

Numerical modelling of micropiles

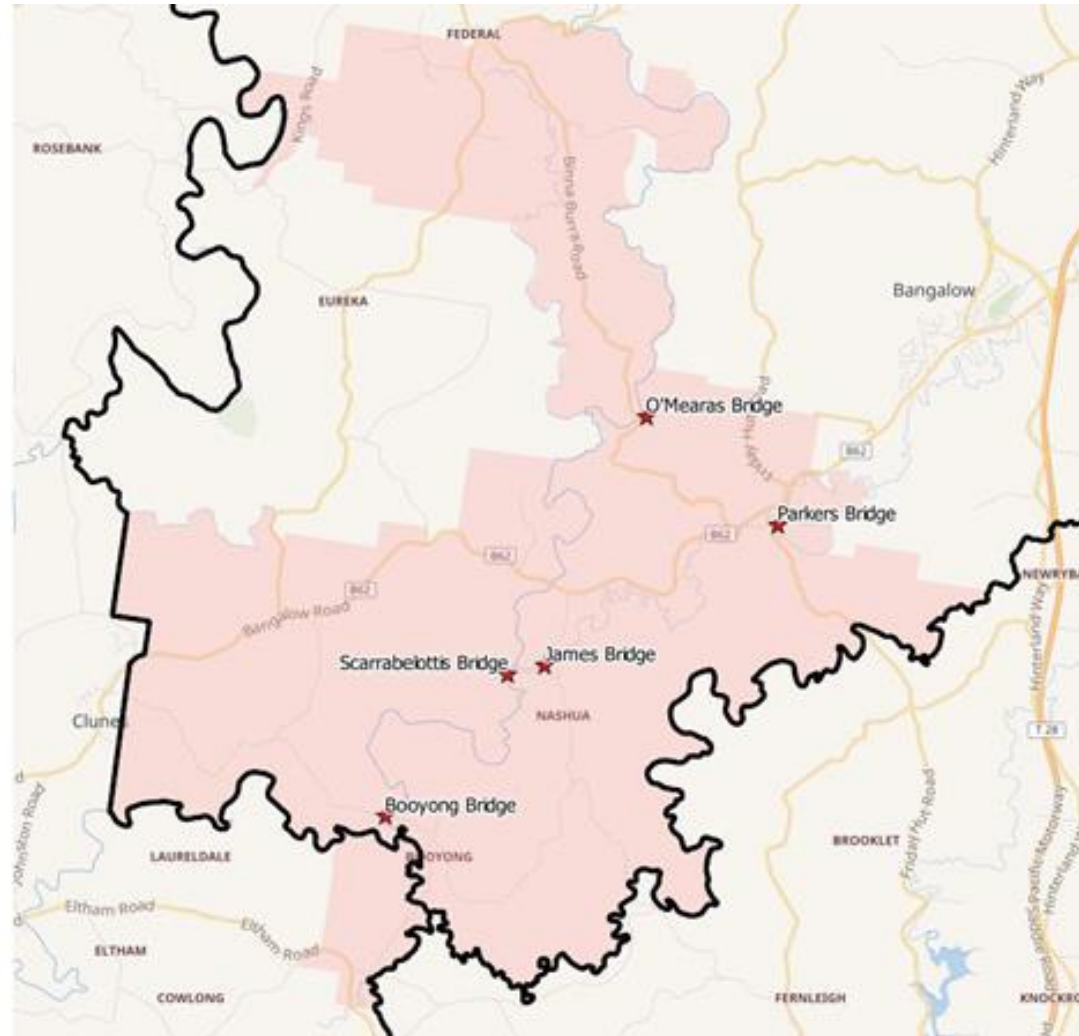
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Numerical modelling of micropiles

- ▶ 5 timber bridges needed replacement
- ▶ Byron Shire in northern coastal New South Wales
- ▶ About 85 km south of here

Bridge locations



Typical bridges





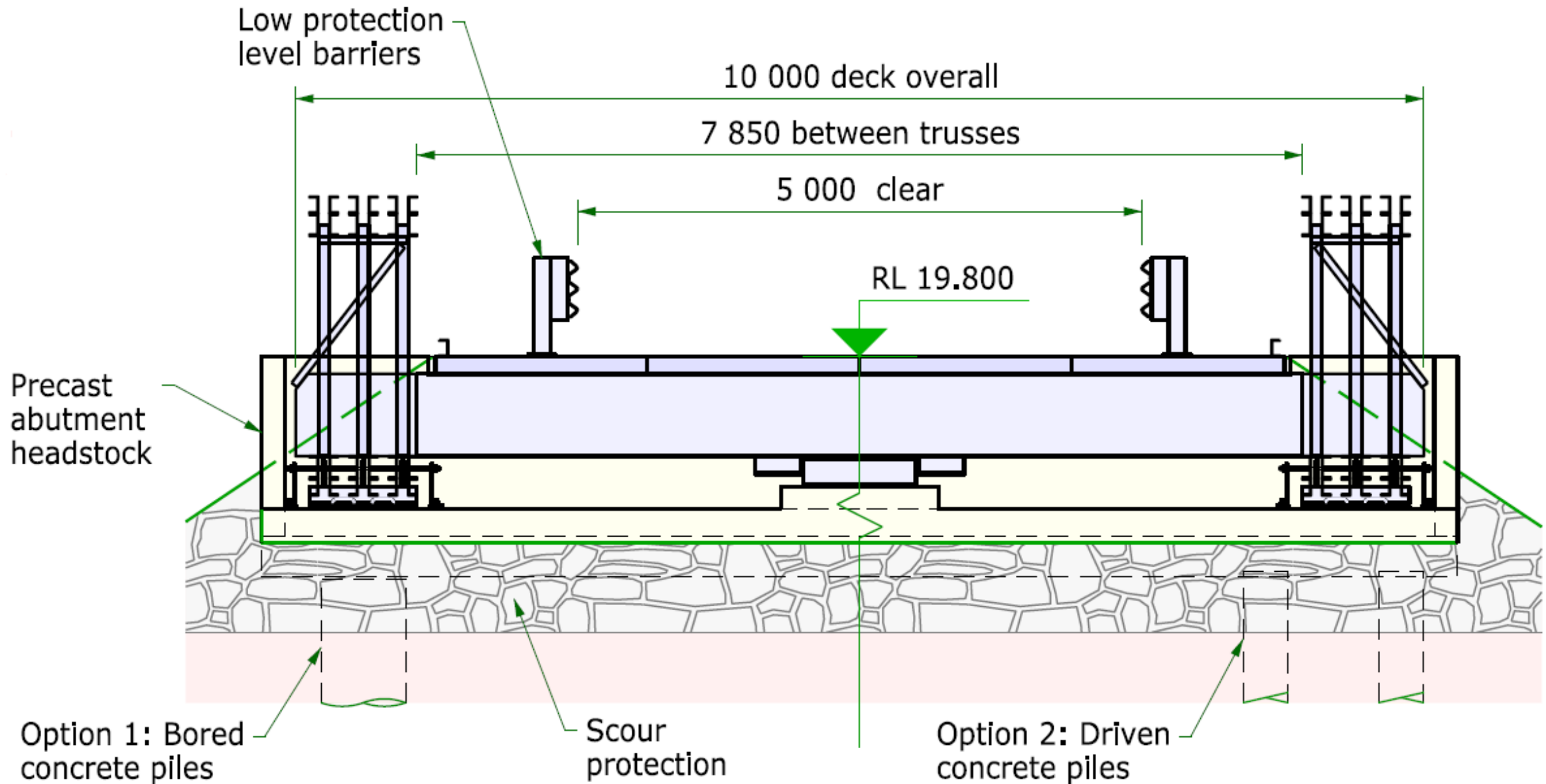
Typical bridges





The replacement bridges





Load combinations

Load case	Load combination
1	1.1 x Permanent effects + 2 x Live Load + 1.8 x Braking load + 1 x Stream force at deck level
2	Permanent effects + 1 x Live Load + 1 x Braking Load + 1.3 x Stream force at deck level
3	Permanent effects + Ultimate stream forces (1:2000 AEP flood)
4	0.9 x Permanent effects + 0 x Live Load + 1.8 x Braking load + 1 x Stream force at deck level with scour
5	0.9 x Permanent effects + 0 x Live Load + 1 x Braking Load + 1.3 x Stream force at deck level with scour
6	0.9 x Permanent effects + Ultimate stream forces (1:2000 AEP flood) with scour

