Vedlegg A – Brukte Tabeller fra EC 8

Tabell NA.3.1 — Grunntyper

Grunn-type	Beskrivelse av stratigrafisk profil	Parametere[b)c)]		
		$v_{s,30}$ (m/s)	N_{SPT} (slag/30cm)	c_u (kPa)
A[a)]	Fjell eller fjell-liknende geologisk formasjon, medregnet høyst 5 m svakere materiale på overflaten.	> 800	-	-
B	Avleiringer av svært fast sand eller grus eller svært stiv leire, med en tykkelse på flere titalls meter, kjennetegnet ved en gradvis økning av mekaniske egenskaper med dybden.	360 – 800	> 50	> 250
C	Dype avleiringer av fast eller middels fast sand eller grus eller stiv leire med en tykkelse fra et titalls meter til flere hundre meter.	180 – 360	15 - 50	70 - 250
D	Avleiringer av løs til middels fast kohesjonsløs jord (med eller uten enkelte myke kohesjonslag) eller av hovedsakelig myk til fast kohesjonsjord.	120 – 180	10 – 15	30 – 70
E[d)]	Et grunnprofil som består av et alluviumlag i overflaten med v_s-verdier av type C eller D og en tykkelse som varierer mellom ca. 5 m og 20 m, over et stivere materiale med v_s > 800 m/s.			
S_1	Avleiringer som består av eller inneholder et lag med en tykkelse på minst 10 m av bløt leire/silt med høy plastisitetsindeks (PI > 40) og høyt vanninnhold.	> 100	-	10-20
S_2	Avleiringer av jord som kan gå over i flytefase (liquefaction), sensitive leirer eller annen grunnprofil som ikke er med i typene A – E eller S_1.			

a Hvis minst 75 % av konstruksjonen står på fjell og resten på løsmasser, og konstruksjonen står på ett kontinuerlig fundament (platefundament), kan grunntype A benyttes.

b Valget av grunntype kan være basert på enten $v_{s,30}$, N_{SPT} eller c_u. $v_{s,30}$ anses som den mest aktuelle parameteren å benytte.

c Der det er tvil om hvilken jordtype som skal velges, velges den mest ugunstige.

d Ved bestemmelse av grunntype E kan følgende alternative beskrivelse benyttes: Et jordprofil bestående av et overflatelag med $v_{s,30}$ - verdier av type C eller D og tykkelse varierende mellom ca. 5 m og 20 m over et underliggende stivere materiale med $v_{s,30}$ > 500 m/s.

Tabell NA.4 (902) — Veiledende valg av seismisk klasse

Byggverk	I	II	IIIa	IIIb	IV
Byggverk der konsekvensene av sammenbrudd er særlig store					x
Viktig infrastruktur: sykehus, brannstasjoner, redningssentraler, kraftforsyning og lignende			(x)	x	
Industrianlegg[a)]		x	x		
Tårn, skorsteiner, siloer	(x)	x			
Kaier og havneanlegg[b)]	x	(x)			
Støttemurer, nedgravde konstruksjoner, geotekniske konstruksjoner[c)]	x	(x)			
Byggverk med store, og vedvarende, ansamlinger av mennesker og som ofte er i bruk: kjøpesentre, konferanselokaler, kinosaler, kulturelle institusjoner			x		
Byggverk med store, men sjeldne, ansamlinger av mennesker: tribuner, sportshaller		x			
Byggverk med små, men vedvarende, ansamlinger av mennesker og som ofte er i bruk: idrettsbygg		x			
Skoler og institusjonsbygg		(x)	x		
Kontorer, forretningsbygg, hotell og boligbygg		x			
Småhus, rekkehus, mindre lagerhus	x				
Landbruksbygg[d)]	x				
Kaier og fortøyningsanlegg for sport og fritid	x				

MERKNAD Kryss uten parentes angir normalt valg av seismisk klasse.

a Der det er fare for stor skade på miljø og/eller biomangfold bør klasse IIIa velges.

b Der havneanlegg er en del av industrianlegg må disse vurderes også som industrianlegg

c Der bortfall av konstruksjoner påvirker stabiliteten til en konstruksjon med høyere konsekvensklasse må tilsvarende høyere konsekvensklasse vurderes. Konstruksjoner som bidrar til stabilitet langs vei og spor bør vurderes tilsvarende som bruer, se NS-EN 1998-2/NA.

d Landbruksbygg med fare for stor skade på miljø bør vurderes som industribygg

Tabell NA.4 (901) — Verdier for seismisk faktor γ_1

Seismisk klasse	γ_1
I	0,70
II	1,00
IIIa	1,25
IIIb	1,70
IV	- a)
a For byggverk der konsekvensene av sammenbrudd er særlig store, for eksempel ved atomreaktorer og lagringsanlegg for radioaktivt avfall, store dammer, skal seismisk faktor vurderes særskilt enten på grunnlag en egen risikoanalyse eller en definert pålitelighet etter bestemmelsene for den aktuelle konstruksjonstypen.	

Tabell NA.3.2 (902) — Spissverdier for berggrunnens akselerasjon a_{gR} (PGA) med en returperiode på 475 år for Oslo

Kommune	Nr.	a_{gR} [m/s^2]
Oslo	301	0,30

NA.3.2.2.2 Horisontalt elastisk responsspektrum

NA.3.2.2.2(2) Verdiene i tabell 3.3 for type 2 elastisk responsspekter bør benyttes for de seismiske sonene angitt i dette dokumentet. For grunntypene S_1 og S_2 bør verdiene angitt i tabell NA.3.3 benyttes.

Tabell NA.3.3 — Verdier for paramtere som beskriver elastiske responsspektrene for grunntype S_1 og S_2

Dybde til berg	S	T_B (s)	T_C (s)	T_D (s)
6 - 20 m	2,0	0,10	0,40	1,4
20 - 35 m	1,9	0,15	0,50	1,5
35 - 60 m	1,8	0,20	0,60	1,6

NA.3.2.2.3 Vertikalt elastisk responsspektrum

NA.3.2.2.3(1) Verdiene gitt i tabell 3.4 for type 2 vertikalt elastisk responsspekter bør benyttes for de seismiske sonene angitt i dette dokumentet.

MERKNAD Det vertikalt elastiske responsspektrumet kan også benyttes for grunntypene S_1 og S_2.

MERKNAD 1 Verdiene som skal tilskrives T_B, T_C, T_D og S for hver grunntype og spektralform som skal brukes i et land, kan angis i det nasjonale tillegget til dette dokumentet. Hvis det ikke tas hensyn til geologiske forhold i dybden (se **3.1.2(1)**), anbefales det å bruke to typer spektre: type 1 og type 2. Hvis jordskjelvene som bidrar mest til den seismiske faren definert for byggegrunnen, og som ligger til grunn for den probabilistiske beregningen av faren, har magnitude M_s på høyst 5,5, anbefales det å bruke spektrum type 2. For de fem grunntypene A, B, C, D og E er de anbefalte verdiene av parametrene S, T_B, T_C og T_D gitt i tabell 3.2 for spektrum type 1 og i tabell 3.3 for spektrum type 2. Figur 3.2 og figur 3.3 viser henholdsvis formene på de anbefalte spektrene type 1 og type 2, normalisert av a_g, for 5 % demping. Forskjellige spektre kan defineres i det nasjonale tillegget hvis det tas hensyn til geologiske forhold i dybden.

Tabell 3.2 – Verdier for parametere som beskriver de anbefalte elastiske responsspektrene av type 1

Grunntype	S	T_B (s)	T_C (s)	T_D (s)
A	1,0	0,15	0,4	2,0
B	1,2	0,15	0,5	2,0
C	1,15	0,20	0,6	2,0
D	1,35	0,20	0,8	2,0
E	1,4	0,15	0,5	2,0

Tabell 3.3 – Verdier for parametere som beskriver de anbefalte elastiske responsspektrene av type 2

Grunntype	S	T_B (s)	T_C (s)	T_D (s)
A	1,0	0,05	0,25	1,2
B	1,35	0,05	0,25	1,2
C	1,5	0,10	0,25	1,2
D	1,8	0,10	0,30	1,2
E	1,6	0,05	0,25	1,2

Tabell NA.3.2 (902) — Spissverdier for berggrunnens akselerasjon a_{gR} (PGA) med en returperiode på 475 år for Oslo

Kommune	Nr.	a_{gR} [m/s^2]
Oslo	301	0,30

NA.3.2.2.2 Horisontalt elastisk responsspektrum

NA.3.2.2.2(2) Verdiene i tabell 3.3 for type 2 elastisk responsspekter bør benyttes for de seismiske sonene angitt i dette dokumentet. For grunntypene S_1 og S_2 bør verdiene angitt i tabell NA.3.3 benyttes.

Tabell NA.3.3 — Verdier for paramtere som beskriver elastiske responsspektrene for grunntype S_1 og S_2

Dybde til berg	S	T_B (s)	T_C (s)	T_D (s)
6 - 20 m	2,0	0,10	0,40	1,4
20 - 35 m	1,9	0,15	0,50	1,5
35 - 60 m	1,8	0,20	0,60	1,6

NA.3.2.2.3 Vertikalt elastisk responsspektrum

NA.3.2.2.3(1) Verdiene gitt i tabell 3.4 for type 2 vertikalt elastisk responsspekter bør benyttes for de seismiske sonene angitt i dette dokumentet.

MERKNAD Det vertikalt elastiske responsspektrumet kan også benyttes for grunntypene S_1 og S_2 .

MERKNAD 1 Verdiene som skal tilskrives T_B, T_C, T_D og S for hver grunntype og spektralform som skal brukes i et land, kan angis i det nasjonale tillegget til dette dokumentet. Hvis det ikke tas hensyn til geologiske forhold i dybden (se **3.1.2(1)**), anbefales det å bruke to typer spektre: type 1 og type 2. Hvis jordskjelvene som bidrar mest til den seismiske faren definert for byggegrunnen, og som ligger til grunn for den probabilistiske beregningen av faren, har magnitude M_s på høyst 5,5, anbefales det å bruke spektrum type 2. For de fem grunntypene A, B, C, D og E er de anbefalte verdiene av parametrene S, T_B, T_C og T_D gitt i tabell 3.2 for spektrum type 1 og i tabell 3.3 for spektrum type 2. Figur 3.2 og figur 3.3 viser henholdsvis formene på de anbefalte spektrene type 1 og type 2, normalisert av a_g, for 5 % demping. Forskjellige spektre kan defineres i det nasjonale tillegget hvis det tas hensyn til geologiske forhold i dybden.

Tabell 3.2 – Verdier for parametere som beskriver de anbefalte elastiske responsspektrene av type 1

Grunntype	S	T_B (s)	T_C (s)	T_D (s)
A	1,0	0,15	0,4	2,0
B	1,2	0,15	0,5	2,0
C	1,15	0,20	0,6	2,0
D	1,35	0,20	0,8	2,0
E	1,4	0,15	0,5	2,0

Tabell 3.3 – Verdier for parametere som beskriver de anbefalte elastiske responsspektrene av type 2

Grunntype	S	T_B (s)	T_C (s)	T_D (s)
A	1,0	0,05	0,25	1,2
B	1,35	0,05	0,25	1,2
C	1,5	0,10	0,25	1,2
D	1,8	0,10	0,30	1,2
E	1,6	0,05	0,25	1,2

Tabell 3.4 – Anbefalte verdier for parametere som beskriver de vertikale elastiske responsspektrene

Spektrum	a_{vg}/a_g	T_B (s)	T_C (s)	T_D (s)
Type 1	0,90	0,05	0,15	1,0
Type 2	0,45	0,05	0,15	1,0

Table 7.1 — Values of factor r for the calculation of the horizontal seismic coefficient

Type of retaining structure	r
Free gravity walls that can accept a displacement up to $d_r = 300\ \alpha \cdot S$ (mm)	2
Free gravity walls that can accept a displacement up to $d_r = 200\ \alpha \cdot S$ (mm)	1,5
Flexural reinforced concrete walls, anchored or braced walls, reinforced concrete walls founded on vertical piles, restrained basement walls and bridge abutments	1

Vedlegg B – Jordskjelv med PGA 0,16g

CESMD

Information for Strong-Motion Station

Coyote Lake Dam - Southwest Abutment

CGS - CSMIP Station 57217

Earthquakes recorded by this station

(Station Photograph - click to enlarge)

Latitude	37.1182 N
Longitude	121.5512 W
Elevation (m)	245
Site Geology	Fill over carbonate rock
Vs30 (m/sec)	561 (inferred)
Site Class	C
Remarks/Notes	Site information sources

Site Information Sources

- Vs30 Method:

  Inferred (NGA Vs30 code: 2a_3a_4b_4c)

- According to:

  NGA_West2_SiteDatabase_V032 at http://peer.berkeley.edu/ngawest2/databases/, last visited 5 Dec 2013

- Site Class was determined by:

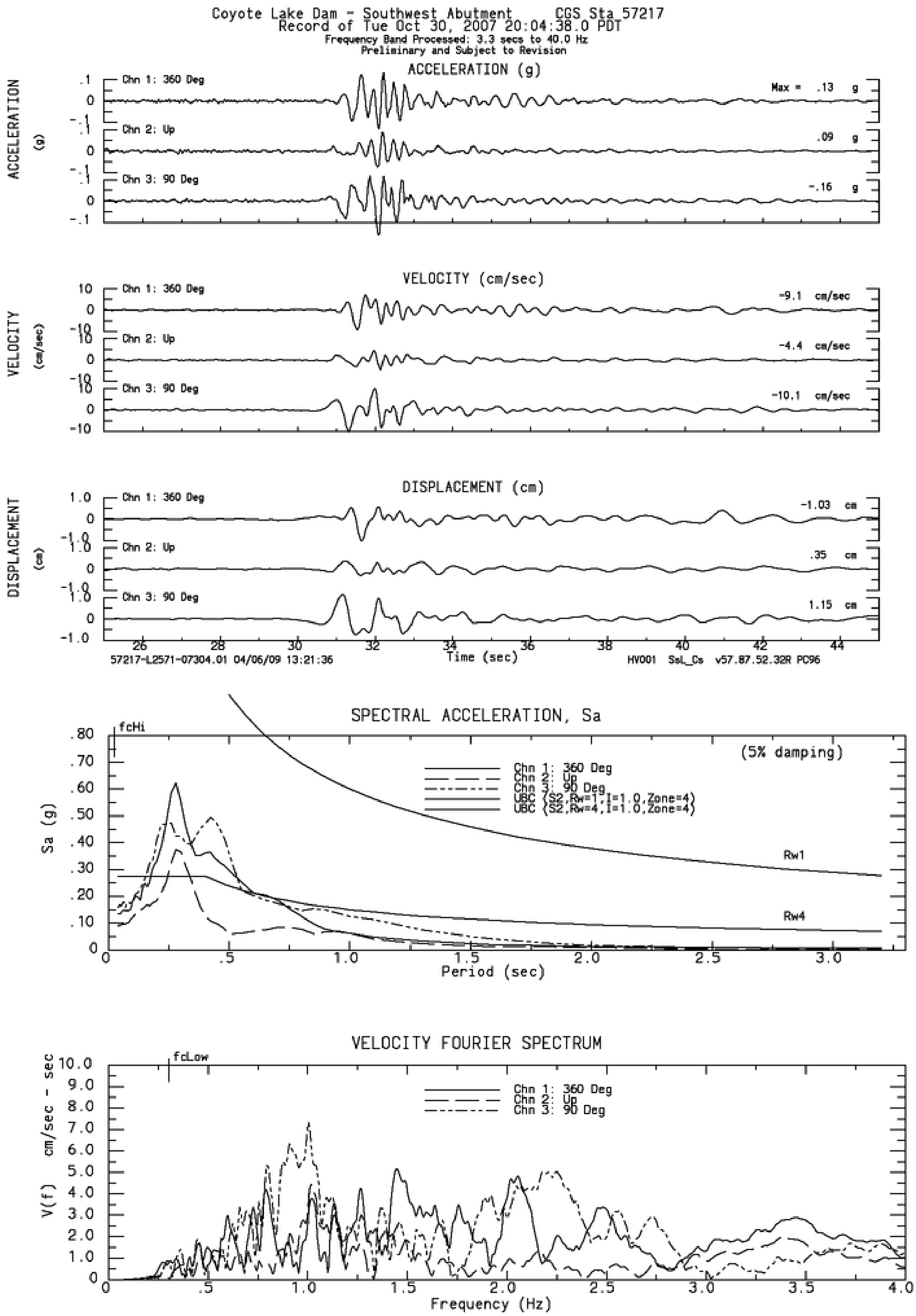
  Vs30 value according to the site class definition table below.

Site Class Definitions

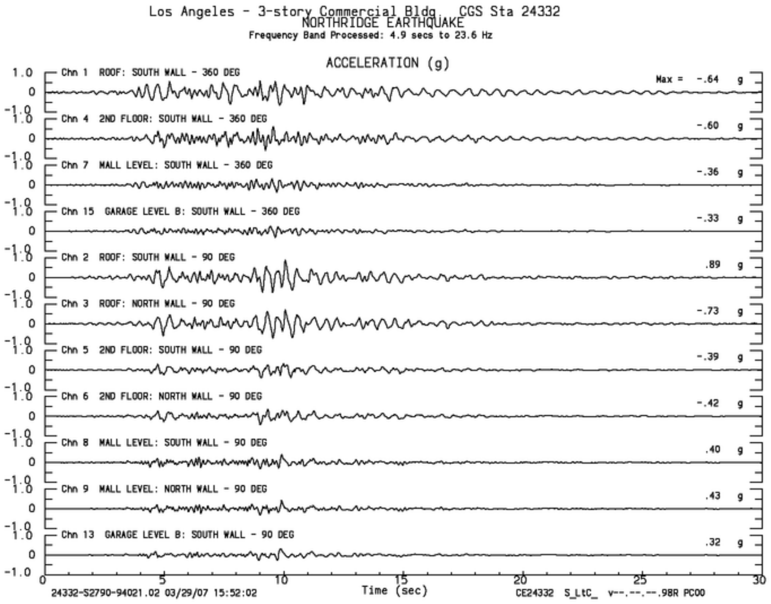
Site Class	Soil Profile Description	Average Soil Shear Wave Velocity in Top 100 ft (30 m), Vs_{30}
A	Hard rock	Vs_{30} > 5,000 ft/s (Vs_{30} > 1,500 m/s)
B	Rock	2,500 < $Vs_{30} \le$ 5,000 ft/s (760 < $Vs_{30} \le$ 1,500 m/s)
C	Very dense soil and soft rock	1,200 < $Vs_{30} \le$ 2,500 ft/s (360 < $Vs_{30} \le$ 760 m/s)
D	Stiff soil	600 $\le Vs_{30} \le$ 1,200 ft/s (180 $\le Vs_{30} \le$ 360 m/s)
E	Soft clay soil	Vs_{30} < 600 ft/s (Vs_{30} < 180 m/s)
F	Soils requiring site response analysis	- -

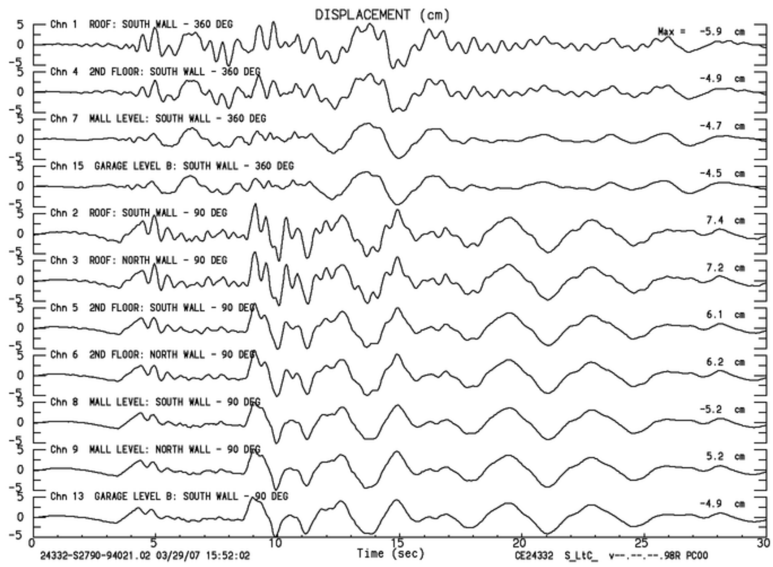
Notes:
1) In cases where the Vs_{30} value is near the lower boundary of a Site Class (within 5%) , the Site Class is noted as A/B, B/C, C/D or D/E .
2) Excerpted from Table 20.3-1 in Chapter 20 of ASCE 7-10.

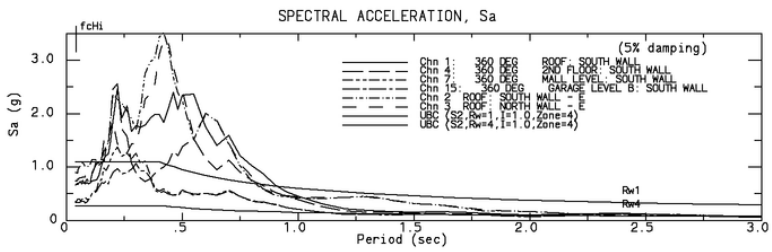
Vedlegg B – Jordskjelv med PGA 0,16g

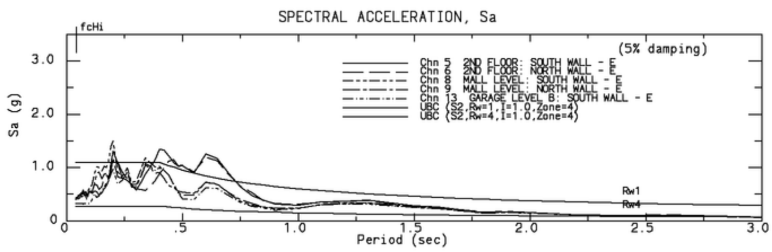


Vedlegg C – Jordskjelv med PGA 0,33g

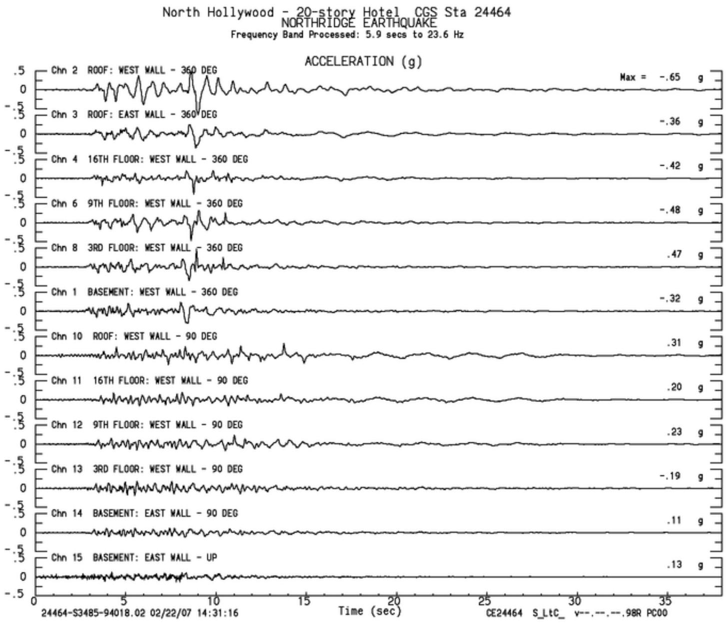


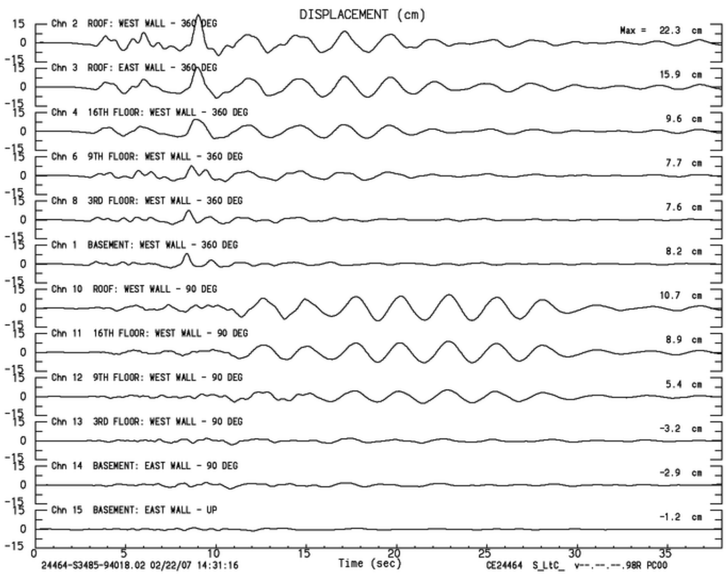


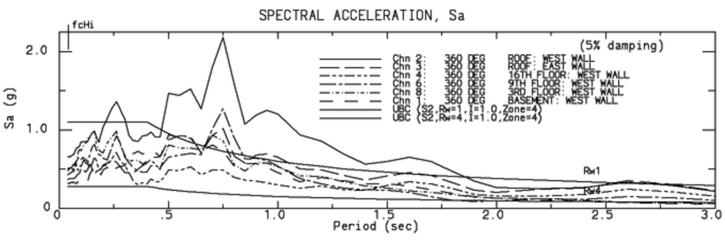


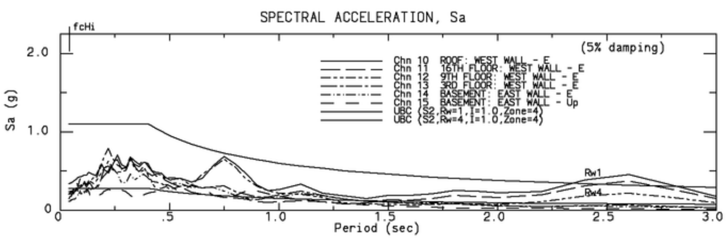


Vedlegg C – Jordskjelv med PGA 0,33g









Site Information Sources

- Vs30 Method:

  Downhole
- According to:

  USGS (1994) In-situ Measurements of Seismic Velocity at 27 Locations in the Los Angeles, California Region, OFR 80-378
- Site Class was determined by:

  Vs30 value according to the site class definition table below.

Site Class Definitions

Site Class	Soil Profile Description	Average Soil Shear Wave Velocity in Top 100 ft (30 m), Vs_{30}
A	Hard rock	$Vs_{30} > 5{,}000$ ft/s ($Vs_{30} > 1{,}500$ m/s)
B	Rock	$2{,}500 < Vs_{30} \leq 5{,}000$ ft/s ($760 < Vs_{30} \leq 1{,}500$ m/s)
C	Very dense soil and soft rock	$1{,}200 < Vs_{30} \leq 2{,}500$ ft/s ($360 < Vs_{30} \leq 760$ m/s)
D	Stiff soil	$600 \leq Vs_{30} \leq 1{,}200$ ft/s ($180 \leq Vs_{30} \leq 360$ m/s)
E	Soft clay soil	$Vs_{30} < 600$ ft/s ($Vs_{30} < 180$ m/s)
F	Soils requiring site response analysis	- -

Notes:
1) In cases where the Vs_{30} value is near the lower boundary of a Site Class (within 5%) , the Site Class is noted as A/B, B/C, C/D or D/E .
2) Excerpted from Table 20.3-1 in Chapter 20 of ASCE 7-10.

Site Information Sources

- Vs30 Method:

  Nearest grid value of Thompson et al. (2014) Vs30 map

- According to:

  Thompson, E. M., D. J. Wald, and C. B. Worden (2014). A VS30 map for California with geologic and topographic constraints, Bull. Seismol. Soc. Am. 104, 2313-2321

- Site Class was determined by:

  Vs30 value according to the site class definition table below.

Site Class Definitions

Site Class	Soil Profile Description	Average Soil Shear Wave Velocity in Top 100 ft (30 m), Vs_{30}
A	Hard rock	$Vs_{30} > 5{,}000$ ft/s ($Vs_{30} > 1{,}500$ m/s)
B	Rock	$2{,}500 < Vs_{30} \leq 5{,}000$ ft/s ($760 < Vs_{30} \leq 1{,}500$ m/s)
C	Very dense soil and soft rock	$1{,}200 < Vs_{30} \leq 2{,}500$ ft/s ($360 < Vs_{30} \leq 760$ m/s)
D	Stiff soil	$600 \leq Vs_{30} \leq 1{,}200$ ft/s ($180 \leq Vs_{30} \leq 360$ m/s)
E	Soft clay soil	$Vs_{30} < 600$ ft/s ($Vs_{30} < 180$ m/s)
F	Soils requiring site response analysis	- -

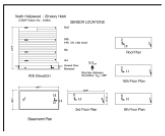
Notes:
1) In cases where the Vs_{30} value is near the lower boundary of a Site Class (within 5%) , the Site Class is noted as A/B, B/C, C/D or D/E .
2) Excerpted from Table 20.3-1 in Chapter 20 of ASCE 7-10.

Vedlegg C – Jordskjelv med PGA 0,33g

CESMD

Information for Strong-Motion Station
North Hollywood - 20-story Hotel
CGS - CSMIP Station 24464
[Earthquakes recorded by this station]

(Station Photograph - click to enlarge)

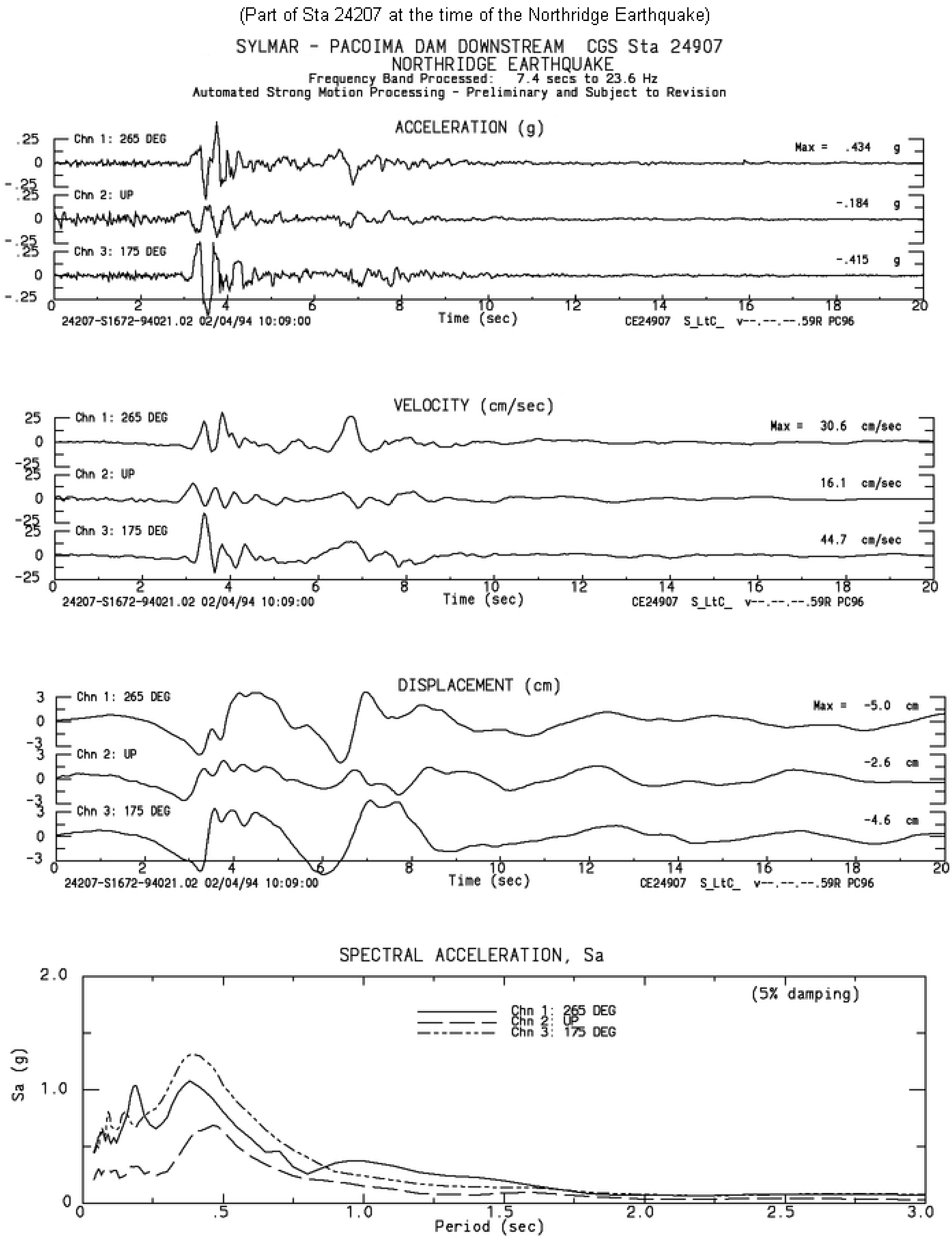


(Sensor Layout - click to see PDF File)

Latitude	34.1374 N
Longitude	118.3600 W
Elevation (m)	209
Site Geology	Rock (sandstone/shale)
Vs30 (m/sec)	464 (inferred)
Site Class	C
Remarks/Notes	Site information sources

No. of Stories above/below ground	20/1
Plan Shape	Rectangular
Base Dimensions	96'-4" x 198'-7"
Typical Floor Dimensions	57'-10" x 183'-6"
Design Date	1967
Instrumentation	1983. 16 accelerometers, on 5 levels in the building.
Vertical Load Carrying System	4-1/2" - 6" concrete slab supported by reinforced concrete columns and beams.
Lateral Force Resisting System	Concrete ductile moment resisting frames.
Foundation Type	Spread footings.
Remarks	The building was designed according to the 1966 Los Angeles Building code.

Vedlegg D – Jordskjelv med PGA 0,455g



Site Information Sources

- Vs30 Method:

  PS Suspension Log

- According to:

  Nigbor, R.L., and Swift, J.N. (2001). Resolution of Site Response Issues in the Northridge Earthquake (ROSRINE), Data Collection, Processing and Dissemination from Phases 1, 2 & 4 Field and Laboratory Investigations, USC Report CE472, 250 p.

- Site Class was determined by:

  Vs30 value according to the site class definition table below

Site Class Definitions

Site Class	Soil Profile Description	Average Soil Shear Wave Velocity in Top 100 ft (30 m), Vs_{30}
A	Hard rock	Vs_{30} > 5,000 ft/s (Vs_{30} > 1,500 m/s)
B	Rock	2,500 < Vs_{30} ≤ 5,000 ft/s (760 < Vs_{30} ≤ 1,500 m/s)
C	Very dense soil and soft rock	1,200 < Vs_{30} ≤ 2,500 ft/s (360 < Vs_{30} ≤ 760 m/s)
D	Stiff soil	600 ≤ Vs_{30} ≤ 1,200 ft/s (180 ≤ Vs_{30} ≤ 360 m/s)
E	Soft clay soil	Vs_{30} < 600 ft/s (Vs_{30} < 180 m/s)
F	Soils requiring site response analysis	- -

Notes:
1) In cases where the Vs_{30} value is near the lower boundary of a Site Class (within 5%) , the Site Class is noted as A/B, B/C, C/D or D/E .
2) Excerpted from Table 20.3-1 in Chapter 20 of ASCE 7-10.

