GEODOMISI Ltd. - Dr. Costas Sachpazis
Civil & Geotechnical Engineering Consulting Company for Structural Engineering, Soil Mechanics, Rock Mechanics, Foundation Engineering & Retaining Structures.
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Project: Steel Sheet Piling Design Analysis & Design, Free Earth Support. In accordance with BS 8002:1994 - Code of practice for earth retaining structures.				Job Ref. www.geodomisi.com	
Section: Civil & Geotechnical Engineering				Sheet no./rev. 1	
Calc. by: Dr. C. Sachpazis	Date: 17/11/2015	Chk'd by	Date	App'd by	Date

STEEL SHEET PILING DESIGN

In accordance with BS 8002:1994 - Code of practice for earth retaining structures

Tied wall with free earth support

Geometry

Length of sheet pile for equilibrium (for analysis); H = **9446** mm
Total length of sheet pile provided; H_{pile} = **11800** mm
Number of different types of soil; N_s = **2**
Retained height; d_{ret} = **6500** mm
Depth of unplanned excavation; d_{ex} = **500** mm
Total retained height; $d_s = d_{ret} + d_{ex}$ = **7000** mm
Angle of retained slope; β = **0.0** deg
Depth from GL to top of water table retained side; d_w = **4000** mm
Depth from GL to top of water table retaining side; d_{wp} = **5000** mm

Soil layer 1

Moist density of soil; γ_{m1} = **14.7** kN/m^3
Dry density of soil; γ_{d1} = **9.3** kN/m^3
Active pressure coefficient; k_{a1} = **0.317**
Passive pressure coefficient; k_{p1} = **3.963**
Height of soil layer 1; h_1 = **4000** mm
Depth from GL to bottom of layer1; d_1 = **4000** mm

Soil layer 2

Moist density of soil; γ_{m2} = **15.4** kN/m^3
Dry density of soil; γ_{d2} = **9.6** kN/m^3
Active pressure coefficient; k_{a2} = **0.260**
Passive pressure coefficient; k_{p2} = **5.329**
Height of soil layer 2; h_2 = **5446** mm

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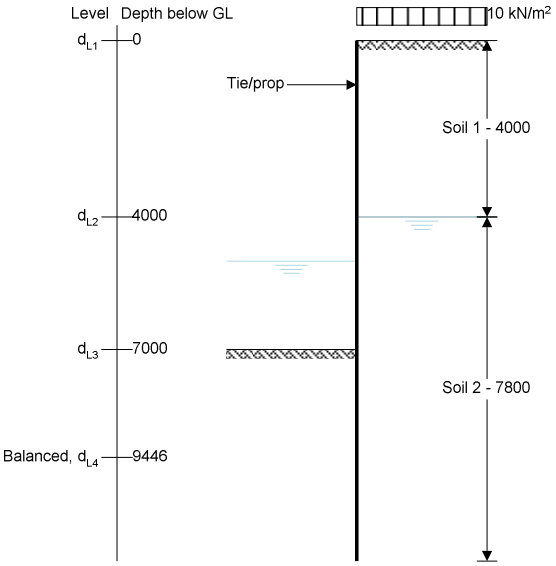
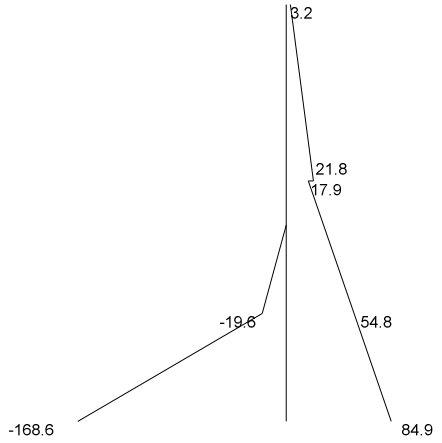


SECTION THROUGH SHEET PILE WALL



BALANCED PRESSURE DIAGRAM (kN/m²)

