STEEL SHEET PILING DESIGN

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

Tied wall with fixed earth support

Geometry

Length of sheet pile for equilibrium (for analysis);	H = **10953** mm
Total length of sheet pile provided;	H_{pile} = **11600** mm
Number of different types of soil;	N_s = **2**
Retained height;	d_{ret} = **7000** mm
Depth of unplanned excavation;	d_{ex} = **0** 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 = **6953** mm

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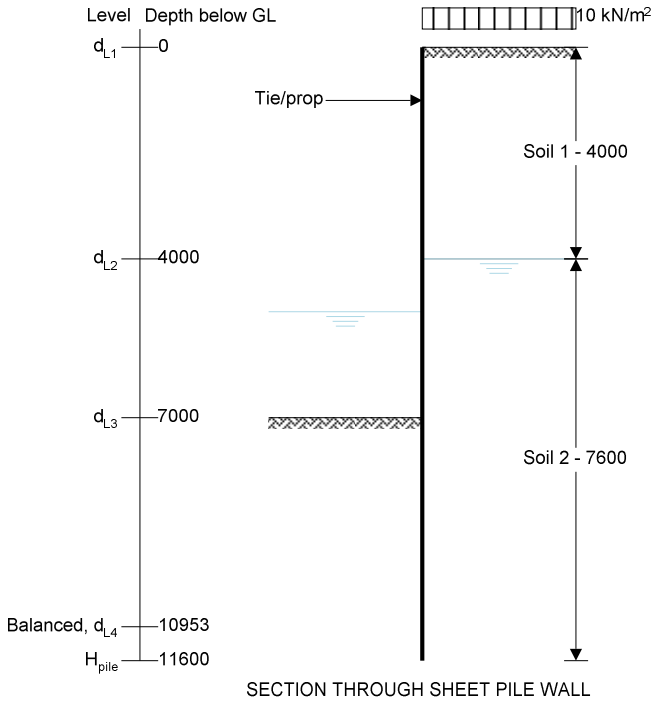
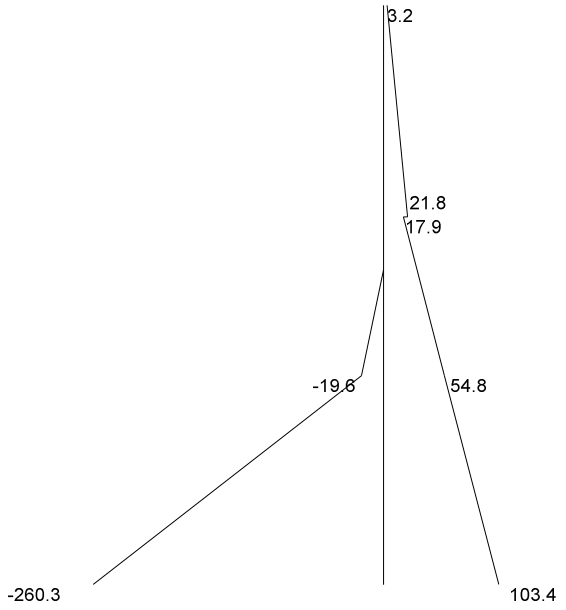


SECTION THROUGH SHEET PILE WALL



BALANCED PRESSURE DIAGRAM (kN/m2)

Overburden on active side

Overburden at 0 mm below GL in soil 1; $OB_{a11} = Q =$ **10.0** kN/m^2

Overburden at 4000 mm below GL in soil 1; $OB_{a21} = \gamma_{m1} \times h_{a1} + OB_{a11} =$ **68.8** kN/m^2

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

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

Overburden at 10952 mm below GL in soil 2; $OB_{a41} = \gamma_{d2} \times h_{a3} + OB_{a31} =$ **135.5** kN/m^2

Overburden on passive side

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

Overburden at 10952 mm below GL in soil 2; $OB_{p41} = \gamma_{d2} \times h_{p3} + OB_{p31} =$ **37.9** kN/m^2

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/m^2

Active pressure at 4000 mm below GL in soil 1; $p_{a21} = k_{a1} \times OB_{a21} \times \cos(\beta) =$ **21.8** kN/m^2

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

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/m^2

Active pressure at 10952 mm below GL in soil 2; $p_{a41} = k_{a2} \times OB_{a41} \times \cos(\beta) + \gamma_w \times (d_{L4} - d_w) =$ **103.4** kN/m^2