Vegg høyde	12 m			**Sand**	
Dybde	5,2				
GV-nivå	14,5 m			Lengde	10,8m
Ønskende plassering av forankring 3 m fill				anchor 3m	

Passiv side			
z	γ_sand	σ_z	σ_x
1	17	17	6,8
2	17	34	13,6
3	17	51	20,4
5,2	17	88,4	35,36
F_p	91,936		
arm	1,73333		
M_p	159,356		

Aktiv side						
z	y_sand	Y_fill	σ_z	K_0_fill	K_0_sand	σ_x
3	17	17,5	52,5	0,55	0,4	28,875
8			85			34
10			119			47,6
12			153			61,2
F_a	540,45					
arm	4					
M_a	2161,8					

M_a-M_p	2002,44
F_anchor	222,494

Vegg høyde	12 m				**Sand**	
Dybde	5,2					
GV-nivå	-8					
Ønskende plassering av forankring: i 3 m fill				Anker bør være -3m		Lanchor 10,8

Passiv side						
z	z_w	γ_sand	σ_z	σ_x		
1,2	0	17	20,4	8,16		
2	0,8	17	5,6	2,24		
3	1,8	17	12,6	5,04		
5,2	4	17	28	11,2		
F_p1	F_p2	F_p3	arm_1	arm_2	arm_3	
4,896	32,64	22,4	4,4	2	1,33333333	M_p
21,5424	65,28	29,8666667			116,689067	ΣM_p

Aktiv side								
	z	z_w	y_sand	Y_fill	σ_z	K_0_fill	K_0_sand	σ_x
	3	0	17	17,5	52,5	0,55	0,4	28,875
	8	0	17	17,5	85	0,55	0,4	34
	10	2	17	17,5	14	0,55	0,4	5,6
	12	4	17	17,5	28	0,55	0,4	11,2
	F_a1	F_a2	F_a3	arm_1	arm_2	arm_3		
	251,5	251,5	22,4	6,66666667	2	1,33333333		
M_a	1676,66667	503	29,8666667					
ΣM_a	2209,53333							

M_a-M_p	2092,84427
F_anchor	232,538252

Vegg høyde	12 m	Sand		
Dybde	5,2			
GV-nivå	6,8			
Ønskende plassering av forankring: i 3 m fill			Anker bør være -3	L_anchor 10,8

Passiv side						
z	z_w	γ_sand	σ_z	σ_x		
1	1	17	7	2,8		
2	2	17	14	5,6		
3	3	17	21	8,4		
5,2	5,2	17	36,4	14,56		
F_p			arm_1			
37,856			1,73333333			
					65,6170667	M_p

Aktiv side							
z	z_w	y_sand	Y_fill	σ_z	K_0_fill	K_0_sand	σ_x
3	0	17	17,5	52,5	0,55	0,4	28,875
6,8	0			64,6			25,84
10	3,2			22,4			8,96
12	5,2			36,4			14,56
F_a1	F_a2	F_a3	arm_1	arm_2	arm_3		
186,031	284,518	37,856	7,46666667	2,6	1,73333333		
M_a	1389,031467	739,7468	65,6170667				
ΣM_a	2194,395333						

M_a-M_p	2128,77827
F_anchor	236,530919

Ønsket GWL 14 m under overflate					**Modell:**	**Leire**
		γ_sat	γ_unsat	K_0		
z_fill	2	20	18	0,43		
z_clay	20	20	20	0,48		
z_sand	25	20	20	0,53		
H_vegg	13					
D_vegg	8					

Passive side					
z	σ_z	σ_x	Pp	arm over bunn (m)	Mp
1	20	9,6			
2	40	19,2			
4	80	38,4			
6	120	57,6			
8	160	76,8	307,2	2,666666667	819,2

Active side					
z	σ_z	σ_x	Pa	arm over bunn (m)	Ma
1	18	7,74			
2	36	15,48			
6	80	38,4			
12	200	96			
13	220	105,6	787,02	4,333333333	3410,42

Moment difference	2591,22
We want anchor at 3m	
Kraft	259,122

Ønsket GVL 7m under overflate					Modell: Leire	
		γ_sat	γ_unsat	K_0		
z_fill	2	20	18	0,43		
z_clay	20	20	20	0,48		
z_sand	25	20	20	0,53		
H_vegg	13					
D_vegg	8					

Passive side							
z	σ_z	σ_x			arm	M_p	Hp_w
1	20	9,6	Pp1	19,2	6,66666667	128	6,00
2	40	19,2	Pp2	115,2	3	345,6	
4	20	9,6	Pp3	86,4	2	172,8	
8	60	28,8				646,4	

Δ Moment		2432,14
We vant anchor at 3m		
Kraft		243,214

Active side					
Ha_w	z	σ_z	σ_x		
3	1	18	7,74		
	2	36	15,48		
	7	100	48		
	10	30	14,4		
	13	60	28,8		
			arm	M_a	ΣM_a
	Pa1	222,18	8,33333333	1851,5	
	Pa2	380,88	3	1142,64	
	Pa3	86,4	2	84,4	3078,54

Ønsket GVL 5 m under overflate					Modell: Leire	
		γ_sat	γ_unsat	K_0		
z_fill	2	20	18	0,43		
z_clay	20	20	20	0,48		
z_sand	25	20	20	0,53		
H_vegg	13					
D_vegg	8					

Passive side					
z	σ_z	σ_x	Pp	arm over bun	Mp
1	10	4,8			
2	20	9,6			
4	40	19,2			
8	80	38,4	96	2,66666667	256

Active side				
z	σ_z	σ_x		
1	18	7,74		
2	36	15,48		
5	60	28,8		
10	50	24		
13	80	38,4		
		arm	Ma	Σma
Pa1	110,7	9,66666667	1070,1	
Pa2	354,24	4	1416,96	
Pa3	153,6	2,66666667	150,933333	2637,99333

Δ Moment		2381,99333
We vant anchor at 3m		
Kraft		238,199333

Modell	Sand	GWL	14,5 m under overflate

$$K_A = \frac{sin^2(\psi + \varphi'_d - \theta)}{cos\theta\, sin^2\psi \sin(\psi - \theta - \delta_d)\left[1 + \sqrt{\frac{\sin(\varphi'_d + \delta_d)\sin(\varphi'_d - \beta - \theta)}{\sin(\psi - \theta - \delta_d)\sin(\psi + \beta)}}\right]^2}$$

	ψ	β	φ	θ	δ
Vinkel (rad)	1,57079633	0	0,733038286	?	0,191986218

Verdier for å beregne k_h						
g	r	S	γ_I	a_gR	a_g	α
9,8	1	1,8	0,7	0,3	0,21	0,021428571

$$tan\theta = \frac{k_h}{1 \mp k_v} \qquad k_h = \alpha\frac{S}{r} \qquad \alpha = \frac{a_g}{g} \qquad a_g = \gamma_I a_{gR}$$

k_h	0,03857143

Verdier for å beregne k_v						
Jordskjelv	a_vg	a_g	a_vg/a_g	k_h	k_v	
1	0,09	0,21	0,428571429	0,03857143	0,011571429	
2	0,13	0,21	0,619047619	0,03857143	0,019285714	
3	0,184	0,21	0,876190476	0,03857143	0,019285714	

$k_v = \mp 0{,}5 k_h$ eller $k_v = \mp 0{,}3 k_h$

$a_{vg}/a_g > 0{,}6$ hvis i andre tilfeller

Parameterne for å beregne φ'_d				
φ' (rad)	tanφ'	y_φ'	tanφ'/y_φ'	φ'_d (rad)
0,73303829	0,90040404	1,25	0,720323235	0,6242359

$$\varphi'_d = tan^{-1}\left(\frac{tan\varphi'}{\gamma'_\varphi}\right)$$

Parametrene for å finne δ_d				
δ (rad)	tanδ	y_φ'	tanδ/y_φ'	δ_d (rad)
0,19198622	0,19438031	1,25	0,155504247	0,15426868

$$\delta_d = tan^{-1}\left(\frac{tan\delta}{\gamma_{\varphi'}}\right)$$

Parametrene for å beregne θ				
Jordskjelv	k_h	k_v	tan θ	θ (rad)
1	0,03857143	0,01157143	0,03902298	0,03900319
2	0,03857143	0,01928571	0,039329934	0,03930967
3	0,03857143	0,01928571	0,039329934	0,03930967

$$tan\theta = \frac{k_h}{1 \mp k_v}$$

Parametrene for å finne K					
ψ (rad)	β (rad)	φ'_d (rad)	δ_d (rad)	θ (rad)	Jordskjelv
1,57079633	0	0,6242359	0,154268679	0,03900319	1
1,57079633	0	0,6242359	0,154268679	0,03930967	2
1,57079633	0	0,6242359	0,154268679	0,03930967	3

Deler av formel til K					
$sin^2(\psi + \varphi'_d - \theta)$	$cos\theta\, sin^2\psi \sin(\psi - \theta - \delta_d)$	Kvadratrute	(1+kvadratrute)^2	K	Jordskjelv
0,694861554	0,98063469	0,3952585	1,946746277	0,363983484	1
0,695143768	0,980564049	0,39509939	1,946302314	0,364240613	2
0,695143768	0,980564049	0,39509939	1,946302314	0,364240613	3

$$K_A = \frac{sin^2(\psi + \varphi'_d - \theta)}{cos\theta\, sin^2\psi \sin(\psi - \theta - \delta_d)\left[1 + \sqrt{\frac{\sin(\varphi'_d + \delta_d)\sin(\varphi'_d - \beta - \theta)}{\sin(\psi - \theta - \delta_d)\sin(\psi + \beta)}}\right]^2}$$

Parametre for å beregne E_d					
y*	k_v	H	K	E_d	Jordskjelv
17	0,01157143	12	0,363983484	440,360531	1
17	0,01928571	12	0,364240613	437,232351	2
17	0,01928571	12	0,364240613	437,232351	3

$$E_d = \frac{1}{2}\gamma^*(1 \mp k_v)K * H^2 + E_{ws} + E_{wd}$$

Modell	**Sand**	**GWL**	**6,8 m under overflate**

	ψ	β	φ	θ	δ
Vinkel (rad)	1,57079633	0	0,733038286	?	0,191986218

$$K_A = \frac{sin^2(\psi + \varphi'_d - \theta)}{cos\theta\, sin^2\psi \sin(\psi - \theta - \delta_d)\left[1 + \sqrt{\dfrac{\sin(\varphi'_d + \delta_d)\sin(\varphi'_d - \beta - \theta)}{\sin(\psi - \theta - \delta_d)\sin(\psi + \beta)}}\right]^2}$$

Verdier for å beregne k_h						
g	r	S	γ_I	a_gR	a_g	α
9,8	1	1,8	0,7	0,3	0,21	0,021428571

$$k_h = \alpha \frac{S}{r} \qquad \alpha = \frac{a_g}{g} \qquad a_g = \gamma_I a_{gR}$$

k_h	0,03857143

Verdier for å beregne k_v						
Jordskjelv	a_vg	a_g	a_vg/a_g	k_h	k_v	
1	0,09	0,21	0,428571429	0,03857143	0,011571429	
2	0,13	0,21	0,619047619	0,03857143	0,019285714	
3	0,184	0,21	0,876190476	0,03857143	0,019285714	

$k_v = \mp 0{,}5 k_h$ eller $k_v = \mp 0{,}3 k_h$

$^{a_{vg}}/_{a_g} > 0{,}6$ hvis i andre tilfeller

Parameterne for å beregne φ'_d				
φ' (rad)	tanφ'	y_φ'	tanφ'/y_φ'	φ'_d (rad)
0,73303829	0,90040404	1,25	0,720323235	0,6242359

$$\varphi'_d = tan^{-1}\left(\frac{tan\varphi'}{\gamma'_\varphi}\right)$$

Parametrene for å finne δ_d				
δ (rad)	tanδ	y_φ'	tanδ/y_φ'	δ_d (rad)
0,19198622	0,19438031	1,25	0,155504247	0,15426868

$$\delta_d = tan^{-1}\left(\frac{tan\delta}{\gamma_{\varphi'}}\right)$$

Parametrene for å beregne θ						
Jordskjelv	k_h	k_v	y_d	y_sat	tanθ	θ (rad)
1	0,03857143	0,01157143	17	20	0,066339066	0,066242006
2	0,03857143	0,01928571	17	20	0,066860889	0,066761524
3	0,03857143	0,01928571	17	20	0,066860889	0,066761524

$$tan\theta = \frac{\gamma_d}{\gamma - \gamma_w}\frac{k_h}{1 \mp k_v} \quad \text{(E.16)}$$

Parametrene for å finne K					
ψ (rad)	β (rad)	φ'_d (rad)	δ_d (rad)	θ (rad)	Jordskjelv
1,57079633	0	0,6242359	0,154268679	0,06624201	1
1,57079633	0	0,6242359	0,154268679	0,06676152	2
1,57079633	0	0,6242359	0,154268679	0,06676152	3

Deler av formel til K					
$sin^2(\psi + \varphi'_d - \theta)$	$cos\theta\, sin^2\psi \sin(\psi - \theta - \delta_d)$	Kvadratrute	(1+kvadratrute)^2	K	Jordskjelv
0,719645162	0,973645782	0,38103943	1,907269916	0,387529943	1
0,72011175	0,973498584	0,38076662	1,906516449	0,387993113	2
0,72011175	0,973498584	0,38076662	1,906516449	0,387993113	3

$$K_A = \frac{sin^2(\psi + \varphi'_d - \theta)}{cos\theta\, sin^2\psi \sin(\psi - \theta - \delta_d)\left[1 + \sqrt{\dfrac{\sin(\varphi'_d + \delta_d)\sin(\varphi'_d - \beta - \theta)}{\sin(\psi - \theta - \delta_d)\sin(\psi + \beta)}}\right]^2}$$

Parametre for å beregne E_d

y*	k_v	H	K	E_d_0	H'	E_wd	Jordskjelv	E_d
17	0,01157143	12	0,387529943	468,847898	5,2	6,084	1	474,931898
17	0,01928571	12	0,387993113	465,744716	5,2	6,084	2	471,828716
17	0,01928571	12	0,387993113	465,744716	5,2	6,084	3	471,828716

$$E_d = \frac{1}{2}\gamma^*(1 \mp k_v)K * H^2 + E_{ws} + E_{wd}$$

$$E_{wd} = \frac{7}{12}k_h\gamma_w H'^2$$

E_ws	E_d	E_d_tot
26	474,931898	500,931898
26	471,828716	497,828716
26	471,828716	497,828716

Modell	**Sand**	**GWL**	**6,8 m under overflate**

	ψ	β	φ	θ	δ
Vinkel (rad)	1,57079633	0	0,73303829	?	0,191986218

$$K_A = \frac{sin^2(\psi + \varphi'_d - \theta)}{cos\theta\, sin^2\psi \sin(\psi - \theta - \delta_d)\left[1 + \sqrt{\frac{\sin(\varphi'_d + \delta_d)\sin(\varphi'_d - \beta - \theta)}{\sin(\psi - \theta - \delta_d)\sin(\psi + \beta)}}\right]^2}$$

Verdier for å beregne k_h						
g	r	S	γ_I	a_gR	a_g	α
9,8	1	1,8	0,7	0,3	0,21	0,02142857

$k_h = \alpha \frac{S}{r}$ $\alpha = \frac{a_g}{g}$ $a_g = \gamma_I a_{gR}$

k_h	0,03857143

Verdier for å beregne k_v						
Jordskjelv	a_vg	a_g	a_vg/a_g	k_h	k_v	
1	0,09	0,21	0,42857143	0,03857143	0,011571429	
2	0,13	0,21	0,61904762	0,03857143	0,019285714	
3	0,184	0,21	0,87619048	0,03857143	0,019285714	

$k_v = \mp 0{,}5 k_h$ eller $k_v = \mp 0{,}3 k_h$

$a_{vg}/a_g > 0{,}6$ hvis andre tilfeller

Parameterne for å beregne φ'_d				
φ' (rad)	tanφ'	y_φ'	tanφ'/y_φ'	φ'_d (rad)
0,73303829	0,90040404	1,25	0,72032324	0,6242359

$$\varphi'_d = tan^{-1}\left(\frac{tan\varphi'}{\gamma'_\varphi}\right)$$

Parametrene for å finne δ_d				
δ (rad)	tanδ	y_φ'	tanδ/y_φ'	δ_d (rad)
0,19198622	0,19438031	1,25	0,15550425	0,15426868

$$\delta_d = tan^{-1}\left(\frac{tan\delta}{\gamma_{\varphi'}}\right)$$

Parametrene for å beregne θ						
Jordskjelv	k_h	k_v	y_d	y_sat	tanθ	θ (rad)
1	0,03857143	0,01157143	17	20	0,07804596	0,07788807
2	0,03857143	0,01928571	17	20	0,078659869	0,07849824
3	0,03857143	0,01928571	17	20	0,078659869	0,07849824

$$tan\theta = \frac{\gamma}{\gamma - \gamma_w}\frac{k_h}{1 \mp k_v} \quad \text{(E.13)}$$

Parametrene for å finne K					
ψ (rad)	β (rad)	φ'_d (rad)	δ_d (rad)	θ (rad)	Jordskjelv
1,57079633	0	0,6242359	0,15426868	0,07788807	1
1,57079633	0	0,6242359	0,15426868	0,07849824	2
1,57079633	0	0,6242359	0,15426868	0,07849824	3

Deler av formel til K					
$sin^2(\psi + \varphi'_d - \theta)$	$cos\theta\, sin^2\psi \sin(\psi - \theta - \delta_d)$	Kvadratrute	(1+kvadratrute)^2	K	Jordskjelv
0,730046826	0,970222031	0,37490811	1,890372324	0,39804506	1
0,7305884	0,970035515	0,37458597	1,889486576	0,3986037	2
0,7305884	0,970035515	0,37458597	1,889486576	0,3986037	3

$$K_A = \frac{sin^2(\psi + \varphi'_d - \theta)}{cos\theta\, sin^2\psi \sin(\psi - \theta - \delta_d)\left[1 + \sqrt{\frac{\sin(\varphi'_d + \delta_d)\sin(\varphi'_d - \beta - \theta)}{\sin(\psi - \theta - \delta_d)\sin(\psi + \beta)}}\right]^2}$$

Parametre for å beregne E_d								
y*	k_v	H	K	E_d_0	H'	E_wd	Jordskjelv	E_d
17	0,01157143	12	0,39804506	481,569466	5,2	0	1	481,5694665
17	0,01928571	12	0,3986037	478,481605	5,2	0	2	478,4816045
17	0,01928571	12	0,3986037	478,481605	5,2	0	3	478,4816045

$$E_d = \frac{1}{2}\gamma^*(1 \mp k_v)K * H^2 + E_{ws} + E_{wd}$$

Modell	Sand	GWL	8 m under overflate

	ψ	β	φ	θ	δ
Vinkel (rad)	1,57079633	0	0,733038286	?	0,191986218

$$K_A = \frac{sin^2(\psi + \varphi'_d - \theta)}{cos\theta\, sin^2\psi \sin(\psi - \theta - \delta_d)\left[1 + \sqrt{\frac{\sin(\varphi'_d + \delta_d)\sin(\varphi'_d - \beta - \theta)}{\sin(\psi - \theta - \delta_d)\sin(\psi + \beta)}}\right]^2}$$

Verdier for å beregne k_h						
g	r	S	γ_I	a_gR	a_g	α
9,8	1	1,8	0,7	0,3	0,21	0,021428571

$$k_h = \alpha \frac{S}{r} \qquad \alpha = \frac{a_g}{g} \qquad a_g = \gamma_I a_{gR}$$

k_h	0,03857143

Verdier for å beregne k_v						
Jordskjelv	a_vg	a_g	a_vg/a_g	k_h	k_v	
1	0,09	0,21	0,428571429	0,03857143	0,011571429	
2	0,13	0,21	0,619047619	0,03857143	0,019285714	
3	0,184	0,21	0,876190476	0,03857143	0,019285714	

$k_v = \mp 0{,}5 k_h$ eller $k_v = \mp 0{,}3 k_h$

${a_{vg}}/{a_g} > 0{,}6$ hvis i andre tilfeller

Parameterne for å beregne φ'_d				
φ' (rad)	tanφ'	y_φ'	tanφ'/y_φ'	φ'_d (rad)
0,73303829	0,90040404	1,25	0,720323235	0,6242359

$$\varphi'_d = tan^{-1}\left(\frac{tan\varphi'}{\gamma'_\varphi}\right)$$

Parametrene for å finne δ_d				
δ (rad)	tanδ	y_φ'	tanδ/y_φ'	δ_d (rad)
0,19198622	0,19438031	1,25	0,155504247	0,15426868

$$\delta_d = tan^{-1}\left(\frac{tan\delta}{\gamma_{\varphi'}}\right)$$

Parametrene for å beregne θ						
Jordskjelv	k_h	k_v	y_d	y_sat	tanθ	θ (rad)
1	0,03857143	0,01157143	17	20	0,066339066	0,066242006
2	0,03857143	0,01928571	17	20	0,066860889	0,066761524
3	0,03857143	0,01928571	17	20	0,066860889	0,066761524

$$tan\theta = \frac{\gamma_d}{\gamma - \gamma_w}\frac{k_h}{1 \mp k_v} \quad \text{(E.16)}$$

Parametrene for å finne K					
ψ (rad)	β (rad)	φ'_d (rad)	δ_d (rad)	θ (rad)	Jordskjelv
1,57079633	0	0,6242359	0,154268679	0,06624201	1
1,57079633	0	0,6242359	0,154268679	0,06676152	2
1,57079633	0	0,6242359	0,154268679	0,06676152	3

Deler av formel til K					
$sin^2(\psi + \varphi'_d - \theta)$	$cos\theta\, sin^2\psi \sin(\psi - \theta - \delta_d)$	Kvadratrute	(1+kvadratrute)^2	K	Jordskjelv
0,719645162	0,973645782	0,38103943	1,907269916	0,387529943	1
0,72011175	0,973498584	0,38076662	1,906516449	0,387993113	2
0,72011175	0,973498584	0,38076662	1,906516449	0,387993113	3

$$K_A = \frac{sin^2(\psi + \varphi'_d - \theta)}{cos\theta\, sin^2\psi \sin(\psi - \theta - \delta_d)\left[1 + \sqrt{\frac{\sin(\varphi'_d + \delta_d)\sin(\varphi'_d - \beta - \theta)}{\sin(\psi - \theta - \delta_d)\sin(\psi + \beta)}}\right]^2}$$

Parametre for å beregne E_d

y*	k_v	H	K	E_d_0	H'	E_wd	Jordskjelv	E_d
17	0,01157143	12	0,387529943	468,847898	4	3,6	1	472,447898
17	0,01928571	12	0,387993113	465,744716	4	3,6	2	469,3447156
17	0,01928571	12	0,387993113	465,744716	4	3,6	3	469,3447156

$$E_d = \frac{1}{2}\gamma^*(1 \mp k_v)K * H^2 + E_{ws} + E_{wd}$$

$$E_{wd} = \frac{7}{12}k_h\gamma_w H'^2$$

E_ws	E_d	E_d_tot
20	472,447898	492,447898
20	469,344716	489,344716
20	469,344716	489,344716

Modell	**Sand**	**GWL**	**8 m under overflate**

	ψ	β	φ	θ	δ
Vinkel (rad)	1,57079633	0	0,73303829	?	0,191986218

$$K_A = \frac{\sin^2(\psi+\varphi'_d-\theta)}{\cos\theta\,\sin^2\psi\,\sin(\psi-\theta-\delta_d)\left[1+\sqrt{\frac{\sin(\varphi'_d+\delta_d)\sin(\varphi'_d-\beta-\theta)}{\sin(\psi-\theta-\delta_d)\sin(\psi+\beta)}}\right]^2}$$

Verdier for å beregne k_h						
g	r	S	γ_I	a_gR	a_g	α
9,8	1	1,8	0,7	0,3	0,21	0,02142857

$k_h = \alpha \frac{S}{r}$ $\alpha = \frac{a_g}{g}$ $a_g = \gamma_I a_{gR}$

k_h	0,03857143

Verdier for å beregne k_v						
Jordskjelv	a_vg	a_g	a_vg/a_g	k_h	k_v	
1	0,09	0,21	0,42857143	0,03857143	0,011571429	
2	0,13	0,21	0,61904762	0,03857143	0,019285714	
3	0,184	0,21	0,87619048	0,03857143	0,019285714	

$k_v = \mp 0{,}5 k_h$ eller $k_v = \mp 0{,}3 k_h$

$a_{vg}/a_g > 0{,}6$ hvis andre tilfeller

Parameterne for å beregne φ'_d				
φ' (rad)	tanφ'	y_φ'	tanφ'/y_φ'	φ'_d (rad)
0,73303829	0,90040404	1,25	0,72032324	0,6242359

$$\varphi'_d = \tan^{-1}\left(\frac{\tan\varphi'}{\gamma'_\varphi}\right)$$

Parametrene for å finne δ_d				
δ (rad)	tanδ	y_φ'	tanδ/y_φ'	δ_d (rad)
0,19198622	0,19438031	1,25	0,15550425	0,15426868

$$\delta_d = \tan^{-1}\left(\frac{\tan\delta}{\gamma_{\varphi'}}\right)$$

Parametrene for å beregne θ						
Jordskjelv	k_h	k_v	y_d	y_sat	tanθ	θ (rad)
1	0,03857143	0,01157143	17	20	0,07804596	0,077888073
2	0,03857143	0,01928571	17	20	0,078659869	0,078498236
3	0,03857143	0,01928571	17	20	0,078659869	0,078498236

$$\tan\theta = \frac{\gamma}{\gamma-\gamma_w}\frac{k_h}{1\mp k_v} \quad \text{(E.13)}$$

Parametrene for å finne K					
ψ (rad)	β (rad)	φ'_d (rad)	δ_d (rad)	θ (rad)	Jordskjelv
1,57079633	0	0,6242359	0,15426868	0,07788807	1
1,57079633	0	0,6242359	0,15426868	0,07849824	2
1,57079633	0	0,6242359	0,15426868	0,07849824	3

Deler av formel til K					
$\sin^2(\psi+\varphi'_d-\theta)$	$\cos\theta\sin^2\psi\sin(\psi-\theta-\delta_d)$	Kvadratrute	(1+kvadratrute)^2	K	Jordskjelv
0,730046826	0,970222031	0,37490811	1,890372324	0,39804506	1
0,7305884	0,970035515	0,37458597	1,889486576	0,3986037	2
0,7305884	0,970035515	0,37458597	1,889486576	0,3986037	3

$$K_A = \frac{\sin^2(\psi+\varphi'_d-\theta)}{\cos\theta\,\sin^2\psi\,\sin(\psi-\theta-\delta_d)\left[1+\sqrt{\frac{\sin(\varphi'_d+\delta_d)\sin(\varphi'_d-\beta-\theta)}{\sin(\psi-\theta-\delta_d)\sin(\psi+\beta)}}\right]^2}$$

Parametre for å beregne E_d								
y*	k_v	H	K	E_d_0	H'	E_wd	Jordskjelv	E_d
17	0,01157143	12	0,39804506	481,569466	4	0	1	481,5694665
17	0,01928571	12	0,3986037	478,481605	4	0	2	478,4816045
17	0,01928571	12	0,3986037	478,481605	4	0	3	478,4816045

$$E_d = \frac{1}{2}\gamma^*(1\mp k_v)K * H^2 + E_{ws} + E_{wd}$$

$$E_{wd} = \frac{7}{12}k_h\gamma_w H'^2$$

Modell	**Sand**	**GWL**	**14,5m under overflate**						
φ(rad)	θ(rad)	δ(rad)	β(rad)	ψ(rad)	K_AE	Jordskjelv	k_h	k_v	ψ
0,73304	0	0,19199	0	0,0390032	0,20428	1	0,03857	0,01157	0,03902
				0,0393097	0,24372	2	0,03857	0,01929	0,03933
				0,0393097	0,24372	3	0,03857	0,01929	0,03933

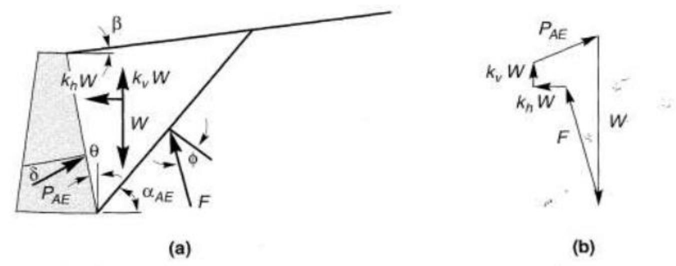
Deler av formel til K_AE			
del1	del2	del3	del4
0,59086	0,9727	0,72442	2,97362
0,59116	0,97262	0,57918	2,49381
0,59116	0,97262	0,57918	2,49381

K_AE	**y_sand**	**H_vegg**	**k_v**	**P_AE**		**Jordskjelv**
0,20428	17	12	0,01157	**247,14073**		1
0,24372	17	12	0,01929	**292,56403**		2
0,24372	17	12	0,01929	**292,56403**		3

$$P_{AE} = \tfrac{1}{2} K_{AE} \gamma H^2 (1 - k_v) \qquad (11.15)$$

where the dynamic active earth pressure coefficient, K_{AE}, is given by

$$K_{AE} = \frac{\cos^2(\phi - \theta - \psi)}{\cos\psi \cos^2\theta \cos(\delta + \theta + \psi)\left[1 + \sqrt{\dfrac{\sin(\delta + \phi)\sin(\phi - \beta - \psi)}{\cos(\delta + \theta + \psi)\cos(\beta - \theta)}}\right]^2} \qquad (11.16)$$



where $\phi - \beta \geq \psi$, $\gamma = \gamma_d$, and $\psi = \tan^{-1}[k_h/(1 - k_v)]$.

Fra EC8 Del. 5: $k_h = \alpha \frac{S}{r}$ $\quad \alpha = \frac{a_g}{g}$ $\quad a_g = \gamma_I a_{gR}$

$a_{vg}/a_g > 0,6$ $\quad k_v = \mp 0,5 k_h$

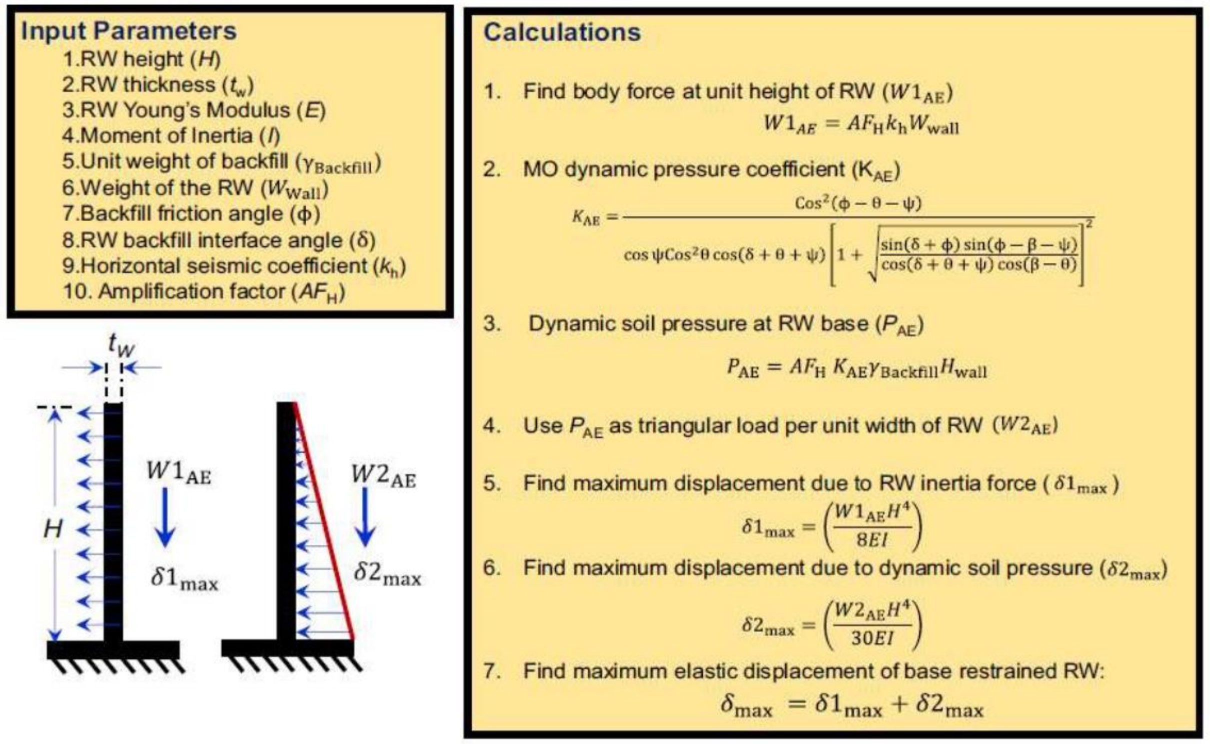
i andre tillfeller: $k_v = \mp 0,3 k_h$

S	1,8
r	1
y_I	0,7
a_gR	0,3
a_g	0,21
α	0,02143
g	9,8

jordskjelv	a_vg	a_vg/a_g	k_h	k_v
1	0,087	0,41429	0,03857	0,01157
2	0,13	0,61905	0,03857	0,01929
3	0,184	0,87619	0,03857	0,01929

Modell	**Sand**	**GWL**	**14,5m under overflate**

Jodskjelv	H_vegg (m)	y_bakfyll (kN/m^3)	W_vegg (kN/m lengde)	a_max_overflate	a_max_bunn	AF_H	k_h	K_AE	W_1AE (kN/m lengde)	P_AE (kN/m^2)	W_2AE (kN/m)	EI (kN/m^2	δ_1max (m)	δ_2max (m)	δ_max (m)
1	12	17	0,573	1,360	0,547	2,487	0,039	0,204	0,055	103,647	621,884	134000	0,001	0,535	0,536
2	12	17	0,573	5,727	1,613	3,551	0,039	0,244	0,078	176,531	1059,184	134000	0,002	0,911	0,912
3	12	17	0,573	10,731	2,271	4,725	0,039	0,244	0,104	234,936	1409,618	134000	0,002	1,212	1,214



Modell	**Sand**	**GWL 14,5 m under overflate**

Parametere for å beregne a_y ifølge metode beskrevet av Kramer							
φ_b (rad)	δ (rad)	θ (rad)	P_AE	W	g	a_y	Jordskjelv
0,291469985	0,191986218	0	247,1407259	0,572698736	9,81	-3344,88958	1
0,291469985	0,191986218	0	292,5640274	0,572698736	9,81	-3960,20547	2
0,291469985	0,191986218	0	292,5640274	0,572698736	9,81	-3960,20547	3

v_max (g)	**a_max (g)**	**a_y (g)**	**d_perm*g**	**Jordskjelv**	**d_perm (m)**
0,087	0,16	-340,9673378	1,99557E-16	1	1,95765E-15
0,13	0,33	-403,6906698	1,98954E-15	2	1,95174E-14
0,184	0,455	-403,6906698	1,04471E-14	3	1,02486E-13

$$d_{perm} = 0{,}087\,\frac{v_{max}^2 a_{max}^3}{a_y^4} \quad \text{hvis} \quad \frac{a_y}{a_{max}} \geq 0{,}3$$

$$d_{perm} = \frac{3 v_{max}^2 \left({}^{a_y}/_{a_{max}}\right)^{-1}}{a_{max}} \quad \text{hvis} \quad \frac{a_y}{a_{max}} < 0{,}3$$

$$a_y = \left[\tan\varphi_b - \frac{P_{AE}\cos(\delta+\theta) - P_{AE}\sin(\delta+\theta)}{W}\right] g$$

Modell	Leire	GWL	5 m under overflate

	ψ	β	φ	θ	δ
Vinkel (rad)	1,57079633	0	0,55850536	?	0,296705973

$$K_A = \frac{\sin^2(\psi + \varphi'_d - \theta)}{\cos\theta \sin^2\psi \sin(\psi - \theta - \delta_d)\left[1 + \sqrt{\frac{\sin(\varphi'_d + \delta_d)\sin(\varphi'_d - \beta - \theta)}{\sin(\psi - \theta - \delta_d)\sin(\psi + \beta)}}\right]^2}$$

Verdier for å beregne k_h							
g	r	S	γ_I	a_gR	a_g		α
9,8	1	1,8	0,7	0,3	0,21		0,021428571

$$\tan\theta = \frac{k_h}{1 \mp k_v} \qquad k_h = \alpha\frac{S}{r} \qquad \alpha = \frac{a_g}{g} \qquad a_g = \gamma_I a_{gR}$$

k_h	0,03857143

Verdier for å beregne k_v						
Jordskjelv	a_vg	a_g	a_vg/a_g	k_h	k_v	
1	0,09	0,21	0,42857143	0,03857143	0,011571429	
2	0,13	0,21	0,61904762	0,03857143	0,019285714	
3	0,184	0,21	0,87619048	0,03857143	0,019285714	

$k_v = \mp 0{,}5 k_h$ eller $k_v = \mp 0{,}3 k_h$

$a_{vg}/a_g > 0{,}6$ hvis andre tilfeller

Parameterne for å beregne φ'_d				
φ' (rad)	tanφ'	y_φ'	tanφ'/y_φ'	φ'_d (rad)
0,55850536	0,62486935	1,25	0,49989548	0,46356399

$$\varphi'_d = \tan^{-1}\left(\frac{\tan\varphi'}{\gamma'_\varphi}\right)$$

Parametrene for å finne δ_d				
δ (rad)	tanδ	y_φ'	tanδ/y_φ'	δ_d (rad)
0,29670597	0,30573068	1,25	0,24458455	0,23987531

$$\delta_d = \tan^{-1}\left(\frac{\tan\delta}{\gamma_{\varphi'}}\right)$$

Parametrene for å beregne θ								
Jordskjelv	k_h	k_v	tan θ	θ (rad)	y	y_w	y_d
1	0,03857143	0,01157143	0,07804596	0,07788807	20	10	20
2	0,03857143	0,01928571	0,07865987	0,07849824	20	10	20
3	0,03857143	0,01928571	0,07865987	0,07849824	20	10	20

$$\tan\theta = \frac{\gamma_d}{\gamma - \gamma_w}\frac{k_h}{1 \mp k_v}$$

Parametrene for å finne K					
ψ (rad)	β (rad)	φ'_d (rad)	δ_d (rad)	θ (rad)	Jordskjelv
1,57079633	0	0,46356399	0,23987531	0,07788807	1
1,57079633	0	0,46356399	0,23987531	0,07849824	2
1,57079633	0	0,46356399	0,23987531	0,07849824	3

Deler av formel til K					
$\sin^2(\psi + \varphi'_d - \theta)$	$\cos\theta \sin^2\psi \sin(\psi - \theta - \delta_d)$	Kvadratrute	(1+kvadratrute)^2	K	Jordskjelv
0,858484477	0,947056646	0,25615759	1,577931896	0,574471167	1
0,858909557	0,94682114	0,25582397	1,577093847	0,575204072	2
0,858909557	0,94682114	0,25582397	1,577093847	0,575204072	3

$$K_A = \frac{\sin^2(\psi + \varphi'_d - \theta)}{\cos\theta \sin^2\psi \sin(\psi - \theta - \delta_d)\left[1 + \sqrt{\frac{\sin(\varphi'_d + \delta_d)\sin(\varphi'_d - \beta - \theta)}{\sin(\psi - \theta - \delta_d)\sin(\psi + \beta)}}\right]^2}$$

Parametre for å beregne E_d

y*	k_v	H	K	E_d_0	Jordskjelv
17	0,01157143	12	0,57447117	695,016226	1
17	0,01928571	12	0,57520407	690,471681	2
17	0,01928571	12	0,57520407	690,471681	3

$$E_d = \frac{1}{2}\gamma^*(1 \mp k_v)K * H^2 + E_{ws} + E_{wd}$$

$$E_{wd} = \frac{7}{12}k_h\gamma_w H'^2$$

E_d_0	E_ws	E_wd	E_tot	H'	Jordskjelv
695,016226	40	14,4	749,416226	8	1
690,471681	40	14,4	744,871681	8	2
690,471681	40	14,4	744,871681	8	3

Modell	Leire	GWL	5 m under overflate

	ψ	β	φ	θ	δ
Vinkel (rad)	1,57079633	0	0,558505361	?	0,296705973

$$K_A = \frac{\sin^2(\psi + \varphi'_d - \theta)}{\cos\theta \sin^2\psi \sin(\psi - \theta - \delta_d)\left[1 + \sqrt{\frac{\sin(\varphi'_d + \delta_d)\sin(\varphi'_d - \beta - \theta)}{\sin(\psi - \theta - \delta_d)\sin(\psi + \beta)}}\right]^2}$$

Verdier for å beregne k_h						
g	r	S	γ_I	a_gR	a_g	α
9,8	1	1,8	0,7	0,3	0,21	0,02142857

$$\tan\theta = \frac{k_h}{1 \mp k_v} \qquad k_h = \alpha\frac{S}{r} \qquad \alpha = \frac{a_g}{g} \qquad a_g = \gamma_I a_{gR}$$

k_h	0,03857143

Verdier for å beregne k_v						
Jordskjelv	a_vg	a_g	a_vg/a_g	k_h	k_v	
1	0,09	0,21	0,428571429	0,038571429	0,011571429	
2	0,13	0,21	0,619047619	0,038571429	0,019285714	
3	0,184	0,21	0,876190476	0,038571429	0,019285714	

