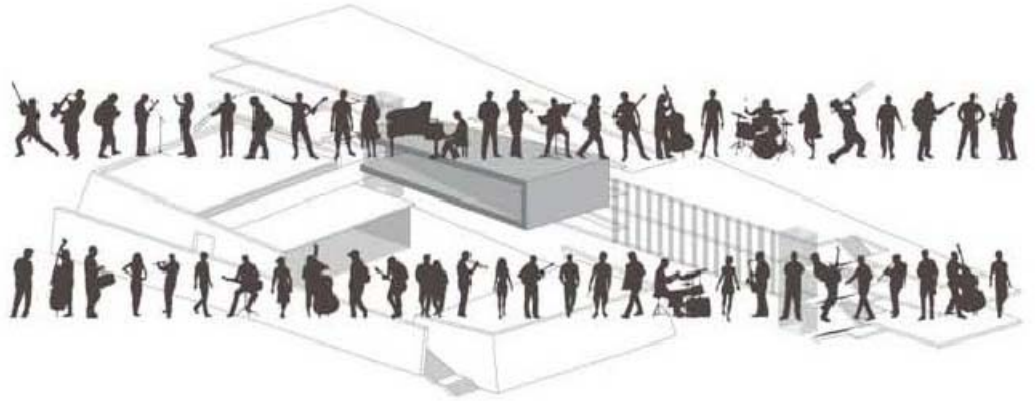


ΕΛΛΗΝΙΚΗ ΔΗΜΟΚΡΑΤΙΑ
ΙΟΝΙΟ ΠΑΝΕΠΙΣΤΗΜΙΟ
ΔΙΕΥΘΥΝΣΗ ΤΕΧΝΙΚΩΝ ΥΠΗΡΕΣΙΩΝ

ΕΡΓΟ :

ΚΤΙΡΙΟ ΤΜΗΜΑΤΟΣ ΜΟΥΣΙΚΩΝ ΣΠΟΥΔΩΝ ΣΤΟ ΟΙΚΟΠΕΔΟ Ε.Α.Σ.Κ.

ΘΕΣΗ ΕΡΓΟΥ :

9η ΠΑΡΟΔΟΣ Δ. ΘΕΟΤΟΚΗ,
ΠΕΡΙΟΧΗ ΠΑΛΛΑΔΑ - Ο.Τ. 379, ΚΕΡΚΥΡΑ

ΣΤΑΔΙΟ ΜΕΛΕΤΗΣ : **ΟΡΙΣΤΙΚΗ - ΜΕΛΕΤΗ ΕΦΑΡΜΟΓΗΣ ΑΝΤΙΣΤΗΡΙΞΗΣ**

ΠΑΡΑΡΤΗΜΑ - ΤΕΥΧΟΣ ΙΙ Β

ΑΡΧΙΤΕΚΤΟΝΙΚΗ ΜΕΛΕΤΗ	ΣΤΑΤΙΚΗ ΜΕΛΕΤΗ	ΜΕΛΕΤΗ Η/Μ ΕΓΚΑΤΑΣΤΑΣΕΩΝ	ΗΜΕΡΟΜΗΝΙΑ
Δ. ΒΑΣΙΛΟΠΟΥΛΟΣ & ΣΥΝΕΡΓΑΤΕΣ Ε.Ε. ΣΥΝΕΡΓΑΤΕΣ ΑΡΧΙΤΕΚΤΟΝΕΣ : Σ. ΚΟΛΟΒΟΥ	ΑΡΤΕΜΙΣ ΣΥΜΒΟΥΛΟΙ ΜΗΧΑΝΙΚΟΙ Ε.Π.Ε.	Η-Μ ΣΧΕΔΙΑΣΜΟΣ Κ. ΓΕΩΡΓΑΚΟΠΟΥΛΟΣ- Σ. ΤΣΑΝΤΕΣ & ΣΙΑ Ε.Ε.	ΟΚΤΩΒΡΙΟΣ 2018
ΣΥΜΒΟΥΛΟΣ ΑΚΟΥΣΤΙΚΗΣ ΜΕΛΕΤΗΣ: Ι. ΜΑΡΙΝΟΣ	ΓΕΩΤΕΧΝΙΚΗ ΜΕΛΕΤΗ: Ν. ΔΕΡΕΚΑΣ		

ΣΦΡΑΓΙΔΕΣ ΥΠΟΓΡΑΦΕΣ

Κεφ.	Υποκ.	Παρ.	***ΠΕΡΙΕΧΟΜΕΝΑ***
8.			***ΠΑΡΑΡΤΗΜΑ – ΤΕΥΧΟΣ ΙΙ Β***
	8.5	8.5.3	Έλεγχος θραύσης πυθμένα
			i) Αντιστηριζόμενο ύψος 6,35m
			ii) Αντιστηριζόμενο ύψος 7,65m
			iii) Αντιστηριζόμενο ύψος 9,85m
	8.6		*Διαστασιολόγηση Φρεατοπασσάλων*
			i) Αντιστηριζόμενο ύψος 6,35m
			ii) Αντιστηριζόμενο ύψος 7,65m
			iii) Αντιστηριζόμενο ύψος 9,85m
			iv) Αντιστηριζόμενο ύψος 3,50m
	8.7		*Διαστασιολόγηση Αγκυρίων και Δοκού Ισορροπίας*
			i) Αντιστηριζόμενο ύψος 6,35m
			ii) Αντιστηριζόμενο ύψος 7,65m
			iii) Αντιστηριζόμενο ύψος 9,85m

ΠΑΡΑΡΤΗΜΑ

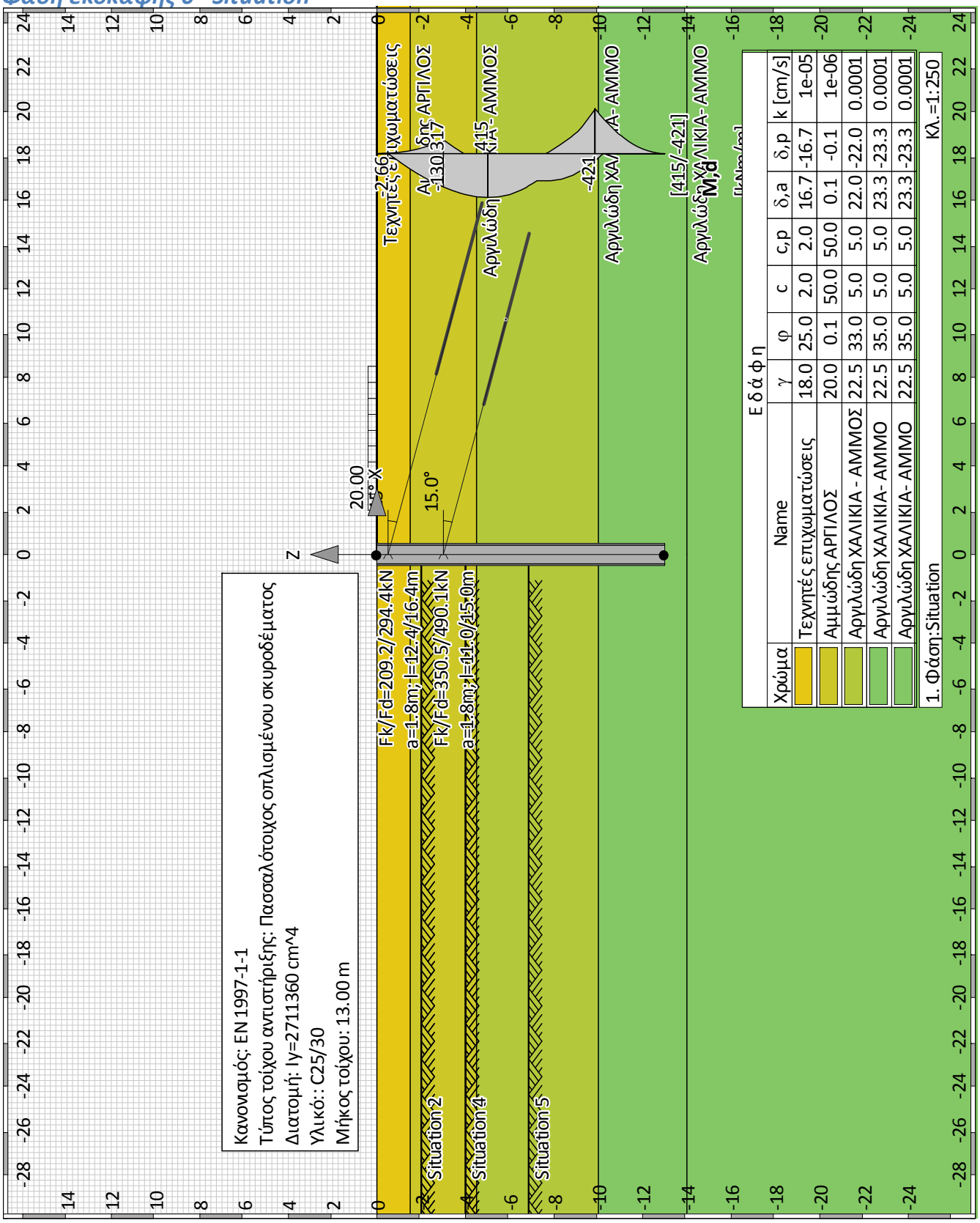
8.5 *Αποτελέσματα ανάλυσης*

8.5.3 Έλεγχος θραύσης πυθμένα

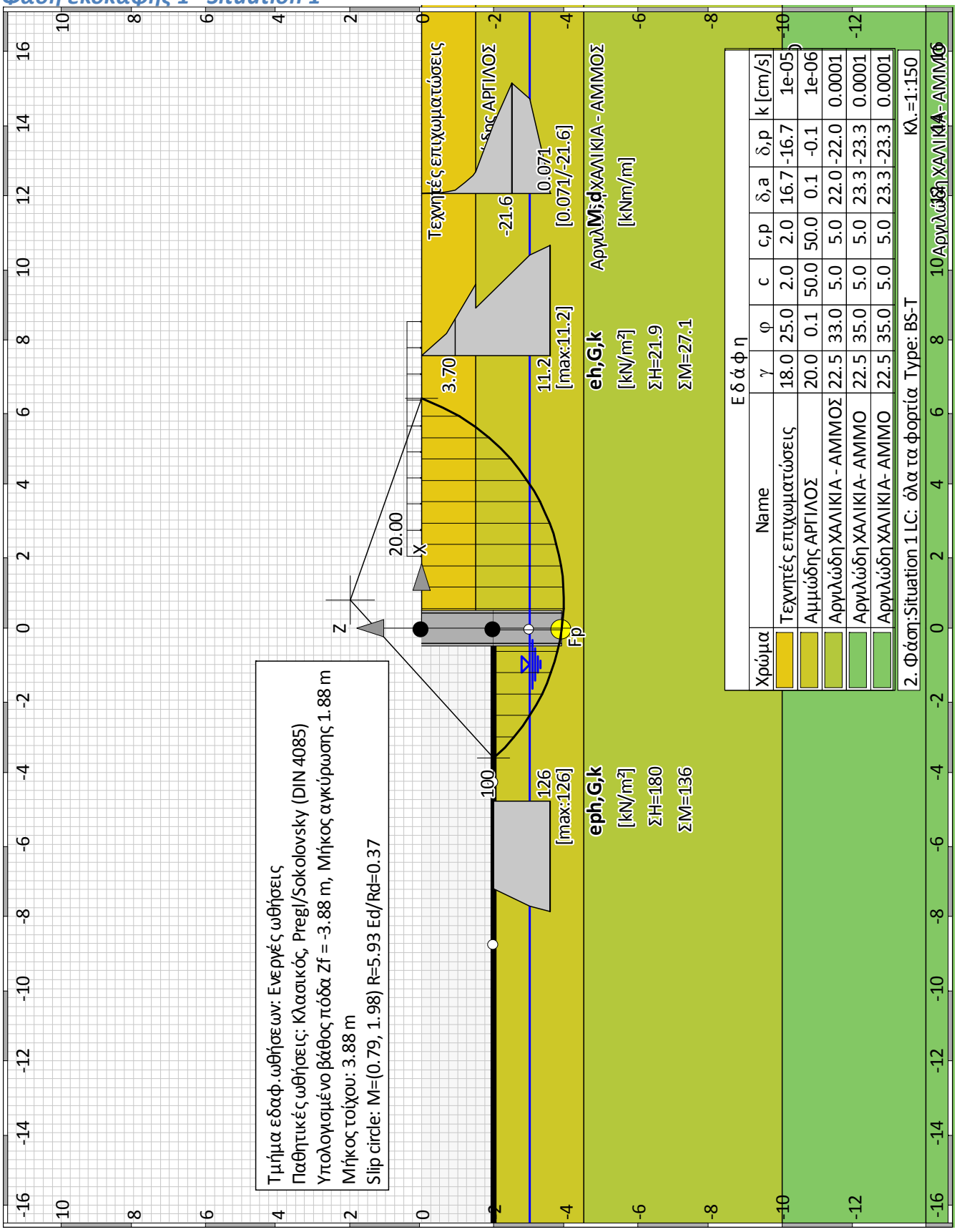
i) Αντιστηριζόμενο ύψος 6,35m

Summary of all stages

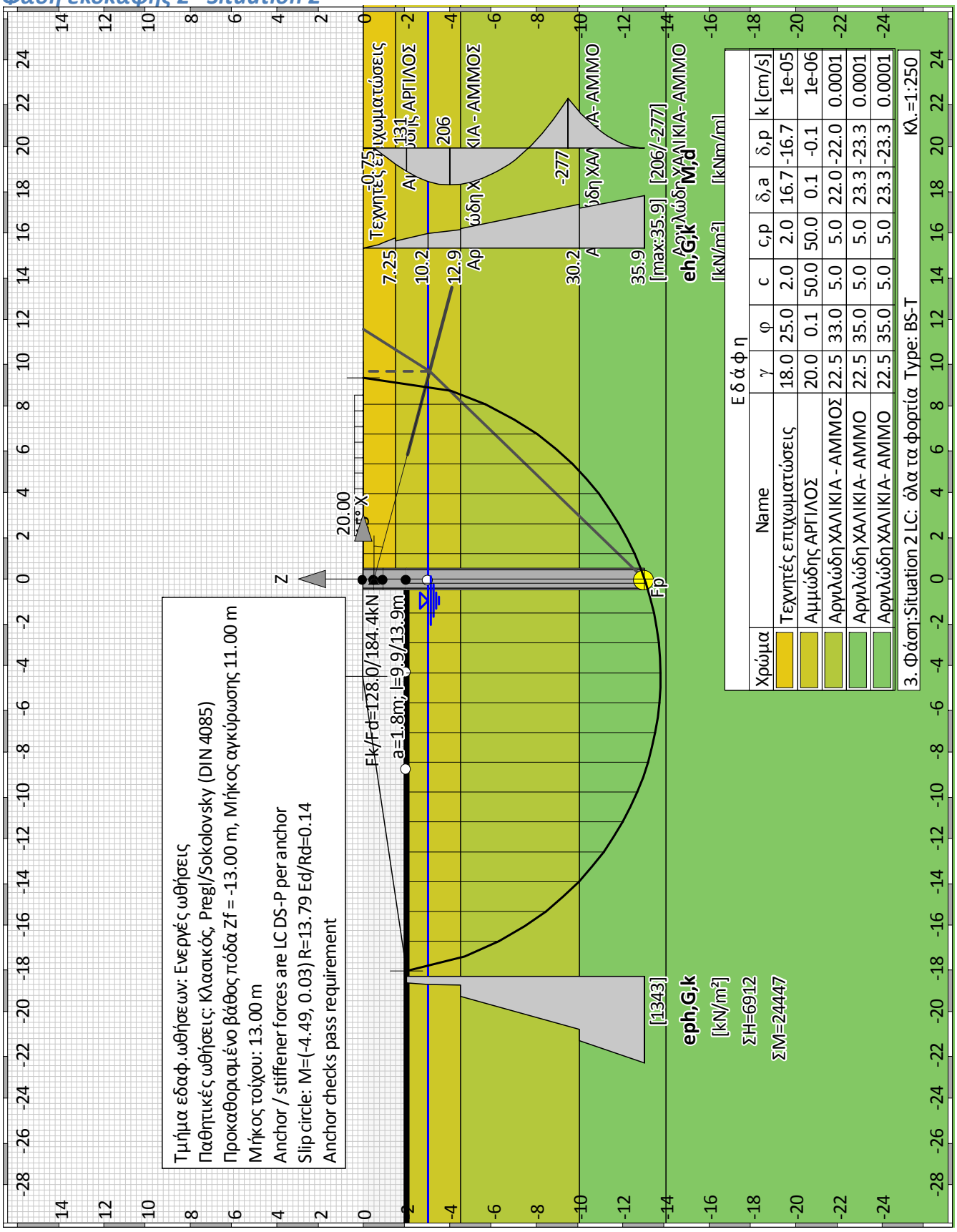
Φάση εκσκαφής 0 "Situation"



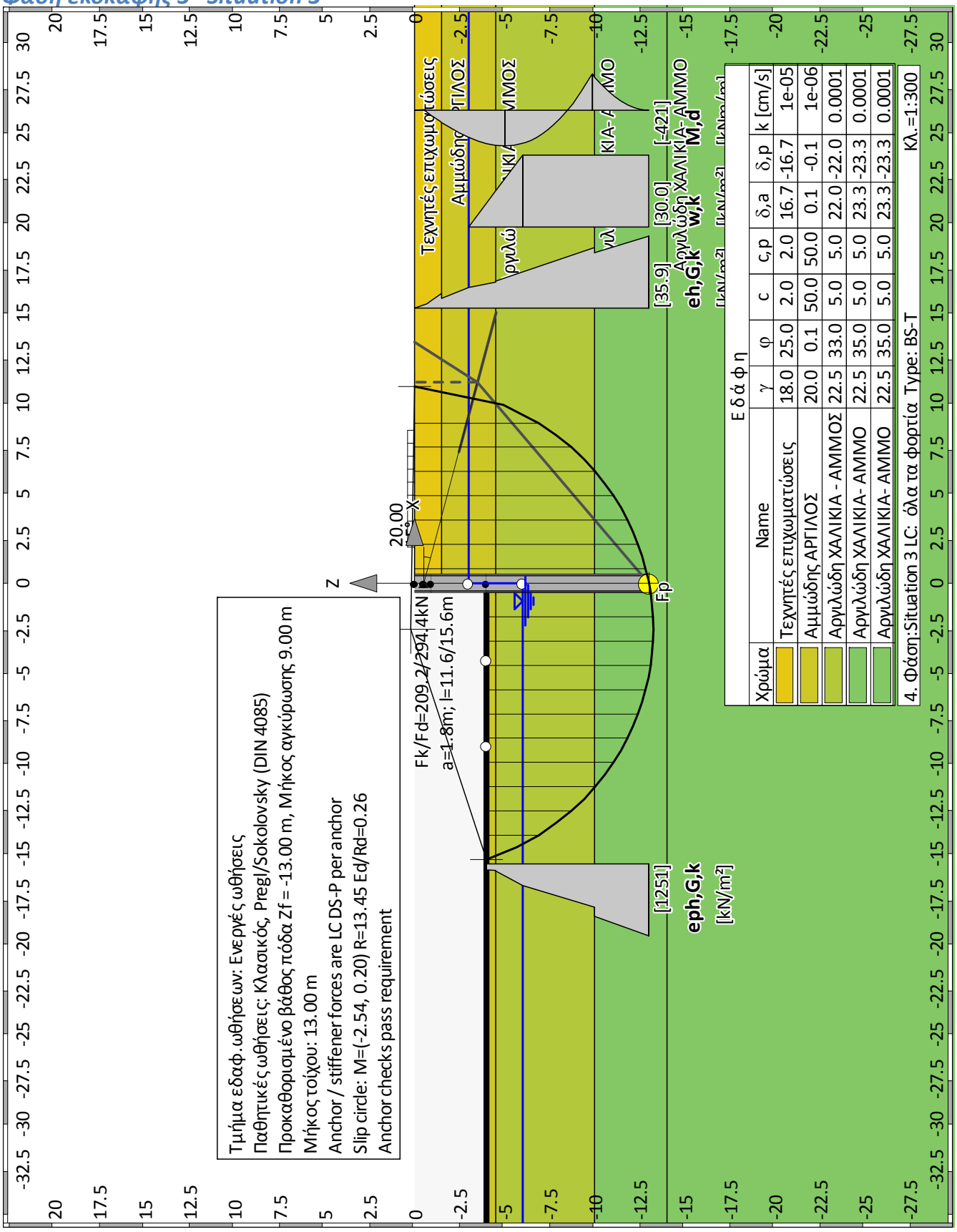
Φάση εκσκαφής 1 "Situation 1"



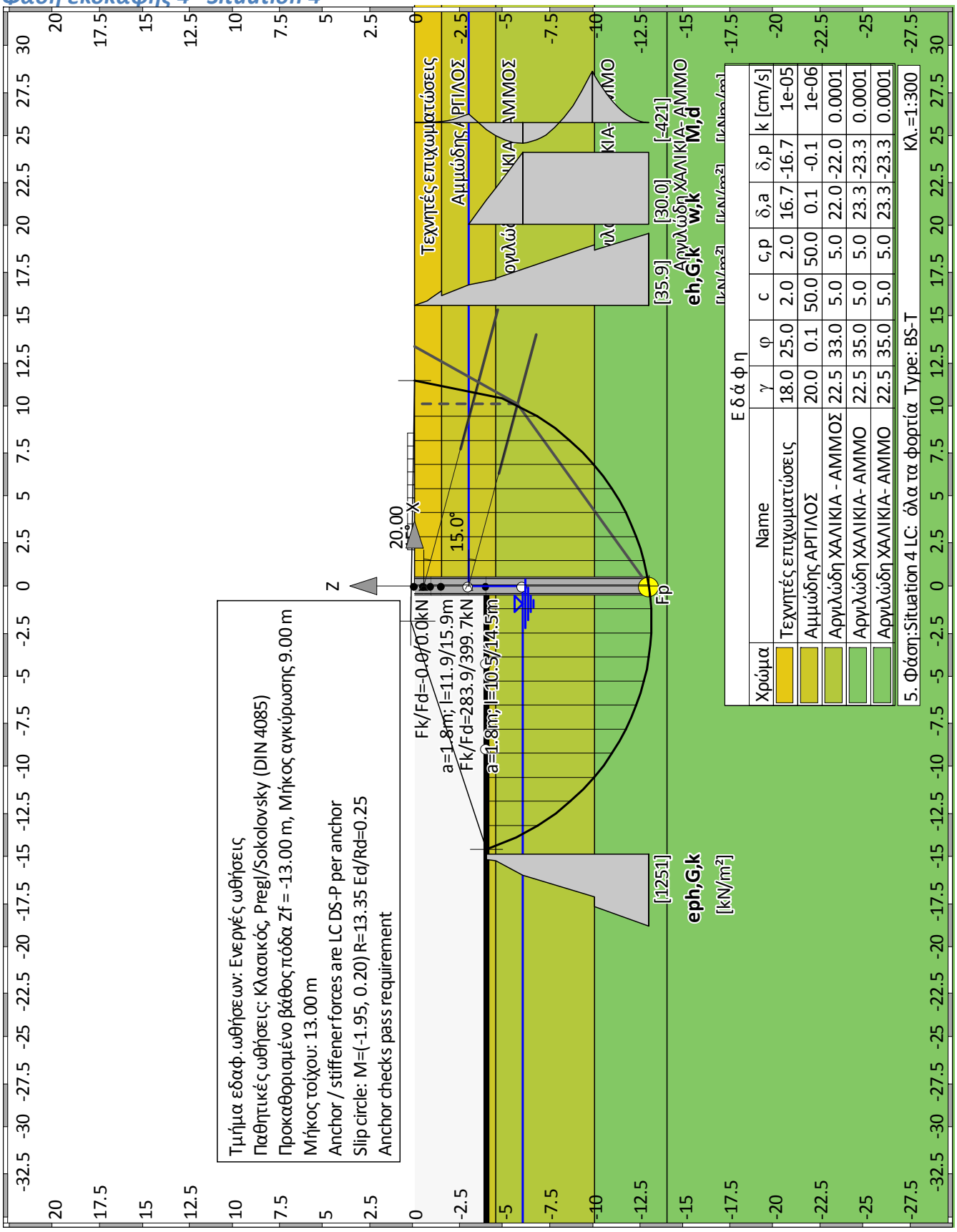
Φάση εκσκαφής 2 "Situation 2"



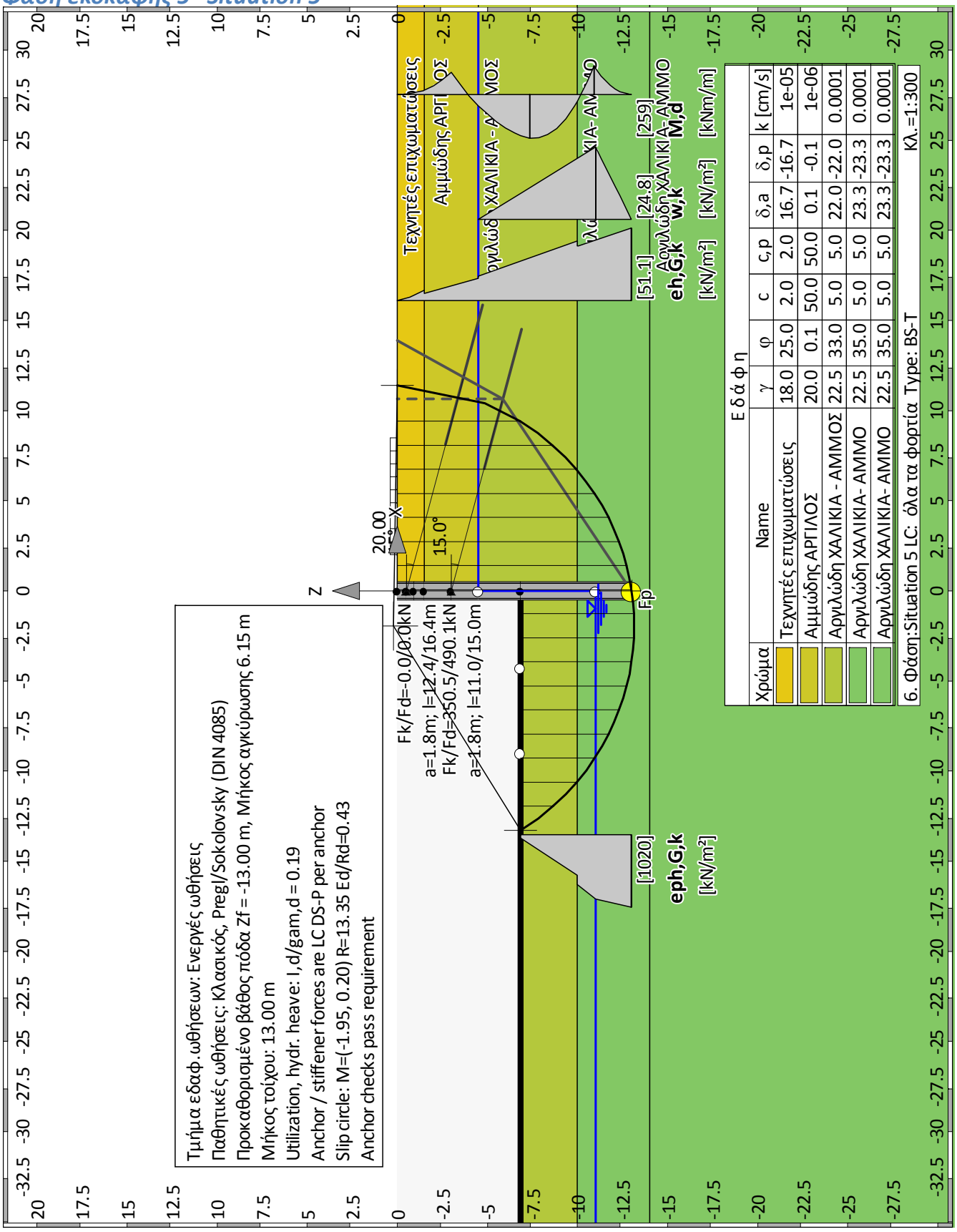
Φάση εκσκαφής 3 "Situation 3"



Φάση εκσκαφής 4 "Situation 4"



Φάση εκσκαφής 5 "Situation 5"



Κανονισμόςγια Ανάλυση και Διαστασιολόγηση

Διαστασ. ωπλισμ.σκυροδ.: EN 1992-1-1
Γεωτεχν.Κανονισμός : EN 1997 (rev.12)_user
National Annex: EN 1997-1

Safety factors:

Earth pressure onto wall: [GEO] A1 M1 R2

γ-	G,dst	E0G	G,stb	Q,dst	Q,stb	phi	coe	cu	g
BS-P	1.350	1.350	1	1.500	0	1	1	1	1
BS-T	1.350	1.350	1	1.500	0	1	1	1	1
BS-T/A	1.350	1.350	1	1.500	0	1	1	1	1
BS-E	1	1	1	1	0	1	1	1	1

ΚΕ-μηχανισμός: [GEO] A2 M2 R3

γ-	G,dst g	G,stb a,t	W a,p	Q,dst Gt	Q,stb N	phi	coe	cu
BS-P	1	1	1	1.300	0	1.250	1.400	1.400
	1	1	1	1	1			
BS-T	1	1	1	1.300	0	1.250	1.400	1.400
	1	1	1	1	1			
BS-T/A	1	1	1	1.300	0	1.250	1.250	1.400
	1	1	1	1	1			
BS-E	1	1	1	1	0	1.250	1.400	1.400
	1	1	1	1	1			

Θραύση εδάφους: [GEO] A1 M1 R2

γ-	G,dst cu	E0G g	W Re	G,stb	Q,dst	Q,stb	phi	coe
BS-P	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.400					
BS-T	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.400					
BS-T/A	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.400					
BS-E	1	1	1	1	1	0	1	1
	1	1	1					

Ολίσθηση: [GEO] A1 M1 R2

γ-	G,dst cu	E0G g	W Rh	G,stb	Q,dst	Q,stb	phi	coe
BS-P	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.100					
BS-T	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.100					
BS-T/A	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.100					
BS-E	1	1	1	1	1	0	1	1
	1	1	1					

Θραύση εδάφους: [GEO] A1 M1 R2

γ-	G,dst cu	E0G g	W Rv	G,stb	Q,dst	Q,stb	phi	coe
BS-P	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.400					
BS-T	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.400					
BS-T/A	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.400					
BS-E	1	1	1	1	1	0	1	1
	1	1	1					

Κύκλος ολίσθησης: [GEO] A2 M2 R3

	γ-g	G,dst Re	G,stb a,t	Q,dst a,p	Q,stb Gt	W N	phi	coe	cu
BS-P	1	1	1.300	0	1	1.250	1.400	1.400
	1	1	1	1	1	1			
BS-T	1	1	1.300	0	1	1.250	1.400	1.400
	1	1	1	1	1	1			
BS-T/A	1	1	1.300	0	1	1.250	1.250	1.400
	1	1	1	1	1	1			
BS-E	1	1	1	0	1	1.250	1.400	1.400
	1	1	1	1	1	1			

Hydraulic heave: [HYD] A1 M1 R1

	γ-	G,dst	G,stb	Q,dst	H
BS-P	1.350	0.900	1.500	1.800
BS-T	1.350	0.900	1.500	1.600
BS-T/A	1.350	0.900	1.500	1.500
BS-E	1	1	1	1

Failure of structural elements: [STR] A1 M1 R1

	γ-	M	Gtf	cd	N
BS-P	1.150	1.400	1.400	1.150
BS-T	1.150	1.300	1.300	1.150
BS-T/A	1.150	1.250	1.250	1.150
BS-E	1	1	1	1

Stability: [EQU] A1 M1 R1

	γ-	G,dst	G,stb	Q,dst	Q,stb	phi	coe	cu	g
BS-P	1	0.900	1.500	0	1.250	1.250	1.400	1
BS-T	1	0.900	1.500	0	1.250	1.250	1.400	1
BS-T/A	1	0.900	1.500	0	1.250	1.250	1.400	1
BS-E	1	1	1	0	1.250	1.400	1.400	1

γ,Re,red (EAB EB14-3): Ναι, η=0.80
γ,Re,red (EAB EB22-6): Ναι, E0h > 0%: η = 0.60 / 0.80

System values

Τοίχος

Τύπος τοίχου αντιστήριξης: Πασσαλότοιχος οπλισμένου σκυροδέματος
Διατομή: Iy=2711360 cm^4
Υλικό:: C25/30
Ίδιο βάρος: 25.000 [kN/m3]

Σημεία τοίχου

z [m]	d [m]	E [MN/m2]	Iy [cm4/m]	E*Iy [MNm2]	A [cm2/m]
0.00	100.0	31500.0	2711360	854.1	8400
-13.00	100.0	31500.0	2711360	854.1	8400

Φάση εκσκαφής 1 "[1] Situation 1"

LC: όλα τα φορτία Type: BS-T

Εδαφικό σύστημα με 5 Στρώσεις

Name		Τεχνητές επιχωματώσεις	Αμμώδης ΑΡΓΙΛΟΣ	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
γ	[kN/m3]	18	20	22.5
γ,R	[kN/m3]	18	20	22.5
γ'	[kN/m3]	8	10	12.5
γ,p	[kN/m3]	18	20	22.5
γ,R,passive	[kN/m3]	18	20	22.5
γ,pw	[kN/m3]	8	10	12.5
φ	[°]	25	0.1	33
c	[kN/m2]	2	50	5
c,u	[kN/m2]	10	50	5
c παθητικό	[kN/m2]	2	50	5
δ,a	[°]	16.66667	0.06666667	22
δ,p	[°]	-16.66667	-0.06666667	-22
δ,c	[°]	8.333333	0.03333333	11
k,agh	[-]	0.3456501	0.9955057	0.2452023
K,ach	[-]	1.043051	1.994195	0.8549058
K,0h	[-]	0.5773817	0.9982547	0.455361
K,pgh	[-]	3.908103	1.004519	7.495617
K,pch	[-]	5.180327	2.00583	8.599509
τ,gr	[kN/m2]	110	110	110
Ψ,A,max	[°]	90	90	90
k	[cm/s]	10e-06	1e-06	100e-06

Name		Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
γ	[kN/m3]	22.5	22.5
γ,R	[kN/m3]	22.5	22.5
γ'	[kN/m3]	12.5	12.5
γ,p	[kN/m3]	22.5	22.5
γ,R,passive	[kN/m3]	22.5	22.5
γ,pw	[kN/m3]	12.5	12.5
φ	[°]	35	35
c	[kN/m2]	5	5
c,u	[kN/m2]	5	5
c παθητικό	[kN/m2]	5	5
δ,a	[°]	23.33333	23.33333
δ,p	[°]	-23.33333	-23.33333
δ,c	[°]	11.66667	11.66667
k,agh	[-]	0.2244207	0.2244207
K,ach	[-]	0.8126539	0.8126539
K,0h	[-]	0.4264236	0.4264236
K,pgh	[-]	9.146943	9.146943
K,pch	[-]	10.104	10.104
τ,gr	[kN/m2]	110	110
Ψ,A,max	[°]	90	90
k	[cm/s]	100e-06	100e-06

Πορεία πρανούς:
x [m] 0.00 0.00
z [m] -2.00 0.00

Πορεία ανώτερου 2. στρώματος Αμμώδης ΑΡΓΙΛΟΣ:
x [m] 0.00 0.00
z [m] -2.00 -1.50

Πορεία ανώτερου 3. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ:
z= -4.50

Πορεία ανώτερου 4. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -10.00

Πορεία ανώτερου 5. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -14.00

Επιφ. φορτία:

Φορτία

xA [m]	zA [m]	xE [m]	zE [m]	PxA [kN/m²]	PzA [kN/m²]	PxE [kN/m²]	PzE [kN/m²]	Typ	LC-description Name
2.00	0.00	8.50	0.00	0.00	20.00	0.00	20.00	q	1

Κατανομή εδαφ.πιέσεων

Κατανομή εδαφ.πιέσεων	Name
Rectangular within a layer	

Στάθμη νερού:

x [m] 0.00
z [m] -3.00

Παράμετροι υπολογισμού

Earth pressure options

Τμήμα εδαφ.ωθήσεων: Ενεργές ωθήσεις.
Angle of slip plane: DIN 4085.
Split block loads into 1 sections.
Consideration of minimum earth pressure: φ,min = 40.000.
Negative earth pressure fractions are set to zero.

Redistribution of earth pressure

Shape of redistribution: No redistribution of earth pressure.
The earth pressure is getting redistb. to: Excavation level
The earth pressure below the excavation acts without redistrb.
The earth pressure from variable loads will be included in redistribution.

Παθητικές ωθήσεις

Method of calculation: Κλασικός, Pregl/Sokolovsky (DIN 4085).

Options for water pressure

Στήριξη πόδα

Πακτωμένη στήριξη κατά Blum

Earth pressure coefficients kh

φ	α	β	δ	k0gh	kagh	kach	kpgh	kpch	
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Τεχνητές επιχωματώσεις
25.0	0.0	0.0	16.7	--	0.346	1.043	--	--	"
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Αμμώδης ΑΡΓΙΛΟΣ
0.1	0.0	0.0	0.1	--	0.996	1.994	--	--	"
33.0	0.0	0.0	-22.0	--	--	--	7.496	-8.600	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
33.0	0.0	0.0	22.0	--	0.245	0.855	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"

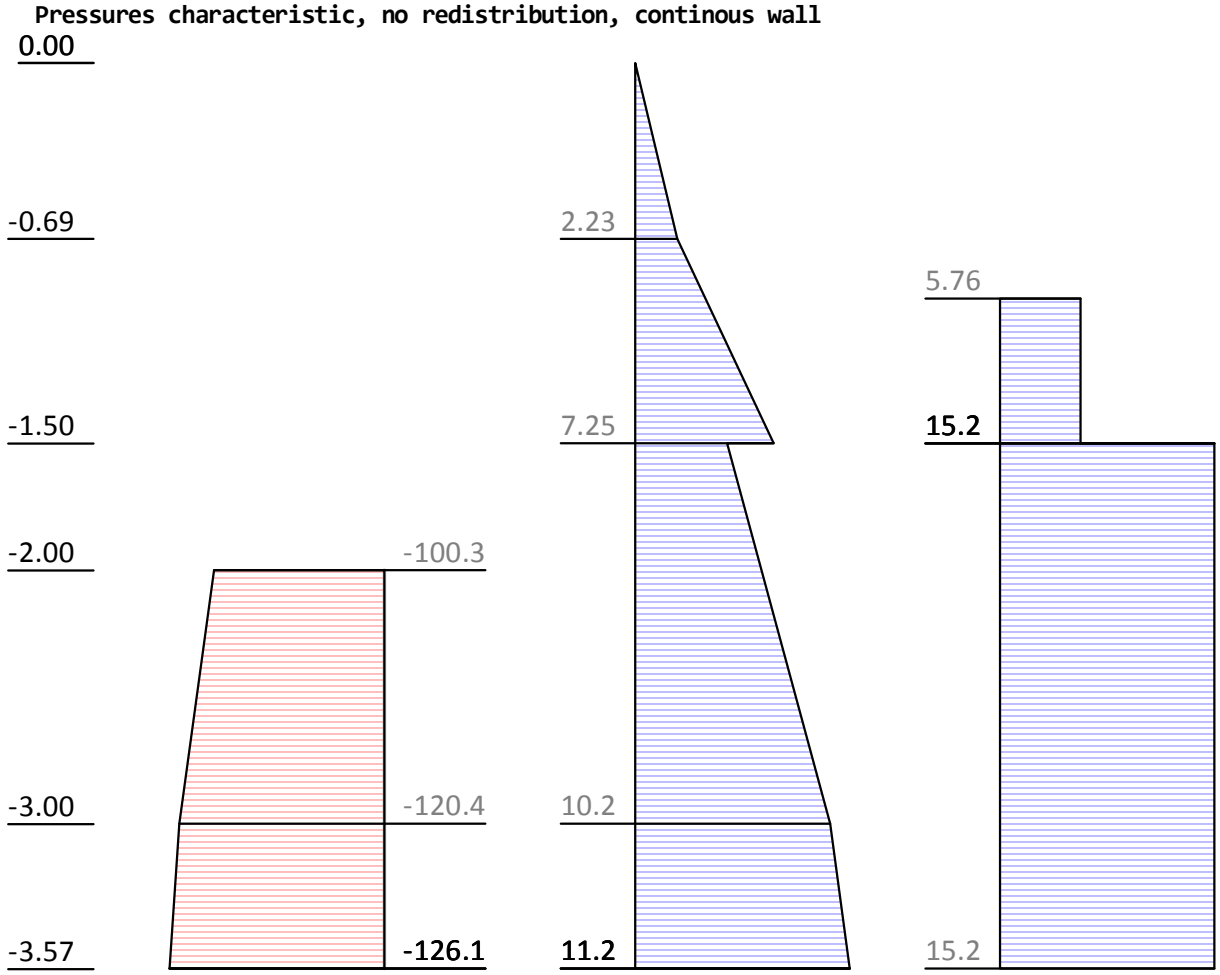
Μήκος τοίχου

N: 1 Z: -3.000 M,Στήριξη πόδα,d: 18.43. Wall too short? Ναι
N: 2 Z: -6.000 M,Στήριξη πόδα,d: -467.02. Wall too short? Όχι
N: 3 Z: -3.990 M,Στήριξη πόδα,d: -24.59. Wall too short? Όχι
N: 4 Z: -3.327 M,Στήριξη πόδα,d: 9.81. Wall too short? Ναι
N: 5 Z: -3.771 M,Στήριξη πόδα,d: -10.67. Wall too short? Όχι
N: 6 Z: -3.473 M,Στήριξη πόδα,d: 4.18. Wall too short? Ναι
N: 7 Z: -3.673 M,Στήριξη πόδα,d: -5.26. Wall too short? Όχι
N: 8 Z: -3.539 M,Στήριξη πόδα,d: 1.30. Wall too short? Ναι
N: 9 Z: -3.629 M,Στήριξη πόδα,d: -2.99. Wall too short? Όχι
N: 10 Z: -3.569 M,Στήριξη πόδα,d: -0.07. Wall too short? Όχι
Foot depth for statics: zf = -3.569

Stress analysis

Earth pressure, horizontal

Pressures characteristic, no redistribution, continous wall

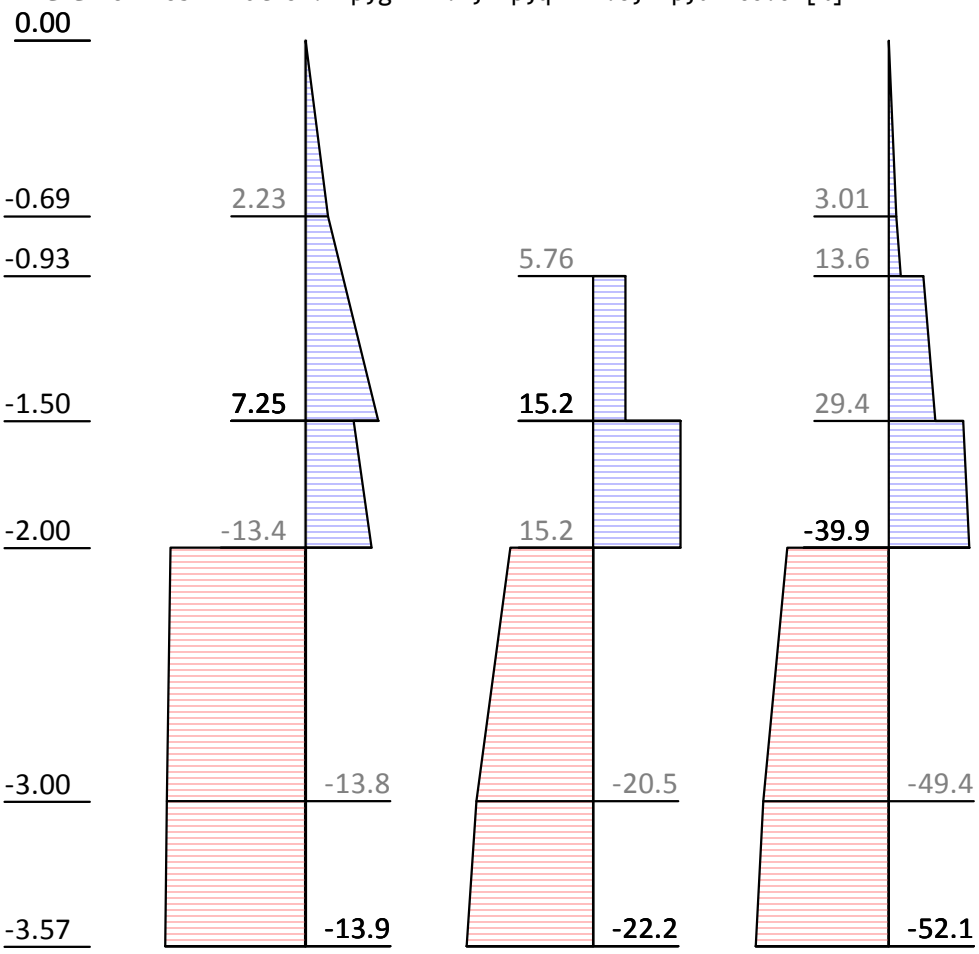


z [m]	eph,G,k [kN/m2]	eah,G,k [kN/m2]	eah,PQ,k [kN/m2]	eah,d [kN/m2]
0.00		0.00		0.00
-0.93		3.72	0.00	5.00
-0.93		3.72	5.76	13.64
-1.50		7.25	5.76	18.43
-1.50		4.82	15.23	29.36
-2.00	-0.00	6.61	15.23	31.77
-2.00	-100.29	6.61	15.23	31.77
-3.57	-126.10	11.20	15.23	37.96

Eph,G,k: -180.43, Eph,PG,k: 0.00 [kN/m]
Eah,G,k: 21.92, Eah,PG,k: 0.00, Eah,PQ,k: 34.80, Eah,d: 81.80

H-pressure on static system

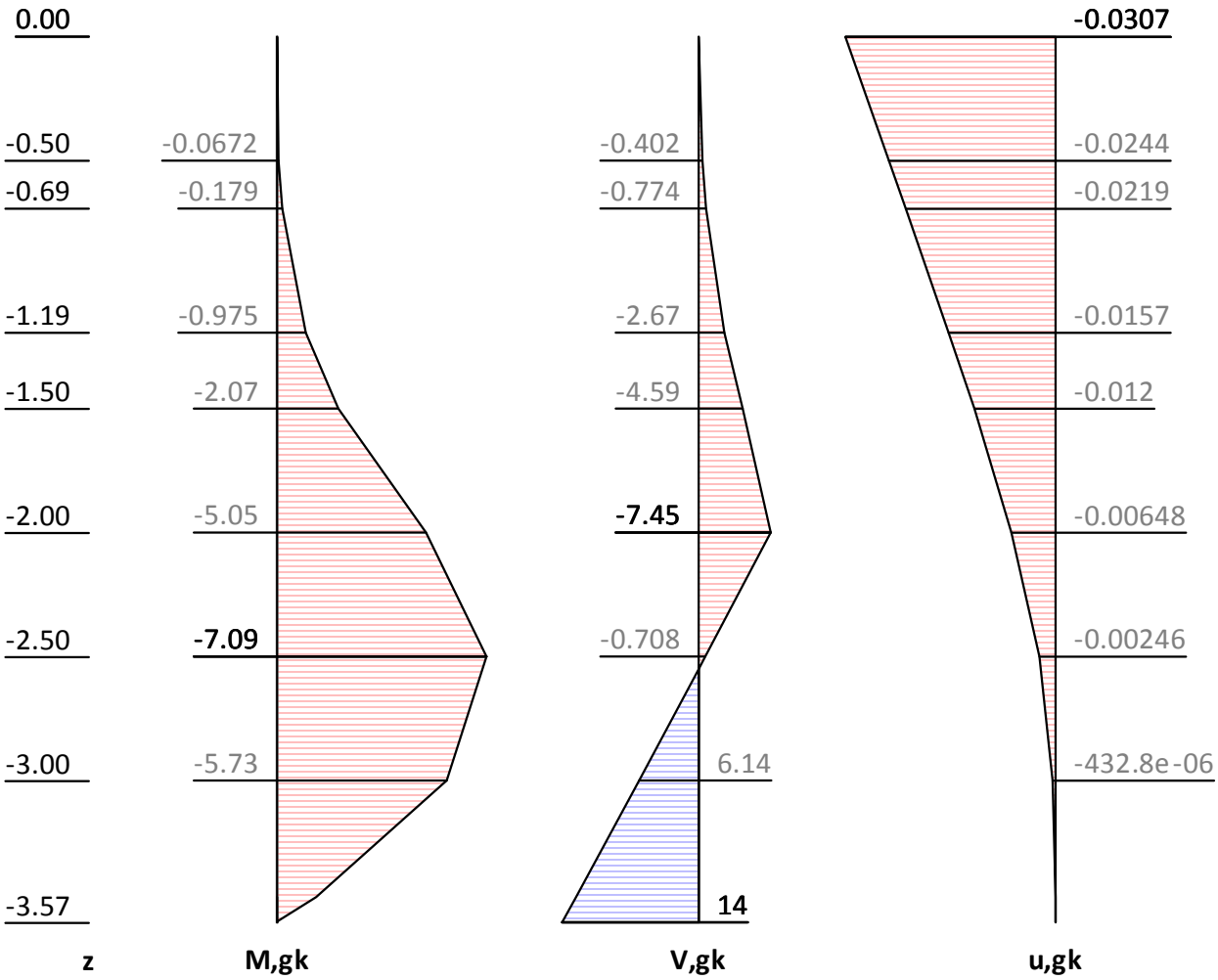
Level of mobilization: Ep,gk 19.9, Ep,qk 29.6, Ep,d 100.0 [%]



z [m]	PH,gk [kN/m2]	PH,qk [kN/m2]	PH,d [kN/m2]
0.00	0.00		0.00
-0.93	3.72	0.00	5.00
-0.93	3.72	5.76	13.64
-1.50	7.25	5.76	18.43
-1.50	4.82	15.23	29.36
-2.00	6.61	15.23	31.77
-2.00	-13.38	-14.50	-39.87
-3.57	-13.93	-22.15	-52.10

V-pressure on static system

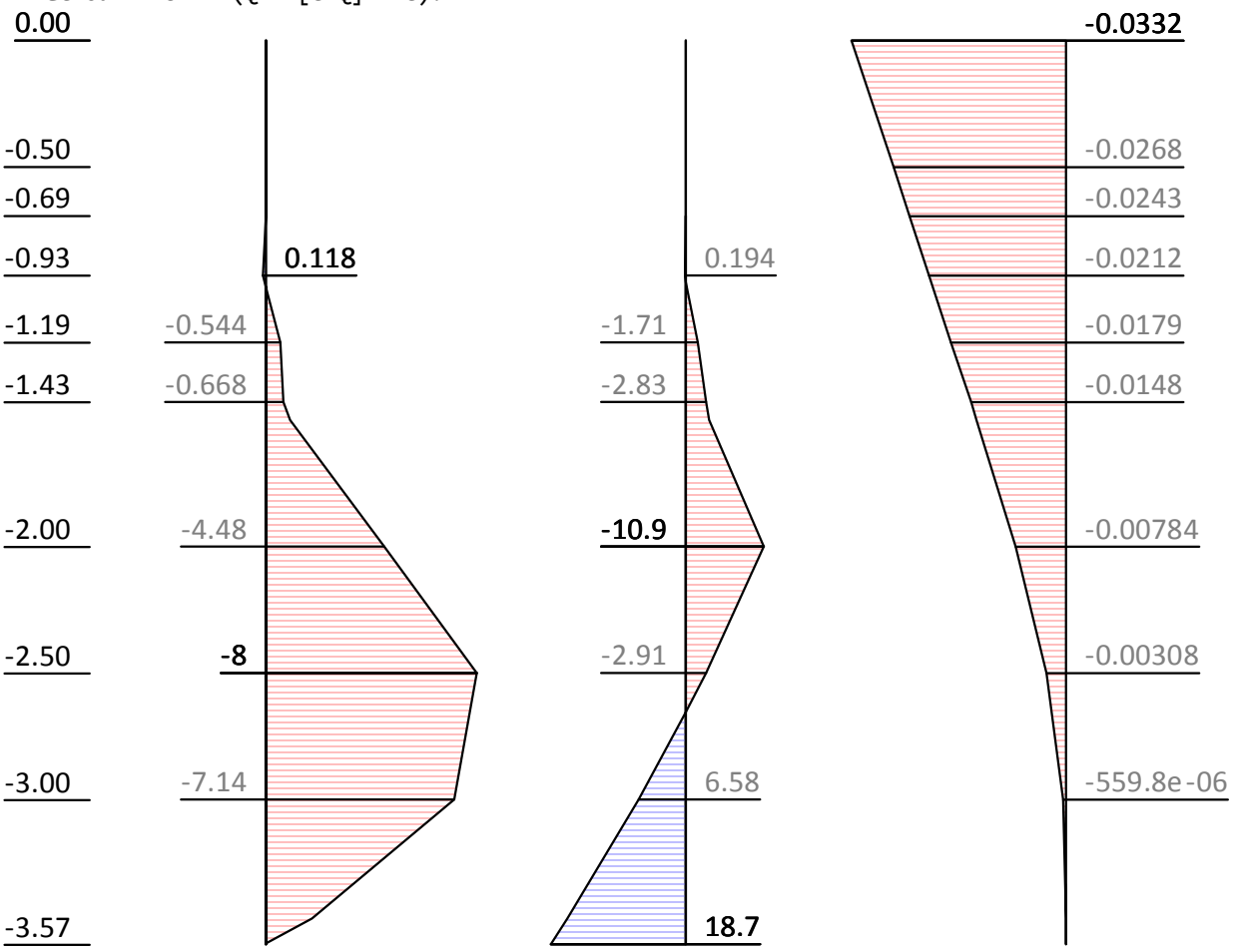
Internal forces: Permanent, characteristically



z [m]	H,g,k [kN/m2]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [mm]
0.00	0.00	0.00	0.00	0.00	-0.03
-1.50	7.25	-2.07	-4.59	-33.13	-0.01
-1.50	4.82	-2.07	-4.59	-33.13	-0.01
-2.00	6.61	-5.05	-7.45	-43.63	-0.01
-2.00	-13.38	-5.05	-7.45	-43.63	-0.01
-2.50	-13.60	-7.09	-0.71	-54.12	-0.00
-2.55	-13.62	-6.95	-0.00	-55.21	-0.00
-3.57	-13.93	0.00	14.03	-71.77	-0.00
-3.57	-13.93	0.00	14.03	-71.77	0.00

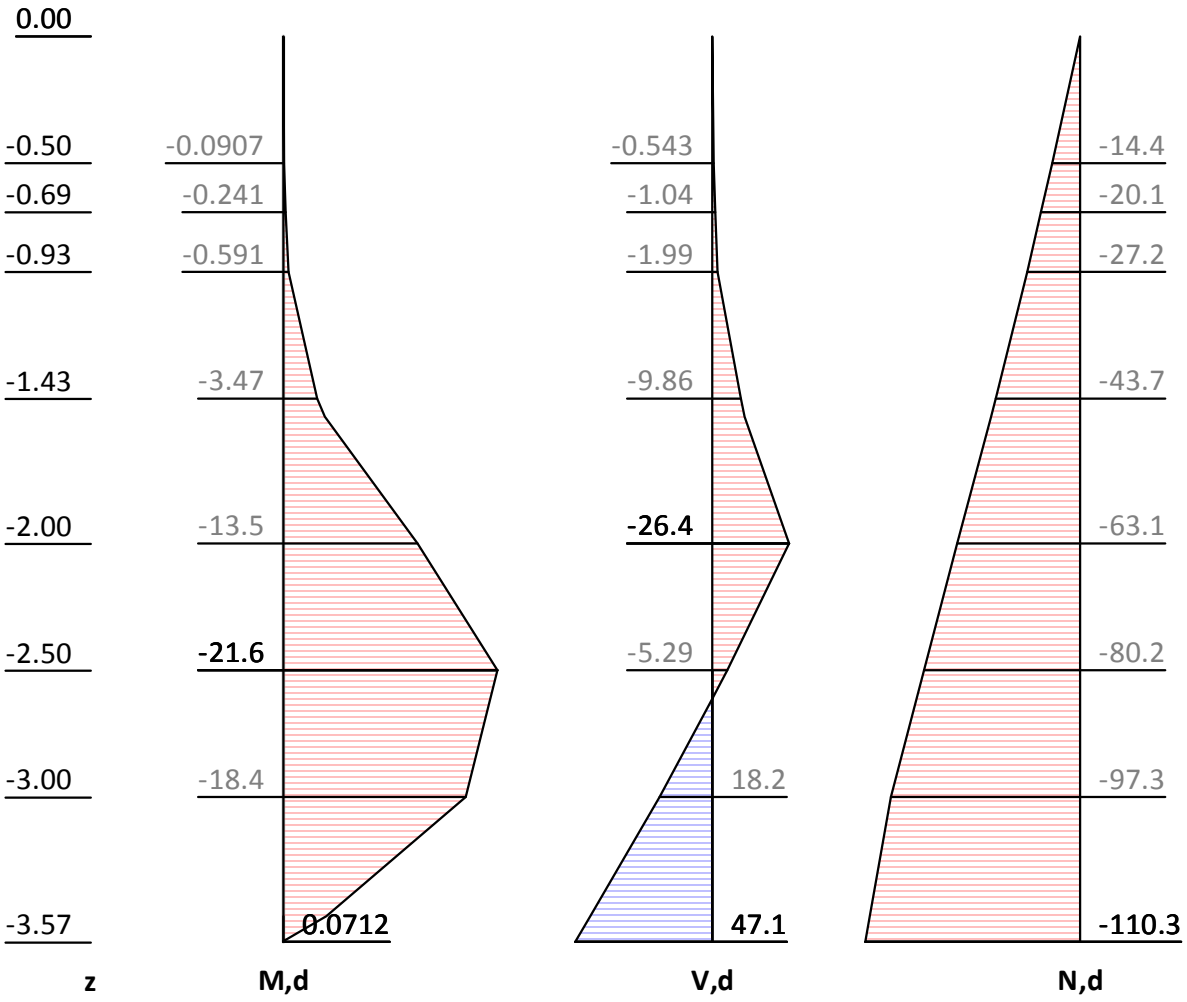
Internal forces: Variable, characteristically

