



Developed by Ce.A.S. srl, Italy and Deep Excavation LLC, U.S.A.

Equivalent thickness calculation in Paratie Plus

A. Steel sheet wall

Consider the sheet wall designed in the example.

It's a tipe AZ28, it's inertia is 58938.8 cm⁴/m.

Paratie Plus calculates an equivalent thickness considering a rectangular section having the same inertia.

It's possible to rea, in Paratie input file (.d):

* 6.1 LEFT WALL STRUCTURAL PROPERTIES

**Calculate equivalent Steel Sheet Pile Ixx. X Wall Spacing*

** Ewall= 210000 Mpa, Stiffness Ixx= 58938.8 cm⁴/m x 1 m = 58938.8 cm⁴*

** Iequivalent= Ewall x Ixx x ConvEI / (Estandard x ConvEL x Wall Spacing) =>*

** Iequivalent= 210000 Mpa x 58938.8 cm⁴/m x 1 m = 58938.8 cm⁴ x 1E-08/ (210000 x 1 x 1)=
0.00059 (m⁴/m)*

**Now calculate Equivalent Wall Thickness from Ixx/Length*

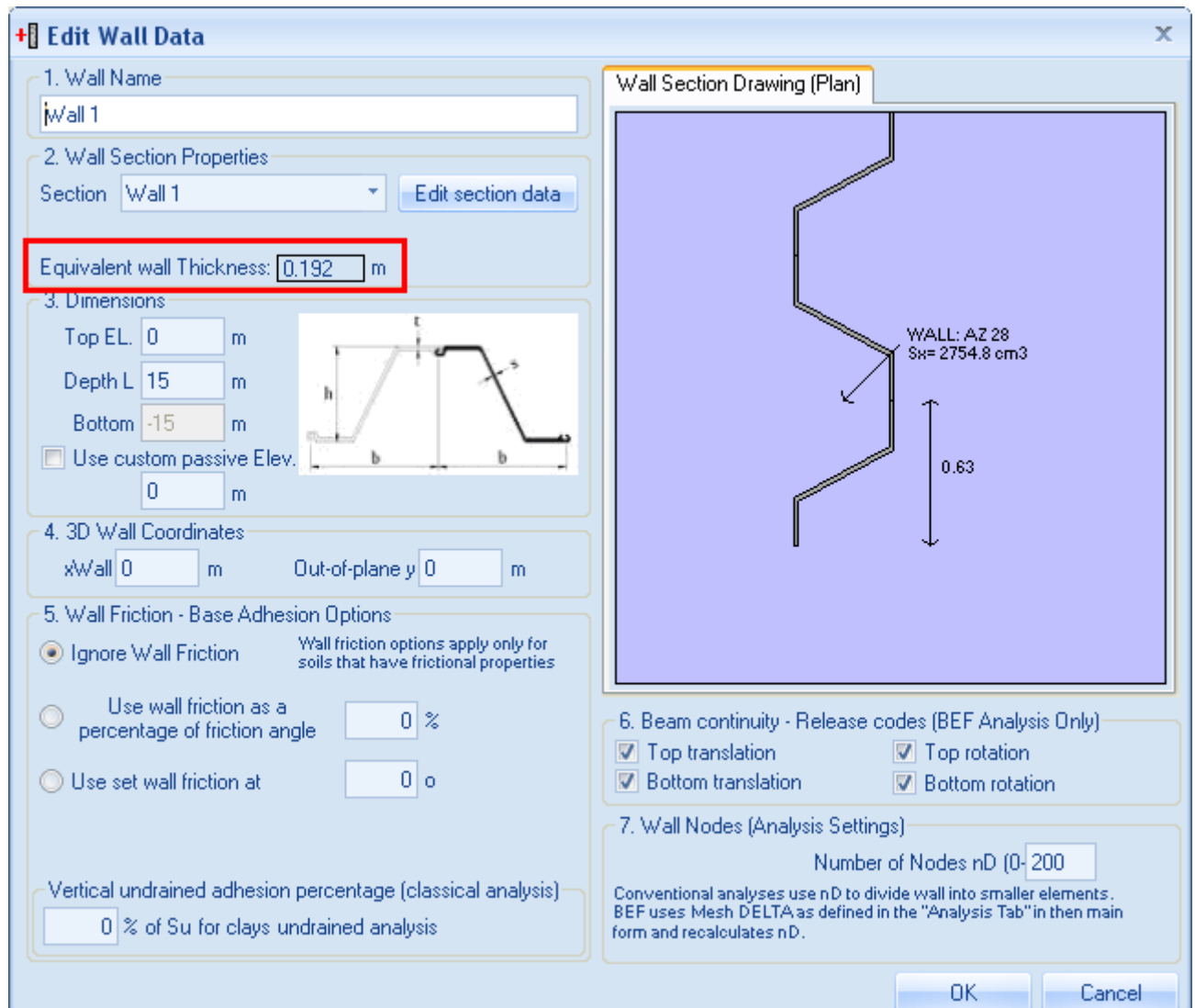
** Wall thick= (12 x Ixx/L)^(1/3) = (12 x 0.00059)^(1/3) = 0.19195 (m)*

