Package: HYDROCAL (via r-universe)

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Title Hydraulic Roughness Calculator

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Description Estimates frictional constants for hydraulic analysis of rivers. This HYDRaulic ROughness CALculator (HYDROCAL) was previously developed as a spreadsheet tool and accompanying documentation by McKay and Fischenich (2011, <https://erdc-library.erdc.dren.mil/jspui/bitstream/11681/2034/1/CHETN-VII-11.pdf>).

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URL GitHub (<https://github.com/USACE-WRISES>)

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Depends R (>= 4.1.0)

NeedsCompilation no

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`mannings_to_darcy` *Convert Manning's n to Darcy-Weisbach f*

Description

`mannings_to_darcy` converts Manning's n to Darcy-Weisbach f

Usage

```
mannings_to_darcy(mannings, R, restrict = TRUE)
```

Arguments

`mannings`	Manning's n value
`R`	hydraulic radius, R in meters (m)
`restrict`	allows for function parameters to restrict certain values. Type boolean. Default TRUE.

Value

Darcy-Weisbach f

Examples

```
# Result: Darcy-Weisbach f of 0.0331
mannings_to_darcy(0.030, 10)
```

`n_bathurst1985` *Compute grain roughness via Bathurst (1985)*

Description

`n_bathurst1985` calculate Manning's n using the Bathurst (1985) method for estimating grain roughness

Usage

```
n_bathurst1985(depth, grain, restrict = TRUE)
```

Arguments

`depth`	flow depth (H) in meters. The original model was calibrated for 0.102 m < H < 1.60 m.
`grain`	grain size (d84) in millimeters. The original model was calibrated for 113 mm < d84 < 740 mm.
`restrict`	allows for function parameters to restrict certain values. Type bool. Default TRUE.

Value

Manning's n

References

Bathurst, J. C. 1985. Flow Resistance Estimation in Mountain Rivers. Journal of Hydraulic Engineering. American Society of Civil Engineers, Vol. 111 (4), pp. 625-643.

Examples

```
# Result: Manning's n of 0.085
n_bathurst1985(0.15,250)

# Result: Manning's n of 0.036
n_bathurst1985(0.8,120)

# Result: Manning's n of 0.056
n_bathurst1985(1.32,600)

# Result: Grain must be within 113 and 740 mm.
n_bathurst1985(1.32,50)
```

n_brownlie1981 *Compute form roughness via Brownlie (1981)*

Description

n_brownlie1981 calculate Manning's n using the Brownlie (1981) Method for estimating form roughness.

Usage

```
n_brownlie1981(depth, slope, d16, d50, d84, restrict = TRUE)
```

Arguments

depth	flow depth (H) in meters (m). The original model was calibrated for 0.025 m < H < 17 m.
slope	channel slope (S) in (m/m). The original model was calibrated for 3*10^-6 < S < 0.037.
d16	grain size (d16) in millimeters.
d50	grain size (d50) in millimeters. The original model was calibrated for 0.088 mm < d50 < 2.8 mm.
d84	grain size (d84) in millimeters.
restrict	allows for function parameters to restrict certain values. Type bool. Default TRUE.

Value

Manning's n

References

Brownlie, W. R. 1981. Prediction of flow depth and sediment discharge in open channels. Report No. KH-R-43A. W.M. Keck Laboratory of Hydraulics and Water Resources. California Institute of Technology.

Examples

```
# Result: Manning's n of 0.022
n_brownlie1981(10,0.02,1,1.1,1.2)

# Result: Manning's n of 0.018
n_brownlie1981(2.5,0.01,0.1,0.2,0.5)

# Result: Manning's n of 0.045
n_brownlie1981(15,0.003,0.6,0.9,1)

# Result: Depth must be within 0.025 and 17 m.
```

```
n_brownlie1981(20,0.003,0.6,0.9,1)
```

---

n_cowan1956 *Compute hydraulic roughness following Cowan (1956)*

Description

n_cowan1956 calculate Manning's n using the Cowan Method (1956) for estimating total channel roughness