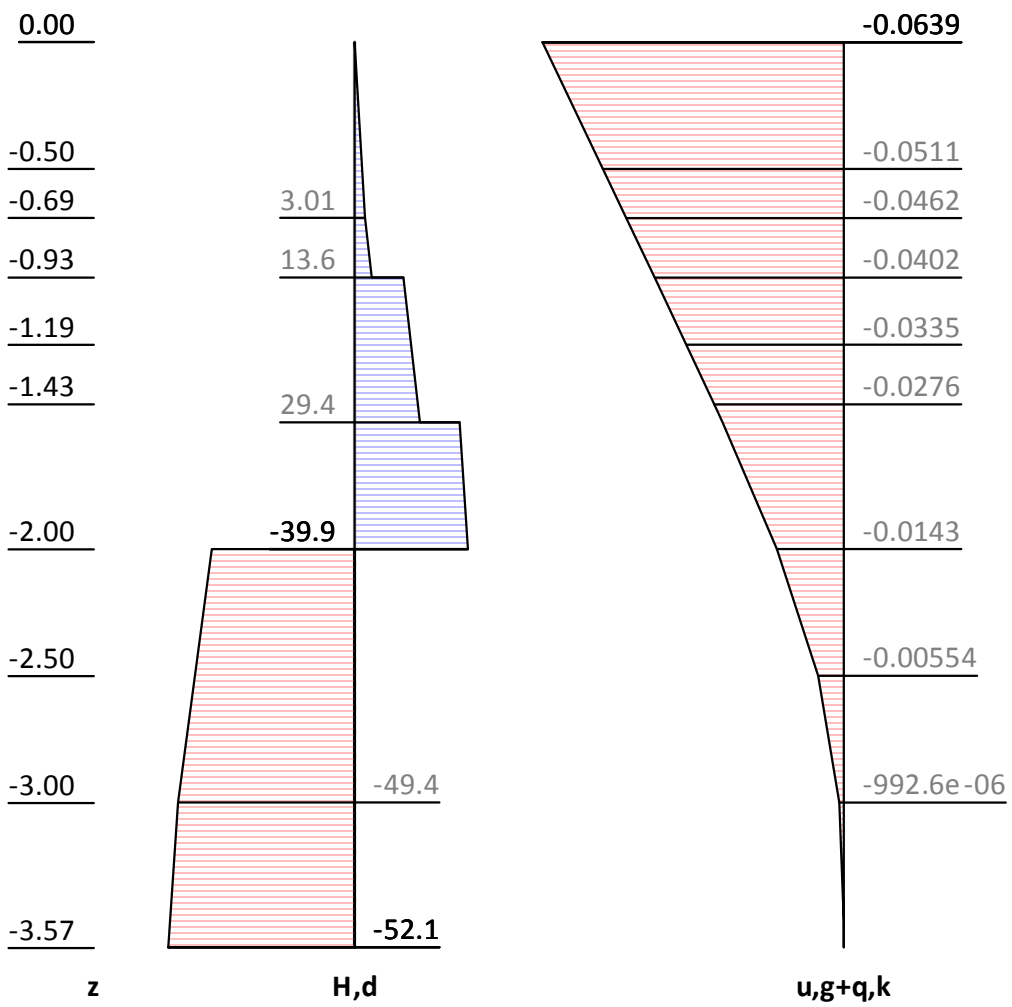
Method EB 82-4 (Q = [G+Q] - G).



z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
0.00		0.00	0.00		-0.03
-0.69		0.00	-0.00	0.00	-0.02
-0.69		-0.00	0.00	0.00	-0.02
-0.93	0.00	0.12	0.19	0.05	-0.02
-0.93	5.76	0.12	0.19	0.05	-0.02
-0.95	5.76	0.06	0.02	0.00	-0.02
-0.96	5.76	0.05	-0.00	-0.00	-0.02
-0.98	5.76	0.00	-0.14	-0.04	-0.02
-1.50	5.76	-0.94	-3.28	-0.85	-0.01
-1.50	15.23	-0.94	-3.28	-0.85	-0.01
-2.00	15.23	-4.48	-10.90	-2.81	-0.01
-2.00	-14.50	-4.48	-10.90	-2.81	-0.01
-2.50	-17.48	-8.00	-2.91	-4.76	-0.00
-2.65	-18.39	-7.73	-0.00	-5.36	-0.00
-3.57	-22.15	-0.00	18.69	-8.92	-0.00
-3.57	-22.15	0.00	18.69	-8.92	0.00

Internal forces: Design

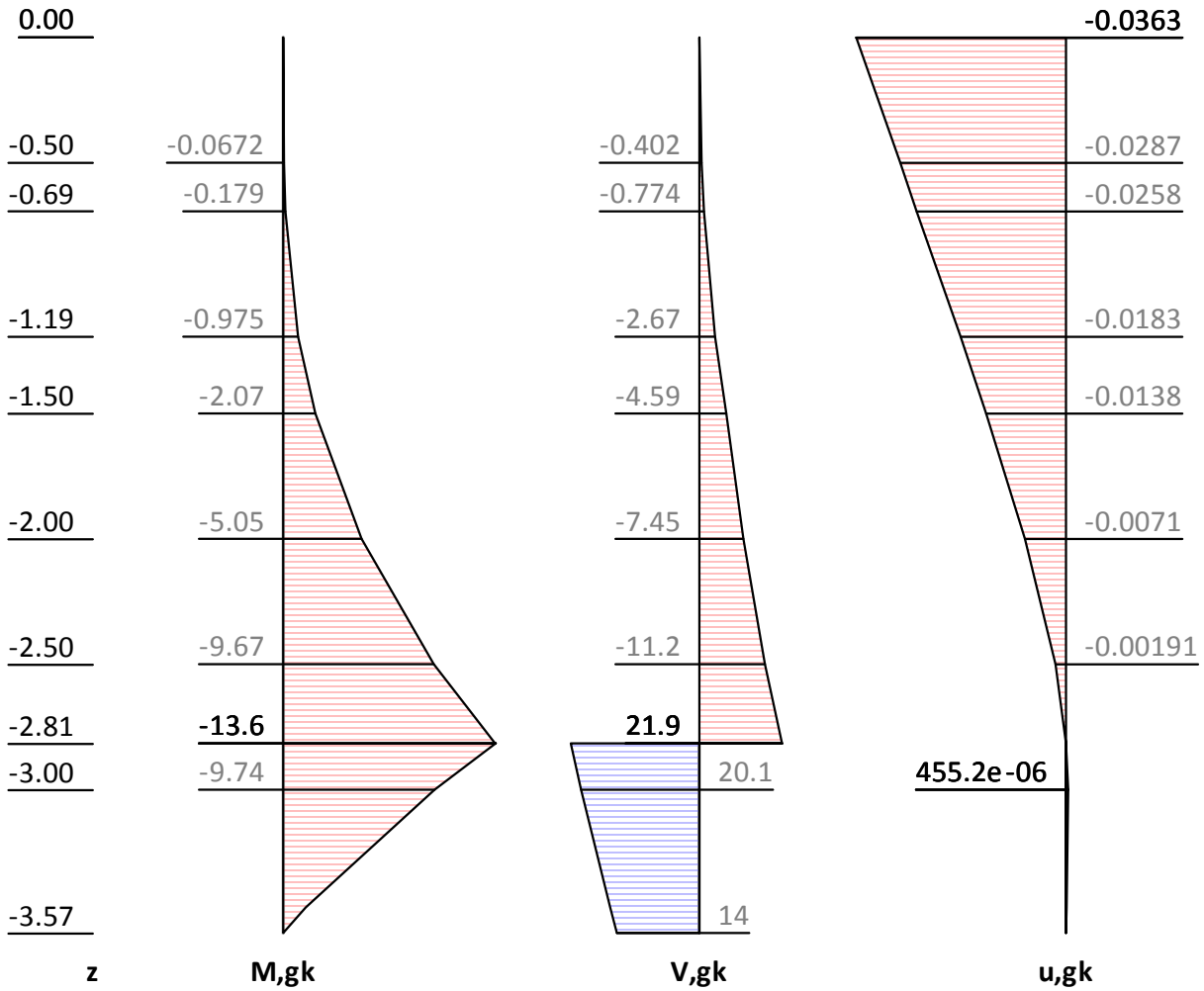




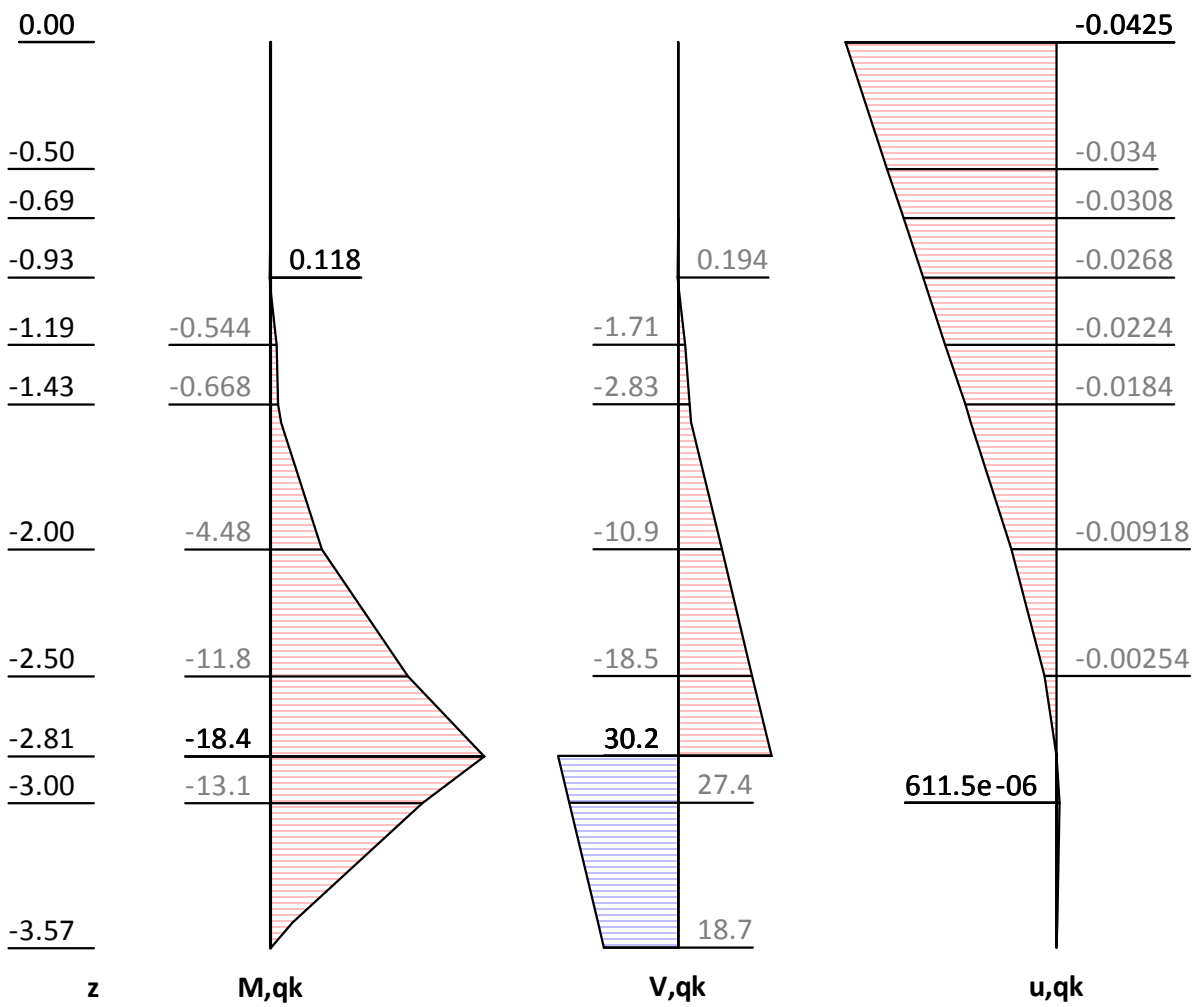
z [m]	H,d [kN/m2]	M,d [kN/m2]	V,d [kN/m2]	N,d [kN/m2]	u,g+q,k [mm]
0.00	0.00	0.00	0.00	0.00	-0.06
-0.93	5.00	-0.59	-1.99	-27.21	-0.04
-0.93	13.64	-0.59	-1.99	-27.21	-0.04
-1.50	18.43	-4.20	-11.13	-45.99	-0.03
-1.50	29.36	-4.20	-11.13	-45.99	-0.03
-2.00	31.77	-13.53	-26.41	-63.12	-0.01
-2.00	-39.87	-13.53	-26.41	-63.12	-0.01
-2.50	-44.63	-21.56	-5.29	-80.21	-0.01
-2.61	-45.68	-20.87	-0.00	-83.97	-0.00
-3.57	-52.10	-0.00	47.00	-110.24	-0.00
-3.57	-52.10	0.07	47.08	-110.27	0.00

Checks of earth statics

Substitute system according to Blum



z [m]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [kN/m2]
0.00	0.00	0.00	0.00	-0.04
-2.81	-13.63	-14.02	-60.75	-0.00
-2.81	-13.63	-14.02	-60.75	0.00
-2.81	-13.63	21.94	-60.75	0.00
-3.00	-9.74	20.11	-64.64	0.00
-3.57	0.00	14.03	-71.82	0.00



z [m]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [kN/m2]
0.00	0.00	0.00	0.00	-0.04
-0.69	-0.00	-0.00	0.00	-0.03
-0.69	0.00	0.00	0.00	-0.03
-0.93	0.12	0.19	0.05	-0.03
-0.95	0.06	0.02	0.00	-0.03
-0.96	0.05	0.00	-0.00	-0.03
-0.98	-0.00	-0.14	-0.04	-0.03
-2.81	-18.42	-23.31	-6.02	0.00
-2.81	-18.42	30.18	-6.02	0.00
-3.00	-13.10	27.36	-6.74	0.00
-3.57	0.00	18.69	-8.98	0.00

Bh,gk = -35.96; Ch,gk = 14.03 [kN/m]
Bh,qk = -53.49; Ch,qk = 18.69 [kN/m]
Bh,d = -128.78; Ch,d = 46.99 [kN/m]

Check of C-force (foot support)

```
z(C)                                          =   -3.57 [kN/m]
G,k = sum(γ*h)                                =   62.69 [kN/m]
P,k = sum(Pz,k(x=  0.1))                      =    0.00 [kN/m]
kpgh,C(phi=  0.1; δ,C=  0.0°)                 =   1.002 [-]
kpch,C                                        =   2.003 [-]
eph,C,gk =(G,k+P,k)*kpgh,C+2*c*sqrt(kpch,C)=  204.34 [kN/m2]
         = (62.69+0.00)*1.002+2*50.0*1.415
Ed = Ch,d                                     =   46.99 [kN/m2]
δ,t,EAU          = Ed/(2*eph,C,d)             =    0.16 [m]
δ,t,EAB          =  0.20 * t                  =    0.31 [m]
δ,t = δ,t,EAB                                 =    0.31 [m]
Rd = 2*δ,t*eph,C,gk/γ,Re
   = 2*0.31*204.34/1.4
                                              =   91.59 [kN/m2]
```

Ed/Rd = 0.513 [-]. Passes requirement

Check or earth support

Check: Mobilizable earth resistance is sufficient for earth support force.
z: -2.81 m
Rd = Eph,k/γ,Re = 180.43 / 1.400 = 128.88 [kN/m]

Ed(Bh,d)/Rd = 128.78 / 128.88 = 0.999 [-]. Passes requirement

Sum of H and V forces, (G)

Forces up to depth z:-3.57

Pos.	H	V
H/V pressure G+P+W,k	21.92	1.65
Wall weight		74.12
H/V pressure passive		0.00
Bh,g,k z=-2.81	-35.96	
Bv,g,k = Bh,k * tan(δ,p=-0.07°)		-0.04
Ch,g	14.03	
Cv,g = Ch*tan(δ,C=0.0°)		0.01
Σ	-0.00	75.74 (downwards)

Simple check, EAB R 9-3a

Vk >= Bvk: 75.78 >= 0.04 Passes requirement

Sum of H and V forces, (G+Q)

Forces up to depth z:-3.57

Pos.	H	V
H/V pressure G+P+W,k	56.72	10.63
Wall weight		74.12
H/V pressure passive		0.00
Bh,g,k z=-2.81	-35.96	
Bv,g,k = Bh,k * tan(δ,p=-0.07°)		-0.04
Bh,q,k z=-2.81	-53.49	
Bv,q,k = Bh,k * tan(δ,p=-0.07°)		-0.06
Ch,g	14.03	
Cv,g = Ch*tan(δ,C=0.0°)		0.01
Ch,q	18.69	
Cv,q = Ch*tan(δ,C=0.0°)		0.01
Σ	0.00	84.66 (downwards)

Simple check, EAB R 9-3a

Vk >= Bvk: 84.77 >= 0.10 Passes requirement

Υπολογ. κύκλου ολίσθησης

LC: όλα τα φορτία Type: BS-T (combination: [GEO] A2 M2 R3, BS-T)
Vertical variable loads only act if they are outside of R*sin(phi).
The automatic slip circle optimization only considers circles that intersect
the surface with an area of at least 0.25 m2.
The slip circle calculation only accepts circles including the wall.
The slipcircle calculation only allows circular failure planes
(no vertical tangents will occour).

Γεωμετ.κύκλου (μήκη και συντεταγμ. σε (m))
Κέντρο = (0.79, 1.98), Ακτίνα = 5.93
Αρχ.σημ.= (-3.61, -2.00), Τελ.σημ. = (6.37, 0.00)

Γεωμετρία λωρίδων:

No	x	Width b	dxM	Weight	Load z-κατ.	Water-φορτ.	u*b	φ	c	θ
	[m]	[m]	[m]	[kN/m]	[kN/m]	[kN/m]	[kN/m]	[°]	[kN/m²]	[°]
1	-3.31	0.59	-4.09	3.6	0.0	0.0	-0.0	0.08	35.71	-43.68
2	-2.72	0.59	-3.50	9.5	0.0	0.0	-0.0	0.08	35.71	-36.20
3	-2.12	0.59	-2.91	14.0	0.0	0.0	-1.0	0.08	35.71	-29.38
4	-1.53	0.59	-2.32	17.5	0.0	0.0	-2.8	0.08	35.71	-22.99
5	-0.94	0.59	-1.72	20.0	0.0	0.0	-4.0	0.08	35.71	-16.89
6	-0.34	0.59	-1.13	21.8	0.0	0.0	-4.9	0.08	35.71	-10.99
7	0.25	0.59	-0.54	42.9	0.0	0.0	-5.4	0.08	35.71	-5.20
8	0.84	0.59	0.06	45.0	0.0	0.0	-5.6	0.08	35.71	0.54
9	1.43	0.59	0.65	44.6	0.0	0.0	-5.3	0.08	35.71	6.28
10	2.03	0.59	1.24	43.4	8.4	0.0	-4.8	0.08	35.71	12.09
11	2.62	0.59	1.83	41.5	15.4	0.0	-3.8	0.08	35.71	18.02
12	3.21	0.59	2.43	38.8	15.4	0.0	-2.5	0.08	35.71	24.17
13	3.81	0.59	3.02	35.2	15.4	0.0	-0.8	0.08	35.71	30.63
14	4.40	0.59	3.61	30.4	15.4	0.0	-0.0	0.08	35.71	37.55
15	4.99	0.59	4.21	24.2	15.4	0.0	-0.0	0.08	35.71	45.19
16	5.58	0.59	4.80	16.0	15.4	0.0	-0.0	20.46	1.43	54.04
17	6.13	0.49	5.34	5.2	12.8	0.0	-0.0	20.46	1.43	64.28

Συνεισφ. κατακόρυφων φορτίων:

No	Weight	G*sin(θ)	(G-u*b)*tan(φ) + c*b	μ*sin(θ)* tan(φ)+cos(θ)	T
	[kN/m]	[kN/m]	[kN/m]	[-]	[kN/m]
1	3.61	-2.49	21.18	0.722903	29.30
2	9.49	-5.60	21.19	0.806677	26.26
3	14.02	-6.88	21.19	0.871145	24.33
4	17.48	-6.83	21.19	0.920369	23.03
5	20.03	-5.82	21.20	0.956702	22.15
6	21.77	-4.15	21.20	0.981574	21.59
7	42.92	-3.89	21.23	0.995843	21.31
8	44.99	0.42	21.23	0.999960	21.23
9	44.57	4.88	21.23	0.994052	21.35
10	51.84	10.86	21.24	0.977933	21.72
11	56.96	17.62	21.25	0.951084	22.34
12	54.25	22.21	21.25	0.912555	23.28
13	50.60	25.78	21.24	0.860778	24.68
14	45.85	27.94	21.24	0.793159	26.78
15	39.66	28.13	21.23	0.705148	30.11
16	31.40	25.41	12.56	0.698375	17.98
17	18.00	16.22	7.42	0.557759	13.30
		143.82			390.74

Δράση Ed = (143.8*5.93)
Αντίσταση Rd = (390.7*5.93 +0.0)

SLIP-CIRCLE μ = Ed/Rd = 0.37 < 1.0: Έλεγχος εκπληρώθηκε.

Φάση εκσκαφής 2 "[2] Situation 2"

LC: όλα τα φορτία Type: BS-T

Εδαφικό σύστημα με 5 Στρώσεις

Name		Τεχνητές επιχωματώσεις	Αμμώδης ΑΡΓΙΛΟΣ	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
γ	[kN/m3]	18	20	22.5
γ,R	[kN/m3]	18	20	22.5
γ'	[kN/m3]	8	10	12.5
γ,p	[kN/m3]	18	20	22.5
γ,R,passive	[kN/m3]	18	20	22.5
γ,pw	[kN/m3]	8	10	12.5
φ	[°]	25	0.1	33
c	[kN/m2]	2	50	5
c,u	[kN/m2]	10	50	5
c παθητικό	[kN/m2]	2	50	5
δ,a	[°]	16.66667	0.06666667	22
δ,p	[°]	-16.66667	-0.06666667	-22
δ,c	[°]	8.333333	0.03333333	11
k,agh	[-]	0.3456501	0.9955057	0.2452023
K,ach	[-]	1.043051	1.994195	0.8549058
K,0h	[-]	0.5773817	0.9982547	0.455361
K,pgh	[-]	3.908103	1.004519	7.495617
K,pch	[-]	5.180327	2.00583	8.599509
τ,gr	[kN/m2]	110	110	110
Ψ,A,max	[°]	90	90	90
k	[cm/s]	10e-06	1e-06	100e-06

Name		Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
γ	[kN/m3]	22.5	22.5
γ,R	[kN/m3]	22.5	22.5
γ'	[kN/m3]	12.5	12.5
γ,p	[kN/m3]	22.5	22.5
γ,R,passive	[kN/m3]	22.5	22.5
γ,pw	[kN/m3]	12.5	12.5
φ	[°]	35	35
c	[kN/m2]	5	5
c,u	[kN/m2]	5	5
c παθητικό	[kN/m2]	5	5
δ,a	[°]	23.33333	23.33333
δ,p	[°]	-23.33333	-23.33333
δ,c	[°]	11.66667	11.66667
k,agh	[-]	0.2244207	0.2244207
K,ach	[-]	0.8126539	0.8126539
K,0h	[-]	0.4264236	0.4264236
K,pgh	[-]	9.146943	9.146943
K,pch	[-]	10.104	10.104
τ,gr	[kN/m2]	110	110
Ψ,A,max	[°]	90	90
k	[cm/s]	100e-06	100e-06

Πορεία πρανούς:
x [m] 0.00 0.00
z [m] -2.00 0.00

Πορεία ανώτερου 2. στρώματος Αμμώδης ΑΡΓΙΛΟΣ:
x [m] 0.00 0.00
z [m] -2.00 -1.50

Πορεία ανώτερου 3. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ:
z= -4.50

Πορεία ανώτερου 4. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -10.00

Πορεία ανώτερου 5. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -14.00

Επιφ. φορτία:

Φορτία

xA [m]	zA [m]	xE [m]	zE [m]	PxA [kN/m²]	PzA [kN/m²]	PxE [kN/m²]	PzE [kN/m²]	Typ	LC-description Name
2.00	0.00	8.50	0.00	0.00	20.00	0.00	20.00	q	1

Κατανομή εδαφ.πιέσεων

Κατανομή εδαφ.πιέσεων	Name
Rectangular within a layer	

Στάθμη νερού:

x [m] 0.00
z [m] -3.00

Αγκύρια

z[m]	min.l[m]	Alpha[°]	C-H[kN/m]	P0[kN]	u0[m]
-0.50	0.00	15.00	αόριστ.	0.00	0.0000

Παράμετροι υπολογισμού

Earth pressure options

Τμήμα εδαφ.ωθήσεων: Ενεργές ωθήσεις.
Angle of slip plane: DIN 4085.
Split block loads into 1 sections.
Consideration of minimum earth pressure: φ,min = 40.000.
Negative earth pressure fractions are set to zero.

Redistribution of earth pressure

Shape of redistribution: Trapezoid.
The earth pressure is getting redistb. to: Excavation level
The earth pressure below the excavation acts without redistrb.
Levels of redistribution Z1: 0.000, Z2: -1.000 [m].
The earth pressure from variable loads will be included in redistribution.

Παθητικές ωθήσεις

Method of calculation: Κλασικός, Pregl/Sokolovsky (DIN 4085).

Options for water pressure

Στήριξη πόδα

Πόδας οριζοντίως μετακινούμενος

Αγκύρια

Anchor checks (lower failure plane): Ναι
Anchor forces with safety level of DS-P: Ναι
Verification of grout body pull out forces: Ναι
δ,a,Anchoring wall : used from soil layer.
δ,p,Anchoring wall : used from soil layer.

Earth pressure coefficients kh

φ	α	β	δ	k0gh	kagh	kach	kpgh	kpch	
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Τεχνητές επιχωματώσεις
25.0	0.0	0.0	16.7	--	0.346	1.043	--	--	"
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Αμμώδης ΑΡΓΙΛΟΣ
0.1	0.0	0.0	0.1	--	0.996	1.994	--	--	"
33.0	0.0	0.0	-22.0	--	--	--	7.496	-8.600	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
33.0	0.0	0.0	22.0	--	0.245	0.855	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"

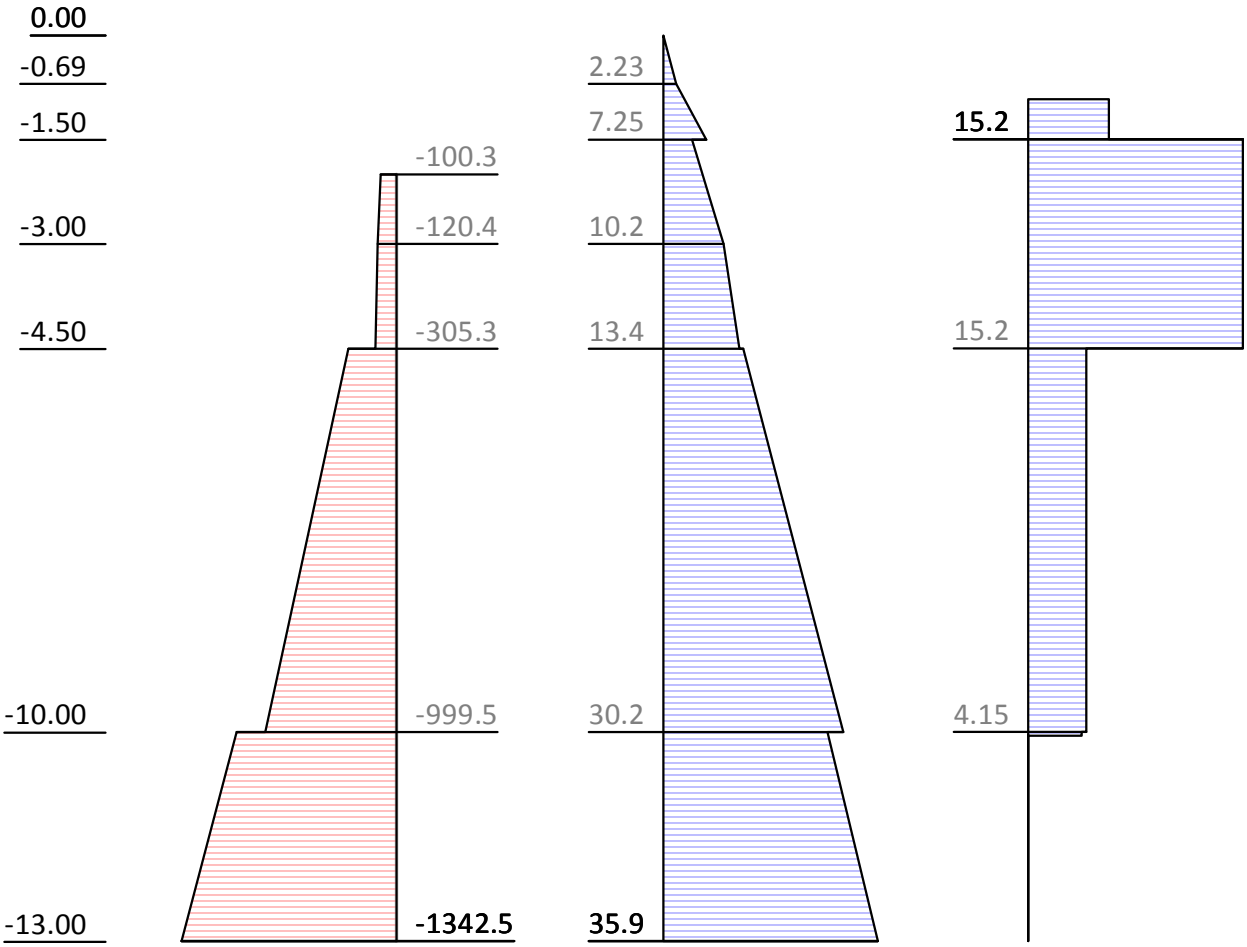
Μήκος τοίχου

Foot depth for statics: zf = -13.000

Stress analysis

Earth pressure, horizontal

Pressures characteristic, no redistribution, continous wall

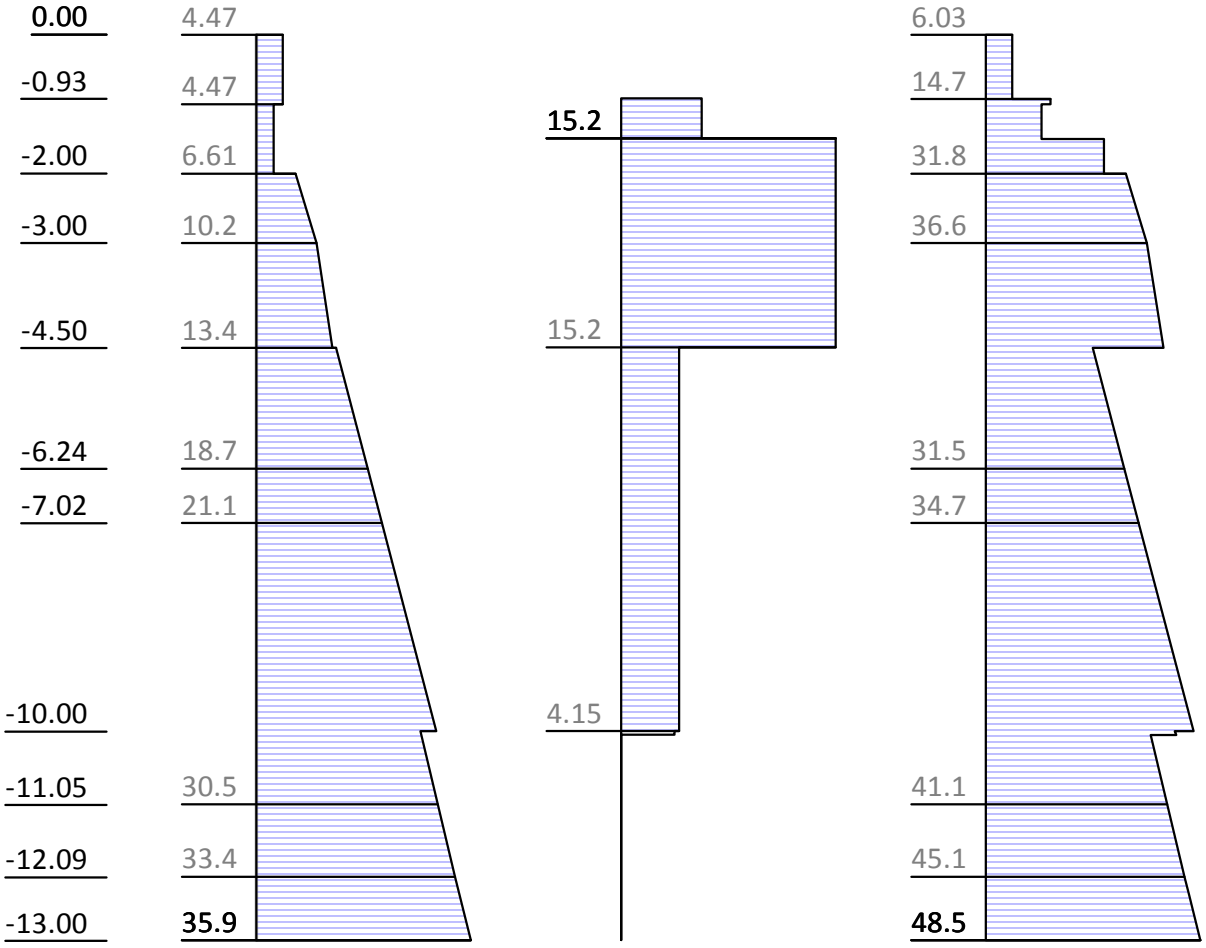


z [m]	eph,G,k [kN/m2]	eah,G,k [kN/m2]	eah,PQ,k [kN/m2]	eah,d [kN/m2]
0.00		0.00		0.00
-0.93		3.72	0.00	5.00
-0.93		3.72	5.76	13.64
-1.50		7.25	5.76	18.43
-1.50		4.82	15.23	29.36
-2.00	-0.00	6.61	15.23	31.77
-2.00	-100.29	6.61	15.23	31.77
-4.50	-135.45	12.86	15.23	40.21
-4.50	-305.34	13.38	4.15	24.29
-10.00	-820.67	30.24	4.15	47.05
-10.00	-999.52	27.52	3.81	42.87
-10.06	-1006.38	27.69	3.81	43.10
-10.06	-1006.38	27.69	0.00	37.38
-13.00	-1342.53	35.94	0.00	48.52

Eph,G,k:-6911.80, Eph,PG,k: 0.00 [kN/m]
Eah,G,k: 248.27, Eah,PG,k: 0.00, Eah,PQ,k: 72.04, Eah,d: 443.22

H-pressure on static system

Level of mobilization: Ep,gk 100.0, Ep,qk 100.0, Ep,d 100.0 [%]

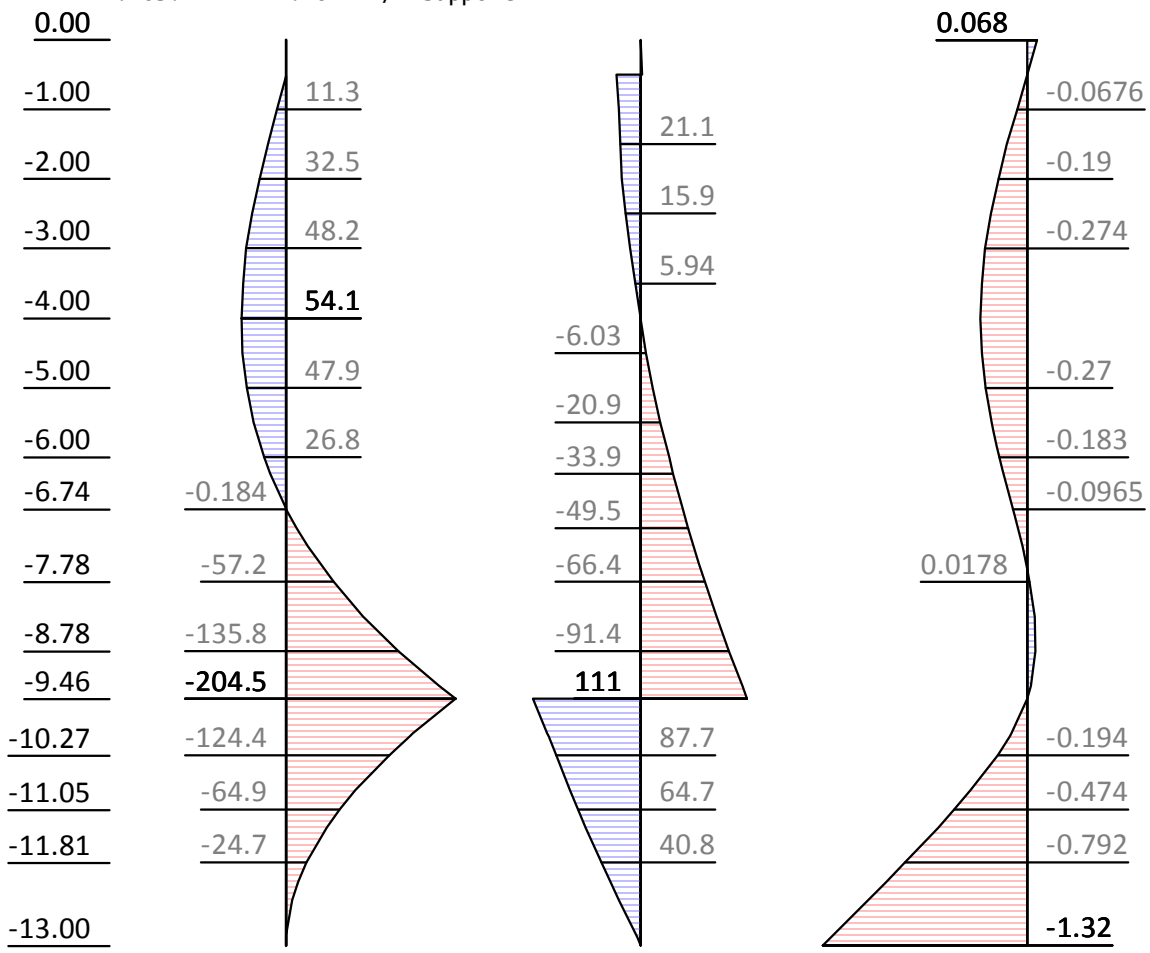


z [m]	PH,gk [kN/m2]	PH,qk [kN/m2]	PH,d [kN/m2]
0.00	4.47		6.03
-0.93	4.47	0.00	6.03
-0.93	4.47	5.76	14.68
-1.00	4.47	5.76	14.68
-1.00	2.98	5.76	12.67
-1.50	2.98	5.76	12.67
-1.50	2.98	15.23	26.88
-2.00	2.98	15.23	26.88
-2.00	6.61	15.23	31.77
-4.50	12.86	15.23	40.21
-4.50	13.38	4.15	24.29
-10.00	30.24	4.15	47.05
-10.00	27.52	3.81	42.87
-10.06	27.69	3.81	43.10
-10.06	27.69	0.00	37.38
-13.00	35.94	0.00	48.52

V-pressure on static system

Internal forces: Permanent, characteristically

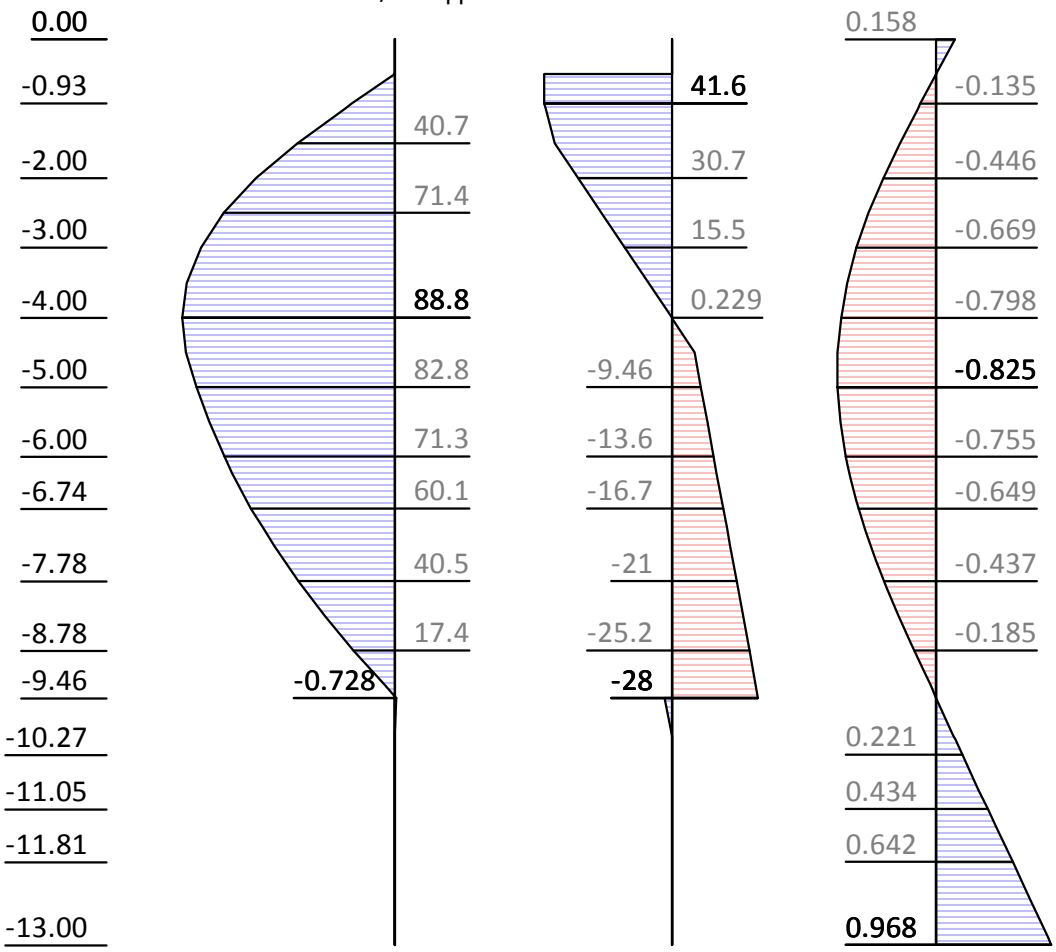
z= -0.500. Fx= -27.099 kN/m Support
z= -9.463. Fx=-221.169 kN/m Support



z [m]	H,g,k [kN/m2]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [mm]
0.00	4.47	0.00	-0.00	0.00	0.07
-0.50	4.47	-0.56	-2.23	-10.91	0.00
-0.50	4.47	-0.56	-2.23	-10.91	-0.00
-0.50	4.47	-0.56	24.86	-18.17	-0.00
-0.52	4.47	-0.00	24.76	-18.69	-0.00
-1.00	4.47	11.31	22.63	-29.09	-0.07
-1.00	2.98	11.31	22.63	-29.09	-0.07
-2.00	2.98	32.45	19.65	-50.64	-0.19
-2.00	6.61	32.45	19.65	-50.64	-0.19
-4.00	11.97	54.06	0.18	-84.27	-0.30
-4.01	11.99	54.02	-0.00	-84.45	-0.30
-4.50	12.86	52.62	-6.03	-90.57	-0.29
-4.50	13.38	52.62	-6.03	-90.57	-0.29
-6.74	20.23	0.00	-43.59	-133.92	-0.10
-7.60	22.89	-46.50	-62.42	-152.47	0.00
-8.78	26.50	-135.80	-91.37	-178.98	0.06
-9.46	28.58	-204.51	-110.18	-195.19	0.00
-9.46	28.58	-204.51	110.99	-195.19	0.00
-9.46	28.58	-204.51	110.99	-195.19	-0.00
-10.00	30.24	-149.11	95.20	-208.34	-0.12
-10.00	27.52	-149.11	95.20	-208.34	-0.12
-13.00	35.94	0.00	0.00	-287.20	-1.32

Internal forces: Variable, characteristically

Method EB 82-4 (Q = [G+Q] - G).
z= -0.500. Fx= -41.597 kN/m Support
z= -9.463. Fx= -30.442 kN/m Support

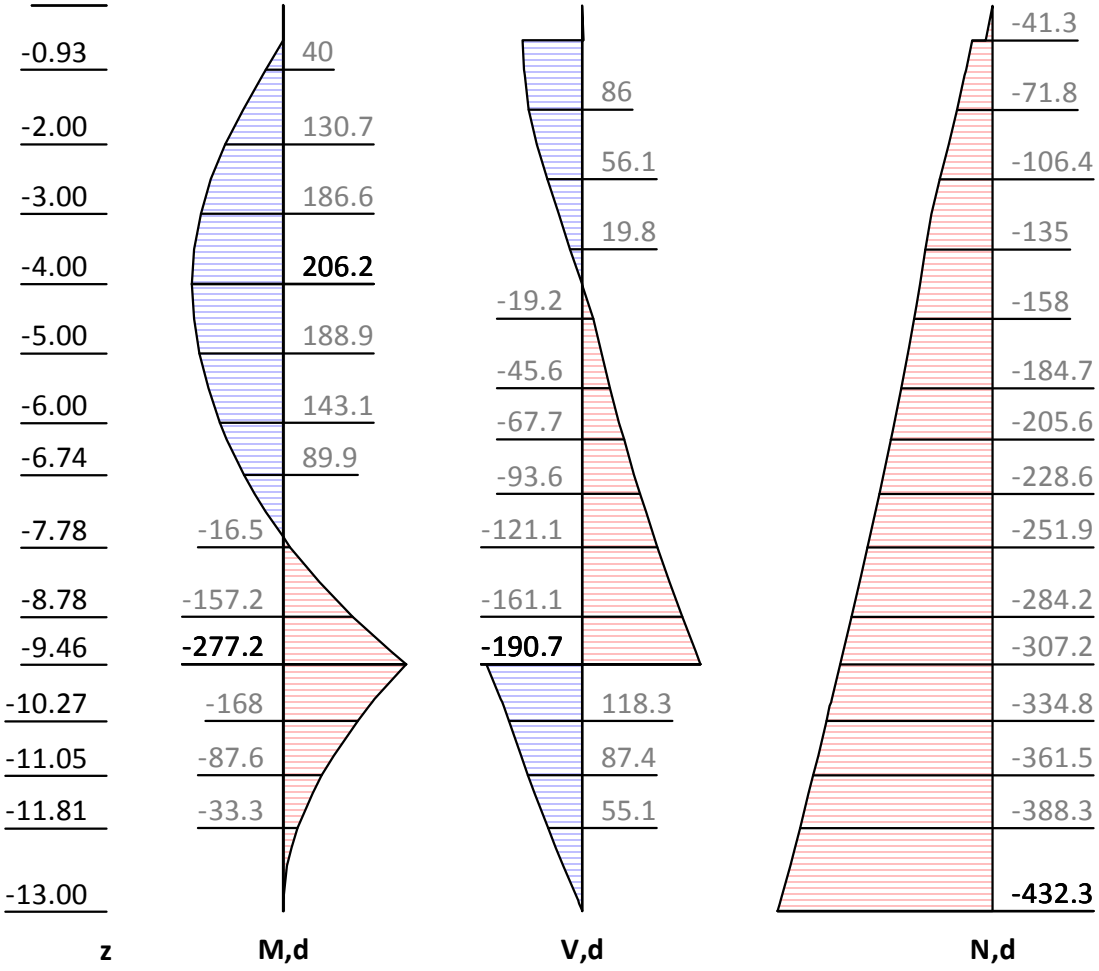


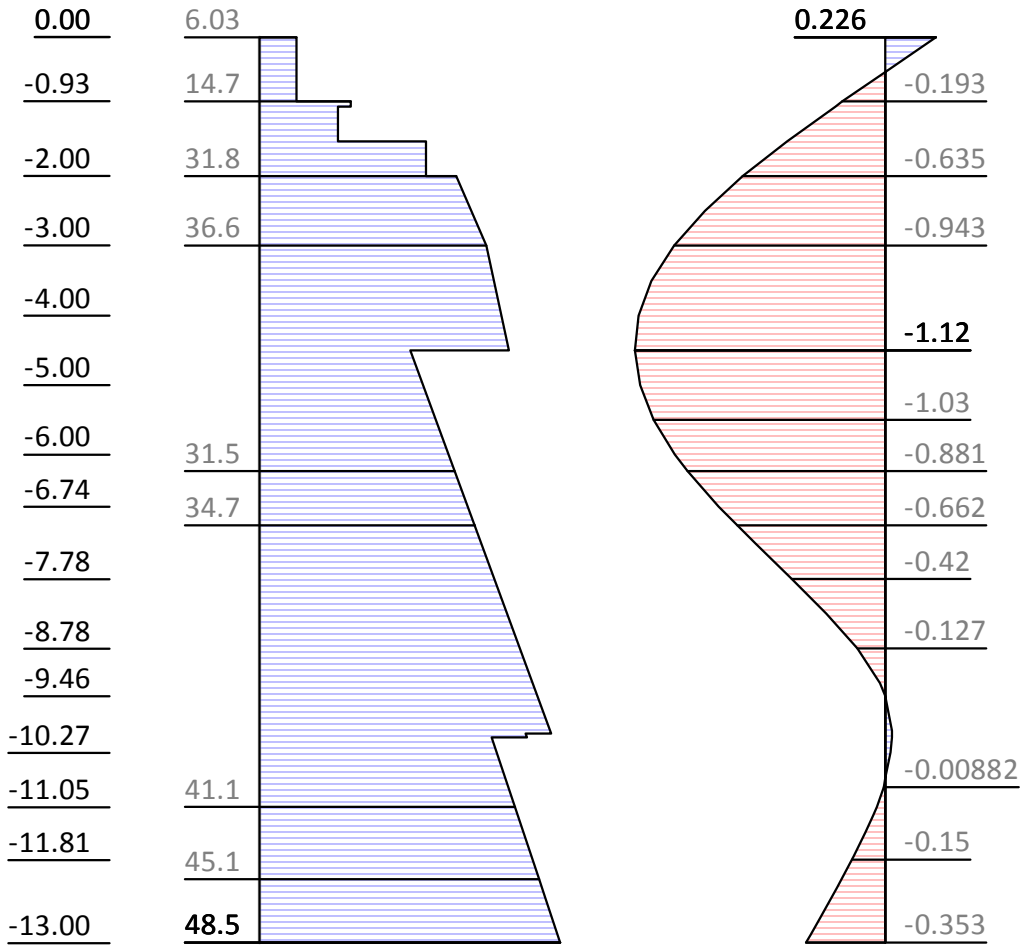
z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
0.00		0.00	0.00	0.00	0.16
-0.50		0.00	0.00	0.00	0.00
-0.50		0.00	0.00	0.00	-0.00
-0.50		0.00	41.60	-11.15	-0.00
-0.93	0.00	17.95	41.60	-11.15	-0.13
-0.93	5.76	17.95	41.60	-11.15	-0.13
-1.50	5.76	40.66	38.31	-11.99	-0.31
-1.50	15.23	40.66	38.31	-11.99	-0.31
-4.00	15.23	88.83	0.23	-21.82	-0.80
-4.02	15.23	88.77	-0.00	-21.88	-0.80
-4.50	15.23	87.05	-7.39	-23.79	-0.82
-4.50	4.15	87.05	-7.39	-23.79	-0.82
-5.00	4.15	82.83	-9.46	-24.32	-0.82
-9.43	4.15	0.00	-27.88	-29.07	-0.01
-9.46	4.15	-0.73	-27.98	-29.10	0.00
-9.46	4.15	-0.73	2.46	-29.10	0.00
-10.00	4.15	-0.01	0.23	-29.68	0.15
-10.00	3.81	-0.01	0.23	-29.68	0.15
-10.00	3.81	0.00	0.22	-29.68	0.15
-10.06	3.81	0.18	0.02	-29.73	0.16
-10.06	0.00	0.18	0.02	-29.73	0.16

z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
-10.27	0.00	0.00	-0.00	-29.74	0.22
-11.31	0.00	0.00	-0.00	-29.74	0.51
-12.09	0.00	0.00	-0.00	-29.74	0.72
-12.88	0.00	-0.00	-0.00	-29.74	0.94
-13.00	0.00	-0.00	-0.00	-29.74	0.97

Internal forces: Design

z= -0.500. Fx= -98.979 kN/m Support
z= -9.463. Fx=-344.242 kN/m Support





z [m]	H,d [kN/m2]	M,d [kN/m2]	V,d [kN/m2]	N,d [kN/m2]	u,g+q,k [mm]
0.00	6.03	0.00	-0.00	0.00	0.23
-0.00	6.03	0.00	-0.00	-0.00	0.23
-0.50	6.03	-0.75	-3.02	-14.73	0.00
-0.51	6.03	0.00	95.91	-41.49	-0.00
-0.93	6.03	39.95	93.37	-53.93	-0.19
-0.93	14.68	39.95	93.37	-53.93	-0.19
-1.00	14.68	46.45	92.34	-56.15	-0.22
-1.00	12.67	46.45	92.34	-56.15	-0.22
-1.50	12.67	91.04	86.01	-71.81	-0.44
-1.50	26.88	91.04	86.01	-71.81	-0.44
-2.00	26.88	130.68	72.57	-89.30	-0.64
-2.00	31.77	130.68	72.57	-89.30	-0.64
-4.00	39.00	206.22	0.59	-146.49	-1.10
-4.01	39.04	206.09	-0.00	-146.83	-1.10
-4.50	40.21	201.61	-19.22	-157.95	-1.12
-4.50	24.29	201.61	-19.22	-157.95	-1.12
-7.63	37.25	-0.00	-115.73	-247.40	-0.47
-9.46	44.81	-277.18	-190.72	-307.16	0.00
-9.46	44.81	-277.18	153.53	-307.16	0.00
-10.00	47.05	-201.30	128.86	-325.77	0.03
-10.00	42.87	-201.30	128.86	-325.77	0.03
-10.06	43.10	-193.65	126.28	-327.85	0.03
-10.06	37.38	-193.65	126.28	-327.85	0.03
-10.64	39.60	-127.27	103.69	-347.53	0.00
-13.00	48.52	-0.00	0.00	-432.33	-0.35
-13.00	48.52	-0.00	-0.00	-432.33	-0.35

Anchor forces with safety level of DS-P

z[m]	A,d[kN]	Fx,d[kN/m]
-0.50	184.4	-99.0

Checks of earth statics

Check or earth support

Check: Mobilizable earth resistance is sufficient for earth support force.
z: -9.46 m
Rd = Eph,k/γ,Re = 6911.80 / 1.400 = 4937.00 [kN/m]

Ed(Uh,d)/Rd = 344.24 / 4937.00 = 0.070 [-]. Passes requirement

Sum of H and V forces, (G)

Forces up to depth z:-13.00

Pos.	H	V
H/V pressure G+P+W,k	248.27	90.93
Wall weight		189.01
H/V pressure passive		0.00
Support z: -0.50	-27.10	7.26
Bh,g,k z=-9.46	-221.17	
Bv,g,k = Bh,k * tan(δ,p=-22.00°)		-89.36
Σ	-0.00	197.84 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than
the downwards pointing vertical forces.

Vk >= Bvk: 287.20 >= 89.36 Passes requirement

Sum of H and V forces, (G+Q)

Forces up to depth z:-13.00

Pos.	H	V
H/V pressure G+P+W,k	320.31	109.52
Wall weight		189.01
H/V pressure passive		0.00
Support z: -0.50	-68.70	18.41
Bh,g,k z=-9.46	-221.17	
Bv,g,k = Bh,k * tan(δ,p=-22.00°)		-89.36
Bh,q,k z=-9.46	-30.44	
Bv,q,k = Bh,k * tan(δ,p=-22.00°)		-12.30
Σ	0.00	215.28 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than
the downwards pointing vertical forces.

Vk >= Bvk: 316.94 >= 101.66 Passes requirement

Anchor verification

Anchor - Stability of lower failure plane

Περίπτ.Φόρτισης: όλα τα φορτία BS-P
Αυτόμ. υπολογ. μήκους αγκυρίων:
All anchors are extended (if necessary)
Favourable variable loads in main failure body are not being considered.
Bottom of lower failure plane: z=-13.00 m

Iteration of failure mechanisms:
lA .....: Length of anchor from head to center of grout body.
W,k .....: Res. force from dead weight, loads, cohesion, ...
Q,k .....: Force in lower failure plane.
Ea1,k.....: Earth pressure onto vertical separation plane.
Ea2,k.....: Earth pressure between wall and main failure body.
Ra_cal,d ...: Dimesioning force of the resistance from the equilibrium of forces. Ra_cal,d corresponds to the max. possible anchor force of the force polygon.
Sum(A,d) ...: Acting anchor forces along the grout body fractions within the failure body. Sum(A,d) is gained from the anchor pull forces of the wall analysis.

z [m]	ϑ1 [°]	ϑ2 [°]	lA [m]	W,k [kN/m]	Q,k [kN/m]	Ea1,k [kN/m]	Ea2,k [kN/m]	Ra_cal,d [kN/m]	Sum(A,d) [kN/m]	Ed/Rd [-]
-0.50	46.0	57.5	9.94	1138.8	1027.6	4.4	338.5	102.6	102.5	1.00

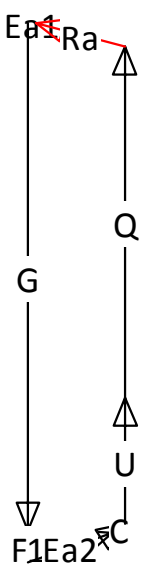
Decisive failure body:
Γεωμετρία:

Foot point of lower failure plane	x/z =	0.01/-13.00 m
Intersection lower/upper slid. plane	x/z =	9.60/ -3.07 m
Intersection upper slid. plane/surface	x/z =	11.56/ 0.00 m
Intersection separation plane/surface	x/z =	9.60/ 0.00 m
Inclination lower failure plane	ϑ1 =	45.98°
Inclination upper failure plane	ϑ2 =	57.50°
Inclination separation plane	ϑ12 =	90.00°

Loads / forces (char.)

		Fx [kN/m]	Fz [kN/m]	F [kN/m]	
Weight of main failure body	G,k:	0.0	-1600.4	1600.4	
Area loads on/in main failure body	F1,k:	0.0	-130.0	130.0	
Cohesion of lower failure plane	C,k:	110.0	113.8	158.3	
Pore water pressure on main body	U,k:	-0.0	483.2	483.2	
Earth pres. on separation plane	Ea1,k:	-4.4	-0.0	4.4	δ= 0.0°
Earth pr. between wall<->main body	Ea2,k:	320.3	109.5	338.5	
Force in lower failure plane	Q,k:	-287.1	986.7	1027.6	
Sum = possible anchor forces:	Ra_cal,k:	138.8	-37.2	143.7	

Force polygon



Acting anchor forces Ed: Sum(A,d) = 102.5 kN/m
Possible anchor forces Rd: Ra_cal,d = 143.7/1.400 = 102.6 kN/m

Verif. of lower failure plane Ed/Rd = 1.00 < 1.0: Έλεγχος εκπληρώθηκε.

Check of steel tension

l,tot ...[m]: Total length of anchor incl. excess length at head
As ....[mm2]: X-section are of steel member
Ri,d ...[kN]: Ultimate strength of tension member (γ,M=1.15)
A,d ....[kN]: Dimensioning force of the anchor from wall analysis

z[m]	Anchor type	l,tot	As	Ri,d		A,d	
-0.50	Strand;3x0.60";1570/1770	13.94	420	573.4	>	184.4	Passes requirement

Check of steel tension: Passes requirement

Check of anchor's soil friction

lVk .....: Length of grout body
DmVk ....: Diameter of grout body
τGr,k ...: Average applied skin friction along the grout body (from soil parameters)
Ra,k ....: Charact. pullout resistance of the anchor
γA .....: Partial safety factor of anchor pullout
Ra,d ....: = Ra,k / γA
A,d .....: Dimensioning force of the anchor from wall analysis

z [m]	lVk [m]	DmVk [mm]	τGr,k [kN/m²]	Ra,k [kN]	γA [-]	Ra,d [kN]		A,d [kN]	A,d/Ra,d [-]
-0.50	8.00	318	110	879.1	1.100	799.2	>	184.4	0.2

Check of anchor's soil friction: Passes requirement

Υπολογ. κύκλου ολίσθησης

LC: όλα τα φορτία Type: BS-T (combination: [GEO] A2 M2 R3, BS-T)
Vertical variable loads only act if they are outside of R*sin(phi).
The automatic slip circle optimization only considers circles that intersect
the surface with an area of at least 0.25 m2.
The slip circle calculation only accepts circles including the wall.
The slipcircle calculation only allows circular failure planes
(no vertical tangents will occour).

