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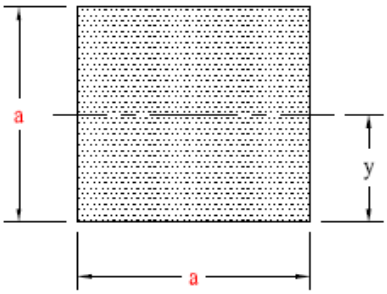
Content Based
Chemical Engineering

Properties of Sections - Solid Centered Square

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

a = mm

---------- **Calculated Properties** ----------

$A = a^2$ = mm^2

$y = \frac{1}{2}a$ = mm

$I = \frac{a^4}{12}$ = mm^4

$Z = \frac{a^3}{6}$ = mm^3

$r = 0.289a$ = mm

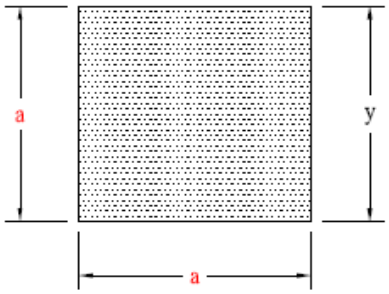
10/04/11

Properties of Sections - Solid Offset Square

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

a = mm

---------- **Calculated Properties** ----------

$A = a^2$ = mm^2

y = a = mm

$I = \frac{a^4}{3}$ = mm^4

$Z = \frac{a^3}{3}$ = mm^3

r = 0.577a = mm

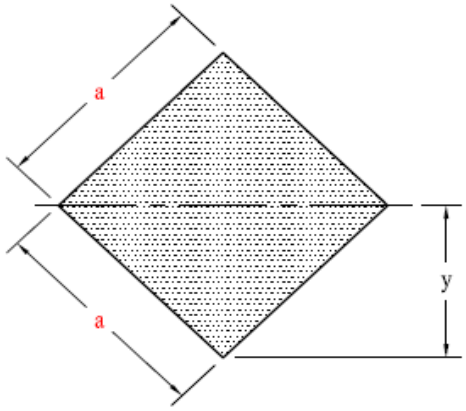
10/04/11

Properties of Sections - Solid Rotated Square

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

a = mm

---------- **Calculated Properties** ----------

$A = a^2$ = mm^2
$y = 0.707a$ = mm
$I = \frac{a^4}{12}$ = mm^4
$Z = 0.118a^3$ = mm^3
$r = 0.289a$ = mm