Usage

```
n_cowan1956(
  material,
  irregularity,
  cross,
  obstructions,
  vegetation,
  meandering,
  restrict = TRUE
)
```

Arguments

material	channel material (e.g. earth, rock cut, fine gravel, coarse Gravel)
irregularity	degree of bed irregularity (e.g. smooth, minor, moderate, severe)
cross	variations of channel cross section (e.g. gradual, alternating occasionally, alternating frequently)
obstructions	relative effect of obstructions (e.g. negligible, minor, appreciable, severe)
vegetation	vegetation (e.g. low, medium, high, very high)
meandering	degree of meandering (e.g. minor, appreciable, severe)
restrict	allows for function parameters to restrict certain values. Type bool. Default TRUE.

Value

Manning's n

References

Cowan, W. L. 1956. Estimating Hydraulic Roughness Coefficients. Agricultural Engineering. ASAE, August, 1956. Phillips, J. V., and S. Tadayon. 2007. Selection of Manning's Roughness Coefficient for Natural and Constructed Vegetated and Non-Vegetated Channels, and Vegetation Maintenance Plan Guidelines for Vegetated Channels in Central Arizona. Scientific Investigations Report 2006–5108. USGS, Reston, Virginia.

Examples

```
# Result: Manning's n of 0.028
material <- 'Earth'
irregularity <- 'Smooth'
cross <- 'Gradual'
obstructions <- 'Negligible'
vegetation <- 'Low'
meandering <- 'Minor'
n_cowan1956(material,irregularity,cross,obstructions,vegetation,meandering)

# Result: Manning's n of 0.075
material <- 'Rock Cut'
irregularity <- 'Minor'
cross <- 'Alternating occasionally'
obstructions <- 'Minor'
vegetation <- 'Medium'
meandering <- 'Appreciable'
n_cowan1956(material,irregularity,cross,obstructions,vegetation,meandering)

# Result: Manning's n of 0.142
material <- 'Fine Gravel'
irregularity <- 'Moderate'
cross <- 'Alternating frequently'
obstructions <- 'Appreciable'
vegetation <- 'High'
meandering <- 'Severe'
n_cowan1956(material,irregularity,cross,obstructions,vegetation,meandering)
```

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n_direct — *Compute total channel roughness via direct field measurement*

Description

`n_direct` calculate Manning's n using direct measurements

Usage

```
n_direct(radius, slope, velocity, restrict = TRUE)
```

Arguments

`radius`	hydraulic radius (R) in meters
`slope`	channel slope (S) in m/m
`velocity`	average velocity (U) in meters per second
`restrict`	allows for function parameters to restrict certain values. Type bool. Default TRUE.

Value

Manning's n

Examples

```
# Result: Manning's n of 0.710
n_direct(2,0.05,0.5)

# Result: Manning's n of 3.216
n_direct(10,0.03,0.25)

# Result: Manning's n of 5.440
n_direct(22,0.12,0.5)

# Result: Hydraulic radius cannot be negative.
n_direct(-2,0.12,0.5)
```

`n_engelund1967` *Compute form roughness following Engelund and Hansen (1967)*

Description

`n_engelund1967` calculate Manning's n using the Engelund-Hansen (1981) method for estimating form roughness

Usage

```
n_engelund1967(depth, slope, d50, restrict = TRUE)
```

Arguments

`depth`	flow depth (H) in meters
`slope`	channel slope (S) in m/m
`d50`	grain size (d50) in millimeters
`restrict`	allows for function parameters to restrict certain values. Type bool. Default TRUE.

Value

Manning's n

References

Engelund, F., and E. Hansen. 1967. A Monograph on Sediment Transport in Alluvial Streams. Technical University of Denmark, Copenhagen, Denmark.

