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British Standard

Measurement of liquid flow in open channels

Part 1. Glossary of terms

Mesure de débit des liquides dans les canaux découverts
Partie 1. Glossaire des termes

Messung der Flüssigkeitsströmung in offenen Kanälen
Teil 1. Begriffe

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Foreword

This British Standard having been prepared under the direction of the Industrial-process Measurement and Control Standards Committee, is a revision of BS 3680 : Part 1 : 1979, which is therefore withdrawn. It is closely related to the draft revision of ISO 772-1978 'Liquid flow measurement in open channels — Vocabulary and symbols' at present in course of preparation by Technical Committee ISO/TC 113, Measurement of liquid flow in open channels, of the International Organization for Standardization (ISO).

In the preparation of this standard, the following principles have been adopted wherever possible:

- (a) to standardize suitable terms and symbols without perpetuating unsuitable ones;
- (b) to discard any term or symbol that has been used with differing meanings in different countries, or by different people, or by the same person at different times and to replace the discarded term or symbol by one which has an unequivocal meaning;
- (c) to exclude terms that are self-evident.

It is recognized, however, that it is not possible to produce a complete set of definitions which will be universally acceptable, but it is hoped that the definitions provided, and the symbols used, will find very wide acceptance and that their use will lead to better understanding amongst the practitioners of the measurement of liquid flow in open channels.

Throughout this standard there are instances of synonymous terms. Where two terms are interchangeable, they are given in bold type. Where a term is deprecated, it is so marked.

Symbols used in the measurement of liquid flow are given in appendix A.

For terms relating to statistical methods and the application of these methods to the measurement of liquid flow in open channels see BS 5532 and BS 5844 respectively.

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British Standard

Measurement of liquid flow in open channels

Part 1. Glossary of terms

This British Standard defines terms used in the field of liquid flow measurement in open channels. The terms and definitions are grouped into sections according to the method of measurement, or in relation to a particular subject.

NOTE. The titles of the publications referred to in this standard are listed on the inside back cover.

Section one. General terms

No.	Term	Definition
101	liquid flow	The movement of a volume of a substance that is neither a solid nor a gas, that is practically incompressible, that offers insignificant resistance to change of shape and that flows freely, e.g. water or water with sediment.
102	steady flow	A condition in which the discharge does not change in magnitude with respect to time.
103	unsteady flow	A condition in which the discharge changes in magnitude with respect to time.
104	uniform flow	Flow in which the depth and velocity remain constant with respect to distance along the channel. NOTE. For uniform flow, the velocity vector is constant along every stream line. Uniform flow is possible only in a channel of constant cross section.
105	critical flow	The flow in which the specific energy is a minimum for a given discharge; under this condition the Froude number is equal to unity and small surface disturbances cannot travel upstream.
106	sub-critical flow	The flow in which the Froude number is less than unity and surface disturbances can travel upstream.
107	super-critical flow	The flow in which the Froude number is greater than unity and small surface disturbances cannot travel upstream.
108	stratification of flow	The state of a fluid that consists of two or more layers arranged according to their density, the lightest layer being on top and the heaviest at the bottom.
109	critical depth	The maximum depth of a cross section at critical flow.
110	critical velocity	The velocity at critical flow.
111	open channel	The longitudinal boundary surface consisting of the bed and banks or sides within which the liquid flows with a free surface. NOTE 1. The term 'channel' generally means the deep part of a river or other waterway and its meaning is normally made clear by a descriptive adjectival term, either stated or implied, such as low-water channel, main channel or artificial channel. NOTE 2. For the purposes of this standard, the term 'channel' is always assumed to be qualified by the adjective 'open'.

