Package 'geotech'

November 6, 2026

Title Geotechnical Engineering

Date 2026-11-04

Version 1.0.2

Description A compilation of functions for performing calculations and creating plots that commonly arise in geotechnical engineering and soil mechanics. The types of calculations that are currently included are: (1) phase diagrams and index parameters, (2) grain-size distributions, (3) plasticity, (4) soil classification, (5) compaction, (6) groundwater, (7) subsurface stresses (geostatic and induced), (8) Mohr circle analyses, (9) consolidation settlement and rate, (10) shear strength, (11) bearing capacity, (12) lateral earth pressures, (13) slope stability, and (14) subsurface explorations. Geotechnical engineering students, educators, researchers, and practitioners will find this package useful.

License GPL-3

Imports graphics, stats

Suggests spelling

NeedsCompilation no

Language en-US

Encoding UTF-8

RoxygenNote 7.3.3

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Repository CRAN

Date/Publication 2026-11-06 14:30:09 UTC

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`A.line` *A-Line (Plasticity)*

Description

Calculates the A-line on Casagrande's plasticity chart. 1 December 2015

Usage

```
A.line(LL)
```

Arguments

`LL`	= Liquid Limit (percent)

Value

The plasticity index corresponding to the A-line on Casagrande's plasticity chart

Note

Either PL or PI must be specified

Author(s)

Kyle Elmy and Jim Kaklamanos

`AASHTO` *AASHTO Soil Classification (AASHTO Group Classification)*

Description

Classifies soil using the American Association of State Highway and Transportation Officials (AASHTO) Soil Classification System. Inorganic soil classification using the AASHTO method. 1 December 2015

Usage

```
AASHTO(
  sieve = NA,
  size = NA,
  percent = NA,
  metric = NA,
  p10 = NA,
  p40 = NA,
  p200 = NA,
  LL = NA,
  PL = NA,
  PI = NA,
  NP = NA
)
```

Arguments

sieve	= vector of sieve numbers (according to ASTM D422) in grain-size distribution [Grain-size parameter]
size	= vector of grain sizes (in or mm) in distribution [Grain-size parameter]
percent	= vector of percent passing in grain-size distribution [Grain-size parameter]
metric	= logical variable for grain-size distribution: TRUE for metric units (mm), FALSE for English units (in); only required if "size" is supplied [Grain-size parameter]
p10	= percent passing #10 sieve [Grain-size parameter]
p40	= percent passing #40 sieve [Grain-size parameter]
p200	= percent passing #200 sieve [Grain-size parameter]
LL	= liquid limit (percent) [Plasticity parameter]
PL	= plastic limit (percent) [Plasticity parameter]
PI	= plasticity index (percent) [Plasticity parameter]
NP	= logical variable indicating whether the soil is nonplastic (TRUE or FALSE) [Plasticity parameter]

Value

AASHTO group classification

Note

For the grain-size data, one of three following pieces of data must be specified: 1. Sieve numbers (sieve); and percent passing 2. Grain sizes (size); and percent passing 3. p10, p40, p200 If sieve data are specified, for sieves larger than the no. 4 sieve, the user should specify the sieve size in inches (e.g., 3/8, 3/4, 1, 1.5, 2, 3, etc.) If sieve or size data are specified, this function assumes that the no. 10, 40, and 200 sieves have been used. For the plasticity data, one of three following pieces of data must be specified: 1. LL and PL 2. LL and PI 3. NP (if the soil is nonplastic) To obtain the group index using the AASHTO method, use the GI function.

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
AASHTO(p10 = 51, p40 = 30, p200 = 15, LL = 40, PI = 10)
```

---

bearingCapacity *Ultimate Bearing Capacity (Terzaghi)*

Description

Calculates the ultimate bearing capacity from Terzaghi's simple theory. 1 October 2015

Usage

```
bearingCapacity(
  phi,
  c,
  B,
  L,
  D,
  Dw,
  gamma,
  gammaW = NA,
  metric,
  case = "general",
  shape = "square"
)
```

Arguments

phi	= effective friction angle (deg)
c	= effective cohesion (psf or kPa)
B	= foundation width (ft or m), or foundation diameter for circular footings
L	= foundation length (ft or m)
D	= Depth of foundation (ft or m)
Dw	= Depth of groundwater table below foundation base (ft or m)
gamma	= unit weight of soil (pcf of kN/m^3)
gammaW	= unit weight of water (default = 62.4 pcf for English units; 9.81 kN/m^3 for metric units)
metric	= logical variable: TRUE (for metric units) or FALSE (for English units)
case	= "general" or "local" to indicate general or local shear failure ("general" is default)
shape	= "square", "rectangle", "circle", "strip" (or "continuous")

Value

Bearing capacity (q_ult) from Terzaghi's simple theory (psf or kPa)

Note

Either SI or English units can be used, but must stay consistent. When specifying the length and width of rectangular foundations, L should be the longer of the two lengths. When the groundwater table is deep or unknown, set Dw >= D + B

Author(s)

Kyle Elmy and Jim Kaklamanos

---

bearingPressure *Gross Bearing Pressure (Bearing Capacity)*

Description

Calculates the footing gross bearing pressure. 1 October 2015

Usage

```
bearingPressure(P, B, L, D, Dw, metric, gammaW = NA, gammaC = NA)
```

Arguments

P	= Vertical gross column load (lb or kN)
B	= foundation width (ft or m)
L	= foundation length (ft or m)
D	= Depth of foundation (ft or m)
Dw	= Depth of groundwater table below foundation base (ft or m)
metric	= logical variable: TRUE (for metric units) or FALSE (for English units)
gammaW	= unit weight of water (default = 62.4 pcf for English units; 9.81 kN/m^3 for metric units)
gammaC	= unit weight of concrete (default = 150 pcf for English units; 23.6 kN/m^3 for metric units)

Value

Gross bearing pressure of footing (psf or kPa)

Note

Either SI or English units can be used, but must stay consistent. When specifying the length and width, L should be the longer of the two lengths. For a continuous (strip) foundation, specify L = 1 and specify P as the load per unit length When the groundwater table is deep or unknown, set Dw >= D.

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
bearingPressure(P = 1000, B = 2, L = 5, D = 6, Dw = 2, metric = FALSE)
```