$I_{eq} = E_{muro} * I_{xx} / (E_{standard} * s) = 0.00059 \text{ m}^4/\text{m}.$

s = horizontal space between elements.

The equivalent thickness is calculated as:

$s = \sqrt[3]{12 * I_{eq}}$ and is worth, in this case, 19.2 cm.



B. IPE pails filled with concrete

Consider the wall designed in the example.

It's a wall made up with aligned IPE beams; the inertia for a IPE220 is worth 1943 cm^4 .

Paratie Plus calculates an equivalent thickness considering a rectangular section having an equivalent inertia.

In the input file of Paratie it's possible to read:

*** 6.1 LEFT WALL STRUCTURAL PROPERTIES**

* Calculate equivalent Soldier Pile I_{xx} , with Steel Beam.

* $E_{wall} = 206000 \text{ MPa}$, Stiffness $I_{xx} = 1943 \text{ cm}^4$

* $I_{equivalent} = E_{wall} \times I_{xx} \times ConvEI / (E_{standard} \times ConvEL \times Wall \text{ Spacing}) \Rightarrow$

* $I_{equivalent} = 206000 \text{ MPa} \times 1943 \text{ cm}^4 \times 1E-08 / (206000 \times 1 \times 0.2) = 0.0001 \text{ (m}^4/\text{m)}$

* Now calculate Equivalent Wall Thickness from I_{xx}/Length

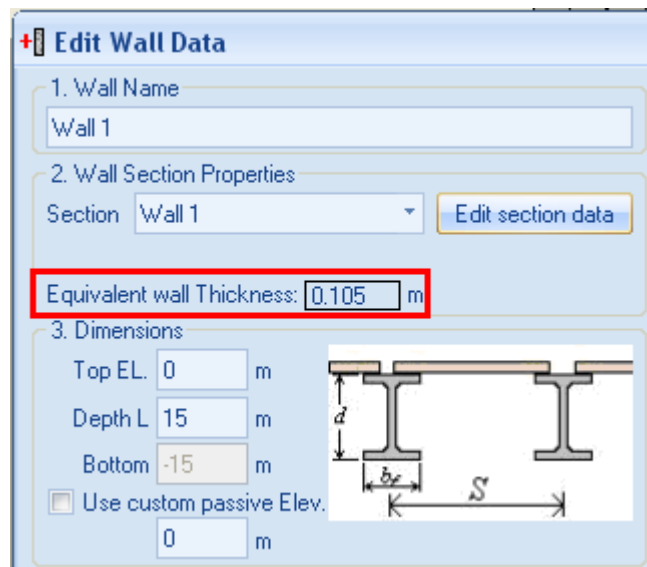
* $Wall \text{ thick} = (12 \times I_{xx}/L)^{1/3} = (12 \times 0.0001)^{1/3} = 0.10525 \text{ (m)}$

$$I_{eq} = E_{muro} * I_{xx} / (E_{standard} * s) = 0.0001 \text{ m}^4/\text{m}.$$

$s = 0,2 \text{ m}$ beams horizontal space

The equivalent thickness is:

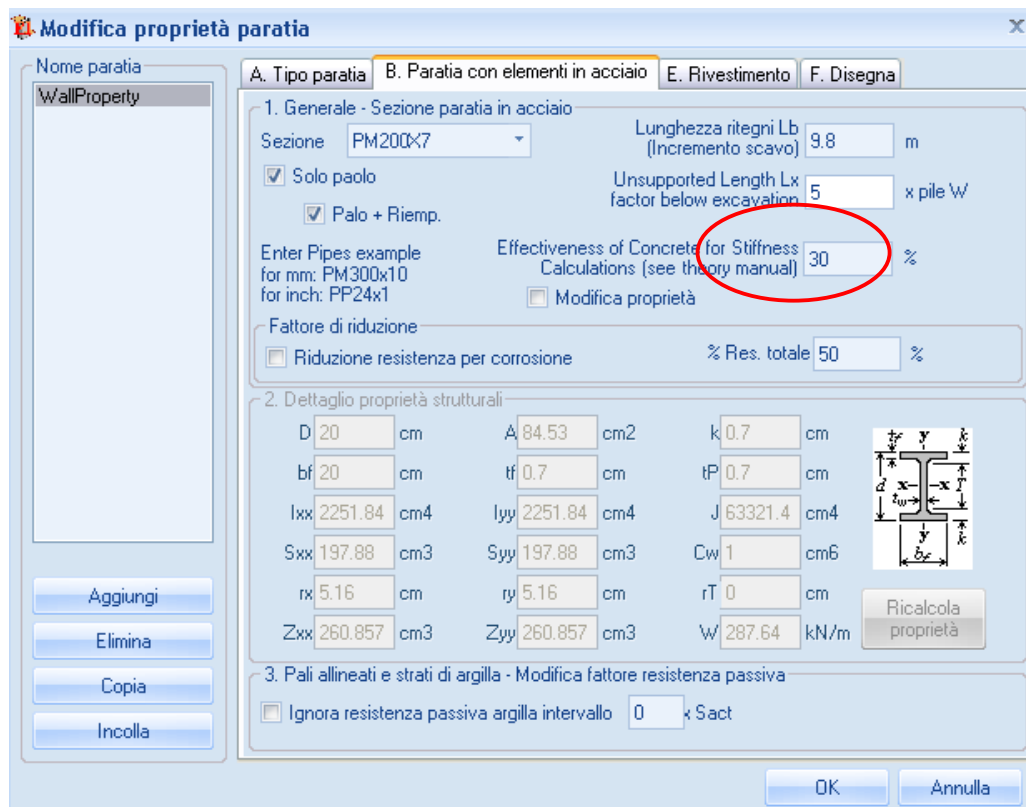
$s = \sqrt[3]{12 * I_{eq}}$ and is worth, in this case, 10.52 cm.



C. Steel pipe filled with concrete

Consider a wall made up with pails, having diameter 200 mm, thickness 7 mm and horizontal spacing 0,3m.

In the window *Edit section data* it's possible to choose the effectiveness of concrete for section stiffness calculation. Assume 30% (see figure below).



Steel section inertia is worth:

$$I_{xx} = /64 * (D^4 - (D - 2*tp)^4) = 1978,8 \text{ cm}^4.$$

Concrete inertia is worth:

$$I_{cls} = /64 * D_{int}^4 * 0,3 * (E_{cls} / E_{steel}) = 237 \text{ cm}^4.$$



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Having:

$$E_{cls} = 31000 \text{ kPa}$$

$$E_{steel} = 200100 \text{ kPa}$$

$$I_{eq} = I_{xx} + I_{cls} = 2252 \text{ cm}^4/\text{m}.$$

Paratie Plus calculates an equivalent thickness considering a rectangular section having an equivalent inertia.