$k_v = \mp 0{,}5k_h$ eller $k_v = \mp 0{,}3k_h$

${a_{vg}}/{a_g} > 0{,}6$ hvis andre tilfeller

Parameterne for å beregne φ'_d				
φ' (rad)	tanφ'	y_φ'	tanφ'/y_φ'	φ'_d (rad)
0,55850536	0,62486935	1,25	0,499895482	0,463563991

$$\varphi'_d = \tan^{-1}\left(\frac{\tan\varphi'}{\gamma'_\varphi}\right)$$

Parametrene for å finne δ_d				
δ (rad)	tanδ	y_φ'	tanδ/y_φ'	δ_d (rad)
0,29670597	0,30573068	1,25	0,244584545	0,239875306

$$\delta_d = \tan^{-1}\left(\frac{\tan\delta}{\gamma_{\varphi'}}\right)$$

Parametrene for å beregne θ						
Jordskjelv	k_h	k_v	tan θ	θ (rad)	y	y_w
1	0,03857143	0,01157143	0,07804596	0,077888073	20	10
2	0,03857143	0,01928571	0,078659869	0,078498236	20	10
3	0,03857143	0,01928571	0,078659869	0,078498236	20	10

$$\tan\theta = \frac{\gamma}{\gamma - \gamma_w}\frac{k_h}{1 \mp k_v}$$

Parametrene for å finne K					
ψ (rad)	β (rad)	φ'_d (rad)	δ_d (rad)	θ (rad)	Jordskjelv
1,57079633	0	0,46356399	0,239875306	0,077888073	1
1,57079633	0	0,46356399	0,239875306	0,078498236	2
1,57079633	0	0,46356399	0,239875306	0,078498236	3

Deler av formel til K					
$\sin^2(\psi + \varphi'_d - \theta)$	$\cos\theta \sin^2\psi \sin(\psi - \theta - \delta_d)$	Kvadratrute	(1+kvadratrute)^2	K	Jordskjelv
0,858484477	0,947056646	0,256157592	1,577931896	0,57447117	1
0,858909557	0,94682114	0,255823971	1,577093847	0,57520407	2
0,858909557	0,94682114	0,255823971	1,577093847	0,57520407	3

$$K_A = \frac{\sin^2(\psi + \varphi'_d - \theta)}{\cos\theta \sin^2\psi \sin(\psi - \theta - \delta_d)\left[1 + \sqrt{\frac{\sin(\varphi'_d + \delta_d)\sin(\varphi'_d - \beta - \theta)}{\sin(\psi - \theta - \delta_d)\sin(\psi + \beta)}}\right]^2}$$

Parametre for å beregne E_d					
y*	k_v	H	K	E_d_0	Jordskjelv
17	0,01157143	12	0,574471167	695,0162265	1
17	0,01928571	12	0,575204072	690,4716812	2
17	0,01928571	12	0,575204072	690,4716812	3

$$E_d = \frac{1}{2}\gamma^*(1 \mp k_v)K * H^2 + E_{ws} + E_{wd}$$

Modell	Leire	GWL	7 m under overflate

	ψ	β	φ	θ	δ
Vinkel (rad)	1,57079633	0	0,55850536	?	0,296705973

$$K_A = \frac{sin^2(\psi + \varphi'_d - \theta)}{cos\theta\, sin^2\psi \sin(\psi - \theta - \delta_d)\left[1 + \sqrt{\frac{\sin(\varphi'_d + \delta_d)\sin(\varphi'_d - \beta - \theta)}{\sin(\psi - \theta - \delta_d)\sin(\psi + \beta)}}\right]^2}$$

Verdier for å beregne k_h						
g	r	S	γ_I	a_gR	a_g	α
9,8	1	1,8	0,7	0,3	0,21	0,021428571

$$tan\theta = \frac{k_h}{1 \mp k_v} \qquad k_h = \alpha\frac{S}{r} \qquad \alpha = \frac{a_g}{g} \qquad a_g = \gamma_I a_{gR}$$

k_h	0,03857143

Verdier for å beregne k_v						
Jordskjelv	a_vg	a_g	a_vg/a_g	k_h	k_v	
1	0,09	0,21	0,42857143	0,03857143	0,011571429	
2	0,13	0,21	0,61904762	0,03857143	0,019285714	
3	0,184	0,21	0,87619048	0,03857143	0,019285714	

$k_v = \mp 0{,}5 k_h$ eller $k_v = \mp 0{,}3 k_h$

${}^{a_{vg}}/_{a_g} > 0{,}6$ hvis andre tilfeller

Parameterne for å beregne φ'_d				
φ' (rad)	tanφ'	γ_φ'	tanφ'/γ_φ'	φ'_d (rad)
0,55850536	0,62486935	1,25	0,49989548	0,46356399

$$\varphi'_d = tan^{-1}(\frac{tan\varphi'}{\gamma'_\varphi})$$

Parametrene for å finne δ_d				
δ (rad)	tanδ	γ_φ'	tanδ/γ_φ'	δ_d (rad)
0,29670597	0,30573068	1,25	0,24458455	0,23987531

$$\delta_d = tan^{-1}\left(\frac{tan\delta}{\gamma_{\varphi'}}\right)$$

Parametrene for å beregne θ							
Jordskjelv	k_h	k_v	tan θ	θ (rad)	γ	γ_w	γ_d
1	0,03857143	0,01157143	0,07804596	0,07788807	20	10	20
2	0,03857143	0,01928571	0,07865987	0,07849824	20	10	20
3	0,03857143	0,01928571	0,07865987	0,07849824	20	10	20

$$tan\theta = \frac{\gamma_d}{\gamma - \gamma_w}\frac{k_h}{1 \mp k_v}$$

Parametrene for å finne K					
ψ (rad)	β (rad)	φ'_d (rad)	δ_d (rad)	θ (rad)	Jordskjelv
1,57079633	0	0,46356399	0,23987531	0,07788807	1
1,57079633	0	0,46356399	0,23987531	0,07849824	2
1,57079633	0	0,46356399	0,23987531	0,07849824	3

Deler av formel til K					
$sin^2(\psi + \varphi'_d - \theta)$	$cos\theta sin^2\psi \sin(\psi - \theta - \delta_d)$	Kvadratrute	(1+kvadratrute)^2	K	Jordskjelv
0,858484477	0,947056646	0,25615759	1,577931896	0,574471167	1
0,858909557	0,94682114	0,25582397	1,577093847	0,575204072	2
0,858909557	0,94682114	0,25582397	1,577093847	0,575204072	3

$$K_A = \frac{sin^2(\psi + \varphi'_d - \theta)}{cos\theta\, sin^2\psi \sin(\psi - \theta - \delta_d)\left[1 + \sqrt{\frac{\sin(\varphi'_d + \delta_d)\sin(\varphi'_d - \beta - \theta)}{\sin(\psi - \theta - \delta_d)\sin(\psi + \beta)}}\right]^2}$$

Parametre for å beregne E_d					
γ*	k_v	H	K	E_d_0	Jordskjelv
17	0,01157143	12	0,57447117	695,016226	1
17	0,01928571	12	0,57520407	690,471681	2
17	0,01928571	12	0,57520407	690,471681	3

$$E_d = \frac{1}{2}\gamma^*(1 \mp k_v)K * H^2 + E_{ws} + E_{wd}$$

$$E_{wd} = \frac{7}{12}k_h\gamma_w H'^2$$

E_d_0	E_ws	E_wd	E_tot	H'	Jordskjelv
695,016226	30	8,1	733,116226	6	1
690,471681	30	8,1	728,571681	6	2
690,471681	30	8,1	728,571681	6	3

Modell	Leire	GWL	7 m under overflate

	ψ	β	φ	θ	δ
Vinkel (rad)	1,57079633	0	0,558505361	?	0,296705973

$$K_A = \frac{sin^2(\psi + \varphi'_d - \theta)}{cos\theta\, sin^2\psi \sin(\psi - \theta - \delta_d)\left[1 + \sqrt{\frac{\sin(\varphi'_d + \delta_d)\sin(\varphi'_d - \beta - \theta)}{\sin(\psi - \theta - \delta_d)\sin(\psi + \beta)}}\right]^2}$$

Verdier for å beregne k_h						
g	r	S	γ_I	a_gR	a_g	α
9,8	1	1,8	0,7	0,3	0,21	0,02142857

$$tan\theta = \frac{k_h}{1 \mp k_v} \qquad k_h = \alpha\frac{S}{r} \qquad \alpha = \frac{a_g}{g} \qquad a_g = \gamma_I a_{gR}$$

k_h	0,03857143

Verdier for å beregne k_v						
Jordskjelv	a_vg	a_g	a_vg/a_g	k_h	k_v	
1	0,09	0,21	0,428571429	0,038571429	0,011571429	
2	0,13	0,21	0,619047619	0,038571429	0,019285714	
3	0,184	0,21	0,876190476	0,038571429	0,019285714	

$k_v = \mp 0{,}5k_h$ eller $k_v = \mp 0{,}3k_h$

${}^{a_{vg}}/_{a_g} > 0{,}6$ hvis andre tilfeller

Parameterne for å beregne φ'_d				
φ' (rad)	tanφ'	y_φ'	tanφ'/y_φ'	φ'_d (rad)
0,55850536	0,62486935	1,25	0,499895482	0,463563991

$$\varphi'_d = tan^{-1}\left(\frac{tan\varphi'}{\gamma'_\varphi}\right)$$

Parametrene for å finne δ_d				
δ (rad)	tanδ	y_φ'	tanδ/y_φ'	δ_d (rad)
0,29670597	0,30573068	1,25	0,244584545	0,239875306

$$\delta_d = tan^{-1}\left(\frac{tan\delta}{\gamma_{\varphi'}}\right)$$

Parametrene for å beregne θ						
Jordskjelv	k_h	k_v	tan θ	θ (rad)	y	y_w
1	0,03857143	0,01157143	0,07804596	0,077888073	20	10
2	0,03857143	0,01928571	0,078659869	0,078498236	20	10
3	0,03857143	0,01928571	0,078659869	0,078498236	20	10

$$tan\theta = \frac{\gamma}{\gamma - \gamma_w}\frac{k_h}{1 \mp k_v}$$

Parametrene for å finne K					
ψ (rad)	β (rad)	φ'_d (rad)	δ_d (rad)	θ (rad)	Jordskjelv
1,57079633	0	0,46356399	0,239875306	0,077888073	1
1,57079633	0	0,46356399	0,239875306	0,078498236	2
1,57079633	0	0,46356399	0,239875306	0,078498236	3

Deler av formel til K					
$sin^2(\psi + \varphi'_d - \theta)$	$cos\theta\, sin^2\psi \sin(\psi - \theta - \delta_d)$	Kvadratrute	(1+kvadratrute)^2	K	Jordskjelv
0,858484477	0,947056646	0,256157592	1,577931896	0,57447117	1
0,858909557	0,94682114	0,255823971	1,577093847	0,57520407	2
0,858909557	0,94682114	0,255823971	1,577093847	0,57520407	3

$$K_A = \frac{sin^2(\psi + \varphi'_d - \theta)}{cos\theta\, sin^2\psi \sin(\psi - \theta - \delta_d)\left[1 + \sqrt{\frac{\sin(\varphi'_d + \delta_d)\sin(\varphi'_d - \beta - \theta)}{\sin(\psi - \theta - \delta_d)\sin(\psi + \beta)}}\right]^2}$$

Parametre for å beregne E_d

y*	k_v	H	K	E_d	Jordskjelv
17	0,01157143	12	0,574471167	695,0162265	1
17	0,01928571	12	0,575204072	690,4716812	2
17	0,01928571	12	0,575204072	690,4716812	3

$$E_d = \frac{1}{2}\gamma^*(1 \mp k_v)K * H^2 + E_{ws} + E_{wd}$$

Modell	Leire	GWL	14 m under overflate

	ψ	β	φ	θ	δ
Vinkel (rad)	1,57079633	0	0,558505361	?	0,296705973

$$K_A = \frac{\sin^2(\psi + \varphi'_d - \theta)}{\cos\theta \sin^2\psi \sin(\psi - \theta - \delta_d)\left[1 + \sqrt{\frac{\sin(\varphi'_d + \delta_d)\sin(\varphi'_d - \beta - \theta)}{\sin(\psi - \theta - \delta_d)\sin(\psi + \beta)}}\right]^2}$$

Verdier for å beregne k_h							
g	r	S	γ_I	a_gR	a_g		α
9,8	1	1,8	0,7	0,3	0,21		0,02142857

$tan\theta = \frac{k_h}{1 \mp k_v}$ $\quad k_h = \alpha\frac{S}{r}$ $\quad \alpha = \frac{a_g}{g}$ $\quad a_g = \gamma_I a_{gR}$

k_h	0,03857143

Verdier for å beregne k_v						
Jordskjelv	a_vg	a_g	a_vg/a_g	k_h	k_v	
1	0,09	0,21	0,428571429	0,038571429	0,011571429	
2	0,13	0,21	0,619047619	0,038571429	0,019285714	
3	0,184	0,21	0,876190476	0,038571429	0,019285714	

$k_v = \mp 0{,}5k_h$ eller $k_v = \mp 0{,}3k_h$

$^{a_{vg}}/_{a_g} > 0{,}6$ hvis andre tilfeller

Parameterne for å beregne φ'_d				
φ' (rad)	tanφ'	y_φ'	tanφ'/y_φ'	φ'_d (rad)
0,55850536	0,62486935	1,25	0,499895482	0,463563991

$$\varphi'_d = tan^{-1}\left(\frac{tan\varphi'}{\gamma'_\varphi}\right)$$

Parametrene for å finne δ_d				
δ (rad)	tanδ	y_φ'	tanδ/y_φ'	δ_d (rad)
0,29670597	0,30573068	1,25	0,244584545	0,239875306

$$\delta_d = tan^{-1}\left(\frac{tan\delta}{\gamma_{\varphi'}}\right)$$

Parametrene for å beregne θ				
Jordskjelv	k_h	k_v	tan θ	θ (rad)
1	0,03857143	0,01157143	0,03902298	0,03900319
2	0,03857143	0,01928571	0,039329934	0,039309674
3	0,03857143	0,01928571	0,039329934	0,039309674

$$tan\theta = \frac{k_h}{1 \mp k_v}$$

Parametrene for å finne K					
ψ (rad)	β (rad)	φ'_d (rad)	δ_d (rad)	θ (rad)	Jordskjelv
1,57079633	0	0,46356399	0,239875306	0,03900319	1
1,57079633	0	0,46356399	0,239875306	0,039309674	2
1,57079633	0	0,46356399	0,239875306	0,039309674	3

Deler av formel til K					
$sin^2(\psi + \varphi'_d - \theta)$	$cos\theta sin^2\psi \sin(\psi - \theta - \delta_d)$	Kvadratrute	(1+kvadratrute)^2	K	Jordskjelv
0,830321408	0,960633623	0,277156546	1,631128844	0,52990764	1
0,830551423	0,960537741	0,276992948	1,63071099	0,53024318	2
0,830551423	0,960537741	0,276992948	1,63071099	0,53024318	3

$$K_A = \frac{\sin^2(\psi + \varphi'_d - \theta)}{\cos\theta \sin^2\psi \sin(\psi - \theta - \delta_d)\left[1 + \sqrt{\frac{\sin(\varphi'_d + \delta_d)\sin(\varphi'_d - \beta - \theta)}{\sin(\psi - \theta - \delta_d)\sin(\psi + \beta)}}\right]^2}$$

Parametre for å beregne E_d

y*	k_v	H	K	E_d	Jordskjelv
17	0,01157143	12	0,529907644	641,1016473	1
17	0,01928571	12	0,530243185	636,5008891	2
17	0,01928571	12	0,530243185	636,5008891	3

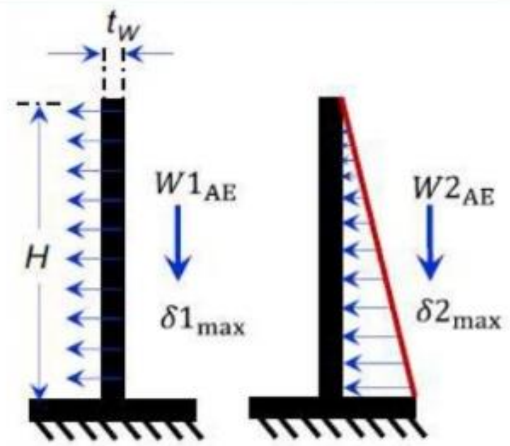
$$E_d = \frac{1}{2}\gamma^*(1 \mp k_v)K * H^2 + E_{ws} + E_{wd}$$

Leire	GWL	14 m under overflate

H_vegg (m)	y_bakfyll (kN/m^3)	W_vegg (kN/ m lengde)	a_max_overflate	a_max_bunn	AF_H	k_h	K_AE	W_1AE (kN/m lengde)	P_AE (kN/m^2)	W_2AE (kN/m)	EI (kN/m^2 per m)	δ_1max (m)	δ_2max (m)	δ_max (m)
13	20	0,573	1,091	3,572	0,305	0,039	0,301	0,007	23,874	155,181	134000	0,000	0,170	0,170
13	20	0,573	3,221	3,603	0,894	0,039	0,383	0,020	89,119	579,274	134000	0,001	0,633	0,634
13	20	0,573	5,152	3,693	1,395	0,039	0,383	0,031	139,072	903,971	134000	0,001	0,988	0,989

Input Parameters

1. RW height (H)
2. RW thickness (t_w)
3. RW Young's Modulus (E)
4. Moment of Inertia (I)
5. Unit weight of backfill ($\gamma_{Backfill}$)
6. Weight of the RW (W_{wall})
7. Backfill friction angle (ϕ)
8. RW backfill interface angle (δ)
9. Horizontal seismic coefficient (k_h)
10. Amplification factor (AF_H)



Calculations

1. Find body force at unit height of RW ($W1_{AE}$)

$$W1_{AE} = AF_H k_h W_{wall}$$

2. MO dynamic pressure coefficient (K_{AE})

$$K_{AE} = \frac{\cos^2(\phi - \theta - \psi)}{\cos\psi \cos^2\theta \cos(\delta + \theta + \psi)\left[1 + \sqrt{\frac{\sin(\delta + \phi)\sin(\phi - \beta - \psi)}{\cos(\delta + \theta + \psi)\cos(\beta - \theta)}}\right]^2}$$

3. Dynamic soil pressure at RW base (P_{AE})

$$P_{AE} = AF_H \, K_{AE} \gamma_{Backfill} H_{wall}$$

4. Use P_{AE} as triangular load per unit width of RW ($W2_{AE}$)

5. Find maximum displacement due to RW inertia force ($\delta 1_{max}$)

$$\delta 1_{max} = \left(\frac{W1_{AE} H^4}{8EI}\right)$$

6. Find maximum displacement due to dynamic soil pressure ($\delta 2_{max}$)

$$\delta 2_{max} = \left(\frac{W2_{AE} H^4}{30EI}\right)$$

7. Find maximum elastic displacement of base restrained RW:

$$\delta_{max} = \delta 1_{max} + \delta 2_{max}$$

Modell	Leire	GWL		14 m under overflate					
φ(rad)	θ(rad)	δ(rad)	β(rad)	ψ(rad)	K_AE	Jordskjelv	k_h	k_v	ψ
0,55850536	0	0,29670597	0	0,03900319	0,30063462	1	0,03857143	0,01157143	0,03902298
				0,03930967	0,38341669	2	0,03857143	0,01928571	0,03932993
				0,03930967	0,38341669	3	0,03857143	0,01928571	0,03932993

Deler av formel til K_AE			
del1	del2	del3	del4
0,75353933	0,94345885	0,62994139	2,65670894
0,75380344	0,94334659	0,44363669	2,0840869
0,75380344	0,94334659	0,44363669	2,0840869

K_AE	y_leire	H_vegg	k_v	P_AE		Jordskjelv
0,30063462	20	13	0,01157143	**502,193379**		1
0,38341669	20	13	0,01928571	**635,477556**		2
0,38341669	20	13	0,01928571	**635,477556**		3

$$P_{AE} = \frac{1}{2}K_{AE}\gamma H^2(1-k_v) \qquad (11.15)$$

where the dynamic active earth pressure coefficient, K_{AE}, is given by

$$K_{AE} = \frac{\cos^2(\phi-\theta-\psi)}{\cos\psi\cos^2\theta\cos(\delta+\theta+\psi)\left[1+\sqrt{\frac{\sin(\delta+\phi)\sin(\phi-\beta-\psi)}{\cos(\delta+\theta+\psi)\cos(\beta-\theta)}}\right]^2} \qquad (11.16)$$

where $\phi - \beta \geq \psi$, $\gamma = \gamma_d$, and $\psi = \tan^{-1}[k_h/(1-k_v)]$.

Fra EC8 Del. 5: $k_h = \alpha\frac{S}{r}$ $\quad \alpha = \frac{a_g}{g}$ $\quad a_g = \gamma_I a_{gR}$

$^{a_{vg}}/_{a_g} > 0{,}6$ $\quad k_v = \mp 0{,}5 k_h$

i andre tillfeller: $k_v = \mp 0{,}3 k_h$

S	1,8
r	1
y_I	0,7
a_gR	0,3
a_g	0,21
α	0,02142857
g	9,8

jordskjelv	a_vg	a_vg/a_g	k_h	k_v
1	0,087	0,41428571	0,0385714	0,01157143
2	0,13	0,61904762	0,0385714	0,01928571
3	0,184	0,87619048	0,0385714	0,01928571

Vedlegg F – Sheet pile wall PZ 40

Momentkapasitet til sheet pile wall PZ 40

Bestemmer tverrsnitts klasse
EC 3 Tabell 5.2

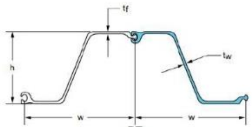
	t_f	t_w	c/t	72ε	83ε	124ε
c (mm)	409		26,8902	58,32	67,23	100,44
t (mm)	15,21	12,67	32,281			
f_y (N/mm^2	355		dvs	1klasse		
ε	0,81					

6.2.5 (2) EC 3 eq 6.13

$$M_{c,Rd} = M_{pl,Rd} = \frac{W_{pl} * f_y}{\gamma_{M0}}$$ NA.6.1(1)2B $\gamma_{M0} = 1.05$

W_pl 3866,7 cm^3/m 3866700 mm^3

M_c,Rd 1307312857 1307,31 kNm/m

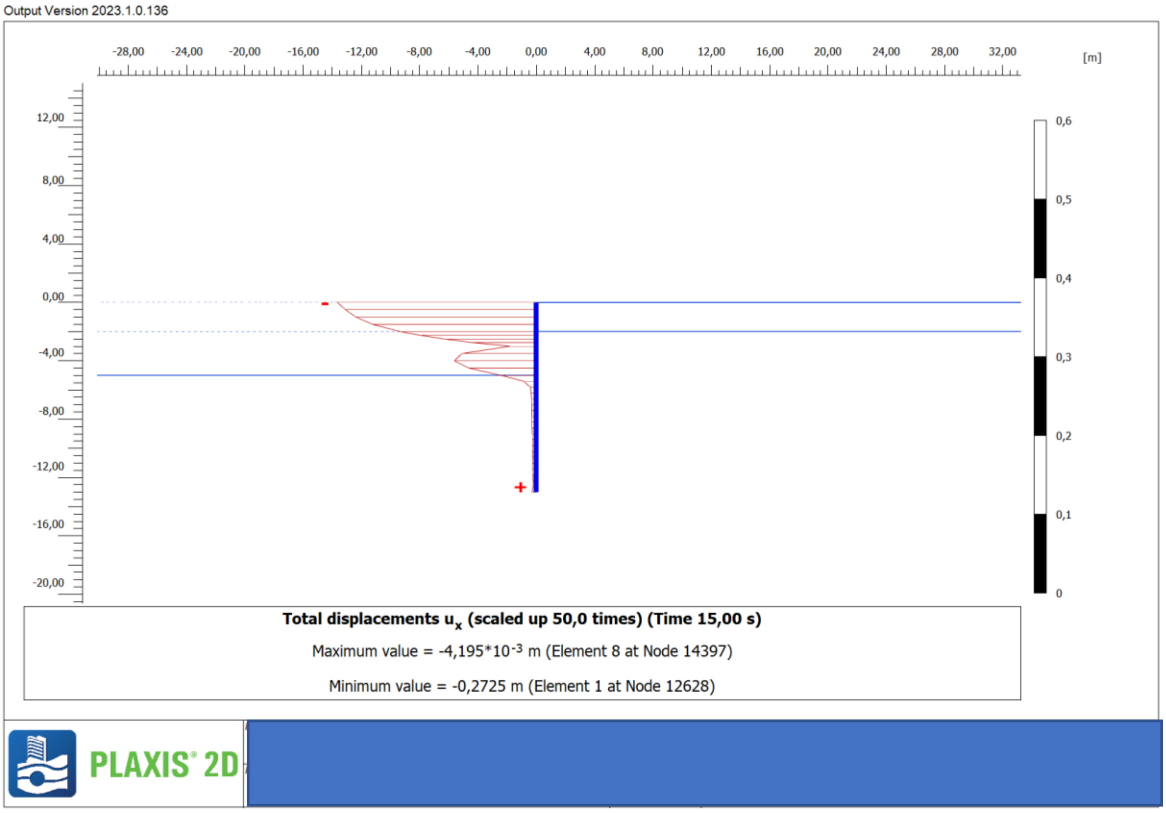


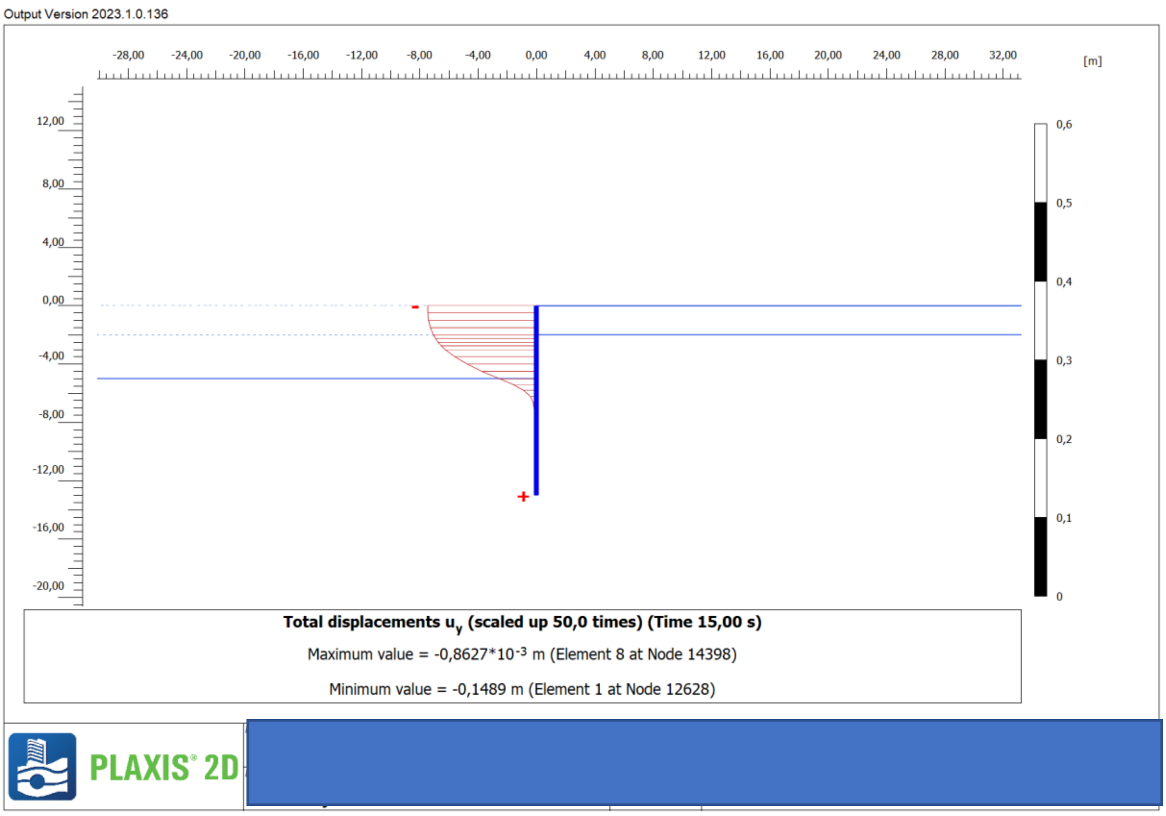
PZ

SECTION	Width (w) in / mm	Height (h) in / mm	THICKNESS Flange (t_f) in / mm	THICKNESS Web (t_w) in / mm	Cross Sectional Area in²/ft / cm²/m	WEIGHT Single Pile lb/ft / kg/m	WEIGHT Wall Area lb/ft² / kg/m²	SECTION MODULUS Elastic in³/ft / cm³/m	SECTION MODULUS Plastic in³/ft / cm³/m	Moment of Inertia in⁴/ft / cm⁴/m	COATING AREA Both Sides ft²/ft of single / m²/m	COATING AREA Wall Surface ft²/ft² / m²/m²
PZ 22	22.00 / 559	9.0 / 229	0.375 / 9.50	0.375 / 9.50	6.47 / 136.9	40.3 / 60.0	22.0 / 107.4	18.1 / 973	21.79 / 1171.4	84.38 / 11500	4.48 / 1.37	1.22 / 1.22
PZ 27	18.00 / 457	12.0 / 305	0.375 / 9.50	0.375 / 9.50	7.94 / 168.1	40.5 / 60.3	27.0 / 131.8	30.2 / 1620	36.49 / 1961.9	184.20 / 25200	4.48 / 1.37	1.49 / 1.49
PZ 35	22.64 / 575	14.9 / 378	0.600 / 15.21	0.500 / 12.67	10.29 / 217.8	66.0 / 98.2	35.0 / 170.9	48.5 / 2608	57.17 / 3073.5	361.22 / 49300	5.37 / 1.64	1.42 / 1.42
PZ 40	19.69 / 500	16.1 / 409	0.600 / 15.21	0.500 / 12.67	11.77 / 249.1	65.6 / 97.6	40.0 / 195.3	60.7 / 3263	71.92 / 3866.7	490.85 / 67000	5.37 / 1.64	1.64 / 1.64

