GEO5 PROJECT SPOTLIGHT

PUBLIC CASE STUDY

Temporary Anchored Soldier Pile Wall

Design stage comparison using GEO5 Sheeting Design and PLAXIS 2D

Design stage study.

Publication title	Temporary Anchored Soldier Pile Wall
Location	Saudi Arabia
Discipline	Geotechnical Engineering - Temporary Excavation Support
Software	GEO5 Sheeting Design / PLAXIS 2D
Prepared by	Eng. Ehab Mahmoud - Geotechnical Engineer
Organization	Maysam Arabia Contracting Company
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Illustrative image of a soldier pile and timber lagging system.

1. Project Information and Executive Summary

Project title for publication	Temporary Anchored Soldier Pile Wall
Location	Saudi Arabia
Design period	2026
Designer	Eng. Ehab Mahmoud - Maysam Arabia Contracting Company
Project type	Temporary two-level anchored soldier pile wall
Software	GEO5 Sheeting Design and PLAXIS 2D

Executive summary

The subject project is currently on hold, and construction has not commenced. This case concerns the design and verification of a temporary two-level anchored soldier pile wall supporting an 8.00 m nominal excavation. A further 0.50 m allowance was included as a design over-excavation condition, giving a maximum analysed excavation depth of 8.50 m. The retained side was subjected to a uniform 20 kPa surcharge.

GEO5 Sheeting Design was used to establish the conventional design basis, including earth pressures, required embedment, wall-force envelopes, steel-section verification, anchor resistance and global stability. A separate PLAXIS 2D model was then prepared to check the adopted arrangement using a staged finite-element analysis and to assess wall deformation, anchor-force development and load transfer along the bonded anchor lengths.

At the common 8.50 m over-excavation condition, the two analyses produced closely aligned wall and anchor actions. The differences were approximately 3.2% for wall bending, 2.4% for wall shear, 3.1% for Anchor Row 1 and 1.6% for Anchor Row 2. The stage history also showed that the final excavation was not the governing condition for every response quantity.

Principal design data

Item	Adopted value	Item	Adopted value
Soldier piles	HEA 200 S275 @ 1.80 m c/c	Adopted wall length	10.00 m
Anchor Row 1	-2.25 m; 6.60 m free + 3.40 m bond	Anchor Row 2	-5.25 m; 3.50 m free + 5.50 m bond
Anchor inclination	25 degrees	Anchor spacing	1.80 m
Surcharge	20 kPa	Design excavation	8.00 m nominal / 8.50 m check

2. Design Basis, Ground Model and Construction Sequence

Ground model

The design profile was idealised into four engineering units. The same principal effective-stress strength parameters were carried into both analyses. In the PLAXIS comparison model, the units were represented using drained Mohr-Coulomb behaviour. The reported analyses consider the stated condition without groundwater pressures.

Ground unit	Depth (m)	gamma (kN/m3)	c' (kPa)	phi' (deg)	Eref (MPa)	K0
Weathered limestone	0.00-2.12	19.0	50	30.0	75.0	0.50
Gravel	2.12-4.37	17.5	0	32.6	22.8	0.46
Limestone - Unit A	4.37-9.82	21.0	66	40.0	451.7	0.44
Limestone - Unit B	> 9.82	21.0	91	40.0	451.7	0.44

Construction sequence

The support system was analysed in the order in which it would be constructed. The PLAXIS model reproduced the same excavation and anchor-activation sequence as a series of consecutive calculation phases.

Stage	Construction activity	PLAXIS phase
1	Install wall and apply retained-side surcharge	P01
2	Excavate to 2.75 m	P02
3	Install and prestress Anchor Row 1	P03
4	Excavate to 5.75 m	P04
5	Install and prestress Anchor Row 2	P05
6	Excavate to 8.00 m	P06
7	Check design over-excavation to 8.50 m	P07

Basis of comparison

The comparison was intended as an engineering cross-check, not as a validation of one program by the other. The two models used harmonised project inputs - stratigraphy, principal soil-strength parameters, surcharge, soldier-pile spacing, anchor levels, anchor inclination and anchor lengths - but the underlying retaining-wall formulations remain different.

