Gutters and Inlets Design

STORMWATER INLETS

Gutter : A gutter is a triangle open channel along the curb stone of streets which carry the storm water along streets to inlets.

Inlets : Inlets are structures constructed in the street along the curb stone or across the street to allow water to inter from the gutter to the underground storm collection system.

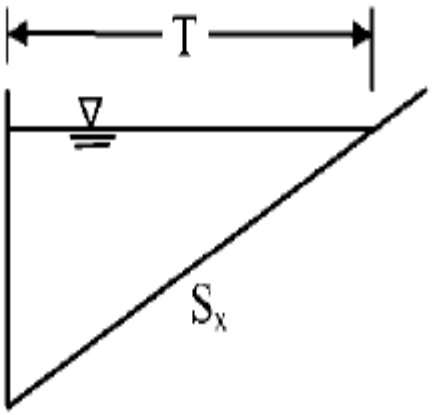
Gutter capacity:

The gutter capacity of carrying storm water is calculated using the modified Manning's equation:

$$Q = \frac{K}{n} S_x^{5/3} S^{1/2} T^{8/3}$$

where $K = 0.375$ SI

S is the longitudinal slope, ft/ft (m/m)
S_x is the cross slope, ft/ft (m/m)
T is the flow spread, ft (m)
Q is the rate of discharge, cfs (m^3/s)



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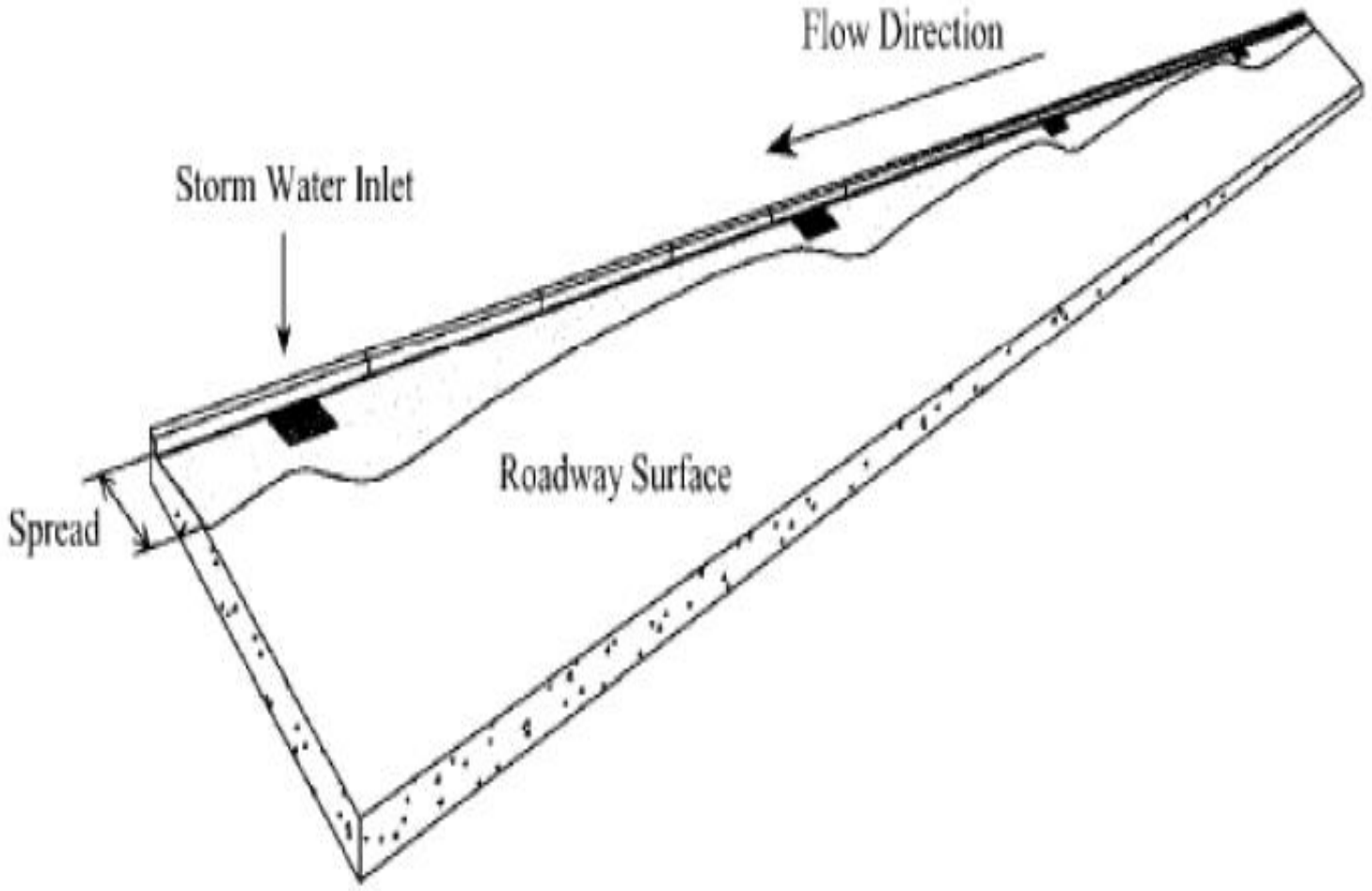


