

iemisc: Comparing Other Hydraulic Software Output to iemisc's Manningtrap for Critical Conditions

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2023-05-02

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Replicate the R code without the images

Note: If you wish to replicate the R code below, then you will need to copy and paste the following commands in R first (to make sure you have all the of the required packages):

```
install.packages(c("install.load", "iemisc", "pander"))  
# install the packages and their dependencies
```

```
# load the required package  
install.load::load_package("iemisc", "pander")
```

FHWA Hydraulic Toolbox Example 1

Channel Analysis

Type: Trapezoidal Define...

Side slope 1 (Z1): 3.0 H : 1V
Side slope 2 (Z2): 3.0 H : 1V
Channel width (B): 4.0 (ft)
Pipe diameter (D): 0.0 (ft)
Longitudinal slope: 0.02 (ft/ft)

☐ Override default
Manning's roughness: 0.0550
☐ Use lining
Lining type: Woven Paper Net

☐ Enter flow: 44.001 (cfs)

☒ Enter depth: 1.454 (ft)

Calculate

Plot...

Compute Curves...

OK

Cancel

Parameter	Value	Unit
Flow	44.001	cfs
Depth	1.454	ft
Area of Flow	12.161	sq ft
Wetted Perimeter	13.197	ft
Hydraulic Radius	0.921	ft
Average Velocity	3.618	fps
Top Width (T)	12.725	ft
Froude Number	0.652	
Critical Depth	1.163	ft
Critical Velocity	5.052	fps
Critical Slope	0.04979	ft/ft
Critical Top Width	10.978	ft
Max Shear Stress	1.815	lb/ft ²
Avg Shear Stress	1.150	lb/ft ²

Dr. Xing Fang's Open Channel Flow Calculator's Solution of Example 1

The open channel flow calculator

Select Channel Type: Trapezoid

Velocity(V)&Discharge(Q) Feet(ft)

Channel slope: 0.02 ft/ft	Water depth(y): 1.454 ft	Bottom width(b): 4.0 ft
Flow velocity: 3.6179 ft/s	LeftSlope (Z1): 3.0 to 1 (H:V)	RightSlope (Z2): 3.0 to 1 (H:V)
Flow discharge: 43.9882 ft^3/s	Input n value: 0.0550 or select r	
Calculate!	Status: Calculation finished	Reset
Wetted perimeter: 13.2 ft	Flow area: 12.16 ft^2	Top width(T): 12.72 ft
Specific energy: 1.66 ft	Froude number: 0.65	Flow status: Subcritical flow
Critical depth: 1.17 ft	Critical slope: 0.0492 ft/ft	Velocity head: 0.2 ft

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iemisc's Manningtrap Solution of Example 1

```
uuc1 <- Manningtrap_critical(y = 1.454, b = 4, m = 3, Sf = 0.02, n = 0.055, units = "Eng",
  type = "symmetrical", critical = "accurate", output = "data.table")
```

```
##
```

```
## Flow IS in the rough turbulent zone so the Gauckler-Manning-Strickler equation
## is acceptable to use.
```

```
##
```

```
##
```

```
## This is subcritical flow.
```

```
pander(uuc1, missing = "")
```

Parameters	Normal Value	Critical Value
Flow depth (y)	1.454	1.551
Flow area (A)	12.158	13.417
Wetted Perimeters (P)	13.196	13.808
Top Width (B)	12.724	13.304

Parameters	Normal Value	Critical Value
Bottom width (b)	4	
Hydraulic Radius (R)	0.921	0.972
Hydraulic Depth (D)	0.956	1.008
Flow Mean Velocity (V)	3.618	7.064
Flow Discharge (Q)	43.986	67.414
Manning's roughness coefficient (n)	0.055	
Slope (Sf)	0.02	0.015
Temperature	68	
Absolute Temperature	293.15	
Saturated Liquid Density	1.937	
Absolute or Dynamic Viscosity	2.092885e-05	
Kinematic Viscosity	1.080619e-05	
Froude number (Fr)	0.652	1
Reynolds number (Re)	308461	
symmetric side slope (m)	3	
non-symmetric side slope (m1)		
non-symmetric side slope (m2)		
Wetted Length (w)	4.598	
Wetted Length for a non-symmetric trapezoid (w1)		
Wetted Length for a non-symmetric trapezoid (w2)		
Section Factor (Z)	11.512	11.885
conveyance (K)	311.026	
Specific Energy (E)	1.657	1.718
Velocity Head (Vel_Head)	0.203	
Maximum Shear Stress (taud)	1.812	
Average Shear Stress (tau0)	1.148	

Units
ft
ft ²
ft
ft
ft
ft
ft
ft/sec (fps)
ft ³ /sec (cfs)
dimensionless
ft/ft
degrees Fahrenheit
Kelvin
slug/ft ³
slug/ft*s
ft ² /s
dimensionless
dimensionless
ft/ft
ft/ft
ft/ft

Units
ft
ft
ft
ft
ft ³ /sec (cfs)
ft
ft
lb/ft ²
lb/ft ²

FHWA Hydraulic Toolbox Example 2

Channel Analysis

Type: Trapezoidal Define...

