

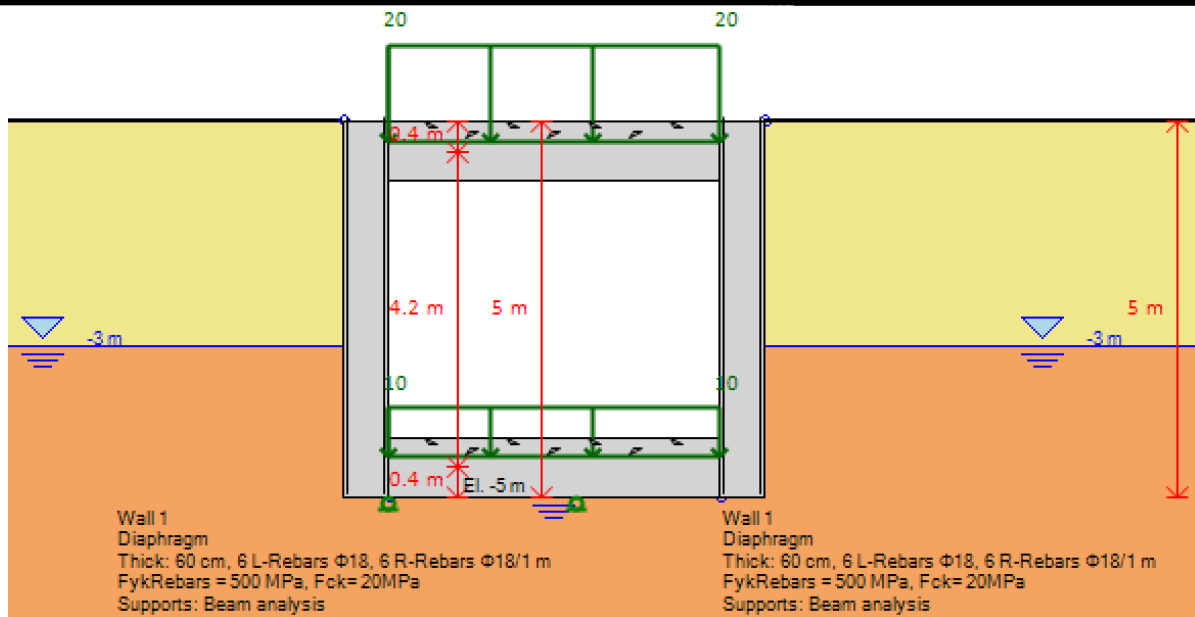


# DEEP EXCAVATION

GEOTECHNICAL SOFTWARE & ENGINEERING

## Concrete Drain Box Design Example - DeepEX

Limit Equilibrium Method – Non-Linear Analysis – Finite Element Analysis



DeepEX – Shoring Design Software

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**INTRODUCTION: DEEPEX – SHORING DESIGN SOFTWARE**

DeepEX is a powerful software program for the design and evaluation of earth retaining systems. It can perform full structural and geotechnical design of any common wall type and support system.

Any model (2D sections, 3D Frames) can be created, analyzed and optimized in minutes. Results and check ratios can be displayed in tables and graphically in a comprehensive way. Analysis warnings and recommendations can lead to the most efficient model optimization.

**Available Wall Types:** Soldier Piles, Secant/Tangent Piles, Sheet Piles, Box Sheet Piles, Concrete Diaphragms, Combined Sheet Piles (King Piles), Gravity Walls and more.

**Available Support Types:** Ground Anchors (Tiebacks), Concrete Slabs, Steel Struts and Steel Rakers, Steel and Concrete Walers, Tiedowns, Tierods and more.

**Analysis Methods:** Limit Equilibrium (LEM), Beam on Elastoplastic Foundations (Non-Linear Analysis with Elastoplastic Springs), Finite Element Analysis (FEM).

**Soil Pressures Methods (LEM):** Active/Passive, FHWA Apparent, Peck 1969 Apparent, AASHTO-17 (Temp. Bridges), Custom Trapezoidal, WMATA, NYC DEP (Sewers), German EAB, Two-step Rectangular, At-Rest and more.