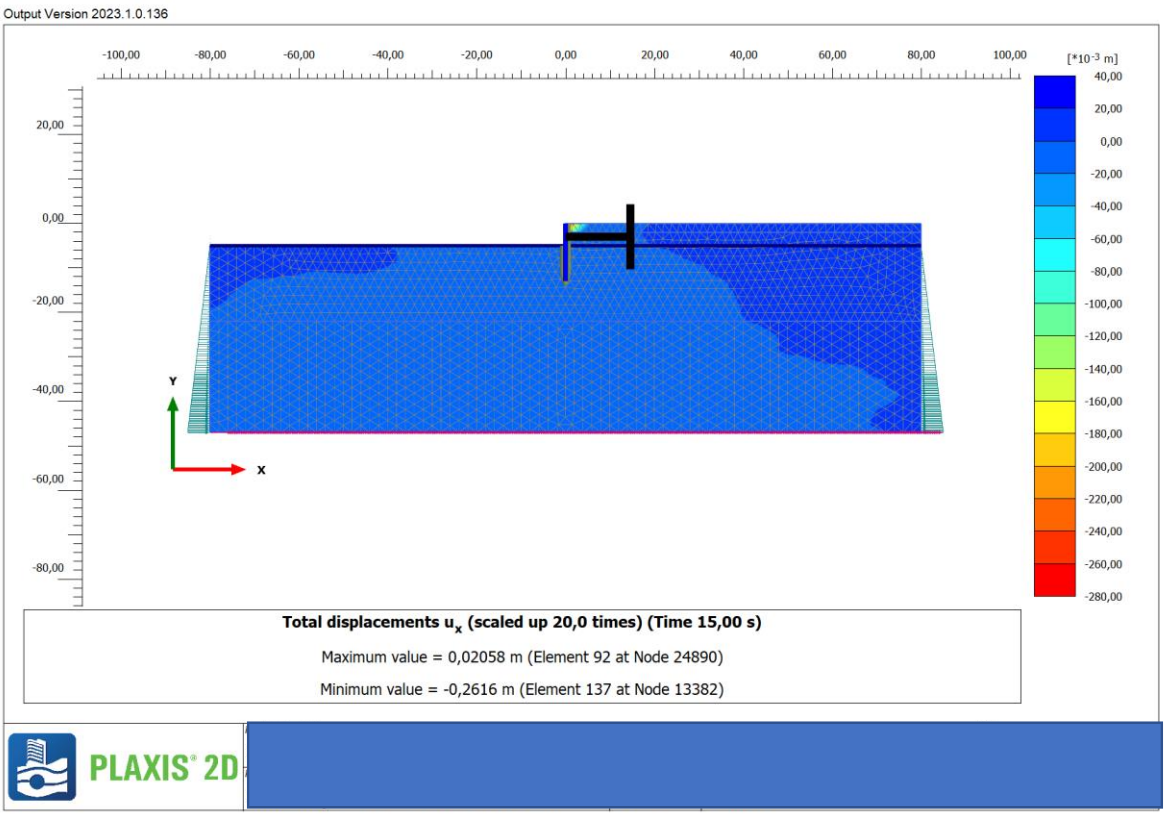
a

Vedlegg G – Deformasjoner ved Elastoplastisk ankor

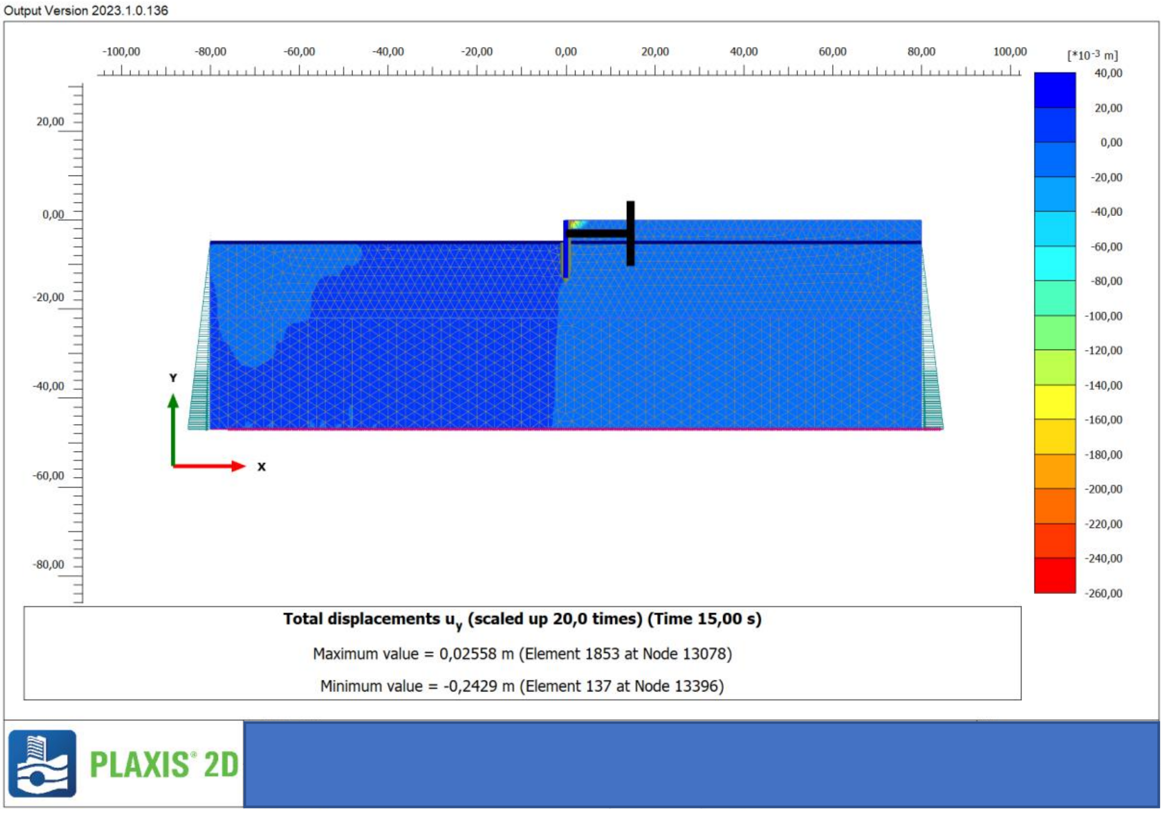


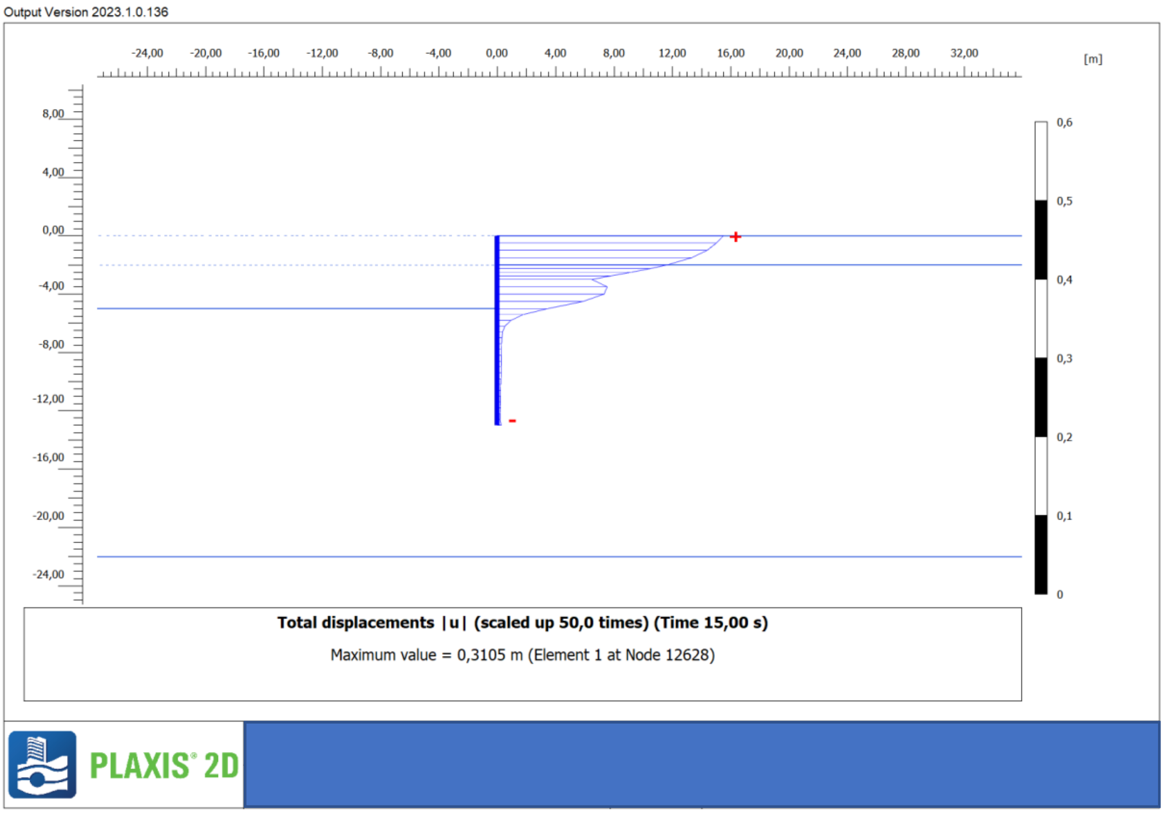


Vedlegg G – Deformasjoner ved Elastoplastisk ankor

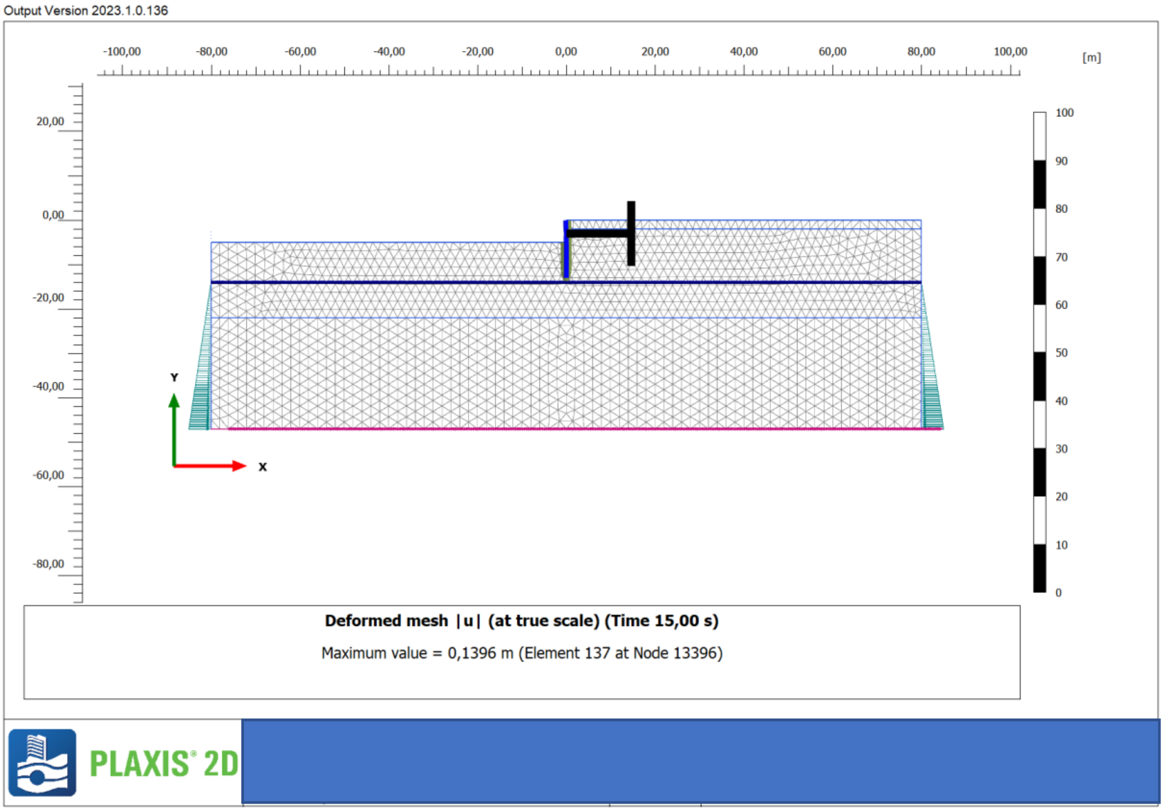


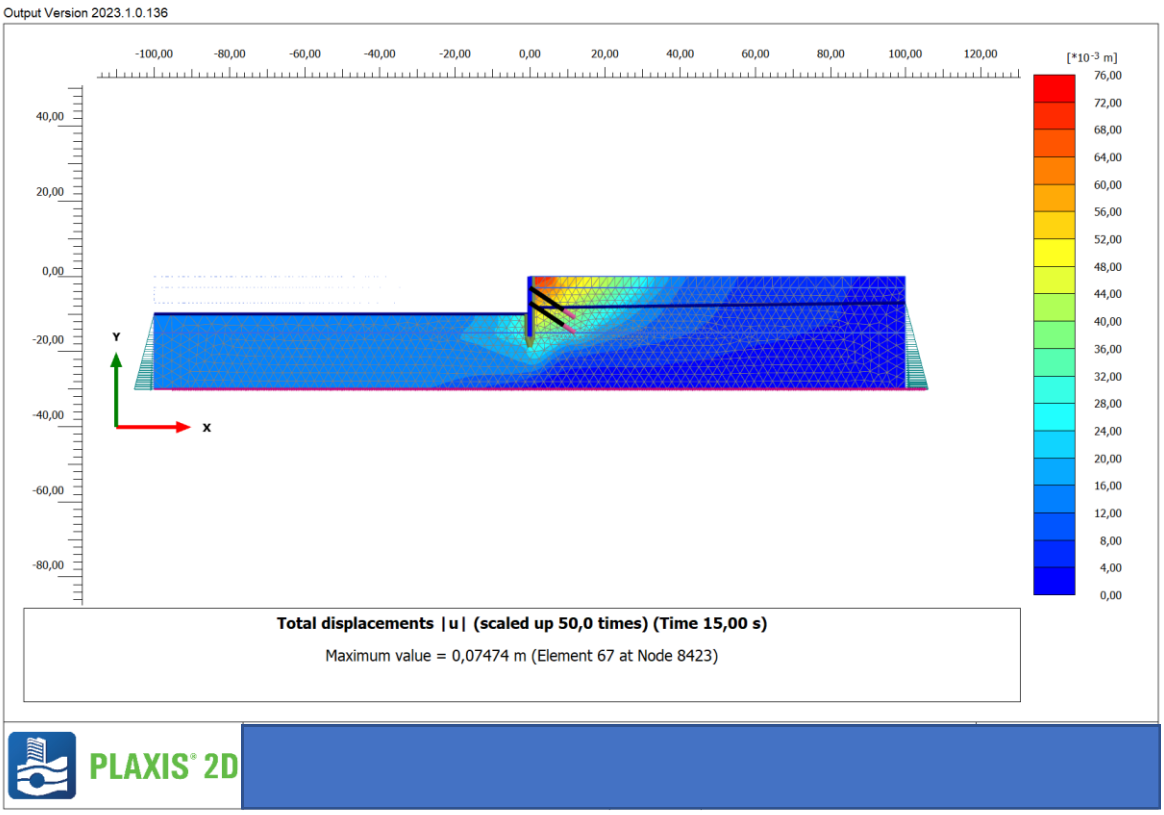
Vedlegg G – Deformasjoner ved Elastoplastisk ankor



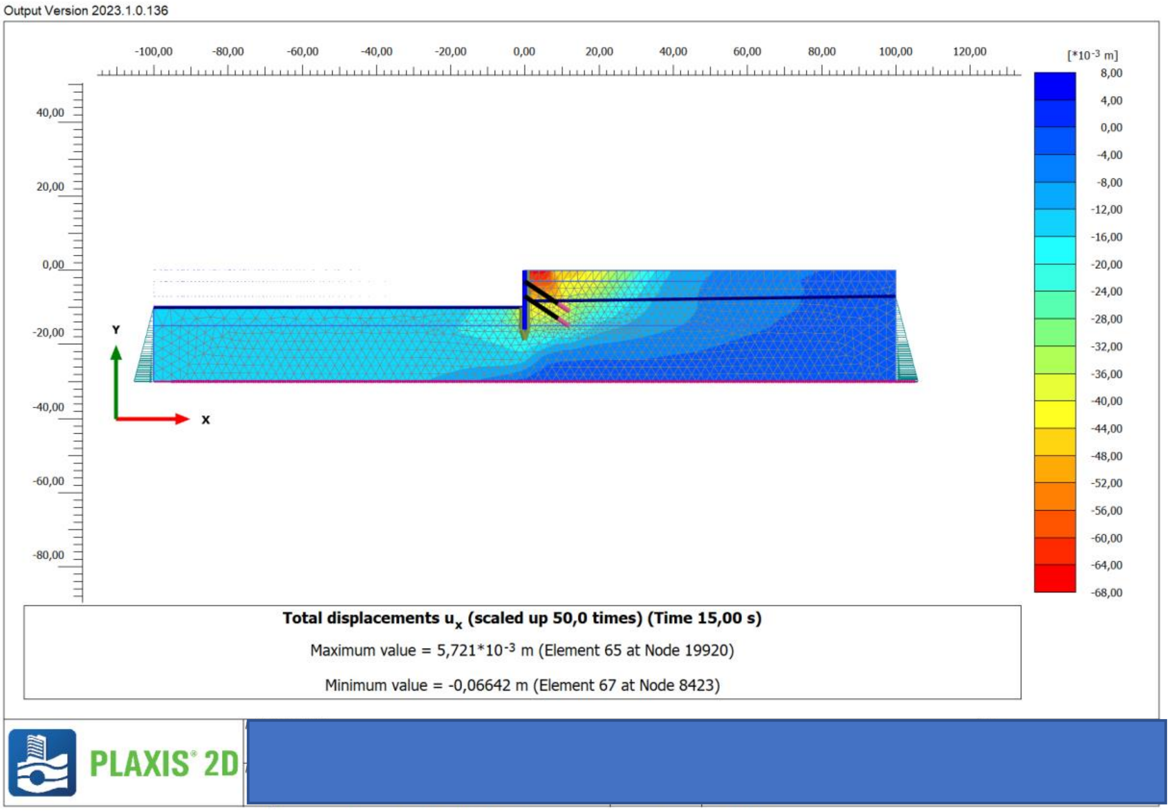


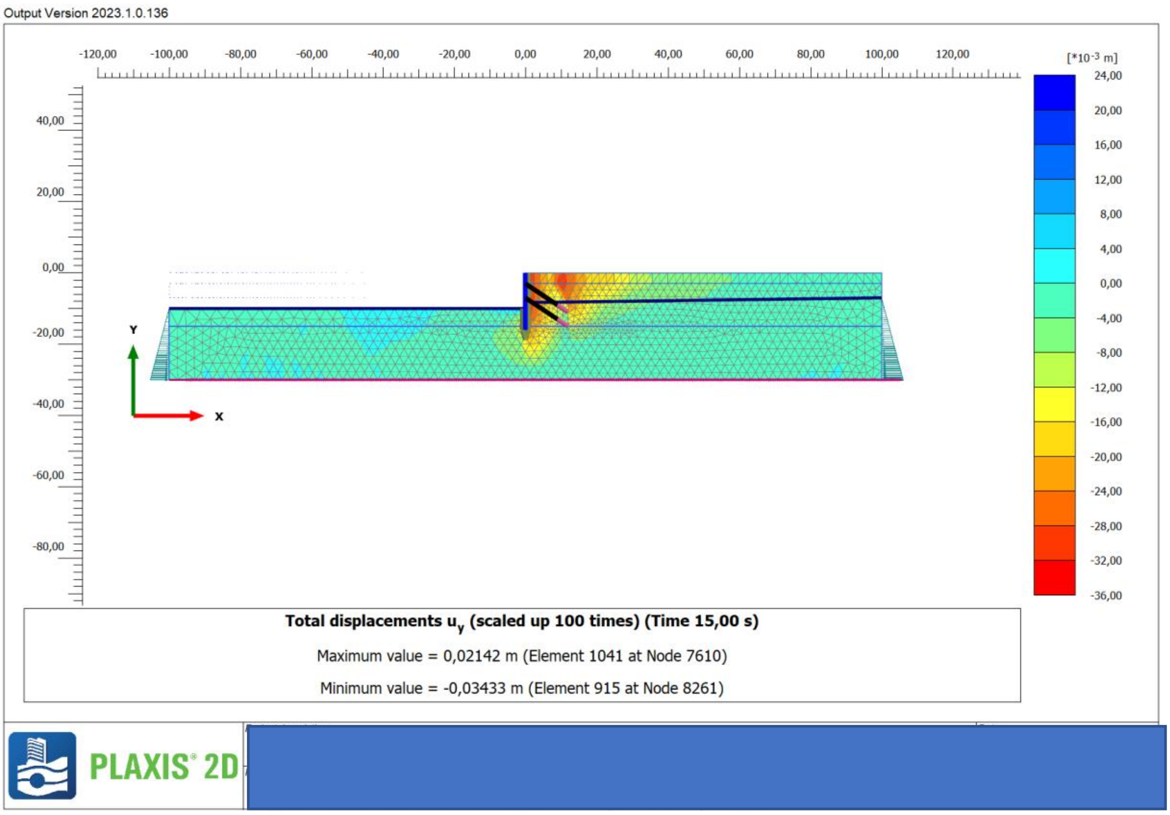
Vedlegg H – «Dry excavation»



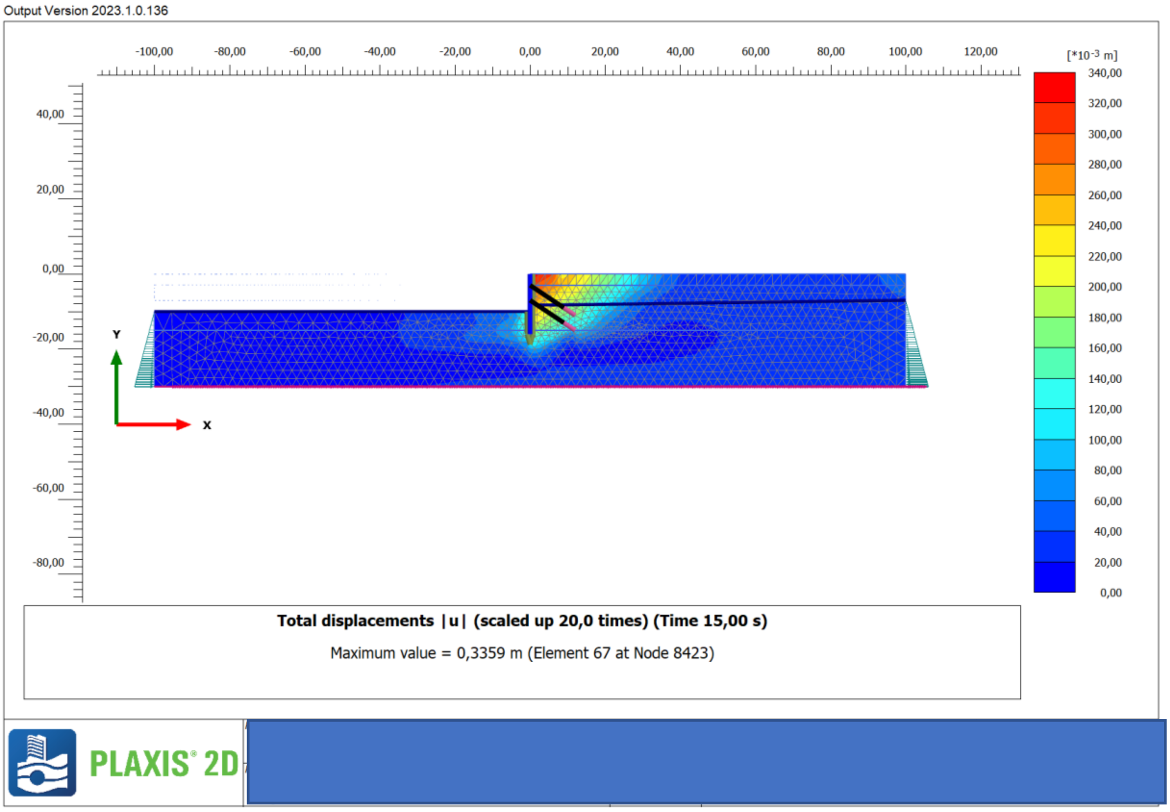


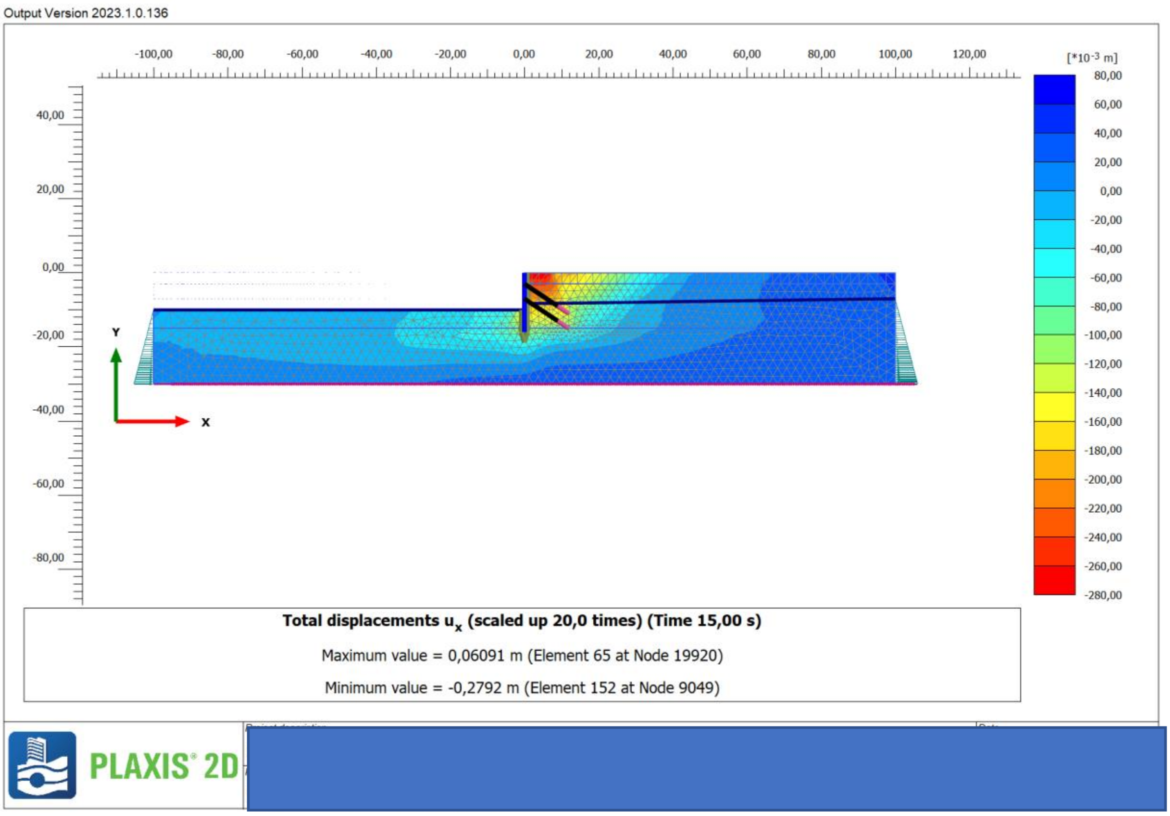
Vedlegg H – «Dry excavation»





Vedlegg H – «Dry excavation»





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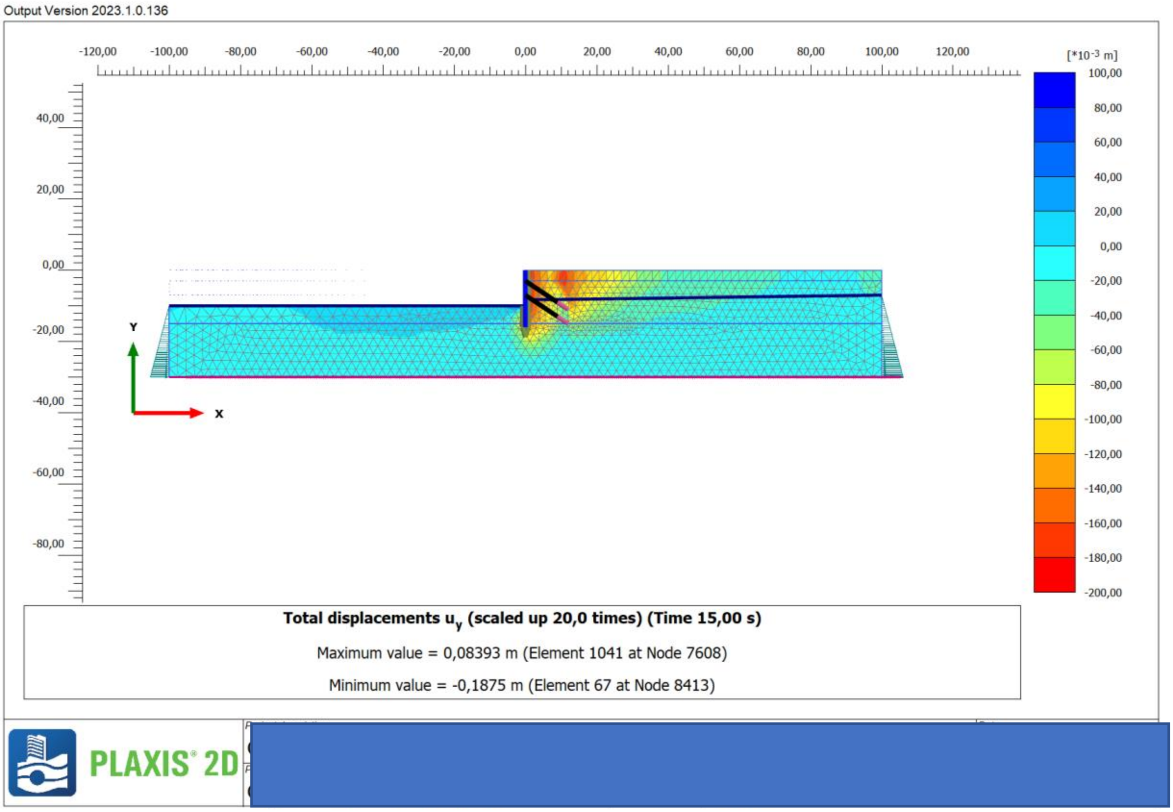

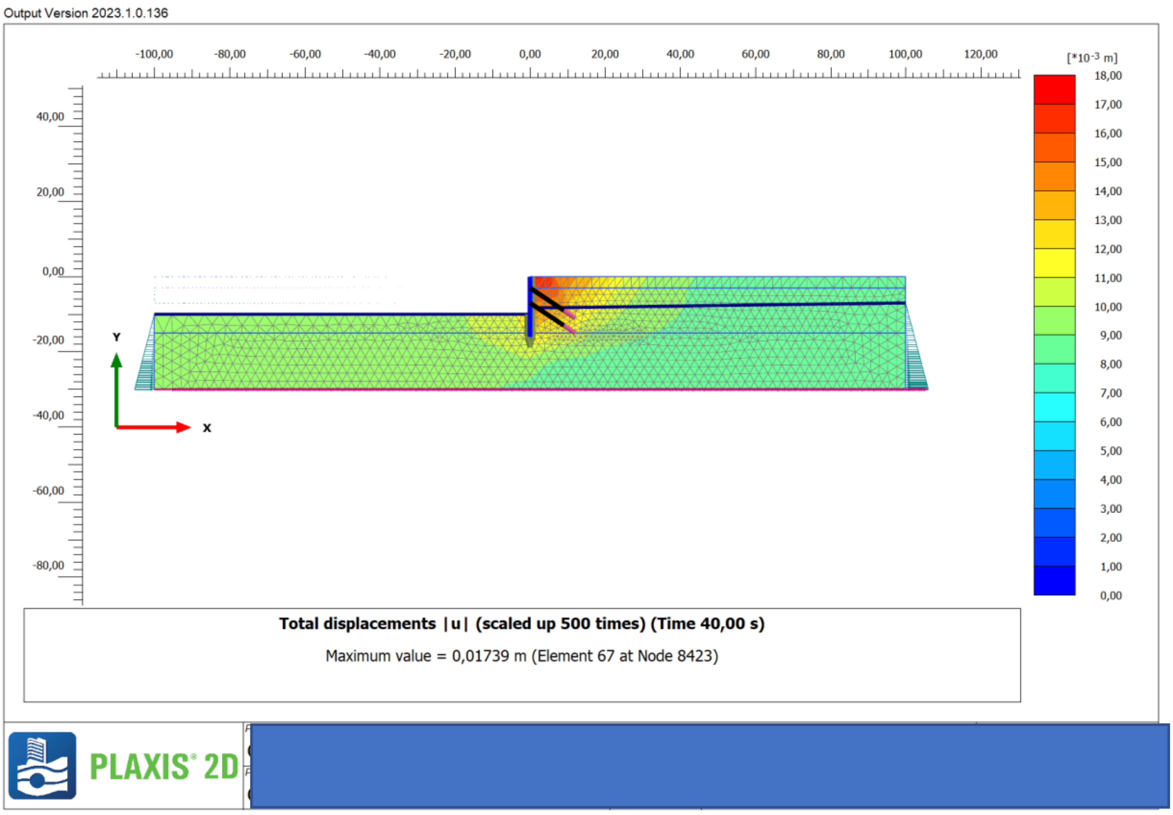

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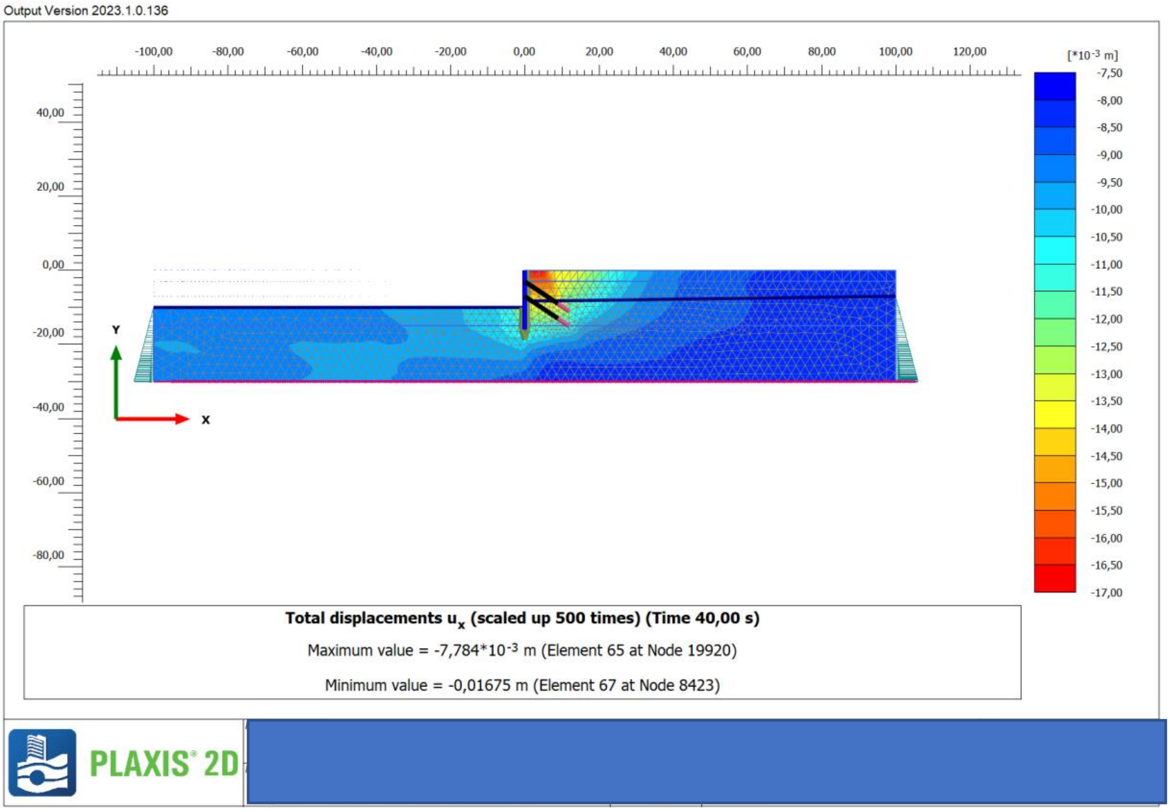

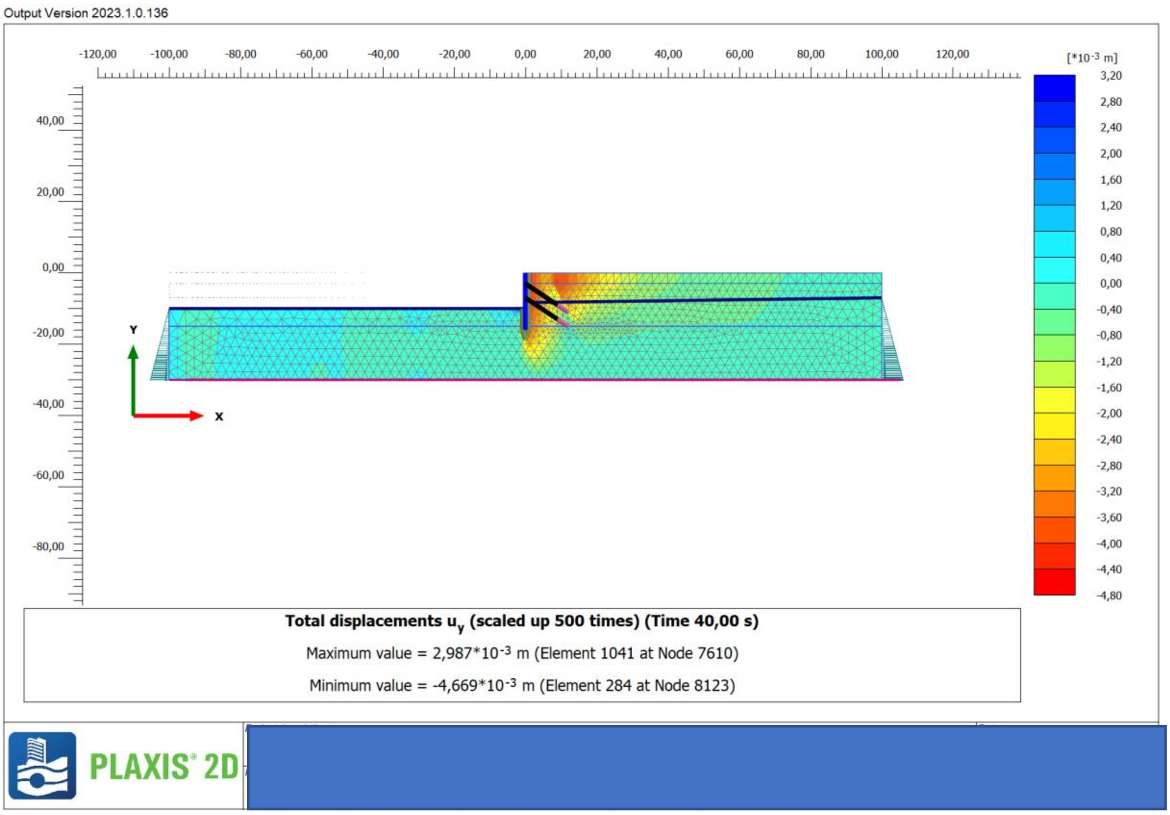

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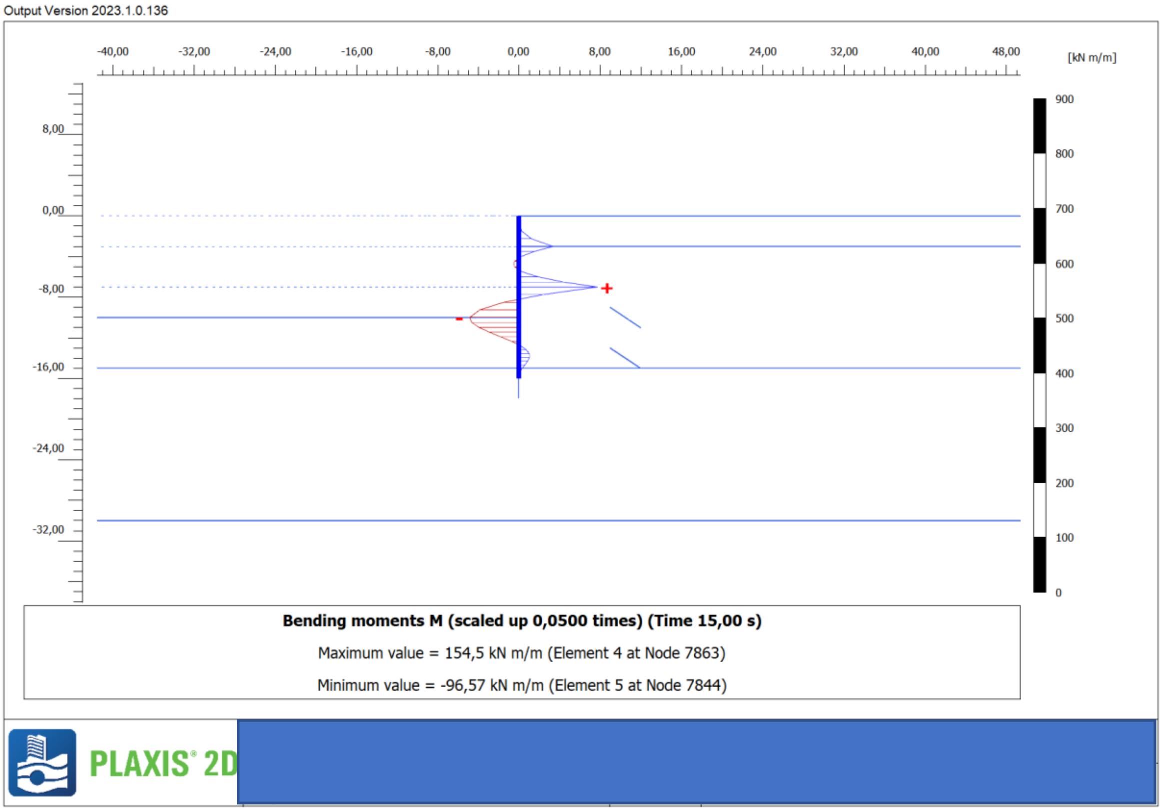

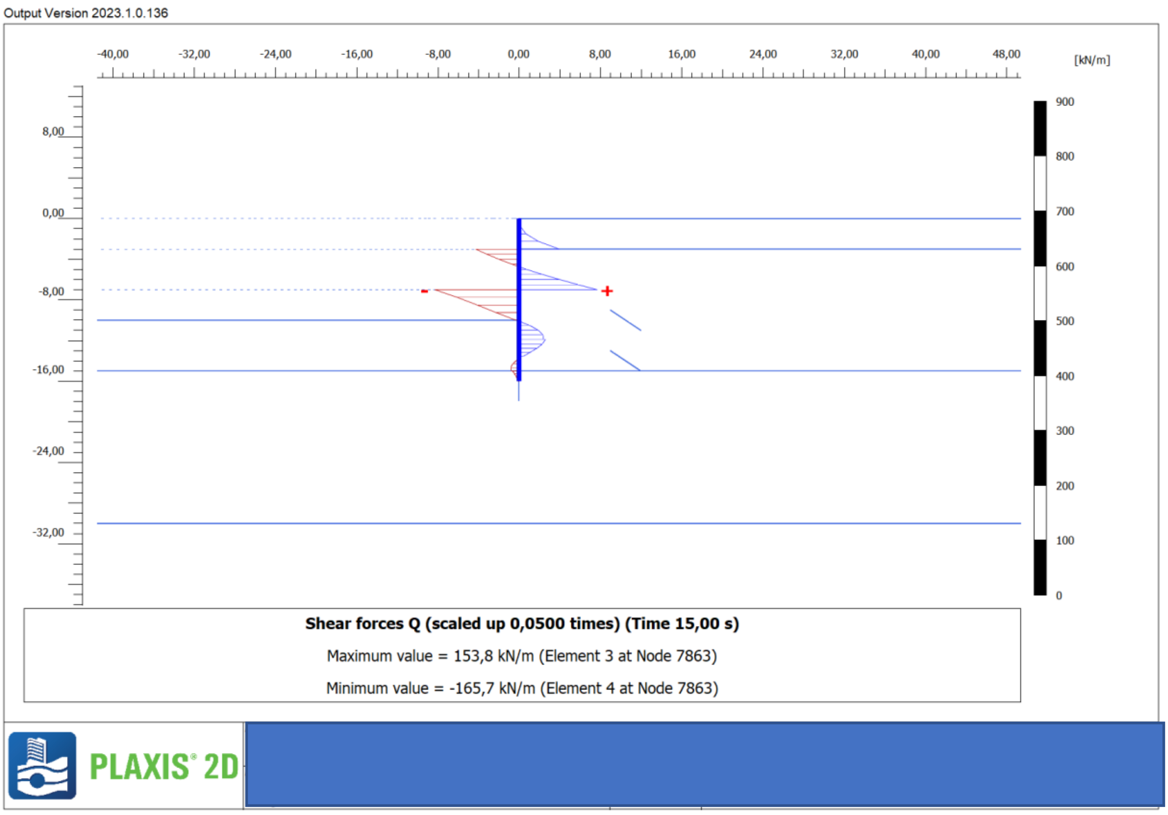

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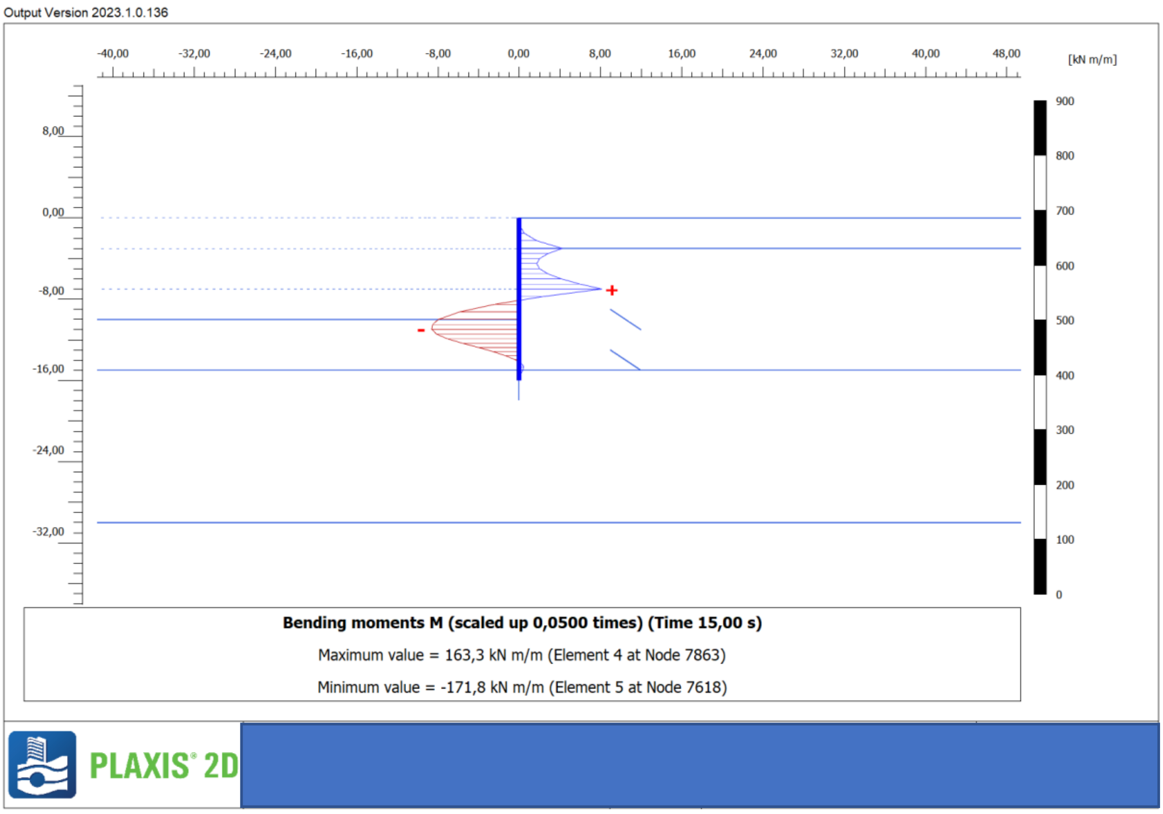

