# Manning's Equation and Watercourse Design Formulas

**Manning Equation**

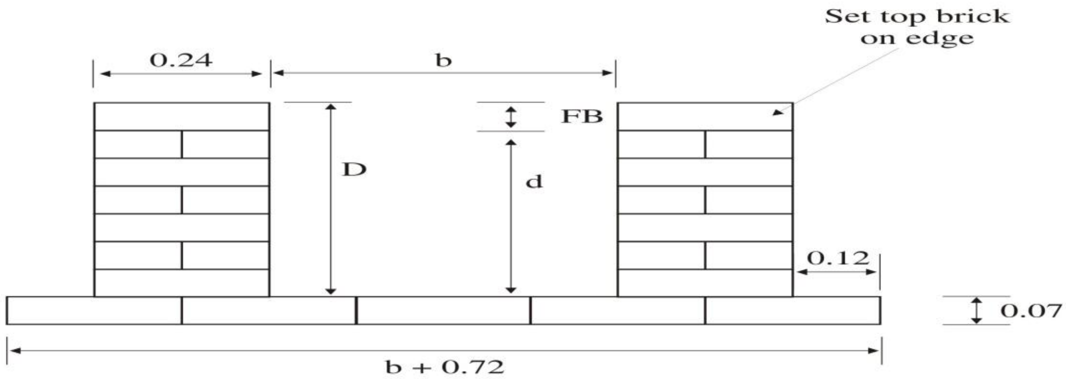
$V = (1/n) * R^{2/3} * S^{1/2}$
$A = Q/V$
$P = A/R$

Where
Q = Discharge, L/s
V = Average Flow Velocity, m/s
n = Manning's Coefficient, Constant
R = Hydraulic Radius, m = A/P
P = Wetted Perimeter, m
S = Longitudinal Slope or Energy Gradient, m/m

## 1. Flow Area and Wetted Perimeter of Rectangular X-section

A = b d
P = b + 2d
b = $(P+(P^2-8A)^{1/2})/2$
d = A/b

b = Flow bottom width, m
d = Flow depth, m
Optimum X-Section: b = 2 d

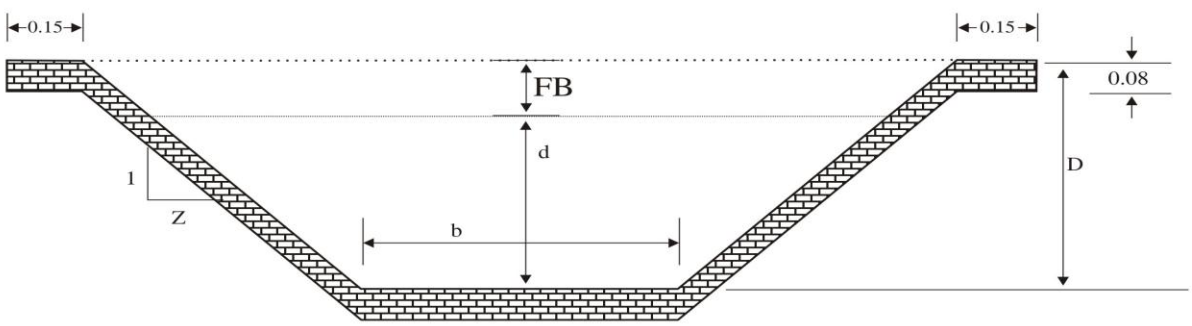


Rectangular Double Brick Lined Section

## 2. Flow Area and Wetted Perimeter of Trapezoidal X-section (Sharp Corners)

A = $b\,d + d^2 Z$
P = $b + 2\,d\,(Z^2 + 1)^{1/2}$
d = $(P-(P^2-4A(2X-Z))^{½})/(2(2X-Z))$
b = $(A-Z\,d^2)/d$

Z = Side Slope
X = $(Z^2 + 1)^{1/2}$
Optimum X-Section: b = $2\,d\,((Z^2 + 1)^{1/2}-Z)$

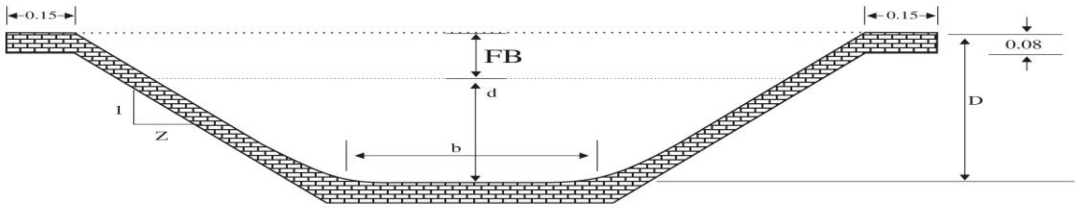


Trapezoidal Concrete Lined (Sharp Corners)