Γεωμετ.κύκλου (μήκη και συντεταγμ. σε (m))
Κέντρο = (-4.49, 0.03), Ακτίνα = 13.79
Αρχ.σημ.= (-18.13, -2.00), Τελ.σημ. = (9.30, 0.00)

Γεωμετρία λωρίδων:

No	x	Width b	dxM	Weight	Load z-κατ.	Water-φορτ.	u*b	φ	c	θ
	[m]	[m]	[m]	[kN/m]	[kN/m]	[kN/m]	[kN/m]	[°]	[kN/m²]	[°]
1	-17.44	1.38	-12.95	75.4	0.0	0.0	-22.6	27.45	3.57	-31.27*
2	-16.06	1.38	-11.57	161.2	0.0	0.0	-60.2	27.45	3.57	-31.27*
3	-14.68	1.38	-10.19	216.6	0.0	0.0	-85.5	27.45	3.57	-31.27*
4	-13.30	1.38	-8.81	257.5	0.0	0.0	-104.0	29.26	3.57	-30.37*
5	-11.92	1.38	-7.44	288.8	0.0	0.0	-118.0	29.26	3.57	-30.37*
6	-10.54	1.38	-6.06	312.9	0.0	0.0	-128.8	29.26	3.57	-26.05
7	-9.17	1.38	-4.68	331.0	0.0	0.0	-136.9	29.26	3.57	-19.82
8	-7.79	1.38	-3.30	343.9	0.0	0.0	-142.6	29.26	3.57	-13.83
9	-6.41	1.38	-1.92	352.2	0.0	0.0	-146.3	29.26	3.57	-8.00
10	-5.03	1.38	-0.54	356.0	0.0	0.0	-148.0	29.26	3.57	-2.24
11	-3.65	1.38	0.84	355.6	0.0	0.0	-147.8	29.26	3.57	3.49
12	-2.27	1.38	2.22	350.8	0.0	0.0	-145.7	29.26	3.57	9.26
13	-0.89	1.38	3.60	341.5	0.0	0.0	-141.6	29.26	3.57	15.12
14	0.49	1.38	4.98	371.1	0.0	0.0	-135.3	29.26	3.57	21.16
15	1.87	1.38	6.36	359.2	14.5	0.0	-126.7	29.26	3.57	27.45
16	3.25	1.38	7.74	333.7	35.9	0.0	-115.3	29.26	3.57	34.12
17	4.63	1.38	9.12	300.6	35.9	0.0	-100.4	29.26	3.57	41.37
18	6.01	1.38	10.49	257.1	35.9	0.0	-80.7	27.45	3.57	49.54
19	7.39	1.38	11.87	197.1	35.9	0.0	-53.1	27.45	3.57	59.42
20	8.69	1.23	13.18	95.6	11.0	0.0	-16.3	0.08	35.71	72.83

*** Σημείωση: Στις λωρίδες σημειωμένες με '*'
περιορίστηκε το theta στο 45°-Phi/2.

Συνεισφ. κατακόρυφων φορτίων:

No	Weight	G*sin(θ)	(G-u*b)*tan(φ) + c*b	μ*sin(θ)* tan(φ)+cos(θ)	T
	[kN/m]	[kN/m]	[kN/m]	[-]	[kN/m]
1	75.43	-70.83	32.36	0.817724	39.57
2	161.17	-135.24	57.41	0.817724	70.21
3	216.65	-160.12	73.04	0.817724	89.32
4	257.54	-164.59	90.95	0.823931	110.38
5	288.83	-155.71	100.62	0.823931	122.12
6	312.89	-137.39	108.06	0.864722	124.97
7	331.00	-112.24	113.67	0.914713	124.27
8	343.94	-82.23	117.69	0.952636	123.54
9	352.20	-48.99	120.25	0.979598	122.75
10	356.03	-13.92	121.44	0.996234	121.90
11	355.56	21.66	121.29	1.002821	120.95
12	350.78	56.44	119.81	0.999327	119.89
13	341.53	89.11	116.94	0.985400	118.67
14	371.13	133.95	137.03	0.960318	142.69
15	373.73	172.26	143.32	0.922844	155.31
16	369.57	207.30	147.39	0.870953	169.23
17	336.44	222.36	137.16	0.801222	171.19
18	292.95	222.91	115.18	0.703054	163.82
19	232.98	200.58	98.38	0.570076	172.58
20	106.61	101.86	44.01	0.295323	149.02
		347.16			2532.36

Συνεισφ. αγκυρίων: Αθρ. ροπών ανατροπής : 0.0 kN*m/m
" " resisting : 0.0 kN*m/m
Καμία συνεισφορά αγκυρίων.

Δράση Ed = (347.2*13.79)
Αντίσταση Rd = (2532.4*13.79 +0.0)

SLIP-CIRCLE μ = Ed/Rd = 0.14 < 1.0: Έλεγχος εκπληρώθηκε.

Φάση εκσκαφής 3 "[3] Situation 3"

LC: όλα τα φορτία Type: BS-T

Εδαφικό σύστημα με 5 Στρώσεις

Name		Τεχνητές επιχωματώσεις	Αμμώδης ΑΡΓΙΛΟΣ	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
γ	[kN/m3]	18	20	22.5
γ,R	[kN/m3]	18	20	22.5
γ'	[kN/m3]	8	10	12.5
γ,p	[kN/m3]	18	20	22.5
γ,R,passive	[kN/m3]	18	20	22.5
γ,pw	[kN/m3]	8	10	12.5
φ	[°]	25	0.1	33
c	[kN/m2]	2	50	5
c,u	[kN/m2]	10	50	5
c παθητικό	[kN/m2]	2	50	5
δ,a	[°]	16.66667	0.06666667	22
δ,p	[°]	-16.66667	-0.06666667	-22
δ,c	[°]	8.333333	0.03333333	11
k,agh	[-]	0.3456501	0.9955057	0.2452023
K,ach	[-]	1.043051	1.994195	0.8549058
K,0h	[-]	0.5773817	0.9982547	0.455361
K,pgh	[-]	3.908103	1.004519	7.495617
K,pch	[-]	5.180327	2.00583	8.599509
τ,gr	[kN/m2]	110	110	110
Ψ,A,max	[°]	90	90	90
k	[cm/s]	10e-06	1e-06	100e-06

Name		Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
γ	[kN/m3]	22.5	22.5
γ,R	[kN/m3]	22.5	22.5
γ'	[kN/m3]	12.5	12.5
γ,p	[kN/m3]	22.5	22.5
γ,R,passive	[kN/m3]	22.5	22.5
γ,pw	[kN/m3]	12.5	12.5
φ	[°]	35	35
c	[kN/m2]	5	5
c,u	[kN/m2]	5	5
c παθητικό	[kN/m2]	5	5
δ,a	[°]	23.33333	23.33333
δ,p	[°]	-23.33333	-23.33333
δ,c	[°]	11.66667	11.66667
k,agh	[-]	0.2244207	0.2244207
K,ach	[-]	0.8126539	0.8126539
K,0h	[-]	0.4264236	0.4264236
K,pgh	[-]	9.146943	9.146943
K,pch	[-]	10.104	10.104
τ,gr	[kN/m2]	110	110
Ψ,A,max	[°]	90	90
k	[cm/s]	100e-06	100e-06

Πορεία πρανούς:
x [m] 0.00 0.00
z [m] -4.00 0.00

Πορεία ανώτερου 2. στρώματος Αμμώδης ΑΡΓΙΛΟΣ:
x [m] 0.00 0.00
z [m] -4.00 -1.50

Πορεία ανώτερου 3. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ:
z= -4.50

Πορεία ανώτερου 4. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -10.00

Πορεία ανώτερου 5. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -14.00

Επιφ. φορτία:

Φορτία

xA [m]	zA [m]	xE [m]	zE [m]	PxA [kN/m²]	PzA [kN/m²]	PxE [kN/m²]	PzE [kN/m²]	Typ	LC-description Name
2.00	0.00	8.50	0.00	0.00	20.00	0.00	20.00	q	1

Κατανομή εδαφ.πιέσεων

Κατανομή εδαφ.πιέσεων	Name
Rectangular within a layer	

Στάθμη νερού:

x [m] 0.00 0.00
z [m] -6.00 -3.00

Αγκύρια

z[m]	min.l[m]	Alpha[°]	C-H[kN/m]	P0[kN]	u0[m]
-0.50	0.00	15.00	αόριστ.	0.00	0.0000

Παράμετροι υπολογισμού

Earth pressure options

Τμήμα εδαφ.ωθήσεων: Ενεργές ωθήσεις.
Angle of slip plane: DIN 4085.
Split block loads into 1 sections.
Consideration of minimum earth pressure: φ,min = 40.000.
Negative earth pressure fractions are set to zero.

Redistribution of earth pressure

Shape of redistribution: Trapezoid.
The earth pressure is getting redistb. to: Excavation level
The earth pressure below the excavation acts without redistrb.
Levels of redistribution Z1: 0.000, Z2: -2.000 [m].
The earth pressure from variable loads will be included in redistribution.

Παθητικές ωθήσεις

Method of calculation: Κλασικός, Pregl/Sokolovsky (DIN 4085).

Options for water pressure

Στήριξη πόδα

Πόδας οριζοντίως μετακινούμενος

Αγκύρια

Anchor checks (lower failure plane): Ναι
Anchor forces with safety level of DS-P: Ναι
Verification of grout body pull out forces: Ναι
δ,a,Anchoring wall : used from soil layer.
δ,p,Anchoring wall : used from soil layer.

Earth pressure coefficients kh

φ	α	β	δ	k0gh	kagh	kach	kpgh	kpch	
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Τεχνητές επιχωματώσεις
25.0	0.0	0.0	16.7	--	0.346	1.043	--	--	"
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Αμμώδης ΑΡΓΙΛΟΣ
0.1	0.0	0.0	0.1	--	0.996	1.994	--	--	"
33.0	0.0	0.0	-22.0	--	--	--	7.496	-8.600	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
33.0	0.0	0.0	22.0	--	0.245	0.855	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"

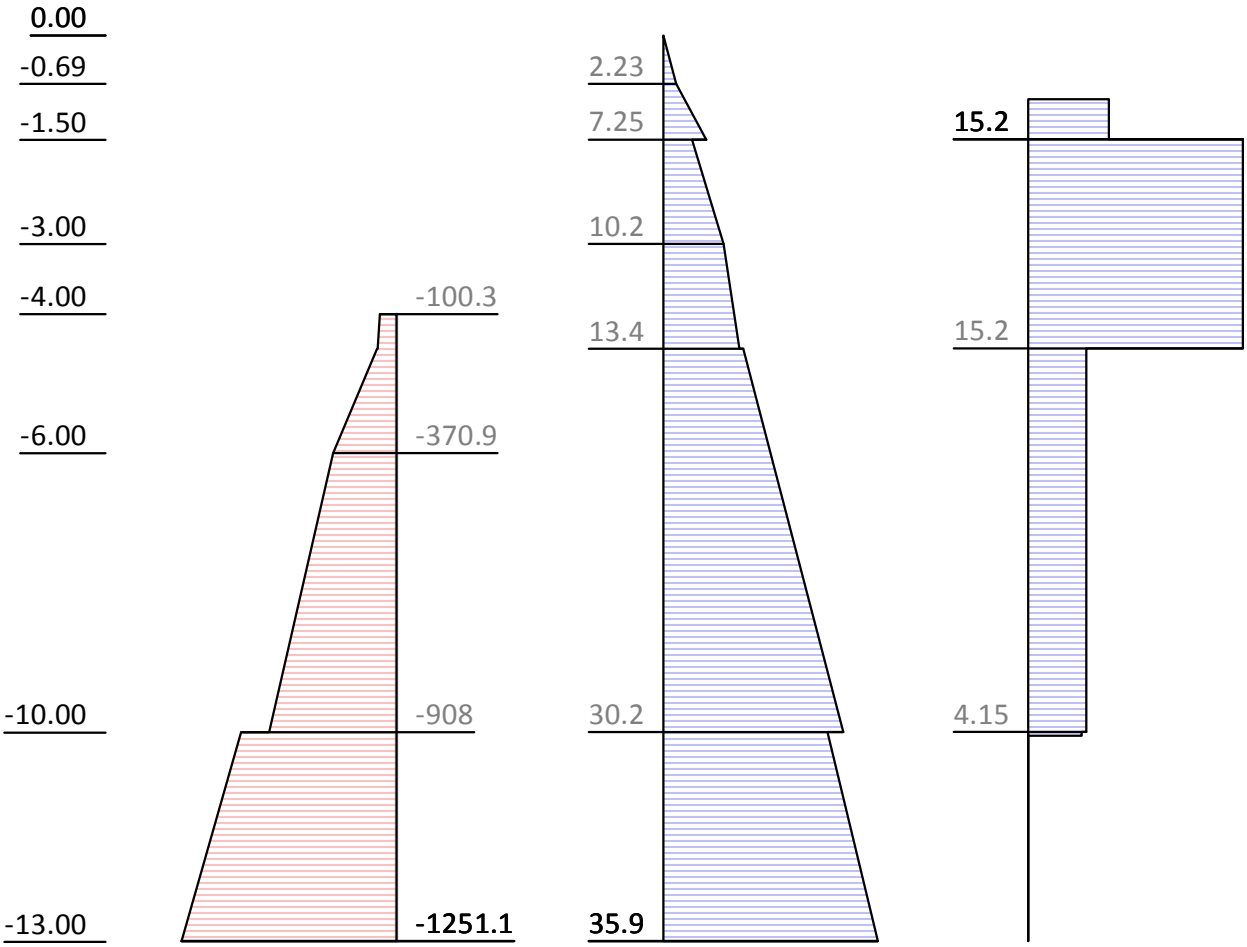
Μήκος τοίχου

Foot depth for statics: zf = -13.000

Stress analysis

Earth pressure, horizontal

Pressures characteristic, no redistribution, continous wall



z [m]	eph,G,k [kN/m2]	eah,G,k [kN/m2]	eah,PQ,k [kN/m2]	eah,d [kN/m2]
0.00		0.00		0.00
-0.93		3.72	0.00	5.00
-0.93		3.72	5.76	13.64
-1.50		7.25	5.76	18.43
-1.50		4.82	15.23	29.36
-4.00	-0.00	11.97	15.23	39.00
-4.00	-100.29	11.97	15.23	39.00
-4.50	-110.34	12.86	15.23	40.21
-4.50	-117.95	13.38	4.15	24.29
-10.00	-745.71	30.24	4.15	47.05
-10.00	-908.05	27.52	3.81	42.87
-10.06	-914.91	27.69	3.81	43.10
-10.06	-914.91	27.69	0.00	37.38
-13.00	-1251.06	35.94	0.00	48.52

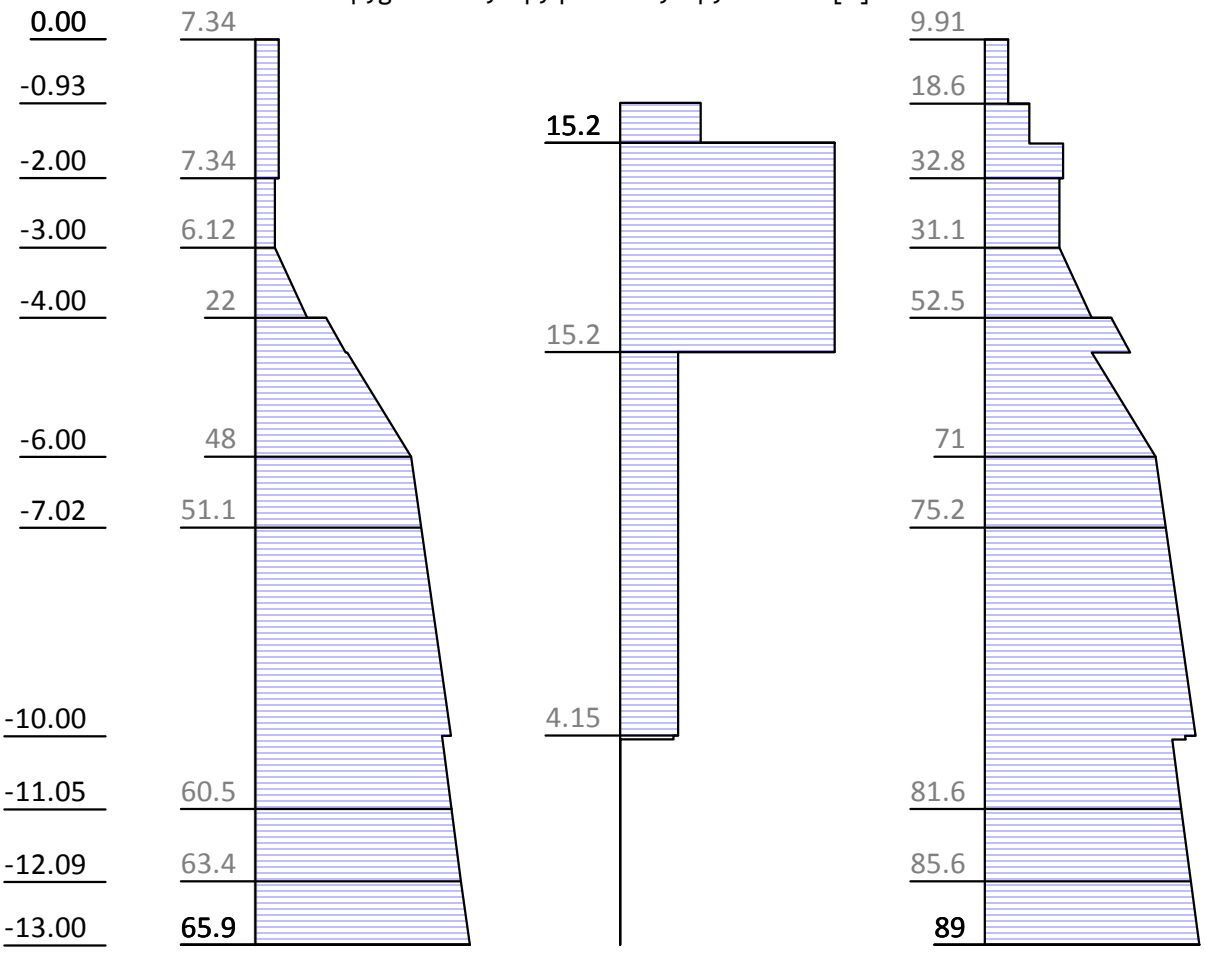
Eph,G,k:-5891.26, Eph,PG,k: 0.00 [kN/m]
Eah,G,k: 248.27, Eah,PG,k: 0.00, Eah,PQ,k: 72.04, Eah,d: 443.22

Πίεση νερού

z [m]	Wp,k [kN/m2]	Wa,k [kN/m2]	W,k [kN/m2]
-3.00		0.00	0.00
-6.00	0.00	30.00	30.00
-6.24	-2.40	32.40	30.00
-13.00	-70.00	100.00	30.00

H-pressure on static system

Level of mobilization: Ep,gk 100.0, Ep,qk 100.0, Ep,d 100.0 [%]

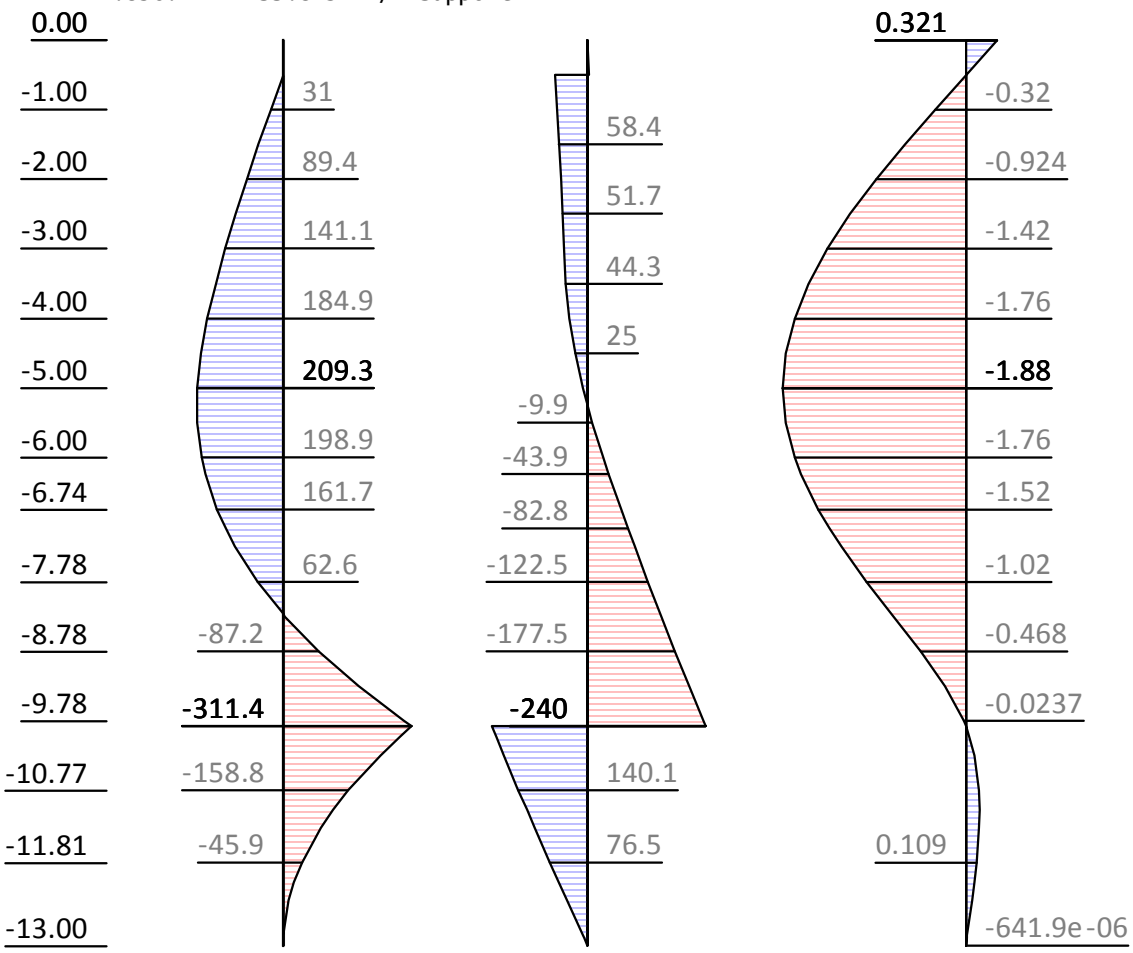


z [m]	PH,gk [kN/m2]	PH,qk [kN/m2]	PH,d [kN/m2]
0.00	7.34		9.91
-0.93	7.34	0.00	9.91
-0.93	7.34	5.76	18.56
-1.50	7.34	5.76	18.56
-1.50	7.34	15.23	32.76
-2.00	7.34	15.23	32.76
-2.00	6.12	15.23	31.11
-4.00	16.12	15.23	44.61
-4.00	21.97	15.23	52.50
-4.50	27.86	15.23	60.46
-4.50	28.38	4.15	44.54
-10.00	60.24	4.15	87.55
-10.00	57.52	3.81	83.37
-10.06	57.69	3.81	83.60
-10.06	57.69	0.00	77.88
-13.00	65.94	0.00	89.02

V-pressure on static system

Internal forces: Permanent, characteristically

z= -0.500. Fx= -69.393 kN/m Support
z= -9.856. Fx=-433.875 kN/m Support

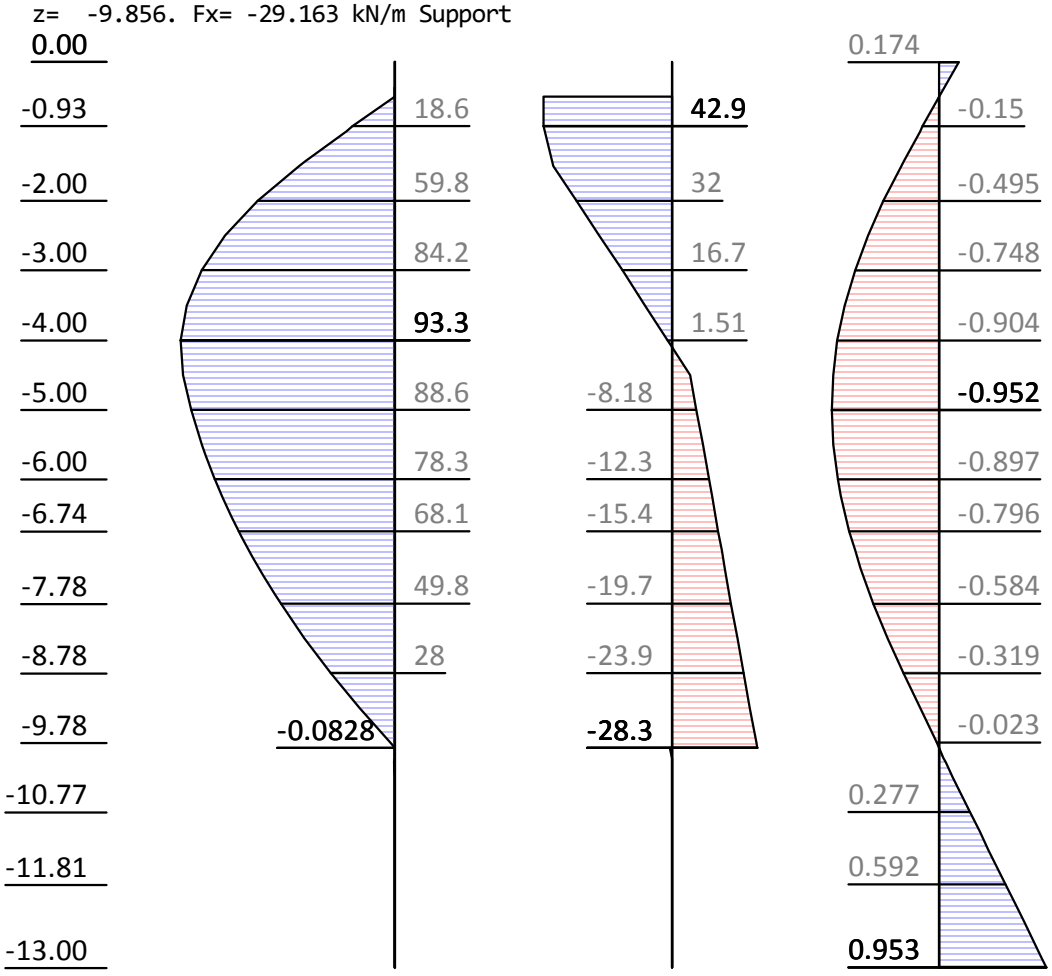


z [m]	H,g,k [kN/m2]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [mm]
0.00	7.34	-0.00	0.00	0.00	0.32
-0.00	7.34	-0.00	0.00	-0.00	0.32
-0.50	7.34	-0.92	-3.67	-10.69	0.00
-0.50	7.34	-0.92	-3.67	-10.69	-0.00
-0.50	7.34	-0.92	65.72	-29.29	-0.00
-0.51	7.34	-0.00	65.62	-29.59	-0.01
-2.00	7.34	89.40	54.71	-61.36	-0.92
-2.00	6.12	89.40	54.71	-61.36	-0.92
-4.00	16.12	184.92	37.48	-104.00	-1.76
-4.00	21.97	184.92	37.48	-104.00	-1.76
-4.50	27.86	200.67	25.02	-114.51	-1.85
-4.50	28.38	200.67	25.02	-114.51	-1.85
-5.00	34.91	209.34	9.19	-123.67	-1.88
-5.24	38.06	209.32	0.00	-128.22	-1.87
-8.24	54.84	-0.00	-147.44	-190.52	-0.76
-9.86	59.81	-311.40	-240.04	-228.71	0.00
-9.86	59.81	-311.40	193.84	-228.71	0.00
-10.00	60.24	-284.11	185.20	-232.27	0.04
-10.00	57.52	-284.11	185.20	-232.27	0.04
-11.05	60.47	-121.90	123.25	-258.64	0.14
-12.99	65.92	-0.02	0.43	-310.95	0.00

z [m]	H,g,k [kN/m2]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [mm]
-13.00	65.94	0.00	0.00	-311.14	-0.00

Internal forces: Variable, characteristically

Method EB 82-4 (Q = [G+Q] - G).
z= -0.500. Fx= -42.876 kN/m Support
z= -9.856. Fx= -29.163 kN/m Support

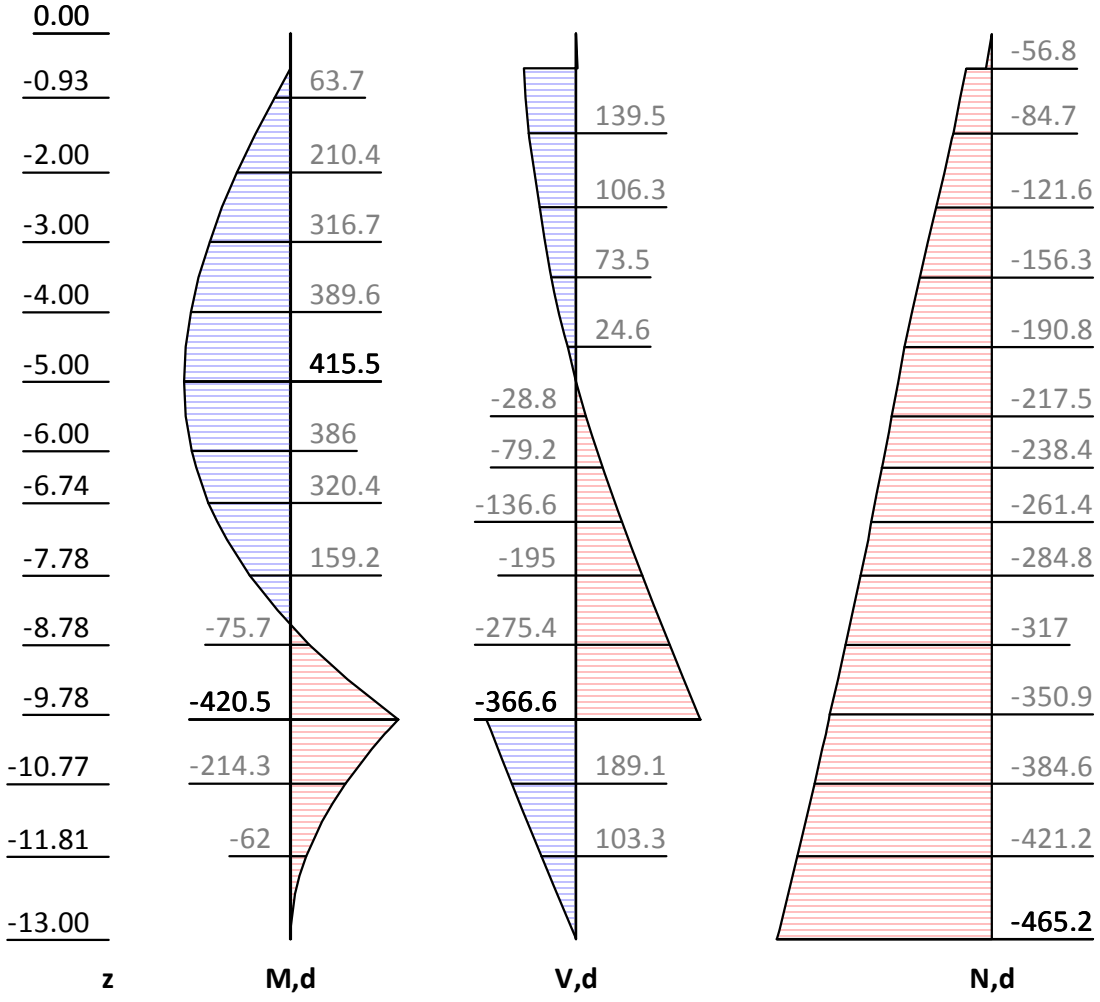


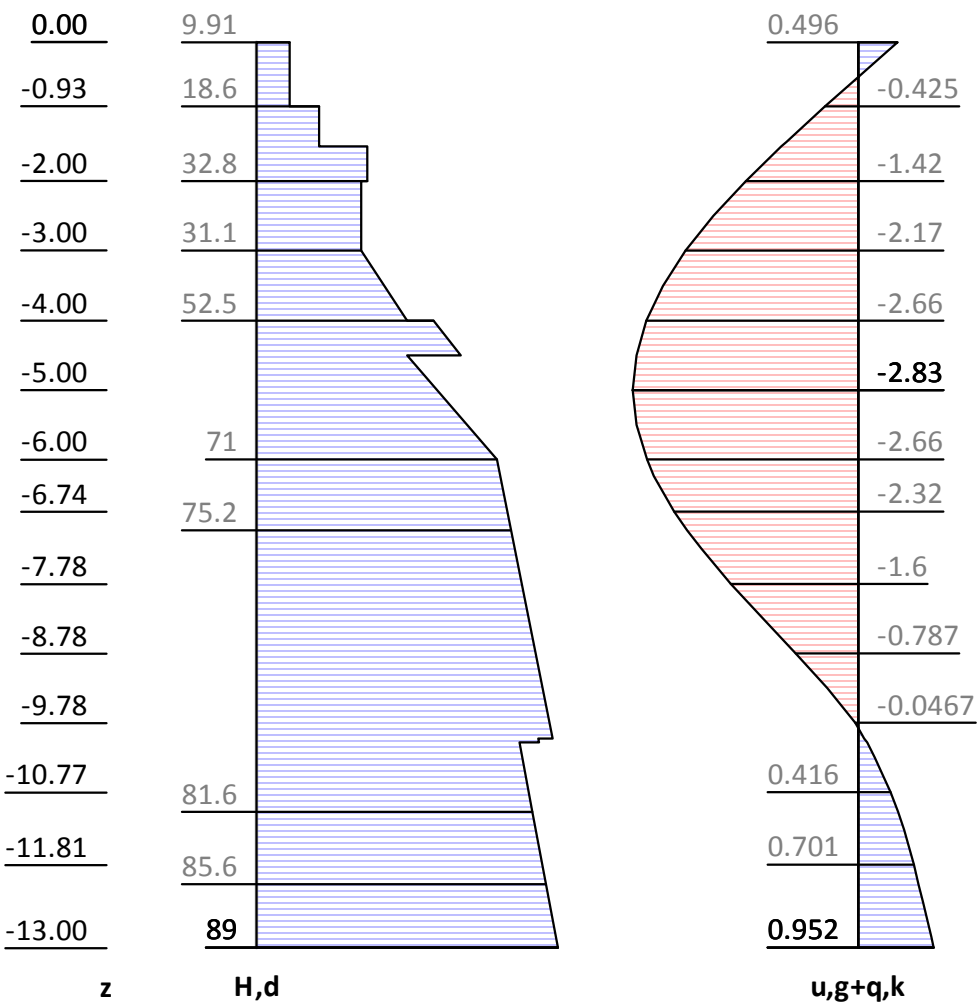
z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
0.00		0.00	-0.00	0.00	0.17
-0.38		0.00	-0.00	0.00	0.04
-0.50		-0.00	-0.00	0.00	0.00
-0.50		-0.00	42.88	-11.49	-0.00
-0.93	0.00	18.55	42.88	-11.49	-0.15
-0.93	5.76	18.55	42.88	-11.49	-0.15
-1.50	5.76	41.94	39.59	-12.34	-0.34
-1.50	15.23	41.94	39.59	-12.34	-0.34
-4.00	15.23	93.31	1.51	-22.16	-0.90
-4.10	15.23	93.09	0.00	-22.55	-0.91
-4.50	15.23	92.16	-6.11	-24.13	-0.94
-4.50	4.15	92.16	-6.11	-24.13	-0.94
-5.00	4.15	88.59	-8.18	-24.66	-0.95
-9.86	4.15	-0.00	-28.32	-29.86	-0.00
-9.86	4.15	-0.08	-28.34	-29.87	0.00
-9.86	4.15	-0.08	0.83	-29.87	0.00
-10.00	4.15	-0.01	0.23	-30.02	0.04
-10.00	3.81	-0.01	0.23	-30.02	0.04

z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
-10.00	3.81	-0.00	0.22	-30.02	0.04
-10.06	3.81	0.36	0.02	-30.07	0.06
-10.06	0.00	0.36	0.02	-30.07	0.06
-10.27	0.00	0.00	0.00	-30.08	0.13
-11.05	0.00	0.00	-0.00	-30.08	0.36
-11.31	0.00	0.00	-0.00	-30.08	0.44
-12.88	0.00	-0.00	-0.00	-30.08	0.92
-12.90	0.00	-0.00	-0.00	-30.08	0.92
-12.97	0.00	-0.00	0.00	-30.08	0.94
-13.00	0.00	0.00	0.00	-30.08	0.95

Internal forces: Design

z= -0.500. Fx=-157.995 kN/m Support
z= -9.856. Fx=-629.476 kN/m Support





z [m]	H,d [kN/m2]	M,d [kN/m2]	V,d [kN/m2]	N,d [kN/m2]	u,g+q,k [mm]
0.00	9.91	0.00	0.00	0.00	0.50
-0.00	9.91	-0.00	0.00	-0.00	0.50
-0.50	9.91	-1.24	-4.96	-14.43	0.00
-0.51	9.91	0.00	152.96	-57.01	-0.01
-0.93	9.91	63.65	148.78	-69.18	-0.42
-0.93	18.56	63.65	148.78	-69.18	-0.42
-1.50	18.56	145.44	138.20	-86.91	-0.97
-1.50	32.76	145.44	138.20	-86.91	-0.97
-2.00	32.76	210.44	121.82	-104.29	-1.42
-2.00	31.11	210.44	121.82	-104.29	-1.42
-4.00	44.61	389.61	52.85	-173.64	-2.66
-4.00	52.50	389.61	52.85	-173.64	-2.66
-4.50	60.46	409.15	24.61	-190.78	-2.79
-4.50	44.54	409.15	24.61	-190.78	-2.79
-5.00	53.36	415.49	0.13	-203.94	-2.83
-5.00	53.40	415.45	0.00	-204.00	-2.83
-8.48	81.27	-0.00	-251.21	-307.31	-1.03
-9.86	86.97	-420.51	-366.55	-353.56	0.00
-9.86	86.97	-420.51	262.92	-353.56	0.00
-10.00	87.55	-383.55	250.36	-358.60	0.08
-10.00	83.37	-383.55	250.36	-358.60	0.08
-10.06	83.60	-368.68	245.35	-360.67	0.11
-10.06	77.88	-368.68	245.35	-360.67	0.11
-13.00	89.02	-0.00	-0.00	-465.15	0.95

Anchor forces with safety level of DS-P

z[m]	A,d[kN]	Fx,d[kN/m]
-0.50	294.4	-158.0

Checks of earth statics

Check or earth support

Check: Mobilizable earth resistance is sufficient for earth support force.
z: -9.86 m
Rd = Eph,k/γ,Re = 5891.26 / 1.400 = 4208.04 [kN/m]

Ed(Uh,d)/Rd = 629.48 / 4208.04 = 0.150 [-]. Passes requirement

Sum of H and V forces, (G)

Forces up to depth z:-13.00

Pos.	H	V
H/V pressure G+P+W,k	503.27	90.93
Wall weight		201.61
H/V pressure passive		0.00
Support z: -0.50	-69.39	18.59
Bh,g,k z=-9.86	-433.87	
Bv,g,k = Bh,k * tan(δ,p=-22.00°)		-175.30
Σ	-0.00	135.84 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than
the downwards pointing vertical forces.

Vk >= Bvk: 311.14 >= 175.30 Passes requirement

Sum of H and V forces, (G+Q)

Forces up to depth z:-13.00

Pos.	H	V
H/V pressure G+P+W,k	575.31	109.52
Wall weight		201.61
H/V pressure passive		0.00
Support z: -0.50	-112.27	30.08
Bh,g,k z=-9.86	-433.87	
Bv,g,k = Bh,k * tan(δ,p=-22.00°)		-175.30
Bh,q,k z=-9.86	-29.16	
Bv,q,k = Bh,k * tan(δ,p=-22.00°)		-11.78
Σ	-0.00	154.14 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than
the downwards pointing vertical forces.

Vk >= Bvk: 341.21 >= 187.08 Passes requirement

Anchor verification

Anchor - Stability of lower failure plane

Περίπτ.Φόρτισης: όλα τα φορτία BS-P
Αυτόμ. υπολογ. μήκους αγκυρίων:
All anchors are extended (if necessary)
Favourable variable loads in main failure body are not being considered.
Bottom of lower failure plane: z=-13.00 m

Iteration of failure mechanisms:
lA .....: Length of anchor from head to center of grout body.
W,k .....: Res. force from dead weight, loads, cohesion, ...
Q,k .....: Force in lower failure plane.
Ea1,k.....: Earth pressure onto vertical separation plane.
Ea2,k.....: Earth pressure between wall and main failure body.
Ra_cal,d ...: Dimesioning force of the resistance from the equilibrium of forces. Ra_cal,d corresponds to the max. possible anchor force of the force polygon.
Sum(A,d) ...: Acting anchor forces along the grout body fractions within the failure body. Sum(A,d) is gained from the anchor pull forces of the wall analysis.

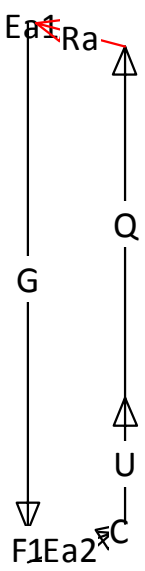
z [m]	ϑ1 [°]	ϑ2 [°]	lA [m]	W,k [kN/m]	Q,k [kN/m]	Ea1,k [kN/m]	Ea2,k [kN/m]	Ra_cal,d [kN/m]	Sum(A,d) [kN/m]	Ed/Rd [-]
-0.50	40.5	57.5	11.55	1367.3	1211.1	4.4	338.5	164.2	163.6	1.00

Decisive failure body:
Γεωμετρία:
Foot point of lower failure plane x/z = 0.01/-13.00 m
Intersection lower/upper slid. plane x/z = 11.16/ -3.49 m
Intersection upper slid. plane/surface x/z = 13.38/ 0.00 m
Intersection separation plane/surface x/z = 11.16/ 0.00 m
Inclination lower failure plane ϑ1 = 40.47°
Inclination upper failure plane ϑ2 = 57.50°
Inclination separation plane ϑ12 = 90.00°

Loads / forces (char.)

		Fx [kN/m]	Fz [kN/m]	F [kN/m]	
Weight of main failure body	G,k:	0.0	-1910.7	1910.7	
Area loads on/in main failure body	F1,k:	0.0	-130.0	130.0	
Cohesion of lower failure plane	C,k:	109.0	93.0	143.3	
Pore water pressure on main body	U,k:	-0.0	584.7	584.7	
Earth pres. on separation plane	Ea1,k:	-4.4	-0.0	4.4	δ= 0.0°
Earth pr. between wall<->main body	Ea2,k:	320.3	109.5	338.5	
Force in lower failure plane	Q,k:	-202.9	1194.0	1211.1	
Sum = possible anchor forces:	Ra_cal,k:	222.0	-59.5	229.8	

Force polygon



Acting anchor forces Ed: Sum(A,d) = 163.6 kN/m
Possible anchor forces Rd: Ra_cal,d = 229.8/1.400 = 164.2 kN/m

Verif. of lower failure plane Ed/Rd = 1.00 < 1.0: Έλεγχος εκπληρώθηκε.

Check of steel tension

l,tot ...[m]: Total length of anchor incl. excess length at head
As ....[mm2]: X-section are of steel member
Ri,d ...[kN]: Ultimate strength of tension member (γ,M=1.15)
A,d ....[kN]: Dimensioning force of the anchor from wall analysis

z[m]	Anchor type	l,tot	As	Ri,d		A,d	
-0.50	Strand;3x0.60";1570/1770	15.55	420	573.4	>	294.4	Passes requirement

Check of steel tension: Passes requirement

Check of anchor's soil friction

lVk .....: Length of grout body
DmVk ....: Diameter of grout body
τGr,k ...: Average applied skin friction along the grout body (from soil parameters)
Ra,k ....: Charact. pullout resistance of the anchor
γA .....: Partial safety factor of anchor pullout
Ra,d ....: = Ra,k / γA
A,d .....: Dimensioning force of the anchor from wall analysis

z [m]	lVk [m]	DmVk [mm]	τGr,k [kN/m²]	Ra,k [kN]	γA [-]	Ra,d [kN]		A,d [kN]	A,d/Ra,d [-]
-0.50	8.00	318	110	879.1	1.100	799.2	>	294.4	0.4

Check of anchor's soil friction: Passes requirement

Υπολογ. κύκλου ολίσθησης

LC: όλα τα φορτία Type: BS-T (combination: [GEO] A2 M2 R3, BS-T)
Vertical variable loads only act if they are outside of R*sin(phi).
The automatic slip circle optimization only considers circles that intersect
the surface with an area of at least 0.25 m2.
The slip circle calculation only accepts circles including the wall.
The slipcircle calculation only allows circular failure planes
(no vertical tangents will occour).

Γεωμετ.κύκλου (μήκη και συντεταγμ. σε (m))
Κέντρο = (-2.54, 0.20), Ακτίνα = 13.45
Αρχ.σημ.= (-15.32, -4.00), Τελ.σημ. = (10.91, 0.00)

Γεωμετρία λωρίδων:

No	x	Width b	dxM	Weight	Load z-κατ.	Water-φορτ.	u*b	φ	c	θ
	[m]	[m]	[m]	[kN/m]	[kN/m]	[kN/m]	[kN/m]	[°]	[kN/m²]	[°]
1	-14.65	1.35	-12.11	48.7	0.0	0.0	-6.0	27.45	3.57	-31.27*
2	-13.30	1.35	-10.76	115.5	0.0	0.0	-24.1	27.45	3.57	-31.27*
3	-11.96	1.35	-9.42	162.0	0.0	0.0	-45.2	27.45	3.57	-31.27*
4	-10.61	1.35	-8.07	196.9	0.0	0.0	-60.9	29.26	3.57	-30.37*
5	-9.27	1.35	-6.73	223.8	0.0	0.0	-73.0	29.26	3.57	-30.00
6	-7.92	1.35	-5.38	244.4	0.0	0.0	-82.2	29.26	3.57	-23.58
7	-6.58	1.35	-4.04	259.6	0.0	0.0	-89.0	29.26	3.57	-17.46
8	-5.23	1.35	-2.69	270.2	0.0	0.0	-93.7	29.26	3.57	-11.54
9	-3.89	1.35	-1.35	276.3	0.0	0.0	-96.4	29.26	3.57	-5.74
10	-2.54	1.35	0.00	278.4	0.0	0.0	-97.3	29.26	3.57	0.00
11	-1.20	1.35	1.35	276.3	0.0	0.0	-96.4	29.26	3.57	5.74
12	0.15	1.35	2.69	333.5	0.0	0.0	-113.8	29.26	3.57	11.54
13	1.50	1.35	4.04	363.2	0.0	0.0	-129.3	29.26	3.57	17.46
14	2.84	1.35	5.38	348.0	0.0	0.0	-122.5	29.26	3.57	23.58
15	4.19	1.35	6.73	327.4	35.0	0.0	-113.3	29.26	3.57	30.00
16	5.53	1.35	8.07	300.5	35.0	0.0	-101.3	29.26	3.57	36.87
17	6.88	1.35	9.42	265.6	35.0	0.0	-85.6	27.45	3.57	44.43
18	8.22	1.35	10.76	219.1	24.7	0.0	-64.5	27.45	3.57	53.13
19	9.90	2.02	12.44	194.1	0.0	0.0	-39.2	27.45	3.57	67.66

*** Σημείωση: Στις λωρίδες σημειωμένες με '*'
περιορίστηκε το theta στο 45°-Phi/2.

Συνεισφ. κατακόρυφων φορτίων:

No	Weight	G*sin(θ)	(G-u*b)*tan(φ) + c*b	μ*sin(θ)* tan(φ)+cos(θ)	T
	[kN/m]	[kN/m]	[kN/m]	[-]	[kN/m]
1	48.66	-43.80	26.99	0.784767	34.39
2	115.49	-92.39	52.28	0.784767	66.62
3	161.97	-113.38	65.47	0.784767	83.43
4	196.94	-118.16	80.99	0.789322	102.61
5	223.82	-111.91	89.31	0.793409	112.56
6	244.38	-97.75	95.68	0.858422	111.46
7	259.62	-77.88	100.40	0.910370	110.28
8	270.15	-54.03	103.67	0.950750	109.04
9	276.34	-27.63	105.58	0.980465	107.69
10	278.38	0.00	106.22	1.000002	106.22
11	276.34	27.64	105.58	1.009513	104.59
12	333.51	66.71	127.85	1.008845	126.73
13	363.21	108.97	135.82	0.997512	136.16
14	347.97	139.19	131.09	0.974612	134.51
15	362.39	181.20	144.32	0.938645	153.75
16	335.50	201.30	136.01	0.887143	153.31
17	300.53	210.38	116.49	0.808431	144.09
18	243.78	195.03	97.97	0.707756	138.42
19	194.12	179.55	87.70	0.504691	173.77
		573.04			2209.63

Συνεισφ. αγκυρίων: Αθρ. ροπών ανατροπής : -1.4 kN*m/m
" " resisting : 1.3 kN*m/m

Δράση Ed = (573.0*13.45 -1.4)
Αντίσταση Rd = (2209.6*13.45 +1.3)

SLIP-CIRCLE μ = Ed/Rd = 0.26 < 1.0: Έλεγχος εκπληρώθηκε.

Φάση εκσκαφής 4 "[4] Situation 4"

LC: όλα τα φορτία Type: BS-T

Εδαφικό σύστημα με 5 Στρώσεις

Name		Τεχνητές επιχωματώσεις	Αμμώδης ΑΡΓΙΛΟΣ	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
γ	[kN/m3]	18	20	22.5
γ,R	[kN/m3]	18	20	22.5
γ'	[kN/m3]	8	10	12.5
γ,p	[kN/m3]	18	20	22.5
γ,R,passive	[kN/m3]	18	20	22.5
γ,pw	[kN/m3]	8	10	12.5
φ	[°]	25	0.1	33
c	[kN/m2]	2	50	5
c,u	[kN/m2]	10	50	5
c παθητικό	[kN/m2]	2	50	5
δ,a	[°]	16.66667	0.06666667	22
δ,p	[°]	-16.66667	-0.06666667	-22
δ,c	[°]	8.333333	0.03333333	11
k,agh	[-]	0.3456501	0.9955057	0.2452023
K,ach	[-]	1.043051	1.994195	0.8549058
K,0h	[-]	0.5773817	0.9982547	0.455361
K,pgh	[-]	3.908103	1.004519	7.495617
K,pch	[-]	5.180327	2.00583	8.599509
τ,gr	[kN/m2]	110	110	110
Ψ,A,max	[°]	90	90	90
k	[cm/s]	10e-06	1e-06	100e-06

Name		Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
γ	[kN/m3]	22.5	22.5
γ,R	[kN/m3]	22.5	22.5
γ'	[kN/m3]	12.5	12.5
γ,p	[kN/m3]	22.5	22.5
γ,R,passive	[kN/m3]	22.5	22.5
γ,pw	[kN/m3]	12.5	12.5
φ	[°]	35	35
c	[kN/m2]	5	5
c,u	[kN/m2]	5	5
c παθητικό	[kN/m2]	5	5
δ,a	[°]	23.33333	23.33333
δ,p	[°]	-23.33333	-23.33333
δ,c	[°]	11.66667	11.66667
k,agh	[-]	0.2244207	0.2244207
K,ach	[-]	0.8126539	0.8126539
K,0h	[-]	0.4264236	0.4264236
K,pgh	[-]	9.146943	9.146943
K,pch	[-]	10.104	10.104
τ,gr	[kN/m2]	110	110
Ψ,A,max	[°]	90	90
k	[cm/s]	100e-06	100e-06

Πορεία πρανούς:
x [m] 0.00 0.00
z [m] -4.00 0.00

Πορεία ανώτερου 2. στρώματος Αμμώδης ΑΡΓΙΛΟΣ:
x [m] 0.00 0.00
z [m] -4.00 -1.50

Πορεία ανώτερου 3. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ:
z= -4.50

Πορεία ανώτερου 4. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -10.00

Πορεία ανώτερου 5. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -14.00

Επιφ. φορτία:

Φορτία

xA [m]	zA [m]	xE [m]	zE [m]	PxA [kN/m²]	PzA [kN/m²]	PxE [kN/m²]	PzE [kN/m²]	Typ	LC-description Name
2.00	0.00	8.50	0.00	0.00	20.00	0.00	20.00	q	1

Κατανομή εδαφ.πιέσεων

Κατανομή εδαφ.πιέσεων	Name
Rectangular within a layer	

Στάθμη νερού:

x [m]	0.00	0.00
z [m]	-6.00	-3.00

Αγκύρια

z[m]	min.l[m]	Alpha[°]	C-H[kN/m]	P0[kN]	u0[m]
-0.50	0.00	15.00	0.00	0.00	0.0000
-3.00	0.00	15.00	αόριστ.	0.00	0.0000

Παράμετροι υπολογισμού

Earth pressure options

Τμήμα εδαφ.ωθήσεων: Ενεργές ωθήσεις.
Angle of slip plane: DIN 4085.
Split block loads into 1 sections.
Consideration of minimum earth pressure: φ,min = 40.000.
Negative earth pressure fractions are set to zero.

Redistribution of earth pressure

Shape of redistribution: Triangle (perpend. to wall).
The earth pressure is getting redistb. to: Excavation level
The earth pressure below the excavation acts without redistrb.
Levels of redistribution Z1: -0.500, Z2: -3.000 [m].
The earth pressure from variable loads will be included in redistribution.

Παθητικές ωθήσεις

Method of calculation: Κλασικός, Pregl/Sokolovsky (DIN 4085).

Options for water pressure

Στήριξη πόδα

Πόδας οριζοντίως μετακινούμενος

Αγκύρια

Anchor checks (lower failure plane): Ναι
Anchor forces with safety level of DS-P: Ναι
Verification of grout body pull out forces: Ναι
δ,a,Anchoring wall : used from soil layer.
δ,p,Anchoring wall : used from soil layer.

