

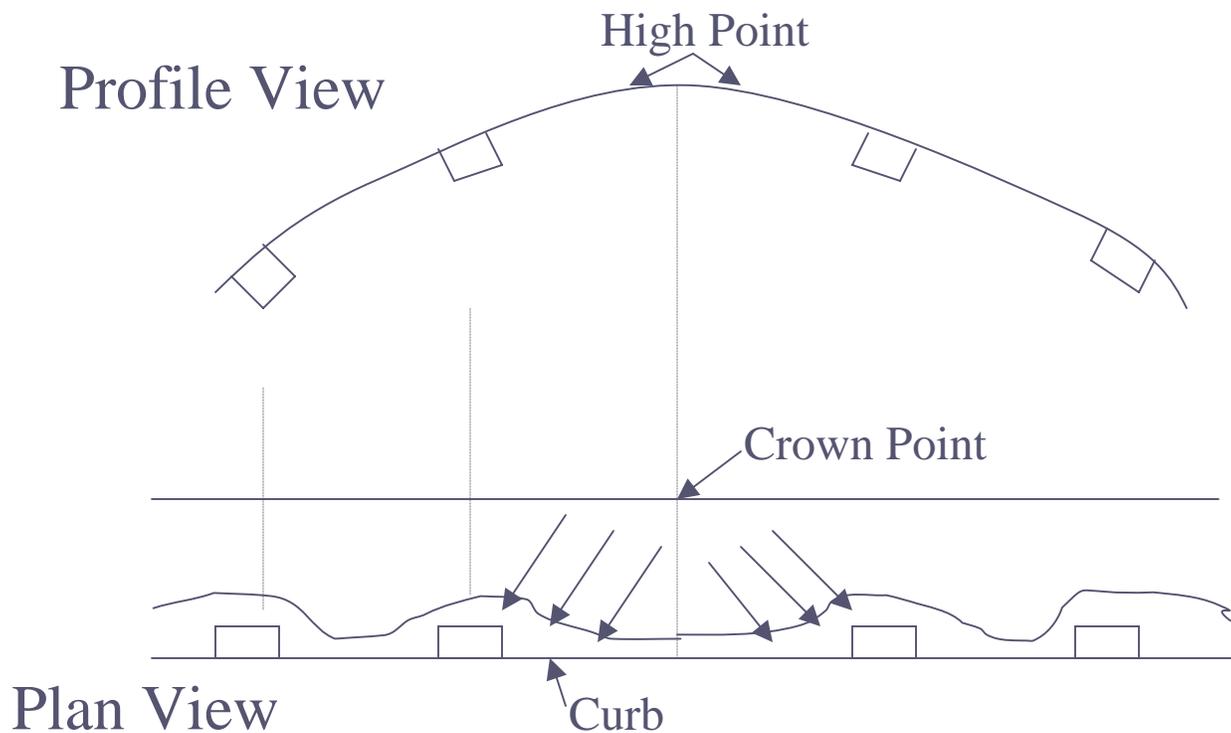
Section 6

Roadway Geometrics and Pavement Drainage

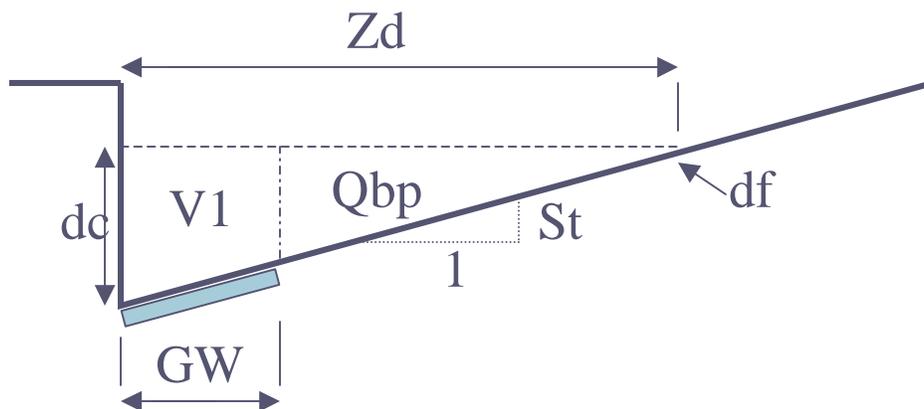


Pavement Drainage

- Pavement Drainage requires consideration of surface drainage, gutter flow and inlet capacity. The design of these elements is dependent on storm frequency and the allowable spread of storm water on the pavement surface.



Pavement Drainage Equations



Where: Z_d = the top width of the flow prism (ft)
 d_c = the depth of flow at face of curb (ft)
 $V1$ = the velocity over the inlet (fps)
 Q_{bp} = portion of flow outside width of the inlet (cfs)
 GW = gross width of grate inlet perpendicular to flow (ft)
 St = transverse slope or superelevation (ft/ft)
 df = depth flow at fog line (ft)
 Q = 10yr flow using rational formula

$$Z_d = d/St \quad Q_{bp} = Q ([Z_d - GW]/Z_d)^{8/3}$$

$$V1 = (Q - Q_{bp}) / (GW [d - 0.5 * GW * St])$$

Over 5fps skipping will occur at inlet

Pavement Drainage Equations

- Depth of Flow equation was derived from Manning's using shallow wide flow.

$$Q = \frac{1.49}{n} AR^{2/3} S_L^{1/2}$$

$$R = \frac{d(Zd)0.5}{Zd} = 0.5d$$

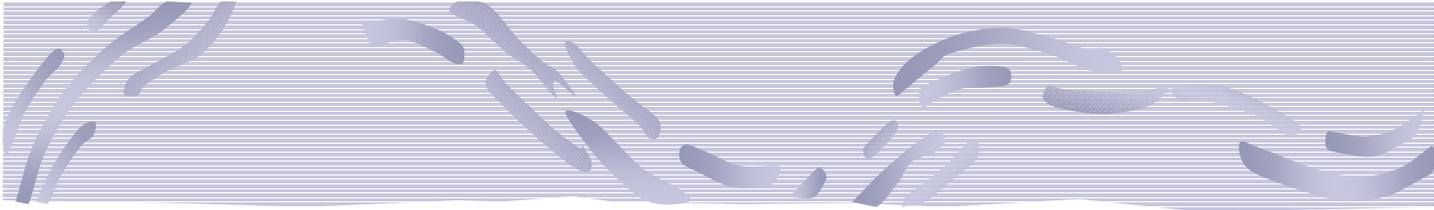
$$A = d(Zd)0.5$$

$$Q = \frac{1.49}{n} d(Zd)0.5(0.5d)^{2/3} S_L^{1/2}$$