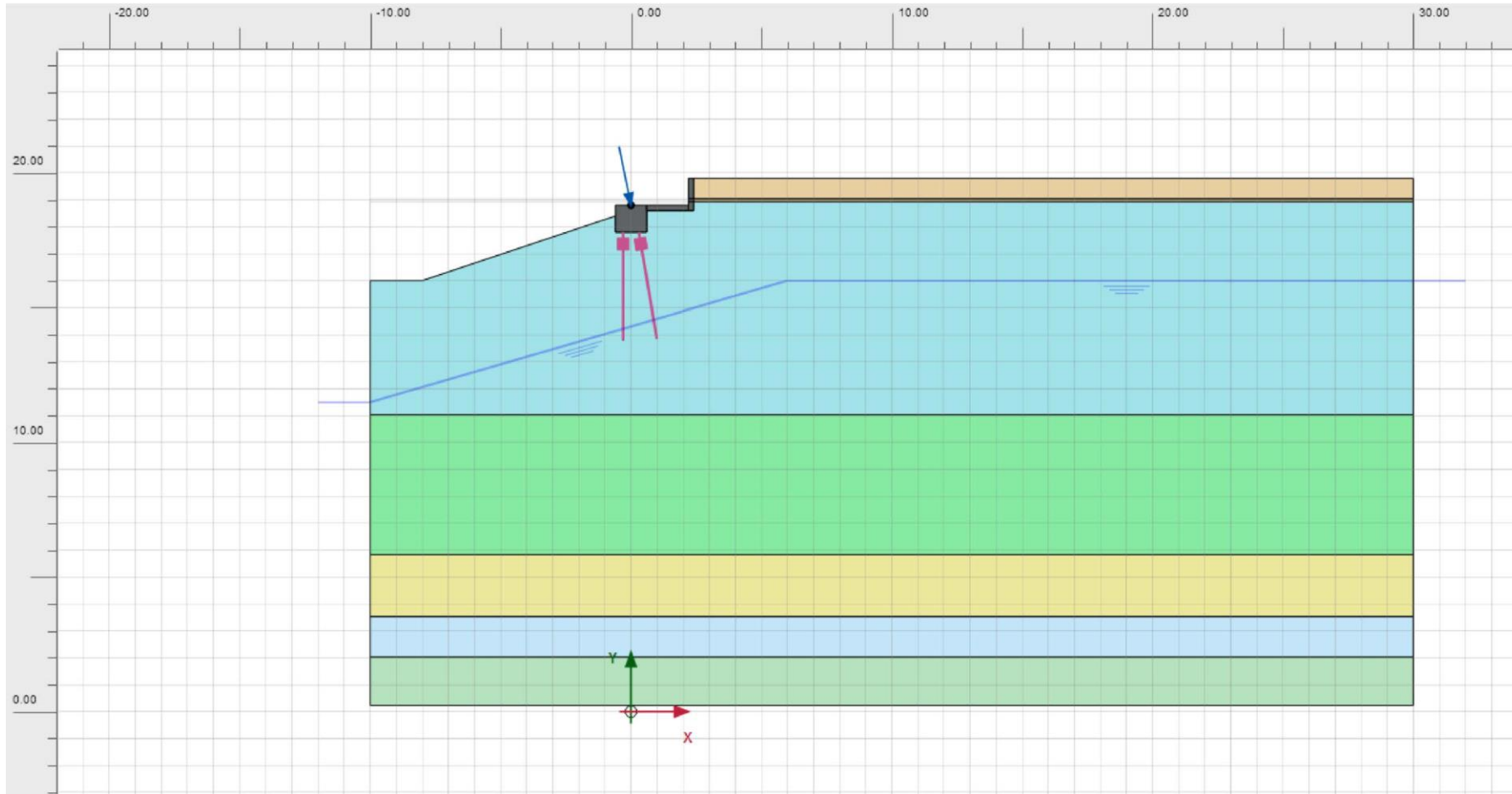
Peer review of design

- ▶ Requirement for independent review
- ▶ Not easily achieved with use of computer programs
- ▶ Decision to carry out fully independent review using same load data but alternative software
- ▶ Designer had used GROUP16 for analysis of group effects under headstocks
- ▶ This uses p-y curves to model vertical and lateral loading behaviour
- ▶ Review used PIGLET, which is based on a continuum model, fully modelling pile-soil-pile interaction
- ▶ Also used PLAXIS 2D to model displacements at SLS

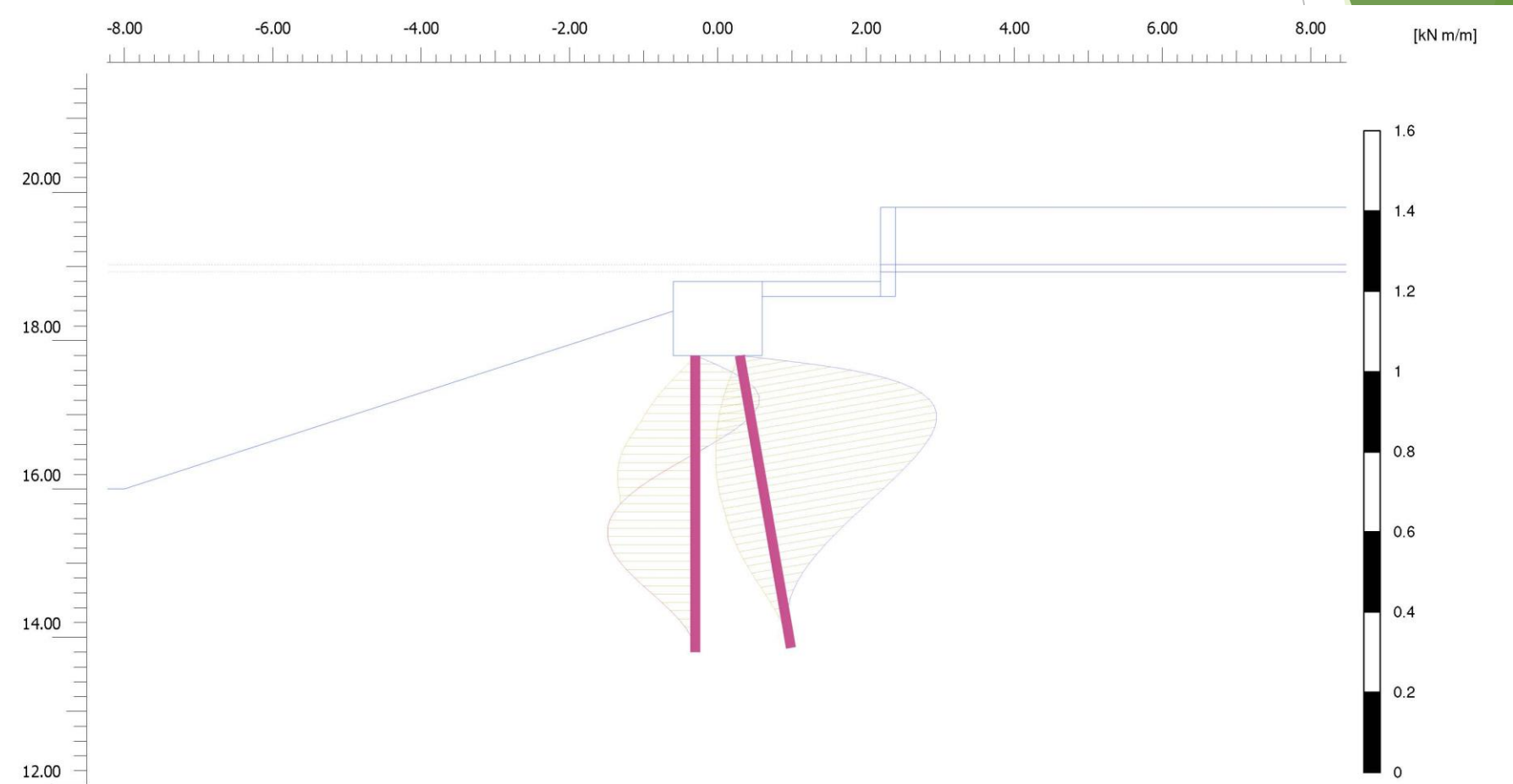
PLAXIS analysis

- ▶ Only PLAXIS 2D available, so analysed longitudinal and transverse sections
- ▶ Able to model piles as embedded beam elements
- ▶ Cannot model step change in stiffness, as cannot connect embedded beams end to end
- ▶ Modelled in two stages:
 - ▶ Upper part with high stiffness to model bending moments and shear forces
 - ▶ Lower part with appropriate stiffness connected to headstock with elastic “anchor” to model axial forces in micropile, and movement
- ▶ Also modelled factor of safety