Earth pressure coefficients kh

φ	α	β	δ	k0gh	kagh	kach	kpgh	kpch	
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Τεχνητές επιχωματώσεις
25.0	0.0	0.0	16.7	--	0.346	1.043	--	--	"
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Αμμώδης ΑΡΓΙΛΟΣ
0.1	0.0	0.0	0.1	--	0.996	1.994	--	--	"
33.0	0.0	0.0	-22.0	--	--	--	7.496	-8.600	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
33.0	0.0	0.0	22.0	--	0.245	0.855	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"

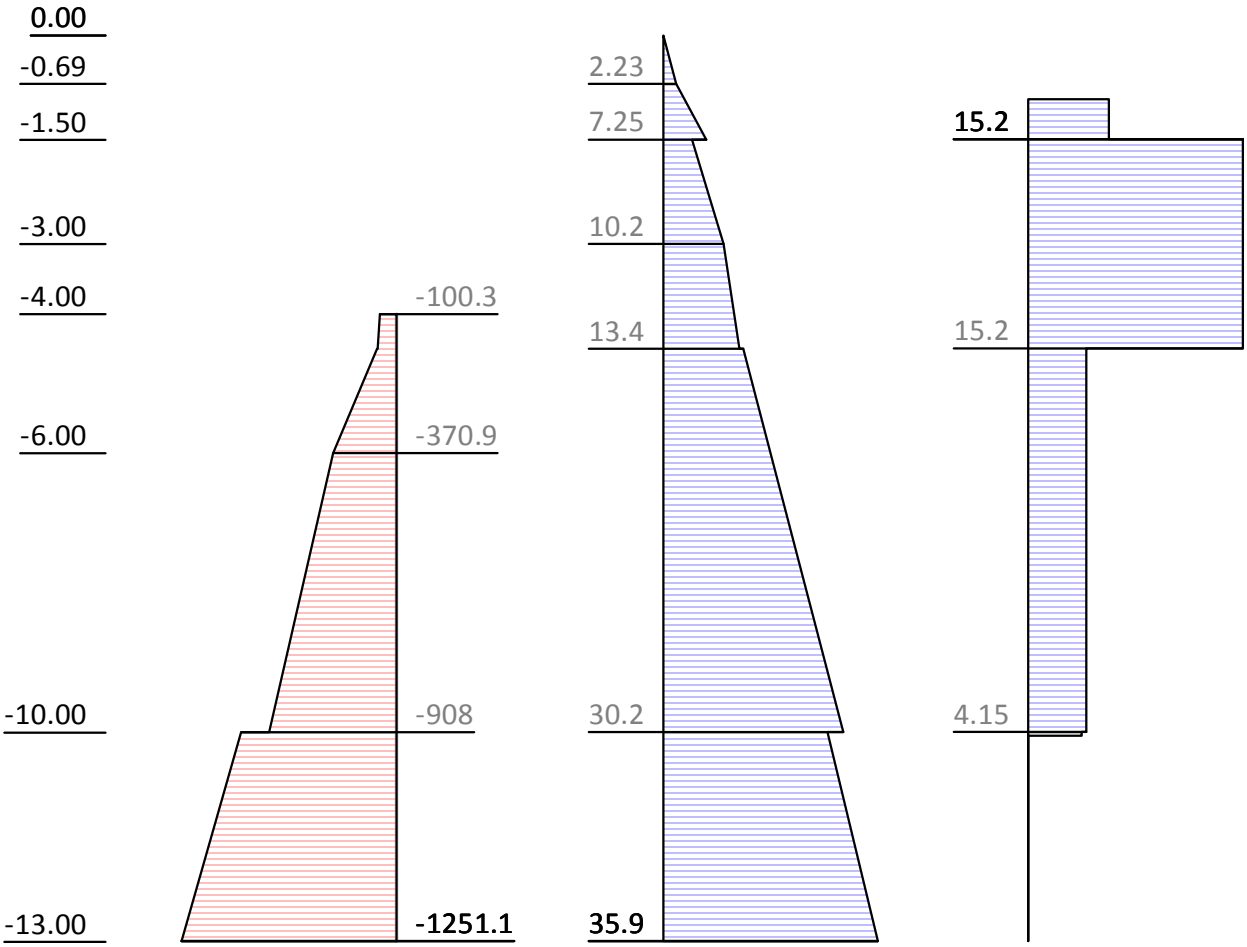
Μήκος τοίχου

Foot depth for statics: zf = -13.000

Stress analysis

Earth pressure, horizontal

Pressures characteristic, no redistribution, continous wall



z [m]	eph,G,k [kN/m2]	eah,G,k [kN/m2]	eah,PQ,k [kN/m2]	eah,d [kN/m2]
0.00		0.00		0.00
-0.93		3.72	0.00	5.00
-0.93		3.72	5.76	13.64
-1.50		7.25	5.76	18.43
-1.50		4.82	15.23	29.36
-4.00	-0.00	11.97	15.23	39.00
-4.00	-100.29	11.97	15.23	39.00
-4.50	-110.34	12.86	15.23	40.21
-4.50	-117.95	13.38	4.15	24.29
-10.00	-745.71	30.24	4.15	47.05
-10.00	-908.05	27.52	3.81	42.87
-10.06	-914.91	27.69	3.81	43.10
-10.06	-914.91	27.69	0.00	37.38
-13.00	-1251.06	35.94	0.00	48.52

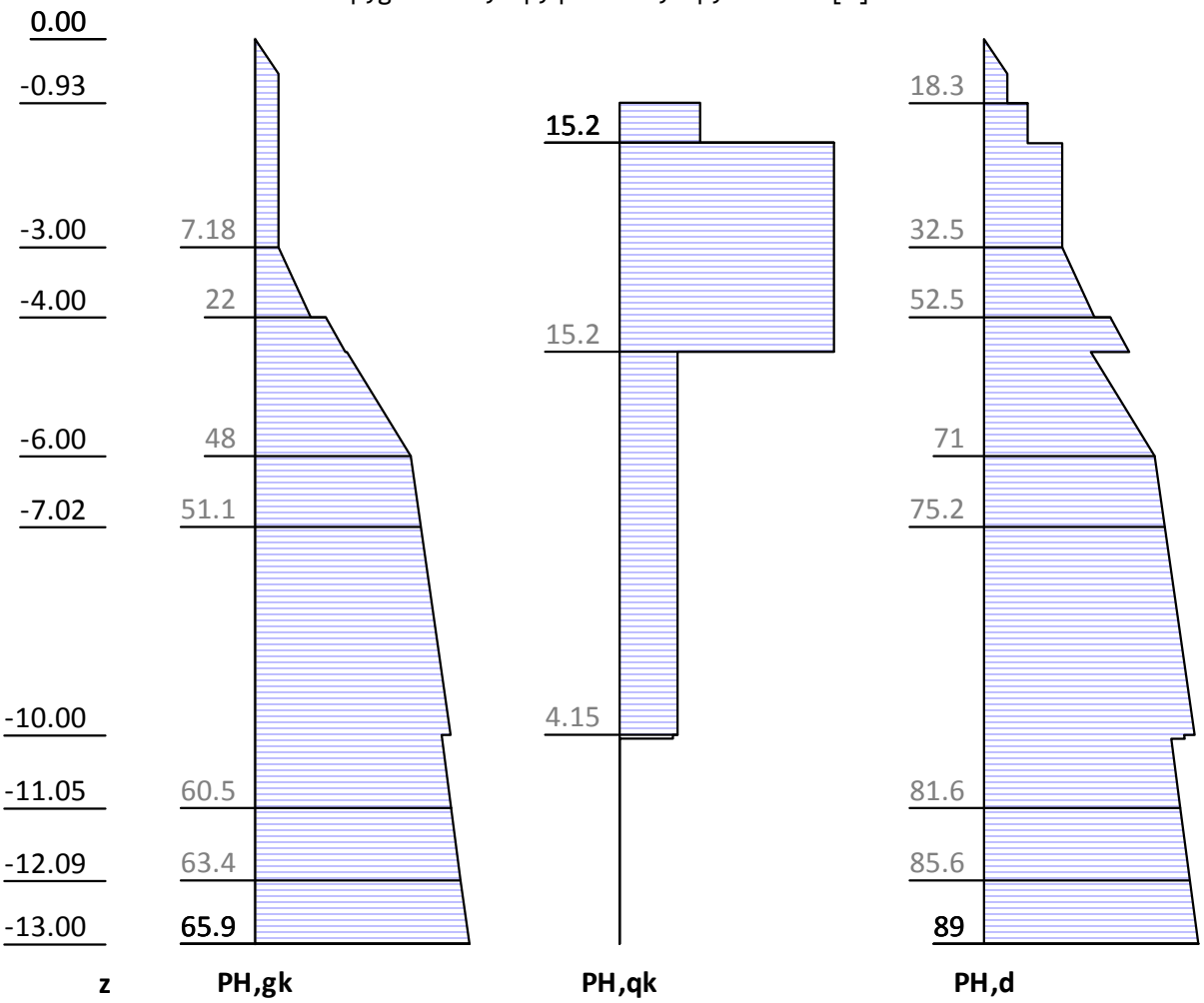
Eph,G,k:-5891.26, Eph,PG,k: 0.00 [kN/m]
Eah,G,k: 248.27, Eah,PG,k: 0.00, Eah,PQ,k: 72.04, Eah,d: 443.22

Πίεση νερού

z [m]	Wp,k [kN/m2]	Wa,k [kN/m2]	W,k [kN/m2]
-3.00		0.00	0.00
-6.00	0.00	30.00	30.00
-6.24	-2.40	32.40	30.00
-13.00	-70.00	100.00	30.00

H-pressure on static system

Level of mobilization: Ep,gk 100.0, Ep,qk 100.0, Ep,d 100.0 [%]

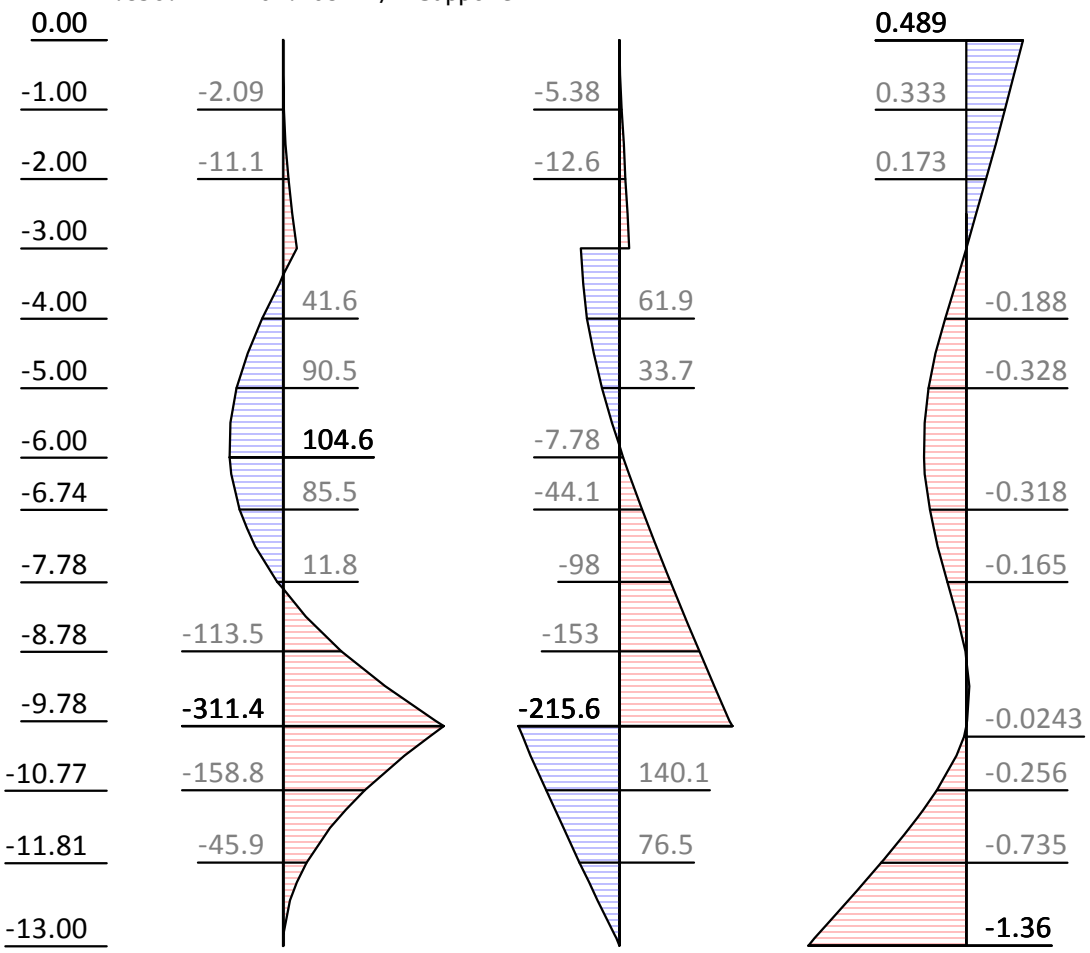


z [m]	PH,gk [kN/m2]	PH,qk [kN/m2]	PH,d [kN/m2]
0.00	0.00		0.00
-0.93	7.18	0.00	9.69
-0.93	7.18	5.76	18.33
-1.50	7.18	5.76	18.33
-1.50	7.18	15.23	32.54
-4.00	17.18	15.23	46.04
-4.00	21.97	15.23	52.50
-4.50	27.86	15.23	60.46
-4.50	28.38	4.15	44.54
-10.00	60.24	4.15	87.55
-10.00	57.52	3.81	83.37
-10.06	57.69	3.81	83.60
-10.06	57.69	0.00	77.88
-13.00	65.94	0.00	89.02

V-pressure on static system

Internal forces: Permanent, characteristically

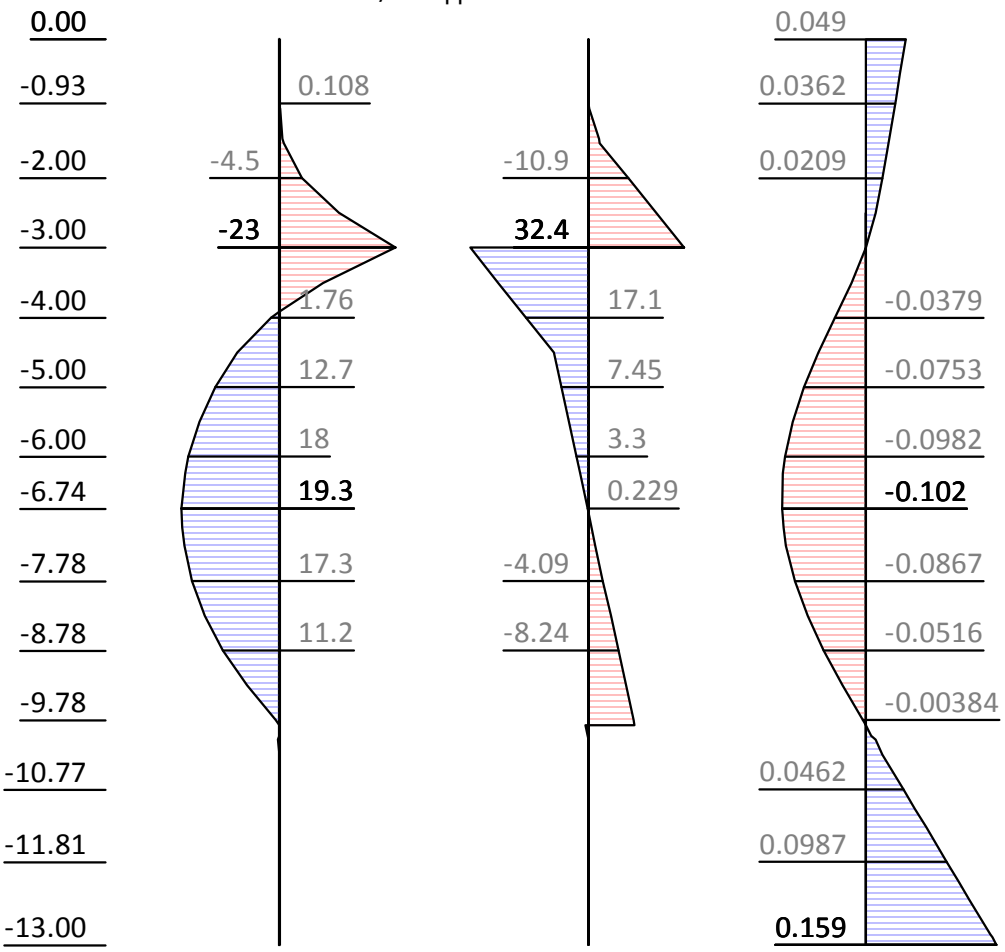
z= -0.500. Fx= -0.000 kN/m Support
z= -3.000. Fx= -93.860 kN/m Support
z= -9.856. Fx=-409.408 kN/m Support



z [m]	H,g,k [kN/m2]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [mm]
0.00	0.00	-0.00	0.00	-0.00	0.49
-0.00	0.00	-0.00	0.00	-0.00	0.49
-3.00	7.18	-27.22	-19.74	-64.03	-0.00
-3.00	7.18	-27.22	74.12	-89.18	-0.00
-3.38	10.96	0.00	70.46	-97.27	-0.07
-4.00	17.18	41.65	61.94	-110.55	-0.19
-4.00	21.97	41.65	61.94	-110.55	-0.19
-4.50	27.86	69.63	49.49	-121.06	-0.27
-4.50	28.38	69.63	49.49	-121.06	-0.27
-5.83	45.70	103.93	-0.00	-146.06	-0.37
-6.00	47.98	104.58	-7.78	-149.46	-0.37
-7.89	53.76	0.00	-103.77	-189.15	-0.15
-8.90	56.85	-132.99	-159.67	-212.22	0.00
-9.28	58.03	-197.17	-181.64	-221.28	0.03
-9.86	59.81	-311.40	-215.57	-235.27	0.00
-9.86	59.81	-311.40	193.84	-235.27	0.00
-10.00	60.24	-284.11	185.20	-238.83	-0.02
-10.00	57.52	-284.11	185.20	-238.83	-0.02
-13.00	65.94	-0.00	0.00	-317.69	-1.36
-13.00	65.94	0.00	0.00	-317.69	-1.36

Internal forces: Variable, characteristically

Method EB 82-4 (Q = [G+Q] - G).
z= -0.500. Fx= 0.000 kN/m Support
z= -3.000. Fx= -58.511 kN/m Support
z= -9.856. Fx= -13.529 kN/m Support



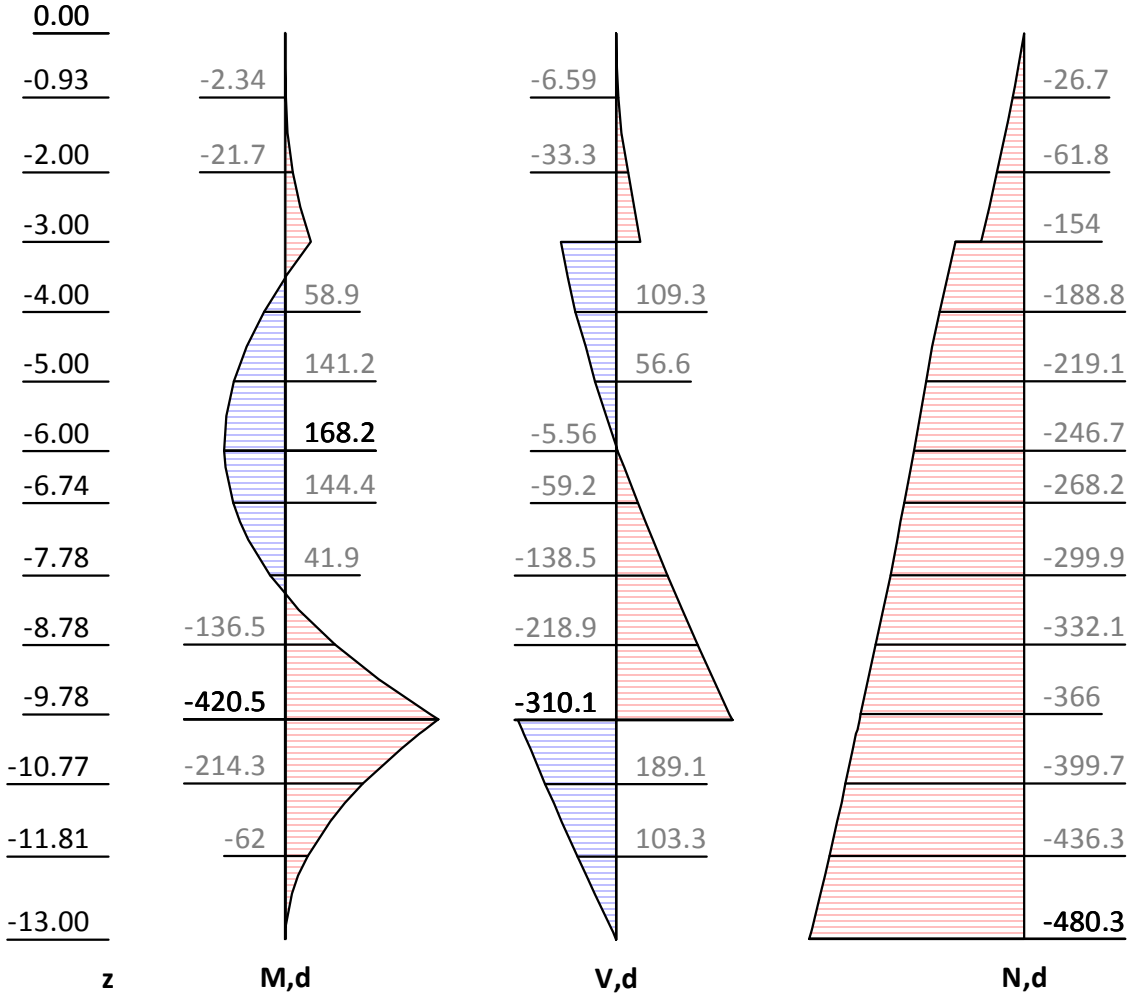
z **M,qk** **V,qk** **u,qk**

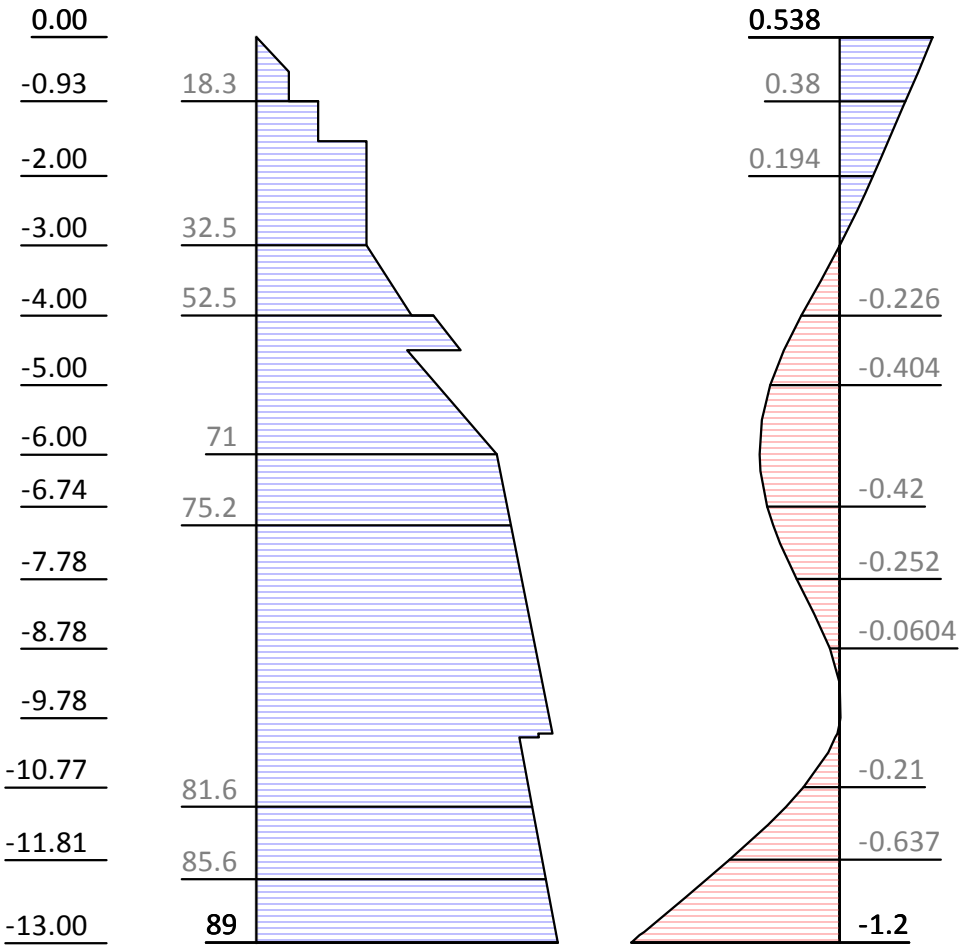
z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
0.00		0.00	0.00	0.00	0.05
-0.50		0.00	0.00	0.00	0.04
-0.93	0.00	0.11	0.00	0.00	0.04
-0.93	5.76	0.11	0.00	-0.00	0.04
-0.95	5.76	-0.00	-0.14	-0.04	0.04
-1.50	5.76	-0.94	-3.28	-0.85	0.03
-1.50	15.23	-0.94	-3.28	-0.85	0.03
-3.00	15.23	-23.00	-26.13	-6.74	-0.00
-3.00	15.23	-23.00	32.38	-22.42	-0.00
-3.92	15.23	-0.00	18.42	-26.02	-0.03
-4.50	15.23	8.42	9.53	-28.32	-0.06
-4.50	4.15	8.42	9.53	-28.32	-0.06
-6.74	4.15	19.35	0.23	-30.72	-0.10
-6.80	4.15	19.33	0.00	-30.78	-0.10
-9.85	4.15	0.00	-12.67	-34.05	-0.00
-9.86	4.15	-0.08	-12.70	-34.05	0.00
-9.86	4.15	-0.08	0.83	-34.05	0.00
-10.00	4.15	-0.01	0.23	-34.21	0.01
-10.00	3.81	-0.01	0.23	-34.21	0.01
-10.00	3.81	-0.00	0.22	-34.21	0.01
-10.06	3.81	0.36	0.02	-34.26	0.01

z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
-10.06	0.00	0.36	0.02	-34.26	0.01
-10.27	0.00	0.00	0.00	-34.27	0.02
-11.05	0.00	-0.00	0.00	-34.27	0.06
-11.81	0.00	-0.00	0.00	-34.27	0.10
-12.09	0.00	-0.00	0.00	-34.27	0.11
-12.85	0.00	-0.00	0.00	-34.27	0.15
-12.90	0.00	-0.00	0.00	-34.27	0.15
-13.00	0.00	-0.00	-0.00	-34.27	0.16

Internal forces: Design

z= -0.500. Fx= -0.000 kN/m Support
z= -3.000. Fx=-214.476 kN/m Support
z= -9.856. Fx=-572.994 kN/m Support





z [m]	H,d [kN/m2]	M,d [kN/m2]	V,d [kN/m2]	N,d [kN/m2]	u,g+q,k [mm]
0.00	0.00	0.00	0.00	0.00	0.54
-0.00	0.00	-0.00	0.00	-0.00	0.54
-0.93	9.69	-2.34	-6.59	-26.71	0.38
-0.93	18.33	-2.34	-6.59	-26.71	0.38
-1.50	18.33	-9.08	-17.04	-44.43	0.28
-1.50	32.54	-9.08	-17.04	-44.43	0.28
-3.00	32.54	-71.24	-65.85	-96.56	-0.00
-3.00	32.54	-71.24	148.63	-154.03	-0.00
-3.51	39.43	-0.00	130.21	-171.77	-0.12
-4.00	46.04	58.86	109.33	-188.78	-0.23
-4.00	52.50	58.86	109.33	-188.78	-0.23
-4.50	60.46	106.63	81.09	-205.91	-0.33
-4.50	44.54	106.63	81.09	-205.91	-0.33
-5.92	69.52	167.29	0.00	-244.33	-0.46
-6.00	70.99	168.25	-5.56	-246.66	-0.46
-8.04	79.46	-0.00	-159.51	-308.33	-0.20
-9.28	84.55	-255.39	-260.34	-348.75	0.00
-9.78	86.64	-397.38	-303.49	-366.05	0.01
-9.86	86.97	-420.51	-310.07	-368.69	0.00
-9.86	86.97	-420.51	262.92	-368.69	0.00
-10.00	87.55	-383.55	250.36	-373.73	-0.02
-10.00	83.37	-383.55	250.36	-373.73	-0.02
-10.06	83.60	-368.68	245.35	-375.80	-0.03
-10.06	77.88	-368.68	245.35	-375.80	-0.03
-13.00	89.02	-0.00	0.00	-480.29	-1.20
-13.00	89.02	0.00	0.00	-480.29	-1.20

Anchor forces with safety level of DS-P

z[m]	A,d[kN]	Fx,d[kN/m]
-0.50	0.0	-0.0
-3.00	399.7	-214.5

Checks of earth statics

Check or earth support

Check: Mobilizable earth resistance is sufficient for earth support force.
z: -9.86 m
Rd = Eph,k/γ,Re = 5891.26 / 1.400 = 4208.04 [kN/m]

Ed(Uh,d)/Rd = 572.99 / 4208.04 = 0.136 [-]. Passes requirement

Sum of H and V forces, (G)

Forces up to depth z:-13.00

Pos.	H	V
H/V pressure G+P+W,k	503.27	90.93
Wall weight		201.61
H/V pressure passive		0.00
Support z: -0.50		0.00
Support z: -3.00	-93.86	25.15
Bh,g,k z=-9.86	-409.41	
Bv,g,k = Bh,k * tan(δ,p=-22.00°)		-165.41
Σ	0.00	152.28 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than
the downwards pointing vertical forces.

Vk >= Bvk: 317.69 >= 165.41 Passes requirement

Sum of H and V forces, (G+Q)

Forces up to depth z:-13.00

Pos.	H	V
H/V pressure G+P+W,k	575.31	109.52
Wall weight		201.61
H/V pressure passive		0.00
Support z: -0.50		0.00
Support z: -3.00	-152.37	40.83
Bh,g,k z=-9.86	-409.41	
Bv,g,k = Bh,k * tan(δ,p=-22.00°)		-165.41
Bh,q,k z=-9.86	-13.53	
Bv,q,k = Bh,k * tan(δ,p=-22.00°)		-5.47
Σ	-0.00	181.08 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than
the downwards pointing vertical forces.

Vk >= Bvk: 351.96 >= 170.88 Passes requirement

Anchor verification

Anchor - Stability of lower failure plane

Περίπτ.Φόρτισης: όλα τα φορτία BS-P
Αυτόμ. υπολογ. μήκους αγκυρίων:
All anchors are extended (if necessary)
Favourable variable loads in main failure body are not being considered.
Bottom of lower failure plane: z=-13.00 m

Iteration of failure mechanisms:
lA .....: Length of anchor from head to center of grout body.
W,k .....: Res. force from dead weight, loads, cohesion, ...
Q,k .....: Force in lower failure plane.
Ea1,k.....: Earth pressure onto vertical separation plane.
Ea2,k.....: Earth pressure between wall and main failure body.
Ra_cal,d ...: Dimesioning force of the resistance from the equilibrium of forces. Ra_cal,d corresponds to the max. possible anchor force of the force polygon.
Sum(A,d) ...: Acting anchor forces along the grout body fractions within the failure body. Sum(A,d) is gained from the anchor pull forces of the wall analysis.

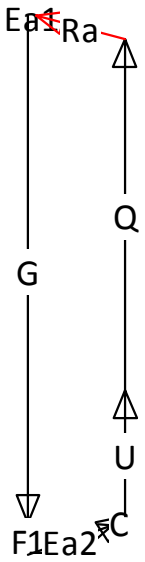
z [m]	ϑ1 [°]	ϑ2 [°]	lA [m]	W,k [kN/m]	Q,k [kN/m]	Ea1,k [kN/m]	Ea2,k [kN/m]	Ra_cal,d [kN/m]	Sum(A,d) [kN/m]	Ed/Rd [-]
-0.50	40.0	57.5	11.71	1389.9	1229.4	4.4	338.5	171.0	170.4	1.00
-3.00	35.9	60.7	10.45	1432.7	1242.5	26.0	338.5	222.3	222.0	1.00

Decisive failure body:
Γεωμετρία:
Foot point of lower failure plane x/z = 0.01/-13.00 m
Intersection lower/upper slid. plane x/z = 10.10/ -5.71 m
Intersection upper slid. plane/surface x/z = 13.29/ 0.00 m
Intersection separation plane/surface x/z = 10.10/ 0.00 m
Inclination lower failure plane ϑ1 = 35.87°
Inclination upper failure plane ϑ2 = 60.74°
Inclination separation plane ϑ12 = 90.00°

Loads / forces (char.)

		Fx [kN/m]	Fz [kN/m]	F [kN/m]	
Weight of main failure body	G,k:	0.0	-1979.2	1979.2	
Area loads on/in main failure body	F1,k:	0.0	-130.0	130.0	
Cohesion of lower failure plane	C,k:	50.4	36.5	62.2	
Pore water pressure on main body	U,k:	0.0	640.9	640.9	
Earth pres. on separation plane	Ea1,k:	-26.0	-0.0	26.0	δ= 0.0°
Earth pr. between wall<->main body	Ea2,k:	320.3	109.5	338.5	
Force in lower failure plane	Q,k:	-44.1	1241.7	1242.5	
Sum = possible anchor forces:	Ra_cal,k:	300.6	-80.6	311.2	

Force polygon



Acting anchor forces Ed: Sum(A,d) = 222.0 kN/m
Possible anchor forces Rd: Ra_cal,d = 311.2/1.400 = 222.3 kN/m

Verif. of lower failure plane Ed/Rd = 1.00 < 1.0: Έλεγχος εκπληρώθηκε.

Check of steel tension

l,tot ...[m]: Total length of anchor incl. excess length at head
As ....[mm2]: X-section are of steel member
Ri,d ...[kN]: Ultimate strength of tension member (γ,M=1.15)
A,d ....[kN]: Dimensioning force of the anchor from wall analysis

z[m]	Anchor type	l,tot	As	Ri,d		A,d	
-0.50	Strand;3x0.60";1570/1770	15.86	420	573.4	>	0.0	Passes requirement
-3.00	Strand;3x0.60";1570/1770	14.45	420	573.4	>	399.7	Passes requirement

Check of steel tension: Passes requirement

Check of anchor's soil friction

lVk .....: Length of grout body
DmVk ....: Diameter of grout body
τGr,k ...: Average applied skin friction along the grout body (from soil parameters)
Ra,k ....: Charact. pullout resistance of the anchor
γA .....: Partial safety factor of anchor pullout
Ra,d ....: = Ra,k / γA
A,d .....: Dimensioning force of the anchor from wall analysis

z [m]	lVk [m]	DmVk [mm]	τGr,k [kN/m²]	Ra,k [kN]	γA [-]	Ra,d [kN]		A,d [kN]	A,d/Ra,d [-]
-0.50	8.00	318	110	879.1	1.100	799.2	>	0.0	0.0
-3.00	8.00	318	110	879.1	1.100	799.2	>	399.7	0.5

Check of anchor's soil friction: Passes requirement

Υπολογ. κύκλου ολίσθησης

LC: όλα τα φορτία Type: BS-T (combination: [GEO] A2 M2 R3, BS-T)
Vertical variable loads only act if they are outside of R*sin(phi).
The automatic slip circle optimization only considers circles that intersect
the surface with an area of at least 0.25 m2.
The slip circle calculation only accepts circles including the wall.
The slipcircle calculation only allows circular failure planes
(no vertical tangents will occour).

Γεωμετ.κύκλου (μήκη και συντεταγμ. σε (m))
Κέντρο = (-1.95, 0.20), Ακτίνα = 13.35
Αρχ.σημ.= (-14.62, -4.00), Τελ.σημ. = (11.40, 0.00)

Γεωμετρία λωρίδων:

No	x	Width b	dxM	Weight	Load z-κατ.	Water-φορτ.	u*b	φ	c	θ
	[m]	[m]	[m]	[kN/m]	[kN/m]	[kN/m]	[kN/m]	[°]	[kN/m²]	[°]
1	-13.96	1.34	-12.01	47.6	0.0	0.0	-5.7	27.45	3.57	-31.27*
2	-12.62	1.34	-10.67	113.3	0.0	0.0	-23.3	27.45	3.57	-31.27*
3	-11.29	1.34	-9.34	158.9	0.0	0.0	-44.1	27.45	3.57	-31.27*
4	-9.95	1.34	-8.00	193.3	0.0	0.0	-59.5	29.26	3.57	-30.37*
5	-8.61	1.34	-6.67	219.8	0.0	0.0	-71.4	29.26	3.57	-29.95
6	-7.28	1.34	-5.33	240.0	0.0	0.0	-80.4	29.26	3.57	-23.53
7	-5.94	1.34	-4.00	255.0	0.0	0.0	-87.1	29.26	3.57	-17.41
8	-4.61	1.34	-2.66	265.3	0.0	0.0	-91.7	29.26	3.57	-11.49
9	-3.27	1.34	-1.33	271.4	0.0	0.0	-94.4	29.26	3.57	-5.69
10	-1.94	1.34	0.01	273.3	0.0	0.0	-95.3	29.26	3.57	0.04
11	-0.60	1.34	1.35	276.4	0.0	0.0	-114.4	29.26	3.57	5.78
12	0.73	1.34	2.68	368.0	0.0	0.0	-131.7	29.26	3.57	11.58
13	2.07	1.34	4.02	357.6	0.0	0.0	-127.1	29.26	3.57	17.50
14	3.40	1.34	5.35	342.5	0.0	0.0	-120.3	29.26	3.57	23.63
15	4.74	1.34	6.69	322.2	34.7	0.0	-111.3	29.26	3.57	30.05
16	6.08	1.34	8.02	295.7	34.7	0.0	-99.4	29.26	3.57	36.93
17	7.41	1.34	9.36	261.2	34.7	0.0	-83.8	27.45	3.57	44.49
18	8.75	1.34	10.69	215.3	11.0	0.0	-63.0	27.45	3.57	53.20
19	10.41	1.99	12.36	189.5	0.0	0.0	-38.0	27.45	3.57	67.72

*** Σημείωση: Στις λωρίδες σημειωμένες με '*'
περιορίστηκε το theta στο 45°-Phi/2.

Συνεισφ. κατακόρυφων φορτίων:

No	Weight	G*sin(θ)	(G-u*b)*tan(φ) + c*b	μ*sin(θ)* tan(φ)+cos(θ)	T
	[kN/m]	[kN/m]	[kN/m]	[-]	[kN/m]
1	47.64	-42.84	26.57	0.786926	33.76
2	113.26	-90.52	51.49	0.786926	65.43
3	158.95	-111.14	64.46	0.786926	81.91
4	193.33	-115.85	79.72	0.791588	100.71
5	219.77	-109.71	87.90	0.796200	110.40
6	239.98	-95.81	94.16	0.860657	109.40
7	254.96	-76.29	98.80	0.912063	108.33
8	265.30	-52.85	102.01	0.951910	107.16
9	271.36	-26.93	103.89	0.981098	105.89
10	273.34	0.21	104.50	1.000109	104.49
11	276.36	27.85	95.48	1.009095	94.62
12	368.00	73.89	137.13	1.007899	136.05
13	357.59	107.55	133.90	0.996034	134.43
14	342.53	137.28	129.23	0.972591	132.88
15	356.95	178.75	142.39	0.936069	152.12
16	330.41	198.50	134.19	0.883985	151.80
17	295.88	207.35	114.93	0.804869	142.79
18	226.22	181.15	89.56	0.703506	127.31
19	189.46	175.31	85.80	0.499963	171.61
		565.92			2171.11

Συνεισφ. αγκυρίων: Αθρ. ροπών ανατροπής : -207.4 kN*m/m
" " resisting : 257.7 kN*m/m

Δράση Ed = (565.9*13.35-207.4)
Αντίσταση Rd = (2171.1*13.35+257.7)

SLIP-CIRCLE μ = Ed/Rd = 0.25 < 1.0: Έλεγχος εκπληρώθηκε.

Φάση εκσκαφής 5 "[5] Situation 5"

LC: όλα τα φορτία Type: BS-T

Εδαφικό σύστημα με 5 Στρώσεις

Name		Τεχνητές επιχωματώσεις	Αμμώδης ΑΡΓΙΛΟΣ	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
γ	[kN/m3]	18	20	22.5
γ,R	[kN/m3]	18	20	22.5
γ'	[kN/m3]	8	10	12.5
γ,p	[kN/m3]	18	20	22.5
γ,R,passive	[kN/m3]	18	20	22.5
γ,pw	[kN/m3]	8	10	12.5
φ	[°]	25	0.1	33
c	[kN/m2]	2	50	5
c,u	[kN/m2]	10	50	5
c παθητικό	[kN/m2]	2	50	5
δ,a	[°]	16.66667	0.06666667	22
δ,p	[°]	-16.66667	-0.06666667	-22
δ,c	[°]	8.333333	0.03333333	11
k,agh	[-]	0.3456501	0.9955057	0.2452023
K,ach	[-]	1.043051	1.994195	0.8549058
K,0h	[-]	0.5773817	0.9982547	0.455361
K,pgh	[-]	3.908103	1.004519	7.495617
K,pch	[-]	5.180327	2.00583	8.599509
τ,gr	[kN/m2]	110	110	110
Ψ,A,max	[°]	90	90	90
k	[cm/s]	10e-06	1e-06	100e-06

Name		Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
γ	[kN/m3]	22.5	22.5
γ,R	[kN/m3]	22.5	22.5
γ'	[kN/m3]	12.5	12.5
γ,p	[kN/m3]	22.5	22.5
γ,R,passive	[kN/m3]	22.5	22.5
γ,pw	[kN/m3]	12.5	12.5
φ	[°]	35	35
c	[kN/m2]	5	5
c,u	[kN/m2]	5	5
c παθητικό	[kN/m2]	5	5
δ,a	[°]	23.33333	23.33333
δ,p	[°]	-23.33333	-23.33333
δ,c	[°]	11.66667	11.66667
k,agh	[-]	0.2244207	0.2244207
K,ach	[-]	0.8126539	0.8126539
K,0h	[-]	0.4264236	0.4264236
K,pgh	[-]	9.146943	9.146943
K,pch	[-]	10.104	10.104
τ,gr	[kN/m2]	110	110
Ψ,A,max	[°]	90	90
k	[cm/s]	100e-06	100e-06

Πορεία πρανούς:
x [m] 0.00 0.00
z [m] -6.85 0.00

Πορεία ανώτερου 2. στρώματος Αμμώδης ΑΡΓΙΛΟΣ:
x [m] 0.00 0.00
z [m] -6.85 -1.50

Πορεία ανώτερου 3. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ:
x [m] 0.00 0.00
z [m] -6.85 -4.50

Πορεία ανώτερου 4. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -10.00

Πορεία ανώτερου 5. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -14.00

Επιφ. φορτία:

Φορτία

xA [m]	zA [m]	xE [m]	zE [m]	PxA [kN/m²]	PzA	PxE	PzE	Typ	LC-description Name
2.00	0.00	8.50	0.00	0.00	20.00	0.00	20.00	q	1

Κατανομή εδαφ.πιέσεων

Κατανομή εδαφ.πιέσεων	Name
Rectangular within a layer	

Στάθμη νερού:

x [m]	0.00	0.00
z [m]	-11.00	-4.50

Αγκύρια

z[m]	min.l[m]	Alpha[°]	C-H[kN/m]	P0[kN]	u0[m]
-0.50	0.00	15.00	0.00	0.00	0.0000
-3.00	0.00	15.00	αόριστ.	0.00	0.0000

Παράμετροι υπολογισμού

Earth pressure options

Τμήμα εδαφ.ωθήσεων: Ενεργές ωθήσεις.
Angle of slip plane: DIN 4085.
Split block loads into 1 sections.
Consideration of minimum earth pressure: φ,min = 40.000.
Negative earth pressure fractions are set to zero.

Redistribution of earth pressure

Shape of redistribution: Trapezoid.
The earth pressure is getting redistb. to: Excavation level
The earth pressure below the excavation acts without redistrb.
Levels of redistribution Z1: 0.000, Z2: -3.000 [m].
The earth pressure from variable loads will be included in redistribution.

Παθητικές ωθήσεις

Method of calculation: Κλασικός, Pregl/Sokolovsky (DIN 4085).

Options for water pressure

Additional water and earth pressure from ground water flow is calculated.
Negative flow pressure is set to zero.
The proof of the basic hydraulic heave is performed.

Στήριξη πόδα

Πόδας οριζοντίως μετακινούμενος

Αγκύρια

Anchor checks (lower failure plane): Ναι
Anchor forces with safety level of DS-P: Ναι
Verification of grout body pull out forces: Ναι
δ,a,Anchoring wall : used from soil layer.
δ,p,Anchoring wall : used from soil layer.

Earth pressure coefficients kh

φ	α	β	δ	k0gh	kagh	kach	kpgh	kpch	
33.0	0.0	0.0	-22.0	--	--	--	7.496	-8.600	Τεχνητές επιχωματώσεις
25.0	0.0	0.0	16.7	--	0.346	1.043	--	--	"
0.1	0.0	0.0	0.1	--	0.996	1.994	--	--	Αμμώδης ΑΡΓΙΛΟΣ
33.0	0.0	0.0	-22.0	--	--	--	7.496	-8.600	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
33.0	0.0	0.0	22.0	--	0.245	0.855	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ

φ	α	β	δ	k0gh	kagh	kach	kpgh	kpch	
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"

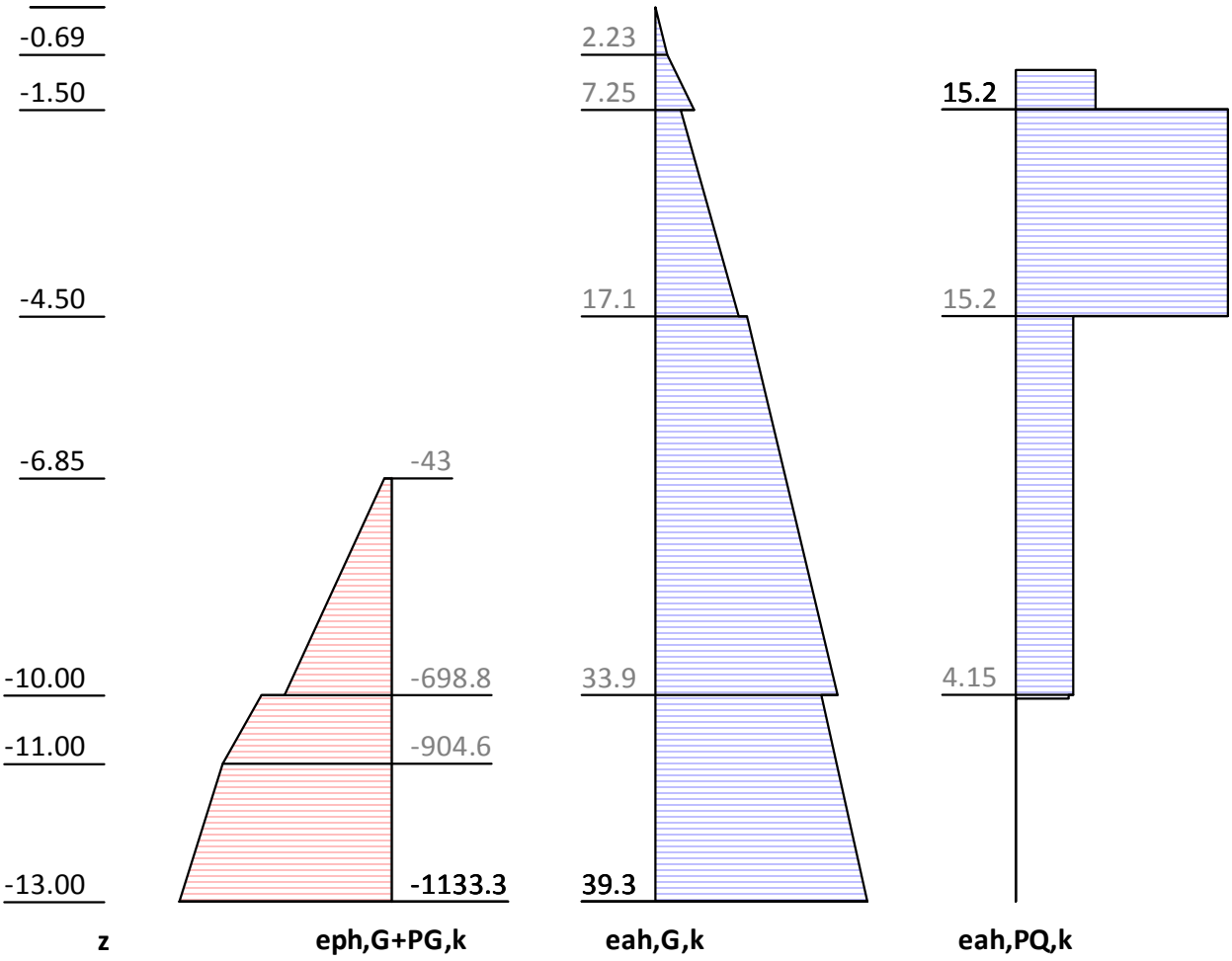
Μήκος τοίχου

Foot depth for statics: zf = -13.000

Stress analysis

Earth pressure, horizontal

Pressures characteristic, no redistribution, continous wall



z [m]	eph,G,k [kN/m2]	eah,G,k [kN/m2]	eah,PQ,k [kN/m2]	eah,d [kN/m2]
0.00		0.00		0.00
-0.93		3.72	0.00	5.00
-0.93		3.72	5.76	13.64
-1.50		7.25	5.76	18.43
-1.50		4.82	15.23	29.36
-4.50		15.54	15.23	43.83
-4.50		17.06	4.15	29.25
-6.85	-0.00	24.26	4.15	43.79
-6.85	-43.00	24.26	4.15	43.79
-10.00	-574.25	33.92	4.15	63.28
-10.00	-698.81	30.89	3.81	57.73
-10.06	-711.16	31.06	3.81	58.07
-10.06	-711.16	31.06	0.00	52.36
-13.00	-1133.29	39.31	0.00	69.01

Eph,G,k:-3811.78, Eph,PG,k: 0.00 [kN/m]
Eah,G,k: 280.61, Eah,PG,k: 0.00, Eah,PQ,k: 72.04, Eah,d: 557.26

Earth pressure from water flow

Pressures characteristic, no redistribution, continous wall

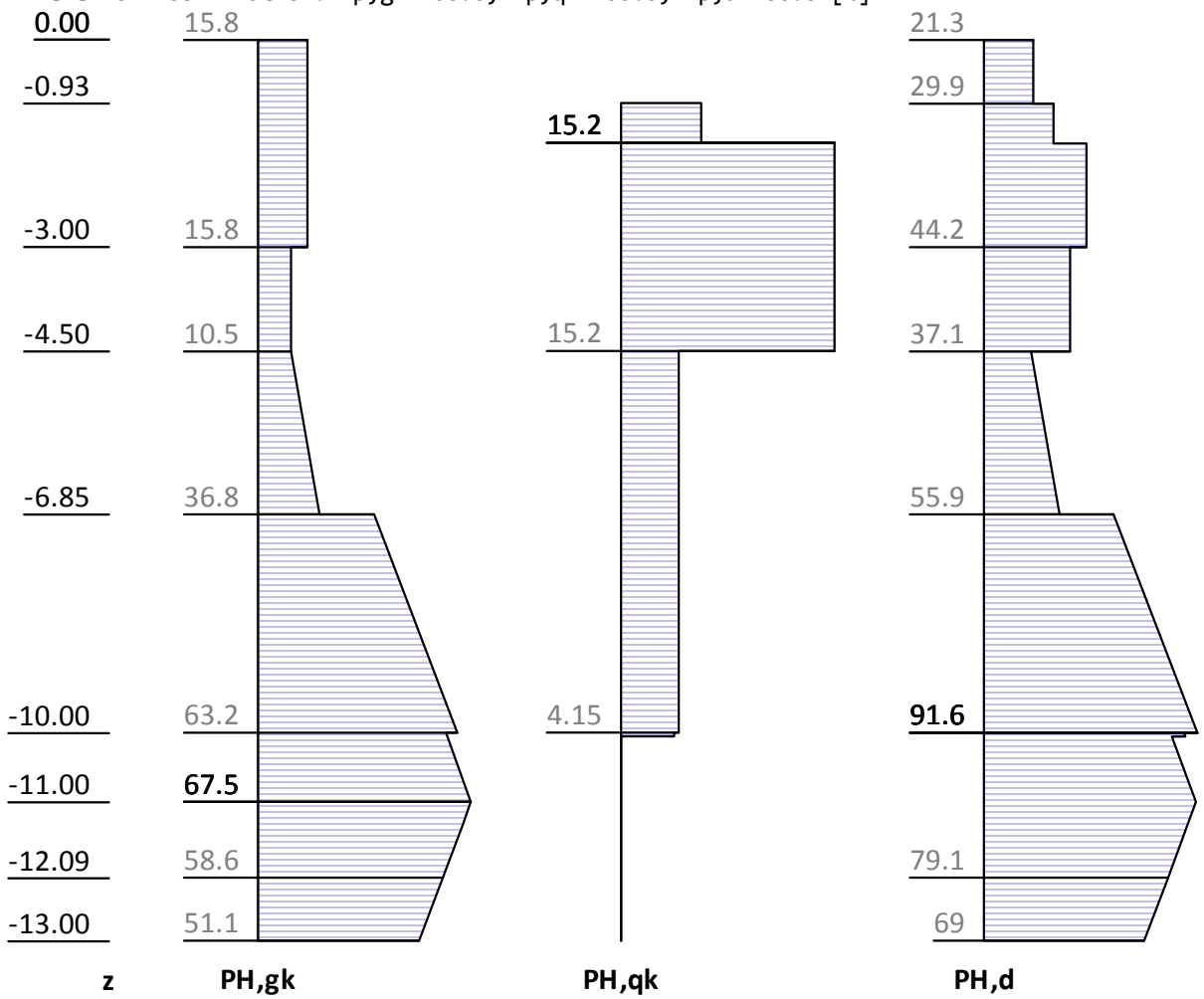
z [m]	eph,dynW,k [kN/m2]	eph,dynW+G+PG,k [kN/m2]	eah,dynW,k [kN/m2]	eah,dynW+G+PG,k [kN/m2]	Ip [-]	Ia [-]
-0.34			0.00			
-1.50			0.00			
-4.50			0.00			
-6.85	0.00	0.00	3.57	0.00		0.62
-6.85	0.00	-43.00	3.57	-43.00		0.62
-10.00	0.00	-574.25	8.35	-574.25		0.62
-10.00	0.00	-698.81	7.64	-698.81		0.62
-11.00	0.00	-904.62	9.03	-904.62		0.62
-13.00	113.25	-1020.04	11.81	-1020.04	0.62	0.62

Πίεση νερού

z [m]	Wp,st,k [kN/m2]	Wa,st,k [kN/m2]	Wp,dyn,k [kN/m2]	Wa,dyn,k [kN/m2]	W,tot,k [kN/m2]
-4.50		0.00		0.00	0.00
-11.00	0.00	65.00	0.00	-40.24	24.76
-13.00	-20.00	85.00	-12.38	-52.62	0.00

H-pressure on static system

Level of mobilization: Ep,gk 100.0, Ep,qk 100.0, Ep,d 100.0 [%]

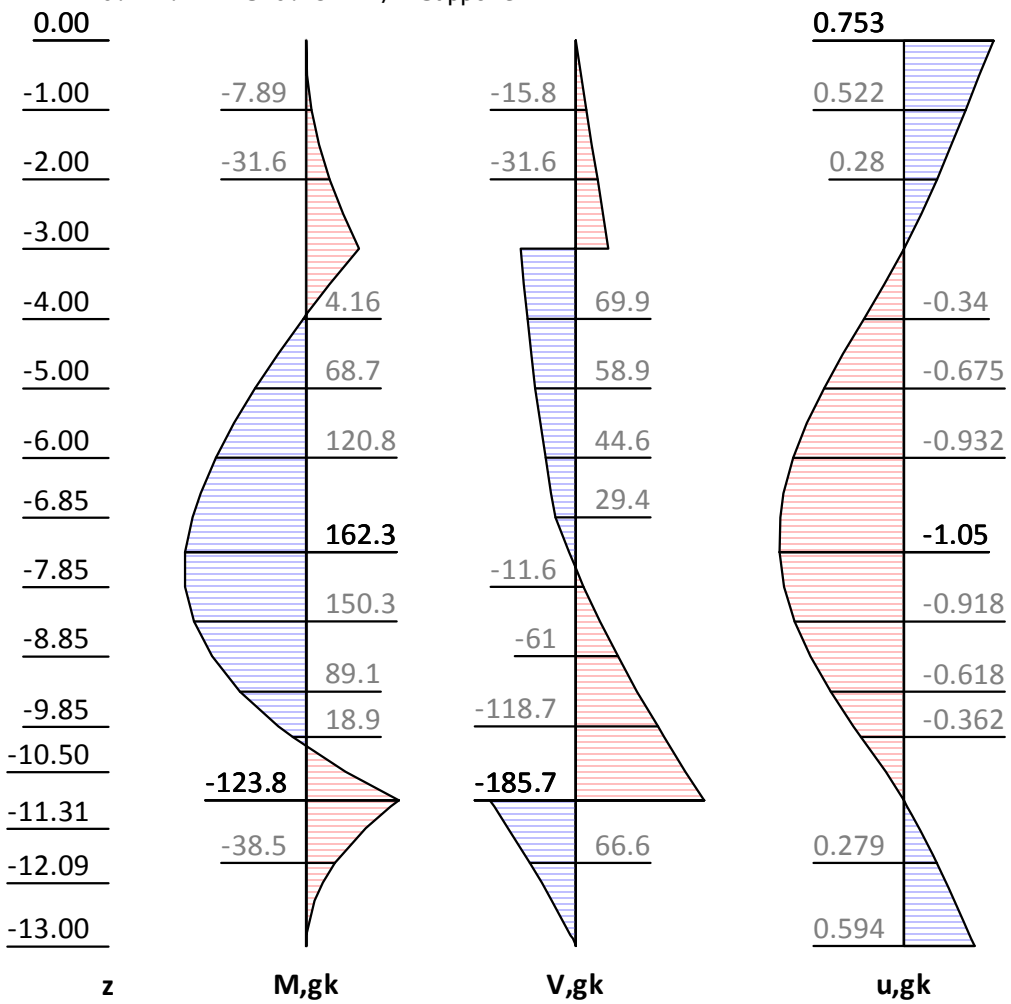


z [m]	PH,gk [kN/m2]	PH,qk [kN/m2]	PH,d [kN/m2]
0.00	15.78		21.31
-0.93	15.78	0.00	21.31
-0.93	15.78	5.76	29.95
-1.50	15.78	5.76	29.95
-1.50	15.78	15.23	44.16
-3.00	15.78	15.23	44.16
-3.00	10.53	15.23	37.06
-4.50	10.53	15.23	37.06
-4.50	10.53	4.15	20.44
-6.85	19.48	4.15	32.52
-6.85	36.78	4.15	55.88
-10.00	63.22	4.15	91.57
-10.00	59.48	3.81	86.02
-10.06	59.96	3.81	86.67
-10.06	59.96	0.00	80.95
-11.00	67.49	0.00	91.11
-13.00	51.11	0.00	69.01

V-pressure on static system

Internal forces: Permanent, characteristically

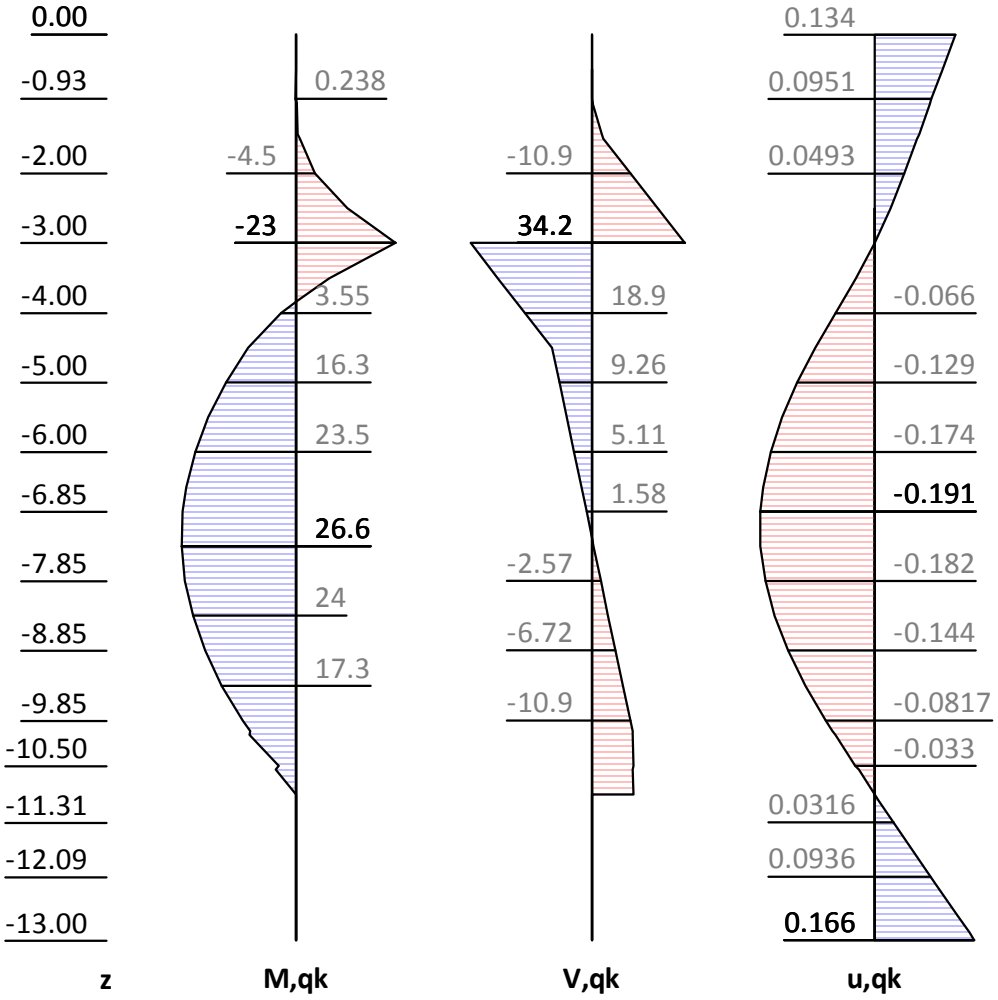
z= -0.500. Fx= -0.000 kN/m Support
z= -3.000. Fx=-127.795 kN/m Support
z= -10.912. Fx=-310.181 kN/m Support



z [m]	H,g,k [kN/m2]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [mm]
0.00	15.78	-0.00	0.00	0.00	0.75
-0.00	15.78	-0.00	0.00	-0.00	0.75
-3.00	15.78	-71.02	-47.35	-75.24	0.00
-3.00	15.78	-71.02	-47.35	-75.24	-0.00
-3.00	10.53	-71.02	80.45	-109.49	-0.00
-3.94	10.53	0.00	70.53	-131.85	-0.32
-6.85	19.48	152.45	29.40	-200.82	-1.04
-6.85	36.78	152.45	29.40	-200.82	-1.04
-7.35	40.98	162.31	9.95	-216.84	-1.05
-7.58	42.91	162.14	-0.00	-224.14	-1.03
-10.00	63.22	18.88	-128.09	-298.34	-0.36
-10.00	59.48	18.88	-128.09	-298.34	-0.36
-10.13	60.54	0.00	-136.19	-302.25	-0.31
-10.91	66.77	-123.78	-185.70	-325.76	0.00
-10.91	66.77	-123.78	124.48	-325.76	0.00
-11.00	67.49	-113.14	118.60	-328.47	0.03
-13.00	51.11	-0.00	-0.00	-394.15	0.59