`Dsize` *D-Size (Grain-Size Distributions)*

Description

Calculates the diameter size. 1 December 2015

Usage

```
Dsize(N, sieve = NA, size = NA, percent, metric)
```

Arguments

`N`	= the percent corresponding to the desired D-size
`sieve`	= vector of sieve numbers (according to ASTM D422) that make up the grain-size distribution
`size`	= vector of grain sizes (in or mm) of the distribution
`percent`	= vector of percent passing of the grain-size distribution
`metric`	= logical variable: TRUE for metric units (mm), FALSE for English units (in)

Value

The grain size corresponding to a certain percent finer (N), given a grain-size distribution

Note

For sieves larger than the no. 4 sieve, the user should specify the sieve size in inches (e.g., 3/8, 3/4, 1, 1.5, 2, 3, etc.) Either sieve numbers OR grain sizes must be provided. The "metric" variable is only required if sieve numbers are provided. The function uses logarithmic interpolation to calculate the D-size from the provided grain-size distribution Log-linear extrapolation is used for grain sizes beyond the range of the data, and a warning is provided

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
sieve.example <- c(3/8, 4, 10, 20, 40, 140, 200)
percent.example <- c(95.72, 90.23, 81.49, 66.36, 50.00, 8.51, 4.82)
Dsize(N = 50, sieve = sieve.example, percent = percent.example, metric = TRUE)
```

FSinf *Slope Stability (Infinite Slope Analysis)*

Description

Determines the slope stability using the infinite slope analysis. 1 January 2016

Usage

```
FSinf(c, phi, gamma, gammaW = NA, alpha, D, zw, metric)
```

Arguments

c	= soil cohesion [Soil parameter]
phi	= soil friction angle (degrees) [Soil parameter]
gamma	= soil unit weight [Soil parameter]
gammaW	= unit weight of water (default = 62.4 pcf for English units; 9.81 kN/m^3 for metric units) [Soil parameter]
alpha	= slope angle (degrees) [Slope geometry]
D	= depth to failure plane [Slope geometry]
zw	= distance of groundwater table above failure plane (use 0 for a dry slope and D for a submerged slope with parallel seepage) [Slope geometry]
metric	= logical variable: TRUE (for metric units: kN/m^3) or FALSE (for English units: pcf) [this is needed if gammaW is unspecified] [Units]

Value

Factor of safety against shear failure on slopes using infinite slope analyses

Note

Assumptions of infinite slope analyses include (Coduto et al., 2011): 1. The slope face is planar and of infinite extent. 2. The failure surface is parallel to the slope face. 3. Vertical columns of equal dimensions through the slope are identical.

Author(s)

Jim Kaklamanos and Kyle Elmy

References

Coduto, D. P., M. R. Yeung, and W. A. Kitch, *Geotechnical Engineering: Principles and Practices*, 2nd Edition, Prentice Hall, Upper Saddle River, N.J., 2011, 794 pp.

`FSplanar` *Slope Stability (Planar Failure Analysis)*

Description

Determines the slope stability using the planar failure analysis. 1 January 2016

Usage

```
FSplanar(c, phi, alpha, L, W, u)
```

Arguments

`c`	= soil cohesion [Soil parameters]
`phi`	= soil friction angle [Soil parameters]
`alpha`	= angle of failure plane (degrees) [Slope geometry]
`L`	= length of failure plane [Slope geometry]
`W`	= weight of slope per unit width [Slope geometry]
`u`	= average pressure head on the failure plane [Slope geometry]

Value

Factor of safety against shear failure on slopes with a planar failure surface

Note

Either English or metric units can be used, but they must be consistent.

Author(s)

Jim Kaklamanos and Kyle Elmy

GI *AASHTO Group Index*

Description

Calculate a soil's group index using the AASHTO method. 1 December 2015

Usage

```
GI(p200, LL, PL = NA, PI = NA)
```

Arguments

p200	= fines content, i.e. percent passing the #200 sieve (percent)
LL	= liquid limit (percent)
PL	= plastic limit (percent)
PI	= plasticity index (percent)

Value

AASHTO group index (rounded to the nearest integer)

Note

Either PL or PI must be specified

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
GI(p200 = 48, LL = 45, PI = 21)
```

grainSize.coefs *Coefficients of Uniformity and Curvature (Grain-Size Distributions)*

Description

Calculates the coefficients of uniformity and curvature. 1 December 2015

Usage

```
grainSize.coefs(percent, sieve = NA, size = NA, D10 = NA, D30 = NA, D60 = NA)
```

Arguments

percent	= vector of percent passing
sieve	= vector of sieve numbers according to ASTM D422
size	= vector of grain sizes
D10	= D-sizes corresponding to 10 percent
D30	= D-sizes corresponding to 30 percent
D60	= D-sizes corresponding to 60 percent

Value

A two-element list containing: Cu = Coefficient of uniformity (D60 / D10) and Cc = Coefficient of curvature (D30^2 / (D10 * D60))

Note

For sieves larger than the no. 4 sieve, the user should specify the sieve size in inches (e.g., 3/8, 3/4, 1, 1.5, 2, 3, etc.) The user has three options for input to this function: 1. Sieve numbers (sieve); and percent passing 2. Grain sizes (size); and percent passing 3. D10, D30, and D60; and percent passing

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
# Example 1

sieve.example <- c(3/8, 4, 10, 20, 40, 140, 200)
percent.example <- c(95.72, 90.23, 81.49, 66.36, 50.00, 8.51, 4.82)
grainSize.coefs(sieve = sieve.example, percent = percent.example)


# Example 2
```

```
grainSize.coefs(D60 = 0.10, D30 = 0.03, D10 = 0.002)
```

`grainSize.plot` *Grain-Size Plot*

Description

Produces the grain-size plot. 1 December 2015

Usage

```
grainSize.plot(sieve = NA, size = NA, percent, metric)
```

Arguments

`sieve`	= vector of sieve numbers according to ASTM D422
`size`	= vector of grain sizes (in or mm)
`percent`	= vector of percent passing
`metric`	= logical variable: TRUE for metric units (mm), FALSE for English units (in)

Value

Plot of soil's grain-size distribution

Note

For sieves larger than the no. 4 sieve, the user should specify the sieve size in inches (e.g., 3/8, 3/4, 1, 1.5, 2, 3, etc.) Either sieve numbers OR grain sizes must be provided.

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
sieve.example <- c(3/8, 4, 10, 20, 40, 140, 200)
percent.example <- c(95.72, 90.23, 81.49, 66.36, 50.00, 8.51, 4.82)
grainSize.plot(sieve = sieve.example, percent = percent.example, metric =
TRUE)
```

`induced.area` *Induced Stress Due to Area Load*

Description

Computes the induced stress due to area load. 1 October 2015

Usage

```
induced.area(z, q, B, L = NA, shape)
```

Arguments

`z`	= depth of interest
`q`	= applied pressure at ground surface
`B`	= width of loaded area
`L`	= length of loaded area (rectangular foundations only)
`shape`	= shape of loaded area (a string containing "circle", "square" , "strip", or "rectangle")

Value

Induced vertical stress at the center of the loaded area

Note

This function uses the approximate method of Poulos and Davis (1974).

Author(s)

Kyle Elmy and Jim Kaklamanos

References

Harry G. Poulos and E. H. Davis, *Elastic Solutions for Soil and Rock Mechanics*, John Wiley & Sons, Inc., 1974. Reprinted in 1991 by University of Sydney Centre for Geotechnical Research

Examples

```
induced.area(z = 10, q = 1000, B = 3, shape = "square")
```

`induced.area.profile` *Induced Stress Due to Area Load: Profile*

Description

Computes the vertical stress at a point. 1 October 2015

Usage

```
induced.area.profile(z = NA, q, B, L = NA, shape)
```

Arguments

z	= vector of depths (default: 1-ft or 1-m increments, to a maximum depth of 50 ft or 50 m)
q	= applied pressure at ground surface
B	= width of loaded area
L	= length of loaded area (rectangular foundations only)
shape	= shape of loaded area (a string containing "circle", "square", "strip", or "rectangle")

Value

A two-element list: depth = vector of depths and sigmaZ = vector of induced vertical stresses below center of the loaded area

Note

Uses the approximate method.

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
induced.area.profile(q = 1000, B = 3, shape = "square")
```

induced.point *Induced Stress Due to Point Load*

Description

Computes the induced stress due to point load. 1 October 2015

Usage

```
induced.point(P, x, y, z, nu)
```

Arguments

P	= point load
x	= horizontal distance from load in the X direction
y	= horizontal distance from load in the Y direction
z	= depth of interest
nu	= Poisson's ratio

Value

A six-element list containing the induced stresses due to a point load following the Boussinesq method: sigmaX = induced horizontal stress in the x direction, sigmaY = induced horizontal stress in the y direction, sigmaZ = induced vertical stress, tauZX = induced shear stress on the ZX plane, tauYX = induced shear stress on the YX plane, tauYZ = induced shear stress on the YZ plane

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
induced.point(P = 100000, x = 5, y = 2, z = 6, nu = 0.35)
```

induced.point.profile *Induced Stress Due to Point Load: Profile*

Description

Computes the induced stress due to point load: profile. 1 October 2015

Usage

```
induced.point.profile(P, x, y, z = NA, nu)
```

Arguments

P	= point load
x	= horizontal distance from load in the X direction
y	= horizontal distance from load in the Y direction
z	= vector of depths of interest (default: 1-ft or 1-m increments, to a maximum depth of 50 ft or 50 m)
nu	= Poisson's ratio

Value

A seven-element list containing seven vectors displaying the depth variation of induced stresses due to a point load following the Boussinesq method: depth = vector of depths, sigmaX = induced horizontal stress in the x direction, sigmaY = induced horizontal stress in the y direction, sigmaZ = induced vertical stress, tauZX = induced shear stress on the ZX plane, tauYX = induced shear stress on the YX plane, tauYZ = induced shear stress on the YZ plane

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
induced.point.profile(P = 100000, x = 5, y = 2, nu = 0.35)
```

K *Coefficient of Lateral Earth Pressure (General)*

Description

Calculates the general coefficient of lateral earth pressure. 1 October 2015

Usage

```
K(sigmax, sigmaz)
```

Arguments

sigmax	= Horizontal effective stress
sigmaz	= Vertical effective stress

Value

Coefficient of lateral earth pressure

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
K(sigmax = 50, sigmaz =90)
```

Ka *Rankine Active Earth Pressures (Lateral Earth Pressure)*

Description

Calculates the active coefficient of lateral earth pressure. 1 October 2015

Usage

```
Ka(phi, beta = 0)
```

Arguments

phi	= effective friction angle (deg)
beta	= angle of backfill (deg); default = 0

Value

Coefficient of lateral earth pressure (active)

Note

The Rankine theory requires that beta <= phi

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
Ka(phi = 30, beta = 10)
```

kConstant *Hydraulic Conductivity From Constant Head Test (Groundwater)*

Description

Computes the hydraulic conductivity from the constant head test. 1 January 2016

Usage

```
kConstant(V, t, h, L, As = NA, Ds = NA)
```

Arguments

V	= volume of water collected
t	= time of flow
h	= head difference between inflow and outflow
L	= length of soil sample
As	= cross-sectional area of the soil sample
Ds	= diameter of soil sample

Value

Hydraulic conductivity from the constant head test

Note

Either English or metric units can be used, but they must be consistent. Either the area or the diameter of the soil sample need to be specified

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
kConstant(V = 800, t = 100, h = 200, As = 40, L = 50)
# k in units of cm/s
```

kFalling *Hydraulic Conductivity From Falling Head Test (Groundwater)*

Description

Computes the hydraulic conductivity from the falling head test. 1 January 2016

Usage

```
kFalling(h0, hf, t, L, As = NA, Ap = NA, Ds = NA, Dp = NA)
```

Arguments

h0	= head difference at beginning of test
hf	= head difference at end of test (h0 > hf)
t	= time of flow
L	= length of soil sample
As	= cross-sectional area of the soil sample
Ap	= cross-sectional area of the standpipe
Ds	= diameter of the soil sample
Dp	= diameter of the standpipe

Value

Hydraulic conductivity from the falling head test

Note

Either English or metric units can be used, but they must be consistent. Either the areas (As and Ap) OR the diameters (Ds and Dp) need to be specified.