PLAXIS analysis



PLAXIS analysis

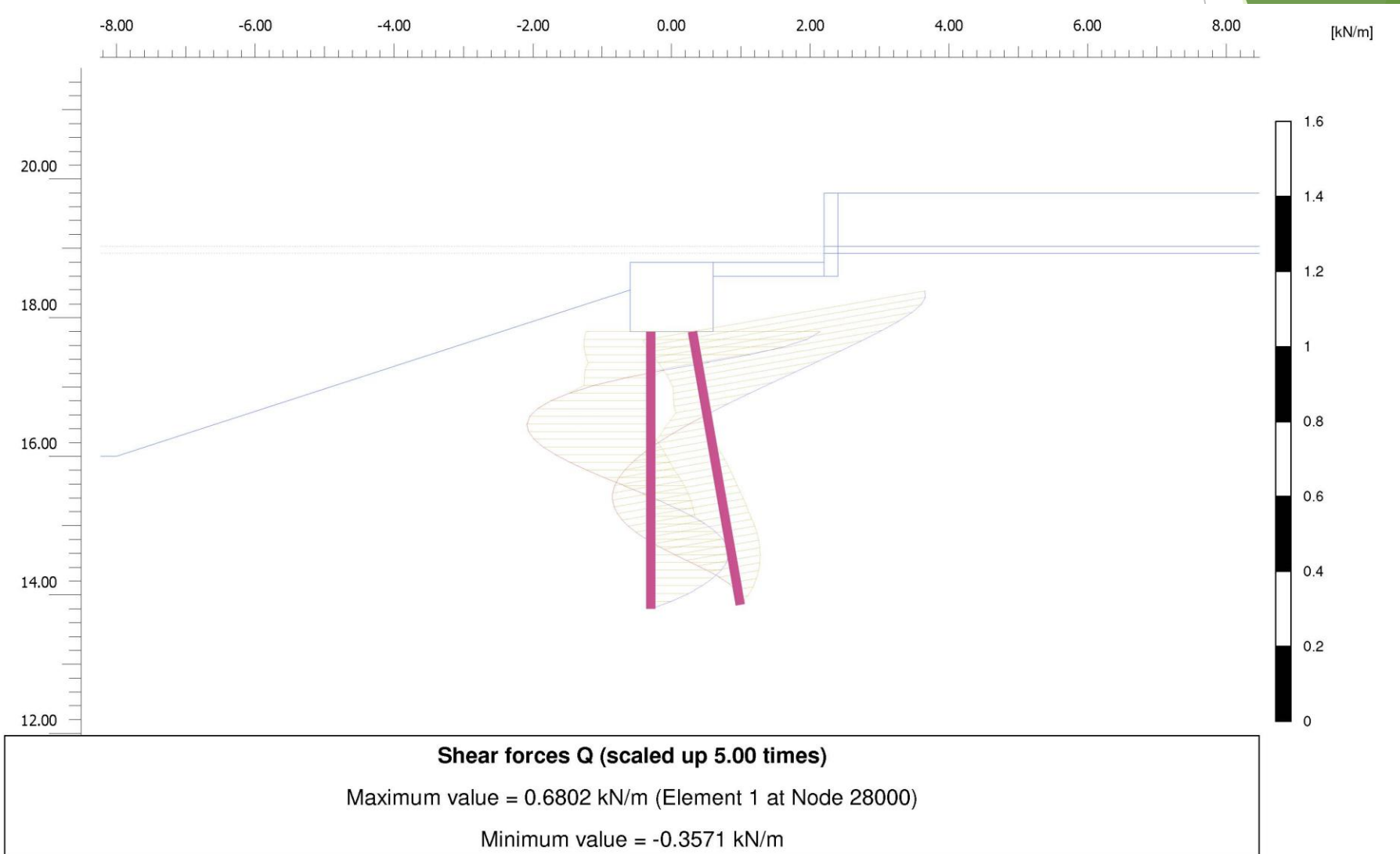


Bending moments M (scaled up 5.00 times)

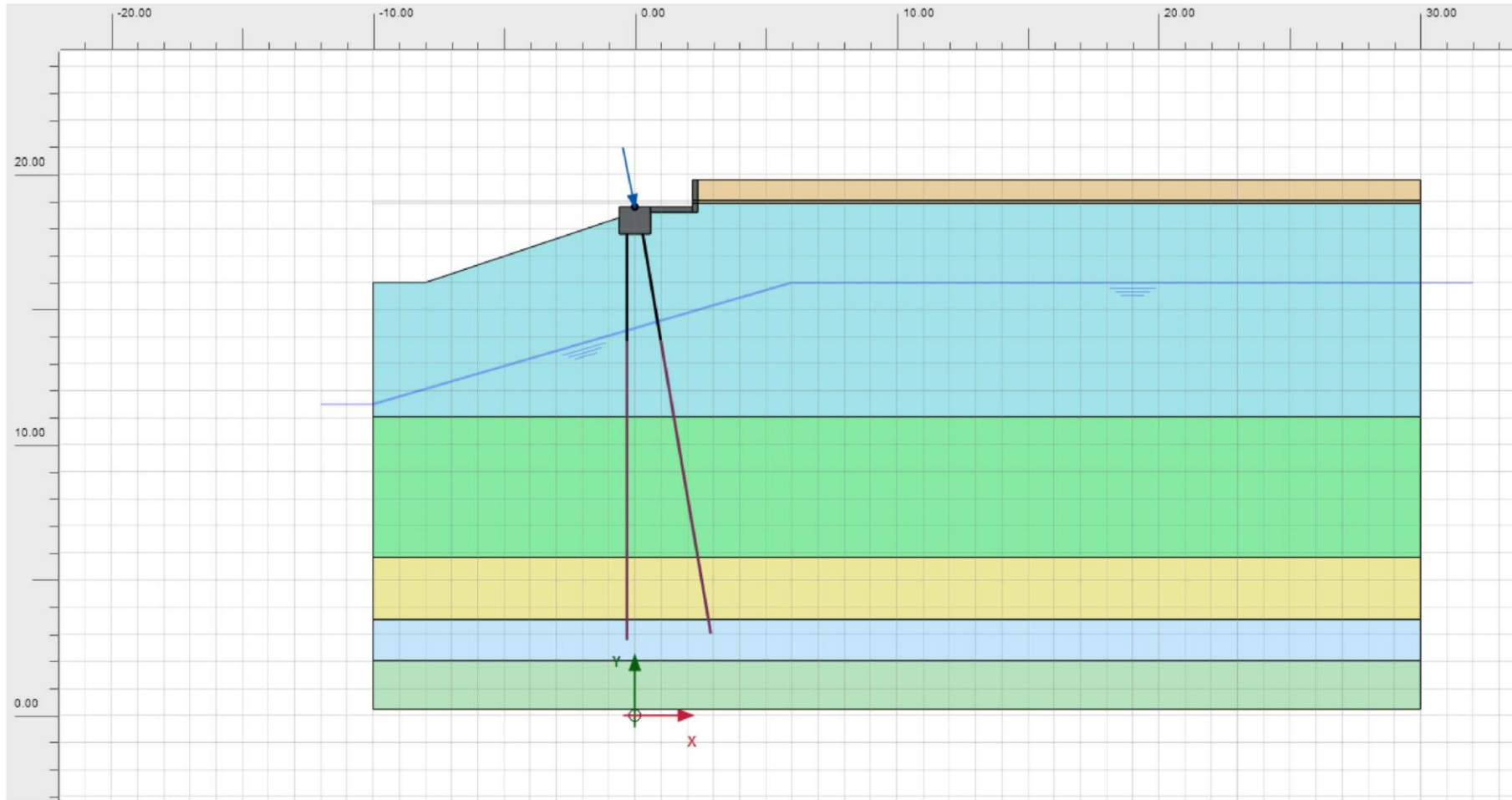
Maximum value = 0.4946 kN m/m (Element 4 at Node 28013)