**Lateral Earth Coefficients:** Rankine, Coulomb, Caquot-Kerisel, Lancelotta.

**Beam Analysis Methods (LEM):** Blum’s, FHWA Simple Span, Simple Span with Negative Moments, CALTRANS, WMATA.

**Seismic Pressures Methods:** Semirigid, Mononobe-Okabe, Wood, User-Defined.

**Water Pressures Methods:** Hydrostatic, Simplified Flow, Full 2D Flownet Analysis.

**Soil Properties:** User-Defined, Estimation Tools (Test Data), SPT and CPT logs.

**Structural Codes:** ACI, AISC. ASD, LRFD, EUROCODES 2, 3 and 8, AS, CN and more.

**Geotechnical Codes:** AASHTO LRFD, CALTRANS, EUROCODE 7, CN, DIN and more.

**Printed Reports:** Reports Exported in PDF and Word, Sketches exported to DXF.

**Model Creation:** Graphical (Interactive Interface), Model Wizard, Voice Commands.

**Model Optimization:** Automatic Optimization Tools – Wall/Support Structural Sections, Tieback fixed lengths, Support Locations and more.

**DeepEX Features and Capabilities**

Design and evaluate any deep excavation system (2D Sections and 3D Frames) with different analysis methods:

- Limit Equilibrium Analysis
- Non-Linear Analysis (Soil Springs)
- Finite Element Analysis

Perform Structural and Geotechnical design of any wall type and support system in the same software package.

[Click here to review all software Features and Capabilities](#)

**Projects Designed with DeepEX**

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**A. PROJECT DESCRIPTION – MODEL DATA**

This example presents a design of a 5m x 5m concrete drain box (0.6m thick concrete diaphragm walls with concrete slabs). The water table is at El: -3 m.

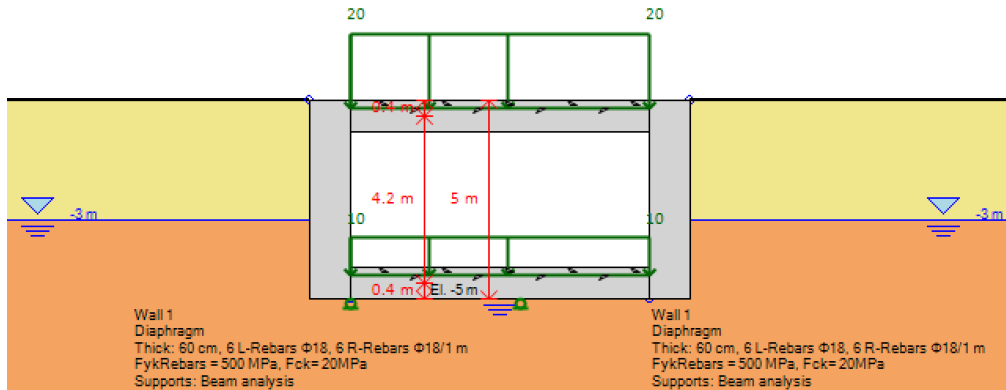


Table: Soil Properties and Soil Layer Elevations

Soil Layer Elev. (m)	Soil (-)	Soil Type (-)	Friction Angle (deg)	Cohesion (kPa)	Total Unit Weight (KN/m3)	Elasticity Modulus (kPa)	Exp.
0	F	Sand (Fill)	30	0	19.5	14000	0.5
-3	S1	Medium Sand	34	0	20.5	28000	0.4

Table: Wall Properties

Property/Wall	Both Walls
Wall Type	Reinforced Concrete Diaphragms (Slurry Walls)
Wall Section	0.6 m thick Concrete Diaphragms
Reinforcement	Long.: 5 $\phi$ 18 bars/m (both sides), Shear: bars / 10 cm
Materials	Rebars: S500 , Concrete: C20/25
Top Wall Elevation	0 m
Total Wall Depth	5 m

Table: Support Locations and Section Properties

Property/Support	Level 1 (Top Slab)	Level 2 (Base Slab)
Elevation (Center)	0.4 m	-4.6 m
Support Type	Conc. Slab	Conc. Slab
Slab Thickness	0.8 m	0.8 m
Reinforcement	5 $\phi$ 10 bars/m of slab (top and bottom reinf.)	
Materials	Rebars: S500 , Concrete: C20/25	
Unbraced L	-	2.5 m
Live Load	20 kPa	10 kPa