Internal forces: Variable, characteristically

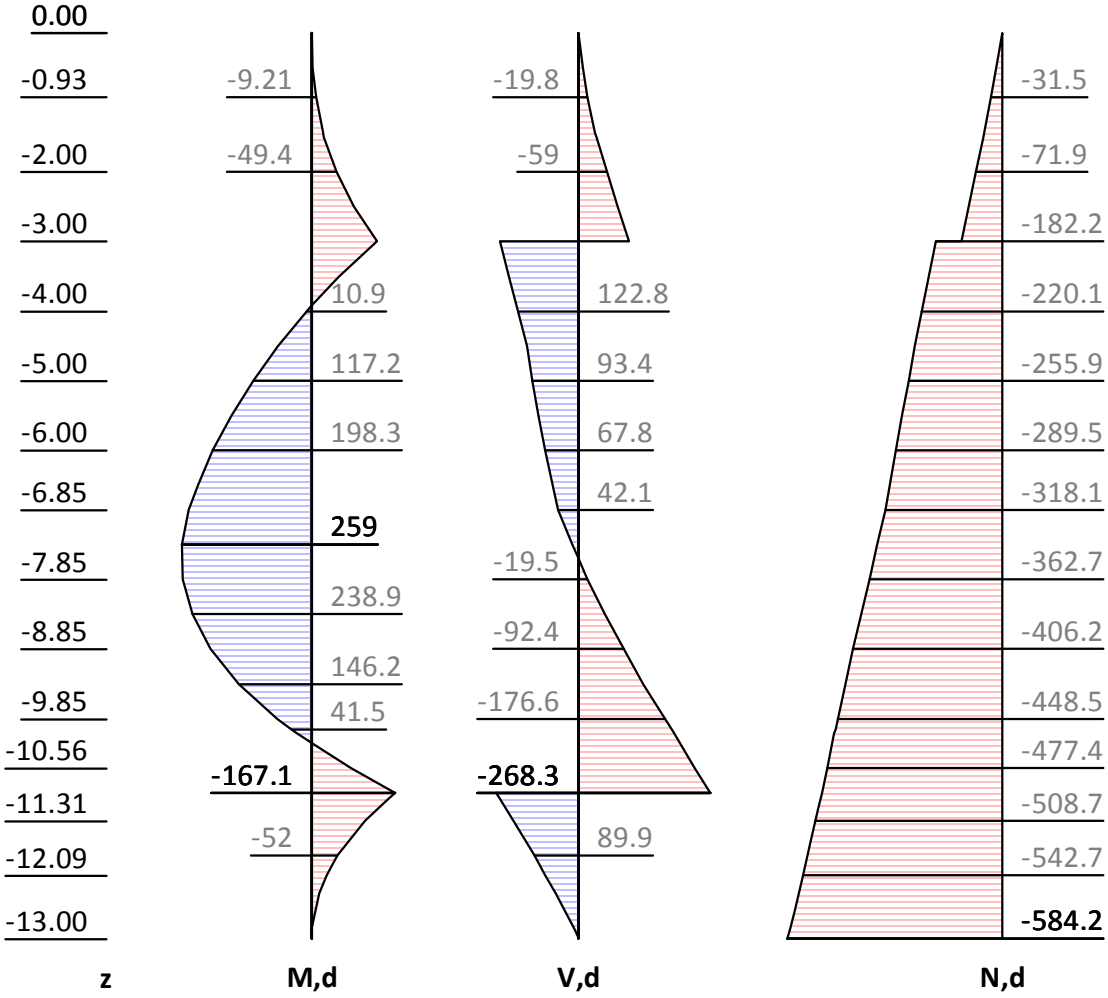
Method EB 82-4 (Q = [G+Q] - G).
z= -0.500. Fx= 0.000 kN/m Support
z= -3.000. Fx= -60.317 kN/m Support
z= -10.912. Fx= -11.722 kN/m Support

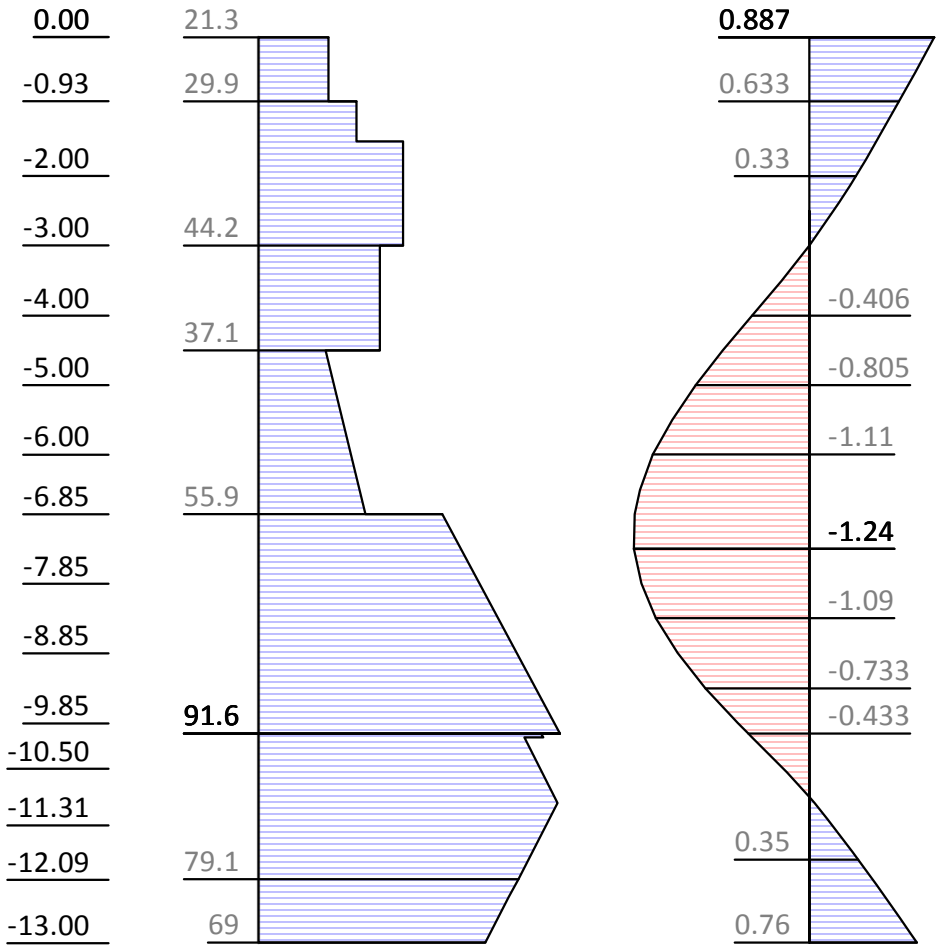


z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
0.00		0.00	0.00		0.13
-0.50		0.00	0.00	0.00	0.11
-0.93	0.00	0.24	-0.00	-0.00	0.10
-0.93	5.76	0.24	0.00	-0.00	0.10
-0.93	5.76	0.24	-0.00	-0.00	0.10
-0.96	5.76	-0.00	-0.17	-0.04	0.09
-1.50	5.76	-0.94	-3.28	-0.85	0.07
-1.50	15.23	-0.94	-3.28	-0.85	0.07
-3.00	15.23	-23.00	-26.13	-6.74	0.00
-3.00	15.23	-23.00	-26.13	-6.74	-0.00
-3.00	15.23	-23.00	34.18	-22.91	-0.00
-3.84	15.23	0.00	21.33	-26.22	-0.06
-4.50	15.23	11.13	11.33	-28.80	-0.10
-4.50	4.15	11.13	11.33	-28.80	-0.10
-6.85	4.15	26.30	1.58	-31.32	-0.19
-7.23	4.15	26.51	0.00	-31.73	-0.19
-7.35	4.15	26.57	-0.50	-31.85	-0.19
-10.00	4.15	10.69	-11.49	-34.69	-0.07
-10.00	3.81	10.69	-11.49	-34.69	-0.07
-10.06	3.81	10.80	-11.62	-34.73	-0.07
-10.06	0.00	10.80	-11.62	-34.73	-0.07
-10.50	0.00	4.00	-11.83	-34.78	-0.03
-10.56	0.00	4.81	-11.64	-34.73	-0.03
-10.91	0.00	0.00	-11.72	-34.75	0.00
-10.91	0.00	0.00	0.00	-34.75	0.00
-11.00	0.00	0.00	0.00	-34.75	0.01
-11.31	0.00	0.00	-0.00	-34.75	0.03
-12.09	0.00	0.00	-0.00	-34.75	0.09
-13.00	0.00	0.00	-0.00	-34.75	0.17

Internal forces: Design

z= -0.500. Fx= -0.000 kN/m Support
z= -3.000. Fx=-262.999 kN/m Support
z= -10.912. Fx=-436.328 kN/m Support





z [m]	H,d [kN/m2]	M,d [kN/m2]	V,d [kN/m2]	N,d [kN/m2]	u,g+q,k [mm]
0.00	21.31	0.00	0.00	0.00	0.89
-0.00	21.31	0.00	-0.00	-0.00	0.89
-0.93	21.31	-9.21	-19.81	-31.49	0.63
-0.93	29.95	-9.21	-19.81	-31.49	0.63
-1.50	29.95	-25.37	-36.89	-52.06	0.47
-1.50	44.16	-25.37	-36.89	-52.06	0.47
-3.00	44.16	-130.38	-103.12	-111.70	0.00
-3.00	44.16	-130.38	-103.12	-111.70	-0.00
-3.00	37.06	-130.38	159.88	-182.17	-0.00
-3.92	37.06	-0.00	125.89	-216.94	-0.37
-4.50	37.06	67.75	104.29	-239.05	-0.61
-4.50	20.44	67.75	104.29	-239.05	-0.61
-6.85	32.52	245.27	42.06	-318.08	-1.23
-6.85	55.88	245.27	42.06	-318.08	-1.23
-7.35	61.54	258.97	12.69	-340.51	-1.24
-7.55	63.78	258.32	0.00	-349.24	-1.22
-10.00	91.57	41.52	-190.17	-454.80	-0.43
-10.00	86.02	41.52	-190.17	-454.80	-0.43
-10.06	86.67	29.95	-195.35	-457.26	-0.40
-10.06	80.95	29.95	-195.35	-457.26	-0.40
-10.20	82.45	0.00	-206.94	-462.84	-0.34
-10.91	90.14	-167.11	-268.28	-491.90	0.00
-10.91	90.14	-167.11	168.05	-491.90	0.00
-11.00	91.11	-152.75	160.11	-495.56	0.04
-13.00	69.01	-0.00	0.00	-584.23	0.76
-13.00	69.01	0.00	-0.00	-584.23	0.76

Anchor forces with safety level of DS-P

z[m]	A,d[kN]	Fx,d[kN/m]
-0.50	0.0	-0.0
-3.00	490.1	-263.0

Checks of earth statics

Check or earth support

Check: Mobilizable earth resistance is sufficient for earth support force.
z: -10.91 m
Rd = Eph,k/γ,Re = 3698.53 / 1.400 = 2641.81 [kN/m]

Ed(Uh,d)/Rd = 436.33 / 2641.81 = 0.165 [-]. Passes requirement

Sum of H and V forces, (G)

Forces up to depth z:-13.00

Pos.	H	V
H/V pressure G+P+W,k	437.98	125.33
Wall weight		228.91
H/V pressure passive		0.00
Support z: -0.50		0.00
Support z: -3.00	-127.80	34.24
Bh,g,k z=-10.91	-310.18	
Bv,g,k = Bh,k * tan(δ,p=-23.33°)		-133.80
Σ	0.00	254.68 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than the downwards pointing vertical forces.

Vk >= Bvk: 388.48 >= 133.80 Passes requirement

Sum of H and V forces, (G+Q)

Forces up to depth z:-13.00

Pos.	H	V
H/V pressure G+P+W,k	510.02	143.92
Wall weight		228.91
H/V pressure passive		-0.00
Support z: -0.50		0.00
Support z: -3.00	-188.11	50.40
Bh,g,k z=-10.91	-310.18	
Bv,g,k = Bh,k * tan(δ,p=-23.33°)		-133.80
Bh,q,k z=-10.91	-11.72	
Bv,q,k = Bh,k * tan(δ,p=-23.33°)		-5.06
Σ	-0.00	284.37 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than the downwards pointing vertical forces.

Vk >= Bvk: 423.23 >= 138.86 Passes requirement

Hydraulic heave

Safety factors: [HYD]
γ,G,stb: 0.900
γ,H: 1.600

Stream length l,tot=10.50 m. Sum(h,i/k,i)=105000.00 1/100s.

Στρώμα "Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ" z: -11.00 / -13.00, h= 2.00m
Ed=Σ(γW*h*i)*γ,H = 12.38* 1.600 = 19.81 (i=0.619)
Rd=Σ(γ*h)*γ,G,stb = 118.38* 0.900 = 106.54
Ed/Rd = 0.186 [-]

Anchor verification

Anchor - Stability of lower failure plane

Περίπτ.Φόρτισης: όλα τα φορτία BS-P
Αυτόμ. υπολογ. μήκους αγκυρίων:
All anchors are extended (if necessary)
Favourable variable loads in main failure body are not being considered.
Bottom of lower failure plane: z=-13.00 m

Iteration of failure mechanisms:
lA .....: Length of anchor from head to center of grout body.
W,k .....: Res. force from dead weight, loads, cohesion, ...
Q,k .....: Force in lower failure plane.
Ea1,k.....: Earth pressure onto vertical separation plane.
Ea2,k.....: Earth pressure between wall and main failure body.
Ra_cal,d ...: Dimesioning force of the resistance from the equilibrium of forces. Ra_cal,d corresponds to the max. possible anchor force of the force polygon.
Sum(A,d) ...: Acting anchor forces along the grout body fractions within the failure body. Sum(A,d) is gained from the anchor pull forces of the wall analysis.

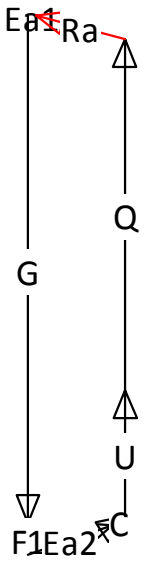
z [m]	ϑ1 [°]	ϑ2 [°]	lA [m]	W,k [kN/m]	Q,k [kN/m]	Ea1,k [kN/m]	Ea2,k [kN/m]	Ra_cal,d [kN/m]	Sum(A,d) [kN/m]	Ed/Rd [-]
-0.50	38.5	57.5	12.19	1632.3	1444.7	4.4	373.2	202.8	202.3	1.00
-3.00	33.9	60.9	11.02	1674.6	1452.8	35.0	373.2	272.9	272.2	1.00

Decisive failure body:
Γεωμετρία:
Foot point of lower failure plane x/z = 0.01/-13.00 m
Intersection lower/upper slid. plane x/z = 10.64/ -5.85 m
Intersection upper slid. plane/surface x/z = 13.90/ 0.00 m
Intersection separation plane/surface x/z = 10.64/ 0.00 m
Inclination lower failure plane ϑ1 = 33.92°
Inclination upper failure plane ϑ2 = 60.90°
Inclination separation plane ϑ12 = 90.00°

Loads / forces (char.)

		Fx [kN/m]	Fz [kN/m]	F [kN/m]	
Weight of main failure body	G,k:	0.0	-2103.2	2103.2	
Area loads on/in main failure body	F1,k:	0.0	-130.0	130.0	
Cohesion of lower failure plane	C,k:	53.2	35.7	64.1	
Pore water pressure on main body	U,k:	-0.1	523.7	523.7	
Earth pres. on separation plane	Ea1,k:	-35.0	-0.0	35.0	δ= 0.0°
Earth pr. between wall<->main body	Ea2,k:	352.6	122.1	373.2	
Force in lower failure plane	Q,k:	-1.7	1452.8	1452.8	
Sum = possible anchor forces:	Ra_cal,k:	369.0	-98.9	382.0	

Force polygon



Acting anchor forces Ed: Sum(A,d) = 272.2 kN/m
Possible anchor forces Rd: Ra_cal,d = 382.0/1.400 = 272.9 kN/m

Verif. of lower failure plane Ed/Rd = 1.00 < 1.0: Έλεγχος εκπληρώθηκε.

Check of steel tension

l,tot ...[m]: Total length of anchor incl. excess length at head
As ....[mm2]: X-section are of steel member
Ri,d ...[kN]: Ultimate strength of tension member (γ,M=1.15)
A,d ....[kN]: Dimensioning force of the anchor from wall analysis

z[m]	Anchor type	l,tot	As	Ri,d		A,d	
-0.50	Strand;3x0.60";1570/1770	16.43	420	573.4	>	0.0	Passes requirement
-3.00	Strand;3x0.60";1570/1770	15.02	420	573.4	>	490.1	Passes requirement

Check of steel tension: Passes requirement

Check of anchor's soil friction

lVk .....: Length of grout body
DmVk ....: Diameter of grout body
τGr,k ...: Average applied skin friction along the grout body (from soil parameters)
Ra,k ....: Charact. pullout resistance of the anchor
γA .....: Partial safety factor of anchor pullout
Ra,d ....: = Ra,k / γA
A,d .....: Dimensioning force of the anchor from wall analysis

z [m]	lVk [m]	DmVk [mm]	τGr,k [kN/m²]	Ra,k [kN]	γA [-]	Ra,d [kN]		A,d [kN]	A,d/Ra,d [-]
-0.50	8.00	318	110	879.1	1.100	799.2	>	0.0	0.0
-3.00	8.00	318	110	879.1	1.100	799.2	>	490.1	0.6

Check of anchor's soil friction: Passes requirement

Υπολογ. κύκλου ολίσθησης

LC: όλα τα φορτία Type: BS-T (combination: [GEO] A2 M2 R3, BS-T)
Vertical variable loads only act if they are outside of R*sin(phi).
The automatic slip circle optimization only considers circles that intersect
the surface with an area of at least 0.25 m2.
The slip circle calculation only accepts circles including the wall.
The slipcircle calculation only allows circular failure planes
(no vertical tangents will occour).

Γεωμετ.κύκλου (μήκη και συντεταγμ. σε (m))
Κέντρο = (-1.95, 0.20), Ακτίνα = 13.35
Αρχ.σημ.= (-13.29, -6.85), Τελ.σημ. = (11.40, 0.00)

Γεωμετρία λωρίδων:

No	x	Width b	dxM	Weight	Load z-κατ.	Water-φορτ.	u*b	φ	c	θ
	[m]	[m]	[m]	[kN/m]	[kN/m]	[kN/m]	[kN/m]	[°]	[kN/m²]	[°]
1	-12.62	1.34	-10.67	29.3	0.0	0.0	-0.0	27.45	3.57	-31.27*
2	-11.29	1.34	-9.34	75.0	0.0	0.0	-0.0	27.45	3.57	-31.27*
3	-9.95	1.34	-8.00	109.4	0.0	0.0	-0.0	29.26	3.57	-30.37*
4	-8.61	1.34	-6.67	135.8	0.0	0.0	-4.9	29.26	3.57	-29.95
5	-7.28	1.34	-5.33	156.0	0.0	0.0	-13.6	29.26	3.57	-23.53
6	-5.94	1.34	-4.00	171.0	0.0	0.0	-20.3	29.26	3.57	-17.41
7	-4.61	1.34	-2.66	181.3	0.0	0.0	-24.9	29.26	3.57	-11.49
8	-3.27	1.34	-1.33	187.4	0.0	0.0	-27.6	29.26	3.57	-5.69
9	-1.94	1.34	0.01	189.4	0.0	0.0	-28.5	29.26	3.57	0.04
10	-0.60	1.34	1.35	196.5	0.0	0.0	-71.0	29.26	3.57	5.78
11	0.73	1.34	2.68	368.0	0.0	0.0	-111.7	29.26	3.57	11.58
12	2.07	1.34	4.02	357.6	0.0	0.0	-107.0	29.26	3.57	17.50
13	3.40	1.34	5.35	342.5	0.0	0.0	-100.3	29.26	3.57	23.63
14	4.74	1.34	6.69	322.2	34.7	0.0	-91.2	29.26	3.57	30.05
15	6.07	1.34	8.02	295.7	34.7	0.0	-79.3	29.26	3.57	36.93
16	7.41	1.34	9.36	261.2	34.7	0.0	-63.8	27.45	3.57	44.49
17	8.75	1.34	10.69	215.3	11.0	0.0	-43.0	27.45	3.57	53.20
18	10.41	1.99	12.36	189.5	0.0	0.0	-23.1	27.45	3.57	67.72

*** Σημείωση: Στις λωρίδες σημειωμένες με '*'
περιορίστηκε το theta στο 45°-Phi/2.

Συνεισφ. κατακόρυφων φορτίων:

No	Weight	G*sin(θ)	(G-u*b)*tan(φ) + c*b	μ*sin(θ)* tan(φ)+cos(θ)	T
	[kN/m]	[kN/m]	[kN/m]	[-]	[kN/m]
1	29.29	-23.41	19.99	0.738170	27.08
2	74.98	-52.43	43.72	0.738170	59.23
3	109.36	-65.53	66.03	0.740387	89.18
4	135.80	-67.80	78.11	0.745640	104.76
5	156.02	-62.29	84.53	0.820224	103.05
6	170.99	-51.17	89.17	0.881758	101.13
7	181.33	-36.13	92.38	0.931733	99.15
8	187.40	-18.60	94.26	0.971048	97.07
9	189.38	0.15	94.87	1.000186	94.86
10	196.51	19.80	75.07	1.019299	73.65
11	368.00	73.88	148.35	1.028231	144.28
12	357.59	107.55	145.12	1.026493	141.38
13	342.54	137.28	140.45	1.013178	138.63
14	356.95	178.75	153.62	0.986783	155.67
15	330.41	198.50	145.41	0.944827	153.90
16	295.89	207.35	125.33	0.870691	143.95
17	226.23	181.16	99.97	0.778723	128.38
18	189.47	175.32	93.56	0.586878	159.42
		902.40			2014.76

Συνεισφ. αγκυρίων: Αθρ. ροπών ανατροπής : -291.4 kN*m/m
" " resisting : 314.7 kN*m/m

Δράση Ed = (902.4*13.35-291.4)
Αντίσταση Rd = (2014.8*13.35+314.7)

SLIP-CIRCLE μ = Ed/Rd = 0.43 < 1.0: Έλεγχος εκπληρώθηκε.

ΠΑΡΑΡΤΗΜΑ

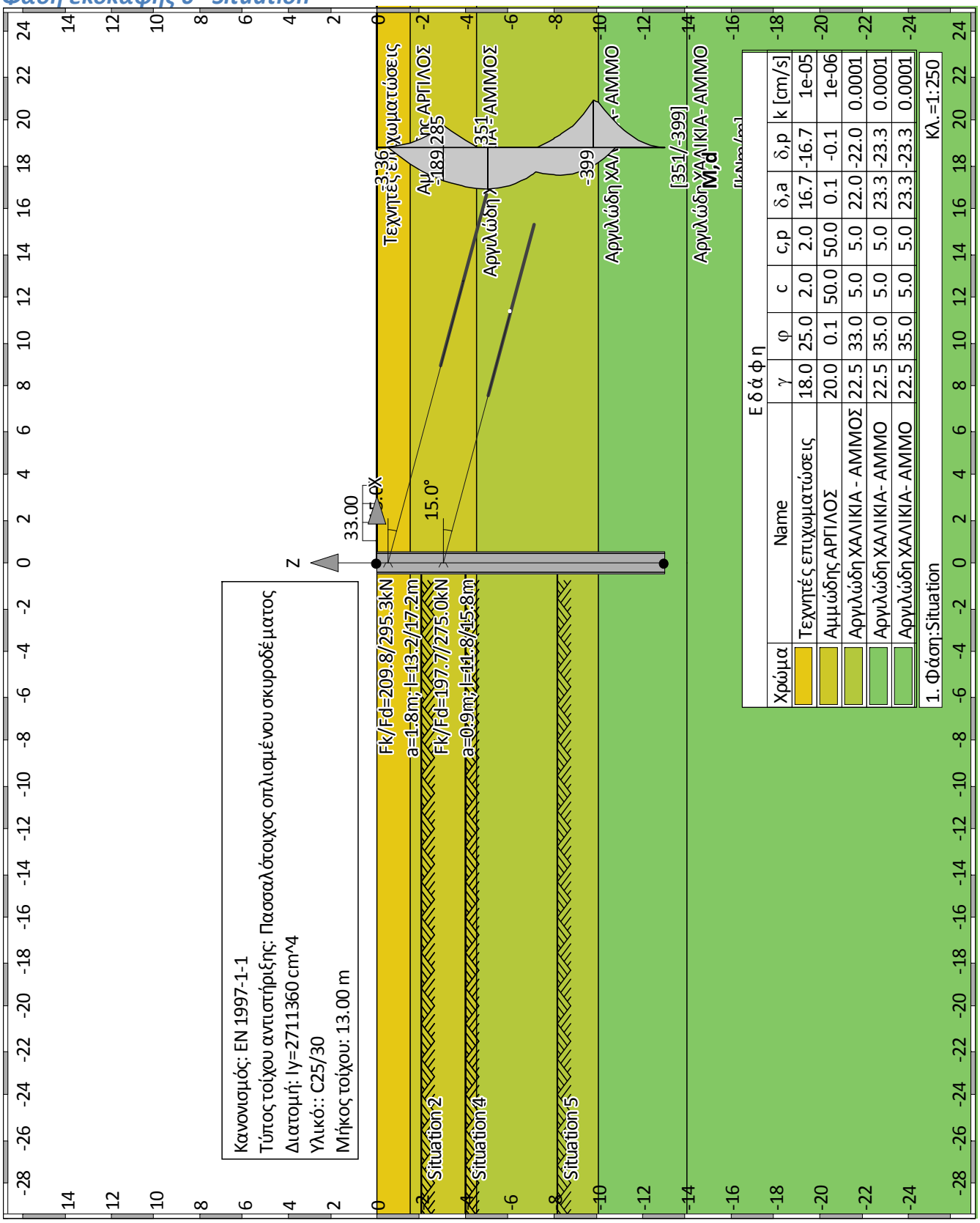
8.5 *Αποτελέσματα ανάλυσης*

8.5.3 Έλεγχος θραύσης πυθμένα

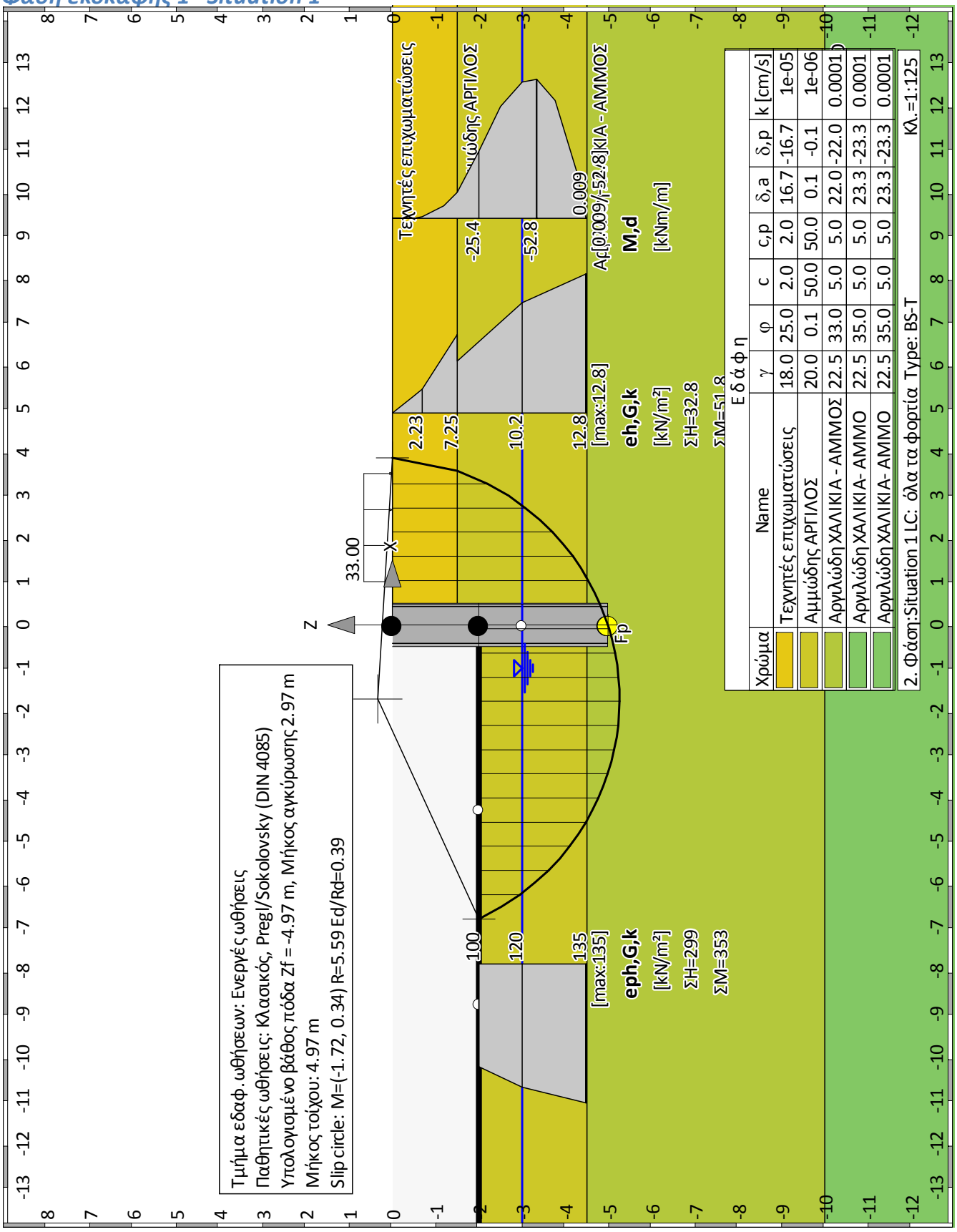
ii) Αντιστηριζόμενο ύψος 7,65m

Summary of all stages

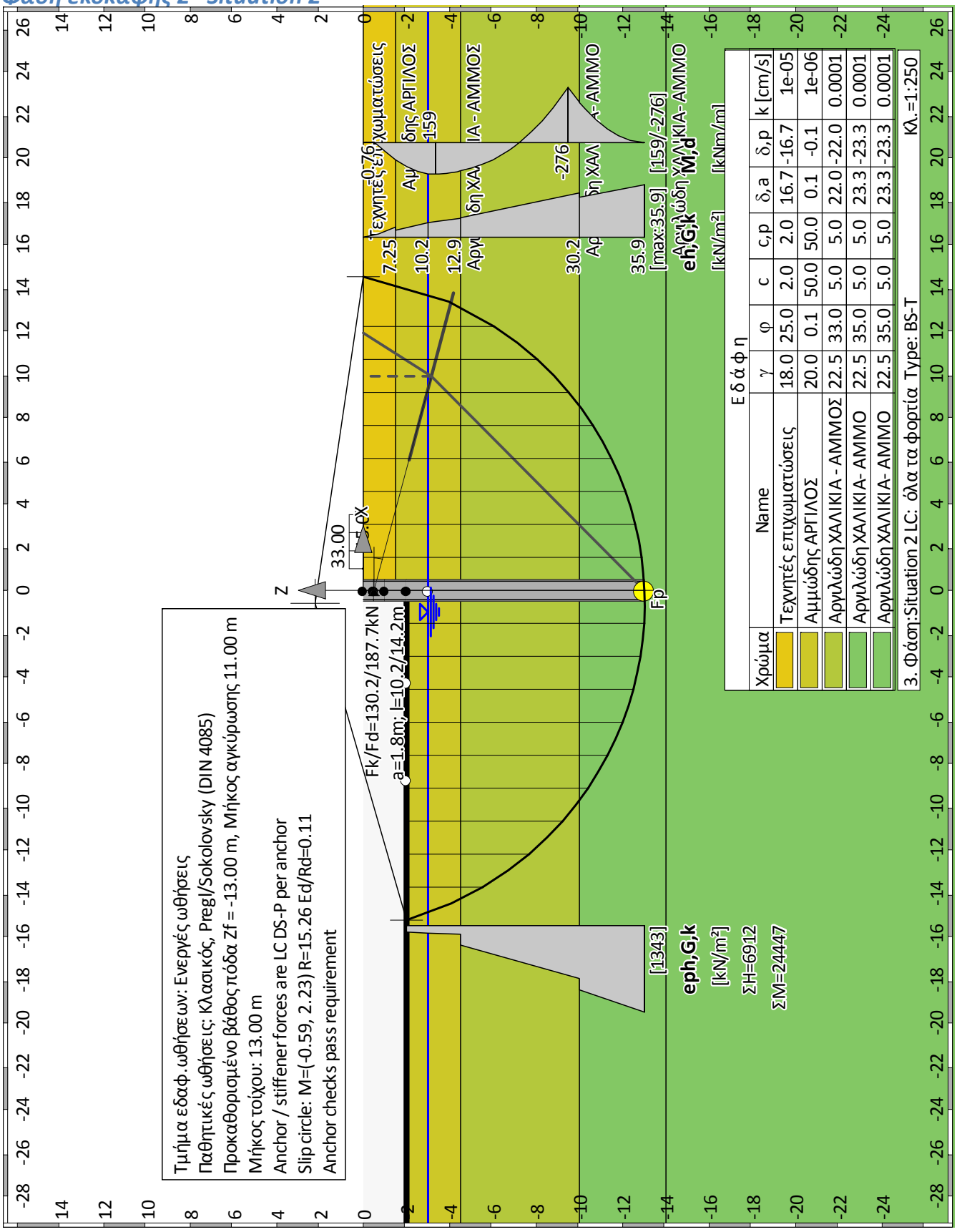
Φάση εκσκαφής 0 "Situation"



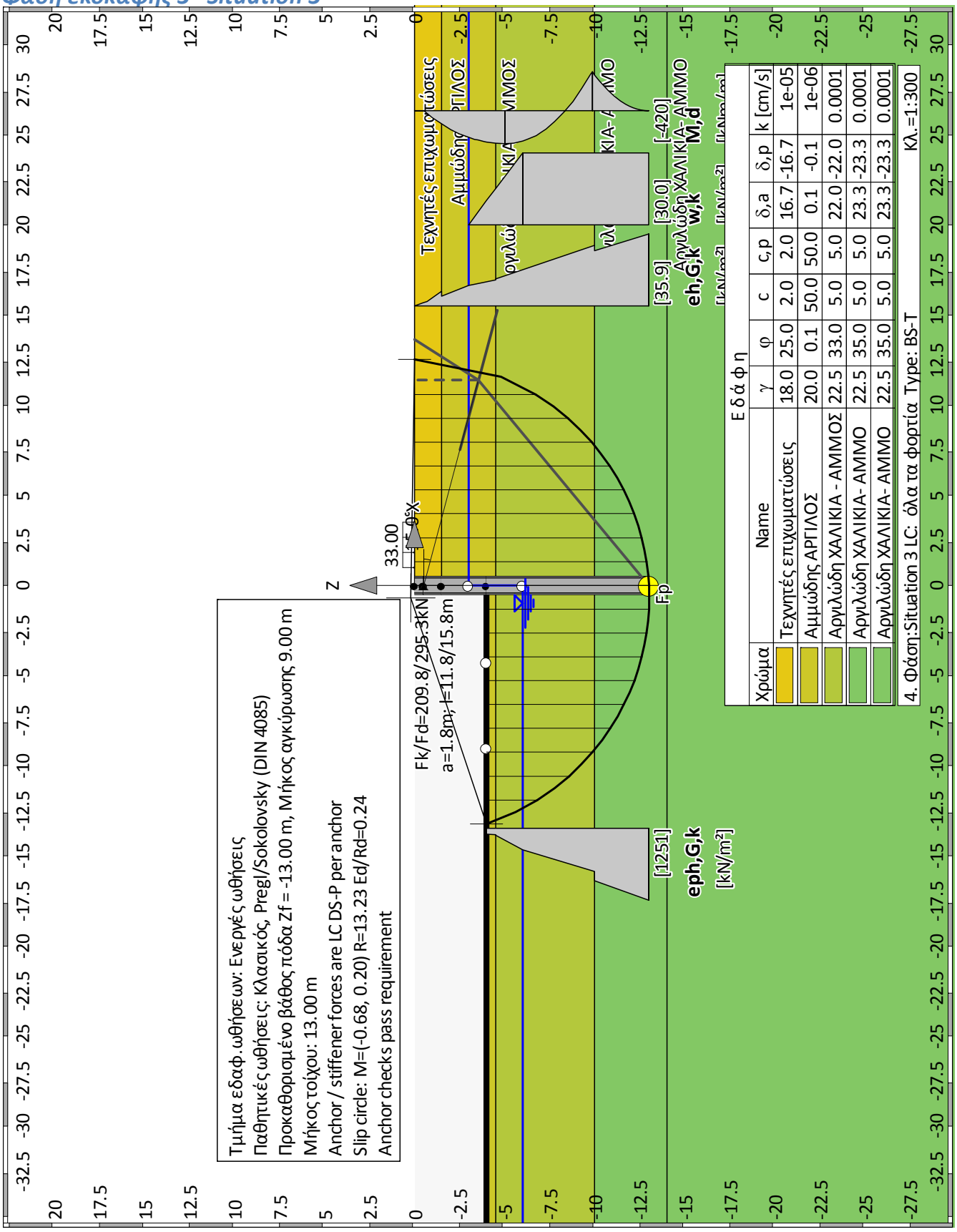
Φάση εκσκαφής 1 "Situation 1"



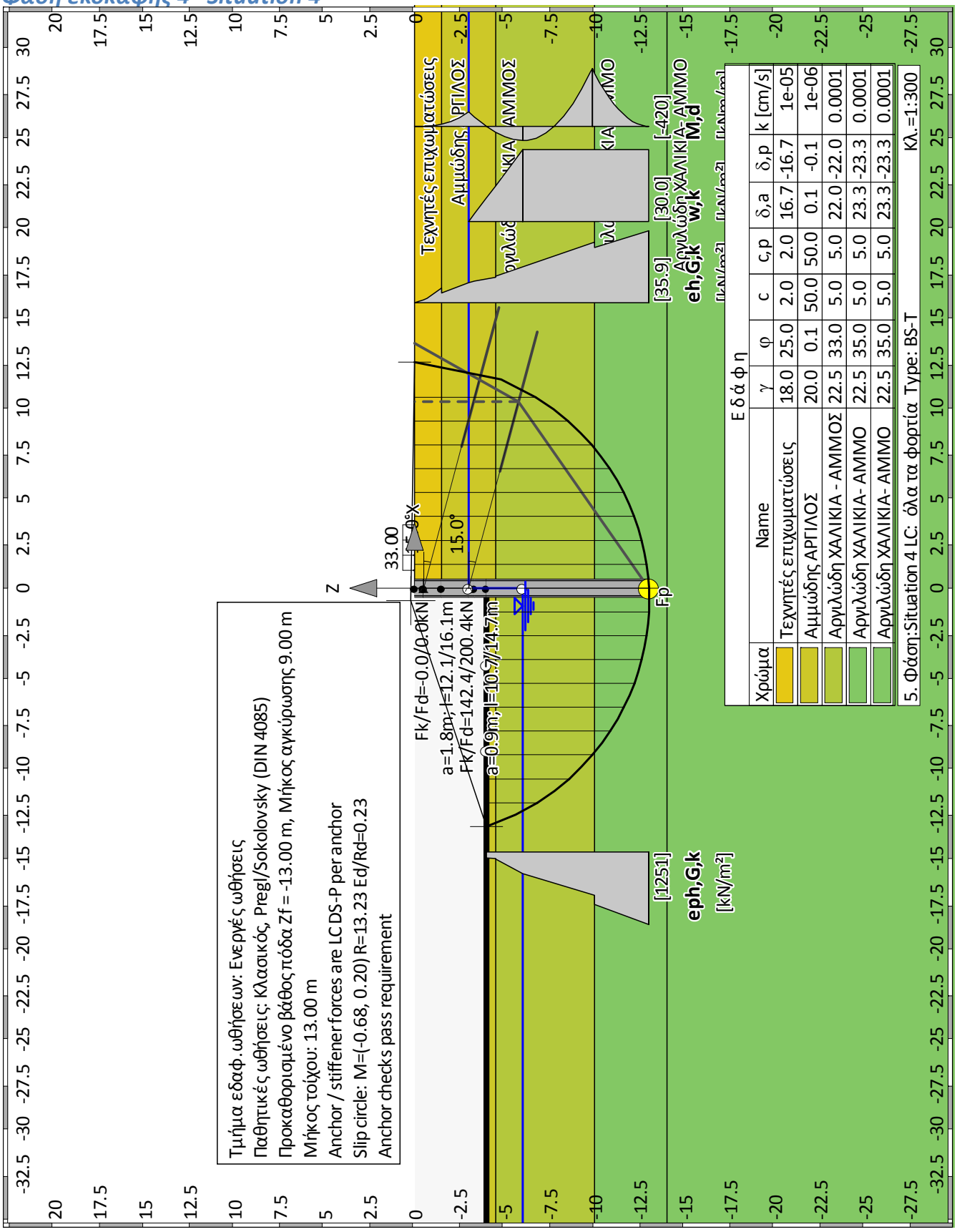
Φάση εκσκαφής 2 "Situation 2"



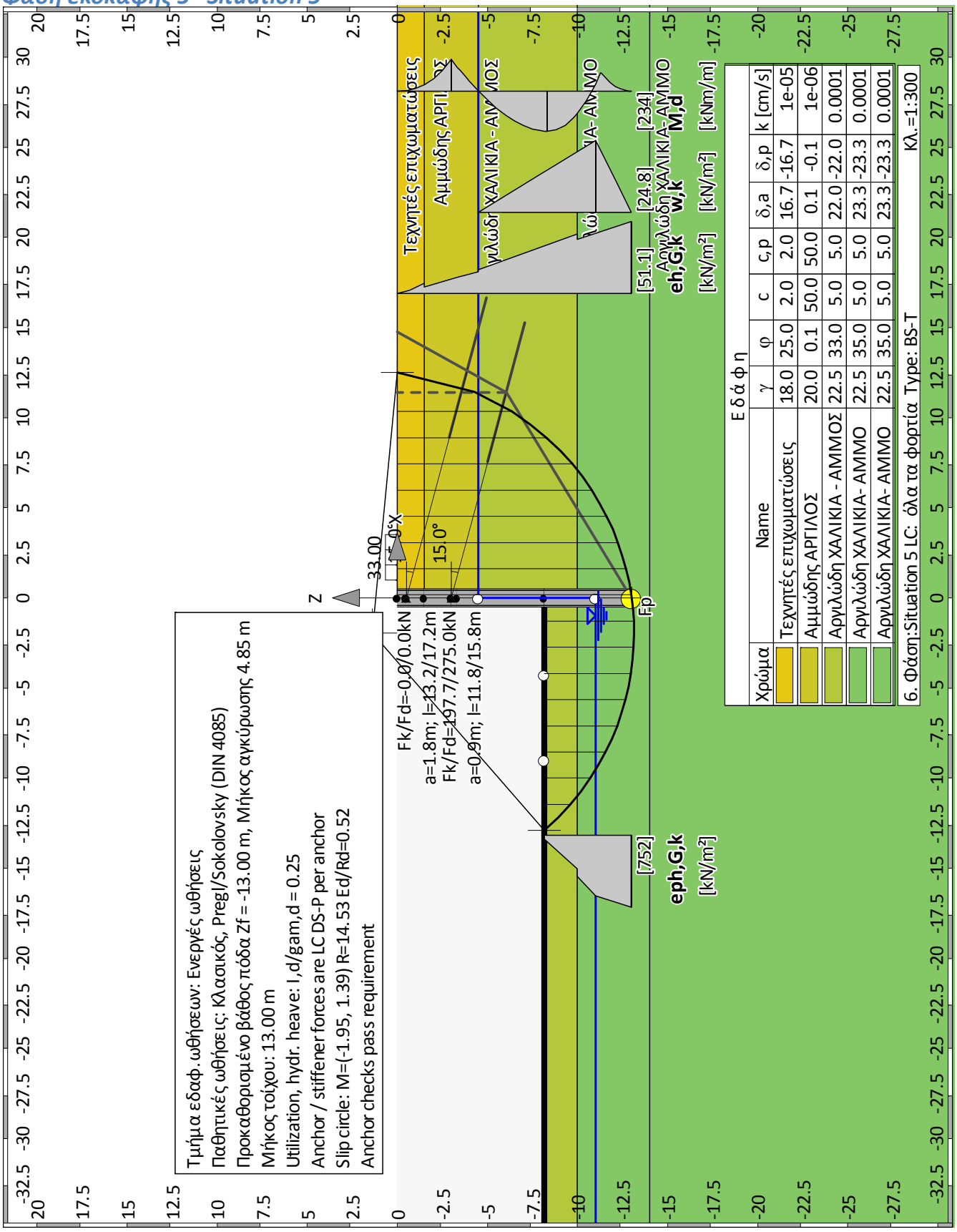
Φάση εκσκαφής 3 "Situation 3"



Φάση εκσκαφής 4 "Situation 4"



Φάση εκσκαφής 5 "Situation 5"



Κανονισμόςγια Ανάλυση και Διαστασιολόγηση

Διαστασ. ωπλισμ.σκυροδ.: EN 1992-1-1
Γεωτεχν.Κανονισμός : EN 1997 (rev.12)_user
National Annex: EN 1997-1

Safety factors:

Earth pressure onto wall: [GEO] A1 M1 R2

γ-	G,dst	E0G	G,stb	Q,dst	Q,stb	phi	coe	cu	g
BS-P	1.350	1.350	1	1.500	0	1	1	1	1
BS-T	1.350	1.350	1	1.500	0	1	1	1	1
BS-T/A	1.350	1.350	1	1.500	0	1	1	1	1
BS-E	1	1	1	1	0	1	1	1	1

ΚΕ-μηχανισμός: [GEO] A2 M2 R3

γ-	G,dst g	G,stb a,t	W a,p	Q,dst Gt	Q,stb N	phi	coe	cu
BS-P	1	1	1	1.300	0	1.250	1.400	1.400
	1	1	1	1	1			
BS-T	1	1	1	1.300	0	1.250	1.400	1.400
	1	1	1	1	1			
BS-T/A	1	1	1	1.300	0	1.250	1.250	1.400
	1	1	1	1	1			
BS-E	1	1	1	1	0	1.250	1.400	1.400
	1	1	1	1	1			

Θραύση εδάφους: [GEO] A1 M1 R2

γ-	G,dst cu	E0G g	W Re	G,stb	Q,dst	Q,stb	phi	coe
BS-P	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.400					
BS-T	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.400					
BS-T/A	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.400					
BS-E	1	1	1	1	1	0	1	1
	1	1	1					

Ολίσθηση: [GEO] A1 M1 R2

γ-	G,dst cu	E0G g	W Rh	G,stb	Q,dst	Q,stb	phi	coe
BS-P	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.100					
BS-T	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.100					
BS-T/A	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.100					
BS-E	1	1	1	1	1	0	1	1
	1	1	1					

Θραύση εδάφους: [GEO] A1 M1 R2

γ-	G,dst cu	E0G g	W Rv	G,stb	Q,dst	Q,stb	phi	coe
BS-P	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.400					
BS-T	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.400					
BS-T/A	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.400					
BS-E	1	1	1	1	1	0	1	1
	1	1	1					

Κύκλος ολίσθησης: [GEO] A2 M2 R3

	γ-g	G,dst Re	G,stb a,t	Q,dst a,p	Q,stb Gt	W N	phi	coe	cu
BS-P	1	1	1.300	0	1	1.250	1.400	1.400
	1	1	1	1	1	1			
BS-T	1	1	1.300	0	1	1.250	1.400	1.400
	1	1	1	1	1	1			
BS-T/A	1	1	1.300	0	1	1.250	1.250	1.400
	1	1	1	1	1	1			
BS-E	1	1	1	0	1	1.250	1.400	1.400
	1	1	1	1	1	1			

Hydraulic heave: [HYD] A1 M1 R1

	γ-	G,dst	G,stb	Q,dst	H
BS-P	1.350	0.900	1.500	1.800
BS-T	1.350	0.900	1.500	1.600
BS-T/A	1.350	0.900	1.500	1.500
BS-E	1	1	1	1

Failure of structural elements: [STR] A1 M1 R1

	γ-	M	Gtf	cd	N
BS-P	1.150	1.400	1.400	1.150
BS-T	1.150	1.300	1.300	1.150
BS-T/A	1.150	1.250	1.250	1.150
BS-E	1	1	1	1

Stability: [EQU] A1 M1 R1

	γ-	G,dst	G,stb	Q,dst	Q,stb	phi	coe	cu	g
BS-P	1	0.900	1.500	0	1.250	1.250	1.400	1
BS-T	1	0.900	1.500	0	1.250	1.250	1.400	1
BS-T/A	1	0.900	1.500	0	1.250	1.250	1.400	1
BS-E	1	1	1	0	1.250	1.400	1.400	1

γ,Re,red (EAB EB14-3): Ναι, η=0.80
γ,Re,red (EAB EB22-6): Ναι, E0h > 0%: η = 0.60 / 0.80

System values

Τοίχος

Τύπος τοίχου αντιστήριξης: Πασσαλότοιχος οπλισμένου σκυροδέματος
Διατομή: Iy=2711360 cm^4
Υλικό:: C25/30
Ίδιο βάρος: 25.000 [kN/m3]

Σημεία τοίχου

z [m]	d [m]	E [MN/m2]	Iy [cm4/m]	E*Iy [MNm2]	A [cm2/m]
0.00	100.0	31500.0	2711360	854.1	8400
-13.00	100.0	31500.0	2711360	854.1	8400

Φάση εκσκαφής 1 "[1] Situation 1"

LC: όλα τα φορτία Type: BS-T

Εδαφικό σύστημα με 5 Στρώσεις

Name		Τεχνητές επιχωματώσεις	Αμμώδης ΑΡΓΙΛΟΣ	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
γ	[kN/m3]	18	20	22.5
γ,R	[kN/m3]	18	20	22.5
γ'	[kN/m3]	8	10	12.5
γ,p	[kN/m3]	18	20	22.5
γ,R,passive	[kN/m3]	18	20	22.5
γ,pw	[kN/m3]	8	10	12.5
φ	[°]	25	0.1	33
c	[kN/m2]	2	50	5
c,u	[kN/m2]	10	50	5
c παθητικό	[kN/m2]	2	50	5
δ,a	[°]	16.66667	0.06666667	22
δ,p	[°]	-16.66667	-0.06666667	-22
δ,c	[°]	8.333333	0.03333333	11
k,agh	[-]	0.3456501	0.9955057	0.2452023
K,ach	[-]	1.043051	1.994195	0.8549058
K,0h	[-]	0.5773817	0.9982547	0.455361
K,pgh	[-]	3.908103	1.004519	7.495617
K,pch	[-]	5.180327	2.00583	8.599509
τ,gr	[kN/m2]	110	110	110
Ψ,A,max	[°]	90	90	90
k	[cm/s]	10e-06	1e-06	100e-06

Name		Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
γ	[kN/m3]	22.5	22.5
γ,R	[kN/m3]	22.5	22.5
γ'	[kN/m3]	12.5	12.5
γ,p	[kN/m3]	22.5	22.5
γ,R,passive	[kN/m3]	22.5	22.5
γ,pw	[kN/m3]	12.5	12.5
φ	[°]	35	35
c	[kN/m2]	5	5
c,u	[kN/m2]	5	5
c παθητικό	[kN/m2]	5	5
δ,a	[°]	23.33333	23.33333
δ,p	[°]	-23.33333	-23.33333
δ,c	[°]	11.66667	11.66667
k,agh	[-]	0.2244207	0.2244207
K,ach	[-]	0.8126539	0.8126539
K,0h	[-]	0.4264236	0.4264236
K,pgh	[-]	9.146943	9.146943
K,pch	[-]	10.104	10.104
τ,gr	[kN/m2]	110	110
Ψ,A,max	[°]	90	90
k	[cm/s]	100e-06	100e-06

Πορεία πρανούς:
x [m] 0.00 0.00
z [m] -2.00 0.00

Πορεία ανώτερου 2. στρώματος Αμμώδης ΑΡΓΙΛΟΣ:
x [m] 0.00 0.00
z [m] -2.00 -1.50

Πορεία ανώτερου 3. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ:
z= -4.50

Πορεία ανώτερου 4. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -10.00

Πορεία ανώτερου 5. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -14.00

Επιφ. φορτία:

Φορτία

xA [m]	zA [m]	xE [m]	zE [m]	PxA [kN/m²]	PzA [kN/m²]	PxE [kN/m²]	PzE [kN/m²]	Typ	LC-description Name
1.00	0.00	3.50	0.00	0.00	33.00	0.00	33.00	q	1

Κατανομή εδαφ.πιέσεων

Κατανομή εδαφ.πιέσεων	Name
Rectangular within a layer	

Στάθμη νερού:

x [m] 0.00
z [m] -3.00

Παράμετροι υπολογισμού

Earth pressure options

Τμήμα εδαφ.ωθήσεων: Ενεργές ωθήσεις.
Angle of slip plane: DIN 4085.
Split block loads into 1 sections.
Consideration of minimum earth pressure: φ,min = 40.000.
Negative earth pressure fractions are set to zero.

Redistribution of earth pressure

Shape of redistribution: No redistribution of earth pressure.
The earth pressure is getting redistb. to: Excavation level
The earth pressure below the excavation acts without redistrb.
The earth pressure from variable loads will be included in redistribution.

Παθητικές ωθήσεις

Method of calculation: Κλασικός, Pregl/Sokolovsky (DIN 4085).