Minimum value = -0.2371 kN m/m

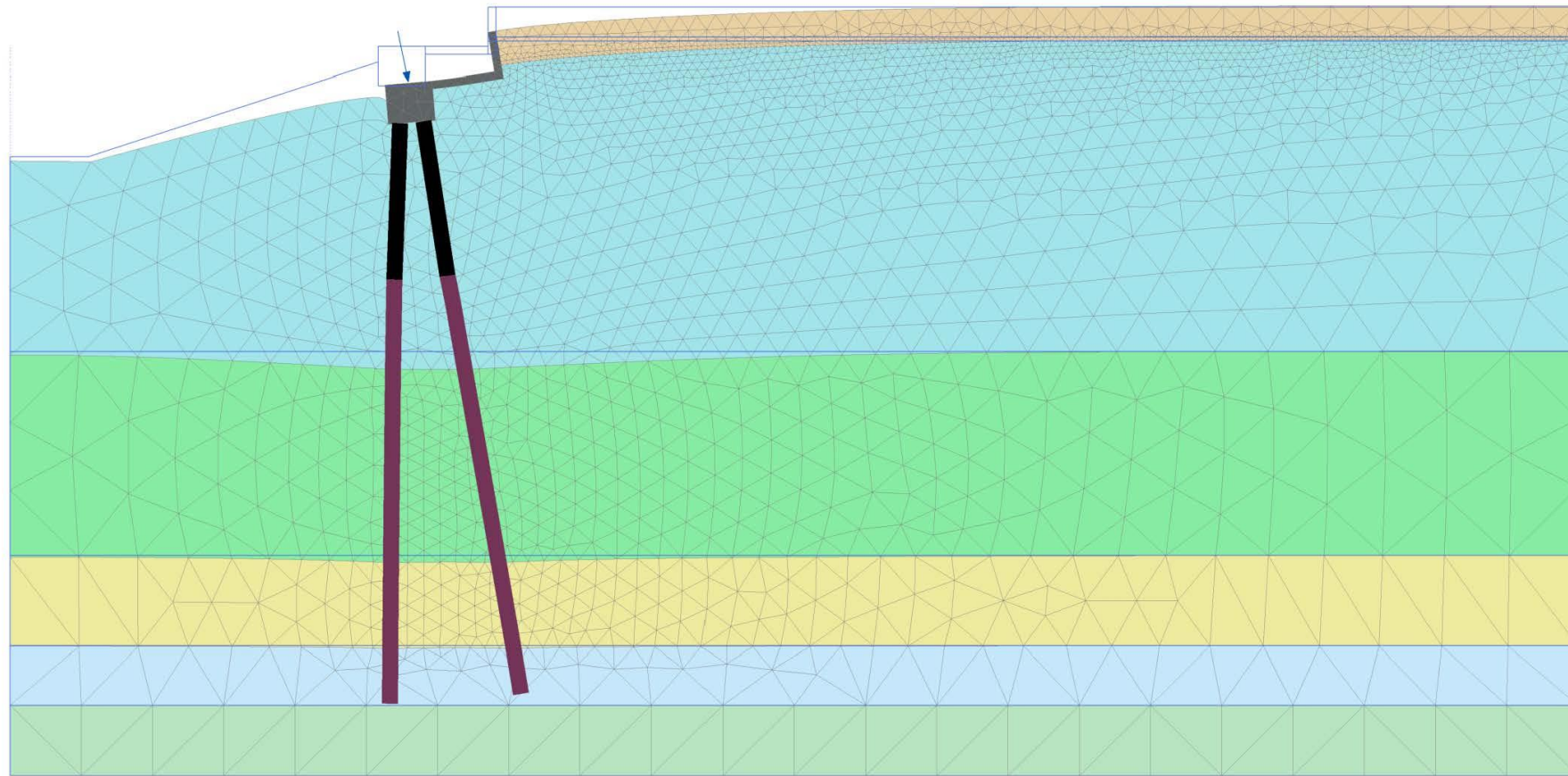
PLAXIS analysis



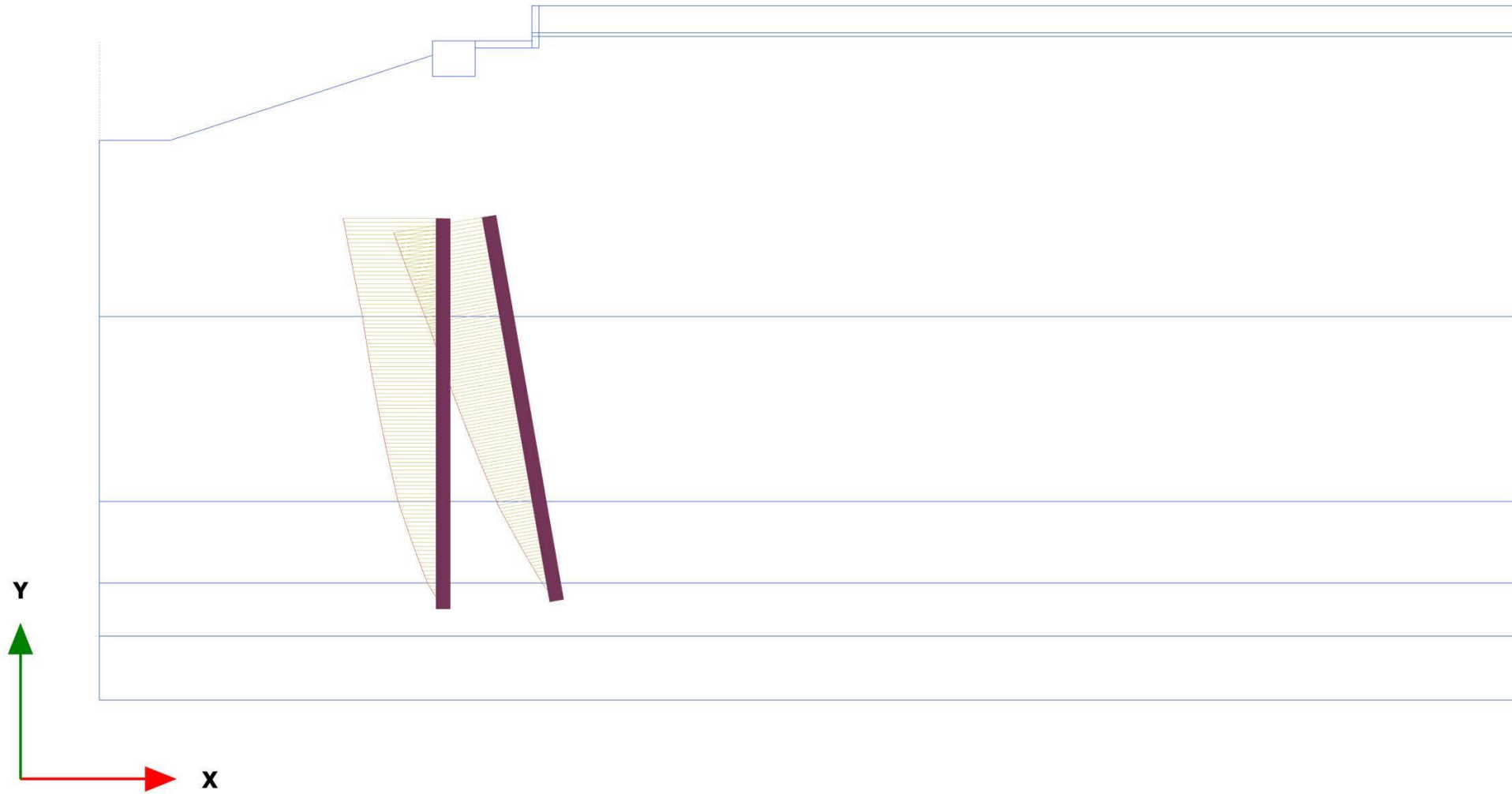
PLAXIS analysis