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
kFalling(h0 = 12, hf = 2, L = 10, Ds = 20, Dp = 2, t = 100)
# k in units of cm/s
```

Ko *Coefficient of Lateral Earth Pressure at Rest*

Description

Calculates the coefficient of lateral earth pressure at rest. 1 October 2015

Usage

```
Ko(phi, OCR = 1)
```

Arguments

phi	= effective friction angle (deg)
OCR	= overconsolidation ratio (default = 1)

Value

Coefficient of lateral earth pressure at rest

Note

For normally consolidated soil, the Jaky (1944) equation is used; for overconsolidated soil, the Mayne and Kulhawy (1982) equation is used

Author(s)

Kyle Elmy and Jim Kaklamanos

References

1. J. Jaky, "The coefficient of earth pressure at rest In Hungarian (A nyugalmi nyomas tenyezoje)", *J. Soc. Hung. Eng. Arch.* (*Magyar Mernok es Epitesz-Egylet Kozlonye*), 1944, Pages 355-358.

2. Paul W. Mayne and Fred H. Kulhawy, "K0-OCR relationship in soil", *J. Geotech. Eng. Div., Am. Soc. Civ. Eng.*, 108(6), 1982, Pages 851-872.

Kp *Rankine Passive Earth Pressures (Lateral Earth Pressure)*

Description

Calculates the passive coefficient of lateral earth pressure. 1 October 2015

Usage

```
Kp(phi, beta = 0)
```

Arguments

phi	= effective friction angle (deg)
beta	= angle of backfill (deg); default = 0

Value

Coefficient of lateral earth pressure (passive)

Note

The Rankine theory requires that beta <= phi

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
Kp(phi = 30, beta = 10)
```

kPump *Hydraulic Conductivity From Pumping Tests (Groundwater)*

Description

Computes the hydraulic conductivity from pumping tests. 1 January 2016

Usage

```
kPump(Q, H = NA, h1, h2, r1, r2)
```

Arguments

Q	= flow rate into well
H	= thickness of aquifer
h1	= total head in farthest observation well
h2	= total head in nearest observation well
r1	= radius from pumped well to farthest observation well
r2	= radius from pumped well to nearest observation well

Value

k = hydraulic conductivity of aquifer

Note

Datum for h0 and hf is the bottom of the aquifer. For unconfined aquifers, H > h1 (or specify as NA) For confined aquifers, H >= h2. For mixed aquifers (which start as confined prior to pumping and finish as unconfined after pumping is complete), H < h2.

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
kPump(Q = 14.5, H = 10, h1 = 20, h2 = 16, r1 = 16, r2 = 8)
```

---

kx *Equivalent Horizontal Hydraulic Conductivity (Groundwater)*

Description

Computes the equivalent horizontal hydraulic conductivity. 1 January 2016

Usage

```
kx(thk, k)
```

Arguments

thk	= vector of layer thicknesses
k	= vector of layer hydraulic conductivities

Value

Equivalent horizontal hydraulic conductivity (kx) for layered soil deposits

Author(s)

Kyle Elmy and Jim Kaklamanos

---

kz *Equivalent Vertical Hydraulic Conductivity (Groundwater)*

Description

Computes the equivalent vertical hydraulic conductivity. 1 January 2016

Usage

```
kz(thk, k)
```

Arguments

thk	= vector of layer thicknesses
k	= vector of layer hydraulic conductivities

Value

Equivalent vertical hydraulic conductivity (kz) for layered soil deposits

---

LI *Liquidity Index (Plasticity)*

Description

Calculates liquidity index from liquid limit, plastic limit, and in-situ moisture content. 1 December 2015

Usage

```
LI(w, LL, PL)
```

Arguments

w	= in-situ moisture content (percent)
LL	= Liquid Limit (percent)
PL	= Plastic Limit (percent)

Value

A two-element list composed of: LI = Liquidity index (percent) and descr = qualitative description of soil in its natural moisture state

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
LI(w = 55, PL = 20, LL = 50)
```

LL *Liquid Limit (Plasticity)*

Description

Calculate and plot a soil's liquid limit (LL) using the flow curve. 1 December 2015

Usage

```
LL(N, w, draw)
```

Arguments

N	= vector of number of blows obtained from the liquid limit test
w	= vector of water contents (PERCENT, not decimal)
draw	= logical variable: TRUE if plot of flow curve is desired, FALSE to suppress the creation of the plot

Value

Liquid limit (percent) and plot of soil's flow curve (optional)

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
LL(N = c(72, 37, 14), w = c(7, 15, 21), draw = TRUE)
# liquid limit analysis
```

`MohrCircle.calc` *Mohr Circle (Calculate)*

Description

Calculates the Mohr circle. 1 October 2015

Usage

```
MohrCircle.calc(
  sigmaX = NA,
  sigmaZ = NA,
  tauXZ = NA,
  sigma1 = NA,
  sigma3 = NA,
  theta = seq(from = 0, to = 180, by = 1)
)
```

Arguments

`sigmaX`	= normal stress acting in the horizontal direction
`sigmaZ`	= normal stress acting in the vertical direction
`tauXZ`	= shear stress acting on the same plane as sigmaX
`sigma1`	= major principal stress
`sigma3`	= minor principal stress
`theta`	= vector of angles (degrees); defaults to 0-180 in increments of 1

Value

A five-element list containing: C = center of Mohr circle, R = radius of Mohr circle, sigma = vector of normal stresses for Mohr circle, tau = vector of shear stresses for Mohr circle, and theta = vector of angles (deg)

Note

One of the following two sets of data must be entered: 1. sigmaX, sigmaZ, tauXZ 2. sigma1, sigma3 If theta is entered in conjunction with sigmaX, sigmaZ, and tauXZ, it is interpreted as the angle of inclination above the horizontal. If theta is entered in conjunction with the principal stresses, then it is interpreted as the angle of inclination above the major principal plane.

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
MohrCircle.calc(sigmaX = 80, sigmaZ = 120, tauXZ = 20)
```

MohrCircle.plot *Mohr Circle (Plot)*

Description

Plots the Mohr circle. 1 October 2015

Usage

```
MohrCircle.plot(
  sigmaX = NA,
  sigmaZ = NA,
  tauXZ = NA,
  sigma1 = NA,
  sigma3 = NA,
  metric = TRUE
)
```

Arguments

sigmaX	= normal stress acting in the horizontal direction
sigmaZ	= normal stress acting in the vertical direction
tauXZ	= shear stress acting on the same plane as sigmaX
sigma1	= major principal stress
sigma3	= minor principal stress
metric	= logical variable: TRUE for metric units (kPa), and FALSE for English units

Value

Plot of Mohr Circle

Note

One of the following two sets of data must be entered: 1. sigmaX, sigmaZ, tauXZ 2. sigma1, sigma3

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
MohrCircle.plot(sigmaX = 80, sigmaZ = 120, tauXZ = 20, metric = FALSE)
```

N160 *SPT Correction N160 for Site Exploration*

Description

Provides the SPT correction: N1,60. 1 January 2016

Usage