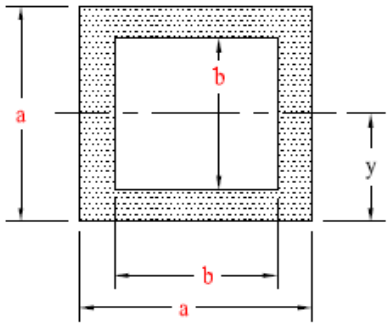
10/04/11

Properties of Sections - Hollow Centered Square

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

a = mm
b = mm

---------- **Calculated Properties** ----------

$A = a^2 - b^2$ = mm^2

$y = \frac{1}{2}a$ = mm

$I = \frac{a^4 - b^4}{12}$ = mm^4

$Z = \frac{a^4 - b^4}{6a}$ = mm^3

$r = 0.289\sqrt{a^2 + b^2}$ = mm

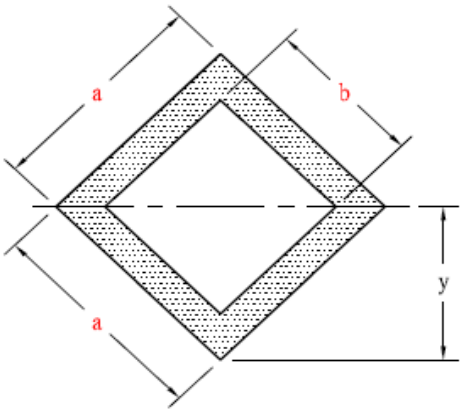
10/04/11

Properties of Sections - Hollow Rotated Square

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

a = mm
b = mm

---------- **Calculated Properties** ----------

$A = a^2 - b^2$ = mm^2

$y = 0.707a$ = mm

$I = \frac{a^4 - b^4}{12}$ = mm^4

$Z = \frac{0.118(a^4 - b^4)}{a}$ = mm^3

$r = 0.289\sqrt{a^2 + b^2}$ = mm

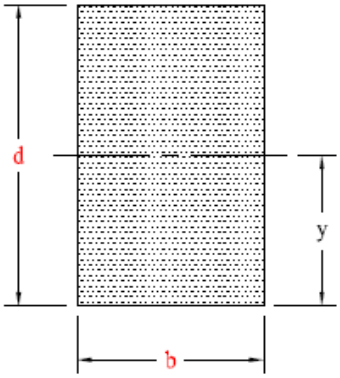
10/04/11

Properties of Sections - Solid Centered Rectangle

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

b = mm
d = mm

---------- **Calculated Properties** ----------

$A = bd$ = mm^2

$y = \frac{1}{2}d$ = mm

$I = \frac{bd^3}{12}$ = mm^4

$Z = \frac{bd^2}{6}$ = mm^3

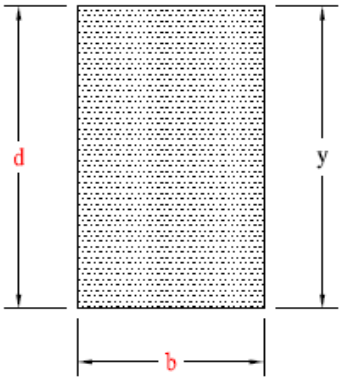
$r = 0.289d$ = mm

Properties of Sections - Solid Offset Rectangle

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

b = mm
d = mm

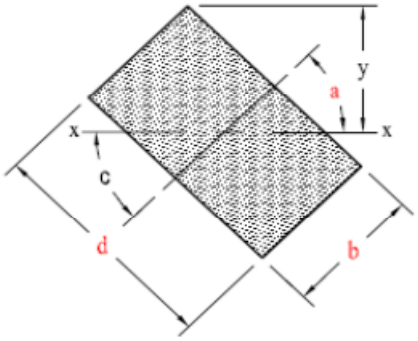
---------- **Calculated Properties** ----------

A = bd = mm^2
y = d = mm
$I = \frac{b \cdot d^3}{3}$ = mm^4
$Z = \frac{b \cdot d^2}{3}$ = mm^3
r = 0.577d = mm

10/04/11

Properties of Sections - Solid Rotated Square

SERVICE:



---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3

---------- **User Input** ----------

a = °
b = mm
d = mm

---------- **Calculated Properties** ----------

A = bd = mm^2
c = °

$$y = \frac{b \cdot \sin a + d \cdot \cos a}{2} = \text{mm}$$

$$I = \frac{b \cdot d \cdot \left(b^2 \cdot \sin^2 a + d^2 \cdot \cos^2 a\right)}{12} = mm^4$$

$$Z = \frac{b \cdot d \cdot \left(b^2 \cdot \sin^2 a + d^2 \cos^2 a\right)}{6(b \cdot \sin a + d \cdot \cos a)} = mm^3$$

$$r = \sqrt{\frac{b^2 \cdot \sin^2 a + d^2 \cos^2 a}{12}} = \text{mm}$$

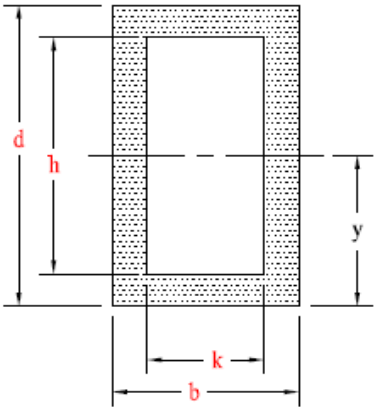
10/04/11

Properties of Sections - Hollow Centered Rectangle

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

b = mm
d = mm
h = mm
k = mm

---------- **Calculated Properties** ----------

$A = bd - hk$ = mm^2

$y = \frac{1}{2}d$ = mm

$I = \frac{bd^3 - hk^3}{12}$ = mm^4

$Z = \frac{bd^3 - hk^3}{6d}$ = mm^3

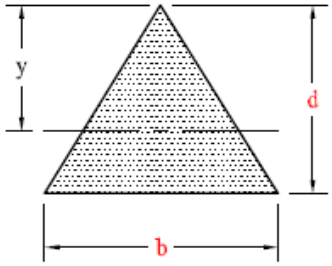
$r = 0.289\sqrt{\frac{bd^3 - hk^3}{bd - hk}}$ = mm