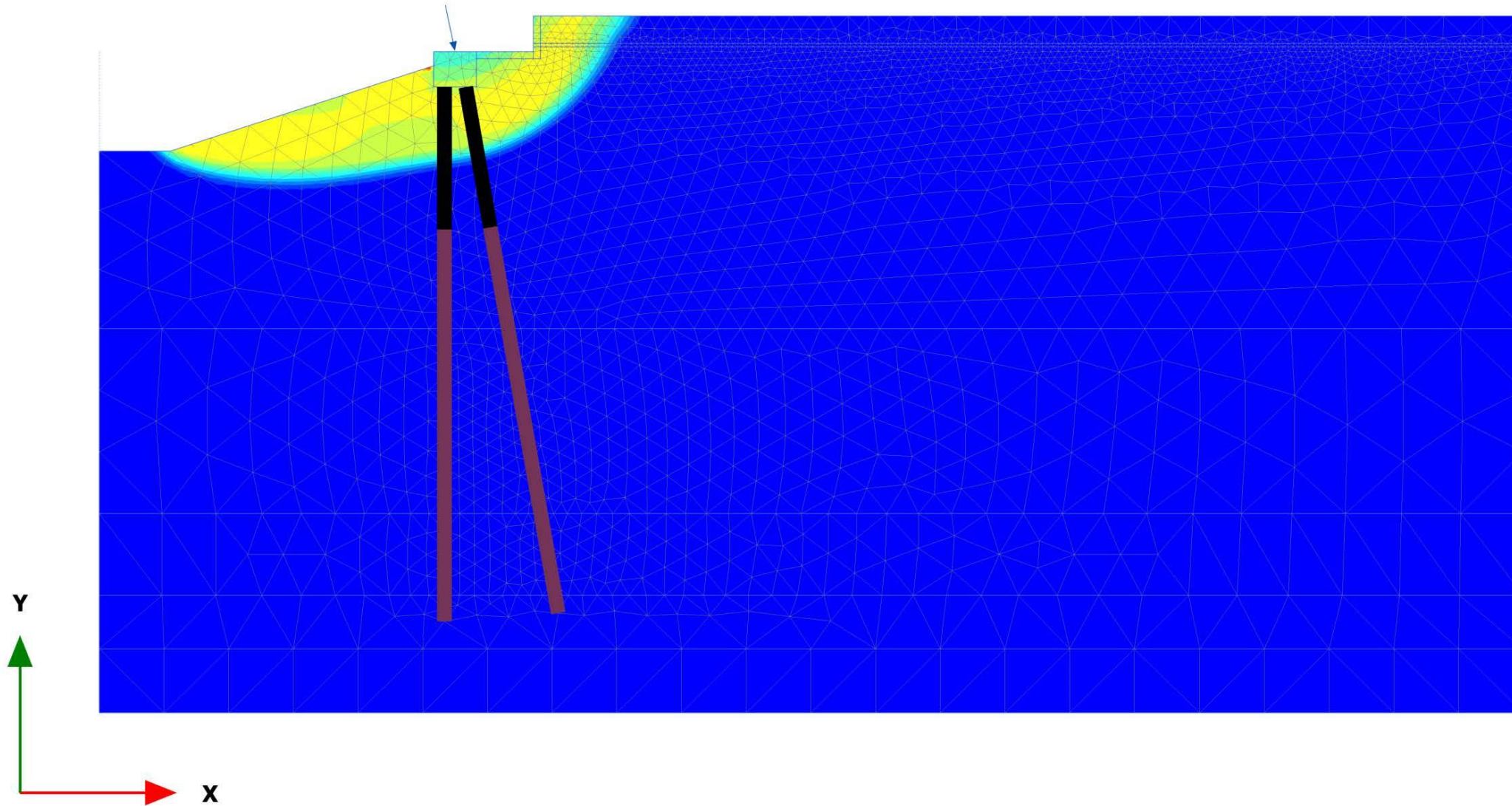
PLAXIS analysis



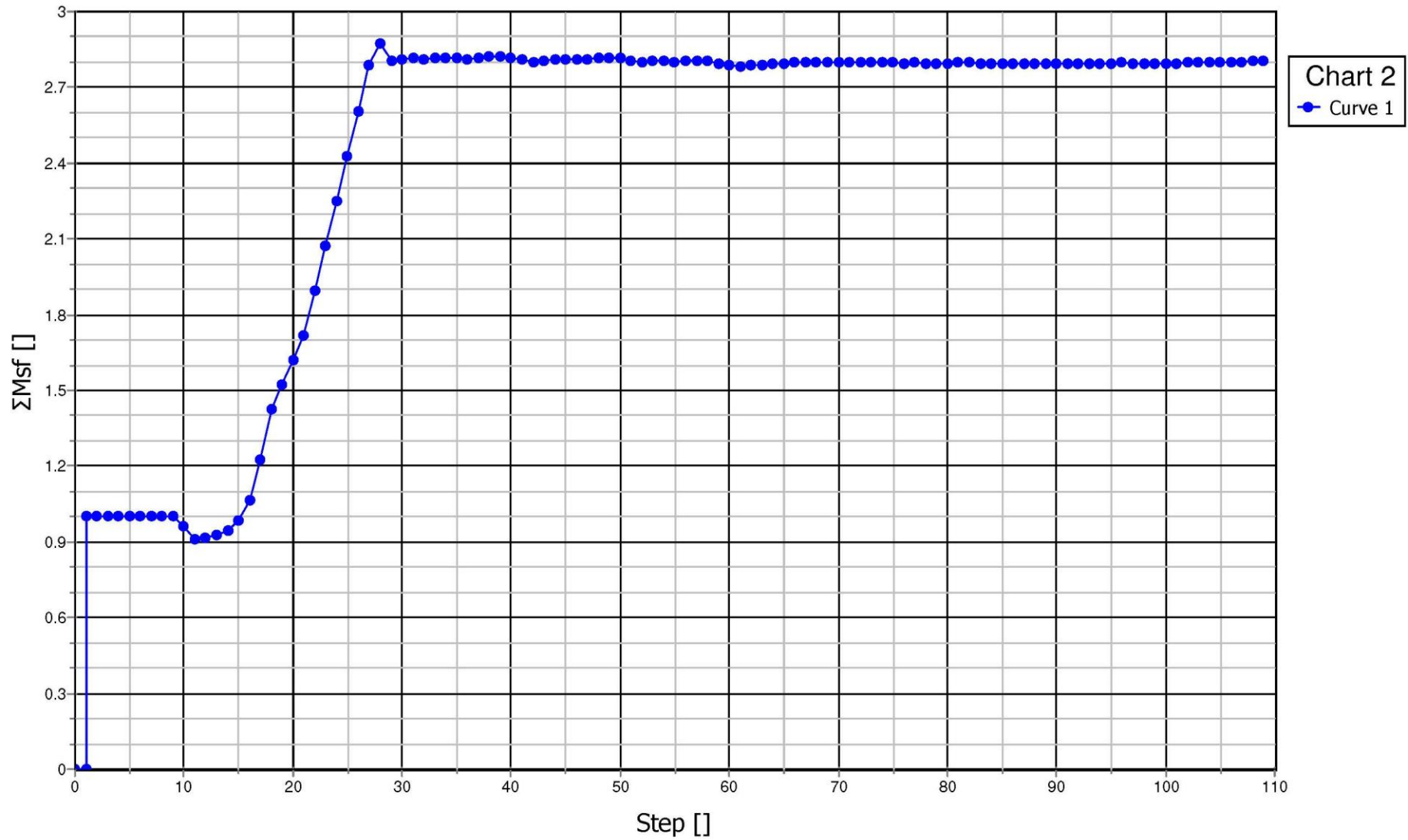
PLAXIS analysis



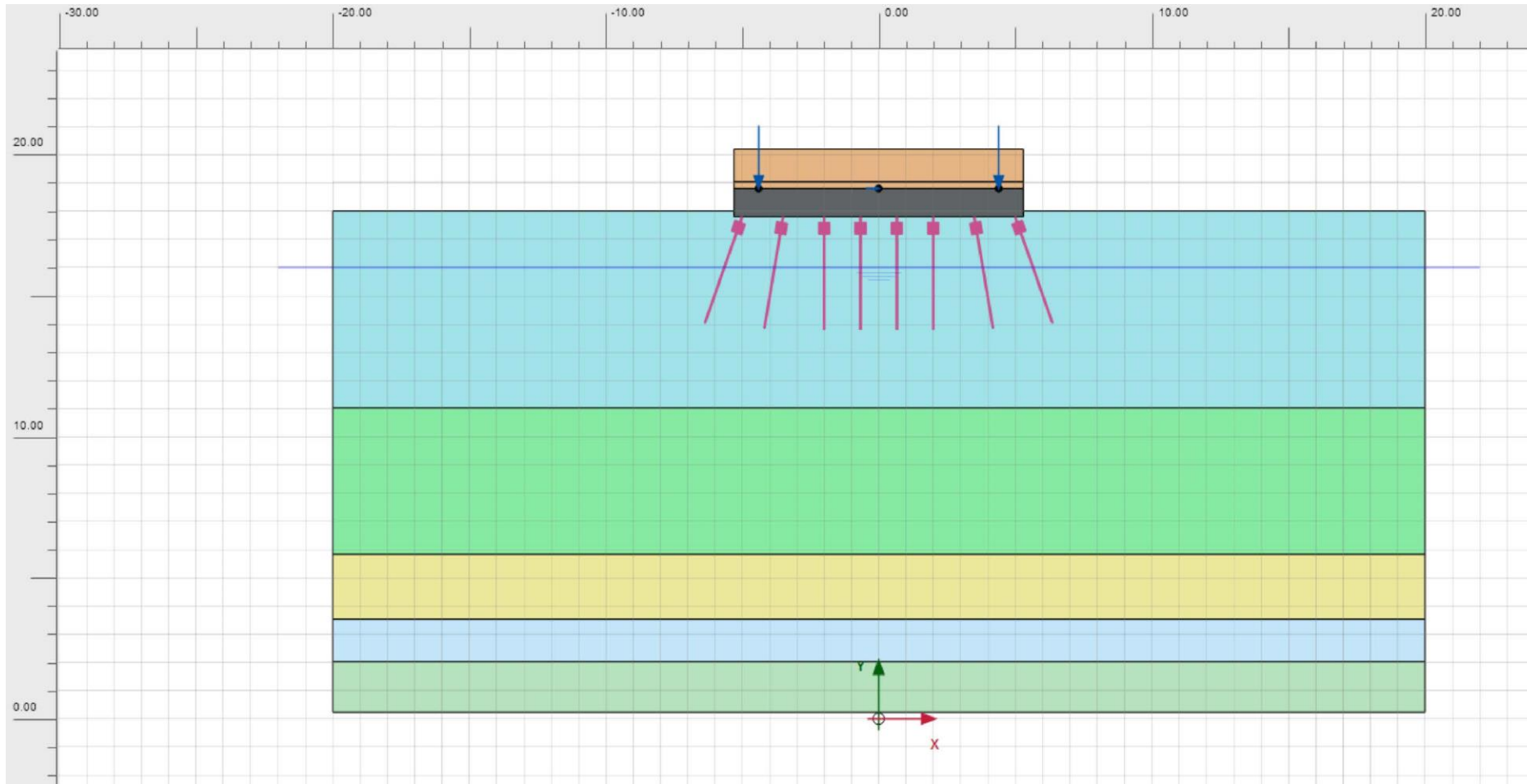
PLAXIS analysis