Options for water pressure

Στήριξη πόδα

Πακτωμένη στήριξη κατά Blum

Earth pressure coefficients kh

φ	α	β	δ	k0gh	kagh	kach	kpgh	kpch	
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Τεχνητές επιχωματώσεις
25.0	0.0	0.0	16.7	--	0.346	1.043	--	--	"
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Αμμώδης ΑΡΓΙΛΟΣ
0.1	0.0	0.0	0.1	--	0.996	1.994	--	--	"
33.0	0.0	0.0	-22.0	--	--	--	7.496	-8.600	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
33.0	0.0	0.0	22.0	--	0.245	0.855	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"

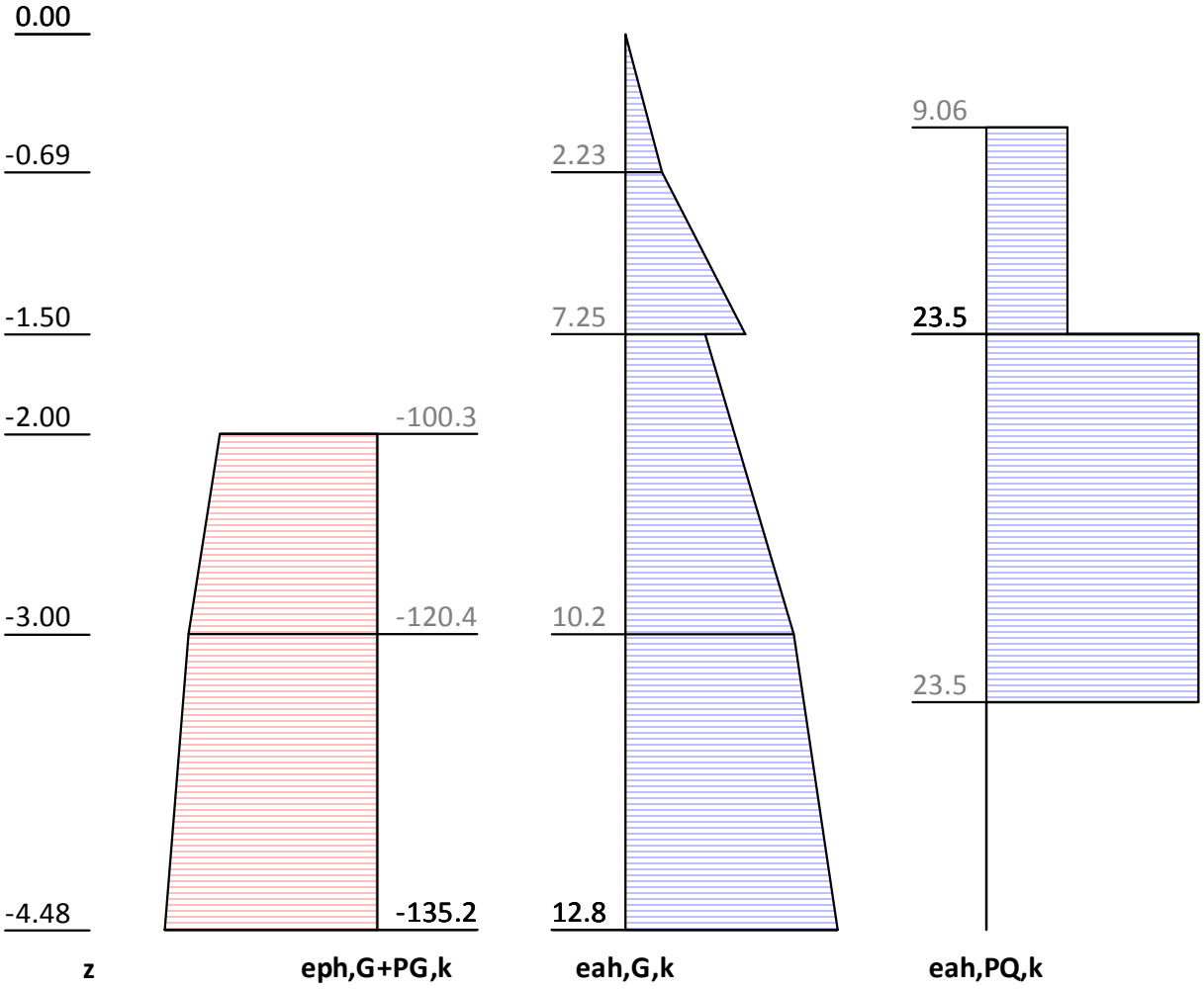
Μήκος τοίχου

```
N:   1 Z:   -3.000 M,Στήριξη πόδα,d:    51.74. Wall too short? Ναι
N:   2 Z:   -6.000 M,Στήριξη πόδα,d:  -401.07. Wall too short? Όχι
N:   3 Z:   -3.990 M,Στήριξη πόδα,d:    34.70. Wall too short? Ναι
N:   4 Z:   -5.337 M,Στήριξη πόδα,d:  -155.60. Wall too short? Όχι
N:   5 Z:   -4.434 M,Στήριξη πόδα,d:     3.70. Wall too short? Ναι
N:   6 Z:   -5.039 M,Στήριξη πόδα,d:   -82.64. Wall too short? Όχι
N:   7 Z:   -4.634 M,Στήριξη πόδα,d:   -16.37. Wall too short? Όχι
N:   8 Z:   -4.500 M,Στήριξη πόδα,d:   -13.22. Wall too short? Όχι
N:   9 Z:   -4.456 M,Στήριξη πόδα,d:     1.79. Wall too short? Ναι
N:  10 Z:   -4.486 M,Στήριξη πόδα,d:    -0.87. Wall too short? Όχι
N:  11 Z:   -4.466 M,Στήριξη πόδα,d:     0.92. Wall too short? Ναι
N:  12 Z:   -4.479 M,Στήριξη πόδα,d:    -0.27. Wall too short? Όχι
N:  13 Z:   -4.470 M,Στήριξη πόδα,d:     0.53. Wall too short? Ναι
N:  14 Z:   -4.476 M,Στήριξη πόδα,d:    -0.01. Wall too short? Όχι
Foot depth for statics: zf = -4.476
```

Stress analysis

Earth pressure, horizontal

Pressures characteristic, no redistribution, continous wall



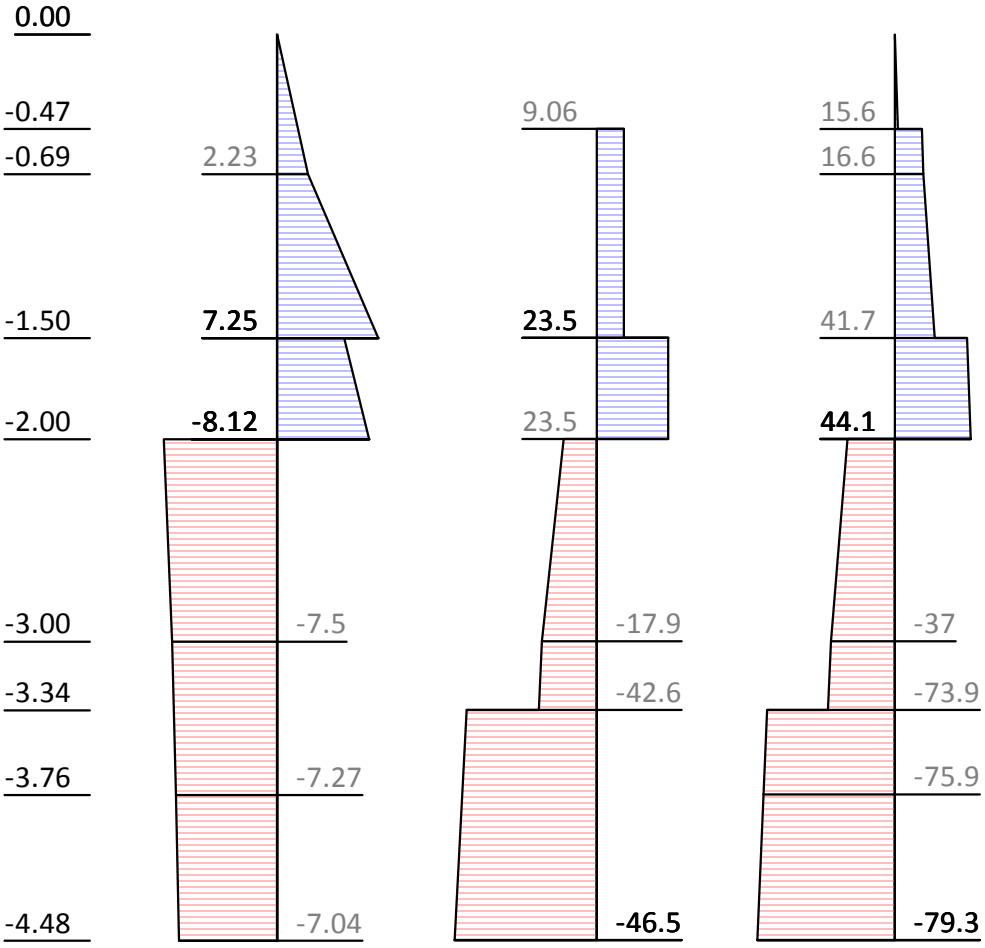
z [m]	eph,G,k [kN/m2]	eah,G,k [kN/m2]	eah,PQ,k [kN/m2]	eah,d [kN/m2]
0.00		0.00		0.00
-0.47		1.52	0.00	2.04
-0.47		1.52	9.06	15.62
-1.50		7.25	9.06	23.37
-1.50		4.82	23.48	41.73
-2.00	-0.00	6.61	23.48	44.14

z [m]	eph,G,k [kN/m2]	eah,G,k [kN/m2]	eah,PQ,k [kN/m2]	eah,d [kN/m2]
-2.00	-100.29	6.61	23.48	44.14
-3.34	-123.79	10.79	23.48	49.78
-3.34	-123.79	10.79	0.00	14.56
-4.48	-135.21	12.82	0.00	17.30

Eph,G,k: -298.99, Eph,PG,k: 0.00 [kN/m]
Eah,G,k: 32.82, Eah,PG,k: 0.00, Eah,PQ,k: 52.53, Eah,d: 123.10

H-pressure on static system

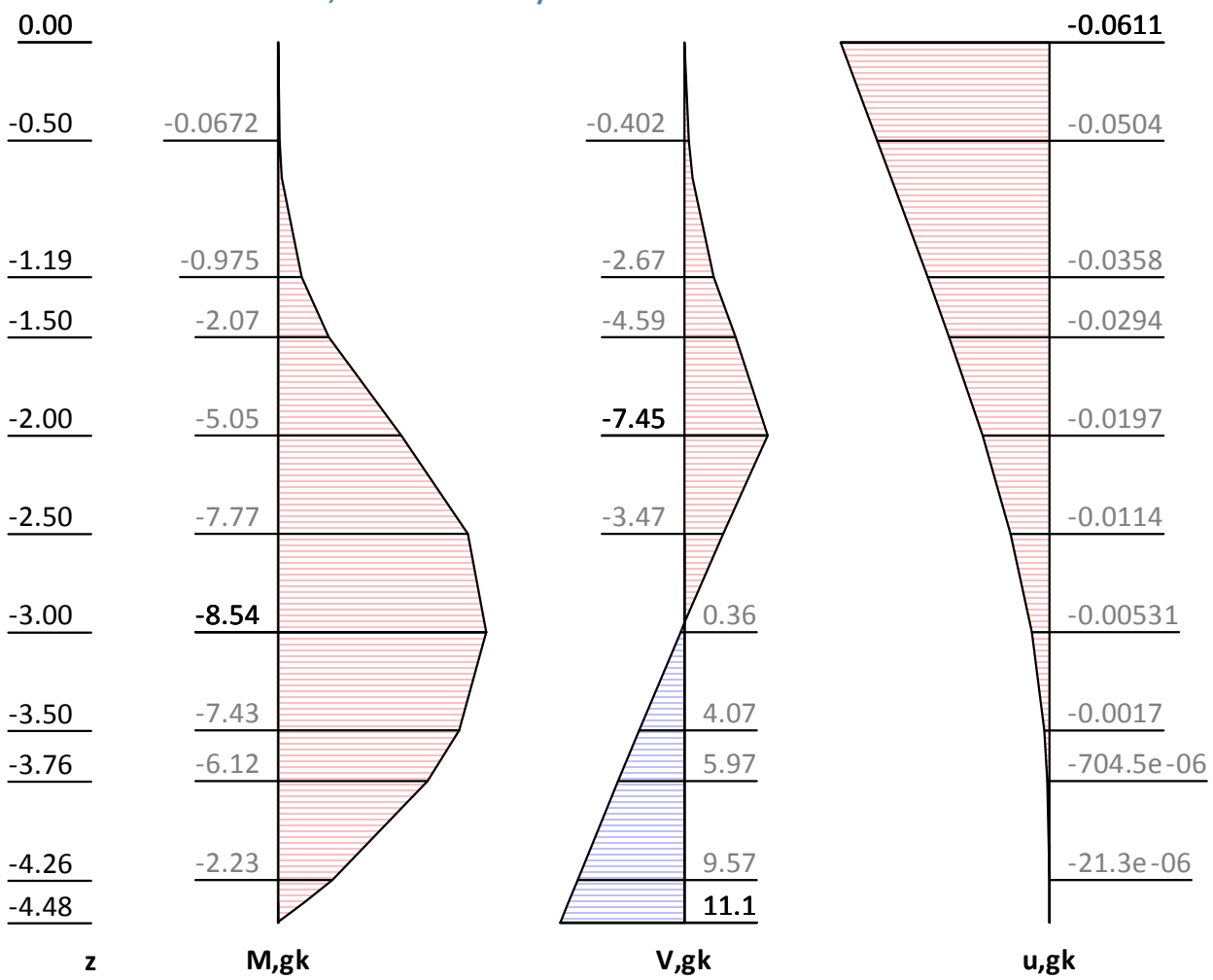
Level of mobilization: Ep,gk 14.7, Ep,qk 34.4, Ep,d 100.0 [%]



z [m]	PH,gk [kN/m2]	PH,qk [kN/m2]	PH,d [kN/m2]
0.00	0.00		0.00
-0.47	1.52	0.00	2.04
-0.47	1.52	9.06	15.62
-1.50	7.25	9.06	23.37
-1.50	4.82	23.48	41.73
-2.00	6.61	23.48	44.14
-2.00	-8.12	-11.02	-27.50
-3.34	-7.40	-19.10	-38.64
-3.34	-7.40	-42.58	-73.86
-4.48	-7.04	-46.51	-79.28

V-pressure on static system

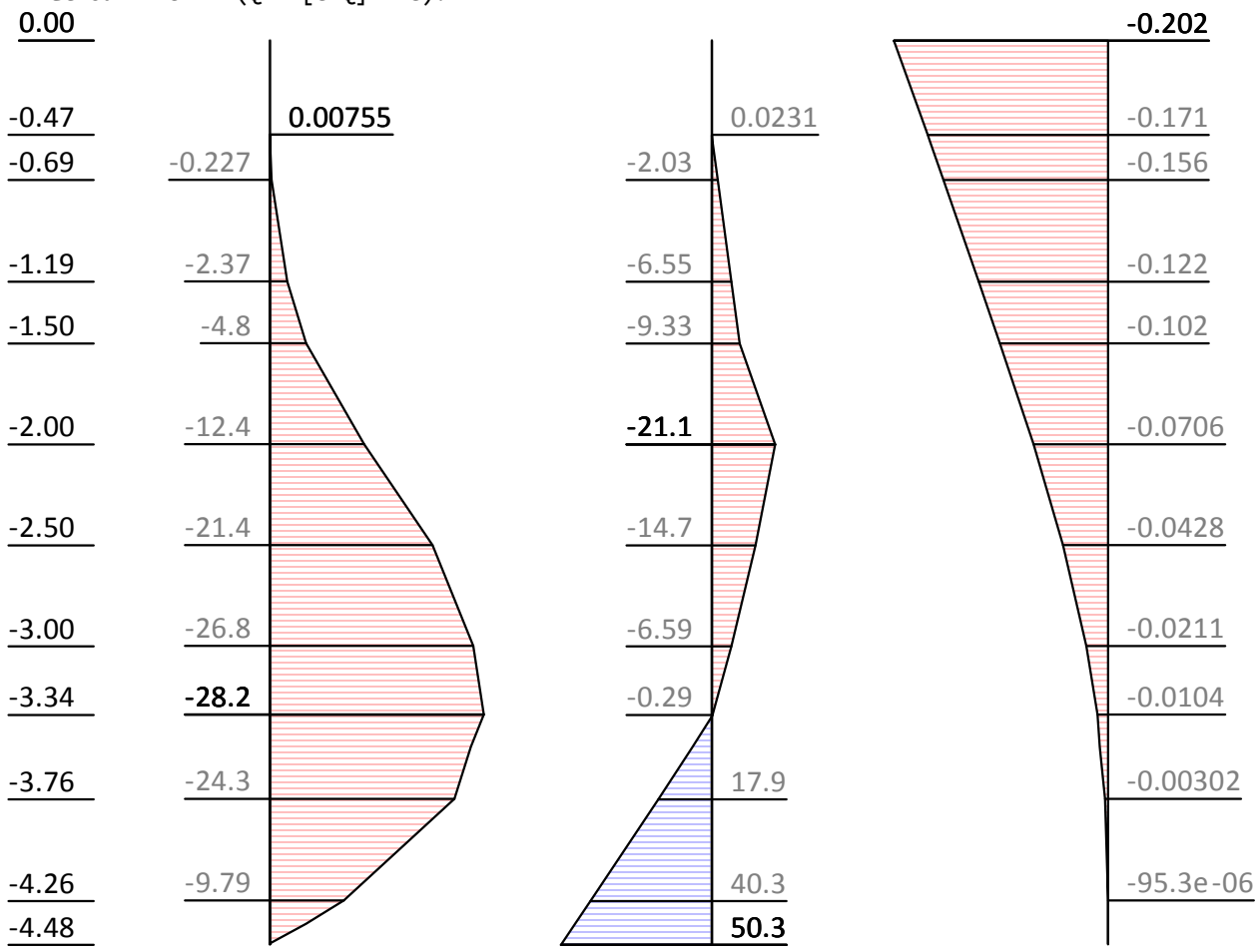
Internal forces: Permanent, characteristically



z [m]	H,g,k [kN/m2]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [mm]
0.00	0.00	0.00	0.00	0.00	-0.06
-1.50	7.25	-2.07	-4.59	-33.13	-0.03
-1.50	4.82	-2.07	-4.59	-33.13	-0.03
-2.00	6.61	-5.05	-7.45	-43.63	-0.02
-2.00	-8.12	-5.05	-7.45	-43.63	-0.02
-2.95	-7.53	-8.47	0.00	-63.64	-0.01
-3.00	-7.50	-8.54	0.36	-64.62	-0.01
-4.48	-7.04	-0.00	11.10	-83.21	-0.00
-4.48	-7.04	0.00	11.10	-83.21	0.00

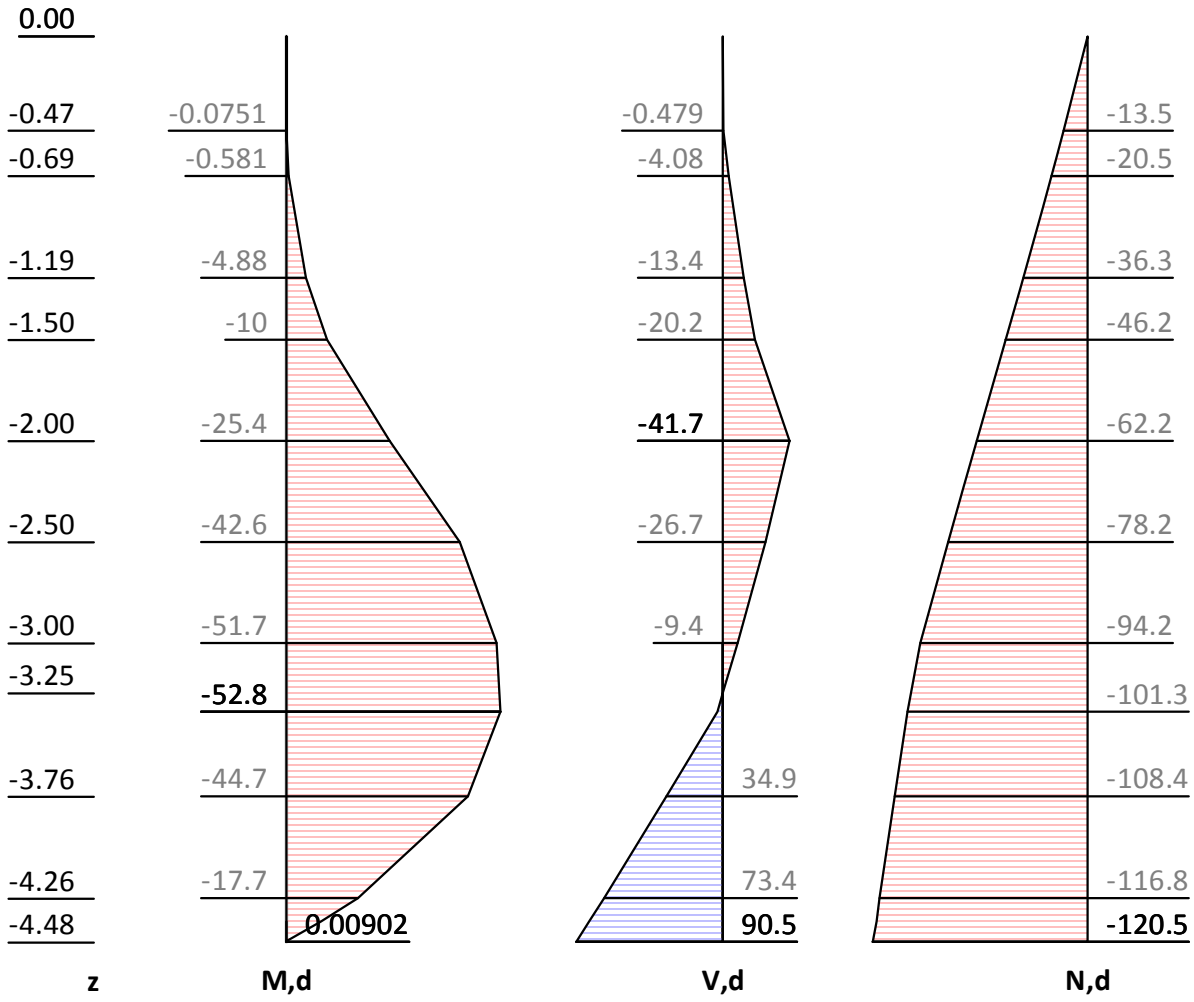
Internal forces: Variable, characteristically

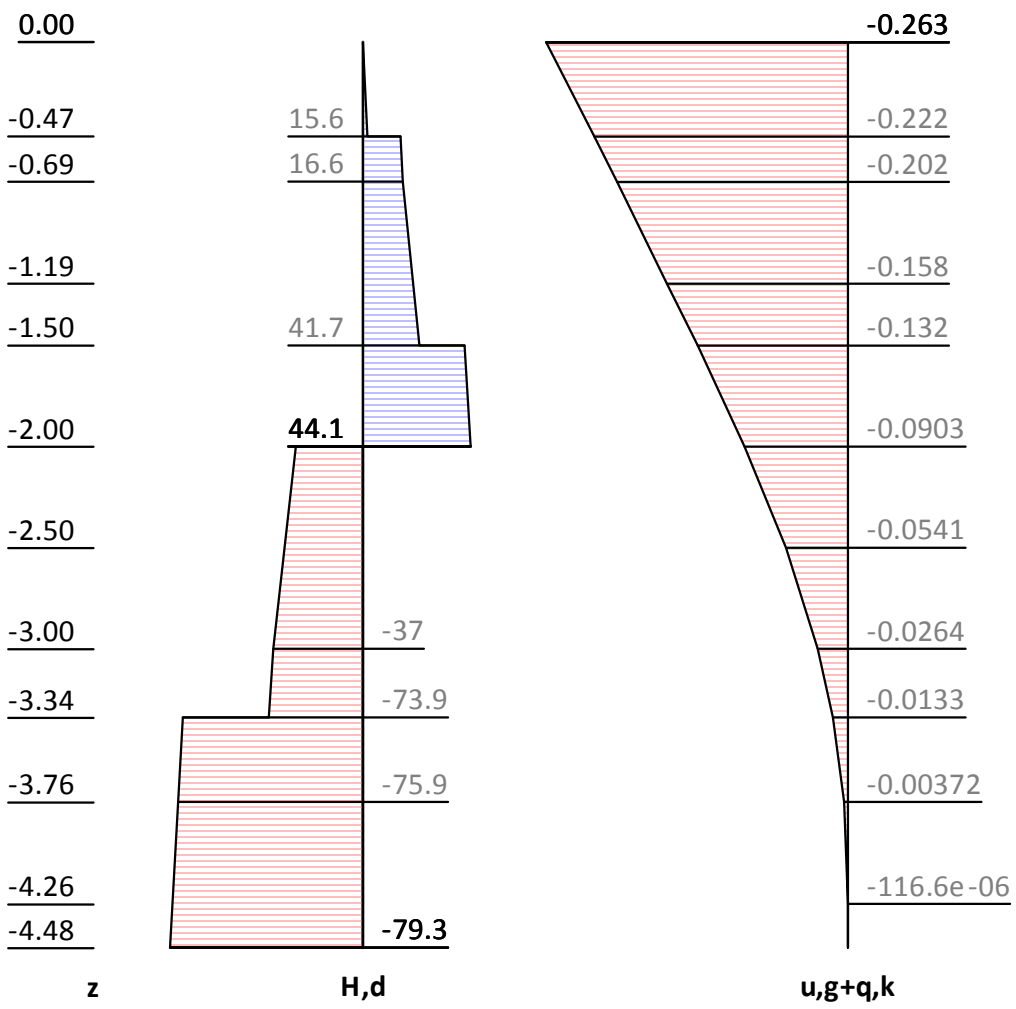
Method EB 82-4 (Q = [G+Q] - G).



z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
0.00		0.00	0.00	0.00	-0.20
-0.47	0.00	0.01	0.02	0.01	-0.17
-0.47	9.06	0.01	0.02	0.01	-0.17
-0.48	9.06	-0.00	-0.05	0.00	-0.17
-1.50	9.06	-4.80	-9.33	-0.99	-0.10
-1.50	23.48	-4.80	-9.33	-0.99	-0.10
-2.00	23.48	-12.40	-21.07	-2.23	-0.07
-2.00	-11.02	-12.40	-21.07	-2.23	-0.07
-3.34	-19.10	-28.20	-0.29	-5.50	-0.01
-3.34	-42.58	-28.20	-0.29	-5.50	-0.01
-3.35	-42.61	-28.12	-0.00	-5.50	-0.01
-4.48	-46.51	0.00	50.32	-5.44	-0.00
-4.48	-46.51	0.00	50.32	-5.44	0.00

Internal forces: Design

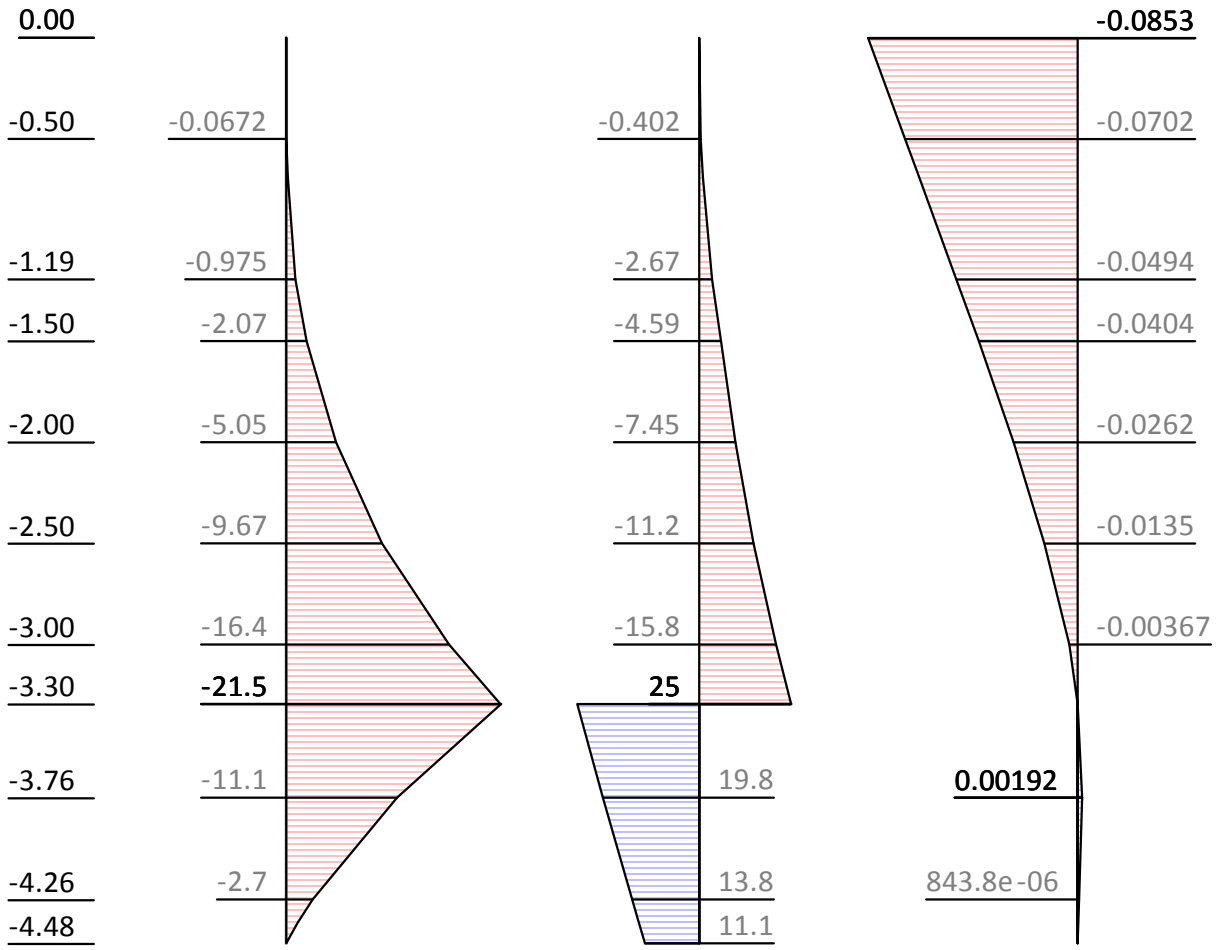




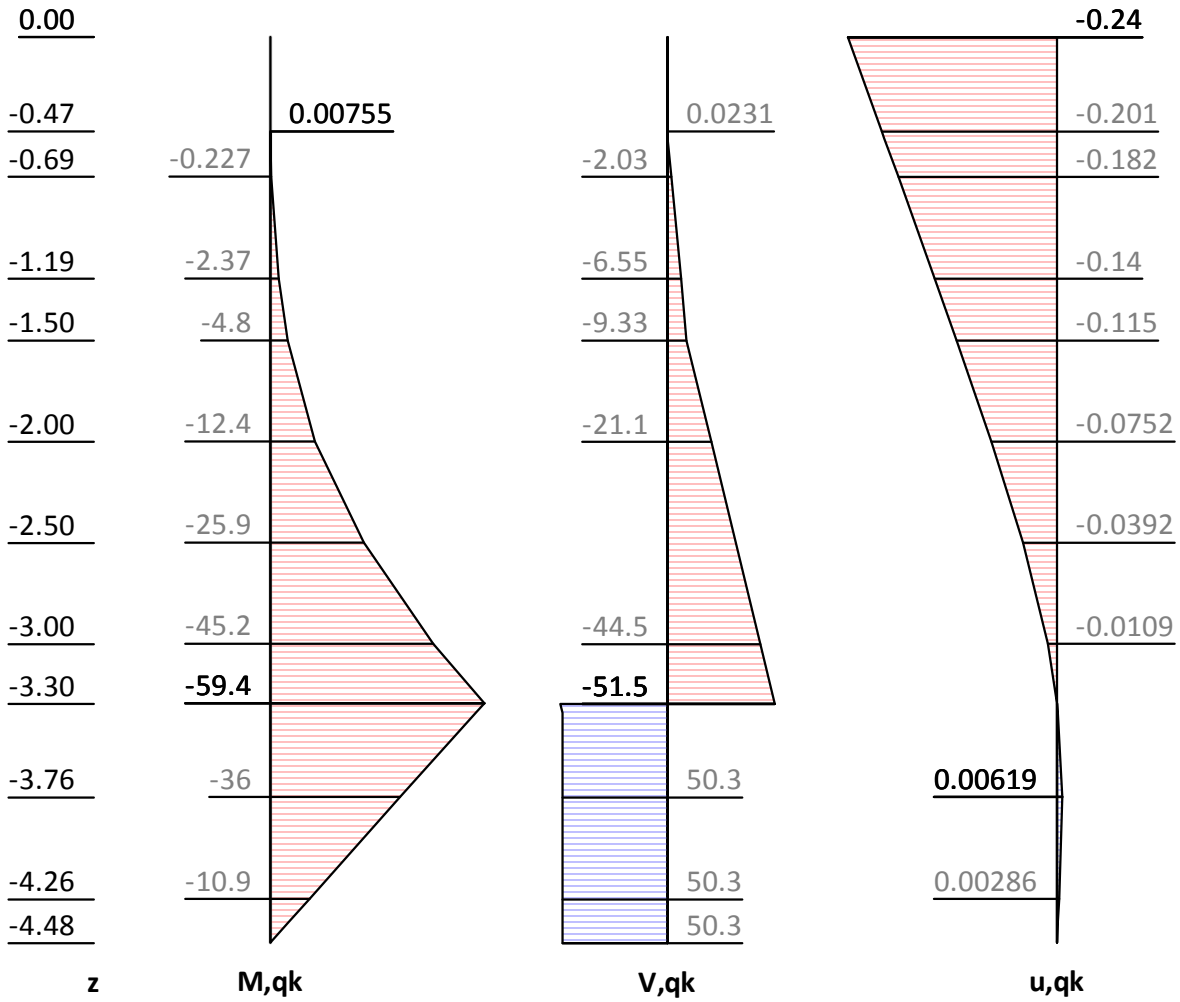
z [m]	H,d [kN/m2]	M,d [kN/m2]	V,d [kN/m2]	N,d [kN/m2]	u,g+q,k [mm]
0.00	0.00	0.00	-0.00	0.00	-0.26
-0.47	2.04	-0.08	-0.48	-13.54	-0.22
-0.47	15.62	-0.08	-0.48	-13.54	-0.22
-1.50	23.37	-10.00	-20.19	-46.20	-0.13
-1.50	41.73	-10.00	-20.19	-46.20	-0.13
-2.00	44.14	-25.42	-41.66	-62.25	-0.09
-2.00	-27.50	-25.42	-41.66	-62.25	-0.09
-3.34	-38.64	-52.77	3.46	-101.27	-0.01
-3.34	-73.86	-52.77	3.46	-101.27	-0.01
-4.48	-79.28	0.00	90.45	-120.49	-0.00
-4.48	-79.28	0.01	90.46	-120.49	0.00

Checks of earth statics

Substitute system according to Blum



z [m]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [kN/m2]
0.00	0.00	0.00	0.00	-0.09
-3.30	-21.54	-18.93	-68.37	0.00
-3.30	-21.54	24.98	-68.37	0.00
-3.76	-11.12	19.82	-74.23	0.00
-4.48	0.00	11.10	-83.26	0.00



z [m]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [kN/m2]
0.00	0.00	0.00	0.00	-0.24
-0.47	0.01	0.02	0.01	-0.20
-0.48	-0.00	-0.05	-0.00	-0.20
-3.30	-59.42	-51.50	-5.45	0.00
-3.30	-59.42	51.35	-5.45	0.00
-3.76	-36.04	50.32	-5.56	0.01
-4.48	0.00	50.32	-5.56	0.00

Bh,gk = -43.91; Ch,gk = 11.10 [kN/m]
Bh,qk = -102.85; Ch,qk = 50.32 [kN/m]
Bh,d = -213.56; Ch,d = 90.45 [kN/m]

Check of C-force (foot support)

```
z(C)                                          =   -4.48 [kN/m]
G,k = sum(γ*h)                                =   71.76 [kN/m]
P,k = sum(Pz,k(x=  0.1))                      =    0.00 [kN/m]
kpgh,C(phi=  0.1; δ,C=  0.0°)                 =   1.002 [-]
kpch,C                                        =   2.003 [-]
eph,C,gk =(G,k+P,k)*kpgh,C+2*c*sqrt(kpch,C)=  213.44 [kN/m2]
         = (71.76+0.00)*1.002+2*50.0*1.415
Ed = Ch,d                                     =   90.45 [kN/m2]
δ,t,EAU          = Ed/(2*eph,C,d)             =    0.30 [m]
δ,t,EAB          =  0.20 * t                  =    0.50 [m]
δ,t = δ,t,EAB                                 =    0.50 [m]
Rd = 2*δ,t*eph,C,gk/γ,Re
   = 2*0.50*213.44/1.4
                                              =  151.00 [kN/m2]
```

Ed/Rd = 0.599 [-]. Passes requirement

Check or earth support

Check: Mobilizable earth resistance is sufficient for earth support force.
z: -3.30 m
Rd = Eph,k/γ,Re = 298.99 / 1.400 = 213.57 [kN/m]

Ed(Bh,d)/Rd = 213.56 / 213.57 = 1.000 [-]. Passes requirement

Sum of H and V forces, (G)

Forces up to depth z:-4.48

Pos.	H	V
H/V pressure G+P+W,k	32.82	1.66
Wall weight		87.84
H/V pressure passive		0.00
Bh,g,k z=-3.30	-43.91	
Bv,g,k = Bh,k * tan(δ,p=-0.07°)		-0.05
Ch,g	11.10	
Cv,g = Ch*tan(δ,C=0.0°)		0.01
Σ	0.00	89.46 (downwards)

Simple check, EAB R 9-3a

Vk >= Bvk: 89.51 >= 0.05 Passes requirement

Sum of H and V forces, (G+Q)

Forces up to depth z:-4.48

Pos.	H	V
H/V pressure G+P+W,k	85.35	7.22
Wall weight		87.84
H/V pressure passive		0.00
Bh,g,k z=-3.30	-43.91	
Bv,g,k = Bh,k * tan(δ,p=-0.07°)		-0.05
Bh,q,k z=-3.30	-102.85	
Bv,q,k = Bh,k * tan(δ,p=-0.07°)		-0.12
Ch,g	11.10	
Cv,g = Ch*tan(δ,C=0.0°)		0.01
Ch,q	50.32	
Cv,q = Ch*tan(δ,C=0.0°)		0.03
Σ	-0.00	94.93 (downwards)

Simple check, EAB R 9-3a

Vk >= Bvk: 95.10 >= 0.17 Passes requirement

Υπολογ. κύκλου ολίσθησης

LC: όλα τα φορτία Type: BS-T (combination: [GEO] A2 M2 R3, BS-T)
Vertical variable loads only act if they are outside of R*sin(phi).
The automatic slip circle optimization only considers circles that intersect
the surface with an area of at least 0.25 m2.
The slip circle calculation only accepts circles including the wall.
The slipcircle calculation only allows circular failure planes
(no vertical tangents will occour).

Γεωμετ.κύκλου (μήκη και συντεταγμ. σε (m))
Κέντρο = (-1.72, 0.34), Ακτίνα = 5.59
Αρχ.σημ.= (-6.79, -2.00), Τελ.σημ. = (3.86, 0.00)

Γεωμετρία λωρίδων:

No	x	Width b	dxM	Weight	Load z-κατ.	Water-φορτ.	u*b	φ	c	θ
	[m]	[m]	[m]	[kN/m]	[kN/m]	[kN/m]	[kN/m]	[°]	[kN/m²]	[°]
1	-6.51	0.56	-4.80	5.9	0.0	0.0	-0.0	0.08	35.71	-44.96*
2	-5.96	0.56	-4.24	14.6	0.0	0.0	-1.7	0.08	35.71	-44.96*
3	-5.40	0.56	-3.68	20.9	0.0	0.0	-4.8	0.08	35.71	-41.18
4	-4.84	0.56	-3.12	25.7	0.0	0.0	-7.2	0.08	35.71	-33.95
5	-4.28	0.56	-2.56	29.6	0.0	0.0	-9.1	27.45	3.57	-27.29
6	-3.72	0.56	-2.00	32.7	0.0	0.0	-10.5	27.45	3.57	-21.01
7	-3.16	0.56	-1.44	35.0	0.0	0.0	-11.5	27.45	3.57	-14.98
8	-2.60	0.56	-0.89	36.5	0.0	0.0	-12.1	27.45	3.57	-9.12
9	-2.04	0.56	-0.33	37.3	0.0	0.0	-12.5	27.45	3.57	-3.35
10	-1.49	0.56	0.23	37.3	0.0	0.0	-12.5	27.45	3.57	2.38
11	-0.93	0.56	0.79	36.7	0.0	0.0	-12.2	27.45	3.57	8.14
12	-0.37	0.56	1.35	35.3	0.0	0.0	-11.6	27.45	3.57	13.98
13	0.19	0.56	1.91	50.5	0.0	0.0	-10.7	27.45	3.57	19.97
14	0.75	0.56	2.47	50.8	1.2	0.0	-9.3	27.45	3.57	26.20
15	1.31	0.56	3.03	47.1	24.0	0.0	-7.5	0.08	35.71	32.79
16	1.87	0.56	3.58	42.5	24.0	0.0	-5.2	0.08	35.71	39.91
17	2.42	0.56	4.14	36.5	24.0	0.0	-2.2	0.08	35.71	47.86
18	2.98	0.56	4.70	28.3	24.0	0.0	-0.2	0.08	35.71	57.30
19	3.56	0.60	5.28	16.0	10.2	0.0	-0.0	20.46	1.43	70.88

*** Σημείωση: Στις λωρίδες σημειωμένες με '*'
περιορίστηκε το theta στο 45°-Phi/2.

Συνεισφ. κατακόρυφων φορτίων:

No	Weight	G*sin(θ)	(G-u*b)*tan(φ) + c*b	μ*sin(θ)* tan(φ)+cos(θ)	T
	[kN/m]	[kN/m]	[kN/m]	[-]	[kN/m]
1	5.93	-5.09	19.96	0.707211	28.23
2	14.60	-11.07	19.97	0.707211	28.24
3	20.90	-13.76	19.98	0.752238	26.56
4	25.70	-14.35	19.98	0.829212	24.10
5	29.58	-13.56	12.66	0.794707	15.93
6	32.72	-11.73	13.56	0.860042	15.77
7	35.01	-9.05	14.22	0.913023	15.57
8	36.51	-5.79	14.65	0.954871	15.34
9	37.27	-2.18	14.87	0.986300	15.08
10	37.33	1.55	14.89	1.007651	14.77
11	36.69	5.19	14.70	1.018951	14.43
12	35.31	8.53	14.31	1.019913	14.03
13	50.54	17.26	22.71	1.009894	22.49
14	52.06	22.98	24.20	0.987773	24.50
15	71.04	38.47	20.04	0.840984	23.83
16	66.44	42.63	20.04	0.767457	26.11
17	60.44	44.82	20.04	0.671336	29.85
18	52.28	43.99	20.03	0.540685	37.04

No	Weight [kN/m]	G*sin(θ) [kN/m]	(G-u*b)*tan(φ) + c*b [kN/m]	μ*sin(θ)* tan(φ)+cos(θ) [-]	T [kN/m]
19	26.20	24.75	10.62	0.466572	22.77
		163.60			414.63

Δράση Ed = (163.6*5.59)
Αντίσταση Rd = (414.6*5.59 +0.0)

SLIP-CIRCLE μ = Ed/Rd = 0.39 < 1.0: Έλεγχος εκπληρώθηκε.

Φάση εκσκαφής 2 "[2] Situation 2"

LC: όλα τα φορτία Type: BS-T

Εδαφικό σύστημα με 5 Στρώσεις

Name		Τεχνητές επιχωματώσεις	Αμμώδης ΑΡΓΙΛΟΣ	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
γ	[kN/m3]	18	20	22.5
γ,R	[kN/m3]	18	20	22.5
γ'	[kN/m3]	8	10	12.5
γ,p	[kN/m3]	18	20	22.5
γ,R,passive	[kN/m3]	18	20	22.5
γ,pw	[kN/m3]	8	10	12.5
φ	[°]	25	0.1	33
c	[kN/m2]	2	50	5
c,u	[kN/m2]	10	50	5
c παθητικό	[kN/m2]	2	50	5
δ,a	[°]	16.66667	0.06666667	22
δ,p	[°]	-16.66667	-0.06666667	-22
δ,c	[°]	8.333333	0.03333333	11
k,agh	[-]	0.3456501	0.9955057	0.2452023
K,ach	[-]	1.043051	1.994195	0.8549058
K,0h	[-]	0.5773817	0.9982547	0.455361
K,pgh	[-]	3.908103	1.004519	7.495617
K,pch	[-]	5.180327	2.00583	8.599509
τ,gr	[kN/m2]	110	110	110
Ψ,A,max	[°]	90	90	90
k	[cm/s]	10e-06	1e-06	100e-06

Name		Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
γ	[kN/m3]	22.5	22.5
γ,R	[kN/m3]	22.5	22.5
γ'	[kN/m3]	12.5	12.5
γ,p	[kN/m3]	22.5	22.5
γ,R,passive	[kN/m3]	22.5	22.5
γ,pw	[kN/m3]	12.5	12.5
φ	[°]	35	35
c	[kN/m2]	5	5
c,u	[kN/m2]	5	5
c παθητικό	[kN/m2]	5	5
δ,a	[°]	23.33333	23.33333
δ,p	[°]	-23.33333	-23.33333
δ,c	[°]	11.66667	11.66667
k,agh	[-]	0.2244207	0.2244207
K,ach	[-]	0.8126539	0.8126539
K,0h	[-]	0.4264236	0.4264236
K,pgh	[-]	9.146943	9.146943
K,pch	[-]	10.104	10.104
τ,gr	[kN/m2]	110	110
Ψ,A,max	[°]	90	90
k	[cm/s]	100e-06	100e-06

Πορεία πρανούς:
x [m] 0.00 0.00
z [m] -2.00 0.00

Πορεία ανώτερου 2. στρώματος Αμμώδης ΑΡΓΙΛΟΣ:
x [m] 0.00 0.00
z [m] -2.00 -1.50

Πορεία ανώτερου 3. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ:
z= -4.50

Πορεία ανώτερου 4. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -10.00

Πορεία ανώτερου 5. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -14.00

Επιφ. φορτία:

Φορτία

xA [m]	zA [m]	xE [m]	zE [m]	PxA [kN/m²]	PzA [kN/m²]	PxE [kN/m²]	PzE [kN/m²]	Typ	LC-description Name
1.00	0.00	3.50	0.00	0.00	33.00	0.00	33.00	q	1

Κατανομή εδαφ.πιέσεων

Κατανομή εδαφ.πιέσεων	Name
Rectangular within a layer	

Στάθμη νερού:

x [m] 0.00
z [m] -3.00

Αγκύρια

z[m]	min.l[m]	Alpha[°]	C-H[kN/m]	P0[kN]	u0[m]
-0.50	0.00	15.00	αόριστ.	0.00	0.0000

Παράμετροι υπολογισμού

Earth pressure options

Τμήμα εδαφ.ωθήσεων: Ενεργές ωθήσεις.
Angle of slip plane: DIN 4085.
Split block loads into 1 sections.
Consideration of minimum earth pressure: φ,min = 40.000.
Negative earth pressure fractions are set to zero.

Redistribution of earth pressure

Shape of redistribution: Trapezoid.
The earth pressure is getting redistb. to: Excavation level
The earth pressure below the excavation acts without redistrb.
Levels of redistribution Z1: 0.000, Z2: -1.000 [m].
The earth pressure from variable loads will be included in redistribution.

Παθητικές ωθήσεις

Method of calculation: Κλασικός, Pregl/Sokolovsky (DIN 4085).

Options for water pressure

Στήριξη πόδα

Πόδας οριζοντίως μετακινούμενος

Αγκύρια

Anchor checks (lower failure plane): Ναι
Anchor forces with safety level of DS-P: Ναι
Verification of grout body pull out forces: Ναι
δ,a,Anchoring wall : used from soil layer.
δ,p,Anchoring wall : used from soil layer.

Earth pressure coefficients kh

φ	α	β	δ	k0gh	kagh	kach	kpgh	kpch	
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Τεχνητές επιχωματώσεις
25.0	0.0	0.0	16.7	--	0.346	1.043	--	--	"
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Αμμώδης ΑΡΓΙΛΟΣ
0.1	0.0	0.0	0.1	--	0.996	1.994	--	--	"
33.0	0.0	0.0	-22.0	--	--	--	7.496	-8.600	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
33.0	0.0	0.0	22.0	--	0.245	0.855	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"

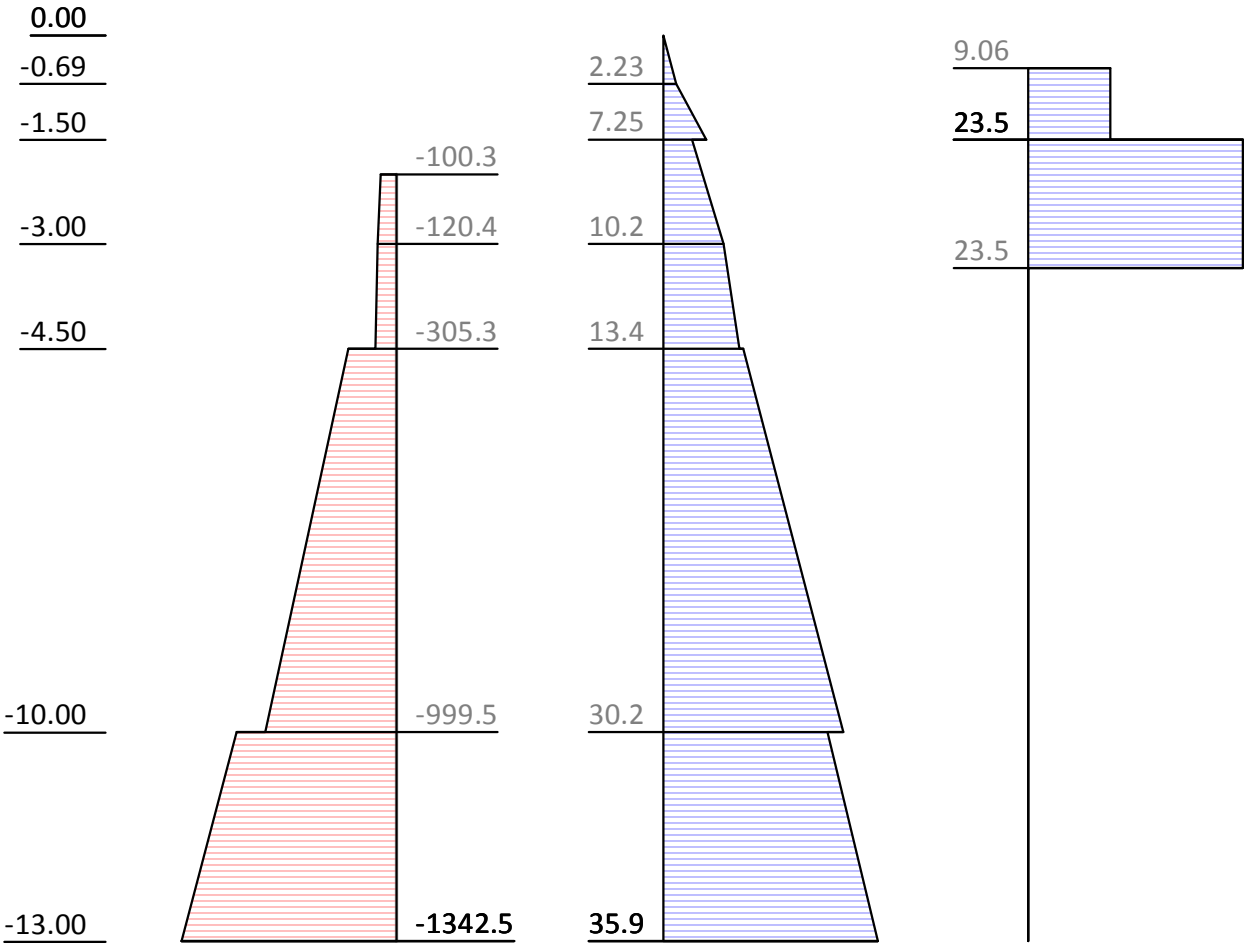
Μήκος τοίχου

Foot depth for statics: zf = -13.000

Stress analysis

Earth pressure, horizontal

Pressures characteristic, no redistribution, continous wall

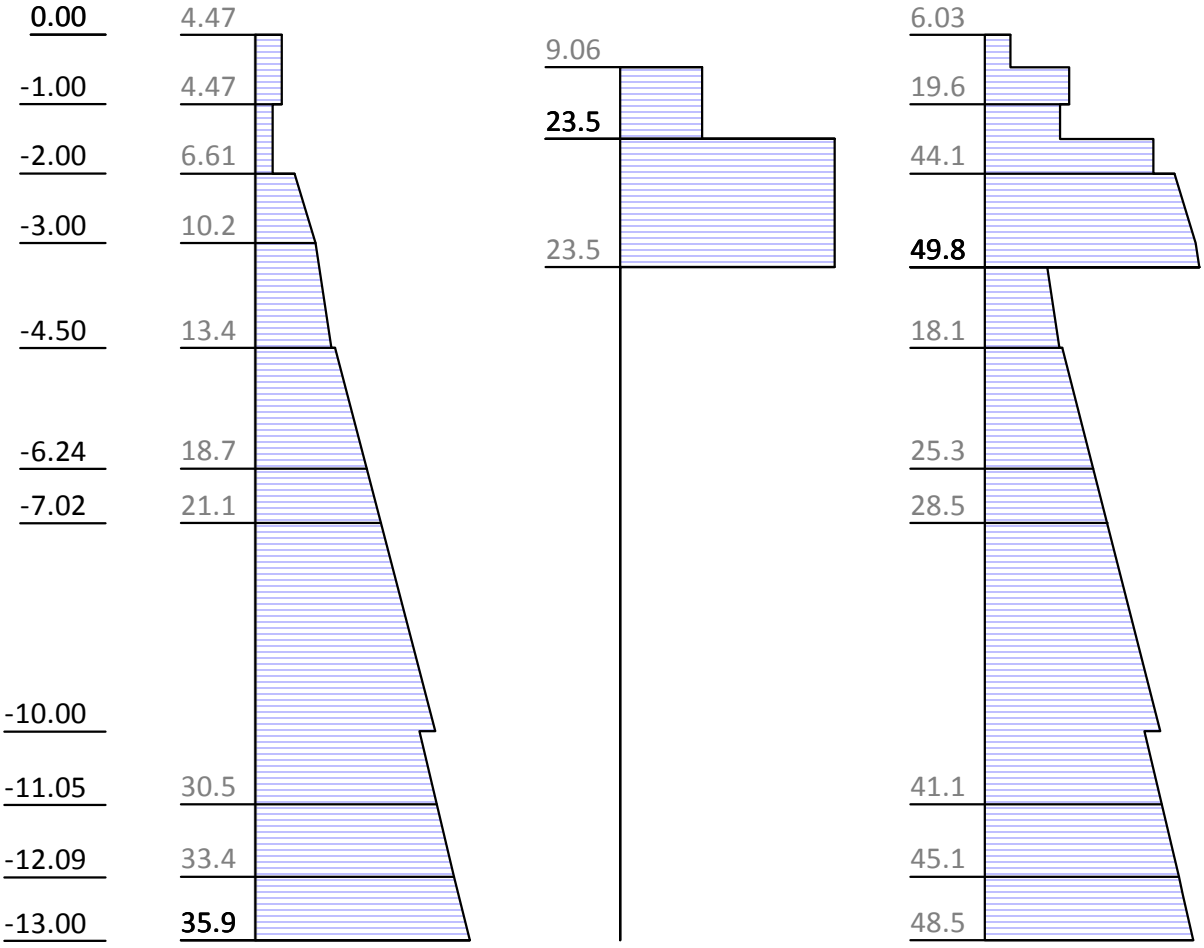


z [m]	eph,G,k [kN/m2]	eah,G,k [kN/m2]	eah,PQ,k [kN/m2]	eah,d [kN/m2]
0.00		0.00		0.00
-0.47		1.52	0.00	2.04
-0.47		1.52	9.06	15.62
-1.50		7.25	9.06	23.37
-1.50		4.82	23.48	41.73
-2.00	-0.00	6.61	23.48	44.14
-2.00	-100.29	6.61	23.48	44.14
-3.34	-123.80	10.79	23.48	49.78
-3.34	-123.80	10.79	0.00	14.56
-4.50	-135.45	12.86	0.00	17.36
-4.50	-305.34	13.38	0.00	18.06
-10.00	-820.67	30.24	0.00	40.82
-10.00	-999.52	27.52	0.00	37.16
-13.00	-1342.53	35.94	0.00	48.52

Eph,G,k:-6911.80, Eph,PG,k: 0.00 [kN/m]
Eah,G,k: 248.27, Eah,PG,k: 0.00, Eah,PQ,k: 52.53, Eah,d: 413.96

H-pressure on static system

Level of mobilization: Ep,gk 100.0, Ep,qk 100.0, Ep,d 100.0 [%]

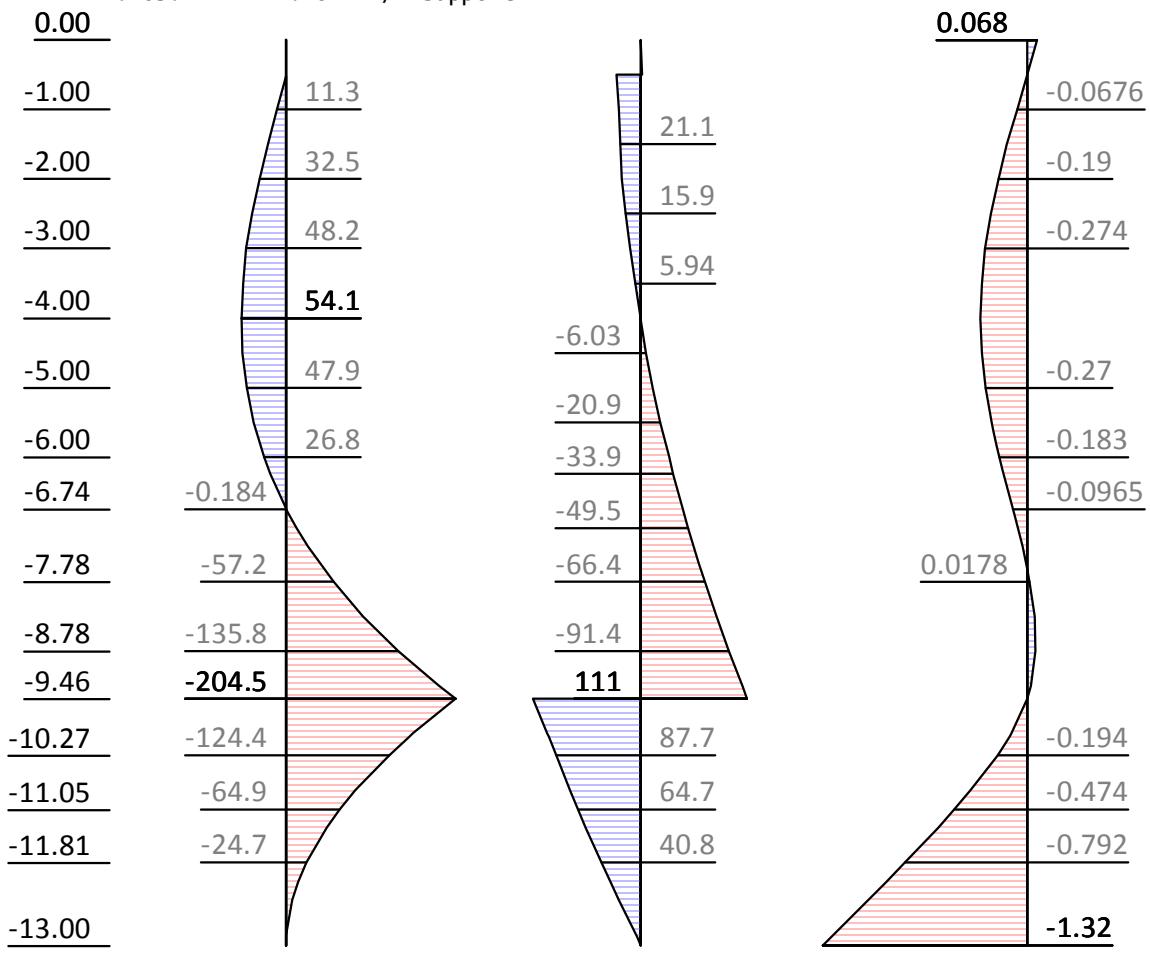


z [m]	PH,gk [kN/m2]	PH,qk [kN/m2]	PH,d [kN/m2]
0.00	4.47		6.03
-0.47	4.47	0.00	6.03
-0.47	4.47	9.06	19.62
-1.00	4.47	9.06	19.62
-1.00	2.98	9.06	17.61
-1.50	2.98	9.06	17.61
-1.50	2.98	23.48	39.25
-2.00	2.98	23.48	39.25
-2.00	6.61	23.48	44.14
-3.34	10.79	23.48	49.78
-3.34	10.79	0.00	14.56
-4.50	12.86	0.00	17.36
-4.50	13.38	0.00	18.06
-10.00	30.24	0.00	40.82
-10.00	27.52	0.00	37.16
-13.00	35.94	0.00	48.52

V-pressure on static system

Internal forces: Permanent, characteristically

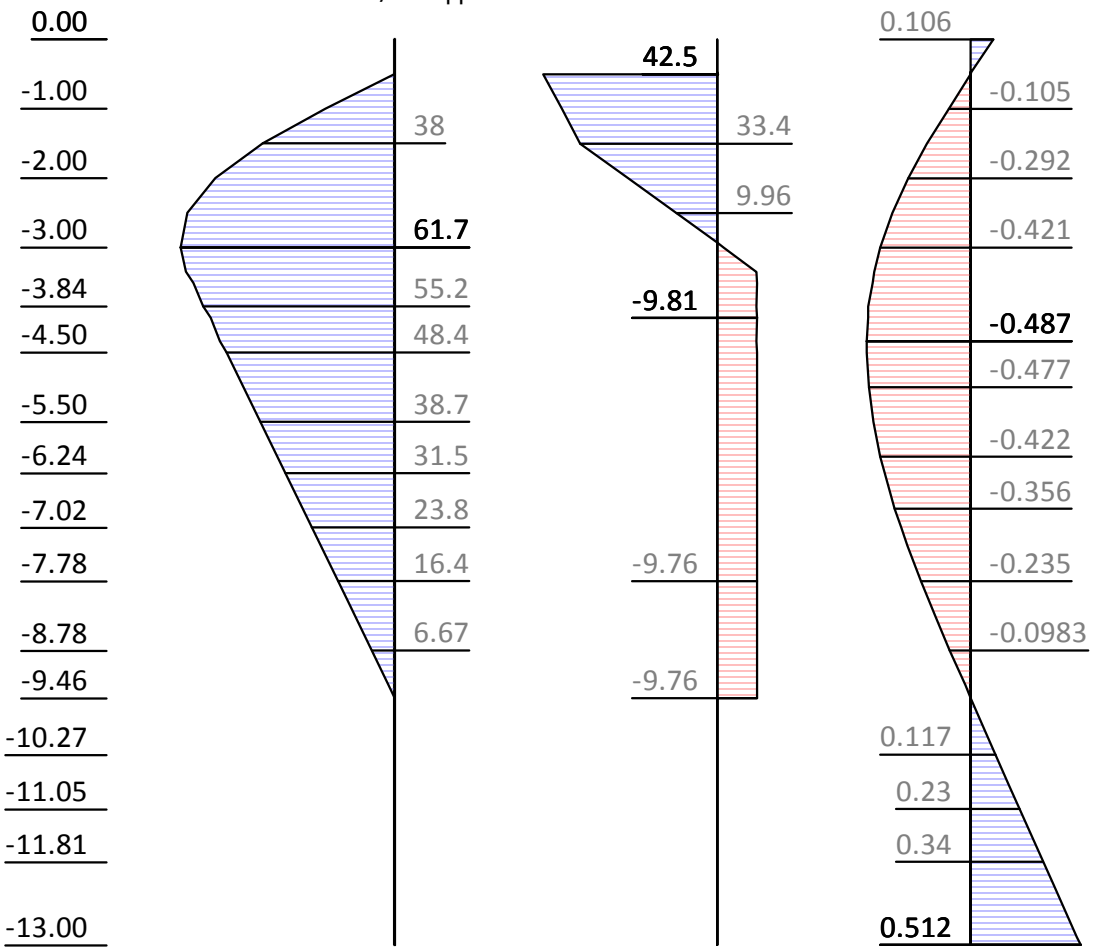
z= -0.500. Fx= -27.099 kN/m Support
z= -9.463. Fx=-221.169 kN/m Support



z [m]	H,g,k [kN/m2]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [mm]
0.00	4.47	0.00	-0.00	0.00	0.07
-0.50	4.47	-0.56	-2.23	-10.91	0.00
-0.50	4.47	-0.56	-2.23	-10.91	-0.00
-0.50	4.47	-0.56	24.86	-18.17	-0.00
-0.52	4.47	-0.00	24.76	-18.69	-0.00
-1.00	4.47	11.31	22.63	-29.09	-0.07
-1.00	2.98	11.31	22.63	-29.09	-0.07
-2.00	2.98	32.45	19.65	-50.64	-0.19
-2.00	6.61	32.45	19.65	-50.64	-0.19
-4.00	11.97	54.06	0.18	-84.27	-0.30
-4.01	11.99	54.02	-0.00	-84.45	-0.30
-4.50	12.86	52.62	-6.03	-90.57	-0.29
-4.50	13.38	52.62	-6.03	-90.57	-0.29
-6.74	20.23	0.00	-43.59	-133.92	-0.10
-7.60	22.89	-46.50	-62.42	-152.47	0.00
-8.78	26.50	-135.80	-91.37	-178.98	0.06
-9.46	28.58	-204.51	-110.18	-195.19	0.00
-9.46	28.58	-204.51	110.99	-195.19	0.00
-9.46	28.58	-204.51	110.99	-195.19	-0.00
-10.00	30.24	-149.11	95.20	-208.34	-0.12
-10.00	27.52	-149.11	95.20	-208.34	-0.12
-13.00	35.94	0.00	0.00	-287.20	-1.32