```
N160(N60, sigma, metric)
```

Arguments

N60	= SPT N-value corrected for field procedures
sigma	= effective vertical stress at the depth of interest (psf or kPa)
metric	= logical variable: TRUE (for metric units) or FALSE (for English units)

Value

SPT blow count (N-value) corrected for field procedures and overburden pressure

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
# In English units
N160(N60 = 8, sigma = 1500, metric = FALSE)

# In SI units
N160(N60 = 8, sigma = 90, metric = TRUE)
```

N60 *SPT Correction N60 for Site Exploration*

Description

Provides the SPT correction: N60. 1 January 2016

Usage

```
N60(N, Lr, Db, SS = TRUE, E = 0.6, metric)
```

Arguments

N	= raw SPT N-value
Lr	= rod length (ft or m)
Db	= borehole diameter (in or mm)
SS	= logical variable: TRUE for standard sampler [default]; FALSE for sampler without liner
E	= hammer efficiency as a decimal (default: 0.60)
metric	= logical variable: TRUE (for metric units) or FALSE (for English units)

Value

SPT blow count (N-value) corrected for field procedures

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
N60(N = 11, Lr = 25, Db = 4, E = 0.50, SS = TRUE, metric = FALSE)
```

Nc *Bearing Capacity Factors (Nc)*

Description

Calculates the bearing capacity factor Nc. 1 October 2015

Usage

```
Nc(phi, case = "general", method = "Terzaghi")
```

Arguments

phi	= friction angle (degrees)
case	= "general" or "local" to indicate general or local shear failure ("general" is default)
method	= "Terzaghi" or "Vesic" ("Terzaghi" is default)

Value

Bearing capacity factor (Nc) using either the Terzaghi or Vesic methods

Note

For local shear, the friction angle is reduced to a value equal to atan(2/3 * tan(phi)).

Author(s)

Kyle Elmy and Jim Kaklamanos

`Ngamma` *Bearing Capacity Factors (Ngamma)*

Description

Calculates the bearing capacity factor Ngamma. 1 October 2015

Usage

```
Ngamma(phi, case = "general", method = "Terzaghi")
```

Arguments

`phi`	= friction angle (degrees)
`case`	= "general" or "local" to indicate general or local shear failure ("general" is default)
`method`	= "Terzaghi" or "Vesic" ("Terzaghi" is default)

Value

Bearing capacity factor (Ngamma) using either the Terzaghi or Vesic methods

Note

For local shear, the friction angle is reduced to a value equal to atan(2/3 * tan(phi)).

Author(s)

Kyle Elmy and Jim Kaklamanos

Nq *Bearing Capacity Factors (Nq)*

Description

Calculates the bearing capacity factor Nq. 1 October 2015

Usage

```
Nq(phi, case = "general", method = "Terzaghi")
```

Arguments

phi	= friction angle (degrees)
case	= "general" or "local" to indicate general or local shear failure ("general" is default)
method	= "Terzaghi" or "Vesic" ("Terzaghi" is default)

Value

Bearing capacity factor (Nq) using either the Terzaghi or Vesic methods

Note

For local shear, the friction angle is reduced to a value equal to atan(2/3 * tan(phi)). Terzaghi's Ngamma is approximated by Coduto (2001).

Author(s)

Kyle Elmy and Jim Kaklamanos

References

Donald P. Coduto, *Foundation Design: Principles and Practices*, 2nd Edition, Prentice Hall, Upper Saddle River, N.J., ISBN 9780135897065, 2001, 883 pp.

`percentComponents` *Percent Components (Grain-Size Distributions)*

Description

Calculates the percent components. 1 December 2015

Usage

```
percentComponents(sieve = NA, size = NA, percent, metric)
```

Arguments

`sieve`	= vector of sieve numbers according to ASTM D422
`size`	= vector of grain sizes (in or mm)
`percent`	= vector of percent passing
`metric`	= logical variable: TRUE for metric units (mm), FALSE for English units (in)

Value

A three-element list containing: pg = Percent gravel, ps = Percent sand, and pf = Percent fines

Note

For sieves larger than the no. 4 sieve, the user should specify the sieve size in inches (e.g., 3/8, 3/4, 1, 1.5, 2, 3, etc.) Either sieve numbers OR grain sizes must be provided. This function assumes that the no. 4 and no. 200 sieves have been used.

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
sieve.example <- c(3/8, 4, 10, 20, 40, 140, 200)
percent.example <- c(95.72, 90.23, 81.49, 66.36, 50.00, 8.51, 4.82)
percentComponents(sieve = sieve.example, percent = percent.example, metric =
TRUE)
```

`phase.params` *Weight-Volume Parameters (Phase Diagrams and Index Parameters)*

Description

Calculates a comprehensive list of index parameters from provided weights and volumes of a soil sample. 1 December 2015

Usage

```
phase.params(Ws, Ww, Vs, Vw, Va)
```

Arguments

`Ws`	= weight of solids
`Ww`	= weight of water
`Vs`	= volume of solids
`Vw`	= volume of water
`Va`	= volume of air

Value

The output is a ten-element list containing: w = water content (as decimal), S = degree of saturation (as decimal), e = void ratio (as decimal), n = porosity (as decimal), Gs = specific gravity, gammaT = total unit weight, gammaD = dry unit weight, gammaS = unit weight of solids, gammaW = unit weight of water, and gammaB = buoyant unit weight

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
phase.params(Ws = 75.8, Ww = 15.6, Vs = 0.45, Vw = 0.25, Va = 0.1)
```

phase.plot *Phase Diagrams Plot (Phase Diagrams and Index Parameters)*

Description

Plots phase diagrams from weights (or masses) and volumes of a soil sample. 1 December 2015

Usage

```
phase.plot(Ws, Ww, Vs, Vw, Va, W.unit, V.unit, mass = FALSE)
```

Arguments

Ws	= weight of solids
Ww	= weight of water
Vs	= volume of solids
Vw	= volume of water
Va	= volume of air
W.unit	= measurement unit of weights
V.unit	= measurement unit of volumes
mass	= logical variable: TRUE for masses or FALSE for weights (default)

Value

Plot of phase diagram

Note

If any parameters are zero, please enter "0"; do not leave them blank. Plot is currently not to scale; may be edited in the future to allow this functionality.

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
phase.plot(Ws = 75.8, Ww = 15.6, Vs = 0.45, Vw = 0.25, Va = 0.1, W.unit =
"lb", V.unit = "ft^3", mass = FALSE)
```

PI *Plasticity Index*

Description

Calculates plasticity index from liquid limit and plastic limit. 1 December 2015

Usage

```
PI(LL, PL)
```

Arguments

LL	= Liquid Limit (percent)
PL	= Plastic Limit (percent)

Value

A two-element list composed of: PI = Plasticity index (percent) and descr = qualitative description of soil based on Sowers (1979)

Author(s)

Kyle Elmy and Jim Kaklamanos

References

George F. Sowers, *Introductory Soil Mechanics and Foundations*, Macmillan, Fourth Edition, ISBN 0024138703, 1979.