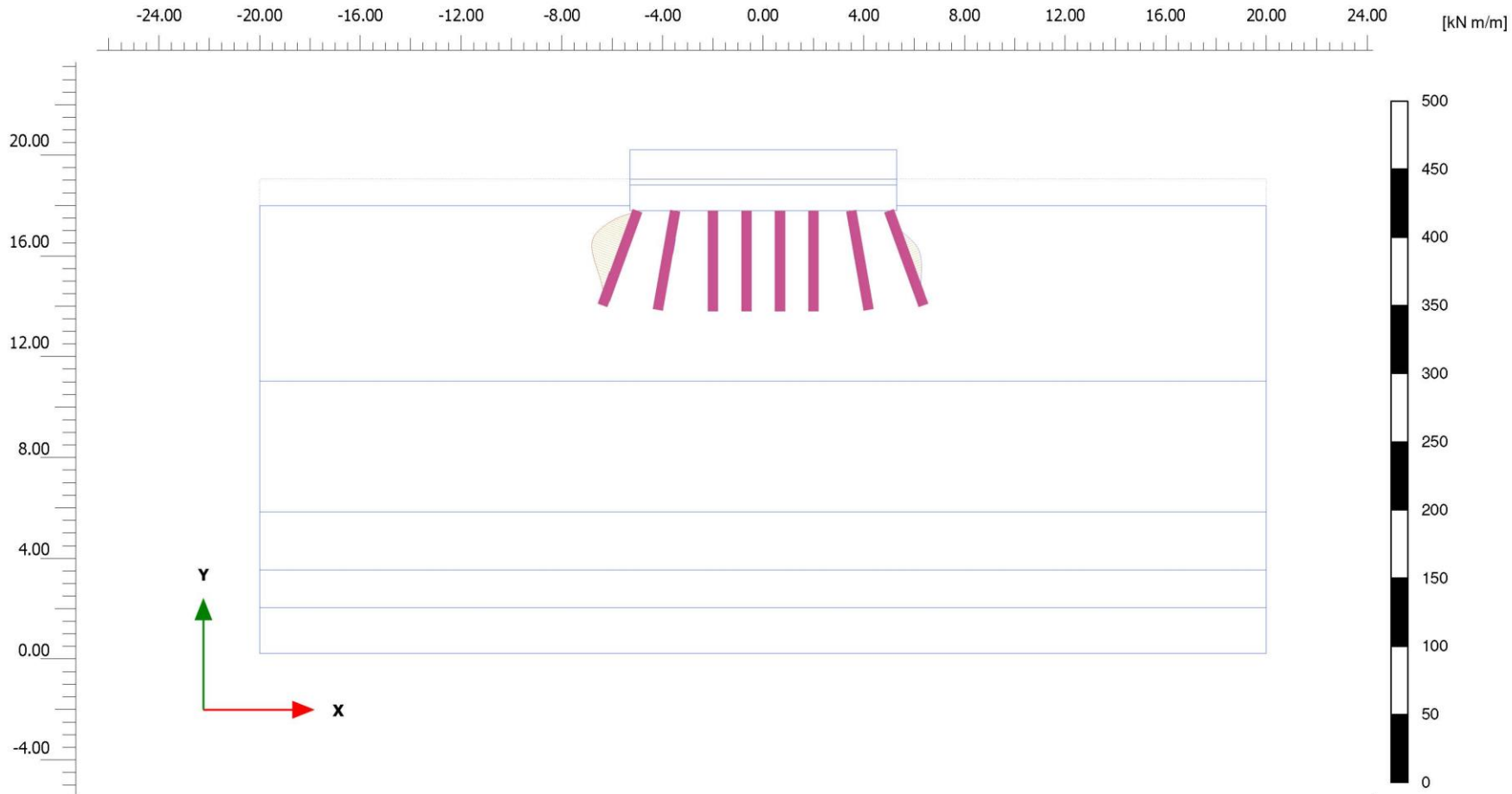
PLAXIS analysis



PLAXIS analysis



PLAXIS analysis

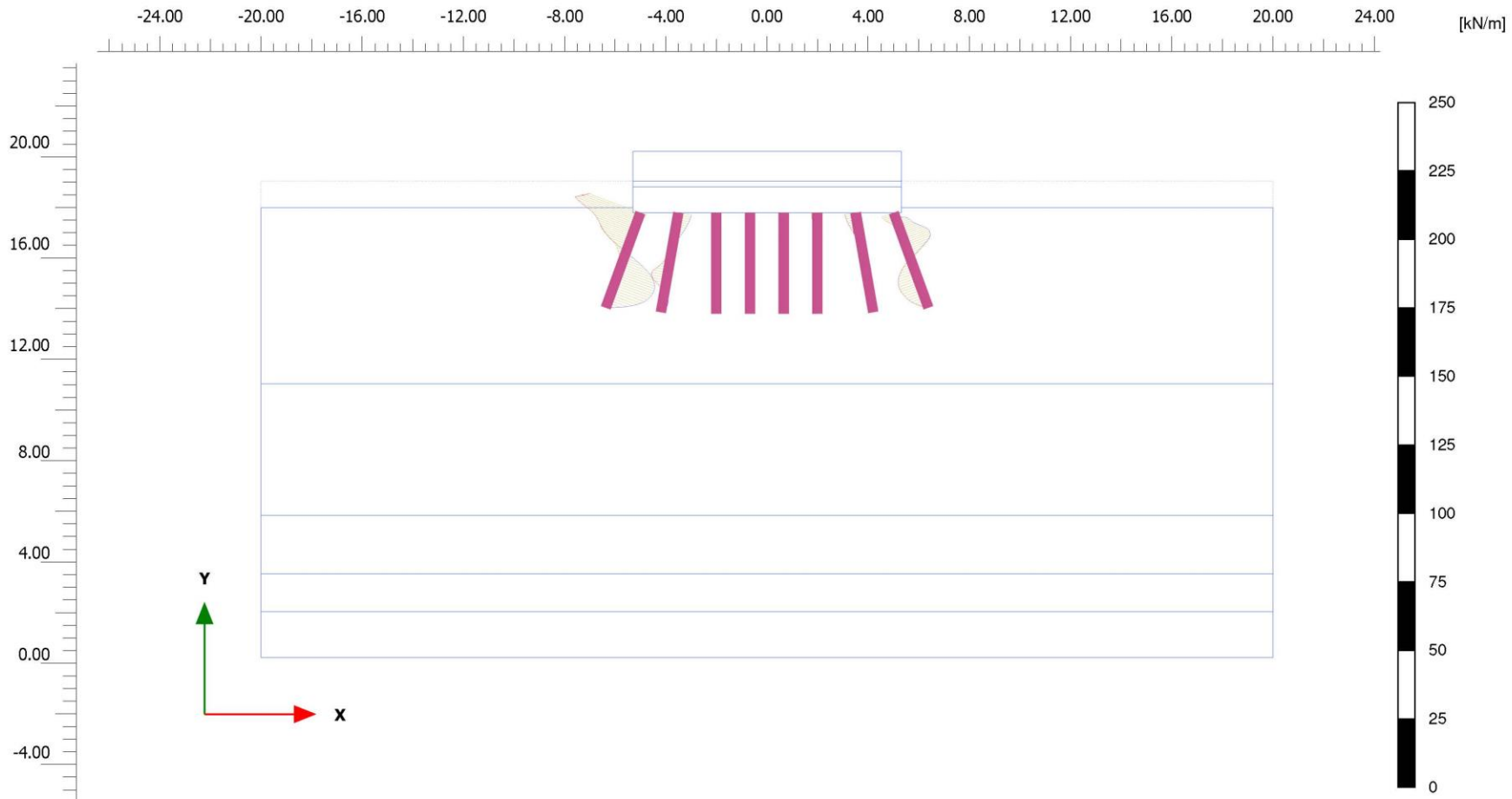


Bending moments M (scaled up 0.0500 times)