In the input file of Paratie it's possible to read:

* 6.1 LEFT WALL STRUCTURAL PROPERTIES

**Calculate equivalent Soldier Pile I_{xx} , with Steel Beam.*

** $E_{wall} = 200100 \text{ MPa}$, Stiffness $I_{xx} = 2251.85 \text{ cm}^4$*

** $I_{equivalent} = E_{wall} \times I_{xx} \times ConvEI / (E_{standard} \times ConvEL \times Wall \text{ Spacing}) \Rightarrow$*

** $I_{equivalent} = 200100 \text{ MPa} \times 2251.85 \text{ cm}^4 \times 1E-08 / (200100 \times 1 \times 0.3) = 8E-05 \text{ (m}^4/\text{m)}$*

**Now calculate Equivalent Wall Thickness from I_{xx}/Length*

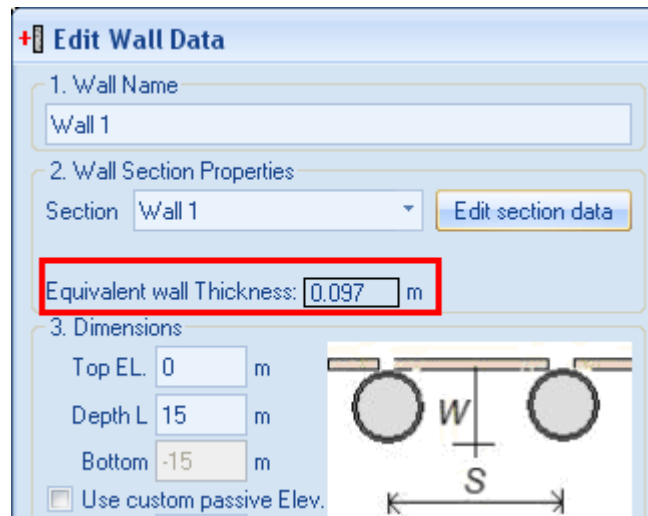
** $Wall \text{ thick} = (12 \times I_{xx}/L)^{(1/3)} = (12 \times 8E-05)^{(1/3)} = 0.09658 \text{ (m)}$*

$$I_{eq} = E_{muro} * I_{xx} / (E_{standard} * s) = 8e-5 \text{ m}^4/\text{m}.$$

$s = 0,3 \text{ m}$ pails horizontal space

The equivalent thickness is:

$s = \sqrt[3]{12 * I_{eq}}$ and is worth, in this case, 9,66 cm.



D. Tangent pile wall

Consider a wall made up with tangent piles, with IPE200 profiles put into concrete pails having $D = 25$ mm and $S = 25$ mm.

In the window *Edit section data* it's possible to choose the effectiveness of concrete for section stiffness calculation. Assume 25% (see figure below).

A. Wall Type **B. Steel Beams** F. Draw

1. General - Steel Beam Section

Section: IPE 200 Unsupported Length Lb (Excavation Increment): 9.8 m

Section is channel [Unsupported Length Lx factor below excavation: 5 x pile W

Double channels s 5 in

Is Pipe

Fill concrete

Include cover for stiffness calculation (not recommended)

Effectiveness of Concrete for Stiffness Calculations (see theory manual): 25 %

Edit strut properties manually

Threaded steel pipe reduction

Reduce steel pipe capacity due to threads Available Thread Strength: 50 %

2. Detailed Structural Properties of Steel Beam Section

D	20	cm	A	81.96	cm ²	k	0.7	cm
bf	20	cm	tf	0.7	cm	tw	0.7	cm
Ixx	1943	cm ⁴	Iyy	2192.42	cm ⁴	J	63321.4	cm ⁴
Sxx	197.88	cm ³	Syy	197.88	cm ³	Cw	1	cm ⁶
rx	5.17	cm	ry	5.17	cm	rT	5.22	cm
Zxx	260.857	cm ³	Zyy	260.857	cm ³	W	278.89	kN/m

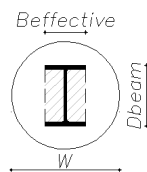
[Recalculate Properties](#)

3. Soldier Piles and Clay Layers - Passive Resistance Modification

Ignore passive resistance from clays within 0 x Sact (flange or size)

An IPE200 profile inertia is worth 1943 cm⁴.

Also the concrete (included into the pipe) contribute must be considered:



$$I_{cls} = ((b - tw) * T^3) / 12 * (E_{cls}/E_{steel}) * 0,25$$

Having:

$$b = 10 \text{ cm}$$

$$tw = 0,6 \text{ cm}$$

$$T = B - 2*tf$$



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$B = 20 \text{ cm}$

$t_f = 0,8 \text{ cm}$

Finally:

$l_{eq} = l_{cls} + l_{ipe}$

Continue as the examples above.