A further distinction is that GEO5 reports the wall length required for each design stage, whereas PLAXIS checks the adopted 10.00 m wall throughout the staged model. At the 8.50 m over-excavation stage, GEO5 returned a required wall length of 9.32 m.

3. GEO5 Sheeting Design - Design Results

GEO5 Sheeting Design was used for the conventional retaining-wall design workflow. The calculation included stage-specific wall actions, required embedment, anchor forces, structural verification of the HEA 200 soldier piles, anchor-capacity checks and a Bishop global-stability assessment.

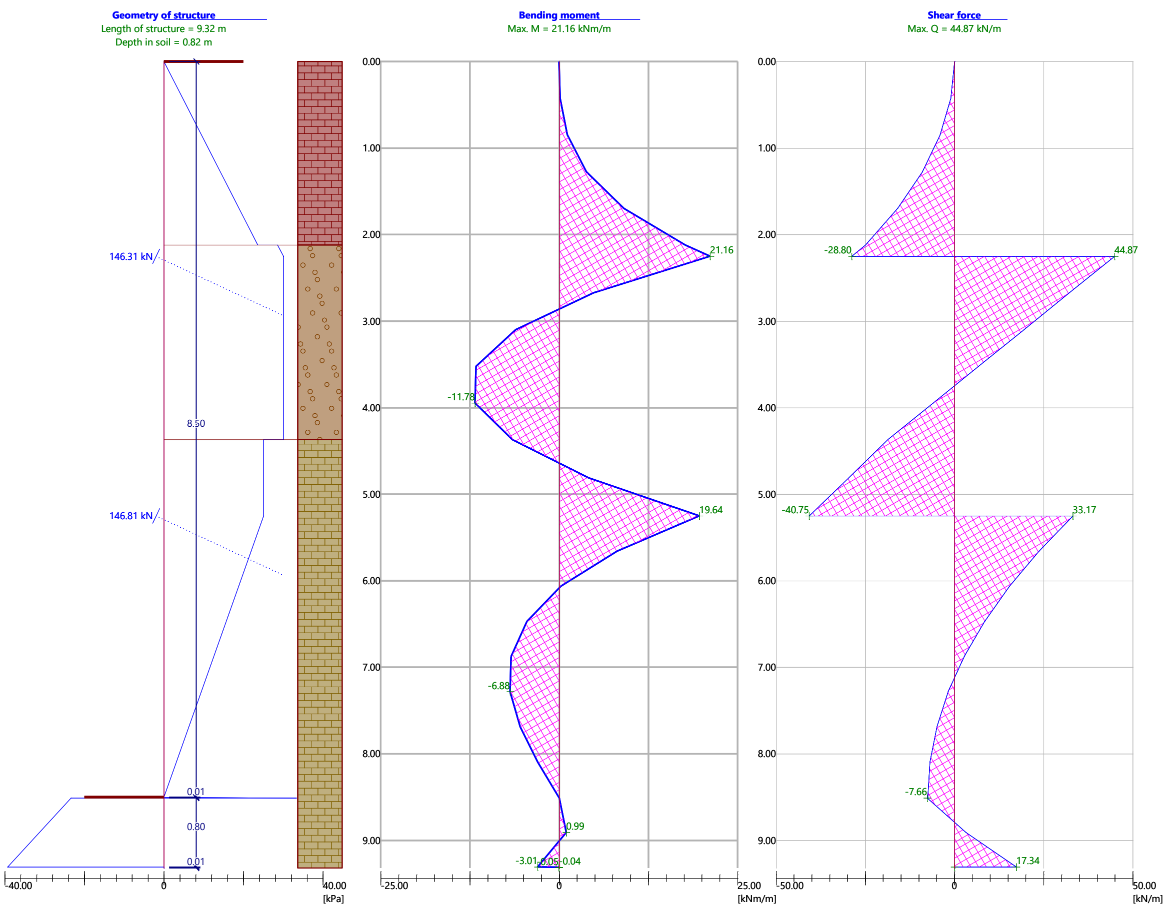


Figure 1. GEO5 result at the 8.50 m design over-excavation stage.