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/m^2

Passive pressure at 10952 mm below GL in soil 2; $p_{p41} = k_{p2} \times OB_{p41} + \gamma_w \times (d_{L4} - \max(d_s, d_w)) + \gamma_w \times (d_s - d_{wp})$ = **260.3** kN/m^2

Find the force in the tie by taking mnts about and above contraflexure point

Depth to point of contraflexure

$$d_{contra} = d_{L3} + ((p_{a31} - p_{p31}) / (((p_{p41} - p_{p31}) - (p_{a41} - p_{a31})) / h_{a3})) = \mathbf{7724} \text{ mm}$$

Sum of active moments; $\Sigma M_{ac} = \mathbf{491.0}$ kNm/m

Sum of Passive moments; $\Sigma M_{pc} = \mathbf{36.3}$ kNm/m

Force in tie; $T = (\Sigma M_{ac} - \Sigma M_{pc}) / (d_{contra} - d_t) = \mathbf{67.6}$ kN/m

Active moments about toe

Moment about toe level 1; $M_{a11} = 0.5 \times p_{a11} \times h_{a1} \times [(H - d_{L2}) + 2/3 \times h_{a1}] = \mathbf{61.0}$ kNm/m

Moment about toe level 1; $M_{a12} = 0.5 \times p_{a21} \times h_{a1} \times [(H - d_{L2}) + 1/3 \times h_{a1}] = \mathbf{361.4}$ kNm/m

Moment about toe level 2; $M_{a21} = 0.5 \times p_{a22} \times h_{a2} \times [(H - d_{L3}) + 2/3 \times h_{a2}] = \mathbf{159.7}$ kNm/m

Moment about toe level 2; $M_{a22} = 0.5 \times p_{a31} \times h_{a2} \times [(H - d_{L3}) + 1/3 \times h_{a2}] = \mathbf{407.1}$ kNm/m

Moment about toe level 3; $M_{a31} = 0.5 \times p_{a31} \times h_{a3} \times [(H - d_{L4}) + 2/3 \times h_{a3}] = \mathbf{285.4}$ kNm/m

Moment about toe level 3; $M_{a32} = 0.5 \times p_{a41} \times h_{a3} \times [(H - d_{L4}) + 1/3 \times h_{a3}] = \mathbf{269.4}$ kNm/m

Passive moments about toe

Moment about toe level 3; $M_{p31} = 0.5 \times p_{p31} \times h_{p3} \times [(H - d_{L4}) + 2/3 \times h_{p3}] = \mathbf{102.2}$ kNm/m

Moment about toe level 3; $M_{p32} = 0.5 \times p_{p41} \times h_{p3} \times [(H - d_{L4}) + 1/3 \times h_{p3}] = \mathbf{678.2}$ kNm/m

Moment about toe – water level on passive side; $M_{pw} = 0.5 \times p_{p31} \times (d_s - d_{wp}) \times [(H - d_{wp}) - 2/3 \times (d_s - d_{wp})] = \mathbf{90.638}$kN

Moment about toe for tie/prop; $M_{pt} = T \times (H - d_t) = \mathbf{673.1}$ kNm/m

Total moments about toe

Total active moment; $\Sigma M_a = \mathbf{1544.1}$ kNm/m

Total passive moment; $\Sigma M_p = \mathbf{1544.2}$ kNm/m

Required pile length

Length of pile required to balance moments; $H = \mathbf{10953}$ mm

Depth to point of contraflexure

$$d_{contra} = d_{L3} + ((p_{a31} - p_{p31}) / (((p_{p41} - p_{p31}) - (p_{a41} - p_{a31})) / h_{a3})) = \mathbf{7724} \text{ mm}$$

Add 20% below point of contraflexure; $d_{e\_add} = 1.2 \times (H - d_{contra}) = \mathbf{3875}$ mm

Minimum required pile length; $H_{total} = d_{contra} + d_{e\_add} = \mathbf{11599}$ mm

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

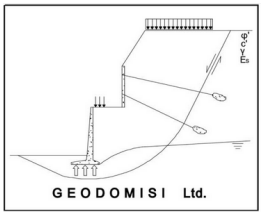
Required section modulus

Maximum moment in pile (from analysis); $M_{pile} = \max(ABS(M_{min}), ABS(M_{max})) =$ **138.0** 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); $Z = \gamma_{ms} \times M_{pile} / \sigma_{pile} =$ **613** cm^3