$$K = \frac{1.49}{0.015} 0.5 * 0.63 = 31.3$$

$$Q = 37 \frac{d^{8/3}}{S_t} S_L^{1/2} \quad Zd = \frac{d}{S_t}$$

$$dc^{8/3} = \frac{Q * S_t}{37 S_L^{1/2}}$$

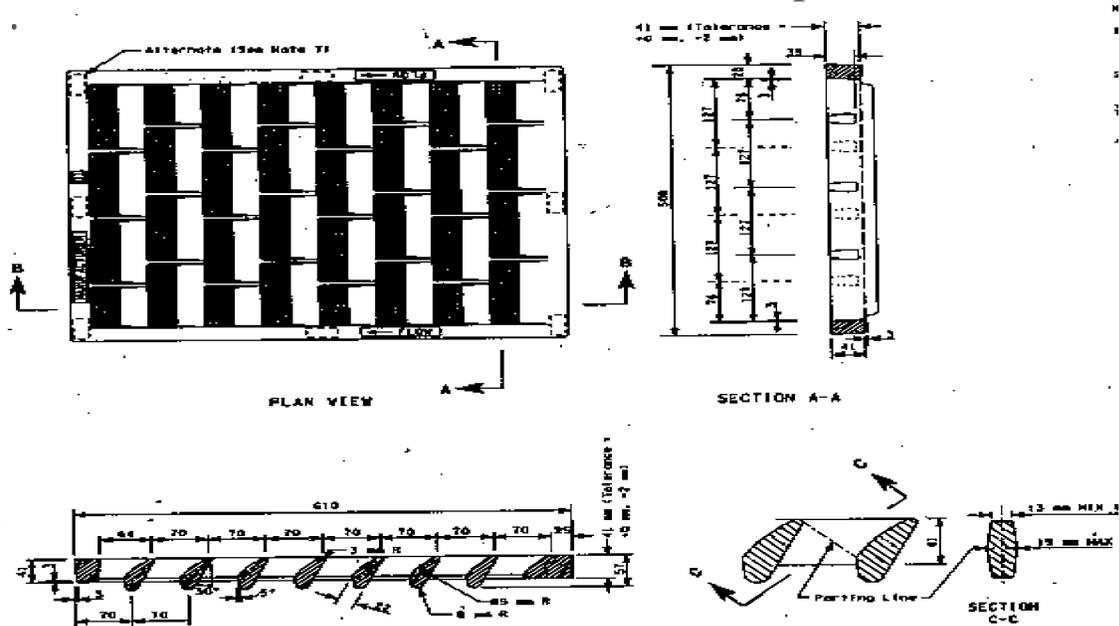


Guidelines to check Pavement Drainage

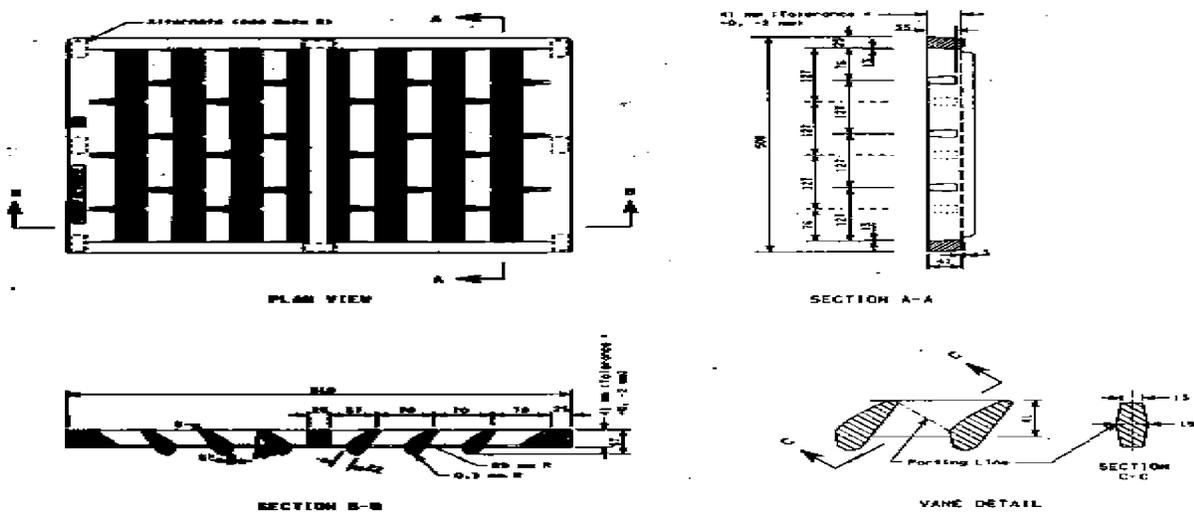
- ☛ Allowable depth along travel path/fog line
 $df = 0.12\text{ft}$ or 37mm
- ☛ Allowable width of water
 $Z_d = \text{shoulder} + \frac{1}{2} \text{ lane}$ for Non Interstate
 $Z_d = \text{shoulder}$ for Interstate
- ☛ Allowable flow bypass from last catch basin
 $Q_{bp} = 0.1\text{cfs}$ or 0.003cms
- ☛ Use rational formula, 10yr for continuous grade
and 50yr for sag/depressed roadway
- ☛ Use T_c of 5 minutes unless longer longer flow path
- ☛ Spacing of inlets: $300\text{ft} < 48''$ storm drain
 $500\text{ft} > 48''$ storm drain