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**B. DEEPEX SOFTWARE – SOIL TYPES AND BORINGS**

The screenshot shows two panels for defining soil properties. The left panel shows general soil information for 'Soil S1', including its name, description ('Medium sand'), and behavior ('Sand'). It also shows strength parameters like cohesion (c'), friction angle (phi), and unit weights. The right panel shows more advanced parameters like the soil model (Elastic-Plastic), loading elasticity parameters (Eload, exp, Pref), and reloading elasticity modulus (rEur).

Figure: General soil properties – Sand Layer (Soil S1)

The screenshot displays the 'Boring Information' section, including the name 'Boring 1' and its coordinates (X: -20m, Y: 0m). Below this, there are options for SPT and CPT data. The 'Soil Layers - Layer Elevations' section contains a table with the following data:

	Top Elev.(m)	Soil Type	OCR	Ko	Edit
▶	0	F	1	0.5	Edit
	-3	S1	1	0.441	Edit
*					

Figure: Soil Layers

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C. DEEPEX SOFTWARE – WALL AND SUPPORT SECTIONS

Figure: DeepEX – Concrete Diaphragm Wall – Section Properties

Figure: DeepEX – Wall Properties

Figure: DeepEX – Concrete Slabs – Section Properties

DeepEX Features and Capabilities

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### D. DEEPEX – CONSTRUCTION STAGES

In DeepEX, all construction stages can be generated and analyzed. This allows the advanced analysis methods (Non-Linear and FEM) to converge, as well as, the user is able to review all results in all stages, recognize the most critical stage and take important decisions, in order to perform the most efficient model optimization.

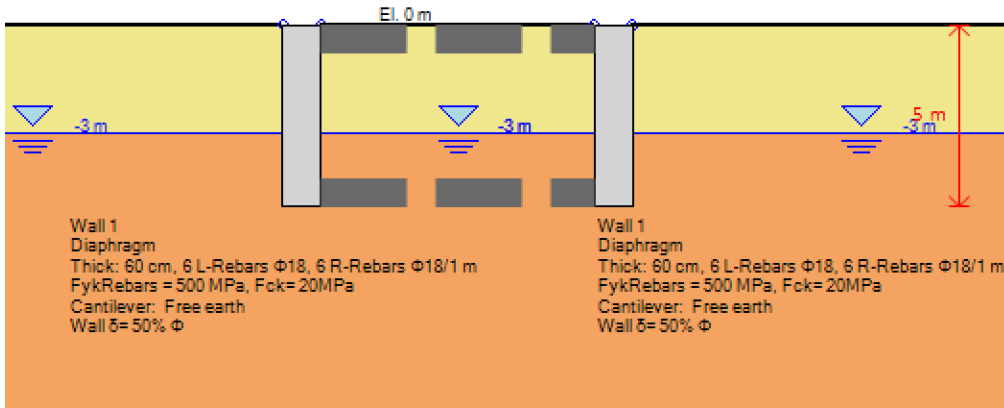


Figure: Stage 0 (Initial Stage – No Excavation)

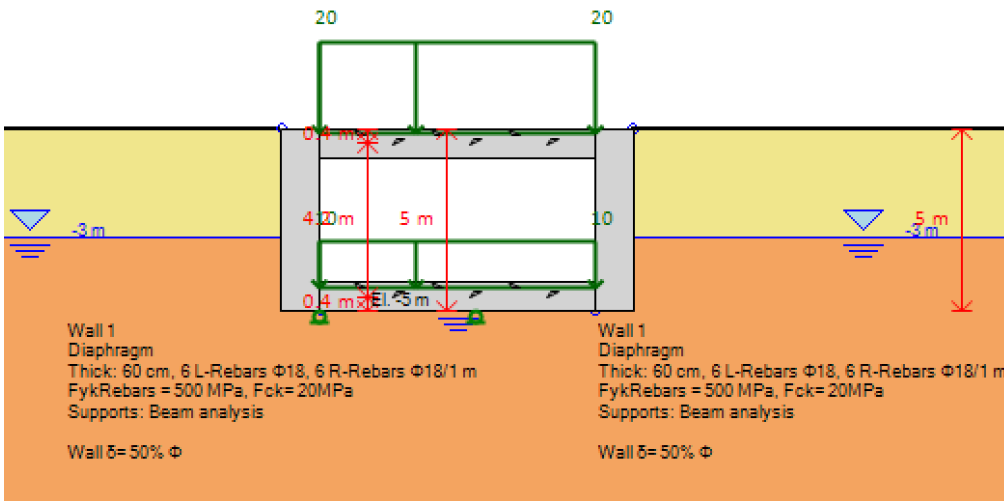


Figure: Stage 1 –Install Drain Box

### DeepEX Features and Capabilities

Design and evaluate any deep excavation system (2D Sections and 3D Frames) with different analysis methods:

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Perform Structural and Geotechnical design of any wall type and support system in the same software package.

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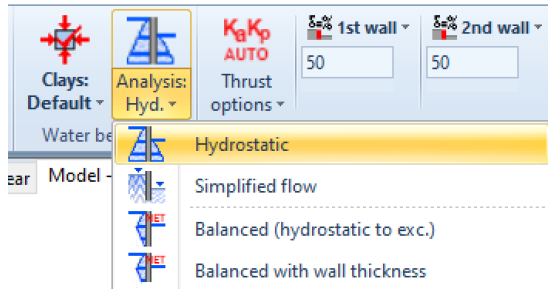
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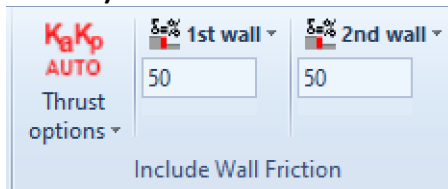


**E. DEEPEX – 2D SECTION ANALYSIS SETTINGS**

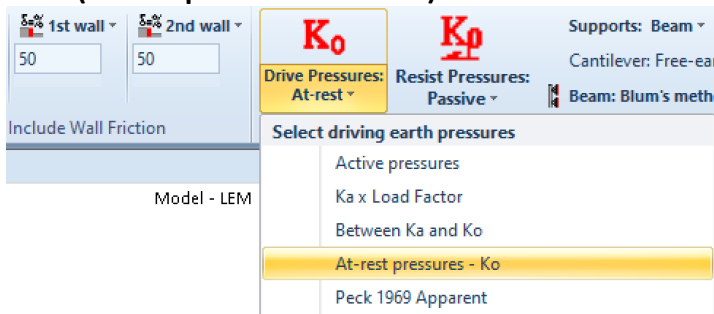
**1. Water Pressures (All Methods) -> Hydrostatic**



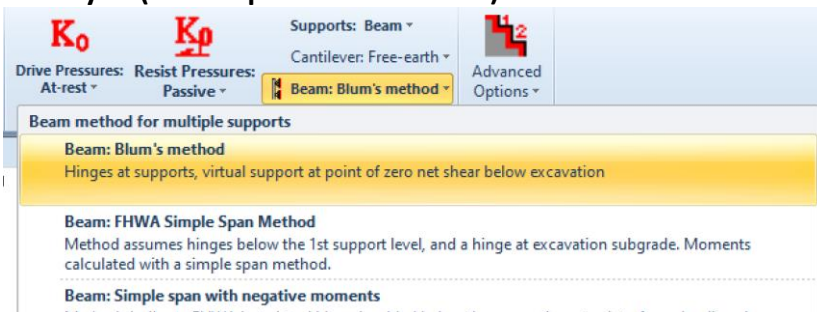
**2. Wall Friction (All Methods) -> 50% of the Soil Friction**



**3. Soil Pressures (Limit Equilibrium Method) -> At-Rest**



**4. Beam Analysis (Limit Equilibrium Method) -> Blum's method**



**5. Analysis Method -> Limit Equilibrium (LEM)  
-> Non-Linear Analysis (NL)  
-> Finite Element Analysis (FEM)**

**DeepEX Features and Capabilities**

Design and evaluate any deep excavation system (2D Sections and 3D Frames) with different analysis methods:

- Limit Equilibrium Analysis
- Non-Linear Analysis (Soil Springs)
- Finite Element Analysis

Perform Structural and Geotechnical design of any wall type and support system in the same software package.