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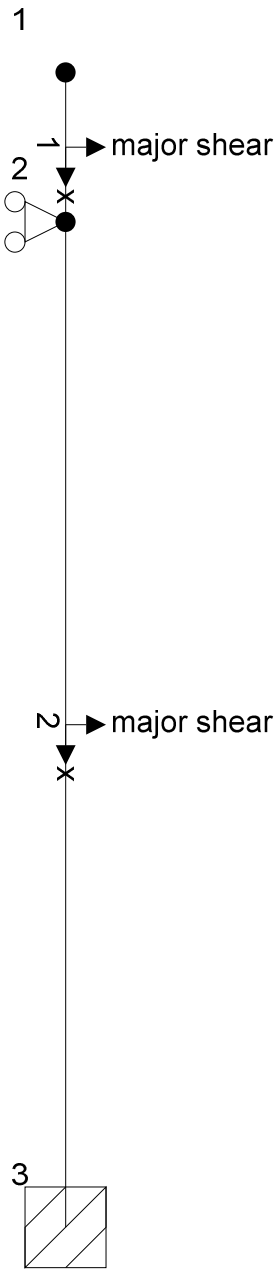
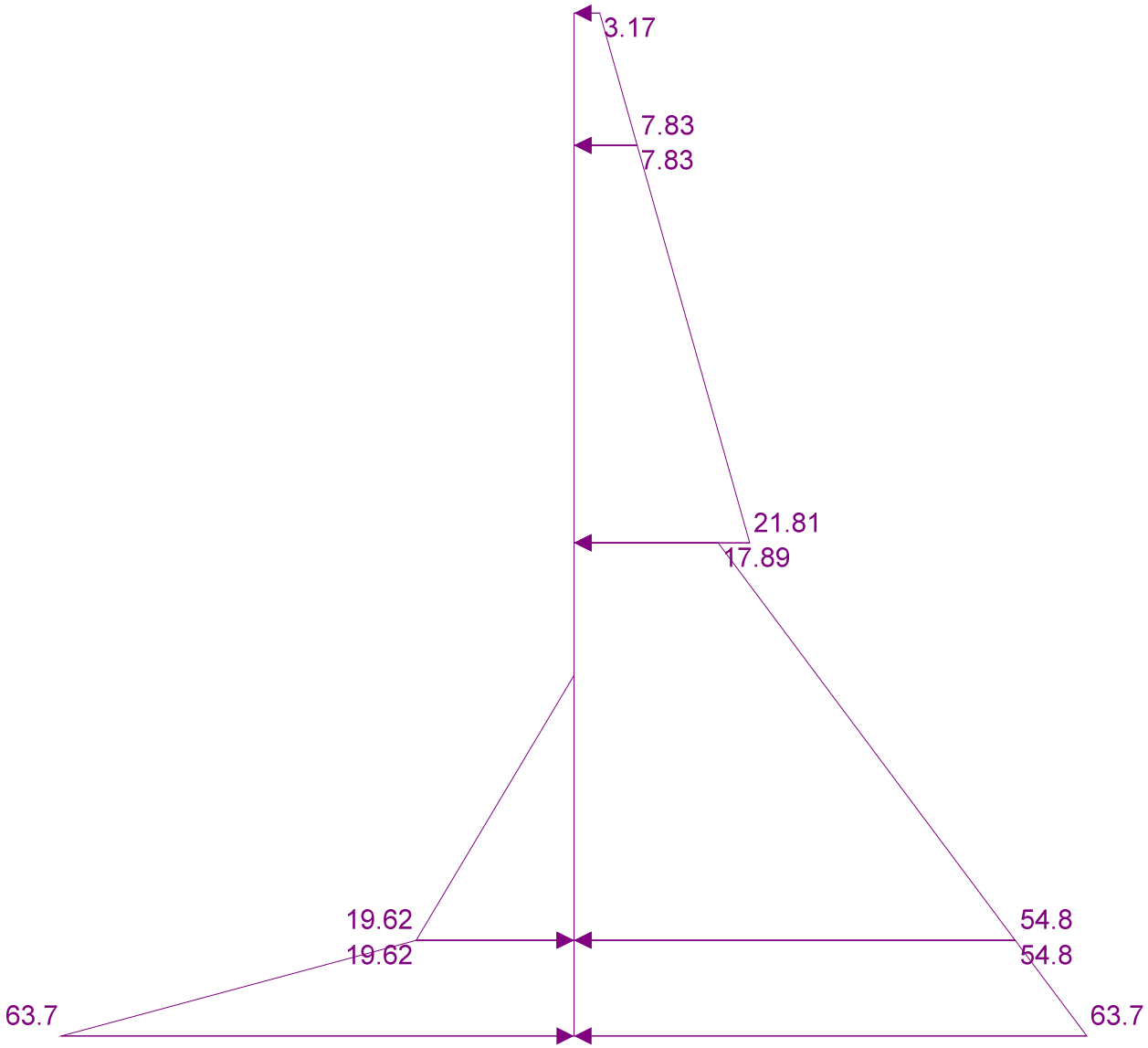
