



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.

+ Edit Wall Data

1. Wall Name
Wall 1

2. Wall Section Properties
Section: Wall 1 Edit section data

Equivalent wall Thickness: 0.192 m

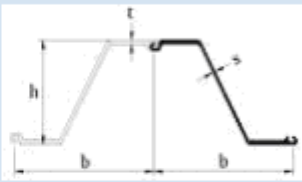
3. Dimensions

Top EL: 0 m

Depth L: 15 m

Bottom: -15 m

Use custom passive Elev. 0 m



4. 3D Wall Coordinates
xWall 0 m Out-of-plane y 0 m

5. Wall Friction - Base Adhesion Options

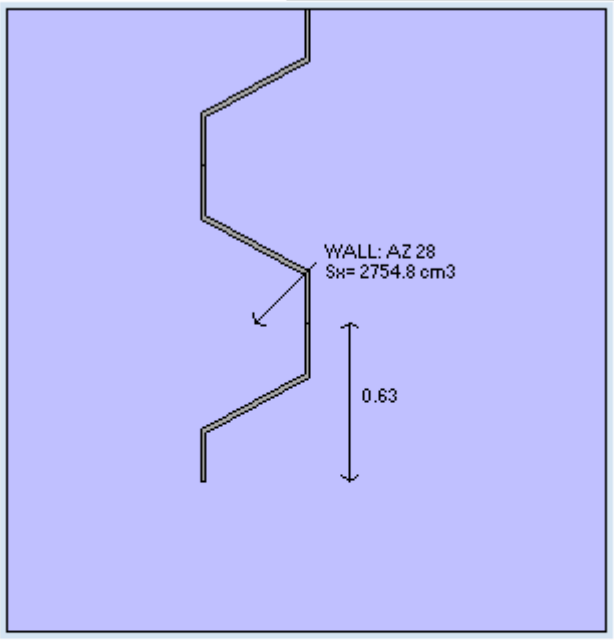
Ignore Wall Friction Wall friction options apply only for soils that have frictional properties

Use wall friction as a percentage of friction angle 0 %

Use set wall friction at 0 o

Vertical undrained adhesion percentage (classical analysis)
0 % of S_u for clays undrained analysis

Wall Section Drawing (Plan)



6. Beam continuity - Release codes (BEF Analysis Only)

Top translation Top rotation

Bottom translation Bottom rotation

7. Wall Nodes (Analysis Settings)

Number of Nodes nD (0-200) 200

Conventional analyses use nD to divide wall into smaller elements. BEF uses Mesh DELTA as defined in the "Analysis Tab" in then main form and recalculates nD.

OK
Cancel

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

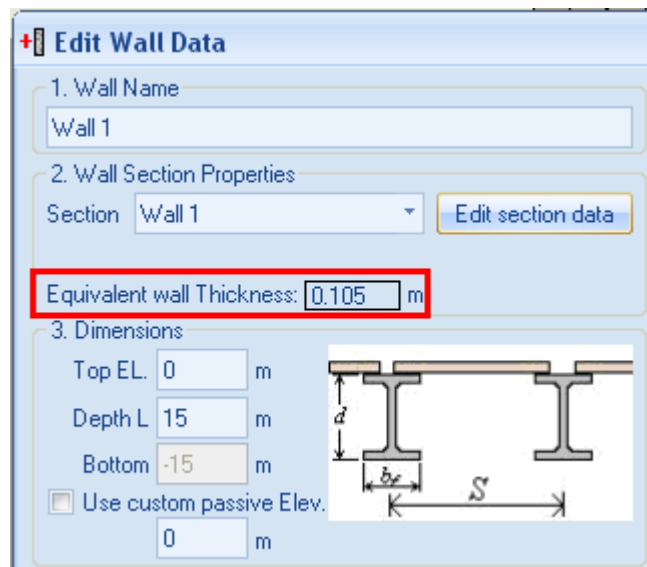
* $Wall \text{ thick} = (12 \times I_{xx}/L)^{1/3} = (12 \times 0.0001)^{1/3} = 0.10525 \text{ (m)}$

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

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

The equivalent thickness is:

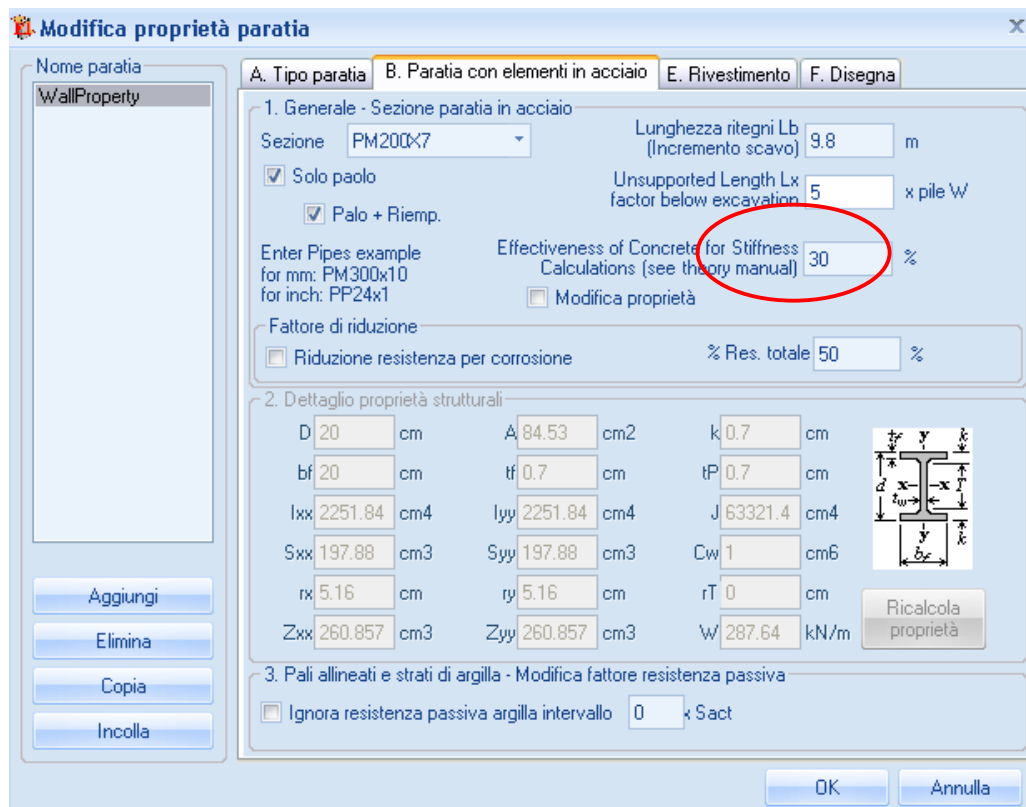
$s = \sqrt[3]{12 * I_{eq}}$ and is worth, in this case, 10.52 cm.



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*

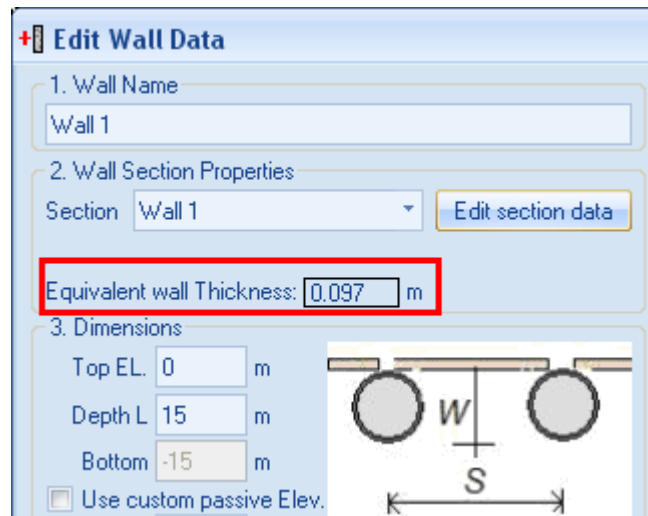
** $Wall \text{ thick} = (12 \times I_{xx}/L)^{(1/3)} = (12 \times 8E-05)^{(1/3)} = 0.09658 \text{ (m)}$*

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

$s = 0,3 \text{ m}$ 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

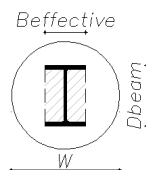
[Recalculate Properties](#)

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.