Universiti Malaysia PAHANG

HYDRAULICS

UNIFORM FLOW IN OPEN CHANNEL
TOPIC 2.2

by

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UNIFORM FLOW IN OPEN CHANNEL

2.2

- Determination of normal depth by various methods

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2.2 DETERMINATION OF NORMAL DEPTH BY VARIOUS METHODS

Three methods available

1. Trial and Error Solution
2. Graphical Solution
3. General Design Chart
4. Numerical Method

2.2.1 Trial And Error Solution

EXAMPLE 2.3:

Given a trapezoidal channel with bottom width of 3m, side slope of 1(V):1.5(H), a longitudinal slope of 0.0016 and a resistance coefficient of n=0.013, determine the normal depth of if the discharge is 71m^3/s using trial and error method.

Trial And Error Solution

$AR^{2/3} = 23.075$

Trial y	A=(3+1.5y)y	P=3+3.6y	R=A/P	$AR^{2/3}$
2.000	12.000	10.200	1.176	13.373
2.500	16.875	12.000	1.406	21.181
2.600	17.940	12.360	1.451	22.998
2.605	17.994	12.378	1.454	23.091
2.604	17.983	12.374	1.453	23.073

2.2.2 Graphical Solution

EXAMPLE 2.4:

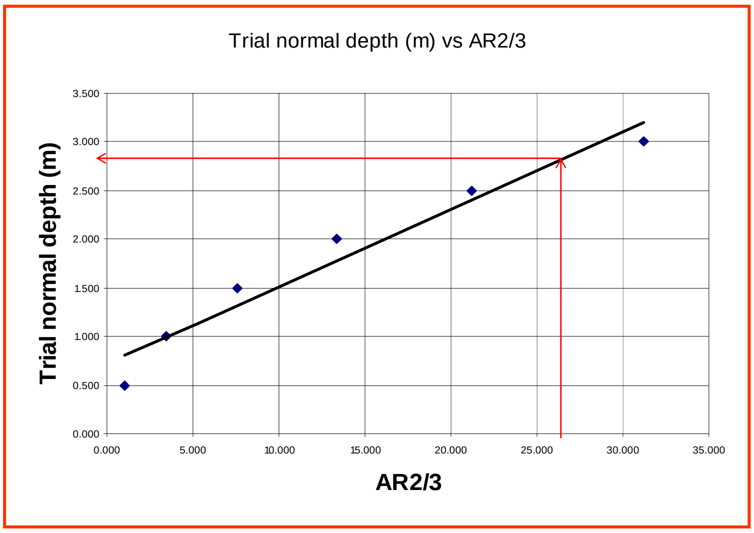
Given a trapezoidal channel with bottom width of 3m, side slope of 1(V):1.5(H), a longitudinal slope of 0.0016 and a resistance coefficient of n=0.013, determine the normal depth of if the discharge is $71 m^3/s$ using graphical method.

Graphical Solution

For graphical solution, plot a graph the depth of flow (normal depth) versus section factor ($AR^{2/3}$) and try to get a straight line.

$AR^{2/3} = 23.075$

Trial y	A=(3+1.5y)y	P=3+3.6y	R=A/P	$AR^{2/3}$
0.500	1.875	4.800	0.391	1.002
1.000	4.500	6.600	0.682	3.486
1.500	7.875	8.400	0.938	7.543
2.000	12.000	10.200	1.176	13.373
2.500	16.875	12.000	1.406	21.181
3.000	22.500	13.800	1.630	31.169



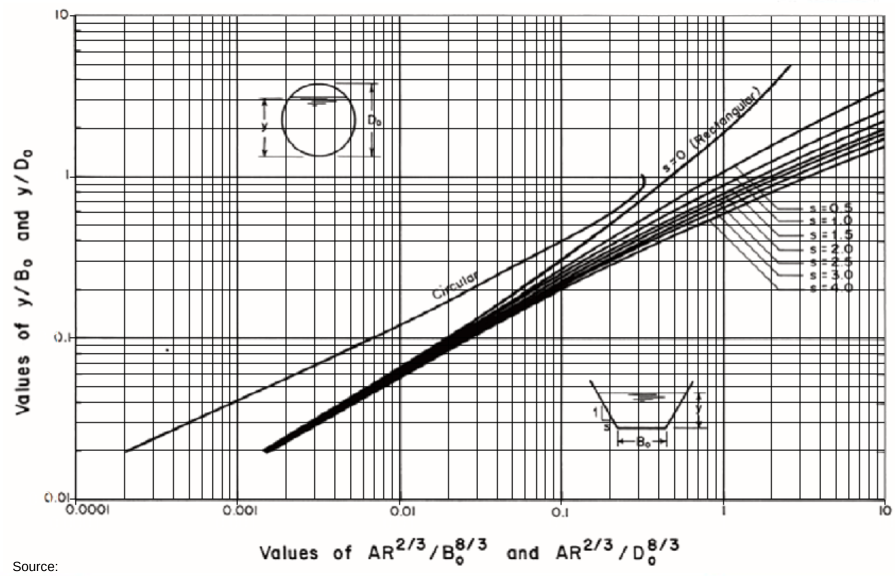
2.2.3 General Design Chart

In order to simplify the computation of the normal depth for common channel shapes, dimensionless curves for the section factor as a function of the depth have been prepared for rectangular, circular and trapezoidal.

Although these curves provide solutions to the problem of normal depth computation for these channel shapes in a manner similar to that used in problem that they do not provide a general method of solution.

EXAMPLE 2.5:

Given a circular culvert 0.91 m in diameter with S=0.0016 and n=0.015, find the normal depth of flow for a discharge of 0.42 m^3/s. (Use Design Chart)



Source:

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2.2.4 Numerical Method

If a computer is available and a large number of normal depth estimation problems must be solved, then a numerical trial and error produced may be the best approach.

A logical diagram for a numerical solution in the case of rectangular, trapezoidal, triangular, circular and natural channels is given.

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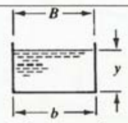
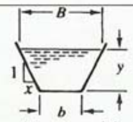
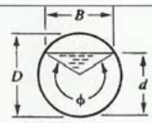
Table 2.3 Geometry of open channel section

	 Rectangle	 Trapezoid	 Circle
Area, A	by	$(b + xy)y$	$\frac{1}{8}(\phi - \sin\phi)D^2$
Wetted perimeter, P	$B + 2y$	$b + 2y\sqrt{1+x^2}$	$\frac{1}{2}\phi D$
Top width, B	b	$b + 2xy$	$\left(\sin\frac{\phi}{2}\right)D$
Hydraulic Radius, R	$\frac{by}{b+2y}$	$\frac{(b+xy)y}{b+2y\sqrt{1+x^2}}$	$\frac{1}{4}\left(1 - \frac{\sin\phi}{\phi}\right)D$
Hydraulic Mean depth, D_m	y	$\frac{(b+xy)y}{b+2xy}$	$\frac{1}{8}\left(\frac{\phi - \sin\phi}{\sin(1/2\phi)}\right)D$

EXAMPLE 2.6:

Develop a spreadsheet or a program for computing the geometry features for each section shown in Table 2.3. Include the area, wetted perimeter and hydraulic radius.

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