Overburden on active side

Overburden at 0 mm below GL in soil 1; $OB_{a11} = Q =$ **10.0** kN/m²

Overburden at 4000 mm below GL in soil 1; $OB_{a21} = \gamma_{m1} \times h_{a1} + OB_{a11} =$ **68.8** kN/m²

Overburden at 4000 mm below GL in soil 2; $OB_{a22} = \gamma_{m1} \times h_{a1} + OB_{a11} =$ **68.8** kN/m²

Overburden at 7000 mm below GL in soil 2; $OB_{a31} = \gamma_{d2} \times h_{a2} + OB_{a22} =$ **97.6** kN/m²

Overburden at 9446 mm below GL in soil 2; $OB_{a41} = \gamma_{d2} \times h_{a3} + OB_{a31} =$ **121.0** kN/m²

Overburden on passive side

Overburden at 7000 mm below GL in soil 2; $OB_{p31} = 0$ kN/m² = **0.0** kN/m²

Overburden at 9446 mm below GL in soil 2; $OB_{p41} = \gamma_{d2} \times h_{p3} + OB_{p31} =$ **23.5** kN/m²

Pressure on active side

Active pressure at 0 mm below GL in soil 1; $p_{a11} = k_{a1} \times OB_{a11} \times \cos(\beta) =$ **3.2** kN/m²

Active pressure at 4000 mm below GL in soil 1; $p_{a21} = k_{a1} \times OB_{a21} \times \cos(\beta) =$ **21.8** kN/m²

Active pressure at 4000 mm below GL in soil 2; $p_{a22} = k_{a2} \times OB_{a22} \times \cos(\beta) =$ **17.9** kN/m²

Active pressure at 7000 mm below GL in soil 2; $p_{a31} = k_{a2} \times OB_{a31} \times \cos(\beta) + \gamma_w \times (d_{L3} - d_w) =$ **54.8** kN/m²

Active pressure at 9446 mm below GL in soil 2; $p_{a41} = k_{a2} \times OB_{a41} \times \cos(\beta) + \gamma_w \times (d_{L4} - d_w) =$ **84.9** kN/m²

Pressure on passive side

Passive pressure at 7000 mm below GL in soil 2; $p_{p31} = k_{p2} \times OB_{p31} + \gamma_w \times (d_{L3} - \max(d_s, d_w)) + \gamma_w \times (d_s - d_{wp}) =$ **19.6** kN/m²

Passive pressure at 9446 mm below GL in soil 2; $p_{p41} = k_{p2} \times OB_{p41} + \gamma_w \times (d_{L4} - \max(d_s, d_w)) + \gamma_w \times (d_s - d_{wp})$ = **168.6** kN/m^2

Active forces

Active force at level 1; $F_{a11} = 0.5 \times p_{a11} \times h_{a1}$ = **6.3** kN/m

Active force at level 1; $F_{a12} = 0.5 \times p_{a21} \times h_{a1}$ = **43.6** kN/m

Active force at level 2; $F_{a21} = 0.5 \times p_{a22} \times h_{a2}$ = **26.8** kN/m

Active force at level 2; $F_{a22} = 0.5 \times p_{a31} \times h_{a2}$ = **82.2** kN/m

Active force at level 3; $F_{a31} = 0.5 \times p_{a31} \times h_{a3}$ = **67.0** kN/m

Active force at level 3; $F_{a32} = 0.5 \times p_{a41} \times h_{a3}$ = **103.8** kN/m

Passive forces

Passive force at level 3; $F_{p31} = 0.5 \times p_{p31} \times h_{p3}$ = **24.0** kN/m

Passive force at level 3; $F_{p32} = 0.5 \times p_{p41} \times h_{p3}$ = **206.2** kN/m

Force due to water level on passive side; $F_{pw} = 0.5 \times p_{p31} \times (d_s - d_{wp})$ = **19.620**kN/m