Over-excavation stage

Required wall length	Wall moment	Wall shear	Anchor Row 1	Anchor Row 2
9.32 m	**21.16 kN m/m**	**44.87 kN/m**	**146.31 kN**	**146.81 kN**

Governing structural and stability checks

Verification	Design action / result	Resistance / requirement	Assessment
Soldier pile bending	96.04 kN m/pile	106.88 kN m	89.9% - satisfactory
Soldier pile shear	170.66 kN/pile	177.42 kN	96.2% - satisfactory

Verification	Design action / result	Resistance / requirement	Assessment
Anchor Row 1	147.0 kN	Grout-related resistance 173.62 kN	84.7% - satisfactory
Anchor Row 2	147.0 kN	Grout-related resistance 280.85 kN	52.3% - satisfactory
Global stability	Bishop FS = 4.02	Required FS = 1.50	Satisfactory

The soldier-pile section was checked against the envelope from all GEO5 construction stages rather than against the 8.50 m stage alone. The governing envelope reached 53.35 kN m/m bending and 94.81 kN/m shear. At 1.80 m pile spacing, these correspond to approximately 96.04 kN m and 170.66 kN per pile.

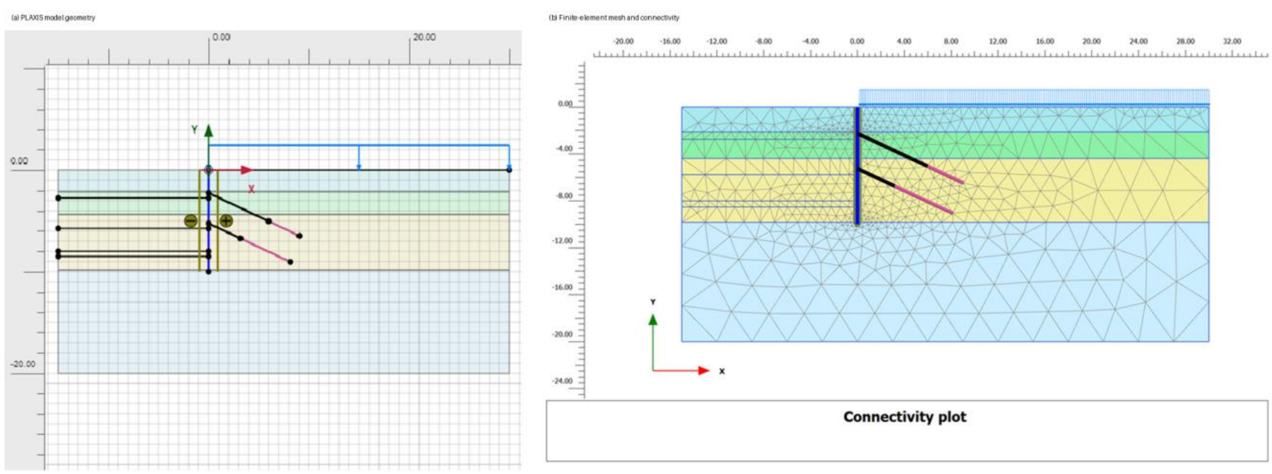
4. PLAXIS 2D - Verification Model and Response

Model formulation

The verification model was developed in plane strain using 15-noded finite elements. The discrete HEA 200 soldier piles at 1.80 m spacing were represented by an equivalent plate with EA = 627.9 x 10^3 kN/m and EI = 4,305 kN m2/m.

Anchor free lengths were represented by node-to-node anchor elements. Bonded lengths were modelled as embedded beams using a 76 mm grout-body diameter, E = 21.54 GPa and a limiting axial skin resistance of 112 kN/m.

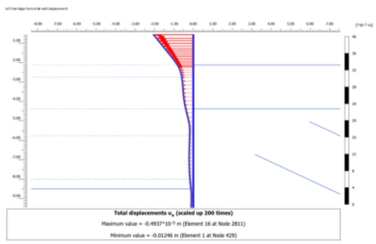
The model contained 1,174 soil elements and 9,764 nodes, with mesh refinement concentrated around the wall and anchor zone.



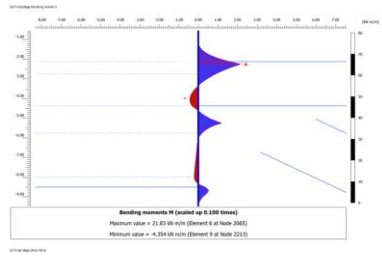
PLAXIS geometry at the adopted support section.