Side slope 1 (Z1): 2.0 H : 1V
Side slope 2 (Z2): 1.5 H : 1V
Channel width (B): 8.0 (ft)
Pipe diameter (D): 0.0 (ft)
Longitudinal slope: 0.01 (ft/ft)
☐ Override default
Manning's roughness: 0.0150
☐ Use lining
Lining type: Woven Paper Net

☒ Enter flow: 745.000 (cfs)
☐ Enter depth: 3.298 (ft)

Calculate

Plot...

Compute Curves...

OK

Cancel

Parameter	Value	Unit
Flow	745.000	cfs
Depth	3.298	ft
Area of Flow	45.419	sq ft
Wetted Perimeter	21.320	ft
Hydraulic Radius	2.130	ft
Average Velocity	16.403	fps
Top Width (T)	19.543	ft
Froude Number	1.896	
Critical Depth	4.639	ft
Critical Velocity	9.965	fps
Critical Slope	0.00257	ft/ft
Critical Top Width	24.235	ft
Max Shear Stress	2.058	lb/ft ²
Avg Shear Stress	1.329	lb/ft ²

Dr. Xing Fang's Open Channel Flow Calculator's Solution of Example 1

The open channel flow calculator

Select Channel Type: Trapezoid

Depth from Q: Select unit system: Feet(ft)

Channel slope: 0.01 ft/ft Water depth(y): 3.3 ft Bottom width(b): 8.0 ft

Flow velocity: 16.371 ft/s LeftSlope (Z1): 2.0 to 1 (H:V) RightSlope (Z2): 1.5 to 1 (H:V)

Flow discharge: 745 ft^3/s Input n value: 0.0150 or select r

Calculate! Status: Calculation finished Reset

Wetted perimeter: 21.34 ft Flow area: 45.51 ft^2 Top width(T): 19.56 ft

Specific energy: 7.46 ft Froude number: 1.89 Flow status: Supercritical flow

Critical depth: 4.64 ft Critical slope: 0.0026 ft/ft Velocity head: 4.16 ft

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iemisc's Manningtrap Solution of Example 2

```
uuc2 <- Manningtrap_critical(Q = 745, b = 8, m1 = 2, m2 = 1.5, Sf = 0.01, n = 0.015,
  units = "Eng", type = "non-symmetrical", critical = "accurate", output = "data.table")

##
## Flow IS in the rough turbulent zone so the Gauckler-Manning-Strickler equation
## is acceptable to use.
##
##
## This is supercritical flow.
pander(uuc2, missing = "")
```

Parameters	Normal Value	Critical Value
Flow depth (y)	3.298	6.442
Flow area (A)	45.423	74.086
Wetted Perimeters (P)	21.321	34.019
Top Width (B)	19.544	30.548

Parameters	Normal Value	Critical Value
Bottom width (b)	8	
Hydraulic Radius (R)	2.13	2.178
Hydraulic Depth (D)	2.324	2.425
Flow Mean Velocity (V)	16.401	14.397
Flow Discharge (Q)	745	392.789
Manning's roughness coefficient (n)	0.015	
Slope (Sf)	0.01	0.004
Temperature	68	
Absolute Temperature	293.15	
Saturated Liquid Density	1.937	
Absolute or Dynamic Viscosity	2.092885e-05	
Kinematic Viscosity	1.080619e-05	
Froude number (Fr)	1.897	1
Reynolds number (Re)	3233520	
symmetric side slope (m)		
non-symmetric side slope (m1)	2	
non-symmetric side slope (m2)	1.5	
Wetted Length (w)		
Wetted Length for a non-symmetric trapezoid (w1)	7.375	
Wetted Length for a non-symmetric trapezoid (w2)	5.946	
Section Factor (Z)	58.585	69.248
conveyance (K)	7449.995	
Specific Energy (E)	7.479	8.014
Velocity Head (Vel_Head)	4.181	
Maximum Shear Stress (taud)	2.055	
Average Shear Stress (tau0)	1.328	

Units
ft
ft ²
ft
ft
ft
ft
ft
ft/sec (fps)
ft ³ /sec (cfs)
dimensionless
ft/ft
degrees Fahrenheit
Kelvin
slug/ft ³
slug/ft*s
ft ² /s
dimensionless
dimensionless
ft/ft
ft/ft
ft/ft

Units
ft
ft
ft
ft
ft ³ /sec (cfs)
ft
ft
lb/ft ²
lb/ft ²

Works Cited

FHWA Hydraulic Toolbox Version 4.4. <https://www.fhwa.dot.gov/engineering/hydraulics/software/toolbox404.cfm>

The open channel flow calculator. Dr. Xing Fang, Department of Civil Engineering, Lamar University, 2000. <https://eng.auburn.edu/~xzf0001/Handbook/Channels.html>

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