FIGURE 5.1 Spatial variation of spread.


Cross slope


Longitudinal slope

Gutter Flow

- Expressing Q in terms of the depth of flow at the curb:

$$Q = \left(\frac{K}{n}\right)\left(\frac{S^{1/2}}{S_x}\right)d^{8/3}$$

where d = is the flow depth in (m) $d = TS_x$

Type of gutter or pavement	Manning *n*
Concrete gutter, troweled finish	0.012
Asphalt pavement	
Smooth texture	0.013
Rough texture	0.016
Concrete gutter with asphalt pavement	
Smooth	0.013
Rough	0.015
Concrete pavement	
Float finish	0.014
Broom finish	0.016

Sheet Flow



Ponding



Example

- Evaluate the spread and depth at the curb for a triangular gutter section carrying a design discharge of 0.09 m3/s and having a uniform cross slope of 0.022 m/m, Manning's roughness of 0.015, and longitudinal slope of 0.014 m/m.

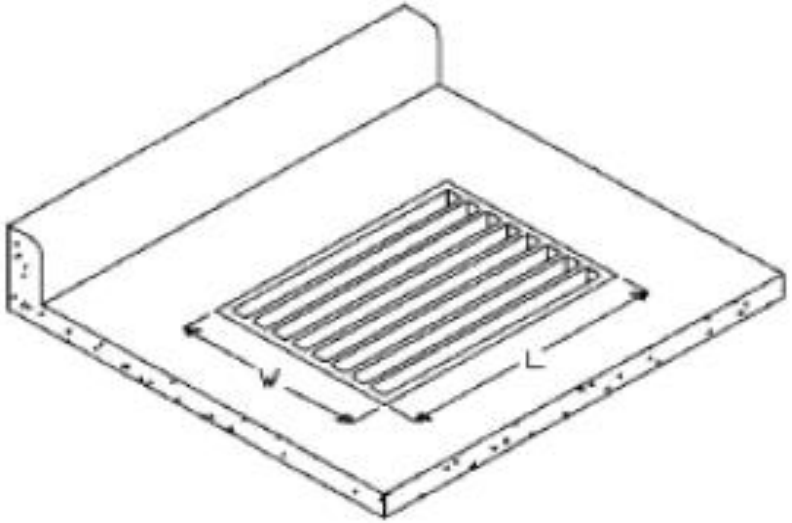
Solution

$$T = \left(\frac{Qn}{K_c S_x^{5/3} S_L^{1/2}}\right)^{3/8} = \left[\frac{(0.09)(0.015)}{(0.376)(0.022)^{5/3}(0.014)^{1/2}}\right]^{3/8} = 2.9 \text{ m}$$