## 3. Flow Area and Wetted Perimeter of Trapezoidal X-section (Round Corners)

| | |
|---|---|
| A | $= b\,d + d^2\,\theta + d^2 \cot\theta$ |
| | $= b\,d + d^2\,(\theta + \cot\theta)$ |
| P | $= b + 2\,d\theta + 2d\cot\theta$ |
| | $= b+2\,d\,(\theta + \cot\theta)$ |
| d | $= (P-(P^2-4AX)^{½})/(2X)$ |
| b | $= (A-X\,d^2)/d$ |

Z = Side Slope
= $\cot\theta$
X = $(\theta + \cot\theta)$

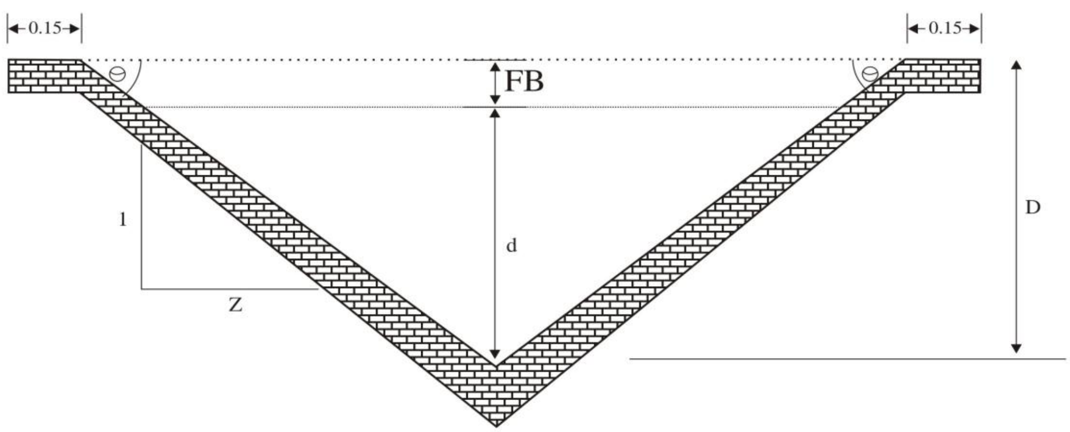



Trapezoidal Concrete Lined (Round Corners)

**4 Flow Area and Wetted Perimeter of Triangular X-section (Sharp Corner)**

| | |
|---|---|
| A | $= d^2\,Z$ |
| P | $= 2\,d\,(Z^2+1)^{1/2}$ |
| d | $= 2\,R\,X/Z$ |

Z = Side Slope
X = $(Z^2+1)^{1/2}$
R = A/P

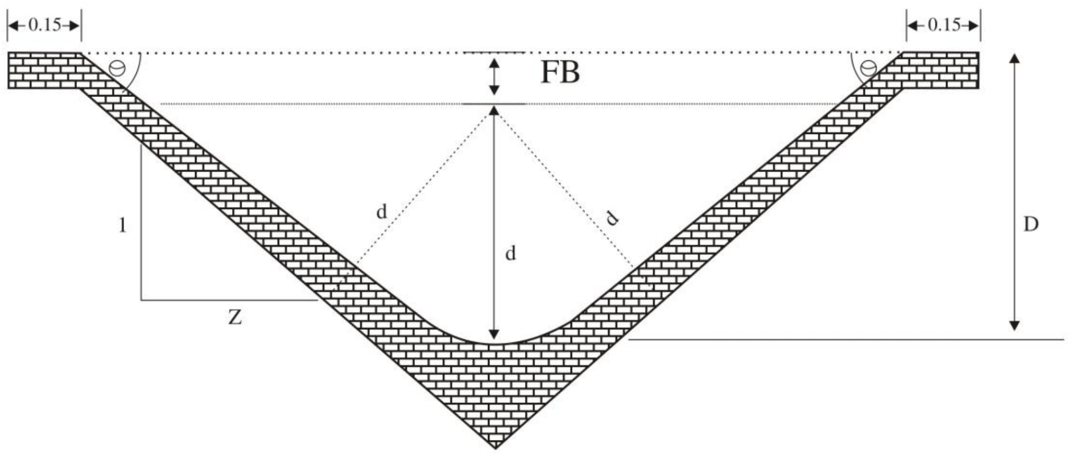



Triangular Concrete Lined Section (Sharp Corner)