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No.	Term	Definition
112	stable channel	A channel in which the bed and the sides remain sensibly stable over a substantial period of time in the control reach, and in which the scour and deposition during the rising and falling stages are inappreciable.
113	unstable channel	A channel with a control that changes frequently and significantly.
114	tidal channel	A channel in which the flow is subject to tidal action.
115	tidal waterway	One or more tidal channels together with the shallows and the banks or sides by which the water at high water is bounded.
116	stream	The liquid flowing in an open channel. NOTE. See also 118.
117	current	The movement of liquid.
118	river	The stream of water in a natural open channel.
119	reach	A length of open channel between two defined cross sections.
120	discharge	The volume of liquid flowing through a cross section in a unit time. NOTE. This term is not synonymous with flow.
121	stream gauging	All of the operations necessary for the measurement of discharge.
122	velocity	The speed of flow past a point in a specified direction.
123	left bank	The bank to the left of an observer looking downstream.
124	right bank	The bank to the right of an observer looking downstream.
125	invert	The lowest part of the cross section of an artificial channel.
126	bed slope; bottom slope	The difference in elevation of the bed per unit horizontal distance measured in the direction of flow. NOTE. This is usually mathematically positive downwards in the direction of flow.
127	bed profile	The shape of the bed in a vertical plane. NOTE. The shape of the bed may be considered longitudinally or transversely; this should be stated.
128	side slope	The tangent of the angle that the side of the open channel makes with either the horizontal or the vertical. NOTE 1. It should be stated whether the tangent is taken with the horizontal or the vertical. NOTE 2. The tangent of the angle may also be expressed as the ratio of the horizontal and vertical components of the slope, taking either of them as unity; the component taken as unity should be stated. The side slope may also be expressed as a percentage.
129	surface slope	The difference in elevation of the surface of the stream per unit horizontal distance, measured in the direction of flow.
130	surface draw-down	The local lowering of the water surface in an approach channel, caused by the acceleration of the flow passing over an obstacle or through a control.
131	fall	The difference in elevation of the water surface between the extremities of a defined reach at a given instant of time, e.g. as recorded at a twin-gauge station.
132	top width	The width of the channel measured across the stream at the water surface.
133	wetted perimeter	The wetted boundary of an open channel at a specified section.

No.	Term	Definition
134	cross section of stream	A specified vertical plane through a stream, bounded by the wetted perimeter and the free surface.
135	gauging section; measuring section	The cross section of an open channel in the plane of which measurements of depth and velocity are made.
136	measuring reach	A reach of open channel selected for measurement of hydraulic parameters.
137	converging reach	A reach in which the cross section gradually decreases in the direction of flow.
138	expanding reach	A reach in which the cross section gradually increases in the direction of flow.
139	flood mark	The trace of any kind left on the banks or obstacles or flood plain by a flood. NOTE 1. It may be used to determine the highest level attained by the water surface during the flood. NOTE 2. See also 506.
140	normal velocity distribution	The velocity distribution in a straight channel of uniform cross section is of sufficient length to develop uniform, resistance-controlled flow.
141	surface velocity	The velocity of a liquid at its surface at a given point.
142	mean velocity depth	The depth below the surface at which the mean velocity on a vertical occurs.
143	mean velocity at a cross section	The velocity at a given cross section of a stream, obtained by dividing the discharge by the cross-sectional area of the stream at that section.
144	mean velocity of a reach	The velocity calculated by dividing the discharge by the average cross-sectional area of the stream along the reach.
145	velocity of approach; approach velocity	The mean velocity in an open channel at a known distance upstream of a measuring section.
146	velocity head	The kinetic energy of the flow expressed as the head obtained by dividing the square of the velocity by twice the acceleration due to gravity.
147	total head; energy head	The sum of the elevation of the free surface above the horizontal datum of a section, and the velocity head based on the mean velocity at that section. NOTE 1. The total head (H) is given by the following expression: $H = h + \frac{\bar{V}^2}{2g_n}$ where h is the head of liquid level; $\bar{V}$ is the mean velocity of the liquid; g_n is the acceleration due to gravity. NOTE 2. See figure 6 and also 151 and 323.
148	total head line; energy head line	A plot of the total (energy) head in the direction of flow. NOTE. See figure 6.
149	energy gradient	The difference in total (energy) head per unit horizontal distance measured in the direction of flow.
150	energy loss; head loss	The difference in total (energy) head between two cross sections.
151	specific energy	The sum of the elevation of the free surface above the bed and the velocity head based on the mean velocity at that section. NOTE. See also 147 and 323.

No.	Term	Definition
152	stage; gauge height liquid level	The elevation of the free surface of a stream, lake, or reservoir relative to a specified datum. NOTE. See also 177.
153	stage-discharge relation	A curve, equation or table that expresses the relation between the stage and the discharge in an open channel at a given cross section. NOTE. See figure 1.