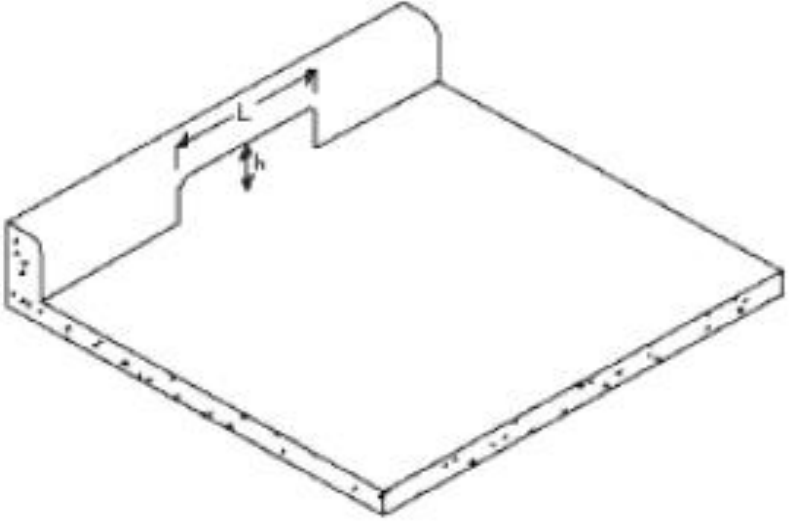
$$d = TS_x = (2.9)(0.022) = 0.064 \text{ m}$$

TYPES OF INLETS

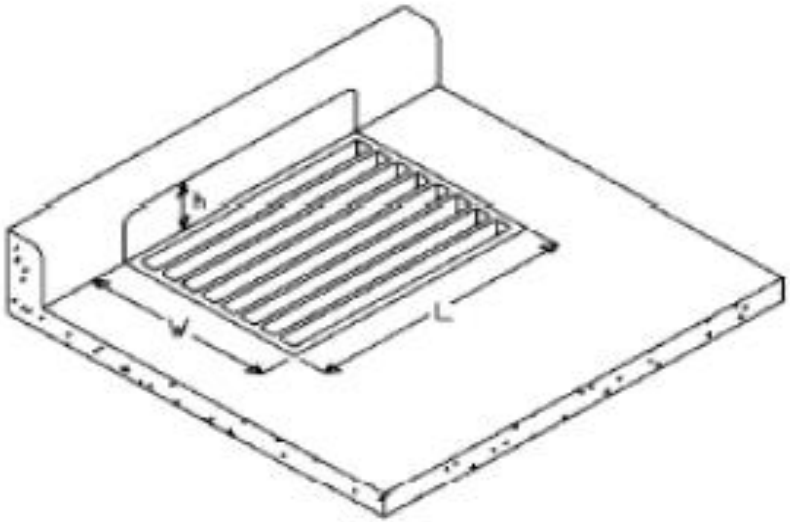
- There are four commonly used type of inlets
  - Grate inlet,
  - Curb opening inlet,
  - Combination inlet, and
  - Slotted drain inlet
- Inadequate inlet capacity or poorly located inlets can cause hazardous roadway flooding.
- The responsibility of the designer is to determine the **type**, **size**, and **spacing** of inlets to intercept a sufficient portion of the design gutter flow, while preserving attention to costs.
- In addition, the designer should ensure that inlets do not project significantly above a pavement surface or pose as an **obstacle** to oncoming traffic.