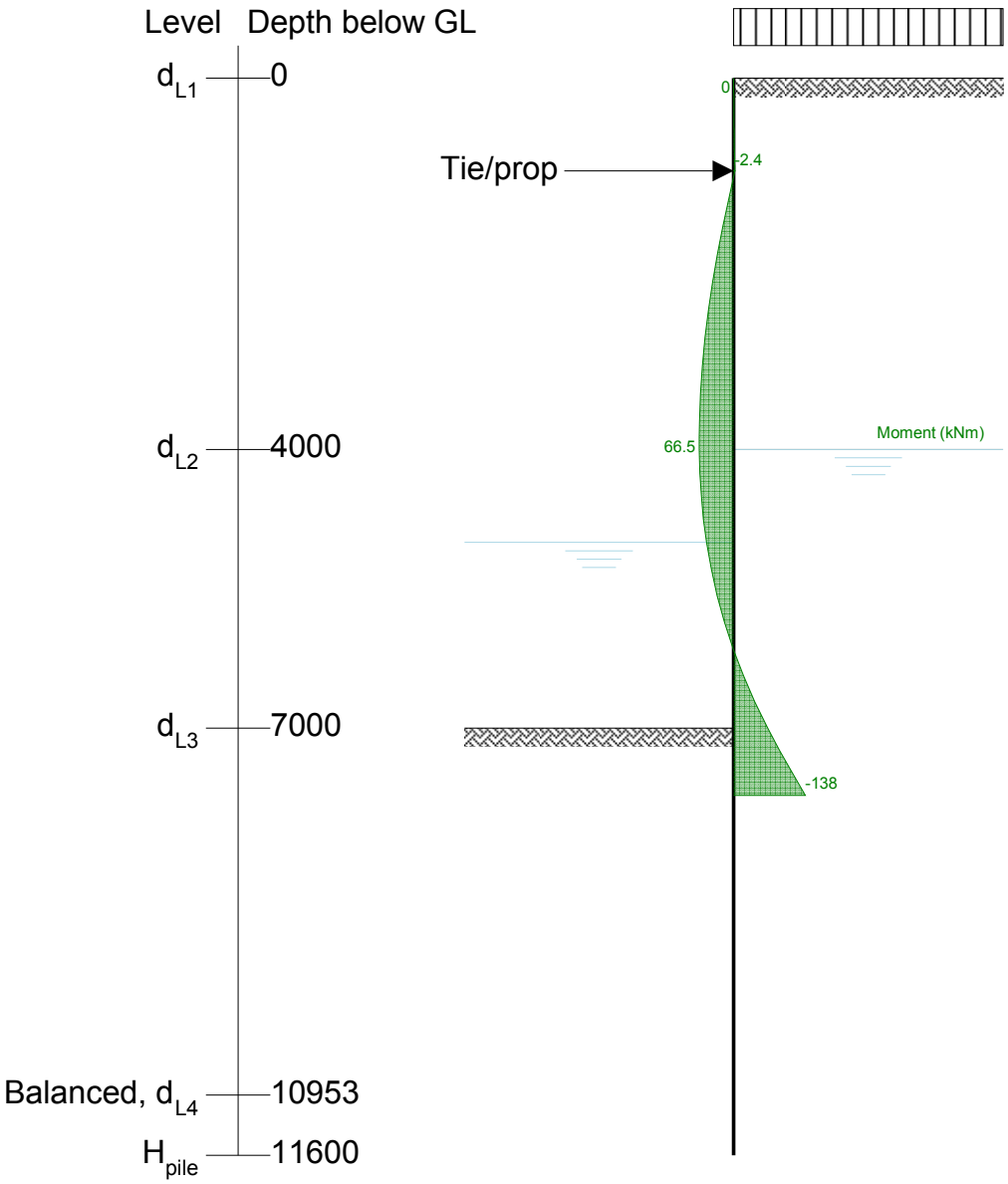


Analysis model



Analysis loading diagram



Bending moment diagram