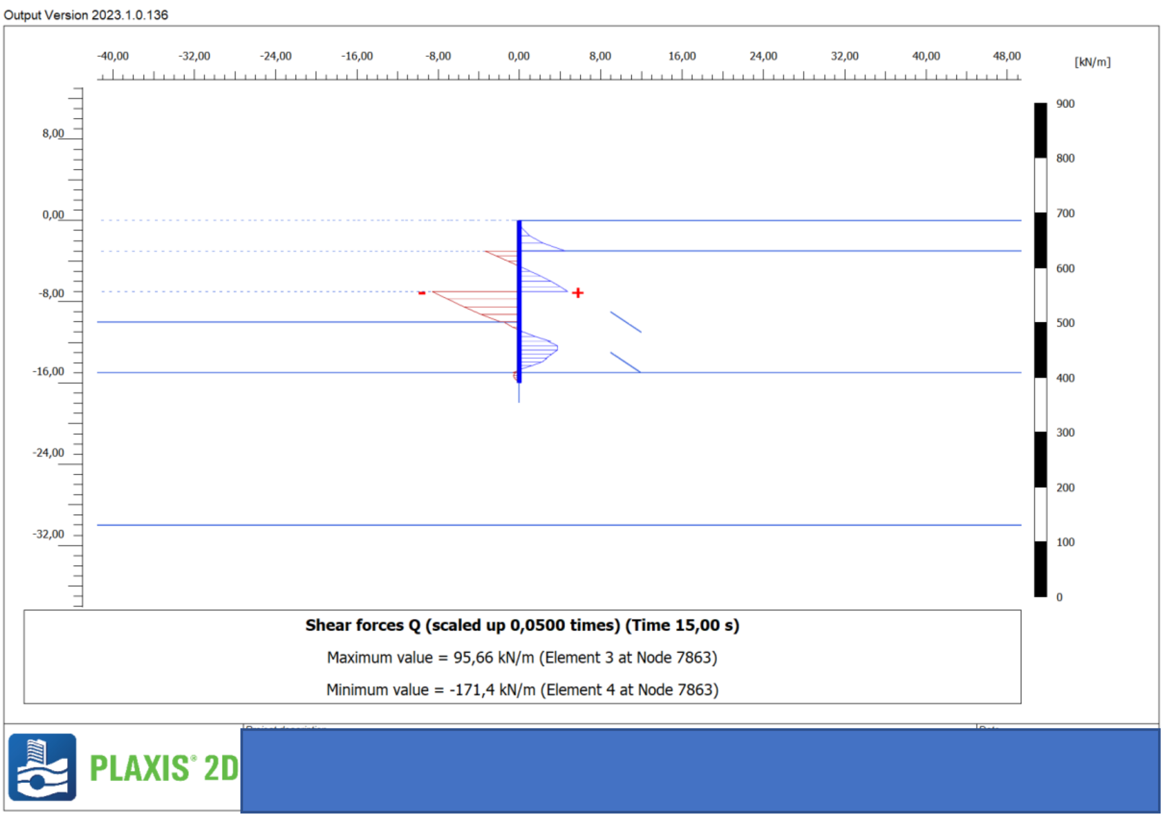

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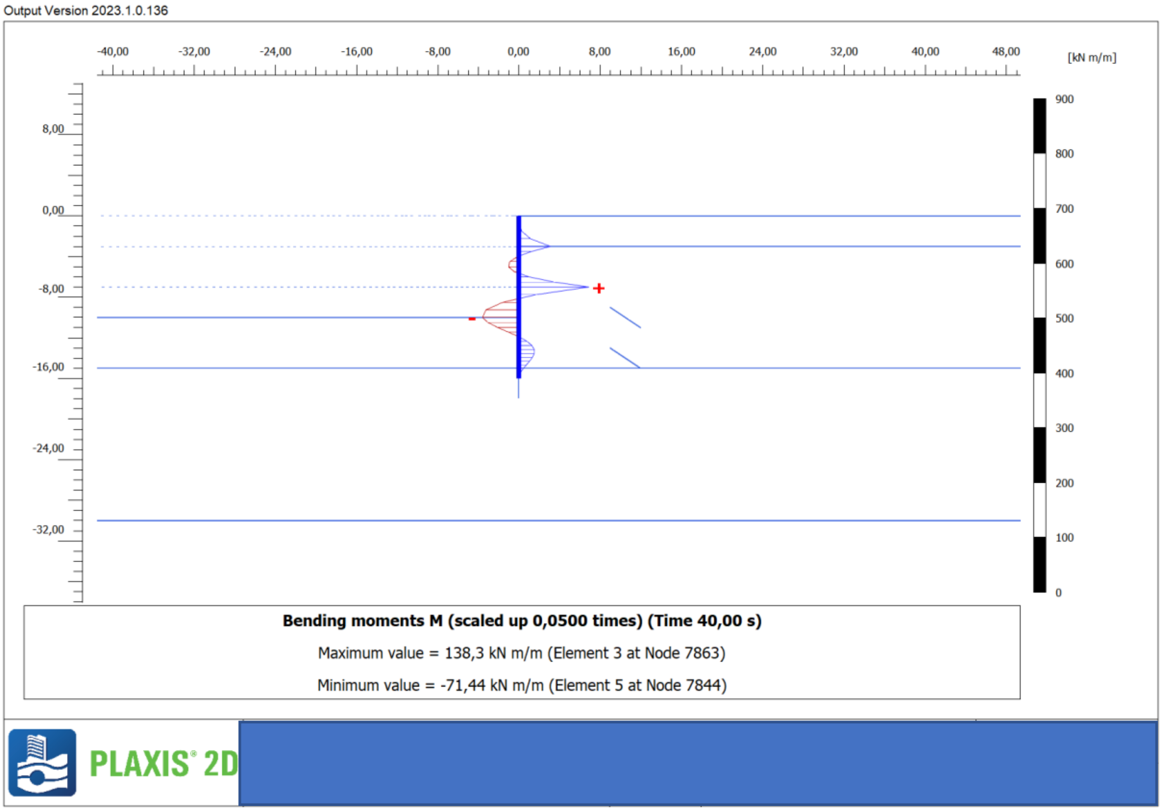
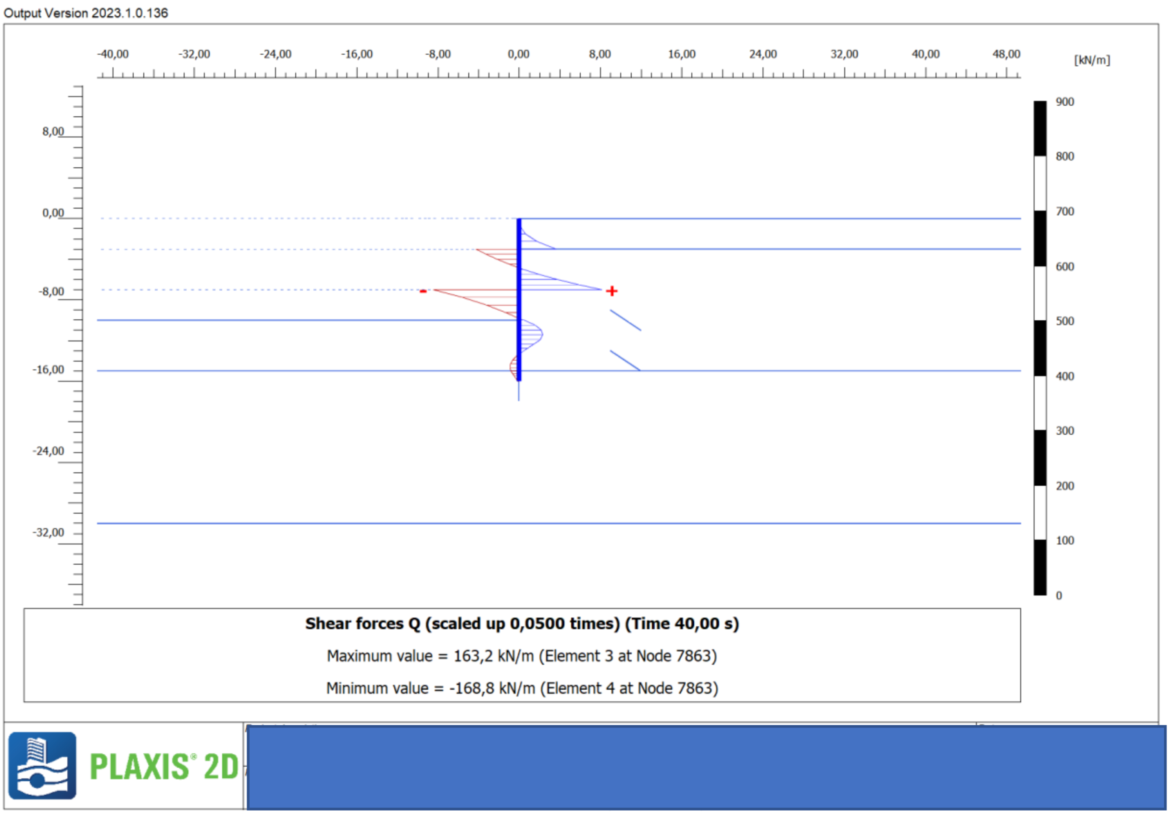
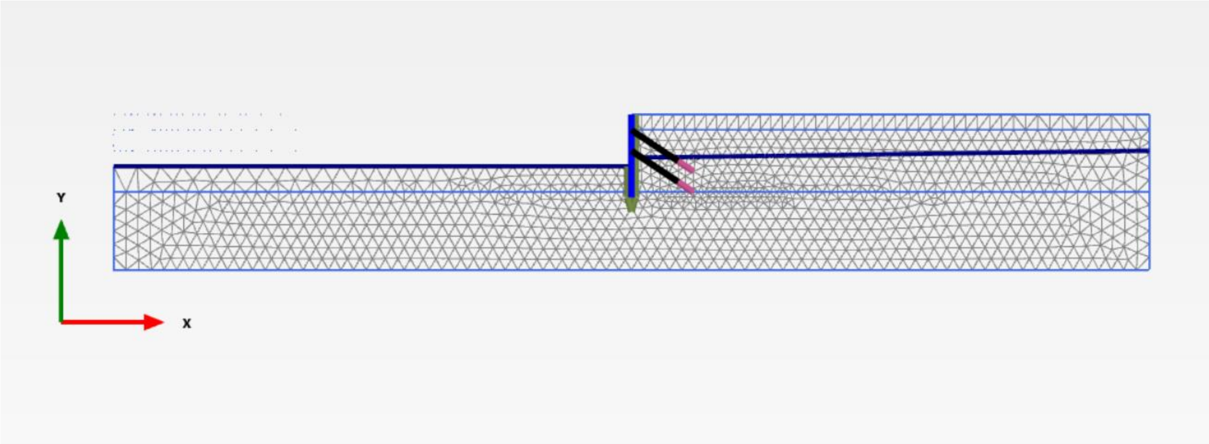
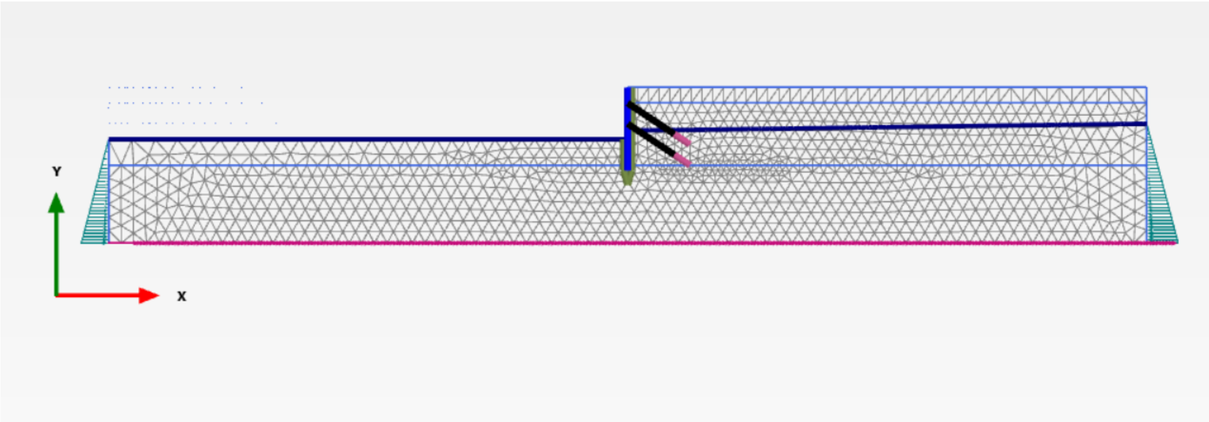




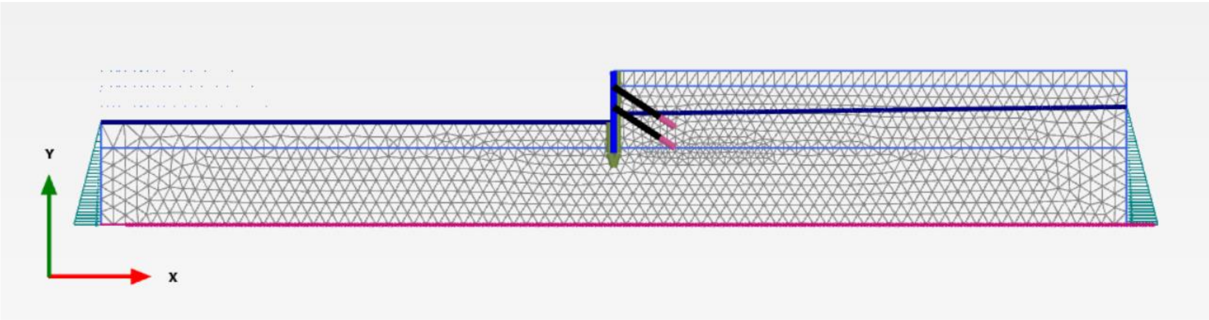
Vedlegg H – «Dry excavation»

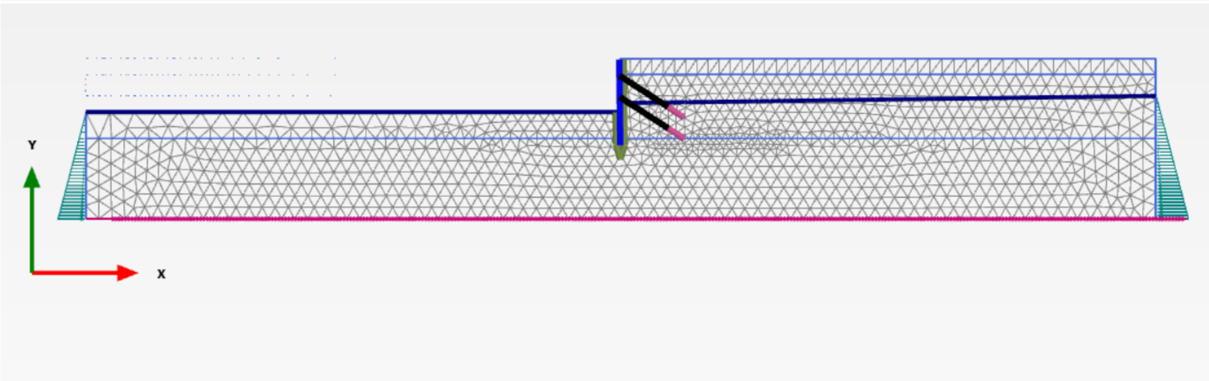


Deformed mesh |u| (at true scale)
Maximum value = $7{,}711 \cdot 10^{-3}$ m (Element 975 at Node 5568)



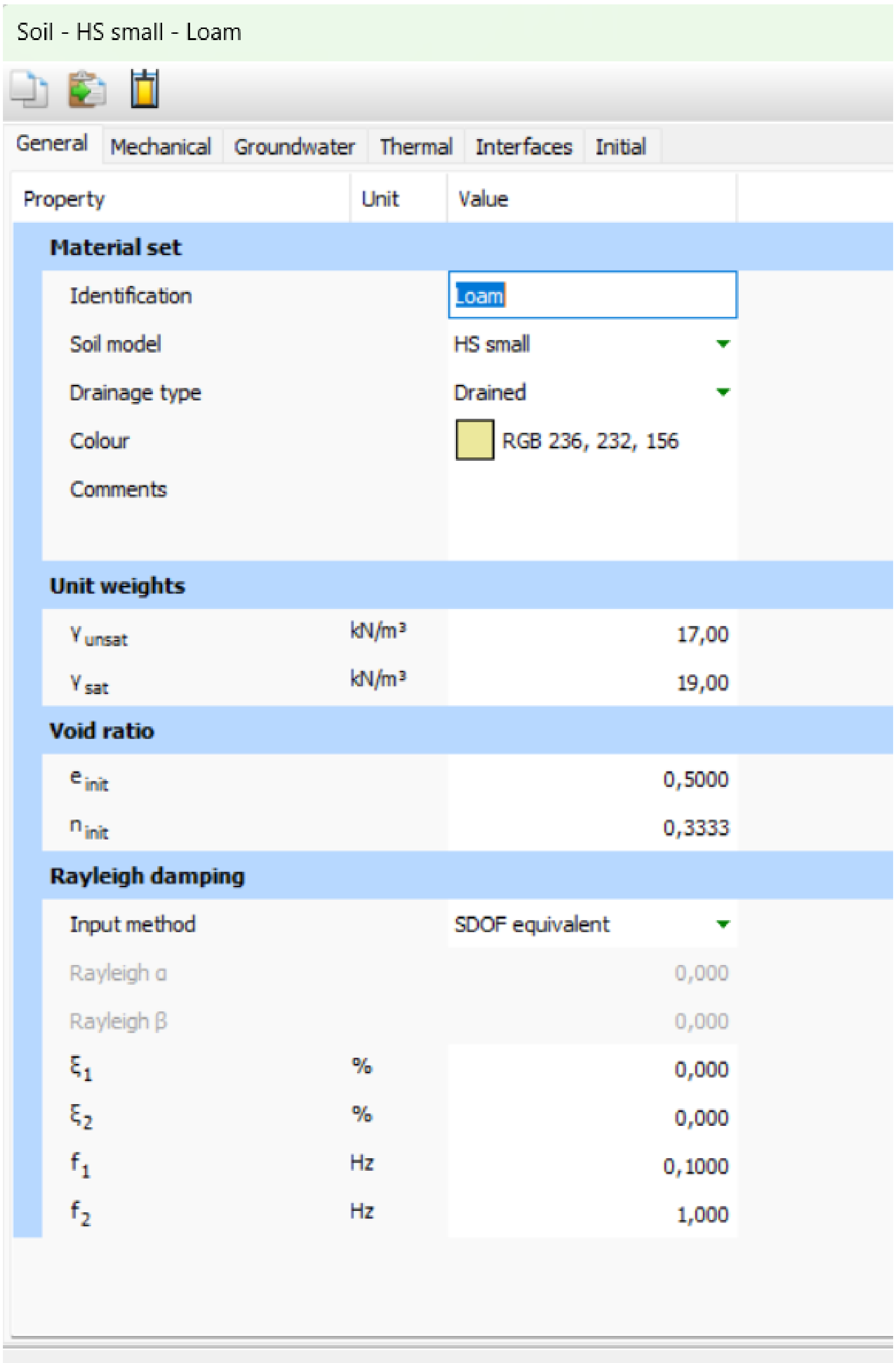
Deformed mesh |u| (at true scale) (Time 40,00 s)
Maximum value = 0,01739 m (Element 67 at Node 8423)





Deformed mesh |u| (at true scale) (Time 15,00 s)
Maximum value = 0,3359 m (Element 67 at Node 8423)

Vedlegg H – «Dry excavation»



Soil - HS small - Loam

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
Material set		
Identification		Loam
Soil model		HS small
Drainage type		Drained
Colour		RGB 236, 232, 156
Comments		
Unit weights		
γ_{unsat}	kN/m³	17,00
γ_{sat}	kN/m³	19,00
Void ratio		
e_{init}		0,5000
n_{init}		0,3333
Rayleigh damping		
Input method		SDOF equivalent
Rayleigh α		0,000
Rayleigh β		0,000
ξ_1	%	0,000
ξ_2	%	0,000
f_1	Hz	0,1000
f_2	Hz	1,000

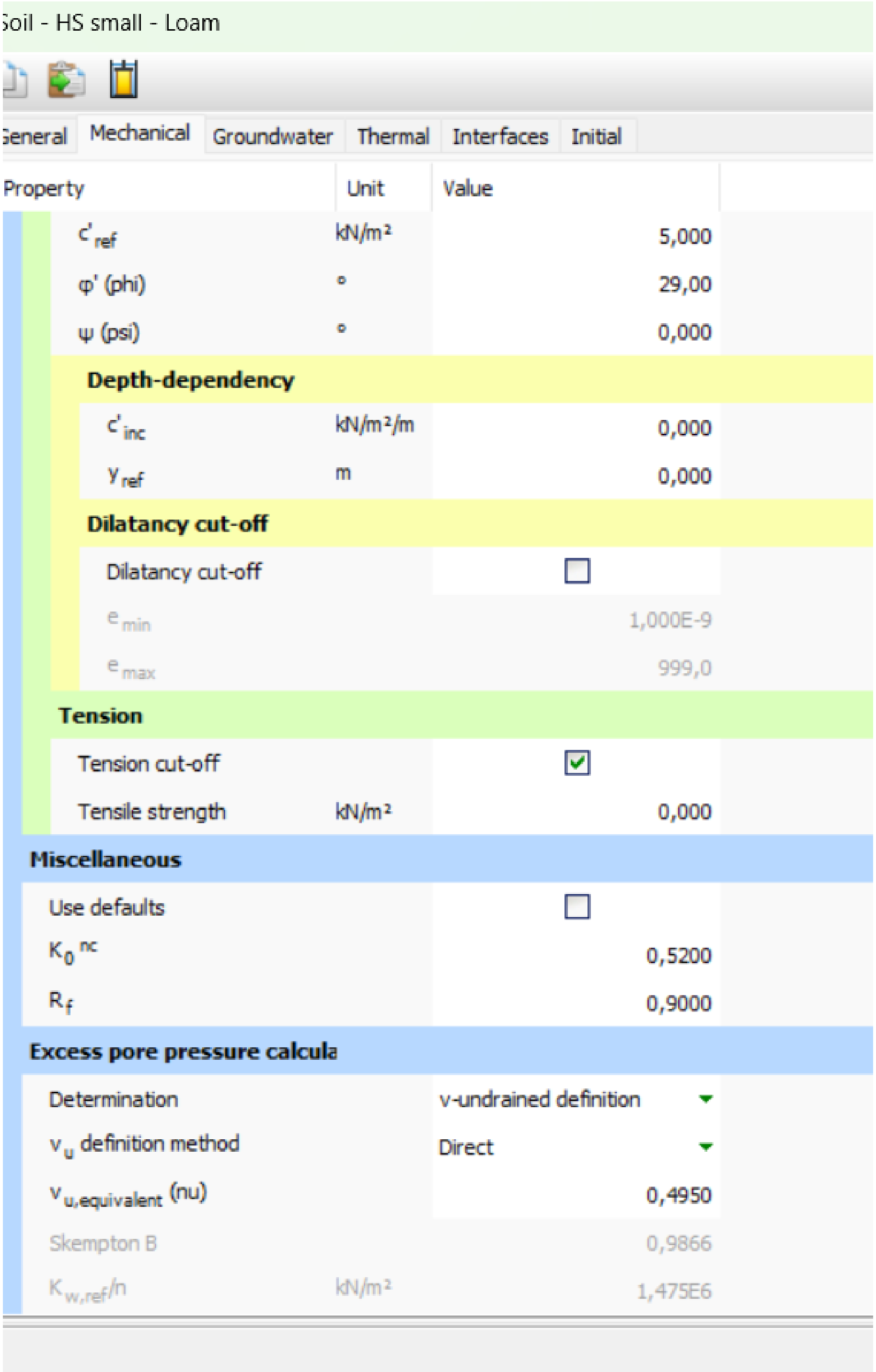
Vedlegg H – «Dry excavation»

Soil - HS small - Loam

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
Stiffness		
E_{50}^{ref}	kN/m²	12,00E3
E_{oed}^{ref}	kN/m²	8000
E_{ur}^{ref}	kN/m²	36,00E3
ν_{ur}		0,2000
Alternatives		
Use alternatives		☐
C_c		0,04317
C_s		0,01661
e_{init}		0,5000
Stress-dependency		
power (m)		0,8000
p_{ref}	kN/m²	100,0
Small-strain		
G_0^{ref}	kN/m²	160,0E3
$\gamma_{0.7}$		0,3000E-3
Strength		
Shear		
c'_{ref}	kN/m²	5,000
φ' (phi)	°	29,00
ψ (psi)	°	0,000
Depth-dependency		
c'_{inc}	kN/m²/m	0,000

Vedlegg H – «Dry excavation»

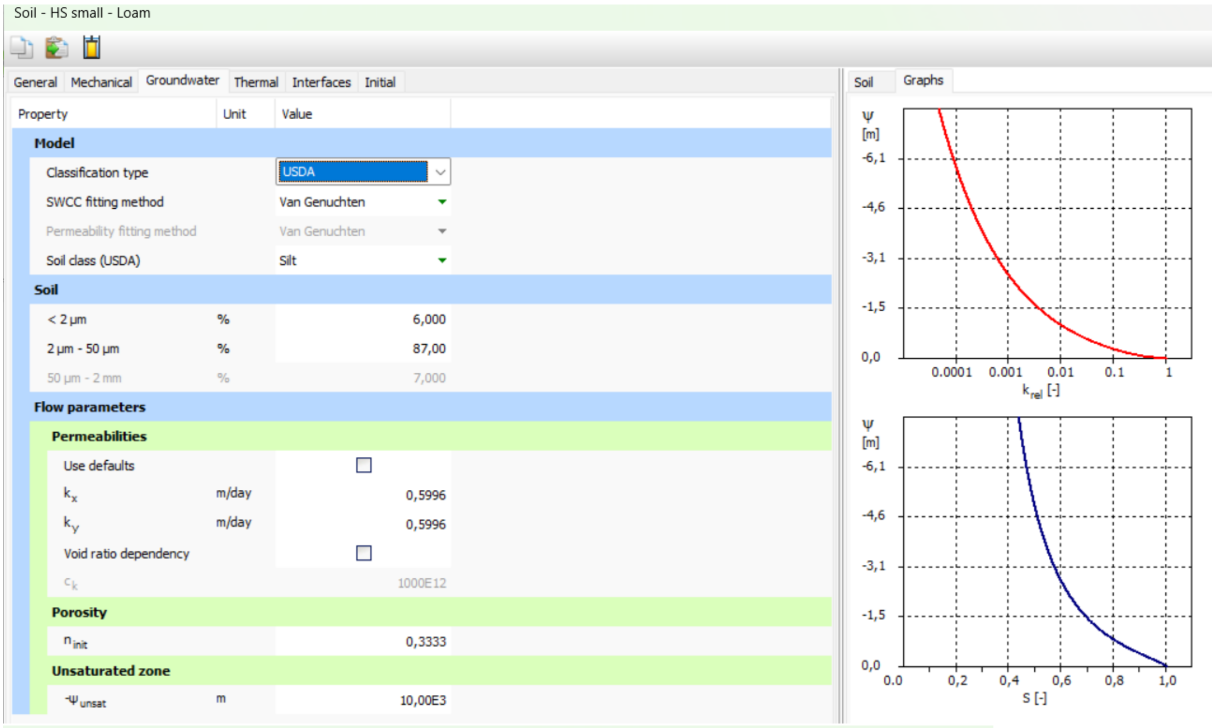


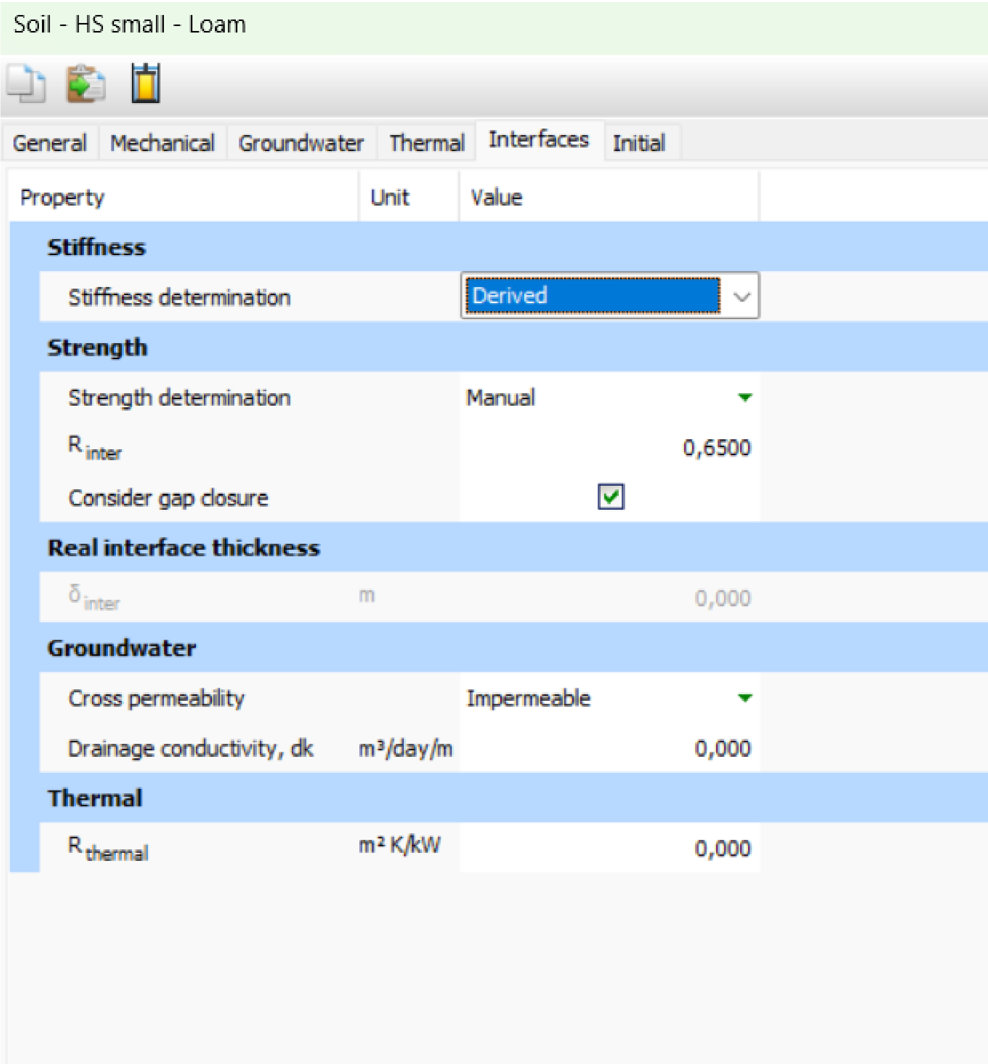
ioil - HS small - Loam

ieneral | Mechanical | Groundwater | Thermal | Interfaces | Initial

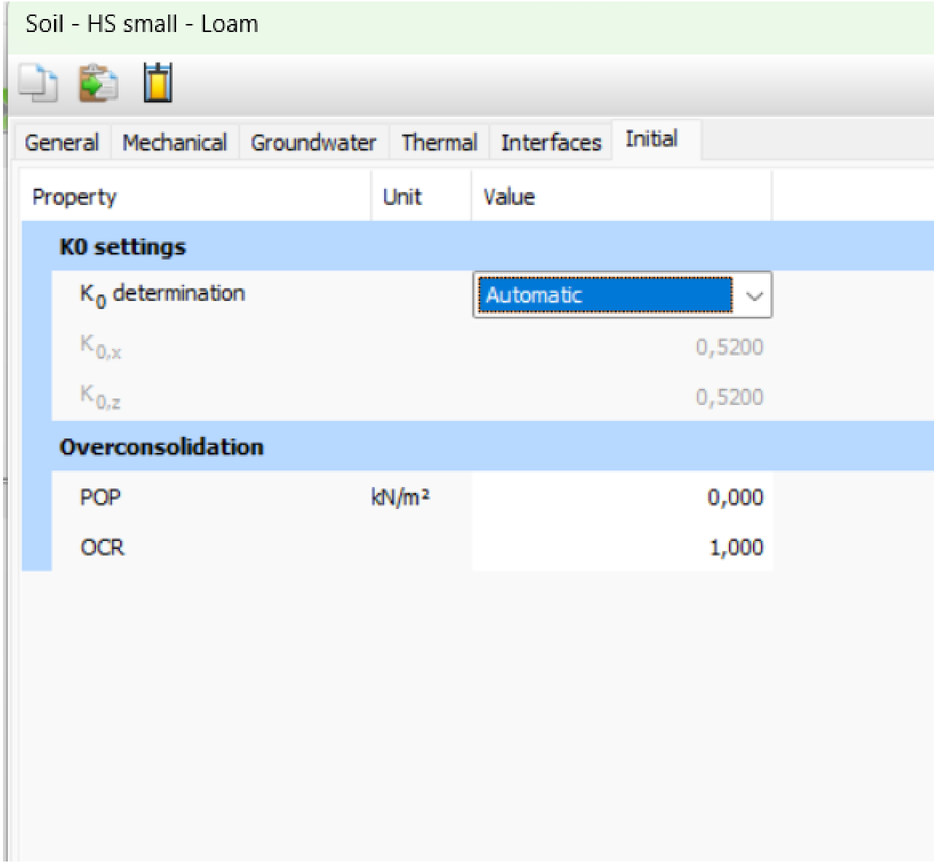
Property	Unit	Value
c'_{ref}	kN/m²	5,000
φ' (phi)	°	29,00
ψ (psi)	°	0,000
Depth-dependency		
c'_{inc}	kN/m²/m	0,000
y_{ref}	m	0,000
Dilatancy cut-off		
Dilatancy cut-off		☐
e_{min}		1,000E-9
e_{max}		999,0
Tension		
Tension cut-off		☑
Tensile strength	kN/m²	0,000
Miscellaneous		
Use defaults		☐
K_0^{nc}		0,5200
R_f		0,9000
Excess pore pressure calcula		
Determination		v-undrained definition
v_u definition method		Direct
$v_{u,equivalent}$ (nu)		0,4950
Skempton B		0,9866
$K_{w,ref}/n$	kN/m²	1,475E6

Vedlegg H – «Dry excavation»





Vedlegg H – «Dry excavation»