Grate Examples

Vane Grate for Catch Basin and Inlet- plan B-2b

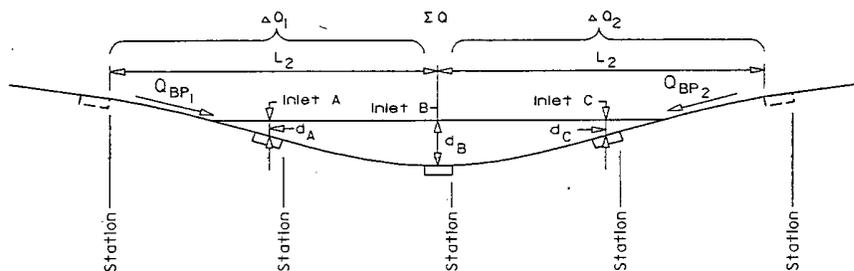


Bi-directional Vane Grate for Catch Basin and Inlet- plan B-2c



Sag Equations

STANDARD FORMAT FOR INLET DESIGN IN SAG LOCATIONS



Profile of Sag Inlets

Transverse Slope	$S_T =$	ft/ft	
Allowable	$Z_d =$	ft	
Allowable	$d_B =$	ft	($d_A = d_C = 0.5d_B$ allowable)
Rainfall	150-yr	in/hr	(for 5 minute duration)
Effective Perimeter of Inlets (P)	$\left\{ \begin{array}{l} P_A = \\ P_B = \\ P_C = \end{array} \right.$	ft	Reduce by 50 percent for plugging.
		ft	
		ft	
Distance between grade inlet & next lower inlet	$L_1 =$	ft	$L_2 =$ ft
Width of catchment area	$W_1 =$	ft	$W_2 =$ ft
	$\Delta Q_1 =$	cfs	$\Delta Q_2 =$ cfs

$$\Sigma Q = Q_{BP1} + \Delta Q_1 + Q_{BP2} + \Delta Q_2$$

$$\Sigma Q = () + () + () + () = \text{cfs}$$

This total flow must be intercepted by the three inlets.

$$\Sigma Q = Q_A + Q_B + Q_C$$

$$\Sigma Q = C_w P (1.707) d_B^{1.5} \text{ (when all inlets are the same size)}$$

$$d_B = \left[\frac{\Sigma Q}{C_w P 1.707} \right]^{2/3}$$

If $d_B <$ allowable d_B , the design is complete.

If $d_B >$ allowable d_B , additional inlets must be added and the process repeated.

6-4

Properties of Grate Inlets

Standard Plan	Description	*Continuous Grade Grate Width GW	** Sump Condition	
			Width	Length
B-2a***	Metal Frame and Grate for Catch Basins and Inlet (Herringbone Pattern)	0.50m (1.67ft)	0.21m (0.69ft)	0.24m (0.78ft)
B-2b	Vane Grate for Catch Basin and Inlet	0.50m (1.67ft)	0.40m (1.31ft)	0.38m (1.25ft)
B-4c	Grate Inlet Type 1 (Grate A or B****)	0.62m (2.05ft)	0.50m (1.67ft)	1.07m (3.52ft)
B-4ca	Grate Inlet Type 2	0.62m (2.05ft)	0.50m (1.67ft)	1.07m (3.52ft)

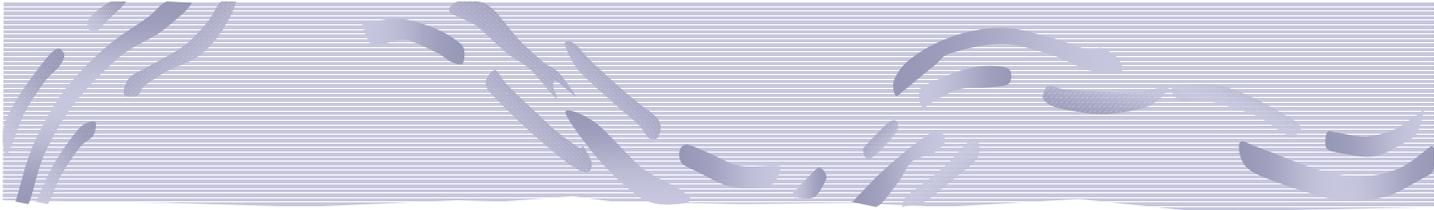
Figure 5-5
Properties of Grate Inlet

*Inlet widths on a continuous grade are not reduced for bar areas or for debris accumulation.

**The perimeter and areas in this portion of the table have been already reduced for bar area. These values should be cut in half when used in a sag location as described in Section 5-5.2

*** Shown for informational purpose only. See Section 5-5.1

****Type B grate is not to be used in areas of pedestrian or vehicular traffic.



Slotted Drains and Trench Systems

- Placed in areas of minimal tangential/longitudinal slope and superelevation.
- Limiting factor of trench drain incapable handling flows over 5cfs.
- Must contact Region or HQ Hydraulics for assistance in design.