Examples

```
PI(LL=80, PL=30)
```

plasticity.plot *Casagrande's Plasticity Chart*

Description

Plots the Casagrande's plasticity chart. 1 December 2015

Usage

```
plasticity.plot(LL, PL = NA, PI = NA)
```

Arguments

LL	= Liquid Limit (percent)
PL	= Plastic Limit (percent)
PI	= Plasticity index (percent)

Value

Plot of a soil's plasticity parameters on Casagrande's plasticity chart

Note

Either PL or PI must be specified

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
plasticity.plot(LL = 40, PL = 20)
```

---

relDensity *Relative Density (Phase Diagrams and Index Parameters)*

Description

Calculates the relative density. 1 December 2015

Usage

```
relDensity(e, emax, emin)
```

Arguments

e	= void ratio
emax	= maximum void ratio
emin	= minimum void ratio

Value

Relative density as a decimal

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
relDensity(e = 0.3, emax = 0.92, emin = 0.35)
```

sigma13 *Principal Stresses (Mohr Circle Analyses)*

Description

Calculates the principal stresses. 1 October 2015

Usage

```
sigma13(sigmaX, sigmaZ, tauXZ)
```

Arguments

sigmaX	= normal stress acting in the horizontal direction
sigmaZ	= normal stress acting in the vertical direction
tauXZ	= shear stress acting on the same plane as sigmaX

Value

A four-element list containing: sigma1 = magnitude of major principal stress, sigma3 = magnitude of minor principal stress, theta1 = direction of major principal stress (deg), and theta3 = direction of minor principal stress (deg)

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
sigma13(sigmaX = 80, sigmaZ = 120, tauXZ = 20)
```

sigmaTrans *Stress Transformation (Mohr Circle Analyses)*

Description

Computes the stress transformation. 1 October 2015

Usage

```
sigmaTrans(
  theta,
  sigmaX = NA,
  sigmaZ = NA,
  tauXZ = NA,
  sigma1 = NA,
  sigma3 = NA
)
```

Arguments

`theta`	= angle of inclination (degrees)
`sigmaX`	= normal stress acting in the horizontal direction
`sigmaZ`	= normal stress acting in the vertical direction
`tauXZ`	= shear stress acting on the same plane as sigmaX
`sigma1`	= major principal stress
`sigma3`	= minor principal stress

Value

A two-element list containing: sigma = normal stress on an inclined plane and tau = shear stress on an inclined plane

Note

In addition to theta, One of the following two sets of data must be entered: 1. sigmaX, sigmaZ, tauXZ 2. sigma1, sigma3 If theta is entered in conjunction with sigmaX, sigmaZ, and tauXZ, it is interpreted as the angle of inclination above the horizontal. If theta is entered in conjunction with the principal stresses, then it is interpreted as the angle of inclination above the major principal plane.

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
sigmaTrans(sigmaX = 80, sigmaZ = 120, tauXZ = 20, theta = 78)
```

sigmaX *Horizontal Stress at a Point (Lateral Earth Pressure)*

Description

Calculates the horizontal stress at a point. 1 October 2015

Usage

```
sigmaX(
  gamma,
  thk = NA,
  depth = NA,
  zw,
  zout,
  K,
  gammaW = NA,
  metric,
  upper = TRUE
)
```

Arguments

gamma	= vector of unit weights (pcf or kN/m^3)
thk	= vector of layer thicknesses (ft or m)
depth	= vector of layer bottom depths (ft or m)
zw	= depth of groundwater table (ft or m)
zout	= desired depth of output (ft or m): a single value
K	= vector of lateral earth pressure coefficients
gammaW	= unit weight of water (default = 62.4 pcf for English units; 9.81 kN/m^3 for metric units)
metric	= logical variable: TRUE (for metric units) or FALSE (for English units)
upper	= logical variable to specify whether the upper (TRUE) or lower (FALSE) lateral earth pressure coefficient should be used, for the special case that zout corresponds to a layer interface

Value

A three-element list containing: sigmaX.eff = effective horizontal stress, sigmaX.total = total horizontal stress, and u = pore water pressure

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
sigmaX(gamma = c(108, 116), depth = c(15, 40), zout = 18, K = c(0.34, 0.32),
zw = 15, metric = FALSE, upper = TRUE)
```

---

sigmaX.plot *Horizontal Stress Plot (Lateral Earth Pressure)*

Description

Draws the horizontal stress plot. 1 October 2015

Usage

```
sigmaX.plot(depth, sigmaX.eff, sigmaX.total = NA, u = NA, metric)
```

Arguments

depth	= vector of depths (ft or m)
sigmaX.eff	= vector of effective stresses (psf or kPa)
sigmaX.total	= vector of total stresses (psf or kPa)
u	= vector of pore water pressures (psf or kPa)
metric	= logical variable: TRUE (for metric units) or FALSE (for English units)

Value

Plot of horizontal stress profile versus depth

Note

If sigmaX.total and u are left blank, the plot is only constructed for effective stress Once constructed, additional profiles may be added to this plot (for example, for induced stress or maximum past pressure)

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
# Site with constant unit weight = 100 pcf, GWT at 10 ft depth
temp <- sigmaX.profile(gamma = rep(100, 3), depth = c(10, 20, 30), K =
c(0.35, 0.30, 0.28), zw = 10, metric = FALSE)
depth <- temp$depth
sigmaTotal <- temp$sigmaX.total
u <- temp$u
sigmaEff <- temp$sigmaX.eff
```

```
sigmaX.plot(depth = depth, sigmaX.eff = sigmaEff, metric = FALSE,
sigmaX.total = sigmaTotal, u = u)
```

`sigmaX.profile` *Horizontal Stress Profile (Lateral Earth Pressure)*

Description

Calculates the horizontal stress profile. 1 October 2015

Usage

```
sigmaX.profile(
  gamma,
  thk = NA,
  depth = NA,
  K,
  zw,
  zout = NA,
  gammaW = NA,
  metric
)
```