Examples

```
# Result: Manning's n of 0.049
n_engelund1967(1, 0.025, 200)

# Result: Manning's n of 0.028
n_engelund1967(5, 0.08, 90)

# Result: Manning's n of 0.053
n_engelund1967(12, 0.025, 160)
```

`n_fischenich2000` *Compute hydraulic roughness due to vegetation following Fischenich (2000)*

Description

`n_fischenich2000` calculate Manning's n using the Fischenich (2000) method for estimating vegetative roughness

Usage

```
n_fischenich2000(
  depth,
  hp,
  seperate = TRUE,
  Cd = 0,
  Ad = 0,
  CdAd = 0,
  restrict = TRUE
)
```

Arguments

`depth`	flow depth (H) in meters. Assumes wide channel geometry where depth is approximately equal to hydraulic radius.
`hp`	vegetation height (h_p) in meters. Vegetation is emergent.
`seperate`	Allows user to choose whether to use separate (Cd and Ad) or combined (CdAd). Type boolean. Default TRUE.
`Cd`	stand drag coefficient (C_d), default 0
`Ad`	vegetation area based on density (A_d), default 0
`CdAd`	Combined Cd and Ad values, default 0
`restrict`	allows for function parameters to restrict certain values. Type bool. Default TRUE.

Value

Manning's n

References

Fischenich, J. C. 2000. Resistance due to Vegetation. ERDC TN-EMRRP-SR-07, U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Fischenich, J. C., and S. Dudley. 2000. Determining Drag Coefficients and Area for Vegetation. ERDC TNEMRRP-SR-08, U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Examples

```
# Result: Manning's n of 0.100
n_fischenich2000(6,2,TRUE,0.955,0.755)

# Result: Manning's n of 0.059
n_fischenich2000(6,2,FALSE,CdAd=0.0199)

# Result: Manning's n of 0.090
n_fischenich2000(3,1,TRUE,0.1806,0.1662)

# Result: Depth must be positive.
n_fischenich2000(-1,1,TRUE,0.1806,0.1662)
```

`n_freeman2000` *Compute hydraulic roughness due to vegetation following Freeman, Rahymeyer, and Copeland (2000)*

Description

`n_freeman2000` calculate Manning's n using the Freeman, Rahymeyer, and Copeland (2000) method for estimating vegetative roughness

Usage

```
n_freeman2000(depth, slope, area, hp, hlm, We, Ds, pnum, snum, restrict = TRUE)
```

Arguments

`depth`	flow depth (H) in meters. Assumes wide channel geometry where depth is approximately equal to hydraulic radius.
`slope`	channel bed slope (S)
`area`	sample vegetative plot bed area in square meters, a list of index 5
`hp`	average plant height (h_p) in meters, a list of index 5

hlm	average leaf mass height (hlm) in meters, a list of index 5
We	average leaf mass width (We) in meters, a list of index 5
Ds	average stem diameter (Ds) in meters, a list of index 5
pnum	number of plants in the corresponding indices, a list of index 5
snum	number of stems at H/4 in the corresponding indices, a list of index 5
restrict	allows for function parameters to restrict certain values. Type bool. Default TRUE.

Value

Manning's n

References

Freeman, G. E., W. H. Rahmeyer, and R. R. Copeland. 2000. Determination of Resistance Due to Shrubs and Woody Vegetation. ERDC/CHL TR-00-25. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Examples

```
# Result: Manning's n of 0.013
depth <- 6
slope <- 0.005
area <- 100
hp <- c(0.51,0.71,0.2,0.97,0.71)
hlm <- c(0.45,0.71,0.16,0.9,0.62)
We <- c(0.229,0.356,0.254,0.482,0.178)
Ds <- c(0.0095,0.0095,0.0063,0.0252,0.0063)
pnum <- c(2,2,2,1,3)
snum <- c(1,1,2,2,6)
n_freeman2000(depth,slope,area,hp,hlm,We,Ds,pnum,snum)

# Result: Manning's n of 0.0183
depth <- 0.3
slope <- 0.005
area <- 100
hp <- c(0.51,0.71,0.2,0.97,0.71)
hlm <- c(0.45,0.71,0.16,0.9,0.62)
We <- c(0.229,0.356,0.254,0.482,0.178)
Ds <- c(0.0095,0.0095,0.0063,0.0252,0.0063)
pnum <- c(2,2,2,1,3)
snum <- c(1,1,2,2,6)
n_freeman2000(depth,slope,area,hp,hlm,We,Ds,pnum,snum)

# Result: Vegetation height must be positive.
depth <- 0.3
slope <- 0.005
area <- 100
hp <- c(0.51,0.71,0.2,0.97,-0.23)
hlm <- c(0.45,0.71,0.16,0.9,0.62)
```

```
We <- c(0.229,0.356,0.254,0.482,0.178)
Ds <- c(0.0095,0.0095,0.0063,0.0252,0.0063)
pnum <- c(2,2,2,1,3)
snum <- c(1,1,2,2,6)
n_freeman2000(depth,slope,area,hp,hlm,We,Ds,pnum,snum)
```