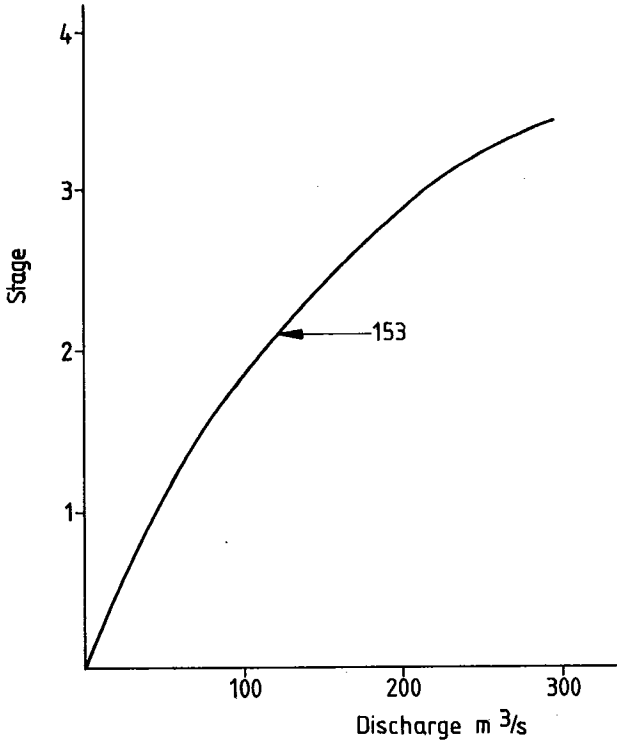


Figure 1. Stage-discharge relation

154	stage hydrograph	A graphical representation of changes in stage with respect to time.
155	discharge hydrograph	A graphical representation of changes in discharge with respect to time.
156	cumulative volume curve; mass discharge curve	A curve in which the cumulative volume of flow or flow mass is plotted against time.
157	gauging station	The complete installation at a measuring site where water level and/or discharge records are regularly maintained.
158	single-gauge station	A gauging station at which stage records from a single gauge are adequate to establish a stage-discharge relation.
159	twin-gauge station	A gauging station at which two water-level gauges define a reach for measurement of water-surface slopes as an essential parameter for establishing a stage-discharge relation. NOTE. See also 202 and 234.
160	reference system of levels	The system of levels prevalent in the vicinity of the gauging station related, where practicable, to a national datum.
161	control; section control	The physical properties of a cross section or a reach of a channel, either natural or artificial, that govern the relation between stage and discharge at a location in the channel.
162	calibration of a station; rating of a station	The establishment of a discharge relation with the measured variable(s).
163	afflux	The rise in liquid level immediately upstream of and due to an obstruction.

No.	Term	Definition
164	backwater	The afflux upstream from a given location on an open channel resulting from the impedances offered to flow. NOTE. Backwater is caused by channel storage for which the reservoir properties vary with the depth of flow at the given location.
165	backwater curve	The profile of the liquid surface upstream when its surface slope is less than the bed slope. NOTE 1. The backwater curve generally occurs upstream of an obstruction or confluence. NOTE 2. The term is also used to denote all liquid surface profiles that are non-uniform with respect to distance upstream or downstream. However, this usage is deprecated.
166	drawdown curve	The profile of the liquid surface when its surface slope exceeds the bed slope.
167	normal depth	The depth from the water surface to the bottom grade line of a channel, for uniform flow. NOTE. It is a function of the geometry, slope and roughness of the channel, and of the rate of discharge.
168	frazil ice	Fine spicules, plates or discoids of ice suspended in water that are generally formed by the supercooling of turbulent water. NOTE. Frazil ice may float or accumulate under ice cover or adhere to the stream bed as anchor ice.
169	anchor ice	Submerged ice found attached to the bed, irrespective of the nature of its formation.
170	rime ice	A white mass of tiny ice crystals or granular ice tufts formed on exposed objects, due to atmospheric moisture.
171	peak stage	The maximum instantaneous stage during a given period. NOTE. See also 139 and 506.
172	friction; drag	The boundary shear resistance that opposes the flow of a liquid.
173	conveyance; conveyance factor, deprecated	The carrying capacity of a channel expressed in terms of the discharge and the bed slope. NOTE. The conveyance (K) is given by the following expression: $K = QS^{-1/2}$ where Q is the total discharge; S is the bed slope.
174	hydraulic jump	The sudden transition from super-critical depth to sub-critical depth.
175	hydraulic mean depth; hydraulic radius	The quotient of the wetted cross-sectional area and the wetted perimeter.
176	stage gauge	A device installed for measuring the level of the surface of the liquid relative to a gauge datum.
177	gauge datum	The elevation of the zero of the gauge to which the level of the liquid surface is related. NOTE. The gauge datum is related to a bench mark (see 178).
178	bench mark	A permanent mark, the elevation of which should be related, where practicable, to a national datum.
179	stilling well	A well connected with the stream in such a way as to permit the measurement of the stage in relatively still liquid.