Maximum value = 11.59 kN m/m (Element 17 at Node 12375)

Minimum value = -25.21 kN m/m

PLAXIS analysis

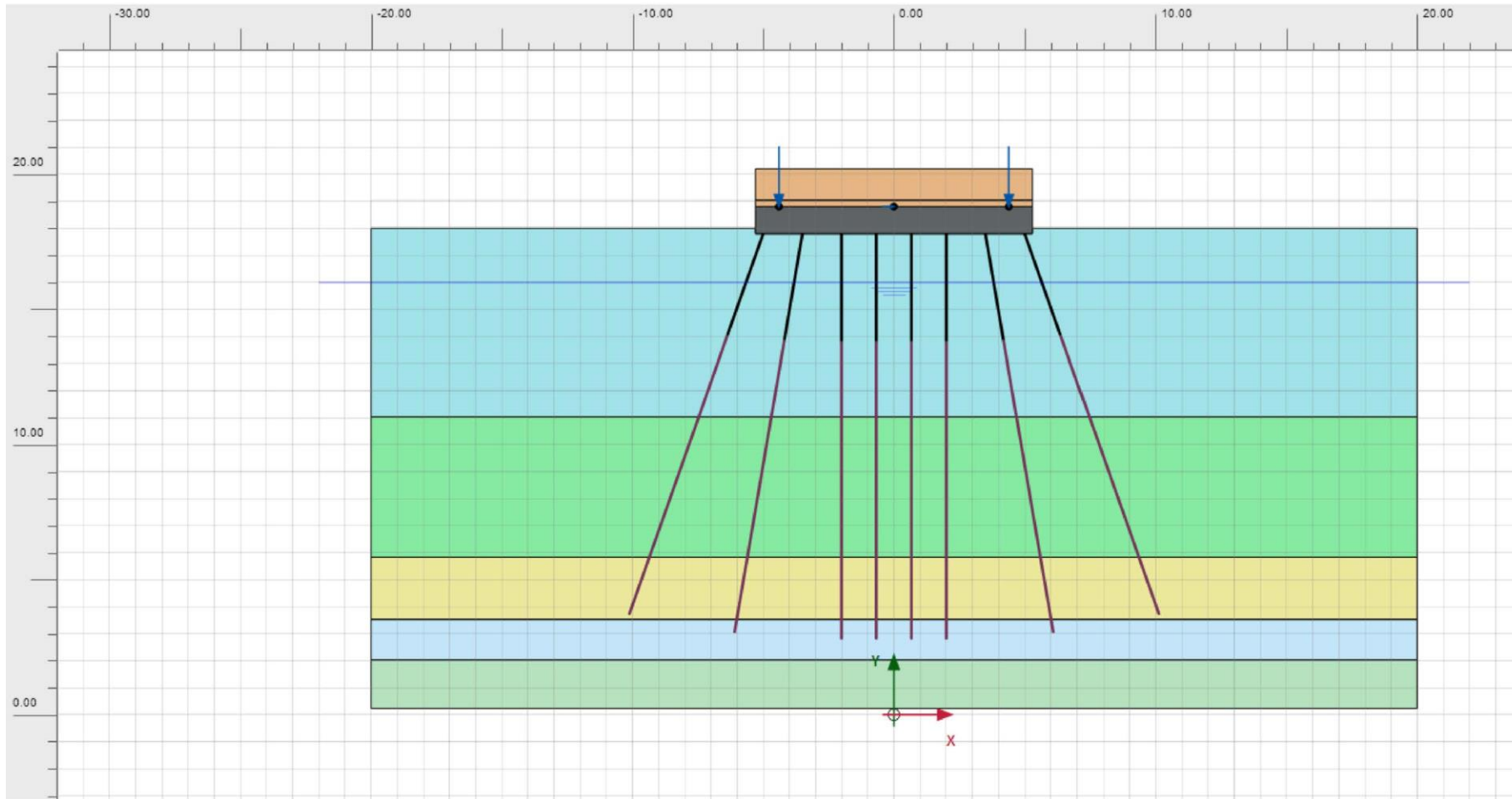


Shear forces Q (scaled up 0.100 times)

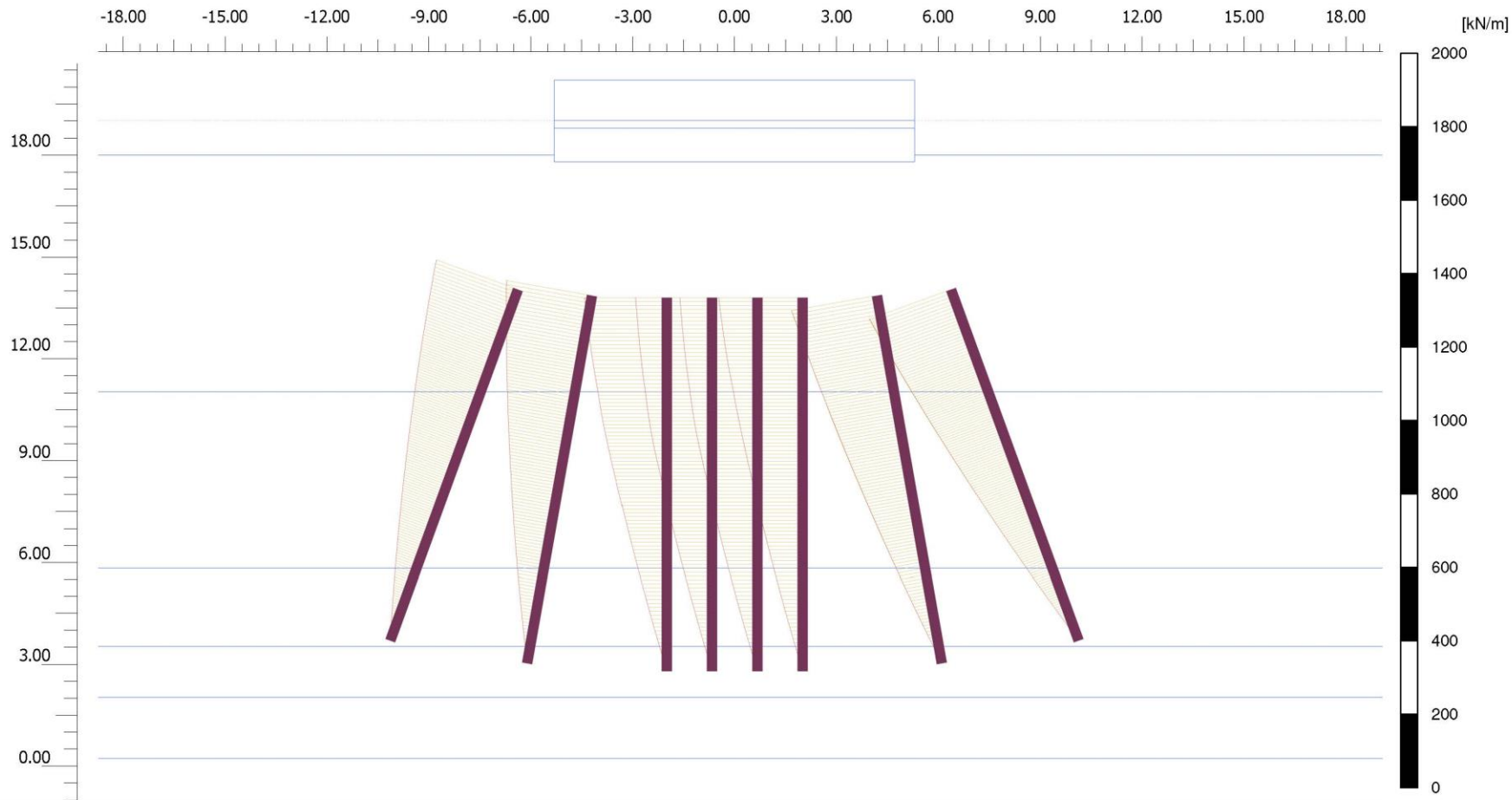
Maximum value = 15.64 kN/m (Element 8 at Node 12338)