---

n_jarrett1984 *Compute grain roughness via Jarrett (1984)*

Description

n_jarrett1984 calculate Manning's n using the Jarrett (1984) Method for estimating grain roughness

Usage

```
n_jarrett1984(radius, slope, restrict = TRUE)
```

Arguments

radius	hydraulic radius (R) in meters. The original model was calibrated for 0.15 m < R < 1.68 m
slope	channel slope (S) in m/m. The original model was calibrated for 0.002 < S < 0.04.
restrict	allows for function parameters to restrict certain values. Type bool. Default TRUE.

Value

Manning's n

References

Jarrett, R. D. 1984. Hydraulics of High-Gradient Streams. Journal of Hydraulic Engineering. American Society of Civil Engineers, Vol. 110 (11), pp. 1519-1539.

Examples

```
# Result: Manning's n of 0.102
n_jarrett1984(0.3,0.03)

# Result: Manning's n of 0.065
n_jarrett1984(1,0.015)

# Result: Slope must be within 0.002 and 0.04 m.
n_jarrett1984(12,0.05)
```

`n_limerinos1970` *Compute grain roughness following Limerinos (1970)*

Description

`n_limerinos1970` calculate Manning's n using the Limerinos (1970) method for estimating grain roughness

Usage

```
n_limerinos1970(radius, grain, restrict = TRUE)
```

Arguments

`radius`	hydraulic radius (R) in meters. The original model was calibrated for 0.31 m < R < 3.32 m.
`grain`	grain size (d84) in millimeters. The original model was calibrated for 19 mm < d84 < 747 mm
`restrict`	allows for function parameters to restrict certain values. Type bool. Default TRUE.

Value

Manning's n

References

Limerinos, J. T. 1970. Determination of the Manning Coefficient from Measured Bed Roughness in Natural Channels. Water Supply Paper 1898-B. USGS, Washington, DC.

Examples

```
# Result: Manning's n of 0.036
n_limerinos1970(1,100)

# Result: Manning's n of 0.031
n_limerinos1970(2.5,70)

# Result: Manning's n of 0.039
n_limerinos1970(3,200)

# Result: Manning's n of 0.039
n_limerinos1970(3,200)

# Result: Grain must be within 19 and 747 mm.
n_limerinos1970(3,1000)
```

`n_maynord1991` *Compute grain roughness following Maynord (1991)*

Description

`n_maynord1991` calculate Manning's n using the Maynord (1991) method of estimating grain roughness

Usage

```
n_maynord1991(grain, restrict = TRUE)
```

Arguments

`grain`	grain size (d90) in millimeters. The original model was calibrated for 4.57 mm < d90 < 134 mm.
`restrict`	allows for function parameters to restrict certain values. Type bool. Default TRUE.

Value

Manning's n

References

Maynord, S. T. 1991. Flow Resistance of Riprap. Journal of Hydraulic Engineering. American Society of Civil Engineers, Vol. 117 (6), pp. 687-696.