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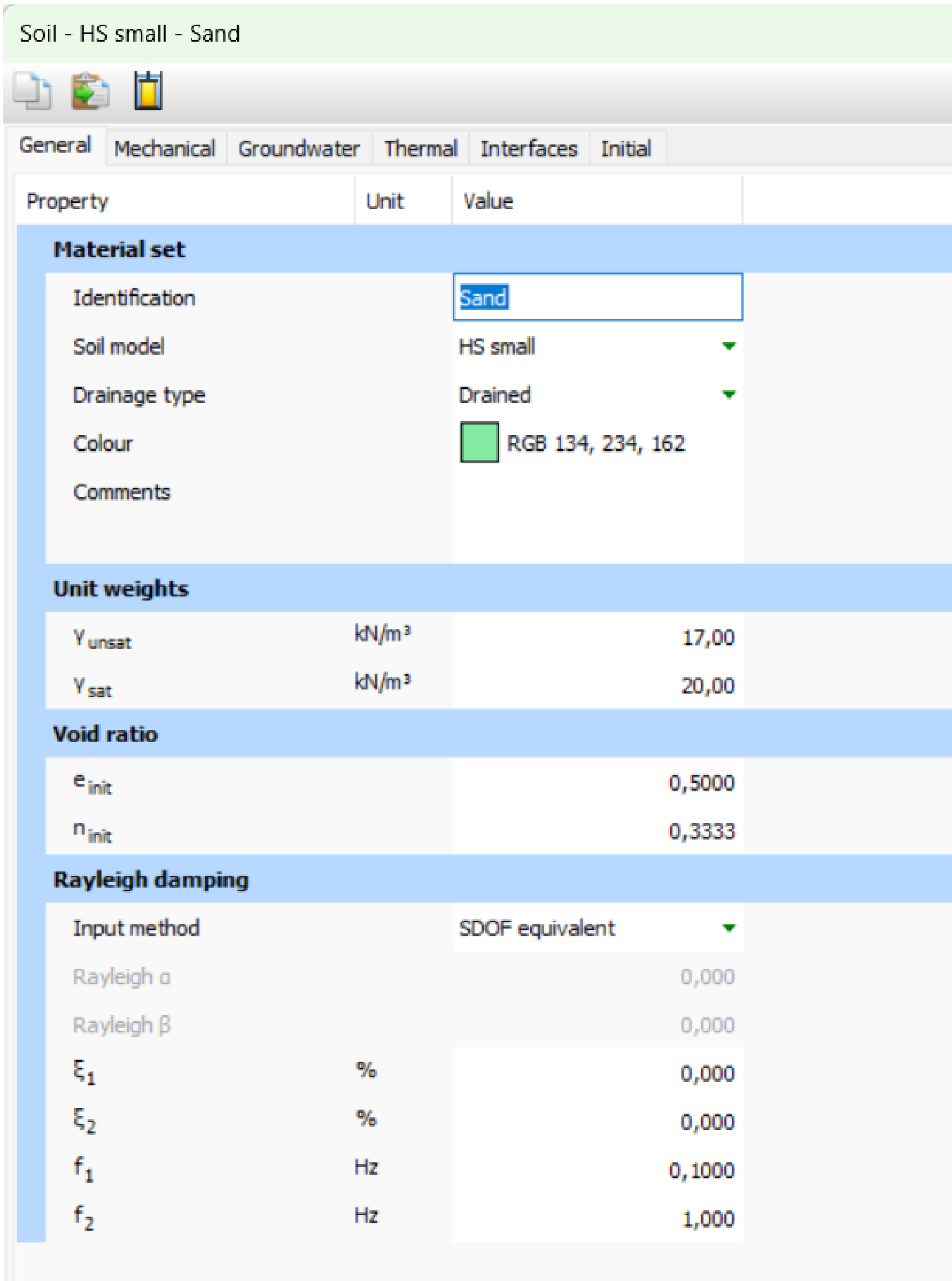
Vedlegg H – «Dry excavation»



Soil - HS small - Sand

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
Material set		
Identification		Sand
Soil model		HS small
Drainage type		Drained
Colour		RGB 134, 234, 162
Comments		
Unit weights		
γ_{unsat}	kN/m³	17,00
γ_{sat}	kN/m³	20,00
Void ratio		
e_{init}		0,5000
n_{init}		0,3333
Rayleigh damping		
Input method		SDOF equivalent
Rayleigh α		0,000
Rayleigh β		0,000
ξ_1	%	0,000
ξ_2	%	0,000
f_1	Hz	0,1000
f_2	Hz	1,000

s

Vedlegg H – «Dry excavation»

Soil - HS small - Sand

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
Stiffness		
$E_{50}{}^{ref}$	kN/m²	30,00E3
$E_{oed}{}^{ref}$	kN/m²	30,00E3
$E_{ur}{}^{ref}$	kN/m²	90,00E3
ν_{ur}		0,2000
Alternatives		
Use alternatives		☐
C_c		0,01151
C_s		7,850E-3
e_{init}		0,5000
Stress-dependency		
power (m)		0,5000
p_{ref}	kN/m²	100,0
Small-strain		
$G_0{}^{ref}$	kN/m²	260,0E3
$\gamma_{0.7}$		0,2000E-3
Strength		
Shear		
c'_{ref}	kN/m²	4,000
φ' (phi)	°	34,00
ψ (psi)	°	4,000
Depth-dependency		
c'_{inc}	kN/m²/m	0,000

t

Vedlegg H – «Dry excavation»

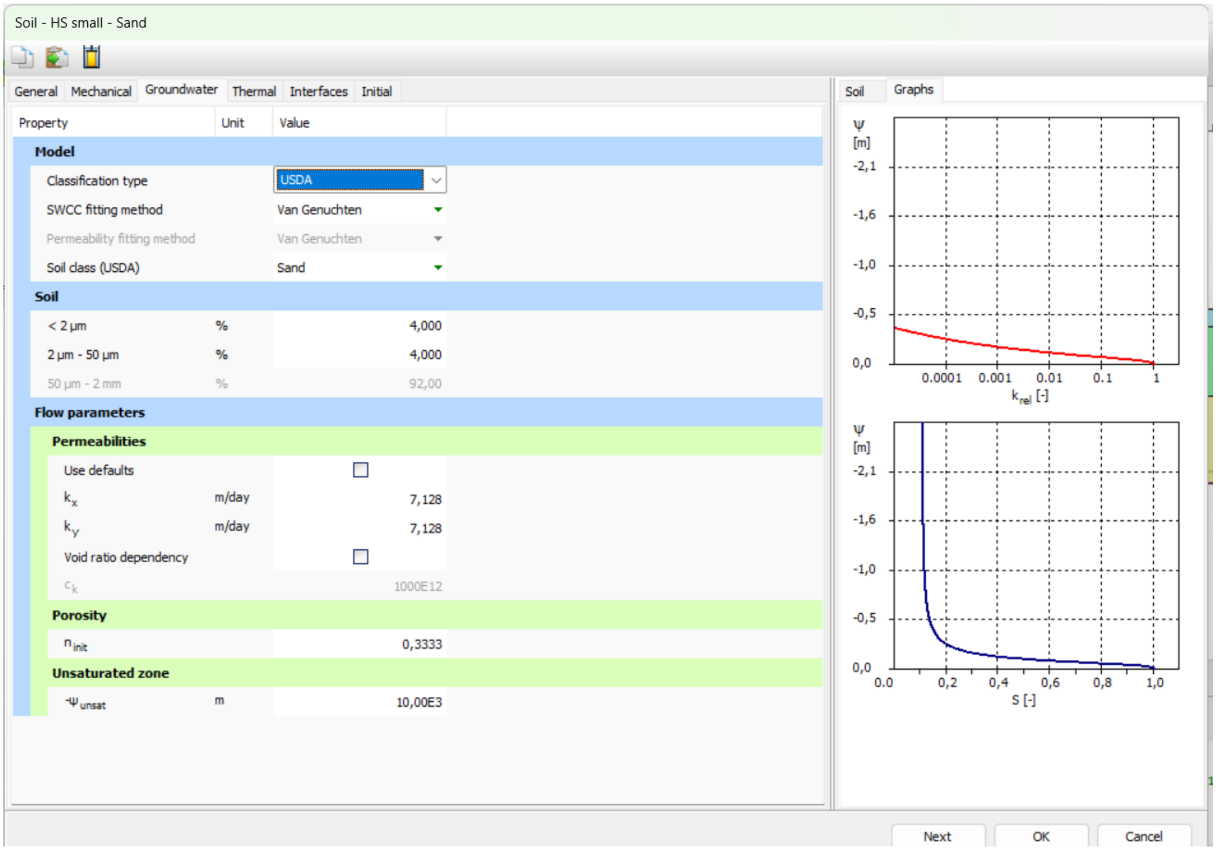
Soil - HS small - Sand

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

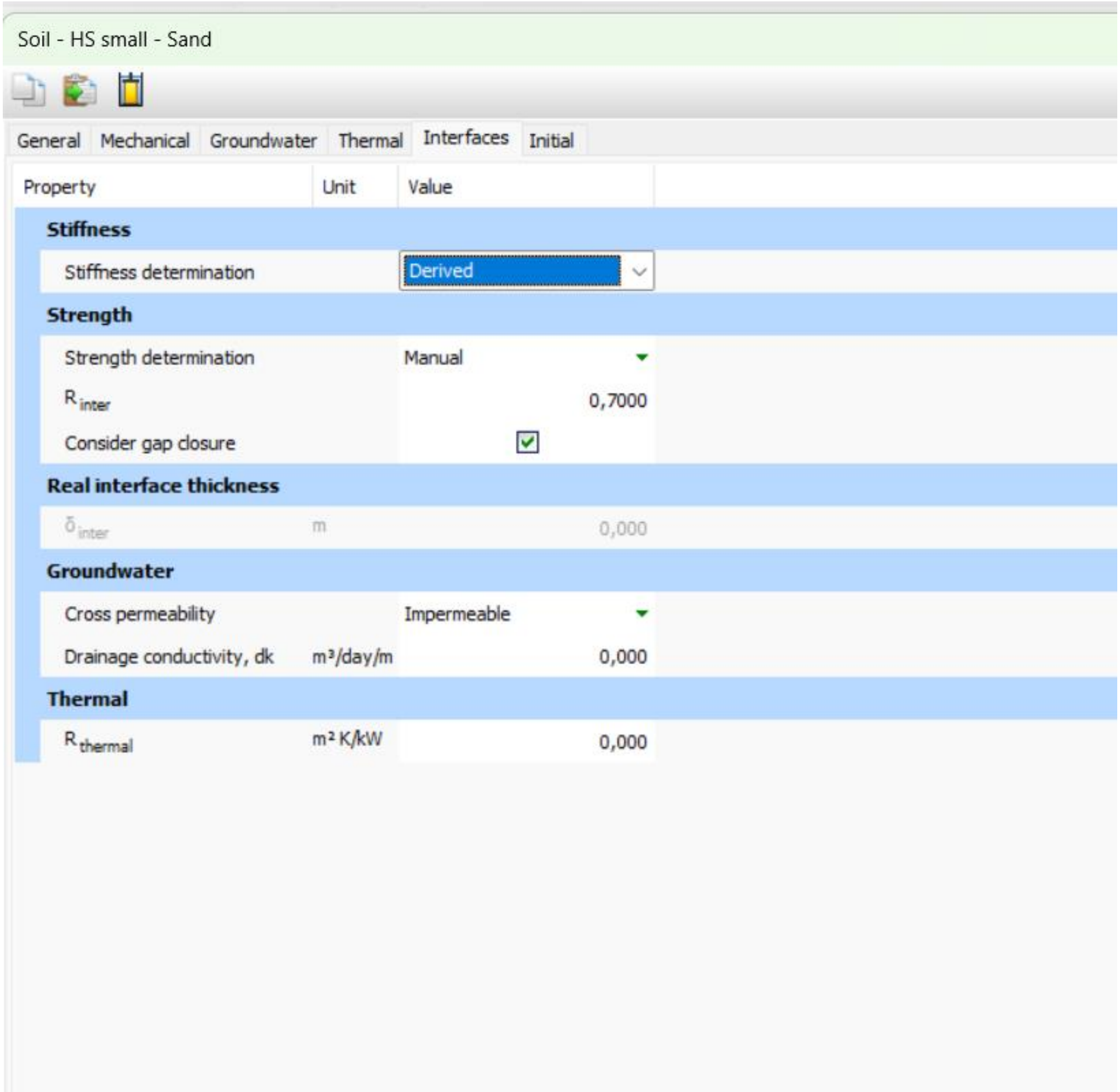
Property	Unit	Value
c'_{ref}	kN/m²	4,000
φ' (phi)	°	34,00
ψ (psi)	°	4,000
Depth-dependency		
c'_{inc}	kN/m²/m	0,000
y_{ref}	m	0,000
Dilatancy cut-off		
Dilatancy cut-off		☐
e_{min}		1,000E-9
e_{max}		999,0
Tension		
Tension cut-off		☑
Tensile strength	kN/m²	0,000
Miscellaneous		
Use defaults		☐
K_0^{nc}		0,4400
R_f		0,9000
Excess pore pressure calcula		
Determination		ν-undrained definition
ν_u definition method		Direct
$\nu_{u,equivalent}$ (nu)		0,4950
Skempton B		0,9866
$K_{w,ref}/n$	kN/m²	3,687E6

u

Vedlegg H – «Dry excavation»



Vedlegg H – «Dry excavation»



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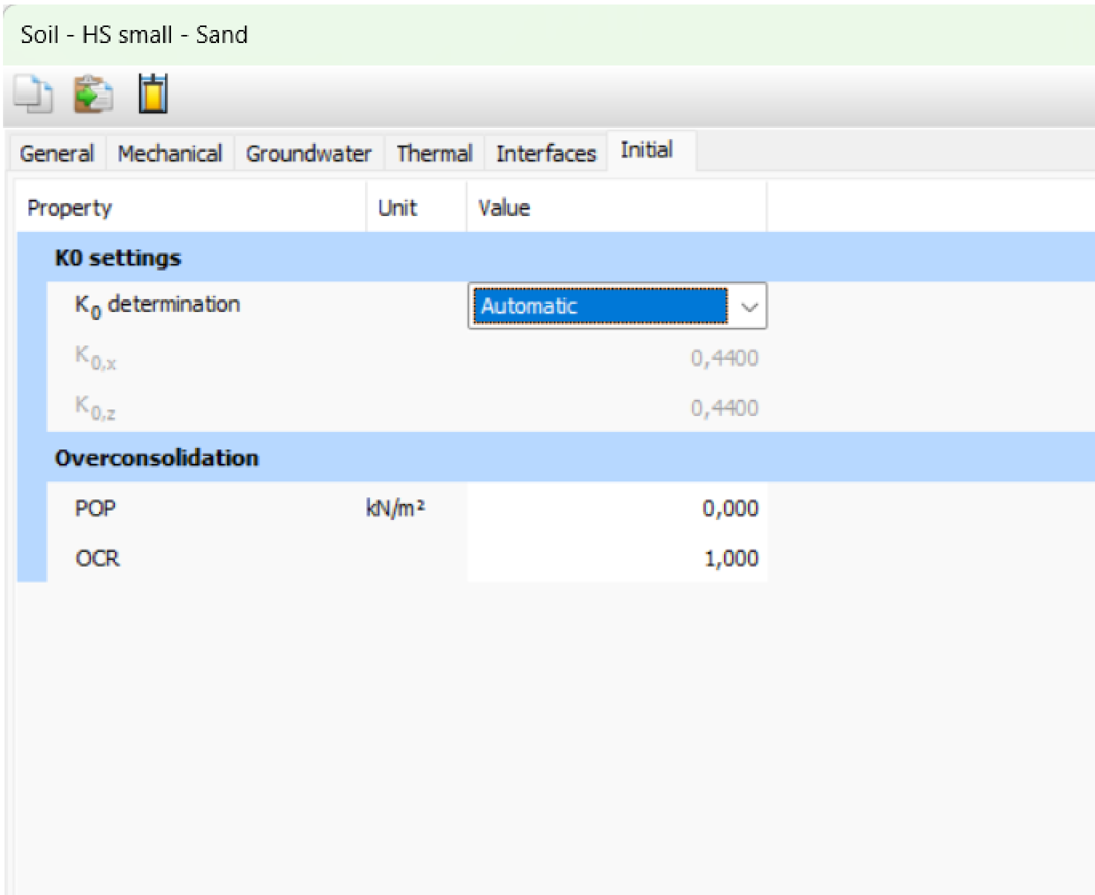
Vedlegg H – «Dry excavation»



Vedlegg H – «Dry excavation»

Soil - HS small - Silt

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
Material set		
Identification		Silt
Soil model		HS small
Drainage type		Drained
Colour		RGB 161, 226, 232
Comments		
Unit weights		
γ_{unsat}	kN/m³	16,00
γ_{sat}	kN/m³	20,00
Void ratio		
e_{init}		0,5000
n_{init}		0,3333
Rayleigh damping		
Input method		SDOF equivalent
Rayleigh α		0,000
Rayleigh β		0,000
ξ_1	%	0,000
ξ_2	%	0,000
f_1	Hz	0,1000
f_2	Hz	1,000

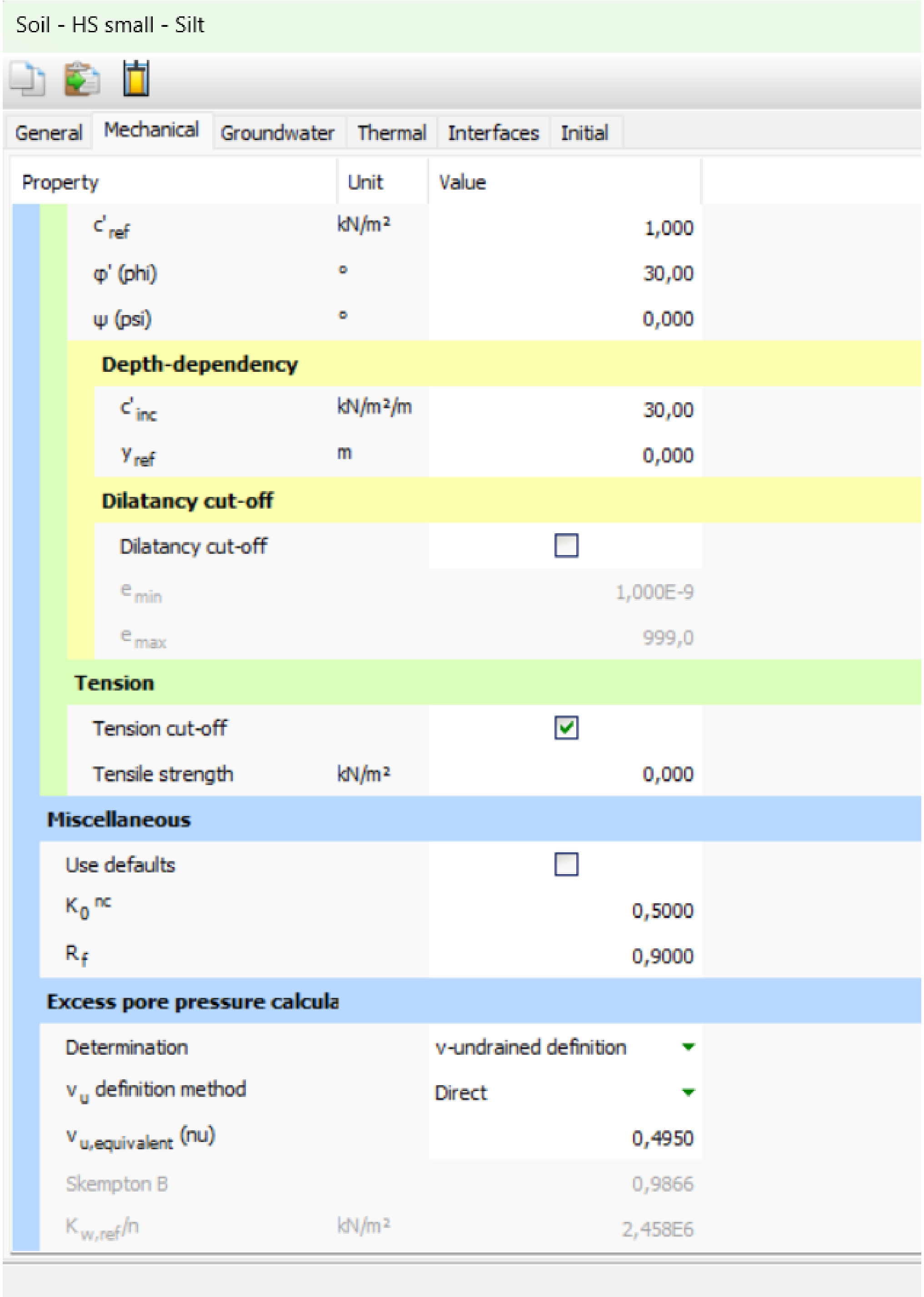
Vedlegg H – «Dry excavation»

Soil - HS small - Silt

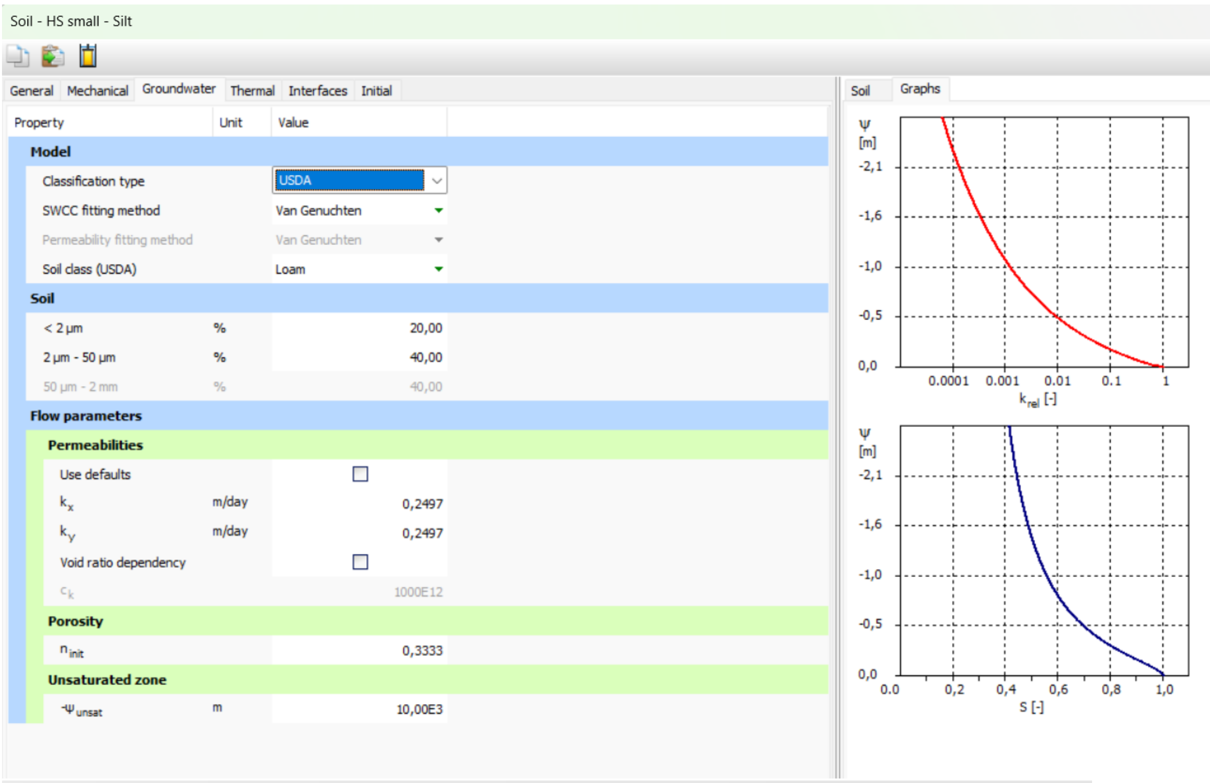
General | Mechanical | Groundwater | Thermal | Interfaces | Initial

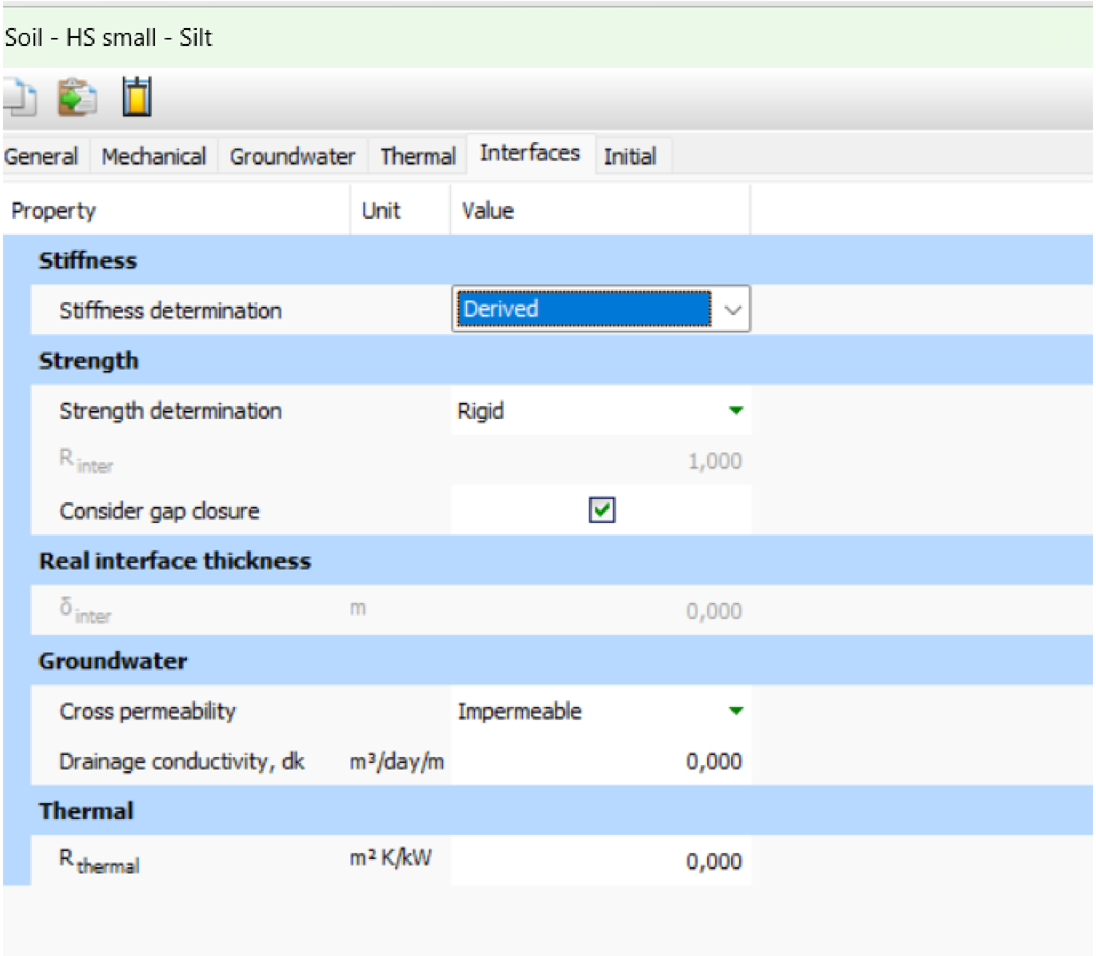
Property	Unit	Value
Stiffness		
E_{50}^{ref}	kN/m²	20,00E3
E_{oed}^{ref}	kN/m²	20,00E3
E_{ur}^{ref}	kN/m²	60,00E3
ν_{ur}		0,2000
Alternatives		
Use alternatives		☐
C_c		0,01727
C_s		0,01036
e_{init}		0,5000
Stress-dependency		
power (m)		0,5000
p_{ref}	kN/m²	100,0
Small-strain		
G_0^{ref}	kN/m²	170,0E3
$\gamma_{0.7}$		2,000E-3
Strength		
Shear		
c'_{ref}	kN/m²	1,000
φ' (phi)	°	30,00
ψ (psi)	°	0,000
Depth-dependency		
c'_{inc}	kN/m²/m	30,00

Vedlegg H – «Dry excavation»



Vedlegg H – «Dry excavation»





Vedlegg H – «Dry excavation»

Soil - HS small - Silt

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
K0 settings		
K_0 determination		Automatic
Overconsolidation		
POP	kN/m²	25,00
OCR		1,000

Plate - diaphgragm wall

General | Mechanical | Thermal

Property	Unit	Value
Material set		
Identification		diaphgragm wall
Material type		Elastic
Colour		RGB 0, 0, 255
Comments		
Unit weights		
w	kN/m/m	8,300
Rayleigh damping		
Input method		Direct
Rayleigh α		0,2323
Rayleigh β		8,000E-3
Advanced		
Prevent punching		☐

Vedlegg H – «Dry excavation»

Plate - diaphgragm wall

General | Mechanical | Thermal

Property	Unit	Value
Properties		
Isotropic		☑
Stiffness		
EA_1	kN/m	12,00E6
EA_2	kN/m	12,00E6
E_1	kN/m²	34,64E6
E_2	kN/m²	34,64E6
EI	kN m²/m	120,0E3
ν (nu)		0,1500
d	m	0,3464

Vedlegg H – «Dry excavation»

Embedded beam - grout body

General | Mechanical

Property	Unit	Value
Material set		
Identification		grout body
Material type		Elastic
Colour		RGB 199, 82, 143
Comments		
Unit weights		
γ	kN/m³	0,000
Rayleigh damping		
Input method		SDOF equivalent
Rayleigh α		0,000
Rayleigh β		0,000
ξ_1	%	0,000
ξ_2	%	0,000
f_1	Hz	0,1000
f_2	Hz	1,000

Vedlegg H – «Dry excavation»

Embedded beam - grout body

General | Mechanical

Property	Unit	Value
Properties		
$L_{spacing}$	m	2,500
Cross section type		Predefined
Predefined cross section type		Solid circular beam
Diameter	m	0,3000
A	m^2	0,07069
I	m^4	0,3976E-3
Stiffness		
E	kN/m^2	7,070E6
Axial skin resistance		
Axial skin resistance		Linear
$T_{skin, start, max}$	kN/m	400,0
$T_{skin, end, max}$	kN/m	400,0
Lateral resistance		
Lateral resistance		Unlimited
Base resistance		
F_{max}	kN	0,000
Interface stiffness factor		
Default values		☑
Axial stiffness factor		0,5097
Lateral stiffness factor		0,5097
Base stiffness factor		5,097

Vedlegg H – «Dry excavation»

Anchor - Anchor rod

General | Mechanical | Thermal

Property	Unit	Value
Material set		
Identification		Anchor rod
Material type		Elastic
Colour		RGB 0, 0, 0
Comments		

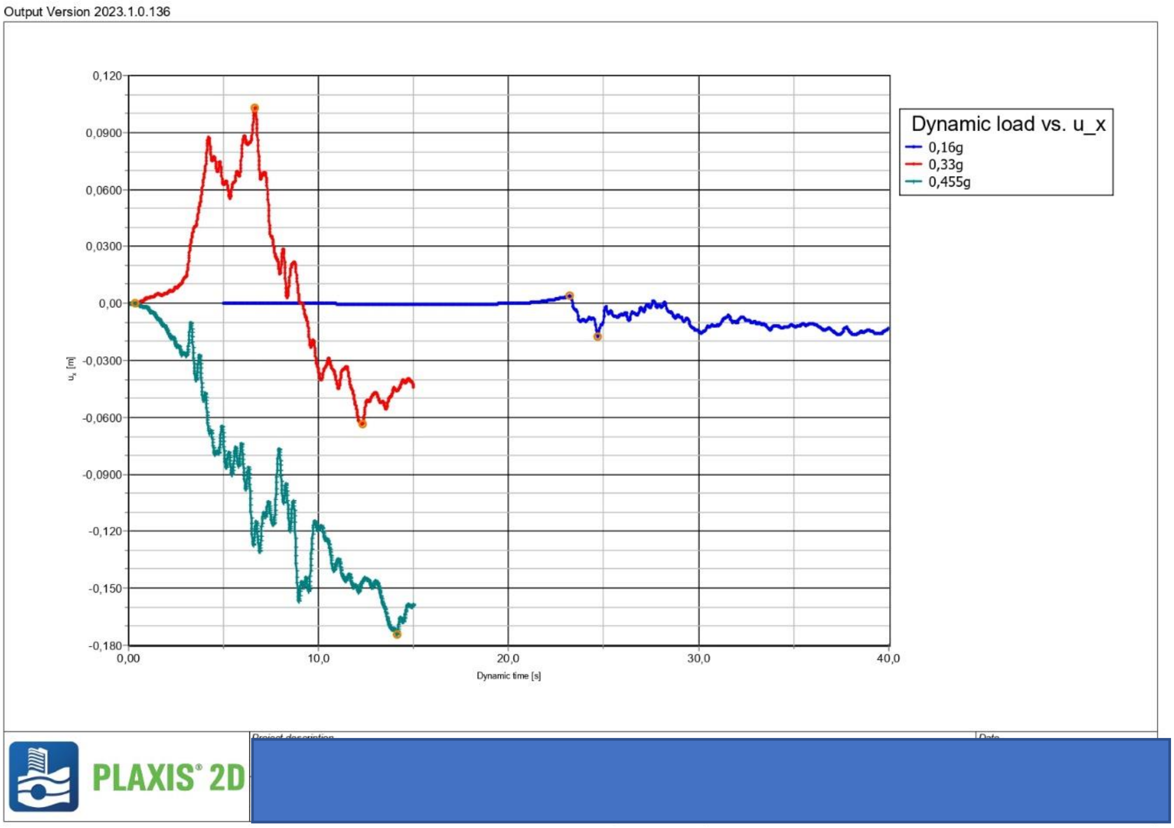
Anchor - Anchor rod

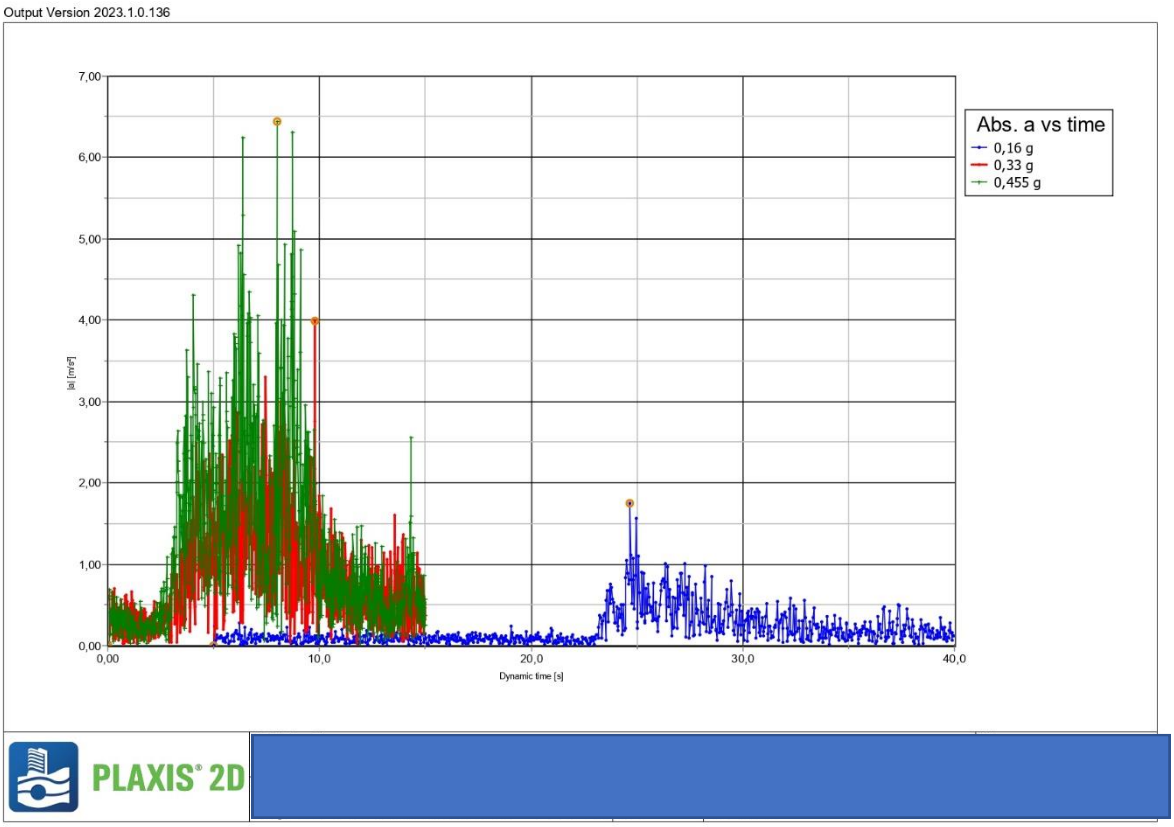
General | Mechanical | Thermal

Property	Unit	Value
Properties		
$L_{spacing}$	m	2,500
Stiffness		
EA	kN	500,0E3

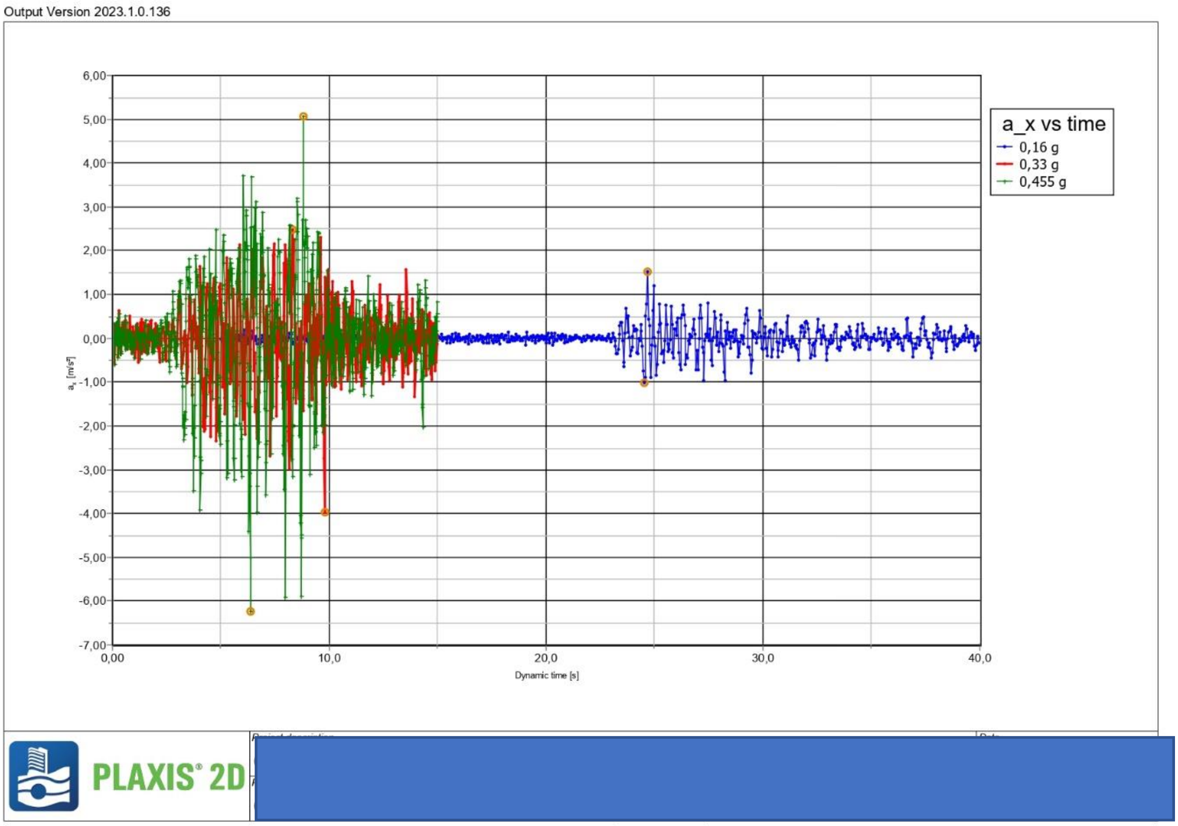
dd

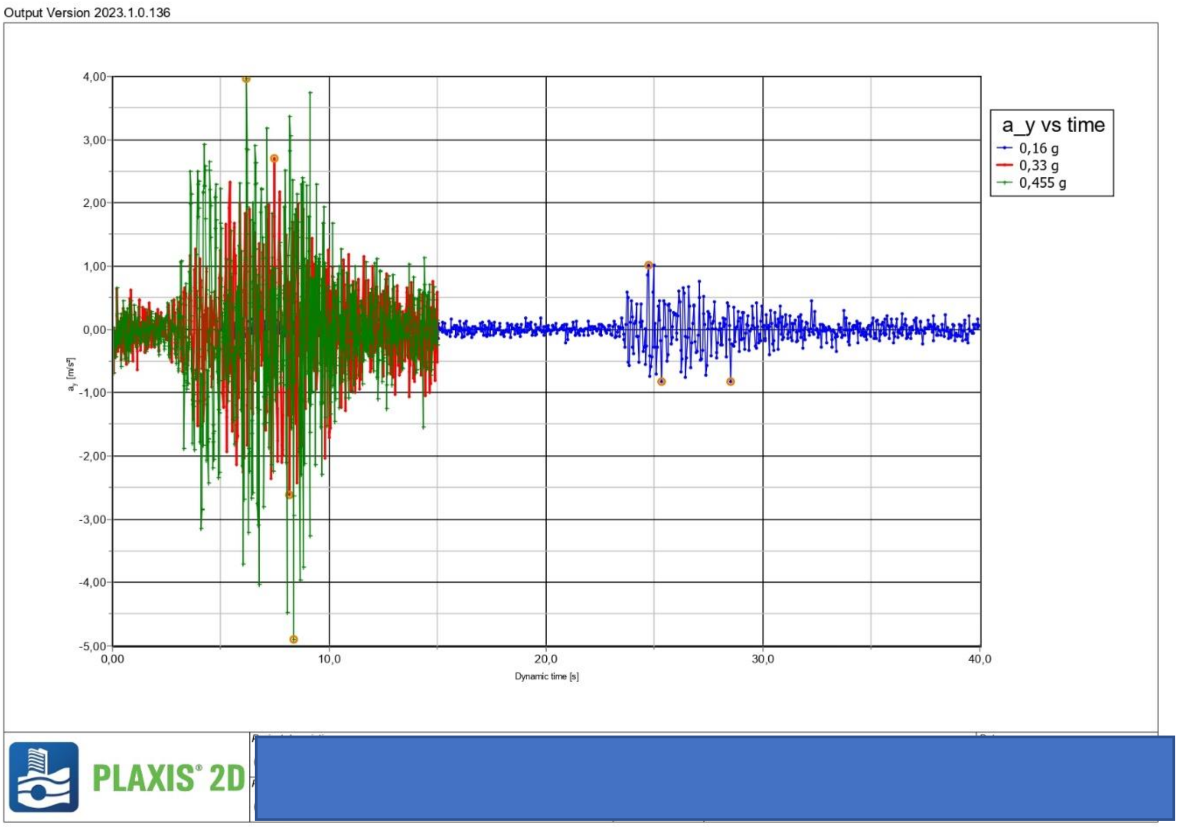
Vedlegg H – «Dry excavation»