Internal forces: Variable, characteristically

Method EB 82-4 (Q = [G+Q] - G).
z= -0.500. Fx= -42.773 kN/m Support
z= -9.463. Fx= -9.760 kN/m Support

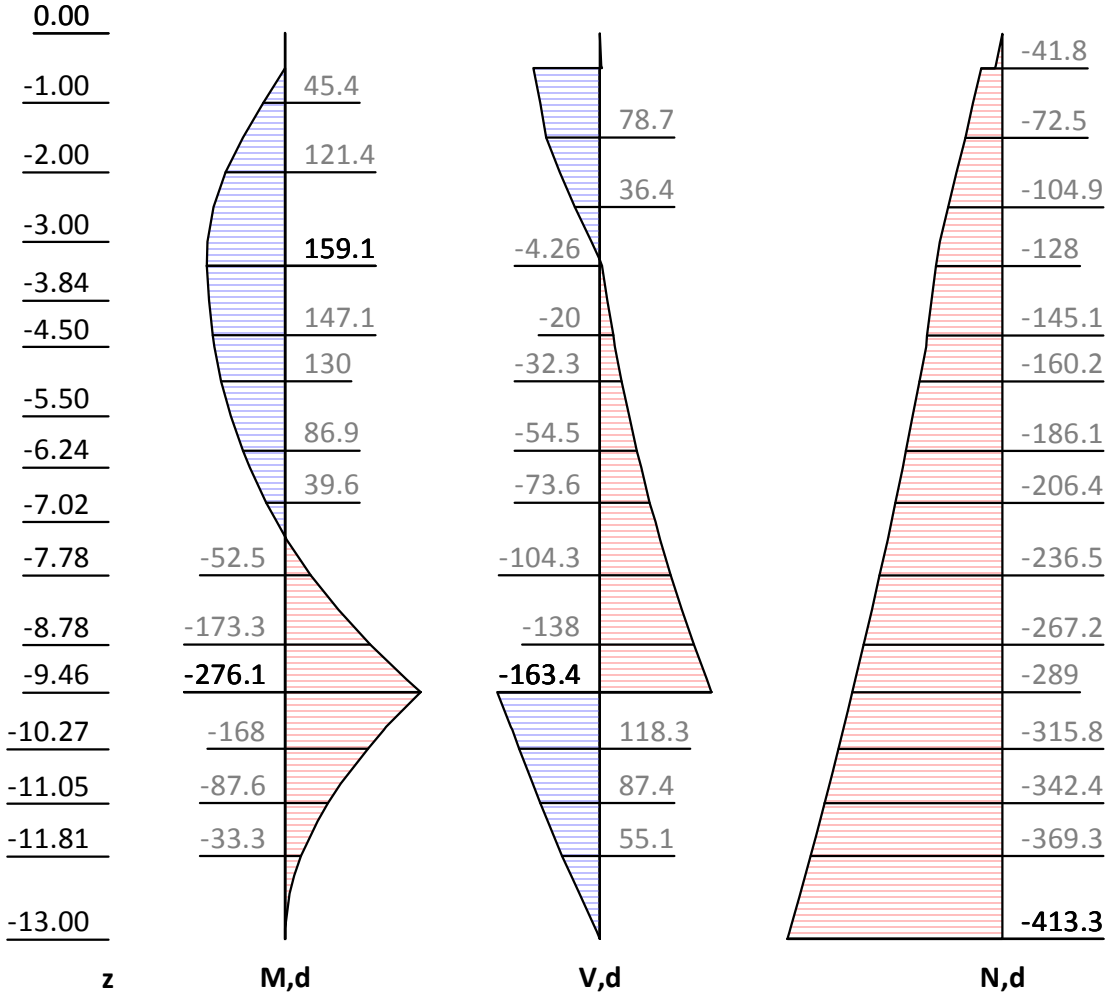


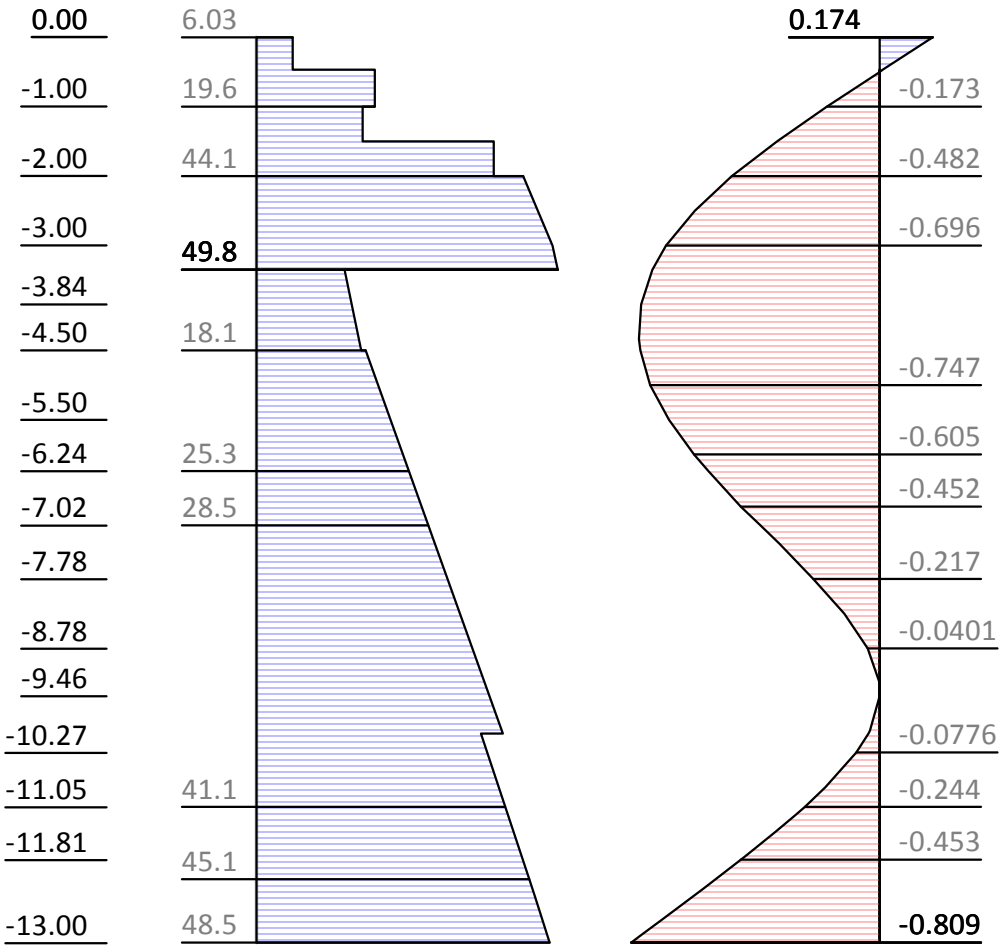
z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
0.00		0.00	-0.00	0.00	0.11
-0.47	0.00	0.03	-0.00	0.00	0.01
-0.47	9.06	0.03	0.00	-0.00	0.01
-0.47	9.06	0.03	-0.00	-0.00	0.01
-0.50	9.06	0.00	-0.24	-0.03	0.00
-0.50	9.06	0.00	42.50	-11.49	-0.00
-1.50	9.06	37.97	33.44	-12.45	-0.20
-1.50	23.48	37.97	33.44	-12.45	-0.20
-2.92	23.48	61.41	0.00	-15.99	-0.41
-3.00	23.48	61.72	-1.78	-16.17	-0.42
-3.34	23.48	60.05	-9.71	-17.02	-0.45
-3.34	0.00	60.05	-9.71	-17.02	-0.45
-3.50	0.00	57.90	-9.81	-17.02	-0.46
-3.84	0.00	55.20	-9.71	-17.02	-0.48
-4.00	0.00	52.99	-9.81	-17.02	-0.48
-4.34	0.00	50.34	-9.71	-17.02	-0.49
-4.50	0.00	48.44	-9.76	-17.02	-0.49
-5.00	0.00	43.56	-9.76	-17.02	-0.48
-6.00	0.00	33.80	-9.76	-17.02	-0.42
-6.24	0.00	31.46	-9.76	-17.02	-0.40
-6.74	0.00	26.58	-9.76	-17.02	-0.36

z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
-7.02	0.00	23.84	-9.76	-17.02	-0.33
-9.46	0.00	0.00	-9.76	-17.02	-0.00
-9.46	0.00	-0.00	-9.76	-17.02	0.00
-9.46	0.00	-0.00	0.00	-17.02	0.00
-10.27	0.00	-0.00	0.00	-17.02	0.12
-12.09	0.00	-0.00	0.00	-17.02	0.38
-12.35	0.00	-0.00	0.00	-17.02	0.42
-12.90	0.00	-0.00	0.00	-17.02	0.50
-13.00	0.00	-0.00	-0.00	-17.02	0.51

Internal forces: Design

z= -0.500. Fx=-100.742 kN/m Support
z= -9.463. Fx=-313.218 kN/m Support





z [m]	H,d [kN/m2]	M,d [kN/m2]	V,d [kN/m2]	N,d [kN/m2]	u,g+q,k [mm]
0.00	6.03	0.00	-0.00	0.00	0.17
-0.47	6.03	-0.67	-2.84	-13.85	0.01
-0.47	19.62	-0.67	-2.84	-13.85	0.01
-0.50	19.62	-0.76	-3.42	-14.78	0.00
-0.51	19.62	-0.00	97.16	-42.03	-0.00
-1.00	19.62	45.45	87.51	-57.22	-0.17
-1.00	17.61	45.45	87.51	-57.22	-0.17
-1.50	17.61	87.00	78.70	-72.49	-0.34
-1.50	39.25	87.00	78.70	-72.49	-0.34
-2.00	39.25	121.44	59.08	-88.90	-0.48
-2.00	44.14	121.44	59.08	-88.90	-0.48
-3.25	49.58	158.71	0.00	-126.26	-0.73
-3.34	49.78	159.06	-4.26	-128.05	-0.74
-3.34	14.56	159.06	-4.26	-128.05	-0.74
-4.34	16.97	147.12	-20.03	-145.07	-0.78
-4.50	17.36	143.70	-22.77	-147.80	-0.78
-4.50	18.06	143.70	-22.77	-147.80	-0.78
-7.23	29.36	0.00	-87.54	-220.41	-0.34
-9.46	38.59	-276.09	-163.38	-289.03	0.00
-9.46	38.59	-276.09	149.84	-289.03	0.00
-10.00	40.82	-201.29	128.51	-306.78	-0.04
-10.00	37.16	-201.29	128.51	-306.78	-0.04
-13.00	48.52	-0.00	0.00	-413.25	-0.81

Anchor forces with safety level of DS-P

z[m]	A,d[kN]	Fx,d[kN/m]
-0.50	187.7	-100.7

Checks of earth statics

Check or earth support

Check: Mobilizable earth resistance is sufficient for earth support force.
z: -9.46 m
Rd = Eph,k/γ,Re = 6911.80 / 1.400 = 4937.00 [kN/m]

Ed(Uh,d)/Rd = 313.22 / 4937.00 = 0.063 [-]. Passes requirement

Sum of H and V forces, (G)

Forces up to depth z:-13.00

Pos.	H	V
H/V pressure G+P+W,k	248.27	90.93
Wall weight		189.01
H/V pressure passive		0.00
Support z: -0.50	-27.10	7.26
Bh,g,k z=-9.46	-221.17	
Bv,g,k = Bh,k * tan(δ,p=-22.00°)		-89.36
Σ	-0.00	197.84 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than
the downwards pointing vertical forces.

Vk >= Bvk: 287.20 >= 89.36 Passes requirement

Sum of H and V forces, (G+Q)

Forces up to depth z:-13.00

Pos.	H	V
H/V pressure G+P+W,k	300.80	96.49
Wall weight		189.01
H/V pressure passive		0.00
Support z: -0.50	-69.87	18.72
Bh,g,k z=-9.46	-221.17	
Bv,g,k = Bh,k * tan(δ,p=-22.00°)		-89.36
Bh,q,k z=-9.46	-9.76	
Bv,q,k = Bh,k * tan(δ,p=-22.00°)		-3.94
Σ	-0.00	210.92 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than
the downwards pointing vertical forces.

Vk >= Bvk: 304.22 >= 93.30 Passes requirement

Anchor verification

Anchor - Stability of lower failure plane

Περίπτ.Φόρτισης: όλα τα φορτία BS-P
Αυτόμ. υπολογ. μήκους αγκυρίων:
All anchors are extended (if necessary)
Favourable variable loads in main failure body are not being considered.
Bottom of lower failure plane: z=-13.00 m

Iteration of failure mechanisms:
lA .....: Length of anchor from head to center of grout body.
W,k .....: Res. force from dead weight, loads, cohesion, ...
Q,k .....: Force in lower failure plane.
Ea1,k.....: Earth pressure onto vertical separation plane.
Ea2,k.....: Earth pressure between wall and main failure body.
Ra_cal,d ...: Dimesioning force of the resistance from the equilibrium of forces. Ra_cal,d corresponds to the max. possible anchor force of the force polygon.
Sum(A,d) ...: Acting anchor forces along the grout body fractions within the failure body. Sum(A,d) is gained from the anchor pull forces of the wall analysis.

z [m]	ϑ1 [°]	ϑ2 [°]	lA [m]	W,k [kN/m]	Q,k [kN/m]	Ea1,k [kN/m]	Ea2,k [kN/m]	Ra_cal,d [kN/m]	Sum(A,d) [kN/m]	Ed/Rd [-]
-0.50	44.9	57.5	10.24	1133.0	1028.2	4.4	315.9	104.4	104.3	1.00

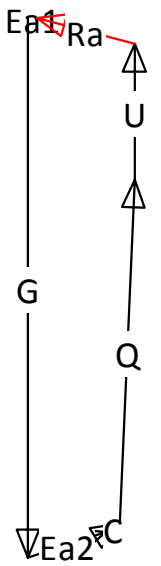
Decisive failure body:
Γεωμετρία:

Foot point of lower failure plane	x/z =	0.01/-13.00 m
Intersection lower/upper slid. plane	x/z =	9.89/ -3.15 m
Intersection upper slid. plane/surface	x/z =	11.90/ 0.00 m
Intersection separation plane/surface	x/z =	9.89/ 0.00 m
Inclination lower failure plane	ϑ1 =	44.91°
Inclination upper failure plane	ϑ2 =	57.50°
Inclination separation plane	ϑ12 =	90.00°

Loads / forces (char.)

		Fx [kN/m]	Fz [kN/m]	F [kN/m]	
Weight of main failure body	G,k:	0.0	-1656.6	1656.6	
Area loads on/in main failure body	F1,k:	0.0	-82.5	82.5	
Cohesion of lower failure plane	C,k:	110.3	110.0	155.8	
Pore water pressure on main body	U,k:	-0.1	501.4	501.4	
Earth pres. on separation plane	Ea1,k:	-4.4	-0.0	4.4	δ= 0.0°
Earth pr. between wall<->main body	Ea2,k:	300.8	96.5	315.9	
Force in lower failure plane	Q,k:	-265.5	993.4	1028.2	
Sum = possible anchor forces:	Ra_cal,k:	141.1	-37.8	146.1	

Force polygon



Acting anchor forces Ed: Sum(A,d) = 104.3 kN/m
Possible anchor forces Rd: Ra_cal,d = 146.1/1.400 = 104.4 kN/m

Verif. of lower failure plane Ed/Rd = 1.00 < 1.0: Έλεγχος εκπληρώθηκε.

Check of steel tension

l,tot ...[m]: Total length of anchor incl. excess length at head
As ....[mm2]: X-section are of steel member
Ri,d ...[kN]: Ultimate strength of tension member (γ,M=1.15)
A,d ....[kN]: Dimensioning force of the anchor from wall analysis

z[m]	Anchor type	l,tot	As	Ri,d		A,d	
-0.50	Strand;3x0.60";1570/1770	14.24	420	573.4	>	187.7	Passes requirement

Check of steel tension: Passes requirement

Check of anchor's soil friction

lVk .....: Length of grout body
DmVk ....: Diameter of grout body
τGr,k ...: Average applied skin friction along the grout body (from soil parameters)
Ra,k ....: Charact. pullout resistance of the anchor
γA ......: Partial safety factor of anchor pullout
Ra,d ....: = Ra,k / γA
A,d .....: Dimensioning force of the anchor from wall analysis

z [m]	lVk [m]	DmVk [mm]	τGr,k [kN/m²]	Ra,k [kN]	γA [-]	Ra,d [kN]		A,d [kN]	A,d/Ra,d [-]
-0.50	8.00	318	110	879.1	1.100	799.2	>	187.7	0.2

Check of anchor's soil friction: Passes requirement

Υπολογ. κύκλου ολίσθησης

LC: όλα τα φορτία Type: BS-T (combination: [GEO] A2 M2 R3, BS-T)
Vertical variable loads only act if they are outside of R*sin(phi).
The automatic slip circle optimization only considers circles that intersect
the surface with an area of at least 0.25 m2.
The slip circle calculation only accepts circles including the wall.
The slipcircle calculation only allows circular failure planes
(no vertical tangents will occour).

Γεωμετ.κύκλου (μήκη και συντεταγμ. σε (m))
Κέντρο = (-0.59, 2.23), Ακτίνα = 15.26
Αρχ.σημ.= (-15.25, -2.00), Τελ.σημ. = (14.50, 0.00)

Γεωμετρία λωρίδων:

No	x	Width b	dxM	Weight	Load z-κατ.	Water-φορτ.	u*b	φ	c	θ
	[m]	[m]	[m]	[kN/m]	[kN/m]	[kN/m]	[kN/m]	[°]	[kN/m²]	[°]
1	-14.49	1.53	-13.89	63.1	0.0	0.0	-19.3	0.08	35.71	-44.96*
2	-12.96	1.53	-12.37	151.7	0.0	0.0	-54.9	27.45	3.57	-31.27*
3	-11.44	1.53	-10.84	213.5	0.0	0.0	-83.0	27.45	3.57	-31.27*
4	-9.91	1.53	-9.32	259.8	0.0	0.0	-103.9	27.45	3.57	-31.27*
5	-8.38	1.53	-7.79	295.3	0.0	0.0	-119.8	29.26	3.57	-30.37*
6	-6.86	1.53	-6.27	322.6	0.0	0.0	-132.0	29.26	3.57	-24.25
7	-5.33	1.53	-4.74	342.9	0.0	0.0	-141.0	29.26	3.57	-18.10
8	-3.81	1.53	-3.21	357.0	0.0	0.0	-147.3	29.26	3.57	-12.16
9	-2.28	1.53	-1.69	365.6	0.0	0.0	-151.2	29.26	3.57	-6.36
10	-0.76	1.53	-0.16	369.0	0.0	0.0	-152.6	29.26	3.57	-0.61
11	0.77	1.53	1.36	423.1	0.0	0.0	-151.7	29.26	3.57	5.12
12	2.29	1.53	2.89	415.8	0.0	0.0	-148.4	29.26	3.57	10.91
13	3.82	1.53	4.41	402.8	0.0	0.0	-142.6	29.26	3.57	16.81
14	5.35	1.53	5.94	383.9	0.0	0.0	-134.2	29.26	3.57	22.91
15	6.87	1.53	7.46	358.3	0.0	0.0	-122.7	29.26	3.57	29.29
16	8.40	1.53	8.99	324.6	0.0	0.0	-107.6	29.26	3.57	36.11
17	9.92	1.53	10.52	281.0	0.0	0.0	-88.0	27.45	3.57	43.57
18	11.45	1.53	12.04	223.1	0.0	0.0	-61.8	27.45	3.57	52.12
19	13.35	2.29	13.95	173.7	0.0	0.0	-35.0	0.08	35.71	66.10

*** Σημείωση: Στις λωρίδες σημειωμένες με '*'
περιορίστηκε το theta στο 45°-Phi/2.

Συνεισφ. κατακόρυφων φορτίων:

No	Weight	G*sin(θ)	(G-u*b)*tan(φ) + c*b	μ*sin(θ)* tan(φ)+cos(θ)	T
	[kN/m]	[kN/m]	[kN/m]	[-]	[kN/m]
1	63.07	-57.44	54.54	0.707491	77.10
2	151.70	-122.98	55.72	0.824848	67.56
3	213.50	-151.74	73.23	0.824848	88.78
4	259.78	-158.65	86.46	0.824848	104.82
5	295.33	-150.83	103.79	0.831413	124.83
6	322.57	-132.48	112.22	0.886298	126.62
7	342.85	-106.53	118.51	0.931237	127.26
8	357.02	-75.23	122.90	0.964482	127.42
9	365.55	-40.47	125.55	0.986987	127.20
10	368.98	-3.95	126.67	0.999278	126.76
11	423.13	37.78	157.52	1.001542	157.27
12	415.75	78.69	155.23	0.993658	156.22
13	402.83	116.53	151.22	0.975180	155.07
14	383.91	149.45	145.36	0.945254	153.77
15	358.26	175.29	137.41	0.902461	152.26
16	324.64	191.31	127.01	0.844463	150.41
17	280.95	193.66	105.70	0.764129	138.32
18	223.11	176.10	89.26	0.659417	135.37
19	173.70	158.80	81.89	0.405287	202.04
		277.29			2499.08

Συνεισφ. αγκυρίων: Αθρ. ροπών ανατροπής : -10.5 kN*m/m
" " resisting : 0.1 kN*m/m

Δράση Ed = (277.3*15.26-10.5)
Αντίσταση Rd = (2499.1*15.26 +0.1)

SLIP-CIRCLE μ = Ed/Rd = 0.11 < 1.0: Έλεγχος εκπληρώθηκε.

Φάση εκσκαφής 3 "[3] Situation 3"

LC: όλα τα φορτία Type: BS-T

Εδαφικό σύστημα με 5 Στρώσεις

Name		Τεχνητές επιχωματώσεις	Αμμώδης ΑΡΓΙΛΟΣ	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
γ	[kN/m3]	18	20	22.5
γ,R	[kN/m3]	18	20	22.5
γ'	[kN/m3]	8	10	12.5
γ,p	[kN/m3]	18	20	22.5
γ,R,passive	[kN/m3]	18	20	22.5
γ,pw	[kN/m3]	8	10	12.5
φ	[°]	25	0.1	33
c	[kN/m2]	2	50	5
c,u	[kN/m2]	10	50	5
c παθητικό	[kN/m2]	2	50	5
δ,a	[°]	16.66667	0.06666667	22
δ,p	[°]	-16.66667	-0.06666667	-22
δ,c	[°]	8.333333	0.03333333	11
k,agh	[-]	0.3456501	0.9955057	0.2452023
K,ach	[-]	1.043051	1.994195	0.8549058
K,0h	[-]	0.5773817	0.9982547	0.455361
K,pgh	[-]	3.908103	1.004519	7.495617
K,pch	[-]	5.180327	2.00583	8.599509
τ,gr	[kN/m2]	110	110	110
Ψ,A,max	[°]	90	90	90
k	[cm/s]	10e-06	1e-06	100e-06

Name		Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
γ	[kN/m3]	22.5	22.5
γ,R	[kN/m3]	22.5	22.5
γ'	[kN/m3]	12.5	12.5
γ,p	[kN/m3]	22.5	22.5
γ,R,passive	[kN/m3]	22.5	22.5
γ,pw	[kN/m3]	12.5	12.5
φ	[°]	35	35
c	[kN/m2]	5	5
c,u	[kN/m2]	5	5
c παθητικό	[kN/m2]	5	5
δ,a	[°]	23.33333	23.33333
δ,p	[°]	-23.33333	-23.33333
δ,c	[°]	11.66667	11.66667
k,agh	[-]	0.2244207	0.2244207
K,ach	[-]	0.8126539	0.8126539
K,0h	[-]	0.4264236	0.4264236
K,pgh	[-]	9.146943	9.146943
K,pch	[-]	10.104	10.104
τ,gr	[kN/m2]	110	110
Ψ,A,max	[°]	90	90
k	[cm/s]	100e-06	100e-06

Πορεία πρανούς:
x [m] 0.00 0.00
z [m] -4.00 0.00

Πορεία ανώτερου 2. στρώματος Αμμώδης ΑΡΓΙΛΟΣ:
x [m] 0.00 0.00
z [m] -4.00 -1.50

Πορεία ανώτερου 3. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ:
z= -4.50

Πορεία ανώτερου 4. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -10.00

Πορεία ανώτερου 5. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -14.00

Επιφ. φορτία:

Φορτία

xA [m]	zA [m]	xE [m]	zE [m]	PxA [kN/m²]	PzA [kN/m²]	PxE [kN/m²]	PzE [kN/m²]	Typ	LC-description Name
1.00	0.00	3.50	0.00	0.00	33.00	0.00	33.00	q	1

Κατανομή εδαφ.πιέσεων

Κατανομή εδαφ.πιέσεων	Name
Rectangular within a layer	

Στάθμη νερού:

x [m]	0.00	0.00
z [m]	-6.00	-3.00

Αγκύρια

z[m]	min.l[m]	Alpha[°]	C-H[kN/m]	P0[kN]	u0[m]
-0.50	0.00	15.00	αόριστ.	0.00	0.0000

Παράμετροι υπολογισμού

Earth pressure options

Τμήμα εδαφ.ωθήσεων: Ενεργές ωθήσεις.
Angle of slip plane: DIN 4085.
Split block loads into 1 sections.
Consideration of minimum earth pressure: φ,min = 40.000.
Negative earth pressure fractions are set to zero.

Redistribution of earth pressure

Shape of redistribution: Trapezoid.
The earth pressure is getting redistb. to: Excavation level
The earth pressure below the excavation acts without redistrb.
Levels of redistribution Z1: 0.000, Z2: -2.000 [m].
The earth pressure from variable loads will be included in redistribution.

Παθητικές ωθήσεις

Method of calculation: Κλασικός, Pregl/Sokolovsky (DIN 4085).

Options for water pressure

Στήριξη πόδα

Πόδας οριζοντίως μετακινούμενος

Αγκύρια

Anchor checks (lower failure plane): Ναι
Anchor forces with safety level of DS-P: Ναι
Verification of grout body pull out forces: Ναι
δ,a,Anchoring wall : used from soil layer.
δ,p,Anchoring wall : used from soil layer.

Earth pressure coefficients kh

φ	α	β	δ	k0gh	kagh	kach	kpgh	kpch	
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Τεχνητές επιχωματώσεις
25.0	0.0	0.0	16.7	--	0.346	1.043	--	--	"
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Αμμώδης ΑΡΓΙΛΟΣ
0.1	0.0	0.0	0.1	--	0.996	1.994	--	--	"
33.0	0.0	0.0	-22.0	--	--	--	7.496	-8.600	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
33.0	0.0	0.0	22.0	--	0.245	0.855	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"

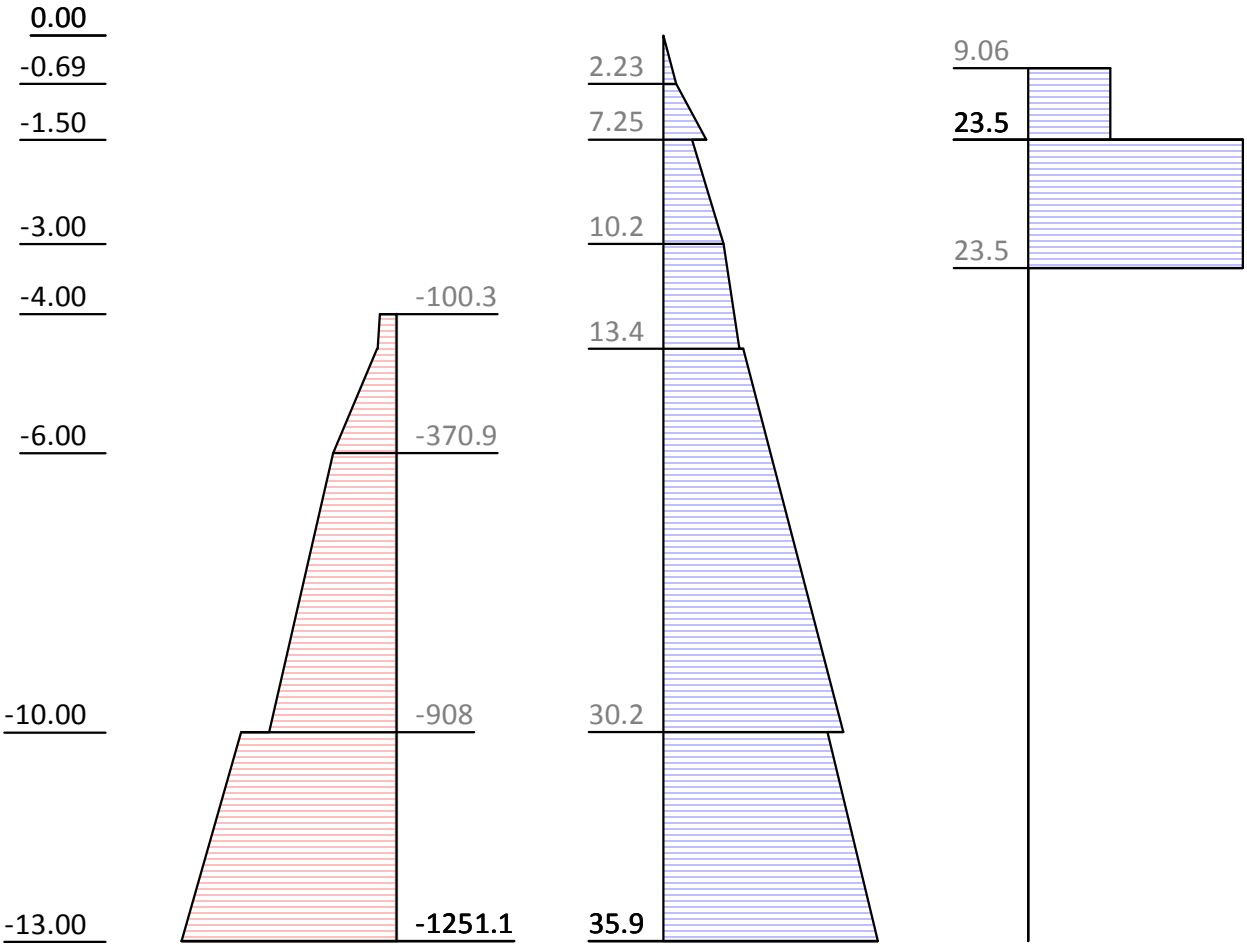
Μήκος τοίχου

Foot depth for statics: zf = -13.000

Stress analysis

Earth pressure, horizontal

Pressures characteristic, no redistribution, continous wall



z [m]	eph,G,k [kN/m2]	eah,G,k [kN/m2]	eah,PQ,k [kN/m2]	eah,d [kN/m2]
0.00		0.00		0.00
-0.47		1.52	0.00	2.04
-0.47		1.52	9.06	15.62
-1.50		7.25	9.06	23.37
-1.50		4.82	23.48	41.73
-3.34		10.79	23.48	49.78
-3.34		10.79	0.00	14.56
-4.00	-0.00	11.97	0.00	16.15
-4.00	-100.29	11.97	0.00	16.15
-4.50	-110.34	12.86	0.00	17.36
-4.50	-117.95	13.38	0.00	18.06
-10.00	-745.71	30.24	0.00	40.82
-10.00	-908.05	27.52	0.00	37.16
-13.00	-1251.06	35.94	0.00	48.52

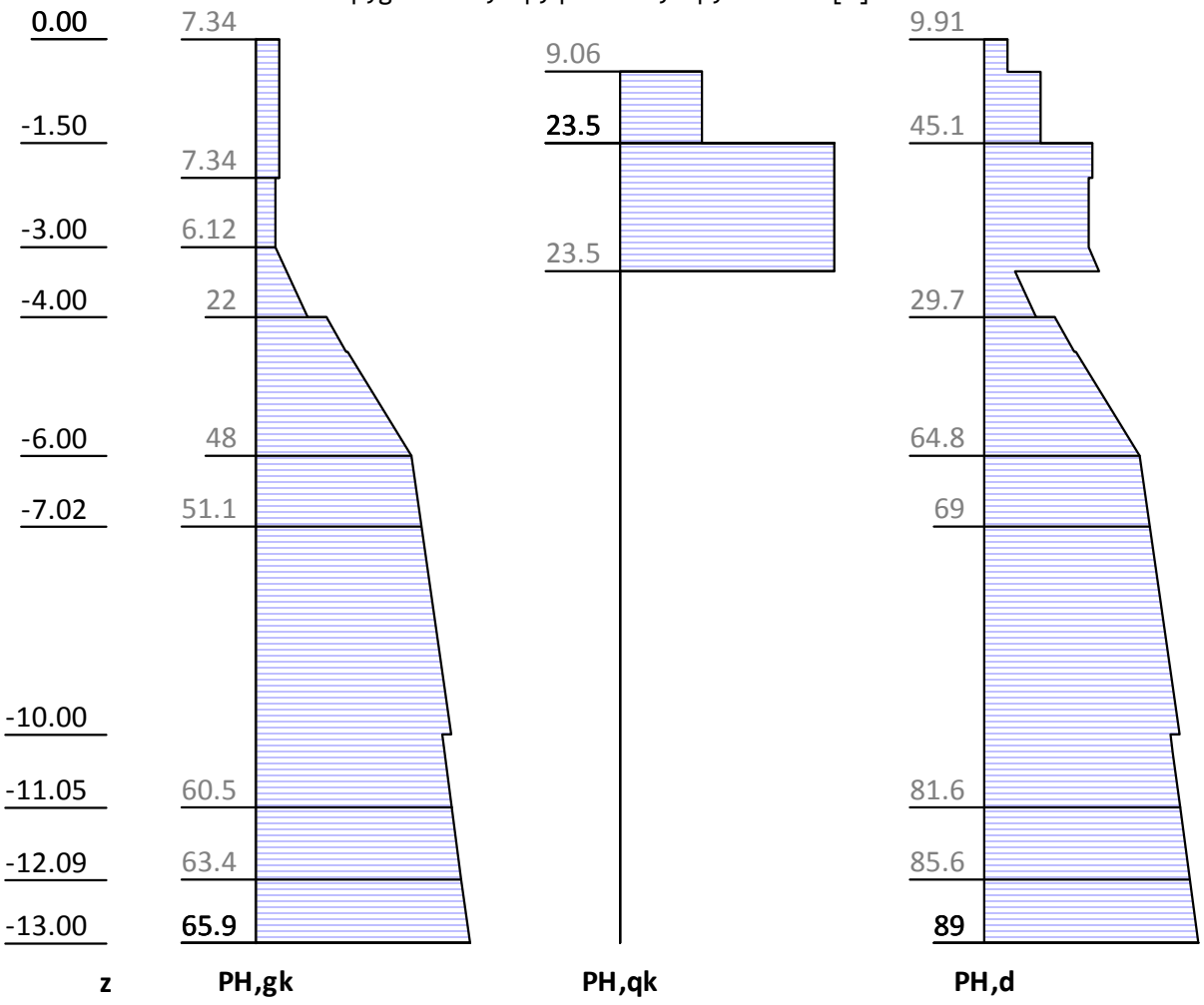
Eph,G,k:-5891.26, Eph,PG,k: 0.00 [kN/m]
Eah,G,k: 248.27, Eah,PG,k: 0.00, Eah,PQ,k: 52.53, Eah,d: 413.96

Πίεση νερού

z [m]	Wp,k [kN/m2]	Wa,k [kN/m2]	W,k [kN/m2]
-3.00		0.00	0.00
-6.00	0.00	30.00	30.00
-6.24	-2.40	32.40	30.00
-13.00	-70.00	100.00	30.00

H-pressure on static system

Level of mobilization: Ep,gk 100.0, Ep,qk 100.0, Ep,d 100.0 [%]

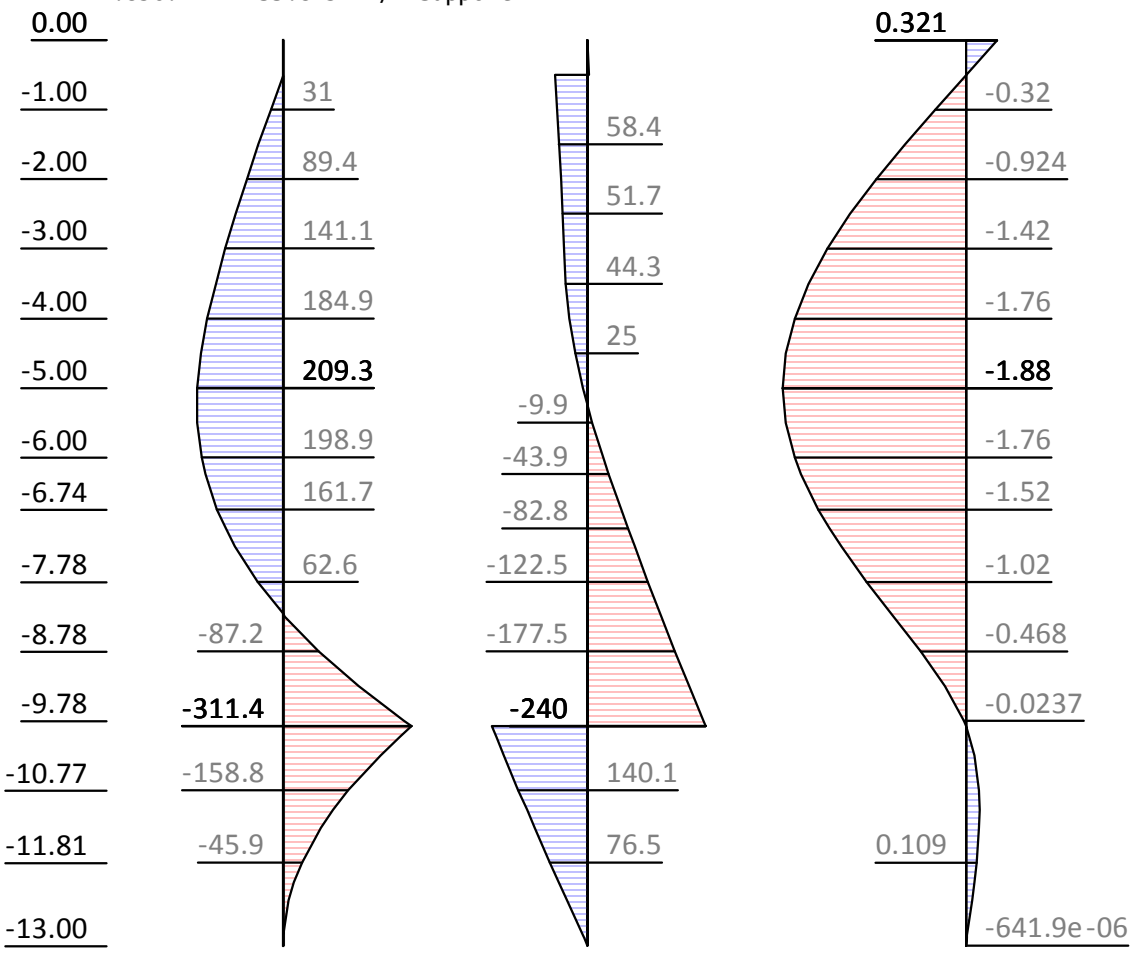


z [m]	PH,gk [kN/m2]	PH,qk [kN/m2]	PH,d [kN/m2]
0.00	7.34		9.91
-0.47	7.34	0.00	9.91
-0.47	7.34	9.06	23.50
-1.50	7.34	9.06	23.50
-1.50	7.34	23.48	45.13
-2.00	7.34	23.48	45.13
-2.00	6.12	23.48	43.48
-3.34	9.52	23.48	48.07
-3.34	9.52	0.00	12.85
-4.00	16.12	0.00	21.76
-4.00	21.97	0.00	29.65
-4.50	27.86	0.00	37.61
-4.50	28.38	0.00	38.31
-10.00	60.24	0.00	81.32
-10.00	57.52	0.00	77.66
-13.00	65.94	0.00	89.02

V-pressure on static system

Internal forces: Permanent, characteristically

z= -0.500. Fx= -69.393 kN/m Support
z= -9.856. Fx=-433.875 kN/m Support

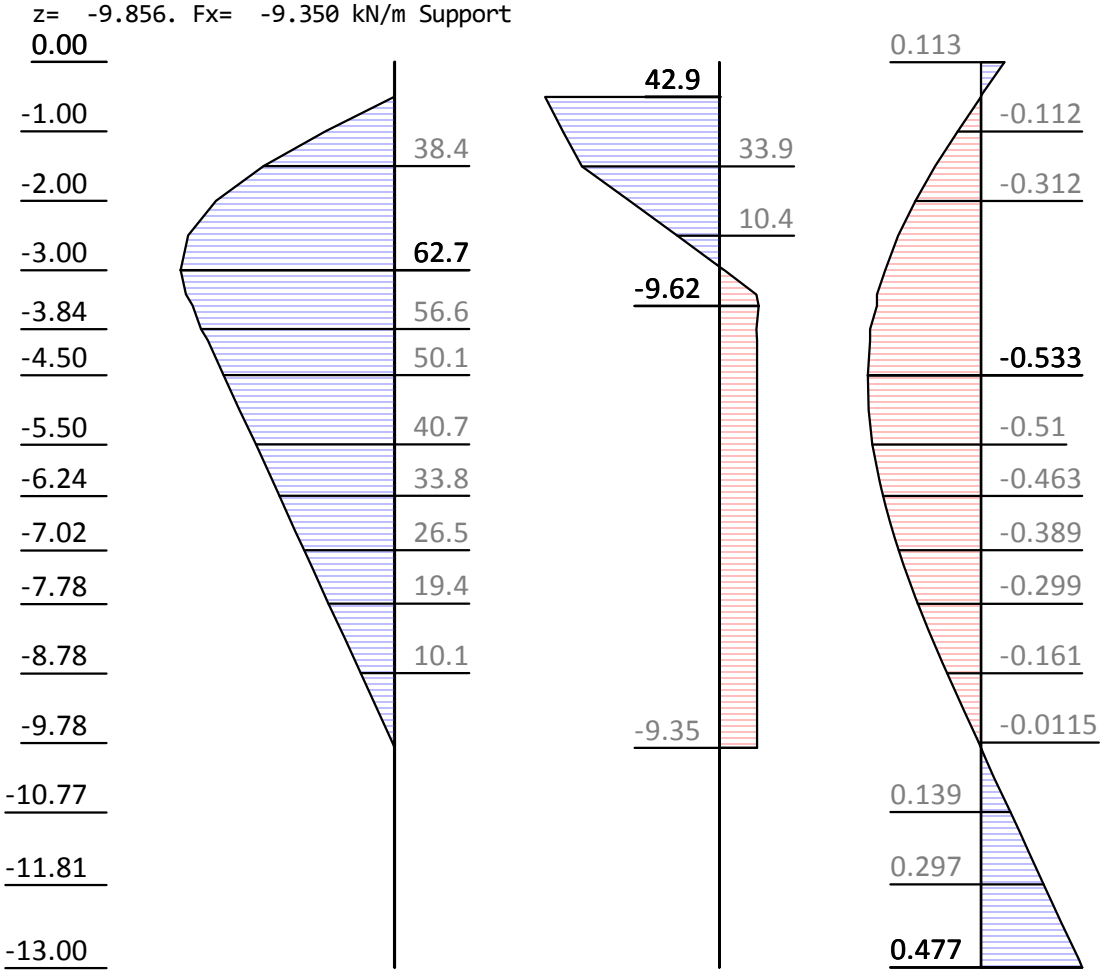


z [m]	H,g,k [kN/m2]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [mm]
0.00	7.34	-0.00	0.00	0.00	0.32
-0.00	7.34	-0.00	0.00	-0.00	0.32
-0.50	7.34	-0.92	-3.67	-10.69	0.00
-0.50	7.34	-0.92	-3.67	-10.69	-0.00
-0.50	7.34	-0.92	65.72	-29.29	-0.00
-0.51	7.34	-0.00	65.62	-29.59	-0.01
-2.00	7.34	89.40	54.71	-61.36	-0.92
-2.00	6.12	89.40	54.71	-61.36	-0.92
-4.00	16.12	184.92	37.48	-104.00	-1.76
-4.00	21.97	184.92	37.48	-104.00	-1.76
-4.50	27.86	200.67	25.02	-114.51	-1.85
-4.50	28.38	200.67	25.02	-114.51	-1.85
-5.00	34.91	209.34	9.19	-123.67	-1.88
-5.24	38.06	209.32	0.00	-128.22	-1.87
-8.24	54.84	-0.00	-147.44	-190.52	-0.76
-9.86	59.81	-311.40	-240.04	-228.71	0.00
-9.86	59.81	-311.40	193.84	-228.71	0.00
-10.00	60.24	-284.11	185.20	-232.27	0.04
-10.00	57.52	-284.11	185.20	-232.27	0.04
-11.05	60.47	-121.90	123.25	-258.64	0.14
-12.99	65.92	-0.02	0.43	-310.95	0.00

z [m]	H,g,k [kN/m2]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [mm]
-13.00	65.94	0.00	0.00	-311.14	-0.00

Internal forces: Variable, characteristically

Method EB 82-4 (Q = [G+Q] - G).
z= -0.500. Fx= -43.183 kN/m Support
z= -9.856. Fx= -9.350 kN/m Support

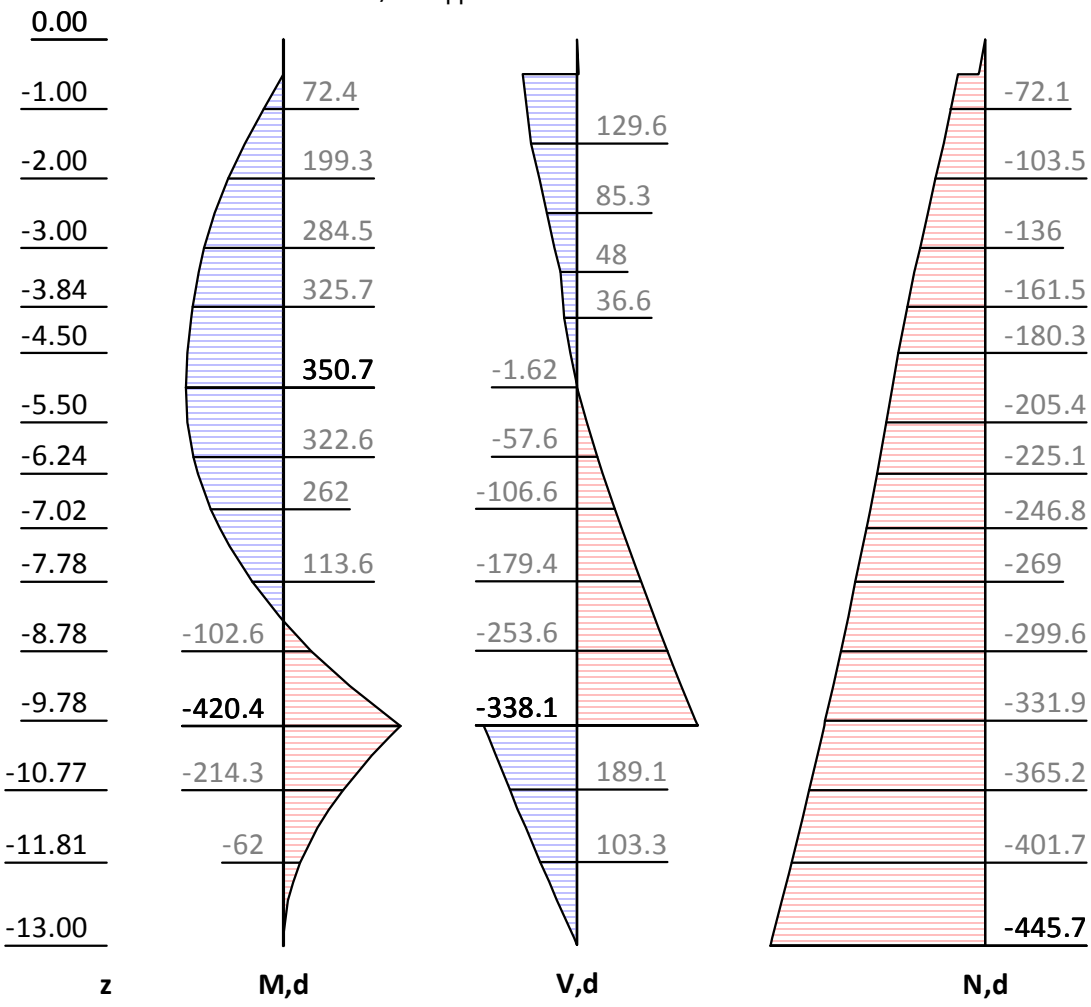


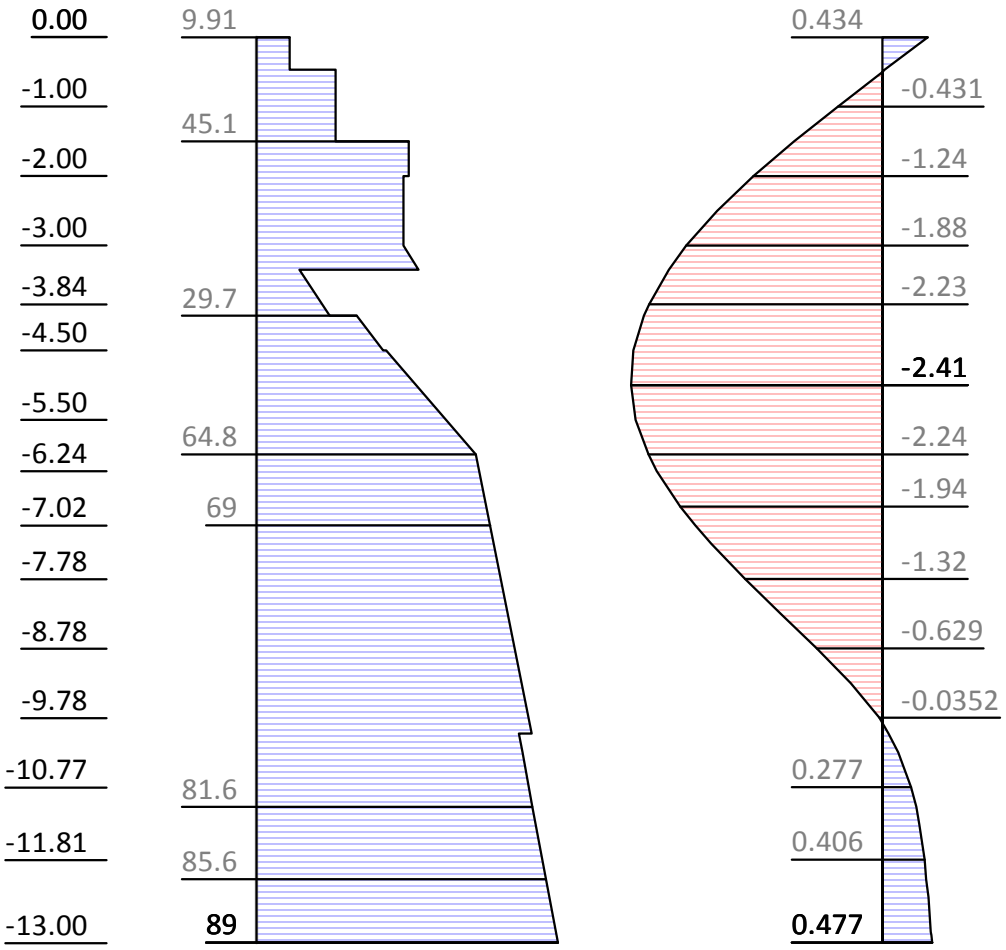
z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
0.00		0.00	-0.00	0.00	0.11
-0.47	0.00	0.05	-0.00	0.00	0.01
-0.47	9.06	0.05	-0.00	-0.00	0.01
-0.50	9.06	-0.00	-0.25	-0.03	0.00
-0.50	9.06	-0.00	42.91	-11.60	-0.00
-1.50	9.06	38.38	33.85	-12.56	-0.22
-1.50	23.48	38.38	33.85	-12.56	-0.22
-2.94	23.48	62.48	0.00	-16.14	-0.45
-3.00	23.48	62.74	-1.37	-16.28	-0.45
-3.34	23.48	61.17	-9.08	-17.13	-0.49
-3.34	0.00	61.17	-9.08	-17.13	-0.49
-3.50	0.00	59.11	-9.62	-17.13	-0.49
-3.84	0.00	56.63	-9.08	-17.13	-0.52
-4.00	0.00	54.75	-9.35	-17.13	-0.52
-4.50	0.00	50.08	-9.35	-17.13	-0.53
-5.00	0.00	45.40	-9.35	-17.13	-0.53
-6.00	0.00	36.05	-9.35	-17.13	-0.48
-6.24	0.00	33.81	-9.35	-17.13	-0.46

z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
-7.28	0.00	24.08	-9.35	-17.13	-0.36
-8.28	0.00	14.74	-9.35	-17.13	-0.23
-9.86	0.00	-0.00	-9.35	-17.13	-0.00
-9.86	0.00	-0.00	-9.35	-17.13	0.00
-9.86	0.00	-0.00	-0.00	-17.13	0.00
-10.00	0.00	-0.00	-0.00	-17.13	0.02
-10.27	0.00	-0.00	-0.00	-17.13	0.06
-11.05	0.00	-0.00	-0.00	-17.13	0.18
-11.31	0.00	-0.00	0.00	-17.13	0.22
-12.09	0.00	-0.00	0.00	-17.13	0.34
-12.35	0.00	-0.00	-0.00	-17.13	0.38
-12.90	0.00	-0.00	-0.00	-17.13	0.46
-12.96	0.00	-0.00	0.00	-17.13	0.47
-13.00	0.00	0.00	0.00	-17.13	0.48

Internal forces: Design

z= -0.500. Fx=-158.455 kN/m Support
z= -9.856. Fx=-599.756 kN/m Support





z [m]	H,d [kN/m2]	M,d [kN/m2]	V,d [kN/m2]	N,d [kN/m2]	u,g+q,k [mm]
0.00	9.91	0.00	-0.00	0.00	0.43
-0.00	9.91	-0.00	-0.00	0.00	0.43
-0.47	9.91	-1.09	-4.66	-13.57	0.03
-0.47	23.50	-1.09	-4.66	-13.57	0.03
-0.50	23.50	-1.25	-5.36	-14.48	0.00
-0.51	23.50	-0.00	152.89	-57.19	-0.01
-1.50	23.50	140.10	129.59	-87.24	-0.85
-1.50	45.13	140.10	129.59	-87.24	-0.85
-2.00	45.13	199.25	107.03	-103.54	-1.24
-2.00	43.48	199.25	107.03	-103.54	-1.24
-3.34	48.07	303.55	47.99	-147.09	-2.04
-3.34	12.85	303.55	47.99	-147.09	-2.04
-4.00	21.76	331.77	36.57	-166.09	-2.28
-4.00	29.65	331.77	36.57	-166.09	-2.28
-4.50	37.61	346.02	19.75	-180.27	-2.38
-4.50	38.31	346.02	19.75	-180.27	-2.38
-4.96	46.46	350.35	-0.00	-191.70	-2.41
-5.00	47.13	350.71	-1.62	-192.64	-2.41
-8.34	74.46	0.00	-220.72	-286.06	-0.93
-9.86	80.74	-420.39	-338.07	-334.45	0.00
-9.86	80.74	-420.39	261.68	-334.45	0.00
-10.00	81.32	-383.54	250.01	-339.26	0.06
-10.00	77.66	-383.54	250.01	-339.26	0.06
-13.00	89.02	-0.00	0.00	-445.73	0.48
-13.00	89.02	0.00	0.00	-445.73	0.48

Anchor forces with safety level of DS-P

z[m]	A,d[kN]	Fx,d[kN/m]
-0.50	295.3	-158.5

Checks of earth statics

Check or earth support

Check: Mobilizable earth resistance is sufficient for earth support force.
z: -9.86 m
Rd = Eph,k/γ,Re = 5891.26 / 1.400 = 4208.04 [kN/m]

Ed(Uh,d)/Rd = 599.76 / 4208.04 = 0.143 [-]. Passes requirement

Sum of H and V forces, (G)

Forces up to depth z:-13.00

Pos.	H	V
H/V pressure G+P+W,k	503.27	90.93
Wall weight		201.61
H/V pressure passive		0.00
Support z: -0.50	-69.39	18.59
Bh,g,k z=-9.86	-433.87	
Bv,g,k = Bh,k * tan(δ,p=-22.00°)		-175.30
Σ	-0.00	135.84 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than
the downwards pointing vertical forces.

Vk >= Bvk: 311.14 >= 175.30 Passes requirement

Sum of H and V forces, (G+Q)

Forces up to depth z:-13.00

Pos.	H	V
H/V pressure G+P+W,k	555.80	96.49
Wall weight		201.61
H/V pressure passive		0.00
Support z: -0.50	-112.58	30.16
Bh,g,k z=-9.86	-433.87	
Bv,g,k = Bh,k * tan(δ,p=-22.00°)		-175.30
Bh,q,k z=-9.86	-9.35	
Bv,q,k = Bh,k * tan(δ,p=-22.00°)		-3.78
Σ	-0.00	149.19 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than
the downwards pointing vertical forces.

Vk >= Bvk: 328.26 >= 179.07 Passes requirement

Anchor verification

Anchor - Stability of lower failure plane

Περίπτ.Φόρτισης: όλα τα φορτία BS-P
Αυτόμ. υπολογ. μήκους αγκυρίων:
All anchors are extended (if necessary)
Favourable variable loads in main failure body are not being considered.
Bottom of lower failure plane: z=-13.00 m

Iteration of failure mechanisms:
lA .....: Length of anchor from head to center of grout body.
W,k .....: Res. force from dead weight, loads, cohesion, ...
Q,k .....: Force in lower failure plane.
Ea1,k.....: Earth pressure onto vertical separation plane.
Ea2,k.....: Earth pressure between wall and main failure body.
Ra_cal,d ...: Dimesioning force of the resistance from the equilibrium of forces. Ra_cal,d corresponds to the max. possible anchor force of the force polygon.
Sum(A,d) ...: Acting anchor forces along the grout body fractions within the failure body. Sum(A,d) is gained from the anchor pull forces of the wall analysis.