Properties of Sections - Centered Triangle

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

b = mm
d = mm

---------- **Calculated Properties** ----------

$A = \frac{1}{2}bd$ = mm^2

$y = \frac{2}{3}d$ = mm

$I = \frac{bd^3}{36}$ = mm^4

$Z = \frac{bd^2}{24}$ = mm^3

$r = 0.236d$ = mm

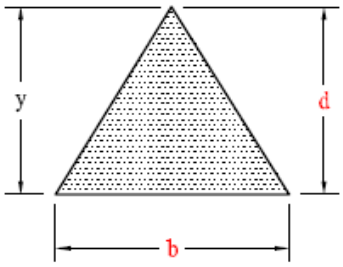
10/04/11

Properties of Sections - Offset Triangle

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

b = mm
d = mm

---------- **Calculated Properties** ----------

$A = \frac{1}{2}bd$ = mm^2
y = d = mm
$I = \frac{bd^3}{12}$ = mm^4
$Z = \frac{bd^2}{12}$ = mm^3
r = 0.408d = mm

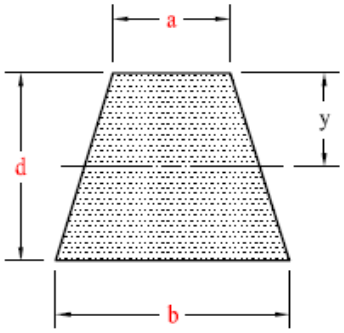
10/04/11

Properties of Sections - Trapezoid

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

a = mm
b = mm
d = mm

---------- **Calculated Properties** ----------

$$A = \frac{d(a + b)}{2} = \quad mm^2$$

$$y = \frac{d(a + 2b)}{3(a + b)} = \quad mm$$

$$I = \frac{d^3 \cdot \left(a^2 + 4 \cdot ab + b^2\right)}{36 \cdot (a + b)} = \quad mm^4$$

$$Z = \frac{d^2\left(a^2 + 4ab + b^2\right)}{12(a + 2b)} = \quad mm^3$$

$$r = \sqrt{\frac{I}{A}} = \quad mm$$

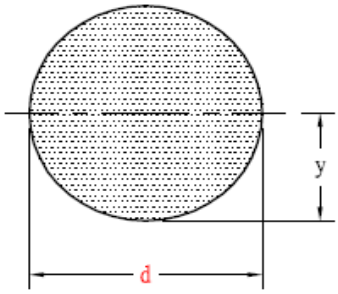
10/04/11

Properties of Sections - Circle

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

d = mm

---------- **Calculated Properties** ----------

$A = 0.7854d^2$ = mm^2

$y = \frac{d}{2}$ = mm

$I = 0.049d^4$ = mm^4

$Z = 0.098d^3$ = mm^3

$r = \frac{d}{4}$ = mm

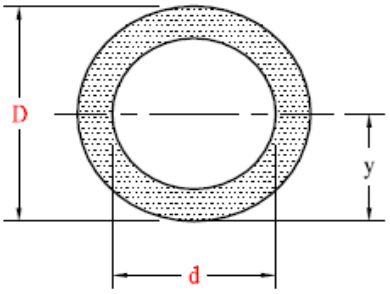
10/04/11

Properties of Sections - Donut

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

D = mm
d = mm

---------- **Calculated Properties** ----------

$A = 0.7854(D^2 - d^2)$ = mm^2

$y = \frac{D}{2}$ = mm

$I = 0.049(D^4 - d^4)$ = mm^4

$Z = \frac{0.098\left(D^4 - d^4\right)}{D}$ = mm^3

$r = \sqrt{D^2 + \frac{d^2}{4}}$ = mm

10/04/11

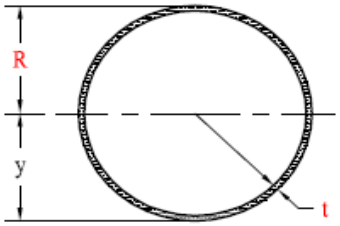
Properties of Sections - Thin-Walled Cylinder

For Section of thin walled cylinder when R>10t

SERVICE:

Definition of Symbols

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



User Input

R = mm
t = mm

Calculated Properties

$A = 2R\pi t$ = mm^2
y = R = mm
$I = R^3t\pi$ = mm^4
$Z = R^2t\pi$ = mm^3
r = 0.707R = mm