Arguments

`gamma`	= vector of unit weights (pcf or kN/m^3)
`thk`	= vector of layer thicknesses (ft or m)
`depth`	= vector of layer bottom depths (ft or m)
`K`	= vector of layers' lateral earth pressure coefficients
`zw`	= depth of groundwater table (ft or m)
`zout`	= desired depths of output (ft or m): defaults to critical locations in the profile (the top and bottom of the profile, layer interfaces, and the groundwater table) [recommended]
`gammaW`	= unit weight of water (default = 62.4 pcf for English units; 9.81 kN/m^3 for metric units)
`metric`	= logical variable: TRUE (for metric units) or FALSE (for English units)

Value

A four-element list containing four vectors: depth = depth, sigmaZ.eff = effective vertical stress, sigmaZ.total = total vertical stress, and u = pore water pressure

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
sigmaX.profile(gamma = c(108, 116), depth = c(15, 40), K = c(0.34, 0.32),
zw = 15, metric = FALSE)
```

---

sigmaZ *Vertical Stress at a Point*

Description

Computes the vertical stress at a point. 1 October 2015

Usage

```
sigmaZ(gamma, thk = NA, depth = NA, zw, zout, gammaW = NA, metric)
```

Arguments

gamma	= vector of unit weights (pcf or kN/m^3)
thk	= vector of layer thicknesses (ft or m)
depth	= vector of layer bottom depths (ft or m)
zw	= depth of groundwater table (ft or m)
zout	= desired depth of output (ft or m): a single value
gammaW	= unit weight of water (default = 62.4 pcf for English units; 9.81 kN/m^3 for metric units)
metric	= logical variable: TRUE (for metric units) or FALSE (for English units)

Value

A three-element list containing: sigmaZ.eff = effective vertical stress, sigmaZ.total = total vertical stress, and u = pore water pressure

Note

Either layer thicknesses or depths to layer bottoms must be specified.

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
sigmaZ(gamma = c(108, 116), depth = c(15, 40), zout = 18, zw = 15, metric =
FALSE)
```

`sigmaZ.plot` *Vertical Stress Plot*

Description

Draws the vertical stress plot. 1 October 2015

Usage

```
sigmaZ.plot(depth, sigmaZ.eff, sigmaZ.total = NA, u = NA, metric)
```

Arguments

`depth`	= vector of depths (ft or m)
`sigmaZ.eff`	= vector of effective stresses (psf or kPa)
`sigmaZ.total`	= vector of total stresses (psf or kPa)
`u`	= vector of pore water pressures (psf or kPa)
`metric`	= logical variable: TRUE (for metric units) or FALSE (for English units)

Value

Plot of vertical stress versus depth

Note

If sigmaZ.total and u are left blank, the plot is only constructed for effective stress Once constructed, additional profiles may be added to this plot (for example, for induced stress or maximum past pressure)

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
# Site with constant unit weight = 100 pcf, GWT at 10 ft depth
temp <- sigmaZ.profile(gamma = rep(100, 3), depth = c(10, 20, 30), zw = 10,
metric = FALSE)
depth <- temp$depth
sigmaTotal <- temp$sigmaZ.total
u <- temp$u
sigmaEff <- temp$sigmaZ.eff
sigmaZ.plot(depth = depth, sigmaZ.eff = sigmaEff,
metric = FALSE, sigmaZ.total = sigmaTotal, u = u)
```

`sigmaZ.profile` *Vertical Stress Profile*

Description

Computes the vertical stress profile. 1 October 2015

Usage

```
sigmaZ.profile(gamma, thk = NA, depth = NA, zw, zout = NA, gammaW = NA, metric)
```

Arguments

`gamma`	= vector of unit weights (pcf or kN/m^3)
`thk`	= vector of layer thicknesses (ft or m)
`depth`	= vector of layer bottom depths (ft or m)
`zw`	= depth of groundwater table (ft or m)
`zout`	= desired depths of output (ft or m): defaults to critical locations in the profile (the top and bottom of the profile, layer interfaces, and the groundwater table) [recommended]
`gammaW`	= unit weight of water (default = 62.4 pcf for English units; 9.81 kN/m^3 for metric units)
`metric`	= logical variable: TRUE (for metric units) or FALSE (for English units)

Value

A four-element list containing four vectors: depth = depth, sigmaZ.eff = effective vertical stress, sigmaZ.total = total vertical stress, and u = pore water pressure

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
sigmaZ.profile(gamma = c(108, 116), depth = c(15, 40), zw = 15, metric =
FALSE)
```

size.from.sieve *Grain Sizes Of Sieves*

Description

Calculate a set of grain sizes corresponding to a set of sieves. 1 December 2015

Usage

```
size.from.sieve(sieve, metric)
```

Arguments

sieve	= vector of sieve numbers according to ASTM D422
metric	= logical variable: TRUE for metric units (mm), FALSE for English units (in)

Value

Vector of grain sizes (in or mm)

Note

For sieves larger than the no. 4 sieve, the user should specify the sieve size in inches (e.g., 3/8, 3/4, 1, 1.5, 2, 3, etc.) Either sieve numbers OR grain sizes must be provided.

Author(s)

Kyle Elmy and Jim Kaklamanos

soil.profile *Soil Profile Plot for Site Exploration*

Description

Plots the soil profile for use in site exploration. 1 January 2016

Usage

```
soil.profile(
  thk = NA,
  depth = NA,
  zw,
  type = NA,
  gamma = NA,
  phi = NA,
  C = NA,
```

```
  title = "Soil Profile",
  metric
)
```

Arguments

thk	= vector of layer thicknesses (ft or m)
depth	= vector of layer bottom depths (ft or m)
zw	= depth of groundwater table (ft or m)
type	= vector of soil types (character strings)
gamma	= vector of unit weights (pcf or kN/m^3)
phi	= vector of soil friction angles (deg)
C	= vector of soil cohesion (psf or kPa)
title	= desired title of plot (default: "Soil Profile")
metric	= logical variable: TRUE (for metric units) or FALSE (for English units)

Value

A plot of a soil profile

Note

Either layer thicknesses or depth to layer bottoms must be specified. The only necessary variables are thk (or depth), zw, and metric. All other variables are optional.