Final over-excavation response

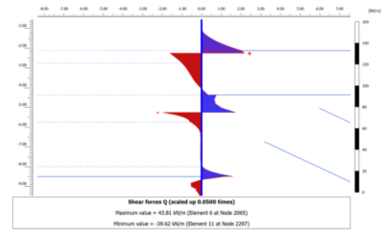
At P07, corresponding to the 8.50 m over-excavation condition, the predicted horizontal wall movement toward the excavation was approximately 12.46 mm. The same phase produced a maximum positive bending moment of 21.83 kN m/m and a maximum positive shear of 43.81 kN/m.



Horizontal displacement ux



Bending moment M



Shear force Q

5. Anchor Behaviour and Comparative Assessment

Anchor response through the PLAXIS phases

Anchor Row 1 reached 151.115 kN during P04, after excavation to the second anchor level, and remained close to that value through the subsequent stages; the P07 force was 150.911 kN. Anchor Row 2 continued to gain load and reached 149.116 kN at P07. Positive wall shear also reached a slightly higher value during P04, approximately 44.37 kN/m, before reducing to 43.81 kN/m at the final stage.

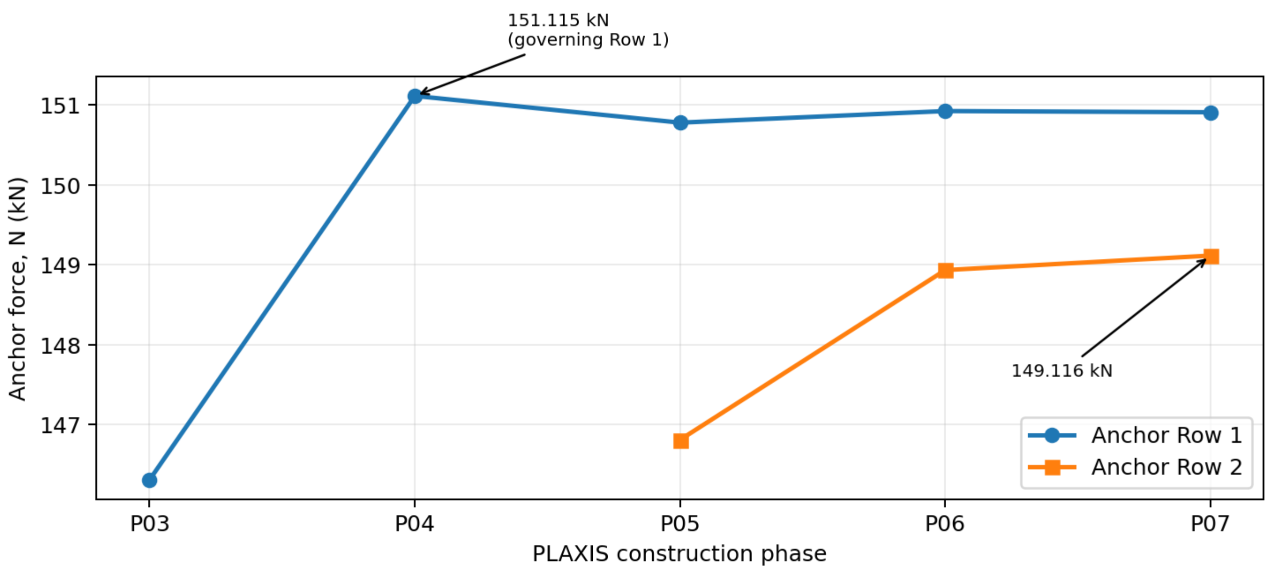


Figure 2. Development of ground-anchor forces through the relevant PLAXIS phases.

Bonded-length response

The embedded-beam results were reviewed to understand the transfer of anchor load along the bonded lengths. At P07, the peak local skin-resistance mobilisation was approximately 89.1% for Row 1 and 86.0% for Row 2. These percentages represent local mobilisation of the modelled shaft resistance and are not directly equivalent to the overall anchor-capacity utilisation ratios reported by GEO5.

