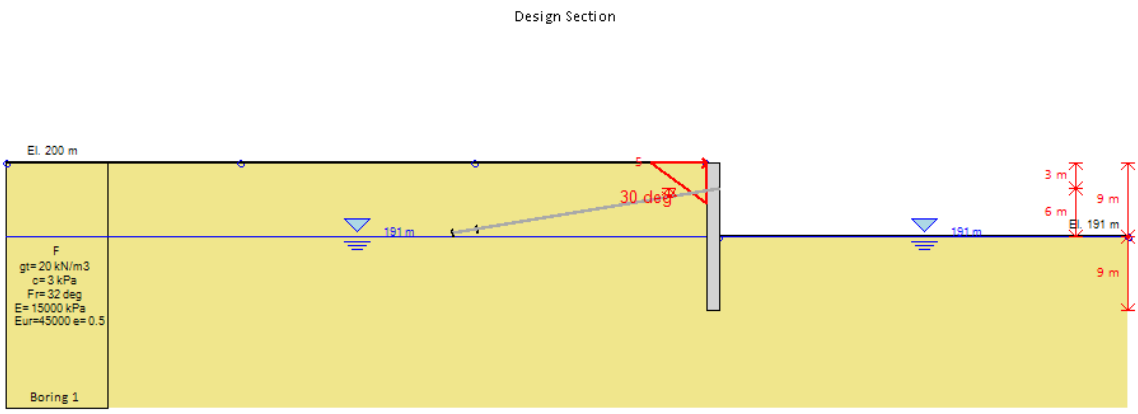
Verification of a helical anchor geotechnical capacity

The purpose of this example is to verify geotechnical capacity calculations for a helical ground anchor. The example below shows a 9m excavation with a helical anchor installed 3m below the top of the wall and at a 30 degree inclination.



The following information is used to determine the geotechnical pullout resistance of the helical anchor:

End offset: 0.152 m (distance from end to first helical plate)

Effective helix area: 0.06271m^2

Helix diameter: 0.3048m (12inches)

Number of plates: 2

Plate spacing: 1m

Ultimate helix cap: 841.05 kN

Soil density above water: 19 kN/m^3

The first task is to determine the elevations of each plate, this can be done by finding the length to each plate from the anchor head:

$L_{plate1} = L_{anchor} – 0.152m = 11m – 0.152m = 10.848m$

$L_{plate2} = L_{plate1} – 1m = 9.848m$

Then the corresponding elevations at each plate are:

$EL_{plate1} = 197m – L_{plate1} \times \sin(30) = 191.576m$

$EL_{plate2} = 197m – L_{plate2} \times \sin(30) = 192.076m$

The effective vertical stress then at each plate is:

$\sigma'_{V.plate1} = 19\ kN/m^3 \times (200 – EL_{plate1}) = 160.056\ kPa$

$\sigma'_{V.Plate2} = 19\ kN/m^3 \times (200 – EL_{plate2}) = 150.556\ kPa$

With the individual bearing method the bearing capacity can then be calculated at each plate as:

$Q_h = A_h\ (9\ c + \gamma\ D\ N_q) \leq Q_{h.str}$

Where $N_q=0.5\ (12^*\phi)^{\phi/54}$ and for $\phi= 32$ deg then $N_q= 17$

Then for each plate:

$Q_{h.1} = A_{h.1}\ (9\ c + \gamma\ D\ N_q) = 0.06271\ m^2 \times (9 \times 3\ kPa + 160.06 \times 17\ kPa) = 172.3\ kN$

$Q_{h.2} = A_{h.2}\ (9\ c + \gamma\ D\ N_q) = 0.06271\ m^2 \times (9 \times 3\ kPa + 150.56 \times 17\ kPa) = 162.2\ kN$

Then the total ultimate geotechnical pullout resistance with the individual plate bearing method is:

$Q_h = Q_{h.1} + Q_{h.2} = 334.5\ kN$

With an allowable FS= 2.0 the allowable geotechnical capacity is:

$Q_{h.ALLOW} = Q_h/2= 167.2\ kN$

Now also calculate the capacity with the cylinder method:

On the cylinder sides:

$Q_{cylinder.sides} = \pi \times D \times spacing \times [\tan(\phi_{average}) \times (\sigma'_{V.plate1} + \sigma'_{V.plate2})/2 + c_{average}) \Rightarrow$

$Q_{cylinder.sides} = \pi \times 0.3048m \times 1m \times (\tan(32) \times (160.056\ kPa + 150.556\ kPa)/2 + 3\ kPa) \Rightarrow$

$Q_{cylinder.sides} = 95.8\ kN$

The last plate (Plate 2) has a bearing capacity of: $Q_{h.2} = 162.2\ kN$

Then the total ultimate cylinder strength is:

$Q_{cylinder} = Q_{cylinder.sides} + Q_{h.2} = 95.8\ kN + 162.2\ kN = 258\ kN$

Since the cylinder strength is smaller than the individual bearing method the ultimate anchor capacity is:

$Q_{h.ult} = Q_{cylinder} = 258\ kN$

Which is verified by the program as the following figure shows: