Flow in Gutters

A. Introduction

A pavement gutter is defined as a section of pavement adjacent to the roadway that conveys stormwater runoff from the pavement and adjacent areas behind the back of curb. Conventional gutter sections may have a straight cross slope, a composite cross slope where the gutter slope varies from the pavement cross slope, or a parabolic section. The standard SUDAS gutter section consists of a straight cross slope and is the type discussed below.

Most of the information presented is this section is based upon FHWA's Hydraulic Engineering Circular No. 22 (HEC-22), Urban Drainage Design Manual. Designers may refer to this document for additional information, including the design of composite, parabolic, and other types of gutter sections.

B. Gutter Capacity and Spread

Gutter flow calculations are necessary to establish the spread of water on the adjacent parking lane or traveled way. A modification of the Manning's equation can be used for computing flow in triangular channels. The modification is necessary because the hydraulic radius in the equation does not adequately describe the gutter cross-section, particularly where the top width of the water surface may be more than 40 times the depth at the curb. To compute gutter flow, the Manning's equation is integrated for an increment of width across the section. The resulting equation is:

$$Q = \left(\frac{0.56}{n}\right)(S_x)^{1.67}(S_L)^{0.5}T^{2.67}$$ **Equation 2C-2.01**

or in terms of T:

$$T = \left[\frac{Q \times n}{(0.56)\left({S_x}^{1.67}\right)\left({S_L}^{0.5}\right)}\right]^{0.375}$$ **Equation 2C-2.02**

where:

Q = Flow rate, cfs
T = Width of flow (spread), ft
n = Manning's coefficient (see Table 2C-2.01)
S_x = Cross slope of pavement, ft/ft
S_L = Longitudinal slope of pavement, ft/ft

Source: FHWA HEC-22

Equations 2C-2.01 and 2C-2.02 neglect the resistance of the curb face since this resistance is negligible.

Table 2C-2.01: Manning's n Values for Street and Pavement Gutters

Type of Gutter or Pavement	Manning's n
Asphalt Pavement	
Smooth texture (surface course)	0.013
Rough texture (base course or open graded mix)	0.016
Concrete Gutter with Asphalt Pavement	
Smooth	0.013
Rough	0.015
Concrete Pavement	
Float Finish	0.014
Broom finish (typical for most streets value)	0.016
Concrete Gutter, Troweled Finish	0.012
For gutters with small slope, where sediment may accumulate, increase values of "n" above by	0.002

C. Flow in Sag Vertical Curves

As gutter flow approaches the low point in a sag vertical curve, the flow can exceed the allowable design spread values as a result of the continually decreasing gutter slope. The spread in these areas should be checked to ensure it remains within tolerable limits. If the computed spread exceeds design values, additional intakes should be provided to reduce the flow as it approaches the low point.

D. Gutter Flow Times

The flow time in gutters is an important component of the time of concentration for the contributing drainage area to an inlet. To find the gutter flow component of the time of concentration, a method for estimating the average velocity in a reach of gutter is needed. The velocity in a gutter varies with the flow rate and the flow rate varies with the distance along the gutter (i.e. both the velocity and flow rate in a gutter vary). The time of flow can be estimated by use of an average velocity obtained by integration of the Manning's equation for the gutter section with respect to time.

$$V = \left(\frac{1.11}{n}\right)(S_L)^{0.5}(S_x)^{0.67}{T_A}^{0.67}$$ **Equation 2C-2.03**

where:

V = Velocity in a triangular channel (gutter), ft/s
T_A = Average width of flow (spread) between intakes, ft
n = Manning's coefficient (see Table 2C-2.01)
S_x = Cross slope of pavement, ft/ft
S_L = Longitudinal slope of pavement, ft/ft

Source: FHWA HEC-22

When using Equation 2C-2.03 to determine the average flow velocity through a gutter section upstream of an intake, or between two intakes with bypass flow, the average spread (T_A) through the flow section should be used.

E. References

U.S. Department of Transportation. *Urban Drainage Design Manual*. Hydraulic Engineering Circular No. 22. Third Ed. 2009.