Examples

```
# Result: Manning's n of 0.030
n_maynord1991(100)

# Result: Manning's n of 0.018
n_maynord1991(5)

# Result: Manning's n of 0.027
n_maynord1991(50)

# Result: Manning's n of Grain must be within 4.57 and 134 mm.
n_maynord1991(1)
```

n_strickler1923 *Compute grain roughness following Strickler (1923)*

Description

n_strickler1923 calculate Manning's n using the Strickler (1923) method for estimating grain roughness

Usage

```
n_strickler1923(grain, restrict = TRUE)
```

Arguments

grain	grain size (d50) in millimeters
restrict	allows for function parameters to restrict certain values. Type bool. Default TRUE.

Value

Manning's n

References

Strickler, A. 1923. Contributions to the Question of a Velocity formula and Roughness Data for Streams, Channels Closed Pipelines, translated by T. Roesgan and W.R. Brownlie. Translation T-10, W.M. Keck Lab of Hydraulics and Water Resources, California Institute of Technology, Pasadena, CA.

Examples

```
# Result: Manning's n of 0.032
n_strickler1923(100)

# Result: Manning's n of 0.025
n_strickler1923(20)

# Result: Manning's n of 0.021
n_strickler1923(8)

# Result: Grain size (mm) must be positive
n_strickler1923(-8)
```

n_vanrijn1984 *Compute channel form roughness following Van Rijn (1984)*

Description

n_vanrijn1984 calculate Manning's n using the Van Rijn (1984) method for estimating roughness due to channel form

Usage

```
n_vanrijn1984(depth, slope, d50, d90, velocity, restrict = TRUE)
```

Arguments

depth	flow depth (H) in meters. The original model was calibrated for 0.1 < H < 16 m.
slope	channel slope (S) in m/m
d50	grain size (d50) in millimeters. The original model was calibrated for 0.19 mm < d50 < 3.6 mm.
d90	grain size (d90) in millimeters.
velocity	initial channel velocity estimate (U) in meters per second
restrict	allows for function parameters to restrict certain values. Type bool. Default TRUE.

Value

Manning's n

References

van Rijn, L. C. 1984a. Sediment Transport, Part I: Bed Load Transport. Journal of Hydraulic Engineering. ASCE, Vol. 110 (10), pp. 1431-1456.

van Rijn, L. C. 1984b. Sediment Transport, Part II: Suspended Load Transport. Journal of Hydraulic Engineering. ASCE, Vol. 110 (11), pp. 1613-1641.

van Rijn, L. C. 1984c. Sediment Transport, Part III: Bed Forms and Alluvial Roughness. Journal of Hydraulic Engineering. ASCE, Vol. 110 (12), pp. 1733-1754.

Examples

```
# Result: Manning's n of 0.173
n_vanrijn1984(10,0.025,1,2,6)

# Result: Manning's n of 0.047
n_vanrijn1984(0.33,0.15,0.3,0.5,2)

# Result: Manning's n of 0.028
n_vanrijn1984(1.55,0.033,0.5,0.8,1)
```

```
# Result: Depth must be within 0.025 and 17 m.
n_vanrijn1984(0.01,0.033,0.5,0.8,1)
```

---

n_wong2006 *Compute grain roughness following Wong and Parker (2006)*

Description

n_wong2006 calculate Manning's n using the Wong and Parker (2006) method for estimating grain roughness

Usage

```
n_wong2006(grain, restrict = TRUE)
```

Arguments

grain	grain size (d90) in millimeters. The original model was calibrated for 0.38 mm < d90 < 28.65 mm
restrict	allows for function parameters to restrict certain values. Type bool. Default TRUE.

Value

Manning's n

References

Wong, M., and G. Parker. 2006. Reanalysis and Correction of Bed-load Relation of Meyer-Peter and Muller Using Their Own Database. Journal of Hydraulic Engineering. American Society of Civil Engineers, Vol. 132 (11), pp. 1159-1168.

Examples

```
# Result: Manning's n of 0.022
n_wong2006(20)

# Result: Manning's n of 0.013
n_wong2006(0.82)

# Result: Manning's n of 0.021
n_wong2006(12)

# Result: Grain must be within 0.38 and 28.65 mm.
n_wong2006(30)
```

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