## 5. Flow Area and Wetted Perimeter of Triangular X-section (Round Corner)

A $= d^2 \theta + d^2 \cot \theta$
$= d^2 (\theta + \cot \theta)$
P $= 2 d\theta + 2d \cot \theta$
$= 2 d (\theta + \cot \theta)$
d $= 2 R$

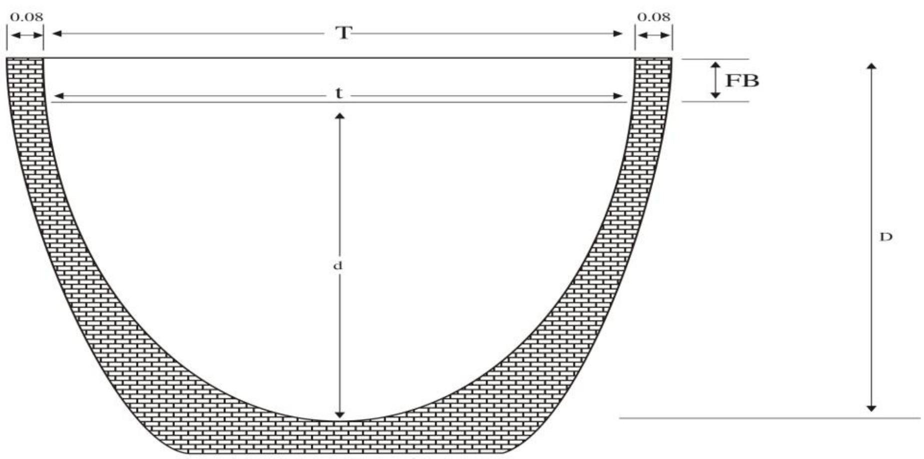
| |
|---|
| $\cot \theta = Z$ <br> $= \text{Side Slope}$ <br> $X = (\theta + \cot \theta)$ <br> $R = A/P$ |




Triangular Concrete Lined Section (Round Corner)

## 6 Flow Area and Wetted Perimeter of Parabolic X-section

A = 2/3*t*d
P = ((t/2*((((1+(4*d)^2)^0.5) + ((t/(4*d)*ln((4*d/t)+(1+((4*d/t)^2)^0.5)))/1000

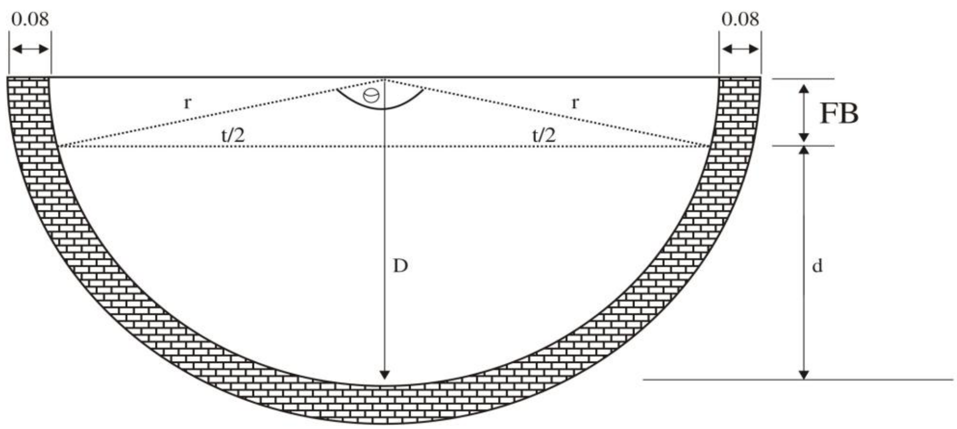



Precast Parabolic Concrete Lined Section

## 7 Flow Area and Wetted Perimeter of Semi-Circular X-section

A $= r^2 \theta/2 - (r-d) * t$
P $= r \theta$

| |
|---|
| $\cos \theta/2 = (r-d)/r$ |
| r = Pipe radius, m |
| t = Top flow width, m |
| $= 2 r \sin \theta/2$ |




Precast Semi Circular Concrete Lined Section