Designation: D5130 – 95 (Reapproved 2014)

Standard Test Method for Open-Channel Flow Measurement of Water Indirectly by Slope-Area Method[1]

This standard is issued under the fixed designation D5130; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the computation of discharge (the volume rate of flow) of water in open channels or streams using representative cross-sectional characteristics, the water-surface slope, and coefficient of channel roughness as input to gradually-varied flow computations.[2,3]

1.2 This test method produces an indirect measurement of the maximum discharge for one flow event, usually a specific flood. The computed discharge may be used to help define the high-water segment of a stage-discharge relation.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[4]

D1129 Terminology Relating to Water

D2777 Practice for Determination of Precision and Bias of Applicable Test Methods of Committee D19 on Water

D3858 Test Method for Open-Channel Flow Measurement of Water by Velocity-Area Method

2.2 *ISO Standards:*[5]

ISO 748 Liquid Flow Measurements in Open Channels—Velocity-Area Method

ISO 1070 Liquid Flow Measurements in Open Channels—Slope-Area Method

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, refer to Terminology D1129.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 Several of the following terms are illustrated in Fig. 1:

3.2.2 *alpha* (α)—a velocity-head coefficient that represents the ratio of the true velocity head to the velocity head computed on the basis of the mean velocity. It is assumed equal to 1.0 if the cross section is not subdivided. For subdivided sections, α is computed as follows:

$$\alpha = \frac{\sum \left(\frac{k_i^{\,3}}{A_i^{\,2}} \right)}{\frac{K_T^{\,3}}{A_T^{\,2}}}$$

where:

K and A	=	the conveyance and area of the subsection indicated by the subscript i, and
K_T and A_T	=	the conveyance and area of the entire cross section.

3.2.3 *conveyance (K)*—a measure of the carrying capacity of a channel and has dimensions of cubic feet per second or cubic metres per second. Conveyance is computed as follows:

$$K = \frac{1.486}{n} AR^{2/3}$$

where:

n = the Manning roughness coefficient,
A = the cross-section area, ft^2 (m^2), and
R = the hydraulic radius, ft (m).

NOTE 1—1.486 = 1.00 SI unit.

3.2.4 *cross sections (numbered consecutively in downstream order)*—representative of a reach of channel and are positioned

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[2] This test method is similar to methods developed by the U.S. Geological Survey and described in Refs (**1-3**).[3]

[3] The boldface numbers in parentheses refer to a list of references at the end of this standard.

[4] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

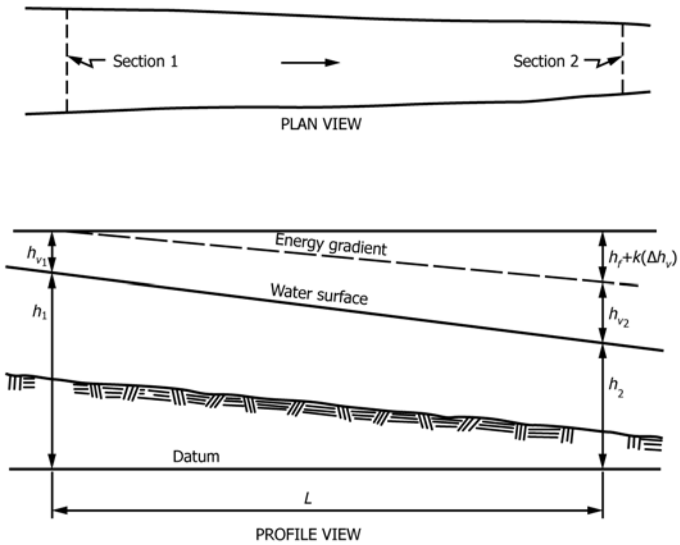

FIG. 1 Definition Sketch of a Slope-Area Reach

as nearly as possible at right angles to the direction of flow. They must be defined by coordinates of horizontal distance and ground elevation. Sufficient ground points must be obtained so that straight-line connection of the coordinates will adequately describe the cross-section geometry. If major breaks in the high-water profile are evident, cross sections should be located at the breaks.

3.2.5 *cross-section area (A)*—the area of the water below the high-water surface elevations that are computed by assuming a straight-line interpolation between elevations on each bank. The area is computed as the summation of the products of mean depth multiplied by the width between stations of the cross section.

3.2.6 *friction loss (h_f)*—the loss due to boundary friction in the reach and is equivalent to the following:

$$\Delta h + \Delta h_v - k(\Delta h_v)$$

where:

Δh = the fall in the reach,
Δh_v = the upstream velocity head minus the downstream velocity head,
$(k\Delta h_v)$ = the energy loss due to acceleration or deceleration and to eddies in a contracting or expanding reach, where k is a coefficient for energy losses.

All of the equations presented in this standard are based on the assumption that k is zero for contracting reaches and 0.5 for expanding reaches.

3.2.7 *fall (Δh)*—the drop in the water-surface computed as the difference in the average water-surface elevation at adjacent cross sections.

3.2.8 *friction slope (S_f)*—the energy loss divided by the length of the reach or:

$$S_f = \frac{h_f}{L}$$

that becomes:

$$S_f = \frac{\Delta h + \Delta h_v}{L}$$

when Δh_v is negative (for a contracting reach), or:

$$S_f = \frac{\Delta h + \frac{\Delta h_v}{2}}{L}$$

when Δh_v is positive (for an expanding reach).

3.2.9 *Froude number (F)*—an index to the state of flow in the channel. In a prismatic channel, the flow is tranquil or subcritical if the Froude number is less than 1.0 and is rapid or supercritical if it is greater than 1.0. The Froude number is computed as follows:

$$F = \frac{V}{\sqrt{gd_m}}$$

where:

V = the mean velocity in ft/s (m/s),
d_m = the average depth in the cross section in feet, and
g = the acceleration of gravity in ft/s/s (m/s/s).

3.2.10 *high-water marks*—the evidence of the highest stage reached by a flood. Debris, stains, foam lines, and scour marks are common types of high-water marks. Water-surface slopes are determined by the elevations of these marks.

3.2.11 *hydraulic radius (R)*—defined as the area of a cross section or subsection divided by the corresponding wetted perimeter.

3.2.12 *roughness coefficient (n)*—or Manning's n is used in the Manning equation. Roughness coefficient or Manning's n is a measure of the resistance to flow in a channel. The factors that influence the magnitude of the resistance to flow include the character of the bed material, cross section irregularities, depth of flow, vegetation, and alignment of the channel. A reasonable evaluation of the resistance to flow in a channel depends on the experience of the person selecting the coefficient and reference to texts and reports that contain values for similar stream and flow conditions (**1 and 2**). (See 9.3.)

3.2.13 *velocity head (h_v)*—computed as follows:

$$h_v = \frac{\alpha V^2}{2g}$$

where:

α = the velocity-head coefficient,
V = the mean velocity in the cross section in ft/s (m/s), and
g = the acceleration of gravity in ft/s/s (m/s/s).

3.2.14 *wetted perimeter (WP)*—the total length of the boundary between the channel bed and the water for a cross section. It is computed as the sum of the hypotenuse of the right triangle defined by the distance between adjacent stations of the cross section and the difference in bed elevations.

4. Summary of Test Method

4.1 The slope-area method is used to indirectly determine the discharge through a reach of channel, usually after a flood,