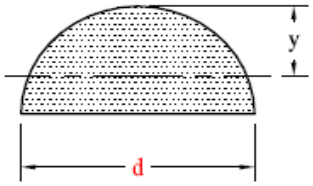
10/04/11

Properties of Sections - Half Circle

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

d = mm

---------- **Calculated Properties** ----------

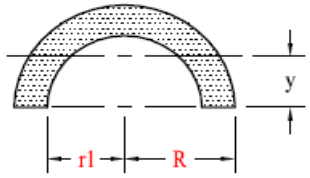
$A = 0.393d^2$ = mm^2
$y = 0.288d$ = mm
$I = 0.007d^4$ = mm^4
$Z = 0.024d^3$ = mm^3
$r = 0.132d$ = mm

Properties of Sections - Half Donut

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

R = mm
r1 = mm

---------- **Calculated Properties** ----------

$A = 1.5708(R^2 - r1^2)$ = mm^2

$y = 0.424\frac{R^3 - r1^3}{R^2 - r1^2}$ = mm

$I = 0.1098\left(R^4 - r1^4\right) - \frac{0.283R^2 r1^2(R-r1)}{R + r1}$ = mm^4

$Z = \frac{I}{y}$ = mm^3

$r = \sqrt{\frac{I}{y}}$ = mm

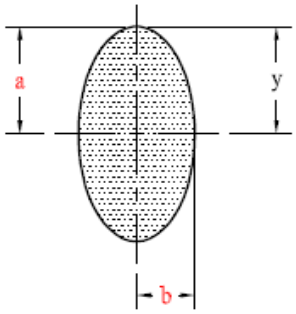
10/04/11

Properties of Sections - Ellipse

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

a = mm
b = mm

---------- **Calculated Properties** ----------

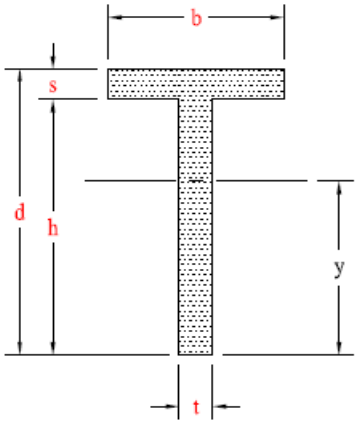
$A = 3.1416ab$ = mm^2
y = a = mm
$I = 0.7854a^3b$ = mm^4
$Z = 0.7854a^2b$ = mm^3
$r = \frac{a}{2}$ = mm

Properties of Sections - Structural Tee

SERVICE:

---------- Definition of Symbols ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- User Input ----------

b = mm
d = mm
h = mm
s = mm
t = mm

---------- Calculated Properties ----------

$A = bs + ht$ = mm^2

$y = d - \frac{d^2t + s^2(b - t)}{2(bs + ht)}$ = mm

$I = \frac{1}{3}[ty^3 + b(d - y)^3 - (b - t)(d - y - s)^2]$ = mm^4

$Z = \frac{I}{y}$ = mm^3

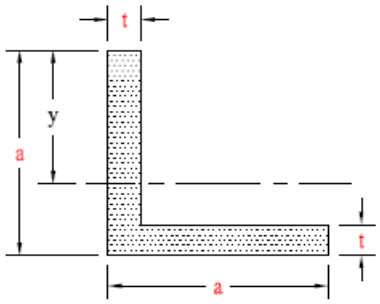
$r = \sqrt{\frac{I}{A}}$ = mm

Properties of Sections - Equal 'L'

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

a = mm
t = mm

---------- **Calculated Properties** ----------

$A = t(2a-t)$ = mm^2

$y = a - \frac{a^2 + at - t^2}{2(2a - t)}$ = mm

$I = \frac{1}{3}[ty^3 + a(a-y)^3 - (a - t)(b - y - t)^3]$ = mm^4

$Z = \frac{I}{y}$ = mm^3

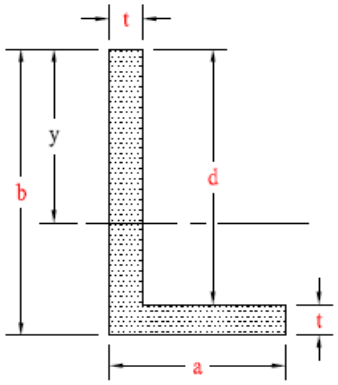
$r = \sqrt{\frac{I}{A}}$ = mm

Properties of Sections - Unequal 'L'