Minimum value = -26.47 kN/m

PLAXIS analysis



PLAXIS analysis

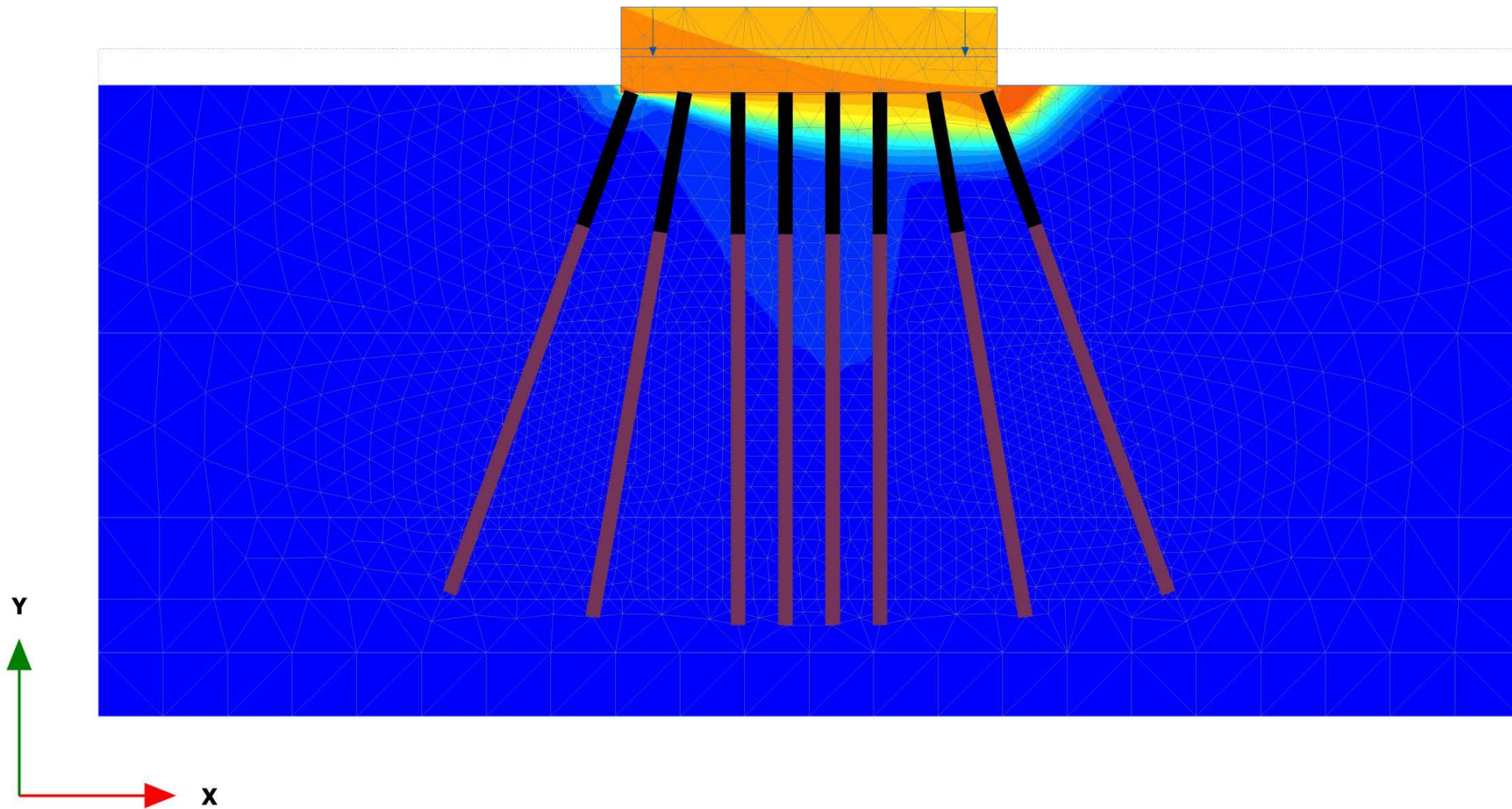


Axial forces N (scaled up 0.0100 times)

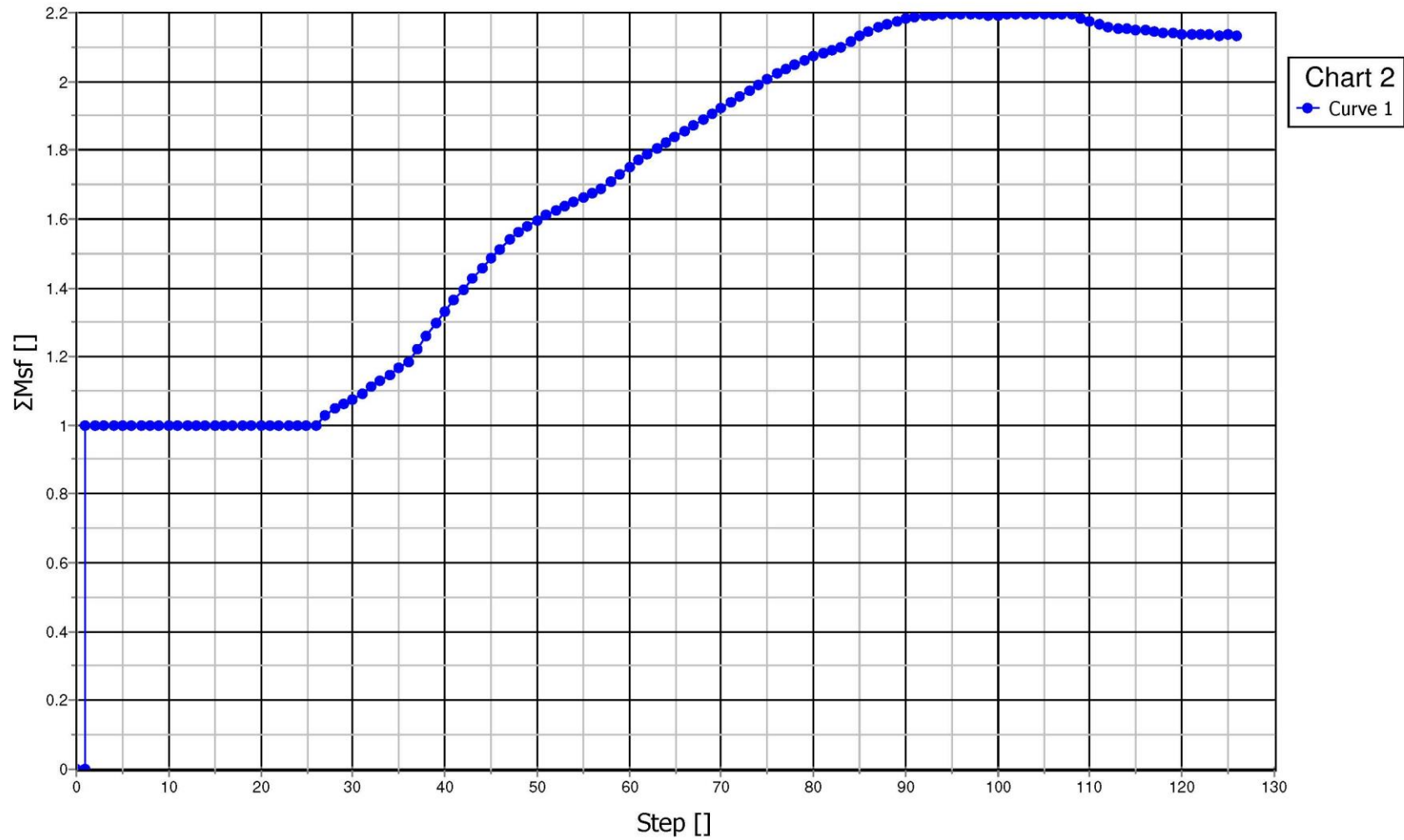
Maximum value = $7.396 \cdot 10^{-3}$ kN/m (Element 201 at Node 30460)

Minimum value = -256.1 kN/m

PLAXIS analysis



PLAXIS analysis



Review result

- ▶ Design was satisfactory, meeting requirements of AS 5100
- ▶ Performance was predicted to be satisfactory
- ▶ Design and review were further reviewed by in house engineer
- ▶ Construction satisfactorily completed in late 2018

Thank you