourses. It is acknowledged that flow measurement structures, with their requirement for a head loss between upstream and downstream conditions, may inhibit the movement of fish. It has become important, therefore, to consider ways of aiding fish migration without seriously affecting flow measurement accuracy.



# Hydrometry — Low cost baffle solution to aid fish passage at triangular profile weirs that conform to ISO 4360

## 1 Scope

This document specifies the requirements for the integration of baffles on the downstream face of triangular profile flow measurement structures to aid the passage of fish.

## 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*

## 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 terminological databases for use in standardization at the following addresses:

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

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



**3.1**
**diadromous fish**
fish that migrate between fresh water and sea water to complete their life cycle

**3.2**
**potamodromous fish**
fish that migrate wholly within fresh water to complete their life cycle

**3.3**
**baffle**
wall or block attached to the downstream face of the structure to aid fish passage

**3.4**
**aerobic swimming**
<fish> sustainable swimming using red muscles, which incur no oxygen debt

**3.5**
**anaerobic swimming**
<fish> time limited swimming using white muscles, which incur oxygen debt

**3.6**
**riverine species**
fish species typically found in and adapted to a flowing water environment

**3.7**
**structural head difference**
**SHD**
difference in elevation between the crest of the triangular profile weir and the downstream water level at a flow equivalent to $Q_{95}$ exceedance

Note 1 to entry: $Q_{95}$ is the flow that is exceeded for 95 % of the time.

Note 2 to entry: See Figure 2.

**3.8**
**streaming flow**
flow which occurs when $H_2/H_1 \geq 0{,}60$, where

$H_2$ is the head on the downstream side of the baffle;

$H_1$ is the head on the upstream side of the baffle

**3.9**
**plunging flow**
flow which occurs when $H_2/H_1$ is less than 0,50, where

$H_2$ is the head on the downstream side of the baffle;

$H_1$ is the head on the upstream side of the baffle

Note 1 to entry: Values between 0,50 and 0,60 can be in hysteresis.



## 4 Symbols

| Symbol | Term | Unit |
|---|---|---|
| $b$ | Breadth of the weir crest perpendicular to the flow direction | m |
| $h$ | Gauged head relative to the crest (upstream head is inferred if no subscript is used) | m |
| $H$ | Total head relative to the crest level | m |
| $H_1$ | Head on the upstream side of the baffle | m |
| $H_2$ | Head on the downstream side of the baffle | m |
| $L$ | Distance from the crest to the front of the first baffle | m |
| $L_1$ | Distance from the crest to the centre of the first baffle | m |
| $L_2$ | 'Rounded up' value of $L_1$ | m |
| $L_a$ | Maximum apron length | m |
| $Q_{95}$ | Flow that is exceeded for 95 % of the time | $m^3 \cdot s^{-1}$ |
| $T$ | Height of the first baffle | m |
| $Ts$ | Height of subsequent baffles | m |
| $c$ | Slot offset distance immediately downstream from the reflection | m |
| $d$ | Distance between baffles, centre to centre | m |
| $p$ | Height of the weir crest above the upstream bed level | m |
| $q$ | Slot width | m |

[a] A spreadsheet tool associated with this document is used to design the layout of the baffles in accordance with this document. A link to the spreadsheet is given. http://standards.iso.org/iso/tr/19234

When opening the spreadsheet, be sure to click on the "Enable Macros "dialogue box.

| Symbol | Term | Unit |
|---|---|---|
| $f$ | Offset distance between the position of slots in successive baffles | m |
| SHD | Crest level above $Q_{95}$ downstream water level | m |
| z$L$ | Intermediate variable used in the spreadsheet[a] to determine local coordinates (left hand side) for determining the slot location | |
| z$R$ | Intermediate variable used in the spreadsheet[a] to determine local coordinates (right hand side) for determining the slot location | |
| d$L$ | Intermediate variable used in the spreadsheet[a] for calculating cutting lengths for the baffles – left hand side baffle | |
| d$R$ | Intermediate variable used in spreadsheet[a] for calculating cutting lengths for the baffles – right hand side baffle | |

[a] A spreadsheet tool associated with this document is used to design the layout of the baffles in accordance with this document. A link to the spreadsheet is given. http://standards.iso.org/iso/tr/19234

When opening the spreadsheet, be sure to click on the "Enable Macros "dialogue box.

## 5 Principles

Baffles are placed in parallel rows on the downstream sloping face of a triangular profile weir. There is a slot in each row of baffles that runs at an angle progressively across and down the weir face. This oblique channel can be reflected from side to side in narrower channels forming a V-shaped pattern in plan view, see Figures 1 and 3. The baffles retard flow, maintain a consistent depth of water, and prevent water velocities increasing down the weir. The oblique channel formed by the slots provides a passage route with greater flow depth and lower velocities than over the baffles. The baffles also break the often significant hydraulic jump that typically occurs down the face of weir and moves it further up the weir face where its intensity is greatly reduced.



The solution creates conditions that fish are able to exploit to find passage over a wide range of flows. Fish may exploit the low velocity channel or, when flow tops the baffles, they may swim straight up the slope, taking advantage of the retarded velocity flows created by the baffles.

The difference in elevation between the invert of the weir crest and the top of the first baffle downstream is of critical importance. The dimensions and location should be determined in such a manner that it does not affect the coefficient of discharge of the triangular profile weir by more than 1 %. The range of level measurement of the gauge will determine the distance of the first baffle downstream from the crest. However if the range is set too high, the first baffle will be set so far downstream that fish will not be able to pass over the final section of low depth and high velocity flow. The solution was tested in the laboratory with structures that operate up to a maximum head of 0,49 m at field scale. It is recommended that the first baffle should not be set any further downstream than a distance equivalent to a maximum head of 0,49 m.

a) Baffles installed on a weir shown under dry conditions

b) Flow condition on a weir with baffles under running condition

**Figure 1 — Examples of baffle installations on triangular profile weirs**

# 6 Installation

## 6.1 Site selection and application

### 6.1.1 Restriction



The baffle application is restricted to the use

— on two dimensional triangular profile flow gauging weirs as set out in ISO 4360;



— on weirs with a downslope 1:5 (Vertical: Horizontal) (20 % gradient in percentage or 11,31 degrees slope with horizontal).

### 6.1.2 Background

The technique was originally developed to improve fish passage on triangular profile gauging weirs but also addressed gradients up to 1:4 (25 %, 14 degrees) Baffles can be fitted to both single and compound triangular profile weirs. In the case of compound structures, the baffles are normally fitted to the lowest weir structure. Where there are two lower weir structures at the same level, consideration should be given to using the structure that has better access for maintenance and/or is least likely to be affected by debris.

### 6.1.3 Preliminary survey

A preliminary survey should be made of the physical and hydraulic features of the site, to check that it conforms (or can be made to conform) to the requirements necessary for baffle installation.

Particular attention should be paid to the following features for gauging weirs.

a) The downstream slope is confirmed as being nominally a 1:5 slope.

b) The concrete face of the slope should be smooth and in good condition without signs of spalling, cracking or leaks.

c) Knowledge of the location and depth of reinforcement bars in the concrete, if present, is advantageous.

d) The mean approach velocity in the downstream stilling basin or natural river channel should be no more than those given in Table 1 at $Q_{10}$ for migratory salmonids; $Q_{20}$ for brown trout, grayling, and coarse fish; and $Q_{70}$ for eels.

e) Where present, the tailwater stilling basin should be a minimum of 3,0 m in length downstream from any truncation, or from the bottom of the weir slope.

f) Where present, the stilling basin should have a minimum depth of 0,3 m below tail river bed level.

g) Where no stilling basin is present, there should be a minimum depth of 0,3 m for 3 m distance immediately downstream from any truncation, or from the bottom of the weir slope and the water velocities should not exceed those given in (d) above.

h) Where the downstream face is truncated and forms a vertical drop to the downstream stilling basin or river bed, additional works may be required to extend the downstream slope to achieve the appropriate baffle layout [see (i) below].

i) A truncated weir (for hydrometric purposes) may be used downstream of the last baffle where salmonids are the only species present. Where other species are present, the downslope should continue to the floor from the stilling basin, but may be at a maximum slope of 1:2 beyond the last baffle.

j) The water level on the downstream side of the most downstream low cost baffle should be such that streaming flow occurs in the free slot (for 0,2 m baffles this means 0,12 m of water, i.e. $H_2/H_1 \geq 0{,}60$) at $Q_{95}$ exceedance.



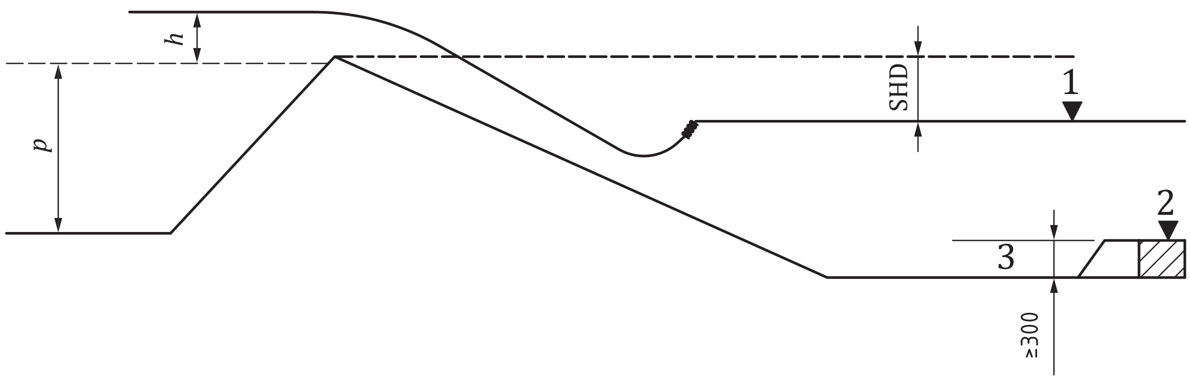
**Table 1 — Maximum acceptable mean approach velocities in the stilling basin for different fish species**



| | Migratory salmonids | Brown trout and graylings | Coarse fish | Eels |
|---|---|---|---|---|
| Mean approach velocity in stilling basin, m/s | 1,0 | 0,7 | 0,5 | 0,3 |



If the site does not possess the characteristics necessary for satisfactory installation, the site should be rejected unless suitable improvements are practicable to achieve those characteristics.




**Key**

1 downstream water level at $Q_{95}$

2 downstream bed level

3 stilling basin

**Figure 2 — Sketch illustrating the definition of structural head difference (SHD)**