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

a = mm
b = mm
d = mm
t = mm

---------- **Calculated Properties** ----------

$A = t(a + b - t)$ = mm^2

$y = b - \frac{t(2d + a) + d^2}{2(d + a)}$ = mm

$I = \frac{1}{3}[ty^3 + a(b - y)^3 - (a - t)(b - y - t)^3]$ = mm^4

$Z = \frac{I}{y}$ = mm^3

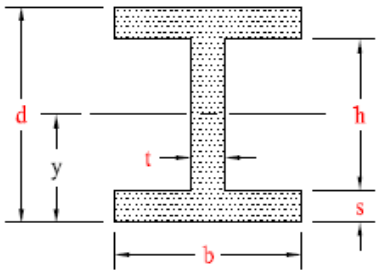
$r = \sqrt{\frac{I}{A}}$ = mm

Properties of Sections - Vertical 'I'

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

b = mm
d = mm
h = mm
s = mm
t = mm

---------- **Calculated Properties** ----------

$A = bd - h(b - t)$ mm^2

$y = \frac{d}{2}$ = mm

$I = \frac{bd^3 - h^3(b - t)}{12}$ = mm^4

$Z = \frac{bd^3 - h^3(b - t)}{6d}$ = mm^3

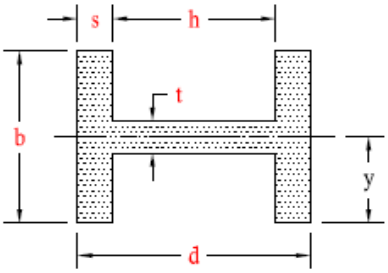
$r = \sqrt{\frac{I}{A}}$ = mm

Properties of Sections - Horizontal 'I'

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

b =		mm
d =		mm
h =		mm
s =		mm
t =		mm

---------- **Calculated Properties** ----------

$A = bd - h(b - t)$ mm^2

$y = \frac{b}{2} =$ mm

$I = \frac{2sb^3 + ht^3}{12} =$ mm^4

$Z = \frac{2sb^3 + ht^3}{6b} =$ mm^3

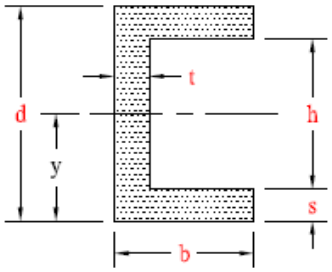
$r = \sqrt{\frac{I}{A}} =$ mm

Properties of Sections - Vertical Channel

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

b = mm
d = mm
h = mm
s = mm
t = mm

---------- **Calculated Properties** ----------

$A = bd - h(b - t)$ mm^2

$y = \frac{d}{2}$ = mm

$I = \frac{bd^3 - h^3(b - t)}{12}$ = mm^4

$Z = \frac{bd^3 - h^3(b - t)}{6d}$ = mm^3

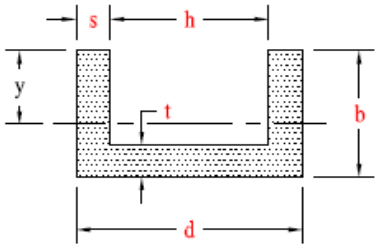
$r = \sqrt{\frac{bd^3 - h^3(b - t)}{12(bd - h(b - t)}}$ = mm

Properties of Sections - Horizontal Channel

SERVICE:

---------- **Definition of Symbols** ----------

A = Area, mm^2
I = Moment of inertia, mm^4
r = Radius of gyration, $\sqrt{(I/A)}$
y = Distance from neutral axis to extreme fiber, mm
Z = Section modulus, I/y, mm^3



---------- **User Input** ----------

b = mm
d = mm
h = mm
s = mm
t = mm

---------- **Calculated Properties** ----------

$A = bd - h(b - t)$ = mm^2

$y = b - \frac{2b^2s + ht^2}{2bd - 2h(b - t)}$ = mm

$I = (2sb^3 + ht^3)/[3 - A(b - y)^2]$ = mm^4

$Z = \frac{I}{y}$ = mm^3

$r = \sqrt{\frac{I}{A}}$ = mm

Properties of Sections

BASIS : This program is for calculating the properties of sections.

NOTE : Always begin a new case by retrieving the original file. Direct entry of data in cells that originally contain table lookups could cause functions to be lost and/or incorrect calculations. Cells that require data entry are colored **RED**; calculated values are black.

REFERENCES :

1) *Pressure Vessel Handbook - 11th Edition*
2) *Manual of Steel Construction - Allowable Stress Design - A.I.S.C. 9th Edition*

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