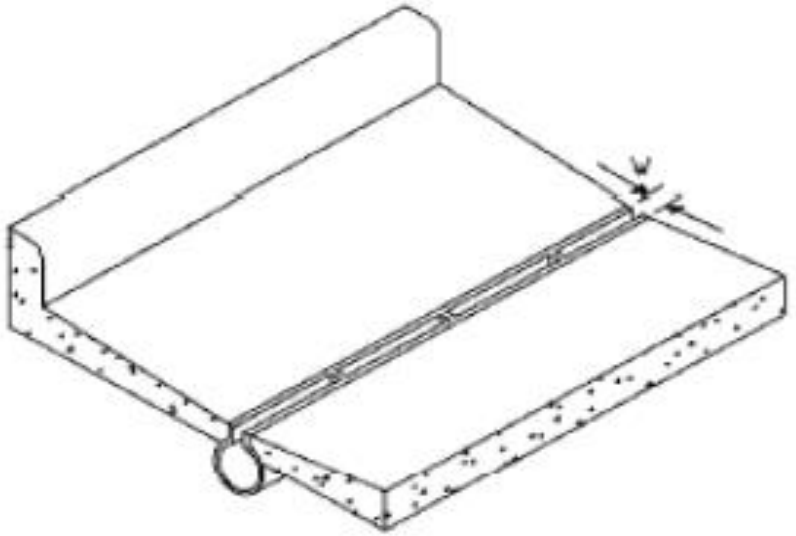
a. Grate



b. Curb-Opening



c. Combination



d. Slotted Drain



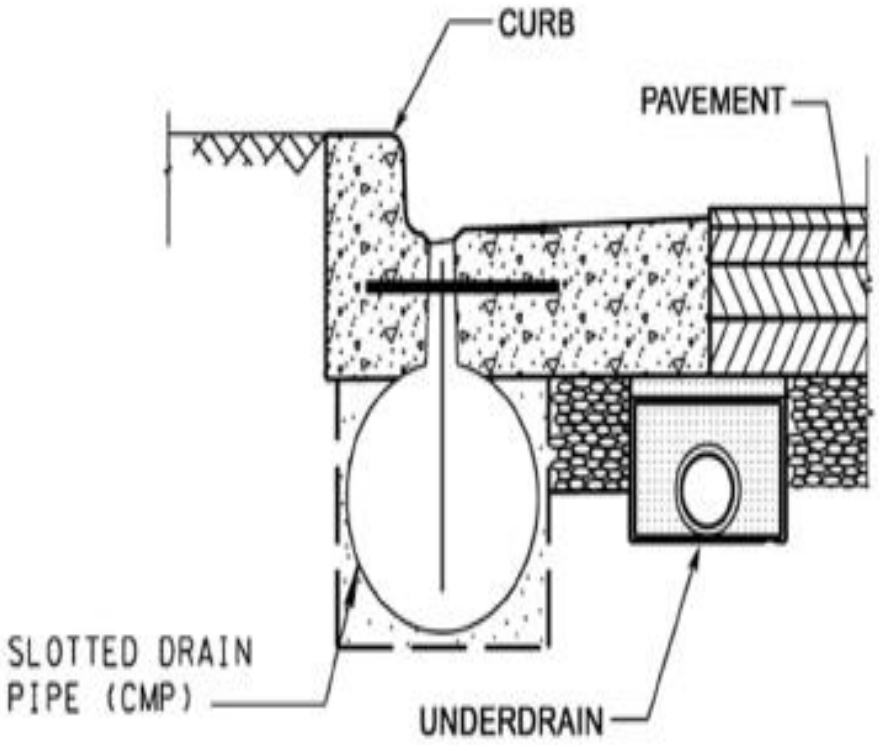

Curb Inlet



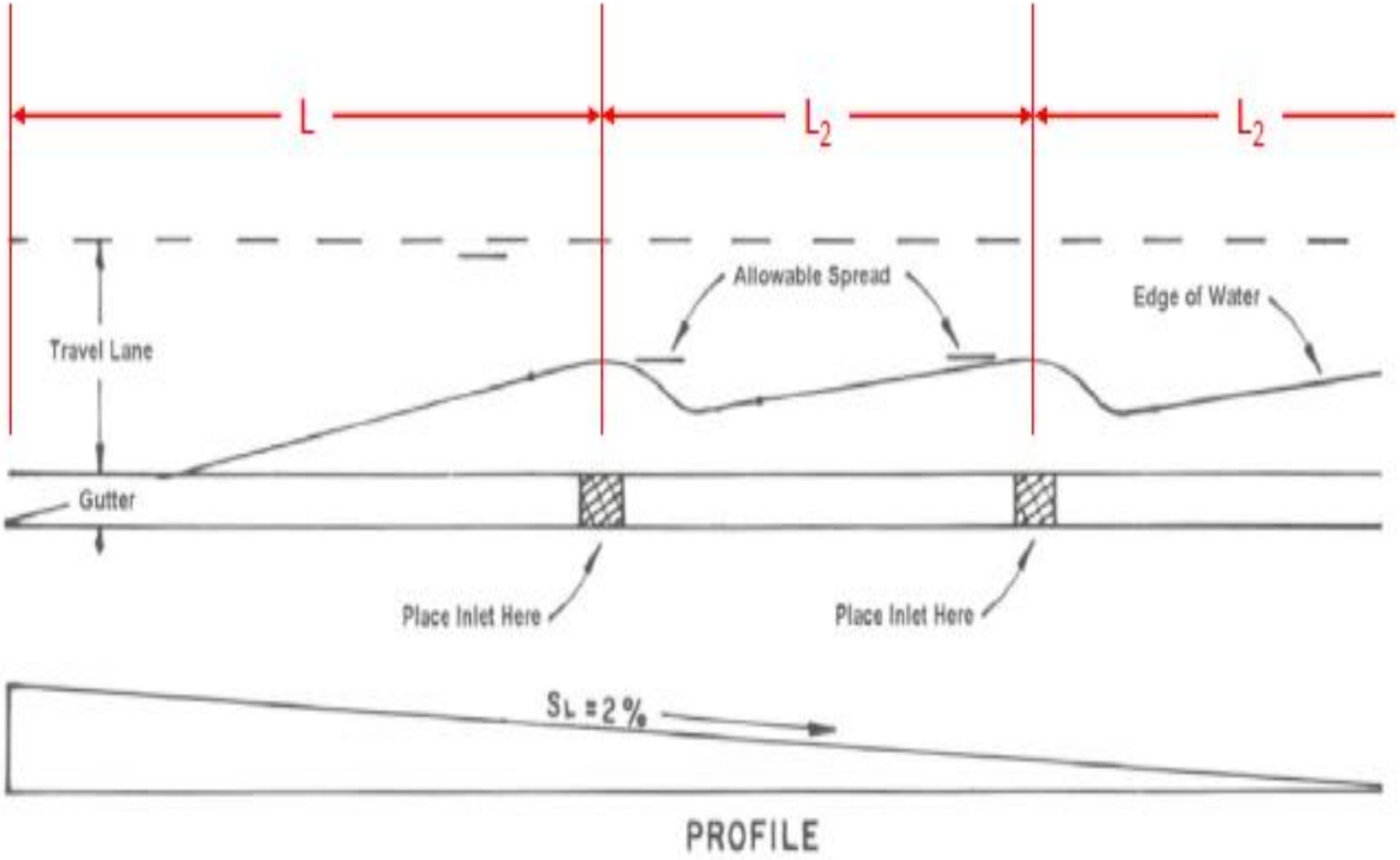







CURB
PAVEMENT
SLOTTED DRAIN
PIPE (CMP)
UNDERDRAIN

Inlet Spacing



Inlet Spacing Formula

$$L = \frac{10,000\,Q_t}{0.0028\,C\,i\,W}$$

L = distance of **first** inlet from crest (m)

Q_t = maximum allowable gutter flow (m^3/s)

C = composite runoff coefficient for drainage area

i = rainfall intensity (mm/hr)

W = width of contributing drainage area (m)

Inlet Spacing Formula

$$L_2 = \frac{10{,}000\, Q_t E_o}{0.0028\, C\, i\, W}$$

L_2 = distance to **subsequent** inlets (m)

Q_t = maximum allowable flow (m^3/s)

E_o = capture efficiency

C = composite runoff coefficient for drainage area

i = rainfall intensity (mm/hr)

W = width of contributing drainage area (m)