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F. LIMIT EQUILIBRIUM ANALYSIS RESULTS

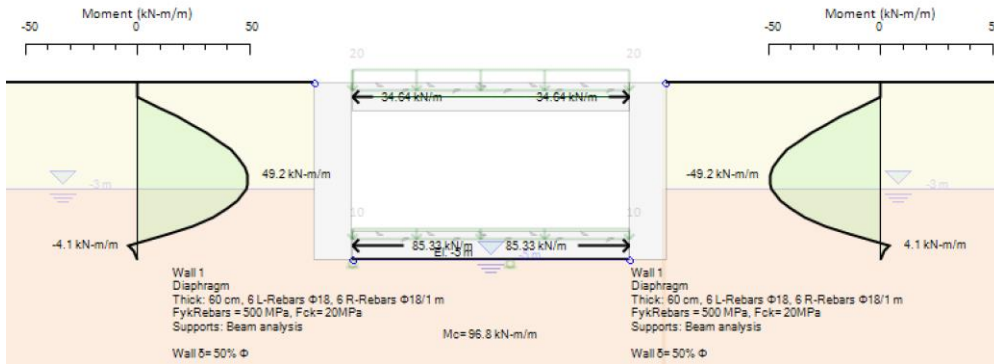


Figure: Wall Moment Diagrams, Support Reactions

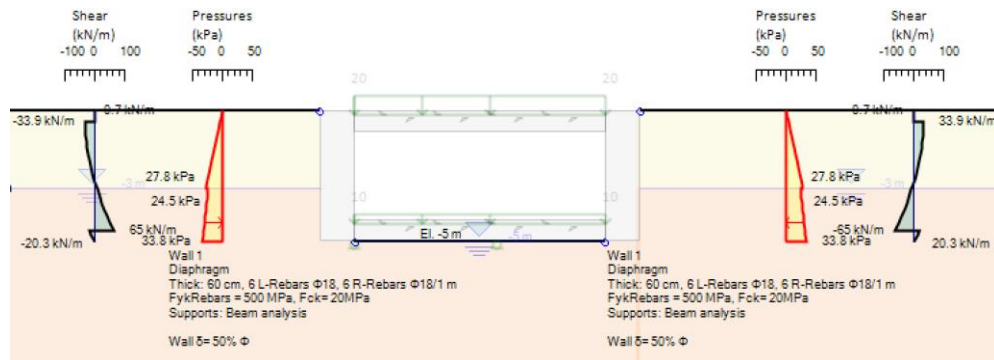


Figure: Wall Shear and Horizontal Soil Pressures Diagrams

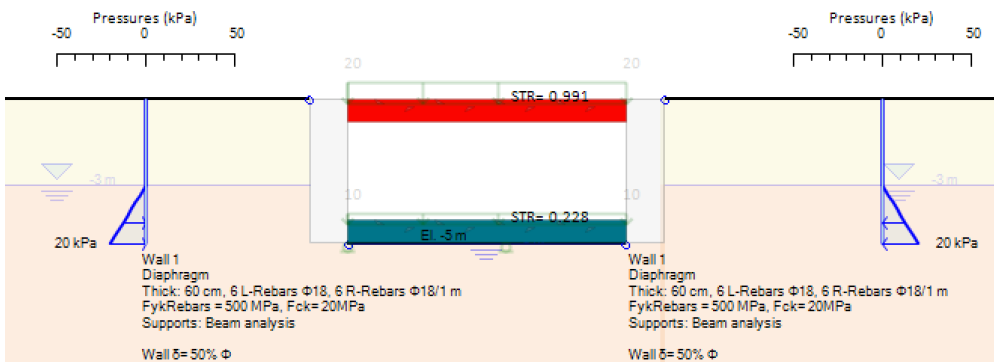


Figure: Water Pressures Diagrams and Support Check Ratios

DeepEX Features and Capabilities

Design and evaluate any deep excavation system (2D Sections and 3D Frames) with different analysis methods:

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- Non-Linear Analysis (Soil Springs)
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**G. NON-LINEAR ANALYSIS RESULTS**

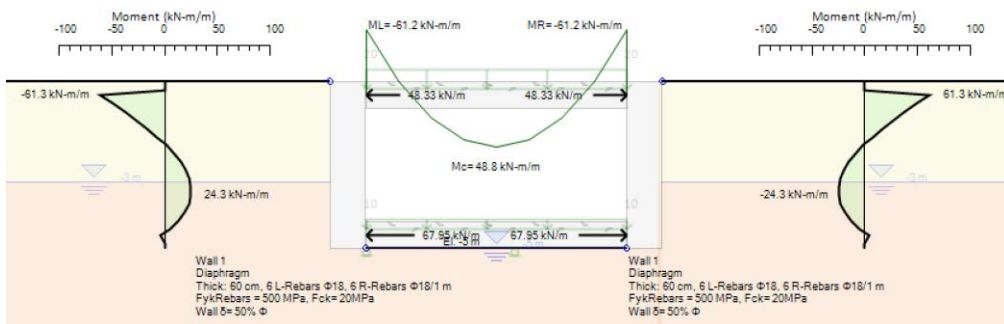


Figure: Wall and Slab Moment Diagrams, Support Reactions

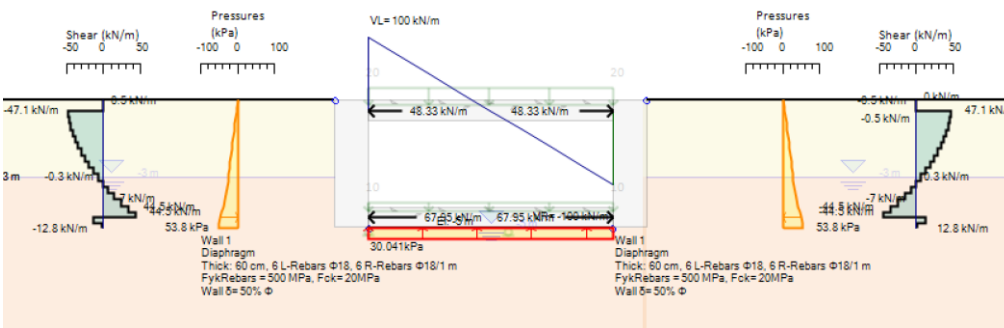


Figure: Wall and Slab Shear - Total Effective Soil Pressures Diagrams

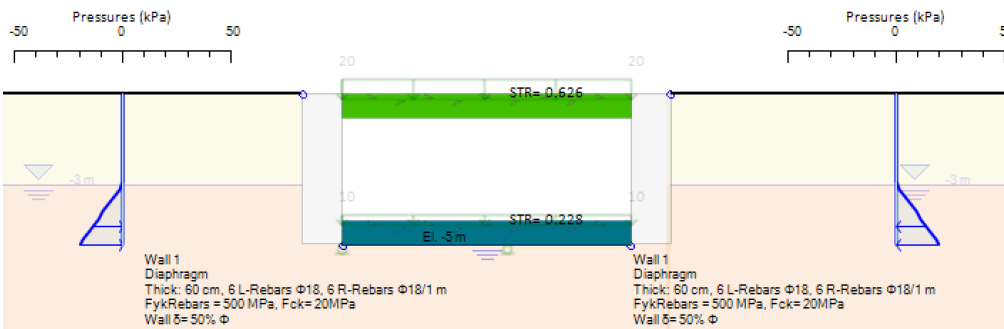


Figure: Water Pressures Diagrams and Support Check Ratios

**DeepEX Features and Capabilities**

Design and evaluate any deep excavation system (2D Sections and 3D Frames) with different analysis methods:

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H. FINITE ELEMENT ANALYSIS RESULTS