Total forces in tie

Total active forces; ΣF_a = **329.8** kN/m

Total passive forces; ΣF_p = **249.8** kN/m

Active moments about tie

Moment about tie level 1; $M_{a11} = 0.5 \times p_{a11} \times h_{a1} \times [(d_{L2} - d_t) - 2/3 \times h_{a1}]$ = **2.1** kNm/m

Moment about tie level 1; $M_{a12} = 0.5 \times p_{a21} \times h_{a1} \times [(d_{L2} - d_t) - 1/3 \times h_{a1}]$ = **72.7** kNm/m

Moment about tie level 2; $M_{a21} = 0.5 \times p_{a22} \times h_{a2} \times [(d_{L3} - d_t) - 2/3 \times h_{a2}]$ = **107.3** kNm/m

Moment about tie level 2; $M_{a22} = 0.5 \times p_{a31} \times h_{a2} \times [(d_{L3} - d_t) - 1/3 \times h_{a2}]$ = **411.0** kNm/m

Moment about tie level 3; $M_{a31} = 0.5 \times p_{a31} \times h_{a3} \times [(d_{L4} - d_t) - 2/3 \times h_{a3}]$ = **456.8** kNm/m

Moment about tie level 3; $M_{a32} = 0.5 \times p_{a41} \times h_{a3} \times [(d_{L4} - d_t) - 1/3 \times h_{a3}]$ = **792.2** kNm/m

Passive moments about tie

Moment about tie level 3; $M_{p31} = 0.5 \times p_{p31} \times h_{p3} \times [(d_{L4} - d_t) - 2/3 \times h_{p3}]$ = **163.5** kNm/m

Moment about tie level 3; $M_{p32} = 0.5 \times p_{p41} \times h_{p3} \times [(d_{L4} - d_t) - 1/3 \times h_{p3}]$ = **1573.6** kNm/m

Moment about tie – water level on passive side; $M_{pw} = 0.5 \times p_{p31} \times (d_s - d_{wp}) \times [(d_s - d_t) - 1/3 \times (d_s - d_{wp})]$ = **104.640**kN

Total moments about tie

Total active moment; ΣM_a = **1842.1** kNm/m

Total passive moment; ΣM_p = **1841.8** kNm/m

Required pile length

Length of pile required to balance moments; H_{total} = **9446** mm

Pass - Provided length of sheet pile greater than minimum required length of pile

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Required section modulus

Maximum moment in pile (from analysis); $M_{pile} = \max(ABS(M_{min}), ABS(M_{max})) =$ **184.4** kNm

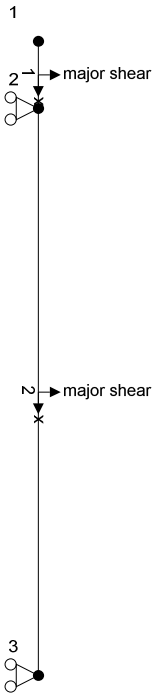
Permissible stress of pile; $\sigma_{pile} =$ **270** N/mm^2

Material factor; $\gamma_{ms} =$ **1.2**

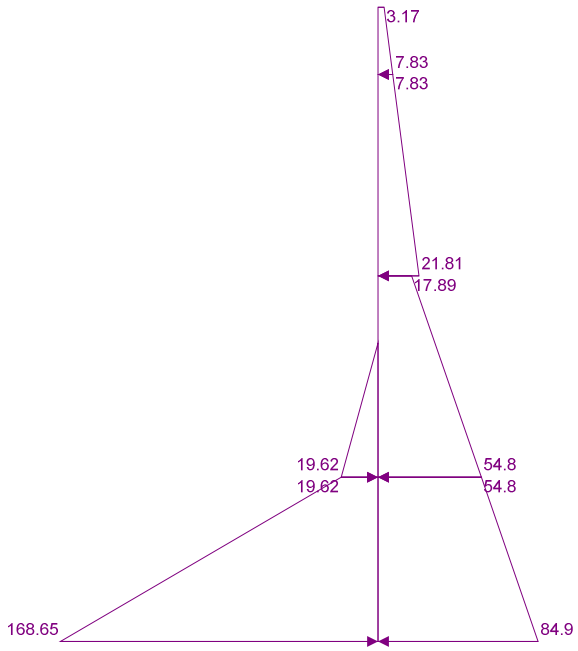
Min req'd plastic section modulus (per metre run); $Z = \gamma_{ms} \times M_{pile} / \sigma_{pile} =$ **819** cm^3