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
soil.profile(depth = c(20, 40, 52, 60), zw = 20,
             type = c("Dry Sand", "Saturated Sand", "Soft Clay",
               "Dense Gravel"),
             gamma = c(110, 115, 120, 150), phi = c(30, 30, NA, 38),
             C = c(NA, NA, 300, NA), metric = FALSE)
```

tauMax *Maximum In-Plane Shear Stress (Mohr Circle Analyses)*

Description

Calculates the maximum in-plane shear stress. 1 October 2015

Usage

```
tauMax(sigmaX, sigmaZ, tauXZ)
```

Arguments

sigmaX	= normal stress acting in the horizontal direction
sigmaZ	= normal stress acting in the vertical direction
tauXZ	= shear stress acting on the same plane as sigmaX

Value

A two-element list containing: tauMax = maximum in-plane shear stress and theta = angle of maximum in-plane shear stress

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
tauMax(sigmaX = 80, sigmaZ = 120, tauXZ = 20)
```

USCS *USCS Soil Classification*

Description

This is a master function that calculates a soil's classification according to the Unified Soil Classification System (USCS). The functions A.line, USCS.coarse.symbol, and USCS.fine.symbol are called by this function. 1 December 2015

Usage

```
USCS(
  pg = NA,
  ps = NA,
  pf = NA,
  Cc = NA,
  Cu = NA,
  LL = NA,
  PL = NA,
  PI = NA,
  sieve = NA,
  size = NA,
  percent = NA,
  metric = NA
)
```

Arguments

pg	= percent gravel (%)
ps	= percent sand (%)
pf	= percent fines (%)
Cc	= coefficient of curvature
Cu	= coefficient of uniformity
LL	= liquid limit
PL	= plastic limit
PI	= plasticity index
sieve	= vector of sieve numbers according to ASTM D422 for grain-size distribution
size	= vector of grain sizes (in or mm) in distribution
percent	= vector of percent passing (grain-size distribution)
metric	= logical variable: TRUE for metric units (mm), FALSE for English units (in) [only needed if grain sizes are provided]

Value

A two-element list providing a soil's USCS group symbol and name symbol = USCS group symbol and name = USCS group name

Note

Data on the soil's grain-size distribution are required if the percent fines is less than or equal to 12 function: 1. Sieve numbers (sieve); and percent passing 2. Grain sizes (size); and percent passing 3. Percent components (pg, ps, pf) and coefficients of uniformity and curvature (Cc and Cu) Data on the soil's fines [either (a) LL and PL or (b) LL and PI] are required if the percent fines is greater than or equal to 5 If percent components are specified, then Cu and Cc are needed if pf < 85

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
USCS(pg = 15, ps = 34, pf = 51, Cc = 1, Cu = 4, LL = 40, PL = 10)
```

USCS.coarse.symbol *USCS Soil Classification (USCS Coarse-Grained Symbol)*

Description

Classifies soil using the Unified Soil Classification System (USCS) using the coarse-grained symbol. 1 December 2015

Usage

```
USCS.coarse.symbol(pg, ps, pf, Cc, Cu, PI = NA, LL, PL)
```

Arguments

pg	= percent gravel (%)
ps	= percent sand (%)
pf	= percent fines (%)
Cc	= coefficient of curvature
Cu	= coefficient of uniformity
PI	= plasticity index
LL	= liquid limit
PL	= plastic limit

Value

A soil's USCS coarse-grained symbol

Note

Data on the soil's gradation (Cu and Cc) are required if the percent fines is less than or equal to 12 or (b) LL and PI] are required if the percent fines is greater than or equal to 5

Author(s)

Kyle Elmy and Jim Kaklamanos

USCS.fine.symbol *USCS Soil Classification (USCS Fine-Grained Symbol)*

Description

Classifies soil using the Unified Soil Classification System (USCS) using the fine-grained symbol. 1 December 2015

Usage

```
USCS.fine.symbol(LL, PL = NA, PI = NA)
```

Arguments

LL	= Liquid Limit
PL	= Plastic Limit
PI	= Plasticity Index

Value

A soil's fine-grained USCS symbol

Note

Either PL or PI must be provided.

Author(s)

Kyle Elmy and Jim Kaklamanos

waterContent *Water Content (Phase Diagrams and Index Parameters)*

Description

Calculates water content from lab results (i.e., measured weights or masses) . 1 December 2015

Usage

```
waterContent(M1, M2, Mc)
```

Arguments

M1	= Mass (or weight) of can and wet soil, before oven dry
M2	= Mass (or weight) of can and dry soil, after drying in oven
Mc	= Mass (or weight) of can

Value

Water content as a decimal

Note

Either mass or weight can be used, since the units cancel.

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
waterContent(M1 = 20.68, M2 = 18.14, Mc = 8.20)
```

---

wellDrawdown *Well Drawdown (Groundwater)*

Description

Computes the well drawdown. 1 January 2016

Usage

```
wellDrawdown(Q, k, H = NA, h0, r0, rw, r)
```

Arguments

Q	= flow rate into well
k	= hydraulic conductivity of aquifer
H	= saturated thickness of aquifer
h0	= initial total head in aquifer (before pumping)
r0	= radius of influence
rw	= radius of well
r	= radius of interest

Value

A two-element list containing: h = height of groundwater surface a distance r from the well and dd = h0 - h = drawdown of groundwater surface a distance r from the well

Note

Datum for total heads are the bottom of the aquifer. For unconfined aquifers, H = NA. For confined aquifers, H >= hf. For mixed aquifers (which start as confined prior to pumping and finish as unconfined after pumping is complete), H < hf.

Author(s)

Kyle Elmy and Jim Kaklamanos

Examples

```
wellDrawdown(Q = 14.5, k = 0.065, H = 10, h0 = 21, r0 = 20, r = 2, rw = 2)
```

---

wellFlow *Flow Rate to Wells (Groundwater)*

Description

Computes the flow rate to wells. 1 January 2016

Usage

```
wellFlow(k, H = NA, h0, hf, r0, rw)
```

Arguments

k	= hydraulic conductivity of aquifer
H	= thickness of aquifer
h0	= initial total head in aquifer (before pumping)
hf	= final total head in well casing (after pumping)
r0	= radius of influence
rw	= radius of well

Value

Q = flow rate to well

Note

Datum for h0 and hf is the bottom of the aquifer. For unconfined aquifers, H > h0 (or specify as NA) For confined aquifers, H >= hf. For mixed aquifers (which start as confined prior to pumping and finish as unconfined after pumping is complete), H < hf.

Author(s)

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Examples

```
wellFlow(k = 0.065, H = 10, h0 = 21, hf = 15, r0 = 20, rw = 2)
```

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