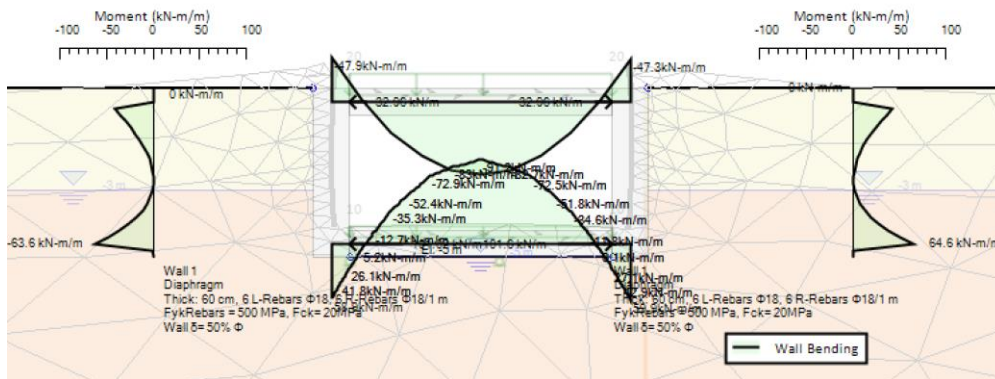


Figure: Wall and Slab Moment Diagrams, Support Reactions

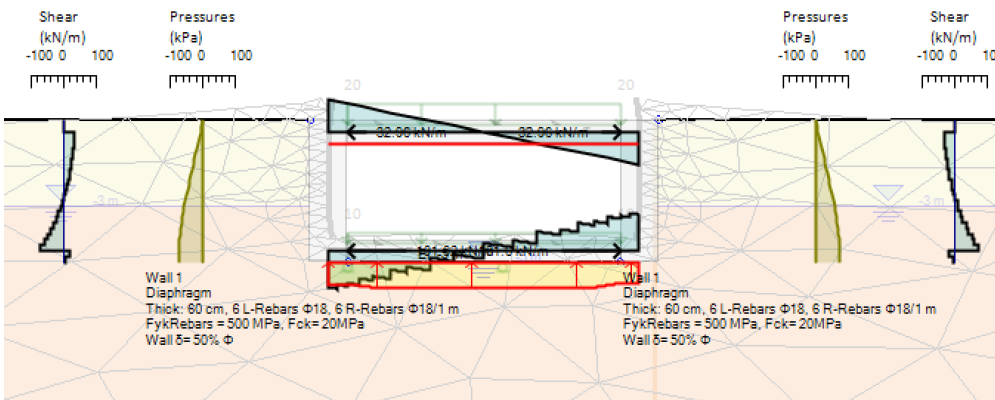


Figure: Wall and Slab Shear - Effective Vertical Pressures Diagrams

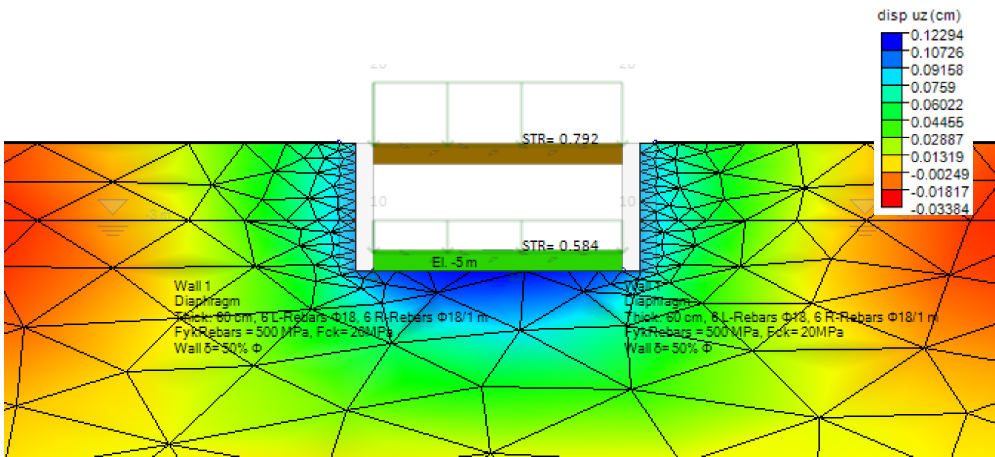


Figure: Soil Settlements Shading and Support Check Ratios

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