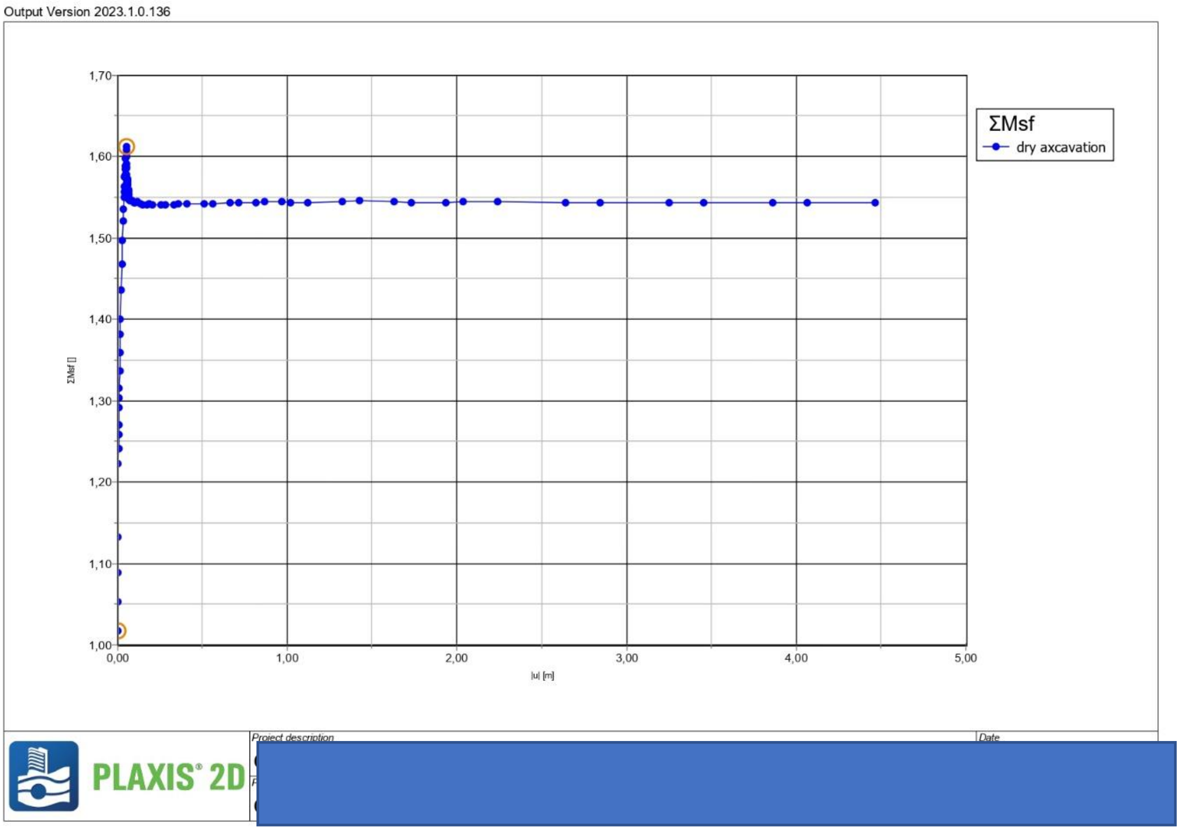


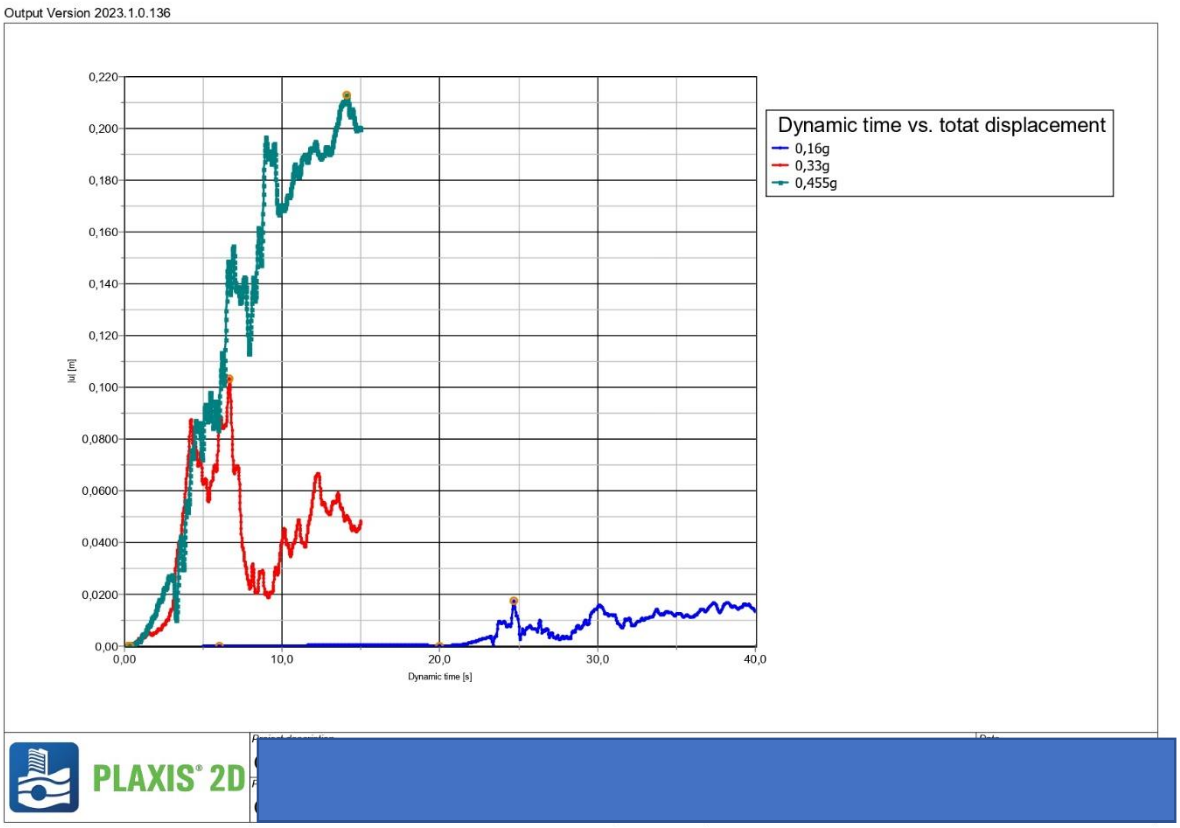
Vedlegg H – «Dry excavation»





Vedlegg H – «Dry excavation»





Vedlegg I – «Fill-Sand» modell

Soil - HS small - Dense sand

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
Material set		
Identification		Dense sand
Soil model		HS small
Drainage type		Drained
Colour		RGB 161, 226, 232
Comments		
Unit weights		
γ_{unsat}	kN/m³	17,00
γ_{sat}	kN/m³	20,00
Void ratio		
e_{init}		0,5000
n_{init}		0,3333
Rayleigh damping		
Input method		SDOF equivalent
Rayleigh α		0,000
Rayleigh β		0,000
ξ_1	%	0,000
ξ_2	%	0,000
f_1	Hz	0,000
f_2	Hz	0,000

hh

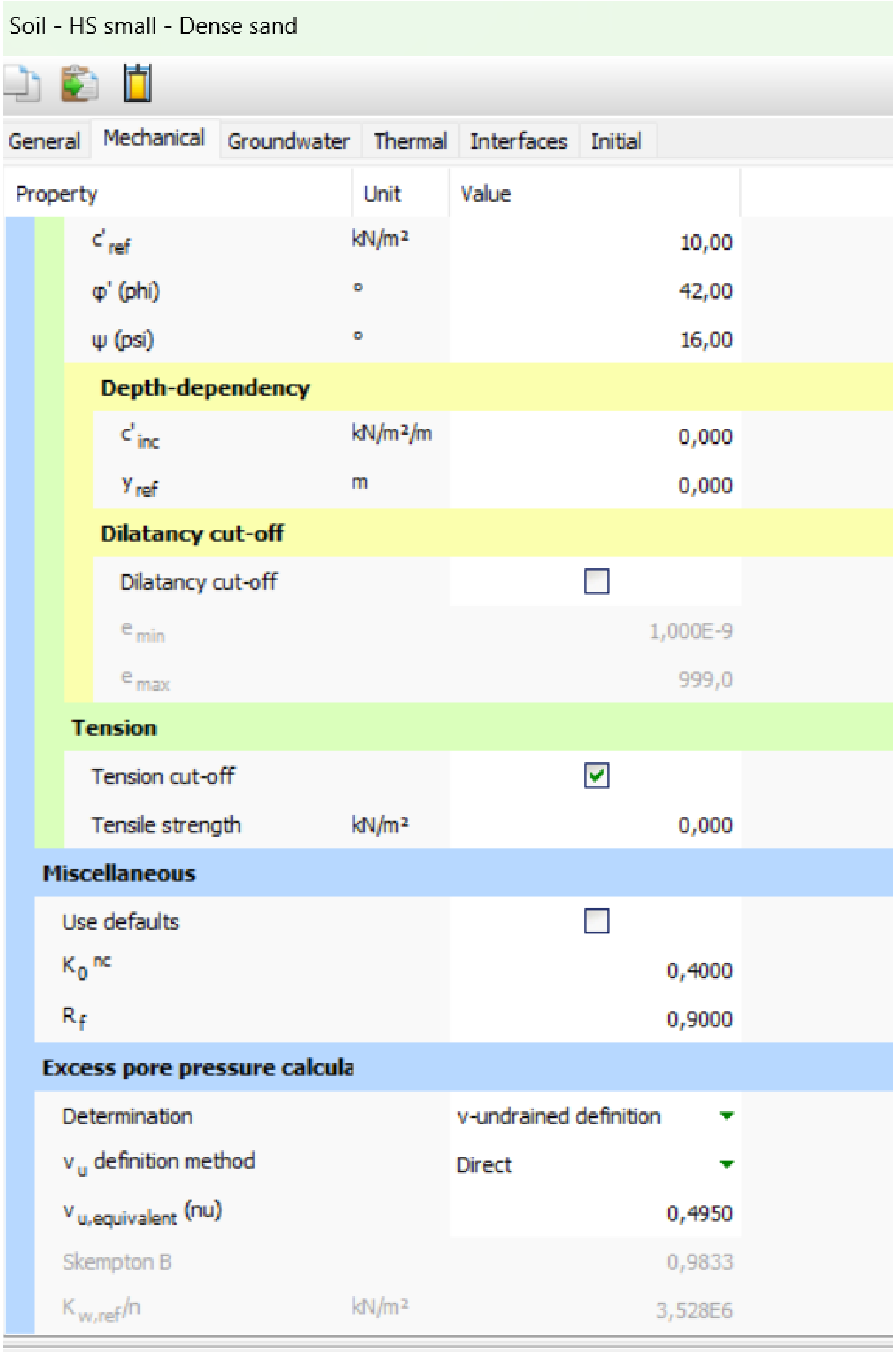
Vedlegg I – «Fill-Sand» modell

Soil - HS small - Dense sand

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
Stiffness		
E_{50}^{ref}	kN/m²	30,00E3
E_{oed}^{ref}	kN/m²	30,00E3
E_{ur}^{ref}	kN/m²	90,00E3
ν_{ur}		0,2500
Alternatives		
Use alternatives		☐
C_c		0,01151
C_s		7,995E-3
e_{init}		0,5000
Stress-dependency		
power (m)		1,000
p_{ref}	kN/m²	100,0
Small-strain		
G_0^{ref}	kN/m²	270,0E3
$\gamma_{0.7}$		0,2000E-3
Strength		
Shear		
c'_{ref}	kN/m²	10,00
φ' (phi)	°	42,00
ψ (psi)	°	16,00
Depth-dependency		
c'_{inc}	kN/m²/m	0,000

Vedlegg I – «Fill-Sand» modell



Soil - HS small - Dense sand

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
c'_{ref}	kN/m²	10,00
φ' (phi)	°	42,00
ψ (psi)	°	16,00
Depth-dependency		
c'_{inc}	kN/m²/m	0,000
y_{ref}	m	0,000
Dilatancy cut-off		
Dilatancy cut-off		☐
e_{min}		1,000E-9
e_{max}		999,0
Tension		
Tension cut-off		☑
Tensile strength	kN/m²	0,000
Miscellaneous		
Use defaults		☐
K_0^{nc}		0,4000
R_f		0,9000
Excess pore pressure calcula		
Determination		ν-undrained definition
ν_u definition method		Direct
$\nu_{u,equivalent}$ (nu)		0,4950
Skempton B		0,9833
$K_{w,ref}/n$	kN/m²	3,528E6

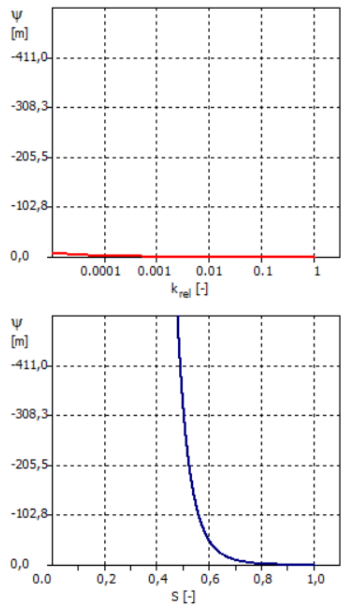
Vedlegg I – «Fill-Sand» modell

Soil - HS small - Dense sand

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
Model		
Classification type		Standard
Soil class (Standard)		Fine
Soil		
< 2 µm	%	46,00
2 µm - 50 µm	%	26,00
50 µm - 2 mm	%	28,00
Flow parameters		
Permeabilities		
Use defaults		☑
Defaults method		From data set
k_x	m/day	0,2480
k_y	m/day	0,2480
Void ratio dependency		☐
c_k		1000E12
Porosity		
n_{init}		0,3333
Unsaturated zone		
$-\Psi_{unsat}$	m	10,00E3

Soil | Graphs

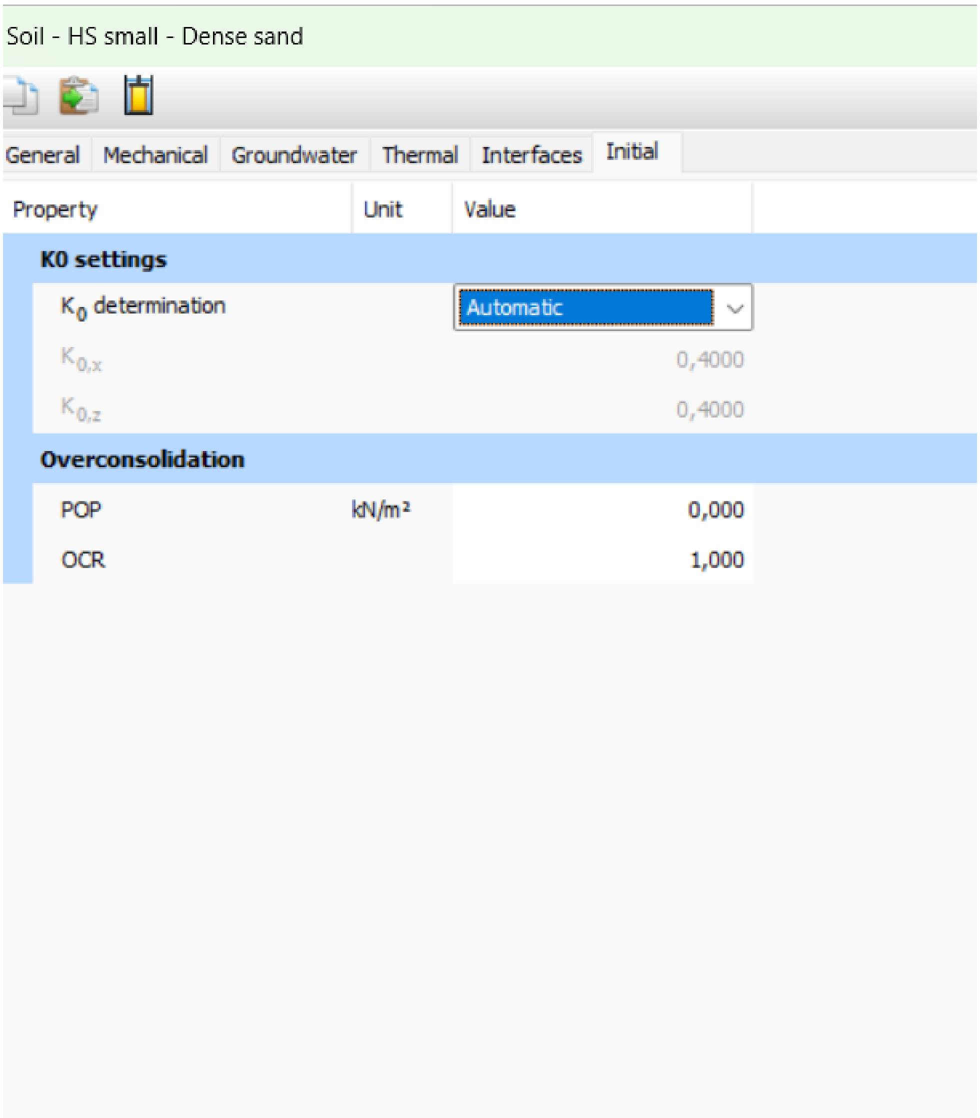


Soil - HS small - Dense sand

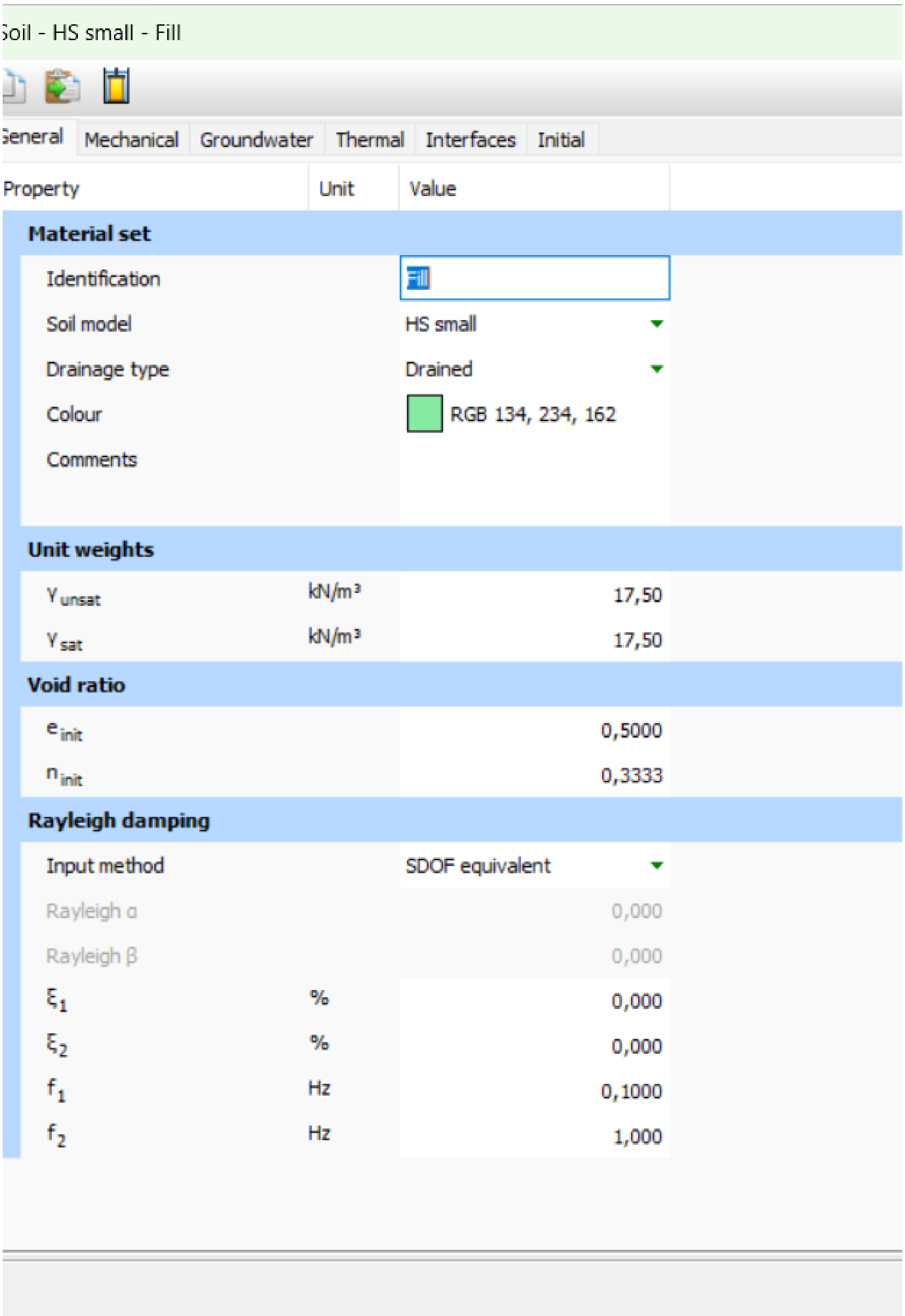
General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
Stiffness		
Stiffness determination		Derived
Strength		
Strength determination		Manual
R_{inter}		0,7000
Consider gap closure		☑
Real interface thickness		
δ_{inter}	m	0,000
Groundwater		
Cross permeability		Impermeable
Drainage conductivity, dk	m³/day/m	0,000
Thermal		
$R_{thermal}$	m² K/kW	0,000

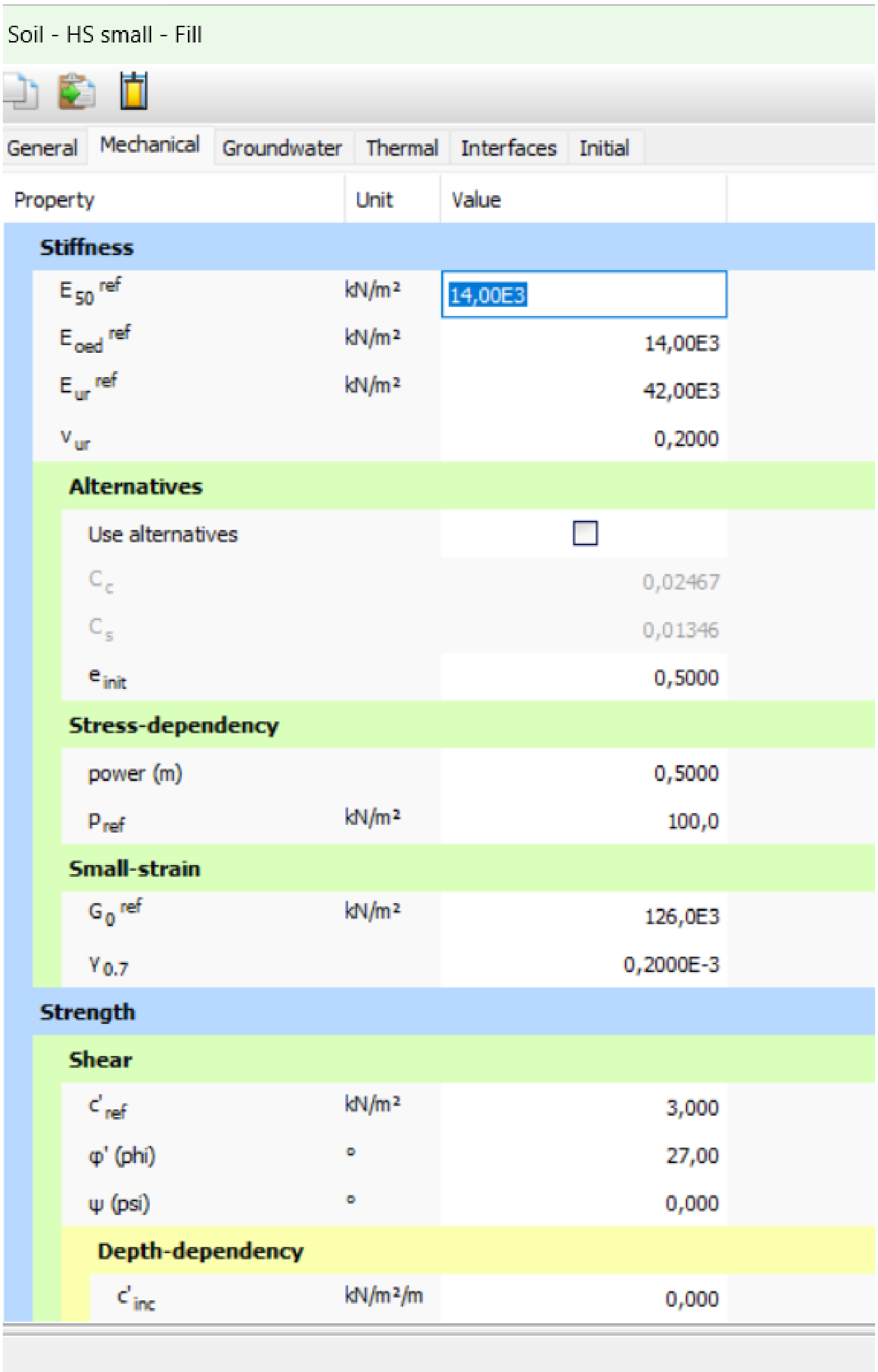
Vedlegg I – «Fill-Sand» modell



Vedlegg I – «Fill-Sand» modell



Vedlegg I – «Fill-Sand» modell



Soil - HS small - Fill

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
Stiffness		
$E_{50}{}^{ref}$	kN/m²	14,00E3
$E_{oed}{}^{ref}$	kN/m²	14,00E3
$E_{ur}{}^{ref}$	kN/m²	42,00E3
ν_{ur}		0,2000
Alternatives		
Use alternatives		☐
C_c		0,02467
C_s		0,01346
e_{init}		0,5000
Stress-dependency		
power (m)		0,5000
p_{ref}	kN/m²	100,0
Small-strain		
$G_0{}^{ref}$	kN/m²	126,0E3
$\gamma_{0.7}$		0,2000E-3
Strength		
Shear		
c'_{ref}	kN/m²	3,000
φ' (phi)	°	27,00
ψ (psi)	°	0,000
Depth-dependency		
c'_{inc}	kN/m²/m	0,000

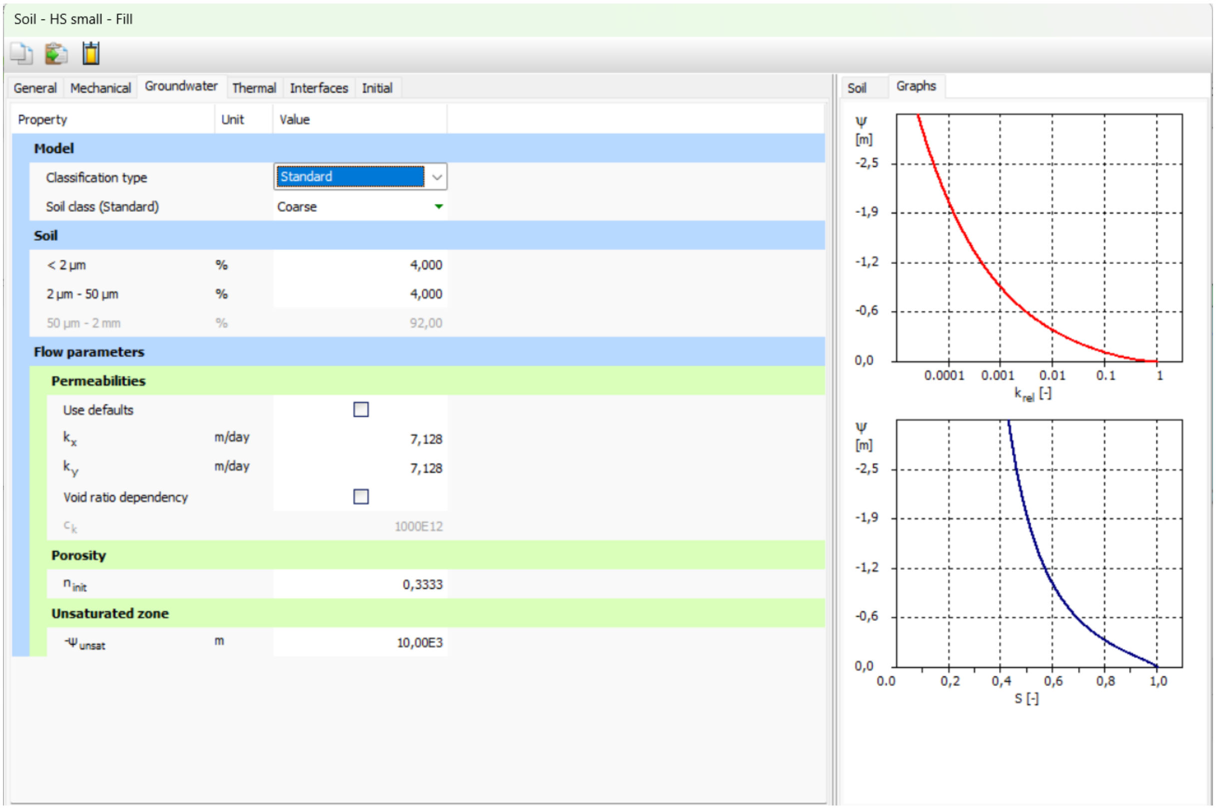
Vedlegg I – «Fill-Sand» modell

Soil - HS small - Fill

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
c'_{ref}	kN/m²	3,000
φ' (phi)	°	27,00
ψ (psi)	°	0,000
Depth-dependency		
c'_{inc}	kN/m²/m	0,000
y_{ref}	m	0,000
Dilatancy cut-off		
Dilatancy cut-off		☐
e_{min}		1,000E-9
e_{max}		999,0
Tension		
Tension cut-off		☑
Tensile strength	kN/m²	0,000
Miscellaneous		
Use defaults		☐
K_0^{nc}		0,5500
R_f		0,9000
Excess pore pressure calcula		
Determination		v-undrained definition
v_u definition method		Direct
$v_{u,equivalent}$ (nu)		0,4950
Skempton B		0,9866
$K_{w,ref}/n$	kN/m²	1,721E6

Vedlegg I – «Fill-Sand» modell



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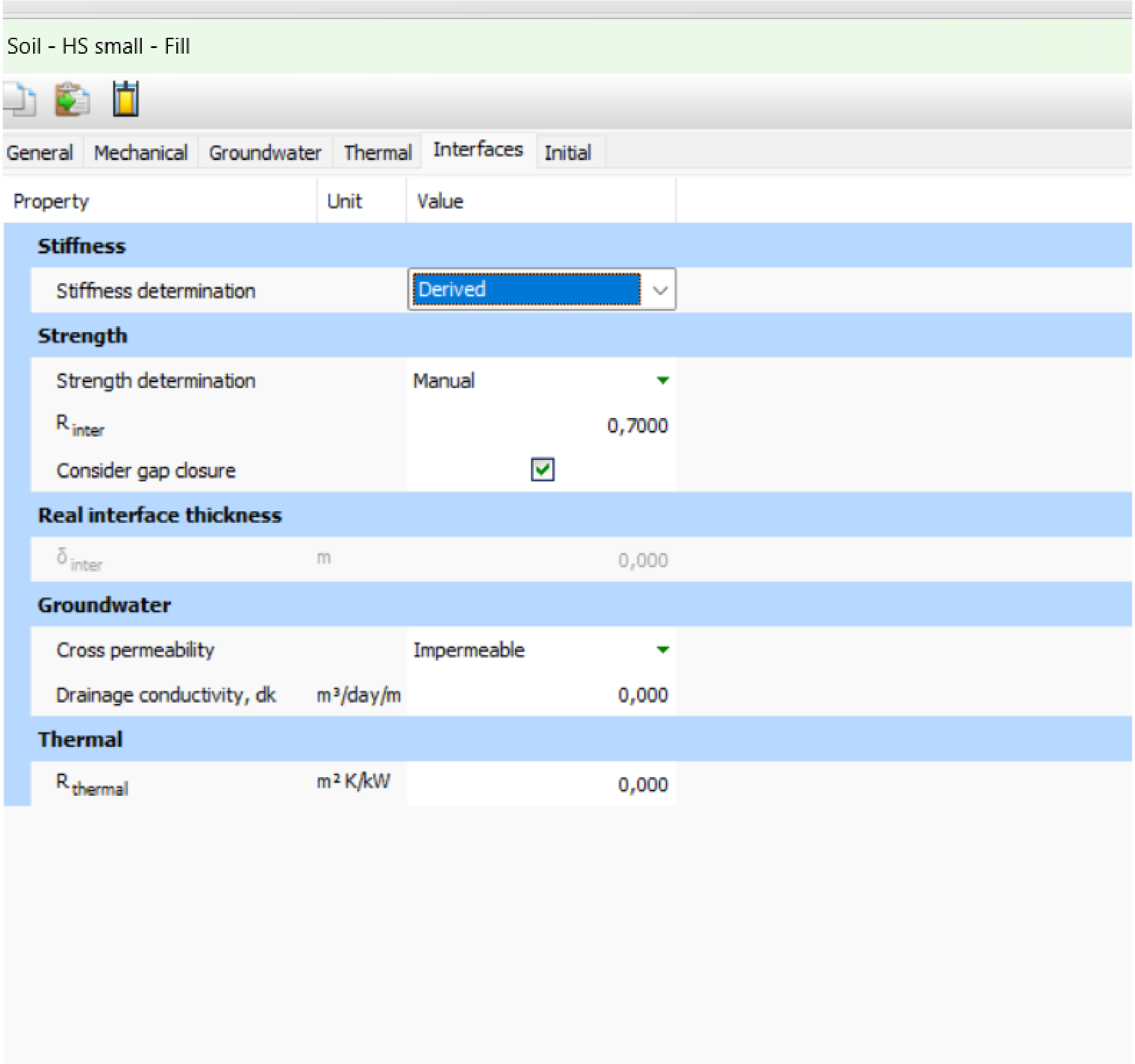
Vedlegg I – «Fill-Sand» modell


Soil - HS small - Fill

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
Stiffness		
Stiffness determination		Derived
Strength		
Strength determination		Manual
R_{inter}		0,7000
Consider gap closure		☑
Real interface thickness		
δ_{inter}	m	0,000
Groundwater		
Cross permeability		Impermeable
Drainage conductivity, dk	m³/day/m	0,000
Thermal		
$R_{thermal}$	m² K/kW	0,000

Vedlegg I – «Fill-Sand» modell

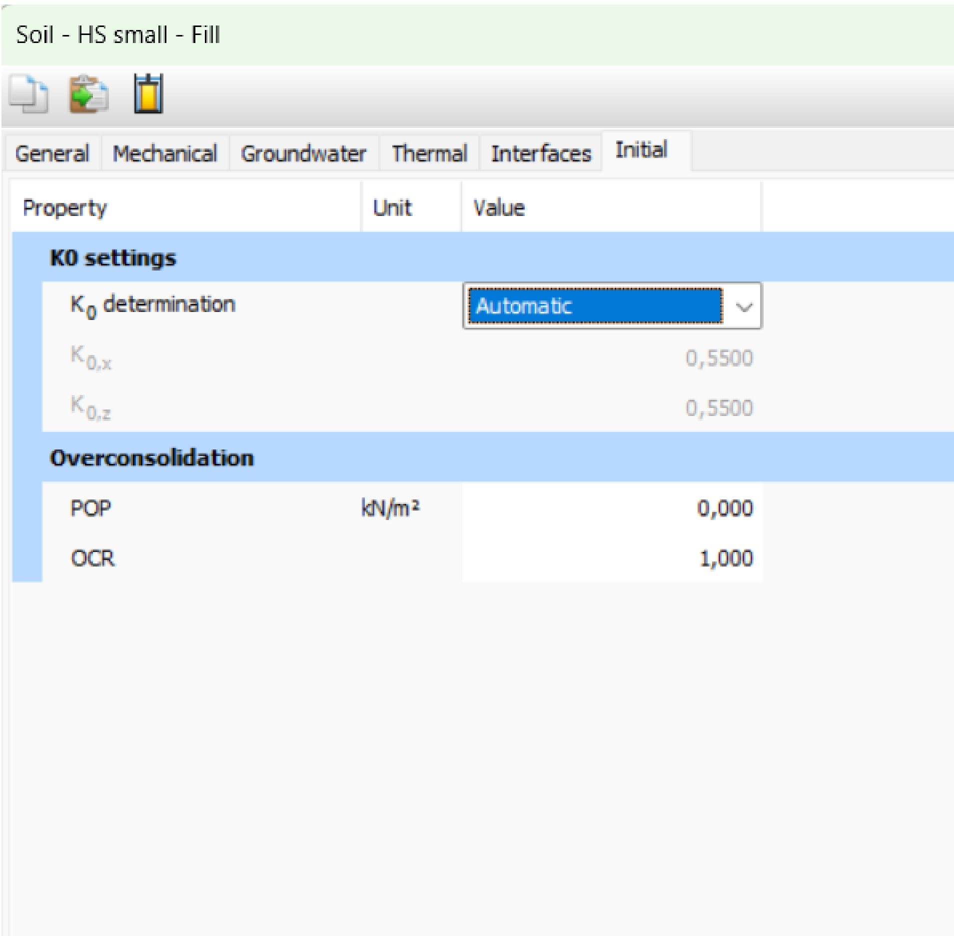


Plate - PZ40

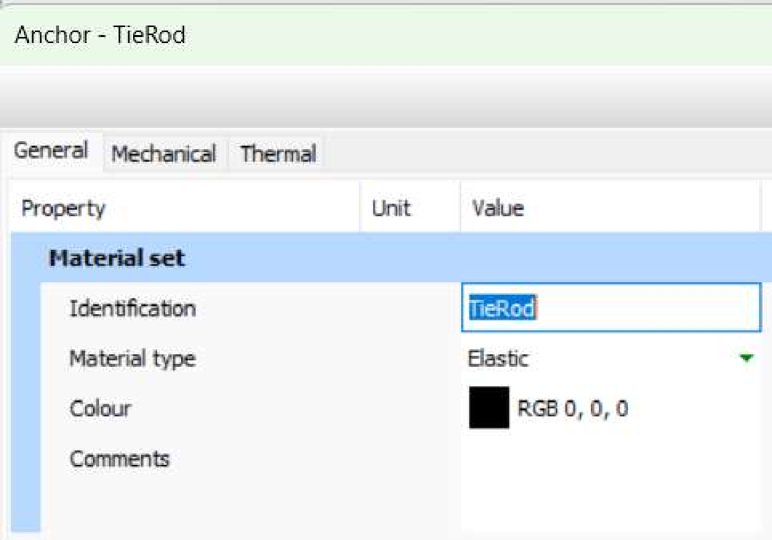
General | Mechanical | Thermal

Property	Unit	Value
Material set		
Identification		PZ40
Material type		Elastic
Colour		RGB 0, 0, 255
Comments		
Unit weights		
w	kN/m/m	2,870
Rayleigh damping		
Input method		Direct
Rayleigh α		0,2320
Rayleigh β		8,000E-3
Advanced		
Prevent punching		✓

Plate - PZ40

General | Mechanical | Thermal

Property	Unit	Value
Properties		
Isotropic		☑
Stiffness		
EA_1	kN/m	508,4
EA_2	kN/m	508,4
E_1	kN/m²	9,040
E_2	kN/m²	9,040
EI	kN m²/m	134,0E3
ν (nu)		0,3000
d	m	56,24



Anchor - TieRod
General
Mechanical
Thermal
Property
Unit
Value
Material set
Identification
TieRod
Material type
Elastic
Colour
RGB 0, 0, 0
Comments

Anchor - TieRod

General | Mechanical | Thermal

Property	Unit	Value
Properties		
$L_{spacing}$	m	2,200
Stiffness		
EA	kN	2,262E6

ASDO TIE BAR DESIGN CAPACITIES

ASDO tie bars can be supplied in two grades of carbon steel and stainless steel.
All components are designed to exceed the capacity of the bar.