No.	Term	Definition
180	stilling tube	A tube connected with the stream in such a way as to permit the measurement of the stage in relatively still liquid.
181	float well	A stilling well in which a float device is used.
182	rugosity coefficient; roughness coefficient	A coefficient that characterizes the condition of the wetted perimeter.
183	friction coefficient	A coefficient used to calculate the energy gradient caused by friction.
184	Froude number	A dimensionless number expressing the ratio of inertia forces to gravity forces. NOTE. For open channels, the Froude number (F_r) is given by the following expression: $F_r = \frac{\bar{V}}{\sqrt{g_n D}}$ where $\bar{V}$ is the mean velocity of the liquid; g_n is the acceleration due to gravity; D is the mean total depth of the cross section.
185	Reynolds number	A dimensionless number expressing the ratio of the inertia forces to viscous forces. NOTE. For open channels, the Reynolds number (R_e) is given by the following expression: $R_e = \frac{\bar{V} \bar{D}}{\nu}$ where $\bar{V}$ is the mean velocity of the liquid; $\bar{D}$ is the mean total depth of the cross section; ν is the kinematic viscosity of the liquid.
186	Weber number	A dimensionless number expressing the ratio of inertia forces to surface tension forces. NOTE. For open channels, the Weber number (W_e) is given by the following expression: $W_e = \frac{\rho \bar{V}^2 \bar{D}}{\delta}$ where ρ is the density of the liquid; $\bar{V}^2$ is the mean velocity of the liquid; $\bar{D}$ is the mean total depth of the cross section; δ is the surface tension of the liquid.

Section two. Velocity-area methods

201	velocity-area method	A method of discharge determination deduced from the area of the cross section, bounded by the wetted perimeter and the free surface, and the integration of the component velocities in the cross section.
202	slope-area method	A method of discharge determination in a reach, based on the surface slope and the wetted areas of the various cross sections in the reach.
203	mean direction of flow	The direction in which the summation of the component velocity elements in a cross section is a maximum when the components are taken along that direction.
204	vertical	The vertical line in which velocity measurements or depth measurements are made.

No.	Term	Definition
205	drift	(1) The distance that a measuring boat travels during the time taken to make a velocity observation. (2) The distance that a current-meter assembly is carried downstream when used with a flexible suspension. NOTE. See figure 3.
206	drift velocity	Velocity due to drift.
207	period of pulsation	The average period of a cycle of pulsation during which the velocity in the cross section fluctuates between limiting high and low values.
208	measured mean velocity on a vertical	The velocity obtained by measuring velocity at one or more depths on a vertical and applying a coefficient, either directly or following some averaging process, to derive the mean.
209	mean velocity in a vertical	Discharge per unit width divided by the depth in the vertical. See figure 2.
210	vertical velocity curve	A curve showing the relation between depth and velocity along a vertical line in a specified section of a stream. NOTE. See figure 2.

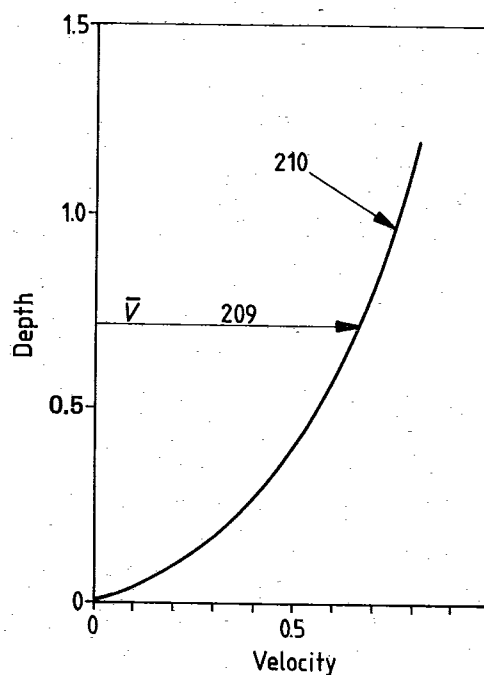


Figure 2. Vertical velocity curve

211	velocity gradient	The change in velocity per unit distance in a vertical direction.
212	vertical velocity coefficient	The coefficient applied to a single, or an equivalent single, velocity determination at any depth on a vertical to infer the mean velocity on that vertical.
213	sounding	The operation of measuring the depth from the free surface to the bed.

