How Does MiTS Calculate Maximum Water Depth in Drain?

Drain · https://mes100.com/docs/how-does-mits-calculate-maximum-water-depth-in-drain/

A steady uniform-flow depth check

This benchmark calculates normal depth for a rectangular drain at the stated peak discharge. We assume steady uniform flow, so Manning's friction slope equals the bed slope. Under that assumption, increasing discharge raises the calculated depth. In backwater or unsteady flow, the maximum water depth also depends on the downstream level and stored water, and it can occur at a different time from peak discharge. The channel-flow and backwater derivation shows the distinction.

Manning's equation

For discharge Q , flow area A , mean speed V , wetted perimeter P and hydraulic radius R=A/P , we use

$$Q=AV=1nAR2/3S0.Q=AV=\frac{1}{n}AR^{2/3}\sqrt{S_0}.$$

(1)

Here n is Manning's roughness coefficient in SI units and S_0 is the dimensionless bed slope. For this uniform-flow check, $S_f=S_0$, where S_f is friction slope. Discharge is in m^3/s, area m^2, lengths m and speed m/s.

Box Drain, RC

Project File

The example used was the Drain 1

Input (dr) Key Plan (dr) Excel Report (dr) Textual Report

Catchment Mark	Drain Mark	Up Sump	Drain Type (Width)	Drain Size (mm)	Drain Volume (m^3)	Gradient	tc, min	Velocity (m/s)	Effective Catchment (ha)	Cum. Effective Catchment (ha)	Intensity, I (mm/hr)	Peak Flow (m^3/s)	Max. Water Depth (m)
-	-	-	(-)	-	-	-	0.00	-	-	-	-	-	-
C1	1	1	BOXD(750)	FB = 50, W = 750, h = 450	30.00	1/172.95	37.83	1.957	2.162	2.162	97.78	0.587	0.400
	2	2	BOXD(600)	FB = 50, W = 600, h = 450	24.00	1/99.73	39.50	2.377	0.000	2.162	95.01	0.570	0.400
	3	3	BOXD(600)	FB = 50, W = 600, h = 450	19.95	1/104.46	40.88	2.323	0.000	2.162	92.83	0.557	0.400
	4	4	BOXD(600)	FB = 50, W = 600, h = 450	24.00	1/110.25	42.55	2.261	0.000	2.162	90.36	0.543	0.400
	5	5	BOXD(600)	FB = 50, W = 600, h = 450	2.96	1/110.98	42.76	2.253	0.000	2.162	90.06	0.541	0.400

Drain Mark [1]

From Node	1
To Node	2
Drain Type	Box
Drain Dimension	FB = 50, W = 750, H = 450
Drain Length	100.000m
Cross-sectional area of flow (A)	$0.300m^2$
Wetted Perimeter	1.550m
Hydraulic Radius	0.194m

Reference	Calculation	Output
Manning coefficient, n	For composite manning coefficient, it can be calculated from its parts by $\Sigma P_i n_i/(\Sigma P_i)$ Where P_i is the Perimeter for the i-side Where n_i is the Manning coefficient for the i-side Thus, composite manning coefficient =0.0130	n =0.0130
Gradient	Friction Slope of Drainage = 1/173 Frictional slope of Drainage is satisfactory	1 / 173

From the Excel & textual report,

Peak flow, Q = 0.587 m3/s

n = 0.013

Width = 0.75m

S = 1/173

We check the reported depth of 0.400 m using the stated inputs. With drain width 0.75 m and water depth y , the area is A=0.75y and the wetted perimeter is P=0.75+2y . Substituting into Equation (1) gives

0.587=0.75y0.013(0.75y0.75+2y)2/31173.

0.587=\frac{0.75y}{0.013}\left(\frac{0.75y}{0.75+2y}\right)^{2/3}\sqrt{\frac{1}{173}}.

(2)

Solving this equation numerically gives $y=0.399970\;\text{m}$, which rounds to the reported 0.400 m. This is the normal-depth result for the selected discharge and slope. A downstream-controlled water level requires a profile calculation with that boundary condition.

Related



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I’m the Benevolent Dictator for Life for MiTS Software cum Editor of this website. Read more here.

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