Table 1 - ASDO grade

		ASDO350-S	ASDO540-S					ASDOE600-S	
Nominal thread size		M100 - M130	M12	M16-42	M45-85	M90 - M100	M105 - M160*	M12 - M42	M48 - M56
f_y	[N/mm²]	355	355	540	540	520	630	600	460
f_{ua}	[N/mm²]	510	510	700	700	700	710	800	650

Minimum elongation for all grades 17%; Minimum charpy for all grades 27J @ -20 °C; ASDO350-S M140-M160 differ from above, refer to table 3 for design resistance
*ASDO540-S bars M105-M160 are quench and tempered and should not be galvanised

Table 2 - Standard stock bar lengths

Nominal thread size		ASDO350-S	ASDO540-S	ASDOE600-S
M16-M42	m	-	12	6
M45-M100	m	-	16	6
M105-M160	m	16	12	-

For longer system lengths bars are connected using couplers or turnbuckles.
M12 available in 6m lengths only.

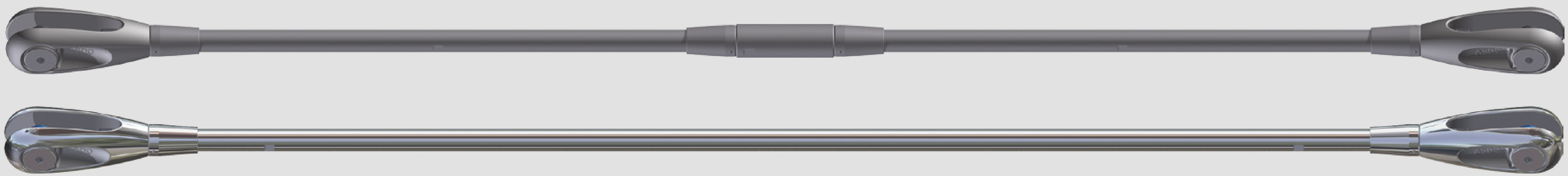


Table 3 - Carbon steel

	Nominal thread size			M12	M16	M20	M24	M27	M30	M36	M42	M45	M48	M52	M56	M60	M64
Dimensional data	Nominal shaft size		mm	12	16	20	24	27	30	36	42	45	48	52	56	60	64
	Shaft area, A_g		mm²	113	201	314	452	573	707	1,018	1,385	1,590	1,810	2,124	2,463	2,827	3,217
	Thread pitch		mm	1.75	2	2.5	3	3	3.5	4	4.5	4.5	5	5	5.5	5.5	6
	Thread stress area, A_s		mm²	84	157	245	353	459	561	817	1,121	1,306	1,473	1,758	2,030	2,362	2,676
	Weight per metre (bar)		kg/m	0.9	1.6	2.5	3.6	4.5	5.5	8.0	10.9	12.5	14.2	16.7	19.3	22.2	25.3
Load capacities	ASDO350-S	Yield	kN	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Ultimate	kN	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ASDO540-S	Yield	kN	30	85	132	190	248	303	441	605	705	795	949	1,096	1,275	1,445
		Ultimate	kN	43	110	171	247	322	392	572	785	914	1,031	1,230	1,421	1,653	1,873
Design resistance[1]	ASDO350-S	$F_{t,Rd}$	kN	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ASDO540-S	$F_{t,Rd}$	kN	31	79	123	178	232	283	412	565	658	742	886	1,023	1,190	1,349

	Nominal thread size			M68	M72	M76	M80	M85	M90	M95	M100	M105	M110	M115	M120	M130	M140	M150	M160
Dimensional data	Nominal shaft size		mm	68	72	76	80	85	90	95	100	105	110	115	120	130	140	150	160
	Shaft area, A_g		mm²	3,632	4,072	4,536	5,027	5,675	6,362	7,088	7,854	8,659	9,503	10,387	11,310	13,273	15,394	17,671	20,106
	Thread pitch		mm	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
	Thread stress area, A_s		mm²	3,055	3,460	3,889	4,344	4,948	5,591	6,273	6,995	7,755	8,556	9,395	10,274	12,149	14,181	16,370	18,716
	Weight per metre (bar)		kg/m	28.5	32.0	35.6	39.5	44.5	49.9	55.6	61.7	68.0	74.6	81.5	88.8	104.2	120.8	138.7	157.8
Load capacities	ASDO350-S	Yield	kN	-	-	-	-	-	-	-	2,483	2,753	3,037	3,335	3,647	4,313	4,183	4,829	5,334
		Ultimate	kN	-	-	-	-	-	-	-	3,567	3,955	4,363	4,791	5,240	6,196	6,665	7,694	8,422
	ASDO540-S	Yield	kN	1,650	1,868	2,100	2,346	2,672	2,907	3,262	3,637	4,886	5,390	5,919	6,472	7,654	8,934	10,313	11,791
		Ultimate	kN	2,139	2,422	2,723	3,041	3,463	3,914	4,391	4,896	5,506	6,074	6,670	7,294	8,626	10,068	11,623	13,289
Design resistance[1]	ASDO350-S	$F_{t,Rd}$	kN	-	-	-	-	-	-	-	2,535	2,795	3,067	3,352	3,650	4,284	4,128	4,739	5,209
	ASDO540-S	$F_{t,Rd}$	kN	1,540	1,744	1,960	2,189	2,494	2,818	3,162	3,525	3,965	4,374	4,803	5,252	6,210	7,249	8,368	9,568

Table 4 - Stainless steel

	Nominal thread size			M12	M16	M20	M24	M27	M30	M36	M42	M48	M56	M60+
Dimensional data	Nominal shaft size		mm	10.8	15	18	22	25	28	34	39	45	52	Larger diameters available at request
	Shaft area, A_g		mm²	92	177	254	380	491	616	908	1,195	1,590	2,124	
	Thread pitch		mm	1.75	2	2.5	3	3	3.5	4	4.5	5	5.5	
	Thread stress area, A_s		mm²	84	157	245	353	459	561	817	1,121	1,473	2,030	
	Weight per metre (bar)		kg/m	0.7	1.4	2.0	3.0	3.9	4.9	7.3	9.6	12.7	17.0	
Load capacities	ASDOE600-S	Yield	kN	51	94	147	212	276	336	490	673	678	934	
		Ultimate	kN	67	125	196	282	368	448	653	897	958	1,320	
Design resistance[1]		$F_{t,Rd}$	kN	47	87	136	195	255	311	453	621	656	900	

Notes for tables 3 & 4:
1. Design tensile resistance $F_{t,Rd} = \min\{f_y \times A_g / \gamma_{M0}; 0.9 \times f_{ua} \times A_s / \gamma_{M2}\}$ as per EN1993-1-8 with partial factors $\gamma_{M0} = 1.0$ & $\gamma_{M2} = 1.25$ for carbon steel and $\gamma_{M0} = 1.1$ & $\gamma_{M2} = 1.25$ for stainless steel according EN1993-1-4
2. For the full design resistance to be utilised connection plates must be fabricated from S355J2 to EN10025 (or equivalent) and to minimum dimensions given in table 5
3. All threads are cut threads and are not suitable for dynamic loads. Rolled threads with higher fatigue resistance can be made on request - please contact our technical department
4. For full design capacity threads must be engaged at least 1.2 x thread diameter, see installation guide page 17
5. Stainless steel bar grades M12-M42 are austenitic 1.4401/4, M48+ are duplex 1.4462.

Corrosion protection

ASDO systems can be supplied self colour or galvanised as standard. Sizes up to M42 are supplied with forks, pins, turnbuckles, couplers and thread-cover sleeves hot dip galvanized as standard. Note ASDO540-S bars M105-M160 are quench and tempered steel and therefore should not be galvanised.

Bar threads can be formed after galvanising or are re-machined to size following galvanizing; repairs to the zinc coating are made in accordance with DIN EN ISO 1461. Spanner flats on the tie-rods are pressed following hot galvanizing to prevent brittle fracture. Note, due to the nature of the galvanising process the visual finish of galvanised product is variable. If a high level of aesthetic finish is required systems should be subsequently painted after a suitable primer has been applied. ASDO tie bars cannot be supplied with 'top-coat' finishes, this should be applied by the customer. Please advise us before placing an order if bars are intended to be painted.

Please contact our technical department for more detail.

Self colour Galvanised Stainless

ASDO DIMENSIONAL DATA

The components shown are generic and the design of pins, couplers and turnbuckles may change dependent on bar diameter. Turnbuckles and couplers from M105 to M160 have a cross bore instead of spanner flats.

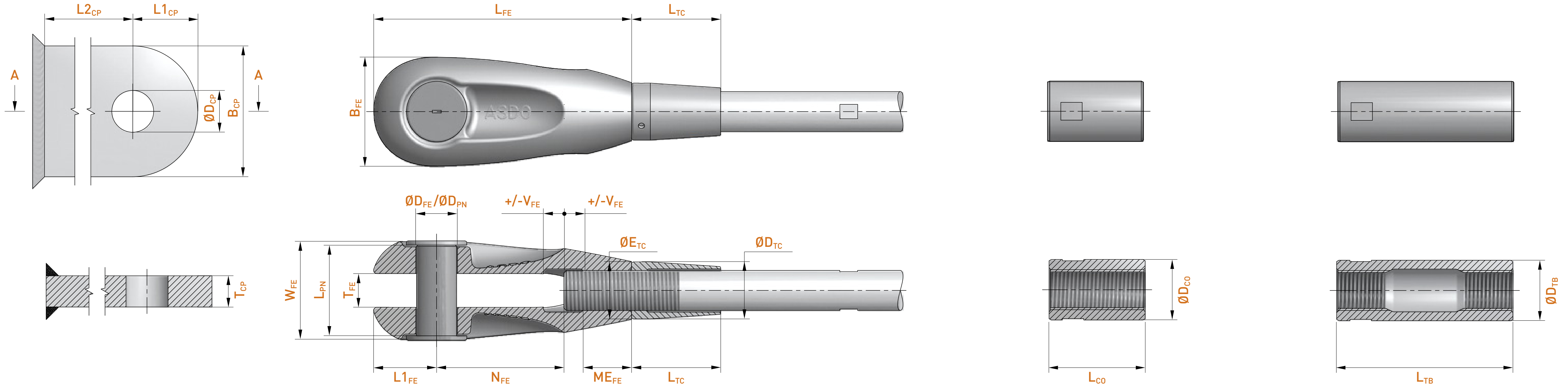
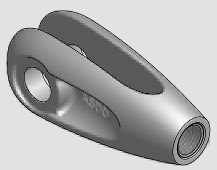
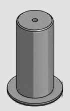


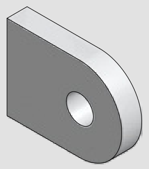
Table 5 - Dimensions for ASDO fittings - all grades (carbon and stainless)



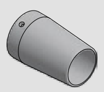
Nominal size		M12	M16	M20	M24	M27	M30	M36	M42	M45	M48	M52	M56	M60	M64	M68	M72	M76	M80	M85	M90	M95	M100	M105	M110	M115	M120	M130	M140	M150	M160
FE Fork end	L_{FE}	77	104	129	155	172	193	232	271	290	310	334	361	386	412	438	463	489	516	547	579	610	645	677	709	742	773	837	901	966	1,031
	B_{FE}	33	44	53	65	73	81	98	114	122	130	139	150	159	172	182	193	203	219	230	243	258	271	287	301	316	330	354	381	410	436
	W_{FE}	31	42	50	61	66	77	90	104	108	119	126	139	149	159	167	179	191	196	211	226	237	248	259	271	284	303	327	351	375	405
	T_{FE}	12	17	18	23	23	28	33	38	38	44	44	49	54	59	59	64	69	74	79	84	89	94	96	101	106	116	126	136	146	156
	$ØD_{FE}$	13	17	21	25	28	32	38	44	47	50	54	58	62	66	70	74	78	82	87	92	97	102	108	113	118	123	133	143	153	163
	$L1_{FE}$	19	26	31	38	42	47	57	66	71	76	81	88	93	100	106	112	119	128	133	140	150	160	167	175	184	191	207	222	239	255
	ME_{FE}	14	19	24	29	32	36	43	50	54	58	62	67	72	77	82	86	91	96	102	108	114	120	126	132	138	144	156	168	180	192
	N_{FE}	38	51	64	76	84	95	114	134	143	152	166	181	196	210	225	240	254	267	287	306	321	340	359	377	395	413	449	486	522	559
	$+/-V_{FE}$	6	8	10	12	13,5	15	18	21	23	24	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
	Weight [kg]	0.17	0.42	0.83	1.4	2.0	2.8	4.8	7.6	9.4	11	15	18	22	27	33	39	45	51	63	74	85	100	119	136	156	177	221	277	340	417



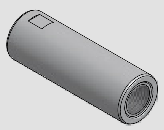
Nominal size		M12	M16	M20	M24	M27	M30	M36	M42	M45	M48	M52	M56	M60	M64	M68	M72	M76	M80	M85	M90	M95	M100	M105	M110	M115	M120	M130	M140	M150	M160
PN Pin	$ØD_{PN}$	12	16	20	24	27	30	36	42	45	48	52	56	60	64	68	72	76	80	85	90	95	100	105	110	115	120	130	140	150	160
	L_{PN}	30	40	47	57	63	73	85	97	102	111	120	129	140	151	157	166	175	182	195	205	218	229	241	250	261	277	301	323	344	365
	Weight [kg]	0.03	0.07	0.14	0.25	0.34	0.46	0.81	1.2	1.5	2	2	3	4	5	5	6	7	8	11	12	14	16	19	22	25	29	37	46	57	71



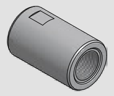
Nominal size		M12	M16	M20	M24	M27	M30	M36	M42	M45	M48	M52	M56	M60	M64	M68	M72	M76	M80	M85	M90	M95	M100	M105	M110	M115	M120	M130	M140	M150	M160
CP Connection plate	T_{CP}	10	15	15	20	20	25	30	35	35	40	40	45	50	55	55	60	65	70	75	80	85	90	90	95	100	110	120	130	140	150
	B_{CP}	42	56	68	80	90	104	122	142	152	160	174	186	200	212	224	238	250	264	280	296	312	328	346	362	378	394	426	458	490	522
	$ØD_{CP}$	13	17	21	25	28	32	38	44	47	50	54	58	62	66	70	74	78	82	87	92	97	102	108	113	118	123	133	143	153	163
	$L1_{CP}$	21	28	34	40	45	52	61	71	76	80	87	93	100	106	112	119	125	132	140	148	156	164	173	181	189	197	213	229	245	261
	$L2_{CP}$ (min)	29	36	46	53	57	62	72	81	86	91	101	108	113	120	126	132	139	148	153	160	170	180	192	200	209	216	232	247	264	280



Nominal size		M12	M16	M20	M24	M27	M30	M36	M42	M45	M48	M52	M56	M60	M64	M68	M72	M76	M80	M85	M90	M95	M100	M105	M110	M115	M120	M130	M140	M150	M160
TC Locking thread cover	$ØE_{TC}$	17	23	29	35	39	42	51	60	64	69	75	81	87	92	99	104	110	113	122	129	134	143	152	158	166	173	187	202	216	232
	L_{TC}	30	40	50	55	60	70	80	95	100	110	115	120	120	135	135	135	135	140	140	140	140	140	140	140	140	140	140	140	140	140
	Weight [kg]	0.03	0.05	0.09	0.1	0.2	0.3	0.4	0.7	0.8	1.1	1.3	1.6	1.8	2.2	2.7	2.9	3.3	3.6	4.2	4.7	4.9	5.7	6.6	7.0	7.8	8.6	10	12	13	15



Nominal size		M12	M16	M20	M24	M27	M30	M36	M42	M45	M48	M52	M56	M60	M64	M68	M72	M76	M80	M85	M90	M95	M100	M105	M110	M115	M120	M130	M140	M150	M160
TB Turnbuckle	$ØD_{TB}$	20	27	36	42	48	51	60	70	76	83	89	95	102	108	114	121	127	133	140	152	159	171	178	191	194	203	219	241	254	273
	L_{TB}	53	70	88	106	119	132	158	185	198	211	225	234	244	254	263	273	282	292	304	326	338	350	387	399	411	423	447	471	495	519
	$+/-V_{TB}$	12	16	20	24	27	30	36	42	45	48	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
	Weight [kg]	0.09	0.16	0.32	0.6	0.9	1.2	1.8	2.8	3.3	3.9	5.4	6.2	8.5	10	12	14	16	18	20	24	30	34	42	49	62	61	82	96	115	147



Nominal size		M12	M16	M20	M24	M27	M30	M36	M42	M45	M48	M52	M56	M60	M64	M68	M72	M76	M80	M85	M90	M95	M100	M105	M110	M115	M120	M130	M140	M150	M160
CO Coupler	$ØD_{CO}$	20	27	36	42	48	51	60	70	76	83	89	95	102	108	114	121	127	133	140	152	159	171	178	191	194	203	219	241	254	273
	L_{CO}	29	39	48	58	65	72	87	101	108	116	125	135	144	154	164	173	183	192	204	226	238	250	287	299	311	323	347	371	395	419
	Weight [kg]	0.05	0.09	0.17	0.3	0.5	0.7	1.1	1.7	2.0	2.3	3.2	3.9	5.3	6.3	7.8	9.2	11	12	14	17	22	25	32	37	47	47	65	77	93	119

All dimensions in mm unless noted otherwise

Soil - HS small - Fill

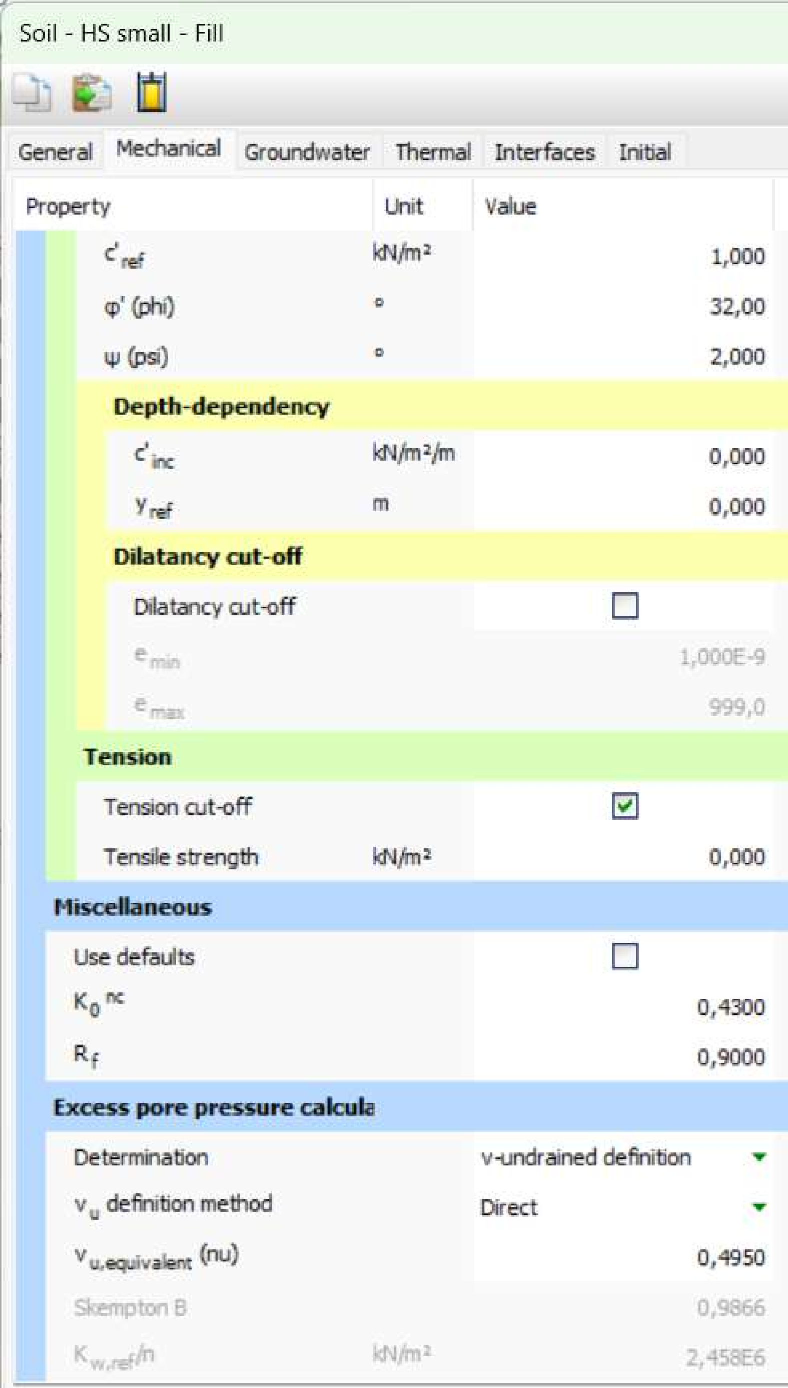
General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
Material set		
Identification		Fill
Soil model		HS small
Drainage type		Drained
Colour		RGB 161, 226, 232
Comments		
Unit weights		
γ_{unsat}	kN/m³	18,00
γ_{sat}	kN/m³	20,00
Void ratio		
e_{init}		0,5000
n_{init}		0,3333
Rayleigh damping		
Input method		SDOF equivalent
Rayleigh α		0,000
Rayleigh β		0,000
ξ_1	%	0,000
ξ_2	%	0,000
f_1	Hz	0,1000
f_2	Hz	1,000

Soil - HS small - Fill

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

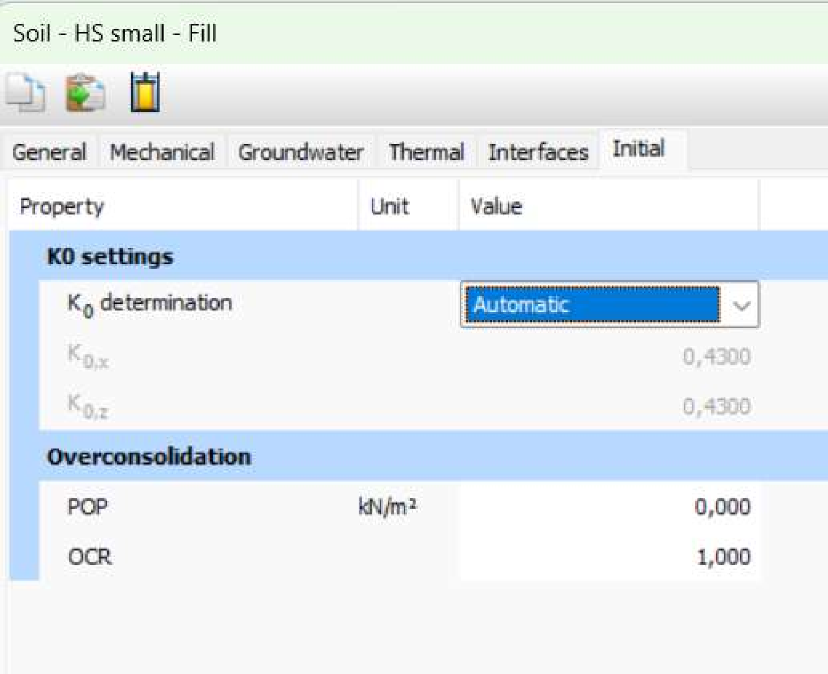
Property	Unit	Value
Stiffness		
$E_{50}{}^{ref}$	kN/m²	20,00E3
$E_{oed}{}^{ref}$	kN/m²	20,00E3
$E_{ur}{}^{ref}$	kN/m²	60,00E3
ν_{ur}		0,2000
Alternatives		
Use alternatives		☐
C_c		0,01727
C_s		0,01205
e_{init}		0,5000
Stress-dependency		
power (m)		0,5000
p_{ref}	kN/m²	100,0
Small-strain		
$G_0{}^{ref}$	kN/m²	180,0E3
$\gamma_{0.7}$		0,1500E-3
Strength		
Shear		
c'_{ref}	kN/m²	1,000
φ' (phi)	°	32,00
ψ (psi)	°	2,000
Depth-dependency		
c'_{inc}	kN/m²/m	0,000


Soil - HS small - Fill
General
Mechanical
Groundwater
Thermal
Interfaces
Initial
Property
Unit
Value
c'ref kN/m² 1,000
φ' (phi) ° 32,00
ψ (psi) ° 2,000
Depth-dependency
c'inc kN/m²/m 0,000
yref m 0,000
Dilatancy cut-off
Dilatancy cut-off
emin 1,000E-9
emax 999,0
Tension
Tension cut-off
Tensile strength kN/m² 0,000
Miscellaneous
Use defaults
K0 nc 0,4300
Rf 0,9000
Excess pore pressure calcula
Determination v-undrained definition
vu definition method Direct
vu,equivalent (nu) 0,4950
Skempton B 0,9866
Kw,ref/n kN/m² 2,458E6

Soil - HS small - Fill

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
Stiffness		
Stiffness determination		Derived
Strength		
Strength determination		Manual
R_{inter}		0,7000
Consider gap closure		☑
Real interface thickness		
δ_{inter}	m	0,000
Groundwater		
Cross permeability		Impermeable
Drainage conductivity, dk	m^3/day/m	0,000
Thermal		
$R_{thermal}$	m^2 K/kW	0,000


Soil - HS small - Fill
General
Mechanical
Groundwater
Thermal
Interfaces
Initial
Property
Unit
Value
K0 settings
K0 determination
Automatic
K0,x
0,4300
K0,z
0,4300
Overconsolidation
POP
kN/m²
0,000
OCR
1,000

Soil - HS small - Clay

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
Material set		
Identification		Clay
Soil model		HS small
Drainage type		Drained
Colour		RGB 134, 234, 162
Comments		
Unit weights		
γ_{unsat}	kN/m³	20,00
γ_{sat}	kN/m³	20,00
Void ratio		
e_{init}		0,5000
n_{init}		0,3333
Rayleigh damping		
Input method		SDOF equivalent
Rayleigh α		0,000
Rayleigh β		0,000
ξ_1	%	0,000
ξ_2	%	0,000
f_1	Hz	0,1000
f_2	Hz	1,000

Soil - HS small - Clay

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
Stiffness		
E_{50}^{ref}	kN/m²	12,00E3
E_{oed}^{ref}	kN/m²	7000
E_{ur}^{ref}	kN/m²	35,00E3
ν_{ur}		0,2000
Alternatives		
Use alternatives		☐
C_c		0,04934
C_s		0,01850
e_{init}		0,5000
Stress-dependency		
power (m)		0,9000
p_{ref}	kN/m²	100,0
Small-strain		
G_0^{ref}	kN/m²	210,0E3
$\gamma_{0.7}$		0,2000E-3
Strength		
Shear		
c'_{ref}	kN/m²	7,000
φ' (phi)	°	31,00
ψ (psi)	°	0,000
Depth-dependency		
c'_{inc}	kN/m²/m	0,000

Soil - HS small - Clay

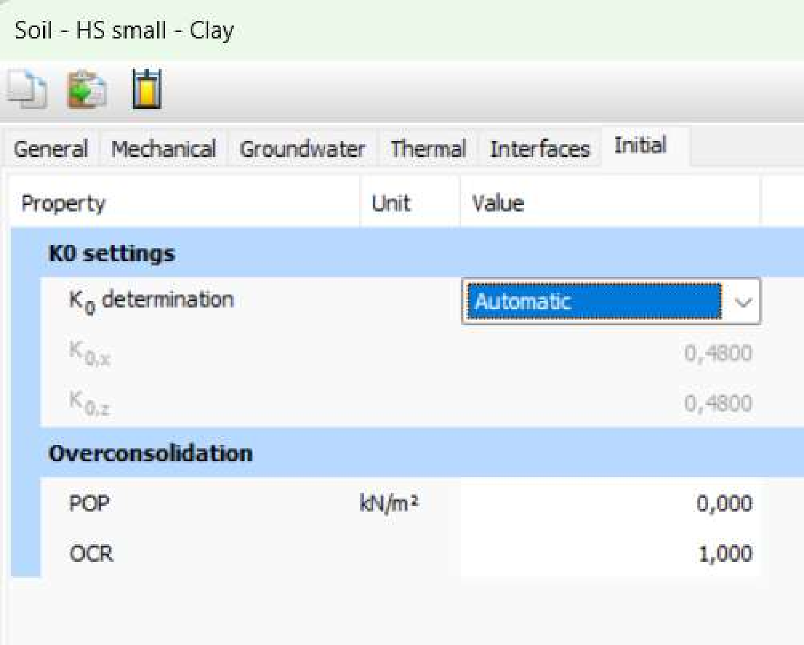
General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
c'_{ref}	kN/m²	7,000
φ' (phi)	°	31,00
ψ (psi)	°	0,000
Depth-dependency		
c'_{inc}	kN/m²/m	0,000
y_{ref}	m	0,000
Dilatancy cut-off		
Dilatancy cut-off		☐
e_{min}		1,000E-9
e_{max}		999,0
Tension		
Tension cut-off		☑
Tensile strength	kN/m²	0,000
Miscellaneous		
Use defaults		☐
K_0^{nc}		0,4800
R_f		0,9000
Excess pore pressure calcula		
Determination		ν-undrained definition
ν_u definition method		Direct
$\nu_{u,equivalent}$ (nu)		0,4950
Skempton B		0,9866
$K_{w,ref}/n$	kN/m²	1,434E6

Soil - HS small - Clay

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
Stiffness		
Stiffness determination		Derived
Strength		
Strength determination		Manual
R_{inter}		0,5000
Consider gap closure		☑
Real interface thickness		
δ_{inter}	m	0,000
Groundwater		
Cross permeability		Impermeable
Drainage conductivity, dk	m³/day/m	0,000
Thermal		
$R_{thermal}$	m² K/kW	0,000


Soil - HS small - Clay
General
Mechanical
Groundwater
Thermal
Interfaces
Initial
Property
Unit
Value
K0 settings
K_0 determination
Automatic
$K_{0,x}$
0,4800
$K_{0,z}$
0,4800
Overconsolidation
POP
kN/m²
0,000
OCR
1,000

Soil - HS small - Sand

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
Material set		
Identification		Sand
Soil model		HS small
Drainage type		Drained
Colour		RGB 236, 232, 156
Comments		
Unit weights		
γ_{unsat}	kN/m³	20,00
γ_{sat}	kN/m³	20,00
Void ratio		
e_{init}		0,5000
n_{init}		0,3333
Rayleigh damping		
Input method		SDOF equivalent
Rayleigh α		0,000
Rayleigh β		0,000
ξ_1	%	0,000
ξ_2	%	0,000
f_1	Hz	0,1000
f_2	Hz	1,000

Soil - HS small - Sand

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
Stiffness		
E_{50}^{ref}	kN/m²	30,00E3
E_{oed}^{ref}	kN/m²	36,00E3
E_{ur}^{ref}	kN/m²	110,0E3
ν_{ur}		0,2000
Alternatives		
Use alternatives		☐
C_c		9,594E-3
C_s		5,327E-3
e_{init}		0,5000
Stress-dependency		
power (m)		0,5000
p_{ref}	kN/m²	100,0
Small-strain		
G_0^{ref}	kN/m²	100,0E3
$\gamma_{0.7}$		0,1000E-3
Strength		
Shear		
c'_{ref}	kN/m²	5,000
φ' (phi)	°	28,00
ψ (psi)	°	0,000
Depth-dependency		
c'_{inc}	kN/m²/m	0,000

Soil - HS small - Sand

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
c'_{ref}	kN/m²	5,000
φ' (phi)	°	28,00
ψ (psi)	°	0,000
Depth-dependency		
c'_{inc}	kN/m²/m	0,000
y_{ref}	m	0,000
Dilatancy cut-off		
Dilatancy cut-off		☐
e_{min}		1,000E-9
e_{max}		999,0
Tension		
Tension cut-off		☑
Tensile strength	kN/m²	0,000
Miscellaneous		
Use defaults		☑
K_0^{nc}		0,5305
R_f		0,9000
Excess pore pressure calcula		
Determination		v-undrained definition
v_u definition method		Direct
$v_{u,equivalent}$ (nu)		0,4950
Skempton B		0,9866
$K_{w,ref}/n$	kN/m²	4,507E6

Soil - HS small - Sand

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
Stiffness		
Stiffness determination		Derived
Strength		
Strength determination		Manual
R_{inter}		0,7000
Consider gap closure		☑
Real interface thickness		
δ_{inter}	m	0,000
Groundwater		
Cross permeability		Impermeable
Drainage conductivity, dk	m³/day/m	0,000
Thermal		
$R_{thermal}$	m² K/kW	0,000

Soil - HS small - Sand

General | Mechanical | Groundwater | Thermal | Interfaces | Initial

Property	Unit	Value
K0 settings		
K_0 determination		Automatic
$K_{0,x}$		0,5305
$K_{0,z}$		0,5305
Overconsolidation		
POP	kN/m²	0,000
OCR		1,000