Load in tie/strut

Tie/strut load; $T = \Sigma F_a - \Sigma F_p =$ **80.0**kN/m



Analysis model



Analysis loading diagram

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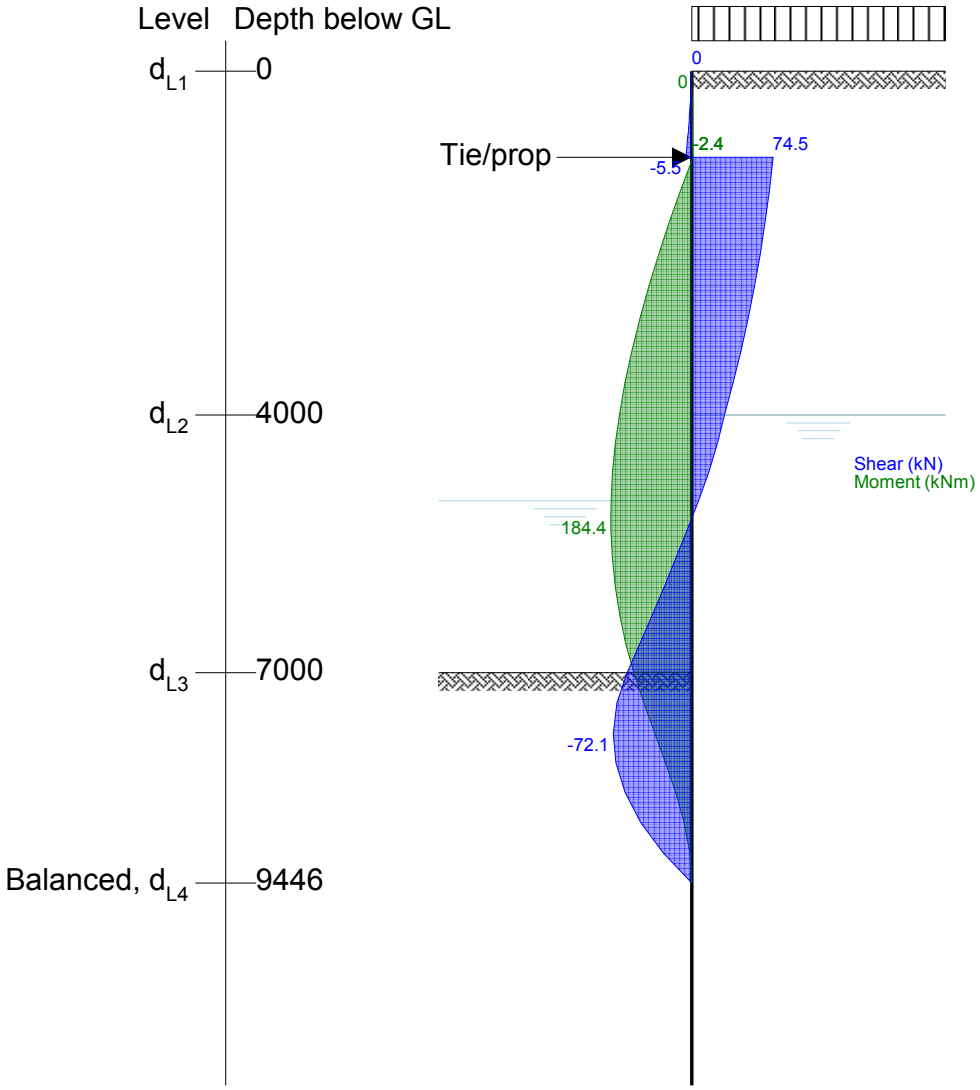

Bending moment and shear force diagram