No.	Term	Definition
214	air line correction	The correction to the sounding line measurement applied to that part of the sounding line above the liquid surface. NOTE. See figure 3.
215	wet line correction	The correction to the sounding line measurement applied to that part of the sounding line below the liquid surface. NOTE. See figure 3.
216	reference gauge	A stage gauge normally linked to a reference system of levels.
217	reference current-meter	A current-meter that is immersed at a fixed position in the cross section during the carrying out of a discharge measurement. NOTE. For slight changes in discharge during the gauging operation, it is assumed that the change in velocity indicated by the reference current-meter is proportional to the change of discharge.

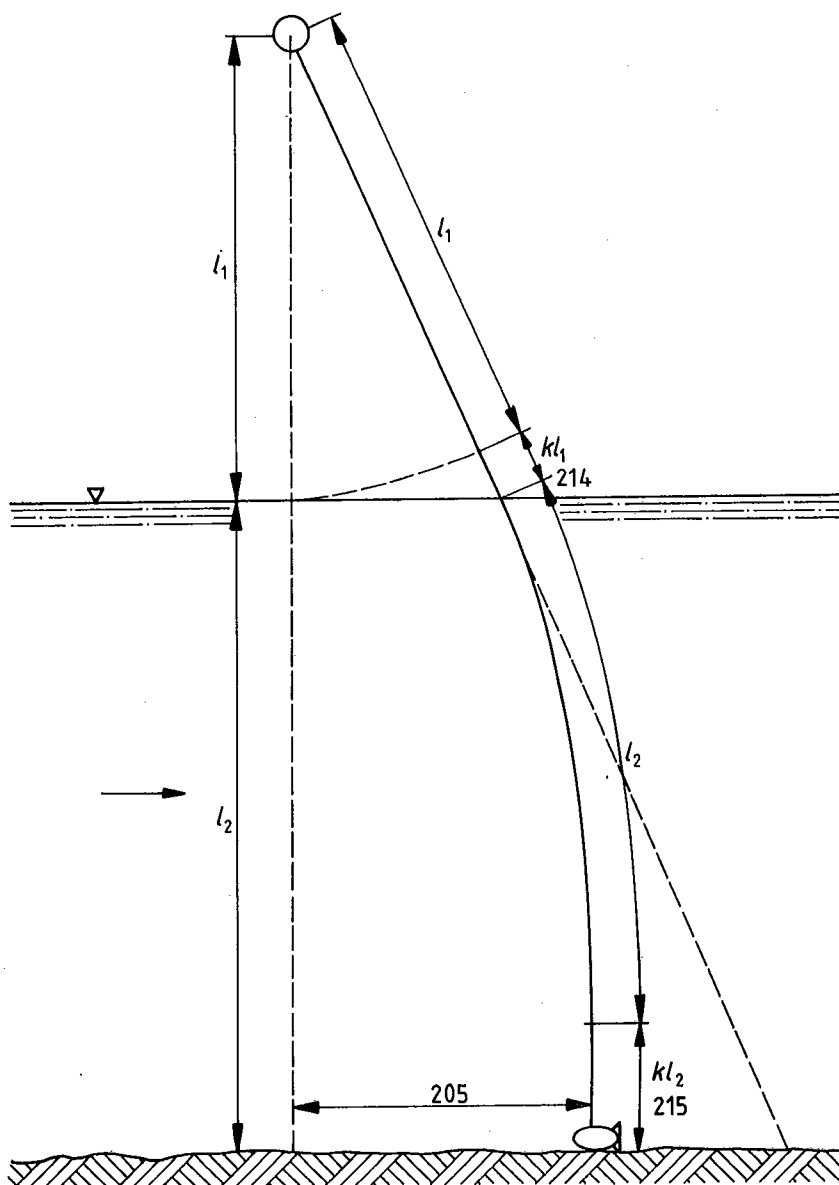


Figure 3. Sounding-line corrections