Bonded length mobilisation at P07

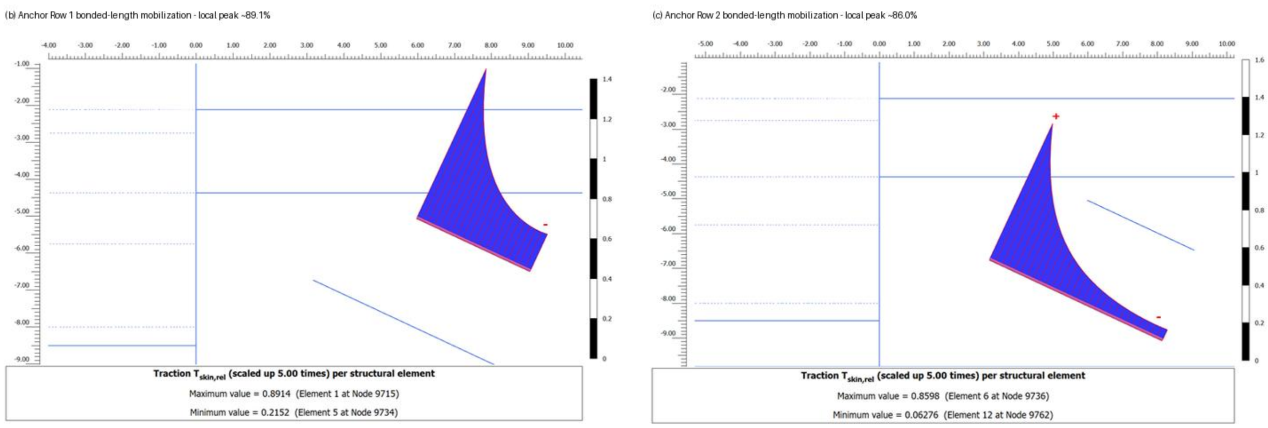


Figure 3. Local skin-resistance mobilisation along the bonded anchor lengths at P07.

Final-stage GEO5 / PLAXIS correlation

Response	GEO5	PLAXIS 2D	Difference
Wall bending moment	21.16 kN m/m	21.83 kN m/m	**+3.2%**
Wall shear force	44.87 kN/m	43.81 kN/m	**-2.4%**
Anchor Row 1	146.31 kN	150.911 kN	**+3.1%**
Anchor Row 2	146.81 kN	149.116 kN	**+1.6%**

6. Engineering Discussion and Conclusions

Interpretation of the comparison

The close final-stage correlation was useful because the two analyses reached the design response through different retaining-wall formulations. The comparison therefore provided a meaningful second check on the adopted wall and anchor demand. It should not, however, be presented as proof that one software package validates the other.

The stage history was equally important. The GEO5 all-stage envelope governed the soldier-pile structural verification, while the PLAXIS results showed the first anchor row and positive wall shear reaching their peak values during an intermediate excavation stage. The deepest cut was therefore not automatically the governing condition for every part of the support system.

Role of GEO5 in the design workflow

GEO5 provided the primary engineering design framework. Its value in this case was the direct connection between excavation stage, earth-pressure distribution, required embedment, anchor demand and structural verification. This made it practical to test the support arrangement and identify the governing design checks without obscuring the underlying calculation sequence.

PLAXIS 2D was used as a separate verification model rather than as a replacement for the conventional design. It added a deformation-based view of the support system and allowed the evolution of anchor loads and the distribution of load transfer along the bonded lengths to be examined.

Final engineering outcome

The adopted support arrangement was retained in the design. The 10.00 m HEA 200 S275 soldier piles exceeded the 9.32 m minimum wall length returned by GEO5 at the 8.50 m design over-excavation condition. The GEO5 all-stage structural envelope remained within the steel-section resistance, both anchors were satisfactory in the GEO5 capacity checks, and global stability satisfied the adopted transient criterion. The PLAXIS final-stage forces remained within approximately 1.6% to 3.2% of the corresponding GEO5 values.

The principal design conclusion is straightforward: temporary excavation support should be assessed through the complete construction sequence. A final retained-height section alone does not necessarily identify the governing wall or anchor response.

These are design-stage predictions and checks based on the stated geometry, ground model, surcharge and groundwater condition. They do not report construction measurements or field validation at the subject project.