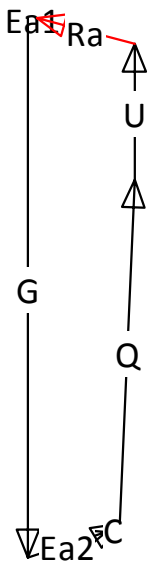
z [m]	ϑ1 [°]	ϑ2 [°]	lA [m]	W,k [kN/m]	Q,k [kN/m]	Ea1,k [kN/m]	Ea2,k [kN/m]	Ra_cal,d [kN/m]	Sum(A,d) [kN/m]	Ed/Rd [-]
-0.50	39.7	57.5	11.80	1356.2	1209.7	4.4	315.9	164.2	164.0	1.00

Decisive failure body:
Γεωμετρία:
Foot point of lower failure plane x/z = 0.01/-13.00 m
Intersection lower/upper slid. plane x/z = 11.40/ -3.55 m
Intersection upper slid. plane/surface x/z = 13.66/ 0.00 m
Intersection separation plane/surface x/z = 11.40/ 0.00 m
Inclination lower failure plane ϑ1 = 39.67°
Inclination upper failure plane ϑ2 = 57.50°
Inclination separation plane ϑ12 = 90.00°

Loads / forces (char.)

		Fx [kN/m]	Fz [kN/m]	F [kN/m]	
Weight of main failure body	G,k:	0.0	-1960.2	1960.2	
Area loads on/in main failure body	F1,k:	0.0	-82.5	82.5	
Cohesion of lower failure plane	C,k:	108.3	89.8	140.6	
Pore water pressure on main body	U,k:	-0.1	601.0	601.0	
Earth pres. on separation plane	Ea1,k:	-4.4	-0.0	4.4	δ= 0.0°
Earth pr. between wall<->main body	Ea2,k:	300.8	96.5	315.9	
Force in lower failure plane	Q,k:	-182.5	1195.8	1209.7	
Sum = possible anchor forces:	Ra_cal,k:	222.1	-59.5	229.9	

Force polygon



Acting anchor forces Ed: Sum(A,d) = 164.0 kN/m
Possible anchor forces Rd: Ra_cal,d = 229.9/1.400 = 164.2 kN/m

Verif. of lower failure plane Ed/Rd = 1.00 < 1.0: Έλεγχος εκπληρώθηκε.

Check of steel tension

l,tot ...[m]: Total length of anchor incl. excess length at head
As ....[mm2]: X-section are of steel member
Ri,d ...[kN]: Ultimate strength of tension member (γ,M=1.15)
A,d ....[kN]: Dimensioning force of the anchor from wall analysis

z[m]	Anchor type	l,tot	As	Ri,d		A,d	
-0.50	Strand;3x0.60";1570/1770	15.80	420	573.4	>	295.3	Passes requirement

Check of steel tension: Passes requirement

Check of anchor's soil friction

lVk .....: Length of grout body
DmVk ....: Diameter of grout body
τGr,k ...: Average applied skin friction along the grout body (from soil parameters)
Ra,k ....: Charact. pullout resistance of the anchor
γA .....: Partial safety factor of anchor pullout
Ra,d ....: = Ra,k / γA
A,d .....: Dimensioning force of the anchor from wall analysis

z [m]	lVk [m]	DmVk [mm]	τGr,k [kN/m²]	Ra,k [kN]	γA [-]	Ra,d [kN]		A,d [kN]	A,d/Ra,d [-]
-0.50	8.00	318	110	879.1	1.100	799.2	>	295.3	0.4

Check of anchor's soil friction: Passes requirement

Υπολογ. κύκλου ολίσθησης

LC: όλα τα φορτία Type: BS-T (combination: [GEO] A2 M2 R3, BS-T)
Vertical variable loads only act if they are outside of R*sin(phi).
The automatic slip circle optimization only considers circles that intersect
the surface with an area of at least 0.25 m2.
The slip circle calculation only accepts circles including the wall.
The slipcircle calculation only allows circular failure planes
(no vertical tangents will occour).

Γεωμετ.κύκλου (μήκη και συντεταγμ. σε (m))
Κέντρο = (-0.68, 0.20), Ακτίνα = 13.23
Αρχ.σημ.= (-13.22, -4.00), Τελ.σημ. = (12.55, 0.00)

Γεωμετρία λωρίδων:

No	x	Width b	dxM	Weight	Load z-κατ.	Water-φορτ.	u*b	φ	c	θ
	[m]	[m]	[m]	[kN/m]	[kN/m]	[kN/m]	[kN/m]	[°]	[kN/m²]	[°]
1	-12.56	1.32	-11.88	46.4	0.0	0.0	-5.3	27.45	3.57	-31.27*
2	-11.24	1.32	-10.56	110.5	0.0	0.0	-22.4	27.45	3.57	-31.27*
3	-9.91	1.32	-9.24	155.2	0.0	0.0	-42.6	27.45	3.57	-31.27*
4	-8.59	1.32	-7.91	188.8	0.0	0.0	-57.8	29.26	3.57	-30.37*
5	-7.27	1.32	-6.59	214.7	0.0	0.0	-69.4	29.26	3.57	-29.88
6	-5.95	1.32	-5.27	234.5	0.0	0.0	-78.2	29.26	3.57	-23.47
7	-4.62	1.32	-3.95	249.1	0.0	0.0	-84.7	29.26	3.57	-17.35
8	-3.30	1.32	-2.62	259.2	0.0	0.0	-89.3	29.26	3.57	-11.43
9	-1.98	1.32	-1.30	265.1	0.0	0.0	-91.9	29.26	3.57	-5.64
10	-0.65	1.32	0.02	267.6	0.0	0.0	-112.6	29.26	3.57	0.10
11	0.67	1.32	1.35	366.9	0.0	0.0	-131.5	29.26	3.57	5.84
12	1.99	1.32	2.67	360.8	0.0	0.0	-128.8	29.26	3.57	11.64
13	3.31	1.32	3.99	350.5	0.0	0.0	-124.2	29.26	3.57	17.56
14	4.64	1.32	5.31	335.7	0.0	0.0	-117.6	29.26	3.57	23.69
15	5.96	1.32	6.64	315.7	0.0	0.0	-108.7	29.26	3.57	30.12
16	7.28	1.32	7.96	289.6	0.0	0.0	-97.0	29.26	3.57	37.00
17	8.61	1.32	9.28	255.7	0.0	0.0	-81.7	27.45	3.57	44.57
18	9.93	1.32	10.61	210.5	0.0	0.0	-61.2	27.45	3.57	53.30
19	11.57	1.96	12.25	183.6	0.0	0.0	-36.5	27.45	3.57	67.79

*** Σημείωση: Στις λωρίδες σημειωμένες με '*'
περιορίστηκε το theta στο 45°-Phi/2.

Συνεισφ. κατακόρυφων φορτίων:

No	Weight	G*sin(θ)	(G-u*b)*tan(φ) + c*b	μ*sin(θ)* tan(φ)+cos(θ)	T
	[kN/m]	[kN/m]	[kN/m]	[-]	[kN/m]
1	46.36	-41.64	26.04	0.790608	32.94
2	110.47	-88.18	50.50	0.790608	63.88
3	155.17	-108.34	63.19	0.790608	79.92
4	188.81	-112.95	78.13	0.795456	98.22
5	214.69	-106.96	86.13	0.800723	107.57
6	234.47	-93.37	92.26	0.864275	106.75
7	249.12	-74.30	96.80	0.914795	105.82
8	259.23	-51.39	99.94	0.953768	104.78
9	265.14	-26.04	101.77	0.982088	103.63
10	267.61	0.47	91.56	1.000234	91.54
11	366.86	37.34	136.55	1.008355	135.42
12	360.80	72.80	134.68	1.006292	133.83
13	350.54	105.78	131.49	0.993551	132.35
14	335.72	134.88	126.90	0.969223	130.93
15	315.75	158.43	120.71	0.931795	129.55
16	289.63	174.29	112.64	0.878775	128.17
17	255.66	179.42	95.10	0.799043	119.01
18	210.47	168.75	82.28	0.696617	118.11
19	183.62	170.00	83.41	0.492248	169.45
		498.98			2091.87

Συνεισφ. αγκυρίων: Αθρ. ροπών ανατροπής : -25.0 kN*m/m
" " resisting : 0.8 kN*m/m

Δράση Ed = (499.0*13.23-25.0)
Αντίσταση Rd = (2091.9*13.23 +0.8)

SLIP-CIRCLE μ = Ed/Rd = 0.24 < 1.0: Έλεγχος εκπληρώθηκε.

Φάση εκσκαφής 4 "[4] Situation 4"

LC: όλα τα φορτία Type: BS-T

Εδαφικό σύστημα με 5 Στρώσεις

Name		Τεχνητές επιχωματώσεις	Αμμώδης ΑΡΓΙΛΟΣ	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
γ	[kN/m3]	18	20	22.5
γ,R	[kN/m3]	18	20	22.5
γ'	[kN/m3]	8	10	12.5
γ,p	[kN/m3]	18	20	22.5
γ,R,passive	[kN/m3]	18	20	22.5
γ,pw	[kN/m3]	8	10	12.5
φ	[°]	25	0.1	33
c	[kN/m2]	2	50	5
c,u	[kN/m2]	10	50	5
c παθητικό	[kN/m2]	2	50	5
δ,a	[°]	16.66667	0.06666667	22
δ,p	[°]	-16.66667	-0.06666667	-22
δ,c	[°]	8.333333	0.03333333	11
k,agh	[-]	0.3456501	0.9955057	0.2452023
K,ach	[-]	1.043051	1.994195	0.8549058
K,0h	[-]	0.5773817	0.9982547	0.455361
K,pgh	[-]	3.908103	1.004519	7.495617
K,pch	[-]	5.180327	2.00583	8.599509
τ,gr	[kN/m2]	110	110	110
Ψ,A,max	[°]	90	90	90
k	[cm/s]	10e-06	1e-06	100e-06

Name		Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
γ	[kN/m3]	22.5	22.5
γ,R	[kN/m3]	22.5	22.5
γ'	[kN/m3]	12.5	12.5
γ,p	[kN/m3]	22.5	22.5
γ,R,passive	[kN/m3]	22.5	22.5
γ,pw	[kN/m3]	12.5	12.5
φ	[°]	35	35
c	[kN/m2]	5	5
c,u	[kN/m2]	5	5
c παθητικό	[kN/m2]	5	5
δ,a	[°]	23.33333	23.33333
δ,p	[°]	-23.33333	-23.33333
δ,c	[°]	11.66667	11.66667
k,agh	[-]	0.2244207	0.2244207
K,ach	[-]	0.8126539	0.8126539
K,0h	[-]	0.4264236	0.4264236
K,pgh	[-]	9.146943	9.146943
K,pch	[-]	10.104	10.104
τ,gr	[kN/m2]	110	110
Ψ,A,max	[°]	90	90
k	[cm/s]	100e-06	100e-06

Πορεία πρανούς:
x [m] 0.00 0.00
z [m] -4.00 0.00

Πορεία ανώτερου 2. στρώματος Αμμώδης ΑΡΓΙΛΟΣ:
x [m] 0.00 0.00
z [m] -4.00 -1.50

Πορεία ανώτερου 3. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ:
z= -4.50

Πορεία ανώτερου 4. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -10.00

Πορεία ανώτερου 5. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -14.00

Επιφ. φορτία:

Φορτία

xA [m]	zA [m]	xE [m]	zE [m]	PxA [kN/m²]	PzA [kN/m²]	PxE [kN/m²]	PzE [kN/m²]	Typ	LC-description Name
1.00	0.00	3.50	0.00	0.00	33.00	0.00	33.00	q	1

Κατανομή εδαφ.πιέσεων

Κατανομή εδαφ.πιέσεων	Name
Rectangular within a layer	

Στάθμη νερού:

x [m]	0.00	0.00
z [m]	-6.00	-3.00

Αγκύρια

z[m]	min.l[m]	Alpha[°]	C-H[kN/m]	P0[kN]	u0[m]
-0.50	0.00	15.00	0.00	0.00	0.0000
-3.00	0.00	15.00	αόριστ.	0.00	0.0000

Παράμετροι υπολογισμού

Earth pressure options

Τμήμα εδαφ.ωθήσεων: Ενεργές ωθήσεις.
Angle of slip plane: DIN 4085.
Split block loads into 1 sections.
Consideration of minimum earth pressure: φ,min = 40.000.
Negative earth pressure fractions are set to zero.

Redistribution of earth pressure

Shape of redistribution: Triangle (perpend. to wall).
The earth pressure is getting redistb. to: Excavation level
The earth pressure below the excavation acts without redistrb.
Levels of redistribution Z1: -0.500, Z2: -3.000 [m].
The earth pressure from variable loads will be included in redistribution.

Παθητικές ωθήσεις

Method of calculation: Κλασικός, Pregl/Sokolovsky (DIN 4085).

Options for water pressure

Στήριξη πόδα

Πόδας οριζοντίως μετακινούμενος

Αγκύρια

Anchor checks (lower failure plane): Ναι
Anchor forces with safety level of DS-P: Ναι
Verification of grout body pull out forces: Ναι
δ,a,Anchoring wall : used from soil layer.
δ,p,Anchoring wall : used from soil layer.

Earth pressure coefficients kh

φ	α	β	δ	k0gh	kagh	kach	kpgh	kpch	
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Τεχνητές επιχωματώσεις
25.0	0.0	0.0	16.7	--	0.346	1.043	--	--	"
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Αμμώδης ΑΡΓΙΛΟΣ
0.1	0.0	0.0	0.1	--	0.996	1.994	--	--	"
33.0	0.0	0.0	-22.0	--	--	--	7.496	-8.600	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
33.0	0.0	0.0	22.0	--	0.245	0.855	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"

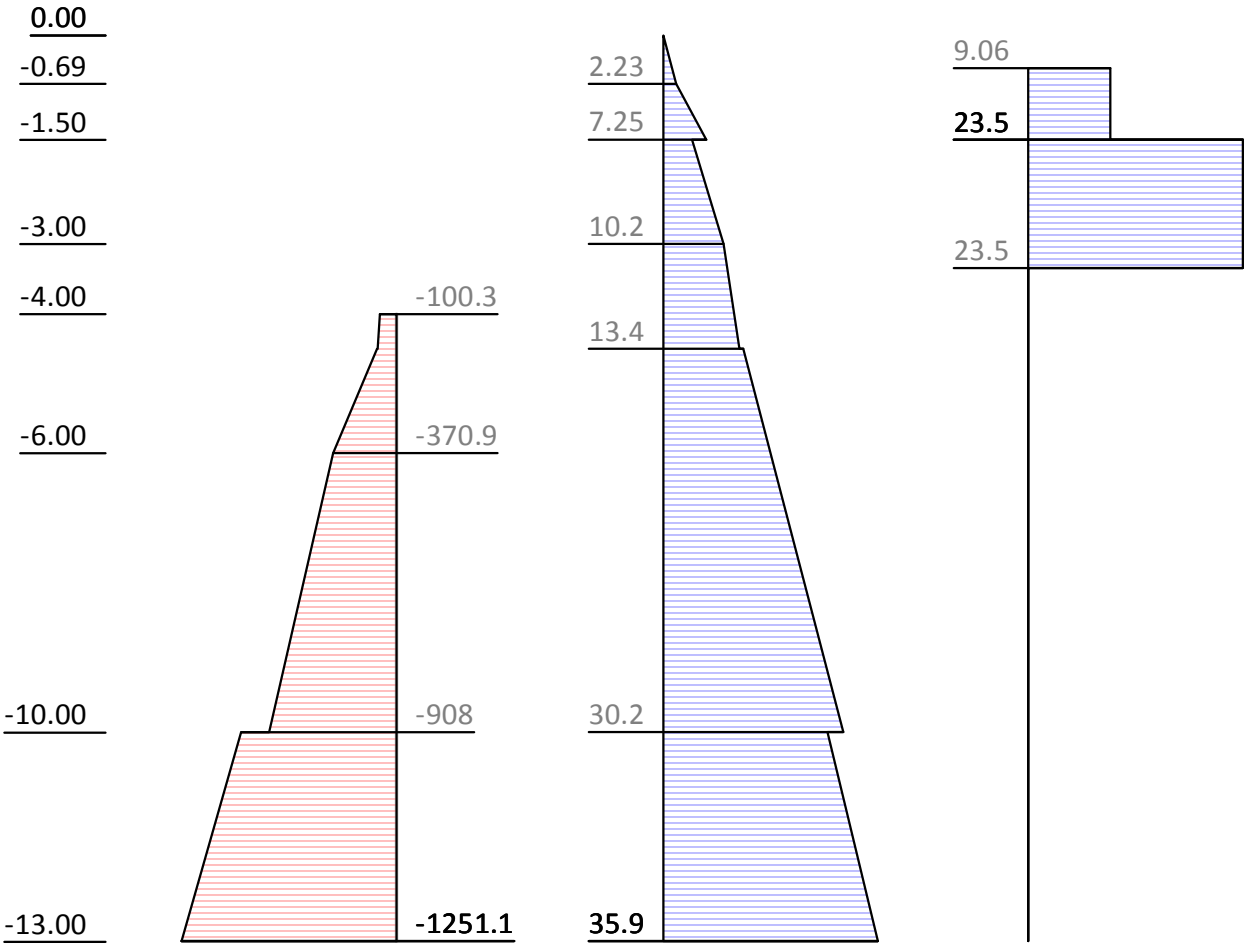
Μήκος τοίχου

Foot depth for statics: zf = -13.000

Stress analysis

Earth pressure, horizontal

Pressures characteristic, no redistribution, continous wall



z [m]	eph,G,k [kN/m2]	eah,G,k [kN/m2]	eah,PQ,k [kN/m2]	eah,d [kN/m2]
0.00		0.00		0.00
-0.47		1.52	0.00	2.04
-0.47		1.52	9.06	15.62
-1.50		7.25	9.06	23.37
-1.50		4.82	23.48	41.73
-3.34		10.79	23.48	49.78
-3.34		10.79	0.00	14.56
-4.00	-0.00	11.97	0.00	16.15
-4.00	-100.29	11.97	0.00	16.15
-4.50	-110.34	12.86	0.00	17.36
-4.50	-117.95	13.38	0.00	18.06
-10.00	-745.71	30.24	0.00	40.82
-10.00	-908.05	27.52	0.00	37.16
-13.00	-1251.06	35.94	0.00	48.52

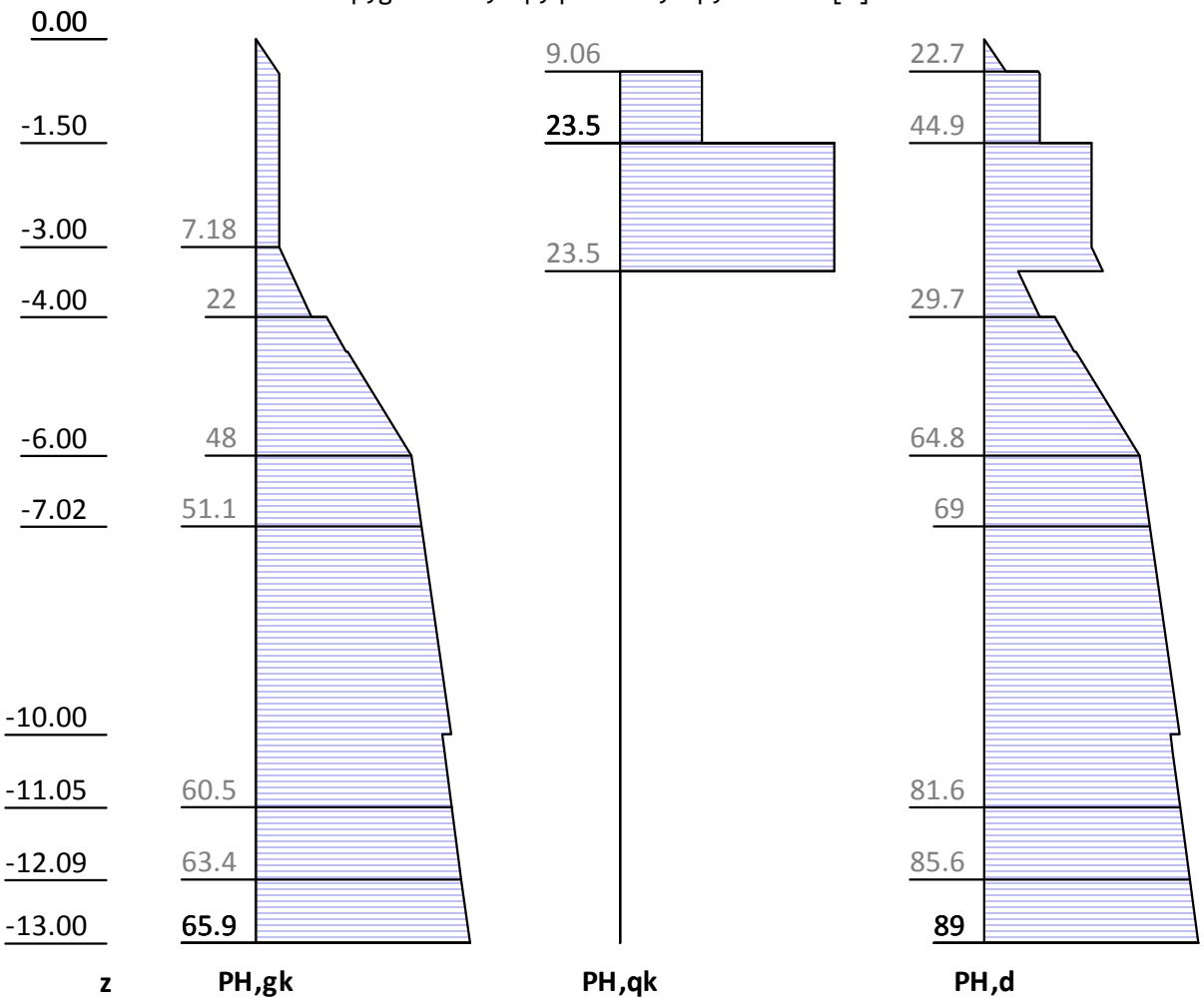
Eph,G,k:-5891.26, Eph,PG,k: 0.00 [kN/m]
Eah,G,k: 248.27, Eah,PG,k: 0.00, Eah,PQ,k: 52.53, Eah,d: 413.96

Πίεση νερού

z [m]	Wp,k [kN/m2]	Wa,k [kN/m2]	W,k [kN/m2]
-3.00		0.00	0.00
-6.00	0.00	30.00	30.00
-6.24	-2.40	32.40	30.00
-13.00	-70.00	100.00	30.00

H-pressure on static system

Level of mobilization: Ep,gk 100.0, Ep,qk 100.0, Ep,d 100.0 [%]

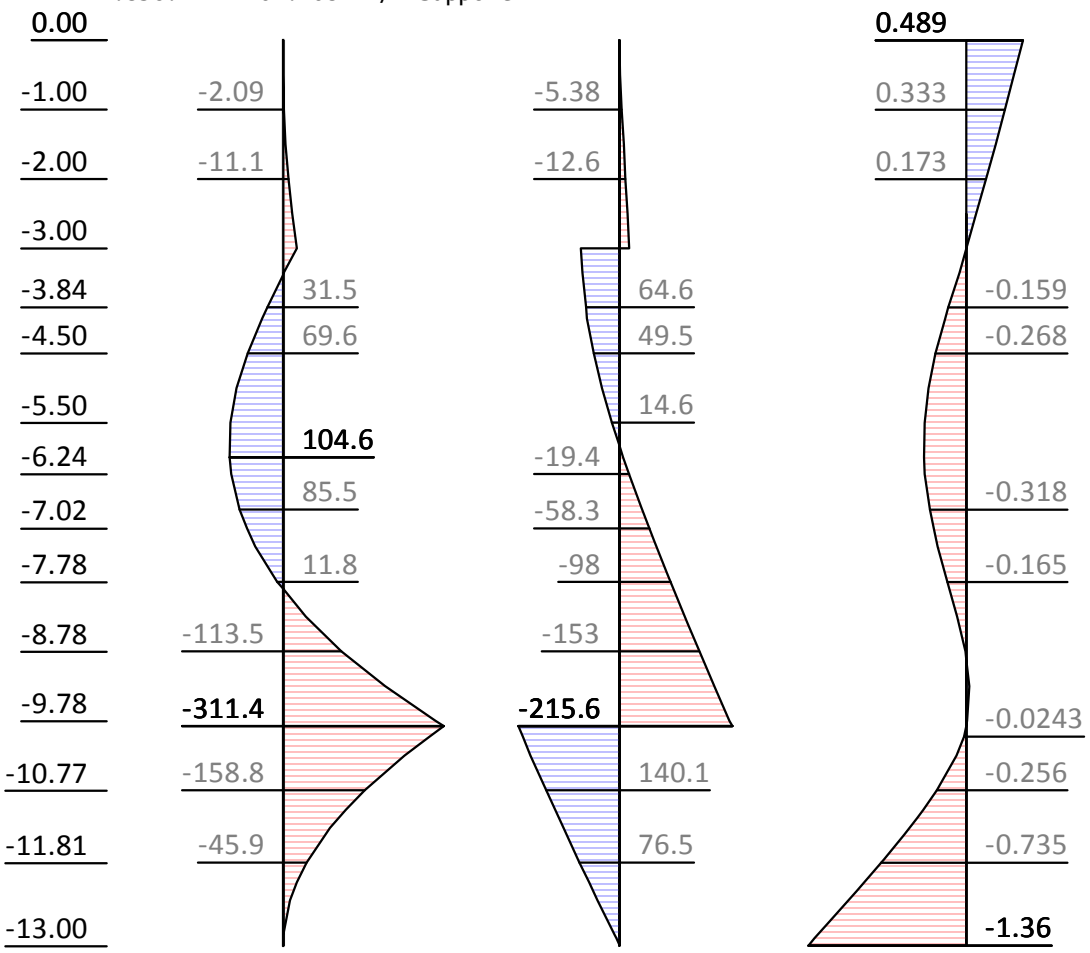


z [m]	PH,gk [kN/m2]	PH,qk [kN/m2]	PH,d [kN/m2]
0.00	0.00		0.00
-0.47	6.75	0.00	9.11
-0.47	6.75	9.06	22.69
-1.50	7.18	9.06	23.28
-1.50	7.18	23.48	44.91
-3.34	10.58	23.48	49.50
-3.34	10.58	0.00	14.28
-4.00	17.18	0.00	23.19
-4.00	21.97	0.00	29.65
-4.50	27.86	0.00	37.61
-4.50	28.38	0.00	38.31
-10.00	60.24	0.00	81.32
-10.00	57.52	0.00	77.66
-13.00	65.94	0.00	89.02

V-pressure on static system

Internal forces: Permanent, characteristically

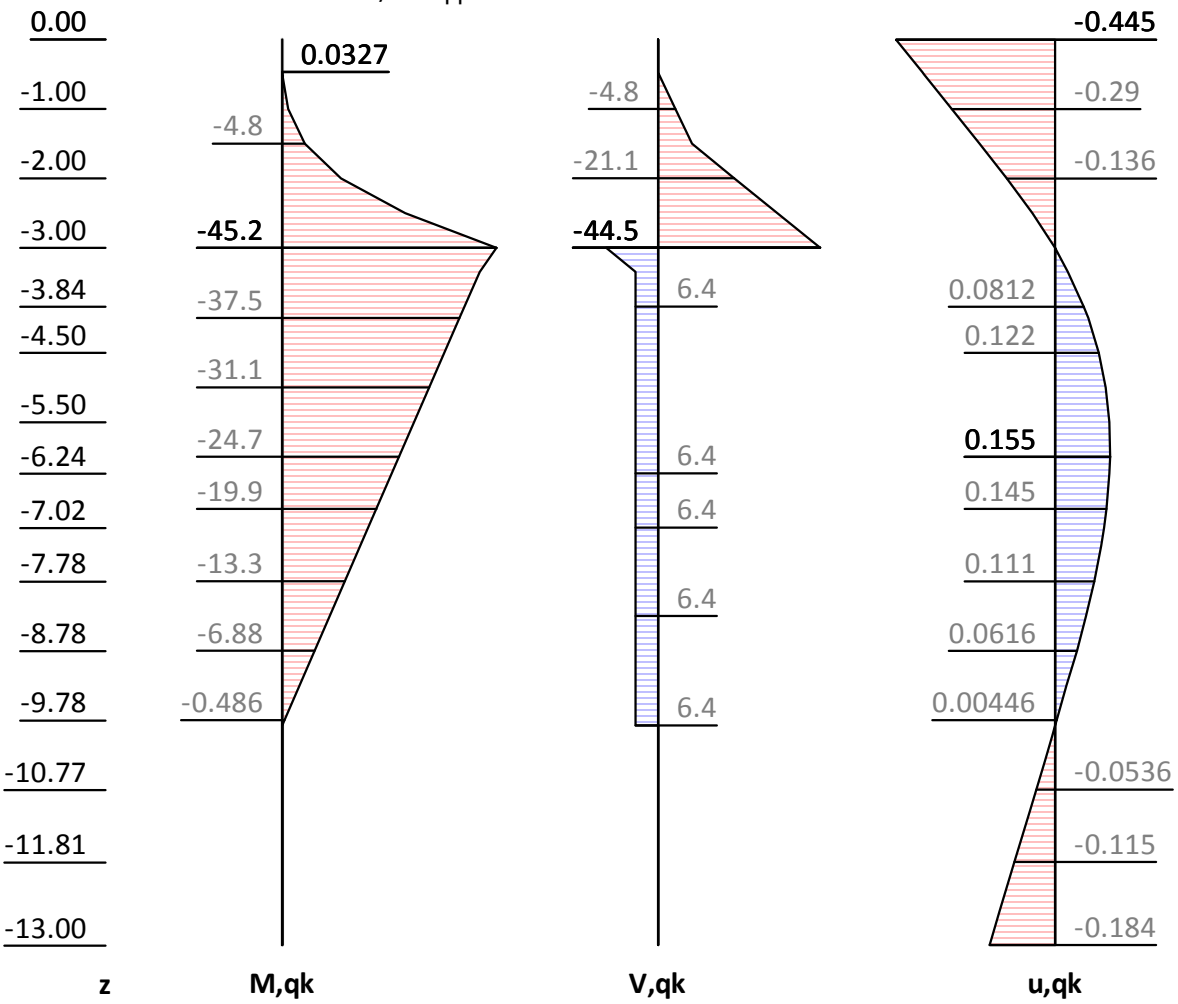
z= -0.500. Fx= -0.000 kN/m Support
z= -3.000. Fx= -93.860 kN/m Support
z= -9.856. Fx=-409.408 kN/m Support



z [m]	H,g,k [kN/m2]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [mm]
0.00	0.00	-0.00	0.00	0.00	0.49
-0.00	0.00	-0.00	0.00	-0.00	0.49
-3.00	7.18	-27.22	-19.74	-64.03	0.00
-3.00	7.18	-27.22	-19.74	-64.03	-0.00
-3.00	7.18	-27.22	74.12	-89.18	-0.00
-3.38	10.94	-0.00	70.62	-97.23	-0.07
-4.00	17.18	41.65	61.94	-110.55	-0.19
-4.00	21.97	41.65	61.94	-110.55	-0.19
-4.50	27.86	69.63	49.49	-121.06	-0.27
-4.50	28.38	69.63	49.49	-121.06	-0.27
-5.83	45.70	103.93	-0.00	-146.06	-0.37
-6.00	47.98	104.58	-7.78	-149.46	-0.37
-7.89	53.76	0.00	-103.77	-189.15	-0.15
-8.90	56.85	-132.99	-159.67	-212.22	0.00
-9.28	58.03	-197.17	-181.64	-221.28	0.03
-9.86	59.81	-311.40	-215.57	-235.27	0.00
-9.86	59.81	-311.40	193.84	-235.27	0.00
-10.00	60.24	-284.11	185.20	-238.83	-0.02
-10.00	57.52	-284.11	185.20	-238.83	-0.02
-13.00	65.94	-0.00	-0.00	-317.69	-1.36
-13.00	65.94	0.00	-0.00	-317.69	-1.36

Internal forces: Variable, characteristically

Method EB 82-4 (Q = [G+Q] - G).
z= -0.500. Fx= 0.000 kN/m Support
z= -3.000. Fx= -58.929 kN/m Support
z= -9.856. Fx= 6.397 kN/m Support

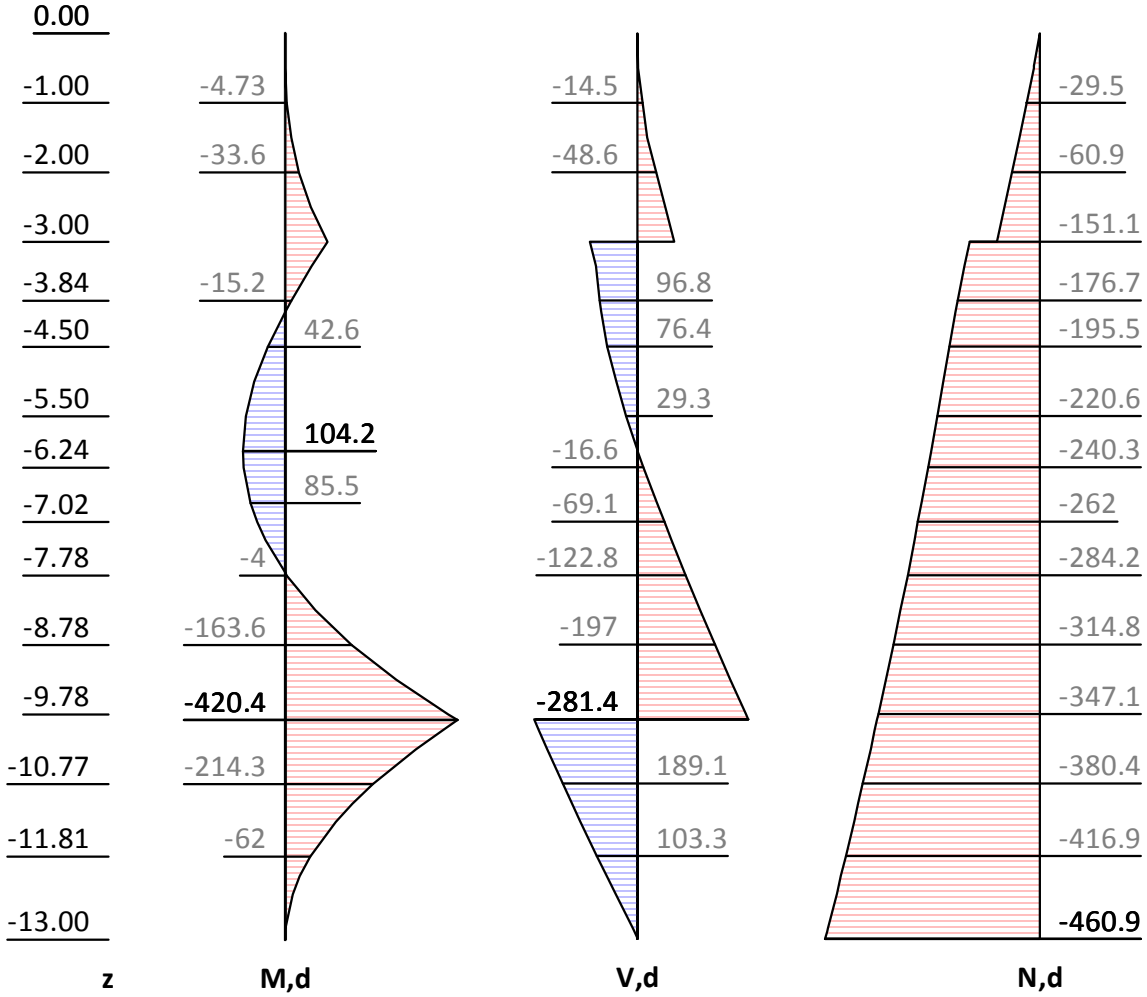


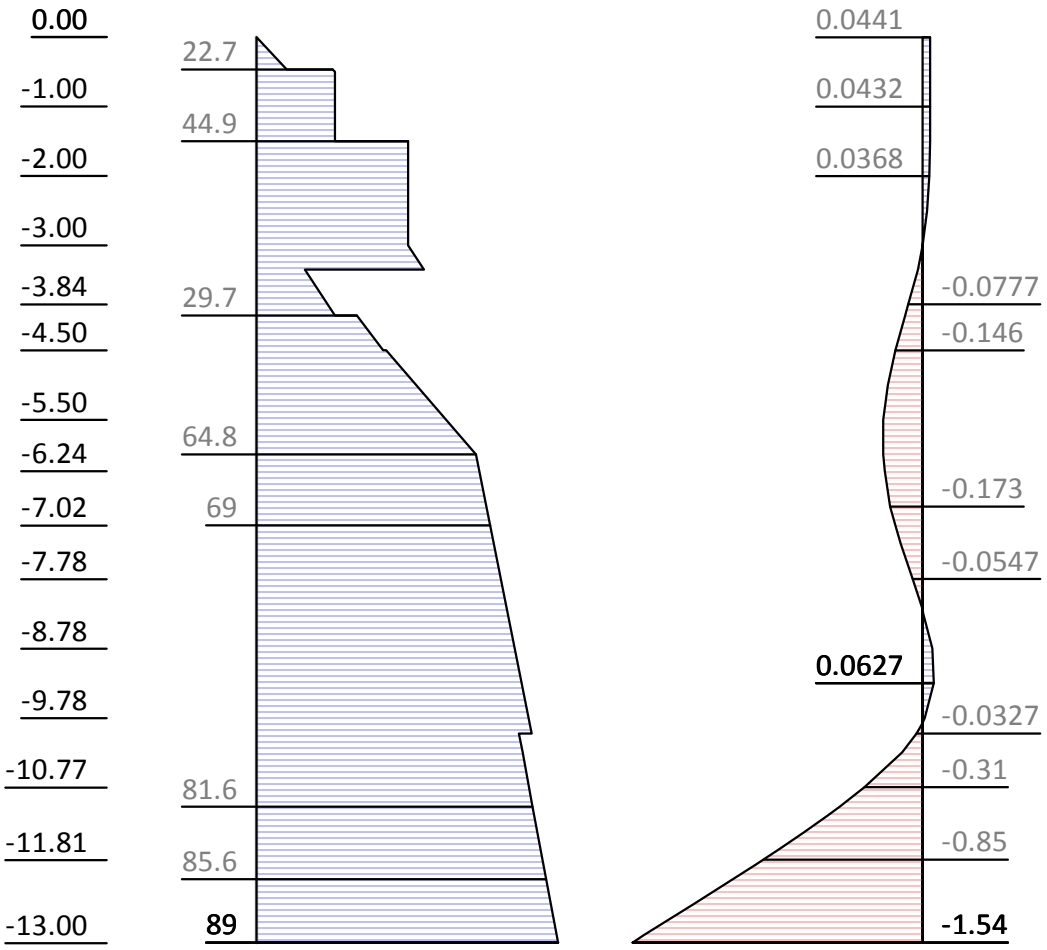
z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
0.00		0.00	-0.00	0.00	-0.45
-0.00		0.00	-0.00	0.00	-0.45
-0.47	0.00	0.03	0.10	0.01	-0.37
-0.47	9.06	0.03	0.10	0.01	-0.37
-0.48	9.06	0.02	-0.00	-0.00	-0.37
-0.50	9.06	-0.00	-0.23	-0.02	-0.37
-1.50	9.06	-4.80	-9.33	-0.99	-0.21
-1.50	23.48	-4.80	-9.33	-0.99	-0.21
-3.00	23.48	-45.21	-44.55	-4.71	-0.00
-3.00	23.48	-45.21	14.38	-20.50	-0.00
-3.00	23.48	-45.21	14.38	-20.50	0.00
-3.34	23.48	-41.68	6.40	-21.35	0.04
-3.34	0.00	-41.68	6.40	-21.35	0.04
-3.84	0.00	-38.48	6.40	-21.35	0.08
-4.50	0.00	-34.26	6.40	-21.35	0.12
-5.00	0.00	-31.06	6.40	-21.35	0.14
-5.50	0.00	-27.86	6.40	-21.35	0.15
-6.00	0.00	-24.67	6.40	-21.35	0.15
-7.02	0.00	-18.14	6.40	-21.35	0.14
-9.86	0.00	-0.00	6.40	-21.35	0.00

z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
-9.86	0.00	-0.00	0.00	-21.35	0.00
-11.05	0.00	-0.00	0.00	-21.35	-0.07
-11.31	0.00	-0.00	0.00	-21.35	-0.09
-12.09	0.00	-0.00	0.00	-21.35	-0.13
-12.85	0.00	0.00	0.00	-21.35	-0.18
-12.90	0.00	0.00	0.00	-21.35	-0.18
-12.98	0.00	0.00	-0.00	-21.35	-0.18
-13.00	0.00	-0.00	-0.00	-21.35	-0.18

Internal forces: Design

z= -0.500. Fx= -0.000 kN/m Support
z= -3.000. Fx=-215.104 kN/m Support
z= -9.856. Fx=-543.107 kN/m Support





z [m]	H,d [kN/m2]	M,d [kN/m2]	V,d [kN/m2]	N,d [kN/m2]	u,g+q,k [mm]
0.00	0.00	0.00	0.00	0.00	0.04
-0.47	9.11	-0.34	-2.14	-13.44	0.04
-0.47	22.69	-0.34	-2.14	-13.44	0.04
-1.50	23.28	-14.88	-26.11	-44.64	0.04
-1.50	44.91	-14.88	-26.11	-44.64	0.04
-3.00	44.91	-104.56	-93.47	-93.51	0.00
-3.00	44.91	-104.56	-93.47	-93.51	-0.00
-3.00	44.91	-104.56	121.63	-151.15	-0.00
-3.34	49.50	-65.89	105.58	-162.22	-0.03
-3.34	14.28	-65.89	105.58	-162.22	-0.03
-4.00	23.19	0.00	93.22	-181.26	-0.09
-4.00	23.19	0.04	93.22	-181.27	-0.09
-4.00	29.65	0.04	93.22	-181.27	-0.09
-4.50	37.61	42.61	76.40	-195.45	-0.15
-4.50	38.31	42.61	76.40	-195.45	-0.15
-5.98	64.50	103.96	0.00	-233.40	-0.21
-6.00	64.77	104.18	-0.91	-233.80	-0.21
-7.74	71.98	-0.00	-120.05	-283.06	-0.06
-8.22	73.97	-66.40	-155.13	-297.55	0.00
-9.28	78.34	-271.71	-235.62	-330.75	0.06
-9.86	80.74	-420.39	-281.42	-349.63	0.00
-9.86	80.74	-420.39	261.68	-349.63	0.00
-10.00	81.32	-383.54	250.01	-354.44	-0.03
-10.00	77.66	-383.54	250.01	-354.44	-0.03
-13.00	89.02	-0.00	0.00	-460.90	-1.54
-13.00	89.02	-0.00	-0.00	-460.90	-1.54

Anchor forces with safety level of DS-P

z[m]	A,d[kN]	Fx,d[kN/m]
-0.50	0.0	-0.0
-3.00	200.4	-215.1

Checks of earth statics

Check or earth support

Check: Mobilizable earth resistance is sufficient for earth support force.
z: -9.86 m
Rd = Eph,k/γ,Re = 5891.26 / 1.400 = 4208.04 [kN/m]

Ed(Uh,d)/Rd = 543.11 / 4208.04 = 0.129 [-]. Passes requirement

Sum of H and V forces, (G)

Forces up to depth z:-13.00

Pos.	H	V
H/V pressure G+P+W,k	503.27	90.93
Wall weight		201.61
H/V pressure passive		0.00
Support z: -0.50		0.00
Support z: -3.00	-93.86	25.15
Bh,g,k z=-9.86	-409.41	
Bv,g,k = Bh,k * tan(δ,p=-22.00°)		-165.41
Σ	0.00	152.28 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than the downwards pointing vertical forces.

Vk >= Bvk: 317.69 >= 165.41 Passes requirement

Sum of H and V forces, (G+Q)

Forces up to depth z:-13.00

Pos.	H	V
H/V pressure G+P+W,k	555.80	96.49
Wall weight		201.61
H/V pressure passive		0.00
Support z: -0.50		0.00
Support z: -3.00	-152.79	40.94
Bh,g,k z=-9.86	-409.41	
Bv,g,k = Bh,k * tan(δ,p=-22.00°)		-165.41
Bh,q,k z=-9.86	6.40	
Bv,q,k = Bh,k * tan(δ,p=-22.00°)		2.58
Σ	-0.00	176.21 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than the downwards pointing vertical forces.

Vk >= Bvk: 339.04 >= 162.83 Passes requirement

Anchor verification

Anchor - Stability of lower failure plane

Περίπτ.Φόρτισης: όλα τα φορτία BS-P
Αυτόμ. υπολογ. μήκους αγκυρίων:
All anchors are extended (if necessary)
Favourable variable loads in main failure body are not being considered.
Bottom of lower failure plane: z=-13.00 m

Iteration of failure mechanisms:
lA .....: Length of anchor from head to center of grout body.
W,k .....: Res. force from dead weight, loads, cohesion, ...
Q,k .....: Force in lower failure plane.
Ea1,k.....: Earth pressure onto vertical separation plane.
Ea2,k.....: Earth pressure between wall and main failure body.
Ra_cal,d ...: Dimesioning force of the resistance from the equilibrium of forces. Ra_cal,d corresponds to the max. possible anchor force of the force polygon.
Sum(A,d) ...: Acting anchor forces along the grout body fractions within the failure body. Sum(A,d) is gained from the anchor pull forces of the wall analysis.

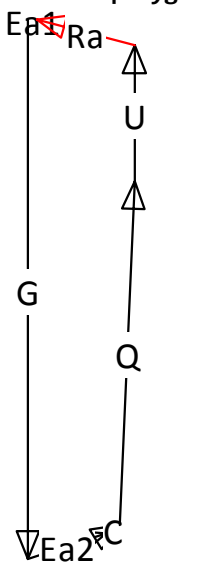
z [m]	ϑ1 [°]	ϑ2 [°]	lA [m]	W,k [kN/m]	Q,k [kN/m]	Ea1,k [kN/m]	Ea2,k [kN/m]	Ra_cal,d [kN/m]	Sum(A,d) [kN/m]	Ed/Rd [-]
-0.50	39.3	57.5	11.91	1372.1	1222.8	4.4	315.9	169.0	168.6	1.00
-3.00	34.9	60.8	10.72	1424.1	1246.1	27.4	315.9	222.8	222.7	1.00

Decisive failure body:
Γεωμετρία:
Foot point of lower failure plane x/z = 0.01/-13.00 m
Intersection lower/upper slid. plane x/z = 10.35/ -5.77 m
Intersection upper slid. plane/surface x/z = 13.58/ 0.00 m
Intersection separation plane/surface x/z = 10.35/ 0.00 m
Inclination lower failure plane ϑ1 = 34.93°
Inclination upper failure plane ϑ2 = 60.78°
Inclination separation plane ϑ12 = 90.00°

Loads / forces (char.)

		Fx [kN/m]	Fz [kN/m]	F [kN/m]	
Weight of main failure body	G,k:	0.0	-2037.5	2037.5	
Area loads on/in main failure body	F1,k:	0.0	-82.5	82.5	
Cohesion of lower failure plane	C,k:	51.7	36.1	63.1	
Pore water pressure on main body	U,k:	0.0	660.7	660.7	
Earth pres. on separation plane	Ea1,k:	-27.4	-0.0	27.4	δ= 0.0°
Earth pr. between wall<->main body	Ea2,k:	300.8	96.5	315.9	
Force in lower failure plane	Q,k:	-23.7	1245.9	1246.1	
Sum = possible anchor forces:	Ra_cal,k:	301.4	-80.7	312.0	

Force polygon



Acting anchor forces Ed: Sum(A,d) = 222.7 kN/m
Possible anchor forces Rd: Ra_cal,d = 312.0/1.400 = 222.8 kN/m

Verif. of lower failure plane Ed/Rd = 1.00 < 1.0: Έλεγχος εκπληρώθηκε.

Check of steel tension

l,tot ...[m]: Total length of anchor incl. excess length at head
As ....[mm2]: X-section are of steel member
Ri,d ...[kN]: Ultimate strength of tension member (γ,M=1.15)
A,d ....[kN]: Dimensioning force of the anchor from wall analysis

z[m]	Anchor type	l,tot	As	Ri,d		A,d	
-0.50	Strand;3x0.60";1570/1770	16.13	420	573.4	>	0.0	Passes requirement
-3.00	Strand;3x0.60";1570/1770	14.72	420	573.4	>	200.4	Passes requirement

Check of steel tension: Passes requirement

Check of anchor's soil friction

lVk .....: Length of grout body
DmVk ....: Diameter of grout body
τGr,k ...: Average applied skin friction along the grout body (from soil parameters)
Ra,k ....: Charact. pullout resistance of the anchor
γA .....: Partial safety factor of anchor pullout
Ra,d ....: = Ra,k / γA
A,d .....: Dimensioning force of the anchor from wall analysis

z [m]	lVk [m]	DmVk [mm]	τGr,k [kN/m²]	Ra,k [kN]	γA [-]	Ra,d [kN]		A,d [kN]	A,d/Ra,d [-]
-0.50	8.00	318	110	879.1	1.100	799.2	>	0.0	0.0
-3.00	8.00	318	110	879.1	1.100	799.2	>	200.4	0.3

Check of anchor's soil friction: Passes requirement

Υπολογ. κύκλου ολίσθησης

LC: όλα τα φορτία Type: BS-T (combination: [GEO] A2 M2 R3, BS-T)
Vertical variable loads only act if they are outside of R*sin(phi).
The automatic slip circle optimization only considers circles that intersect
the surface with an area of at least 0.25 m2.
The slip circle calculation only accepts circles including the wall.
The slipcircle calculation only allows circular failure planes
(no vertical tangents will occour).

Γεωμετ.κύκλου (μήκη και συντεταγμ. σε (m))
Κέντρο = (-0.68, 0.20), Ακτίνα = 13.23
Αρχ.σημ.= (-13.22, -4.00), Τελ.σημ. = (12.55, 0.00)

Γεωμετρία λωρίδων:

No	x	Width b	dxM	Weight	Load z-κατ.	Water-φορτ.	u*b	φ	c	θ
	[m]	[m]	[m]	[kN/m]	[kN/m]	[kN/m]	[kN/m]	[°]	[kN/m²]	[°]
1	-12.56	1.32	-11.88	46.4	0.0	0.0	-5.3	27.45	3.57	-31.27*
2	-11.24	1.32	-10.56	110.5	0.0	0.0	-22.4	27.45	3.57	-31.27*
3	-9.91	1.32	-9.24	155.2	0.0	0.0	-42.6	27.45	3.57	-31.27*
4	-8.59	1.32	-7.91	188.8	0.0	0.0	-57.8	29.26	3.57	-30.37*
5	-7.27	1.32	-6.59	214.7	0.0	0.0	-69.4	29.26	3.57	-29.88
6	-5.95	1.32	-5.27	234.5	0.0	0.0	-78.2	29.26	3.57	-23.47
7	-4.62	1.32	-3.95	249.1	0.0	0.0	-84.7	29.26	3.57	-17.35
8	-3.30	1.32	-2.62	259.2	0.0	0.0	-89.3	29.26	3.57	-11.43
9	-1.98	1.32	-1.30	265.1	0.0	0.0	-91.9	29.26	3.57	-5.64
10	-0.65	1.32	0.02	267.6	0.0	0.0	-112.6	29.26	3.57	0.10
11	0.67	1.32	1.35	366.9	0.0	0.0	-131.5	29.26	3.57	5.84
12	1.99	1.32	2.67	360.8	0.0	0.0	-128.8	29.26	3.57	11.64
13	3.31	1.32	3.99	350.5	0.0	0.0	-124.2	29.26	3.57	17.56
14	4.64	1.32	5.31	335.7	0.0	0.0	-117.6	29.26	3.57	23.69
15	5.96	1.32	6.64	315.7	0.0	0.0	-108.7	29.26	3.57	30.12
16	7.28	1.32	7.96	289.6	0.0	0.0	-97.0	29.26	3.57	37.00
17	8.61	1.32	9.28	255.7	0.0	0.0	-81.7	27.45	3.57	44.57
18	9.93	1.32	10.61	210.5	0.0	0.0	-61.2	27.45	3.57	53.30
19	11.57	1.96	12.25	183.6	0.0	0.0	-36.5	27.45	3.57	67.79

*** Σημείωση: Στις λωρίδες σημειωμένες με '*'
περιορίστηκε το theta στο 45°-Phi/2.

Συνεισφ. κατακόρυφων φορτίων:

No	Weight	G*sin(θ)	(G-u*b)*tan(φ) + c*b	μ*sin(θ)* tan(φ)+cos(θ)	T
	[kN/m]	[kN/m]	[kN/m]	[-]	[kN/m]
1	46.36	-41.64	26.04	0.792733	32.85
2	110.47	-88.18	50.50	0.792733	63.71
3	155.17	-108.34	63.19	0.792733	79.71
4	188.81	-112.95	78.13	0.797687	97.95
5	214.69	-106.96	86.13	0.802922	107.28
6	234.47	-93.37	92.26	0.866033	106.53
7	249.12	-74.30	96.80	0.916111	105.67
8	259.23	-51.39	99.94	0.954643	104.68
9	265.14	-26.04	101.77	0.982521	103.58
10	267.61	0.47	91.56	1.000226	91.54
11	366.86	37.34	136.55	1.007906	135.48
12	360.80	72.80	134.68	1.005401	133.95
13	350.54	105.78	131.49	0.992220	132.53
14	335.72	134.88	126.90	0.967450	131.17
15	315.75	158.43	120.71	0.929580	129.86
16	289.63	174.29	112.64	0.876119	128.56
17	255.66	179.42	95.10	0.796170	119.44
18	210.47	168.75	82.28	0.693336	118.67
19	183.62	170.00	83.41	0.488459	170.76
		498.98			2093.92

Συνεισφ. αγκυρίων: Αθρ. ροπών ανατροπής : -190.3 kN*m/m
" " resisting : 203.2 kN*m/m

Δράση Ed = (499.0*13.23-190.3)
Αντίσταση Rd = (2093.9*13.23+203.2)

SLIP-CIRCLE μ = Ed/Rd = 0.23 < 1.0: Έλεγχος εκπληρώθηκε.

Φάση εκσκαφής 5 "[5] Situation 5"

LC: όλα τα φορτία Type: BS-T

Εδαφικό σύστημα με 5 Στρώσεις

Name		Τεχνητές επιχωματώσεις	Αμμώδης ΑΡΓΙΛΟΣ	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
γ	[kN/m3]	18	20	22.5
γ,R	[kN/m3]	18	20	22.5
γ'	[kN/m3]	8	10	12.5
γ,p	[kN/m3]	18	20	22.5
γ,R,passive	[kN/m3]	18	20	22.5
γ,pw	[kN/m3]	8	10	12.5
φ	[°]	25	0.1	33
c	[kN/m2]	2	50	5
c,u	[kN/m2]	10	50	5
c παθητικό	[kN/m2]	2	50	5
δ,a	[°]	16.66667	0.06666667	22
δ,p	[°]	-16.66667	-0.06666667	-22
δ,c	[°]	8.333333	0.03333333	11
k,agh	[-]	0.3456501	0.9955057	0.2452023
K,ach	[-]	1.043051	1.994195	0.8549058
K,0h	[-]	0.5773817	0.9982547	0.455361
K,pgh	[-]	3.908103	1.004519	7.495617
K,pch	[-]	5.180327	2.00583	8.599509
τ,gr	[kN/m2]	110	110	110
Ψ,A,max	[°]	90	90	90
k	[cm/s]	10e-06	1e-06	100e-06

Name		Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
γ	[kN/m3]	22.5	22.5
γ,R	[kN/m3]	22.5	22.5
γ'	[kN/m3]	12.5	12.5
γ,p	[kN/m3]	22.5	22.5
γ,R,passive	[kN/m3]	22.5	22.5
γ,pw	[kN/m3]	12.5	12.5
φ	[°]	35	35
c	[kN/m2]	5	5
c,u	[kN/m2]	5	5
c παθητικό	[kN/m2]	5	5
δ,a	[°]	23.33333	23.33333
δ,p	[°]	-23.33333	-23.33333
δ,c	[°]	11.66667	11.66667
k,agh	[-]	0.2244207	0.2244207
K,ach	[-]	0.8126539	0.8126539
K,0h	[-]	0.4264236	0.4264236
K,pgh	[-]	9.146943	9.146943
K,pch	[-]	10.104	10.104
τ,gr	[kN/m2]	110	110
Ψ,A,max	[°]	90	90
k	[cm/s]	100e-06	100e-06

Πορεία πρανούς:
x [m] 0.00 0.00
z [m] -8.15 0.00

Πορεία ανώτερου 2. στρώματος Αμμώδης ΑΡΓΙΛΟΣ:
x [m] 0.00 0.00
z [m] -8.15 -1.50

Πορεία ανώτερου 3. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ:
x [m] 0.00 0.00
z [m] -8.15 -4.50

Πορεία ανώτερου 4. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -10.00

Πορεία ανώτερου 5. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -14.00

Επιφ. φορτία:

Φορτία

xA [m]	zA [m]	xE [m]	zE [m]	PxA [kN/m²]	PzA	PxE	PzE	Typ	LC-description Name
1.00	0.00	3.50	0.00	0.00	33.00	0.00	33.00	q	1

Κατανομή εδαφ.πιέσεων

Κατανομή εδαφ.πιέσεων	Name
Rectangular within a layer	

Στάθμη νερού:

x [m]	0.00	0.00
z [m]	-11.00	-4.50

Αγκύρια

z[m]	min.l[m]	Alpha[°]	C-H[kN/m]	P0[kN]	u0[m]
-0.50	0.00	15.00	0.00	0.00	0.0000
-3.00	0.00	15.00	αόρισ.	0.00	0.0000

Παράμετροι υπολογισμού

Earth pressure options

Τμήμα εδαφ.ωθήσεων: Ενεργές ωθήσεις.
Angle of slip plane: DIN 4085.
Split block loads into 1 sections.
Consideration of minimum earth pressure: φ,min = 40.000.
Negative earth pressure fractions are set to zero.

Redistribution of earth pressure

Shape of redistribution: Trapezoid.
The earth pressure is getting redistb. to: Excavation level
The earth pressure below the excavation acts without redistrb.
Levels of redistribution Z1: 0.000, Z2: -3.000 [m].
The earth pressure from variable loads will be included in redistribution.

Παθητικές ωθήσεις

Method of calculation: Κλασικός, Pregl/Sokolovsky (DIN 4085).

Options for water pressure

Additional water and earth pressure from ground water flow is calculated.
Negative flow pressure is set to zero.
The proof of the basic hydraulic heave is performed.

Στήριξη πόδα

Πόδας οριζοντίως μετακινούμενος

Αγκύρια

Anchor checks (lower failure plane): Ναι
Anchor forces with safety level of DS-P: Ναι
Verification of grout body pull out forces: Ναι
δ,a,Anchoring wall : used from soil layer.
δ,p,Anchoring wall : used from soil layer.

Earth pressure coefficients kh

φ	α	β	δ	k0gh	kagh	kach	kpgh	kpch	
33.0	0.0	0.0	-22.0	--	--	--	7.496	-8.600	Τεχνητές επιχωματώσεις
25.0	0.0	0.0	16.7	--	0.346	1.043	--	--	"
0.1	0.0	0.0	0.1	--	0.996	1.994	--	--	Αμμώδης ΑΡΓΙΛΟΣ
33.0	0.0	0.0	-22.0	--	--	--	7.496	-8.600	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
33.0	0.0	0.0	22.0	--	0.245	0.855	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ

φ	α	β	δ	k0gh	kagh	kach	kpgh	kpch	
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"

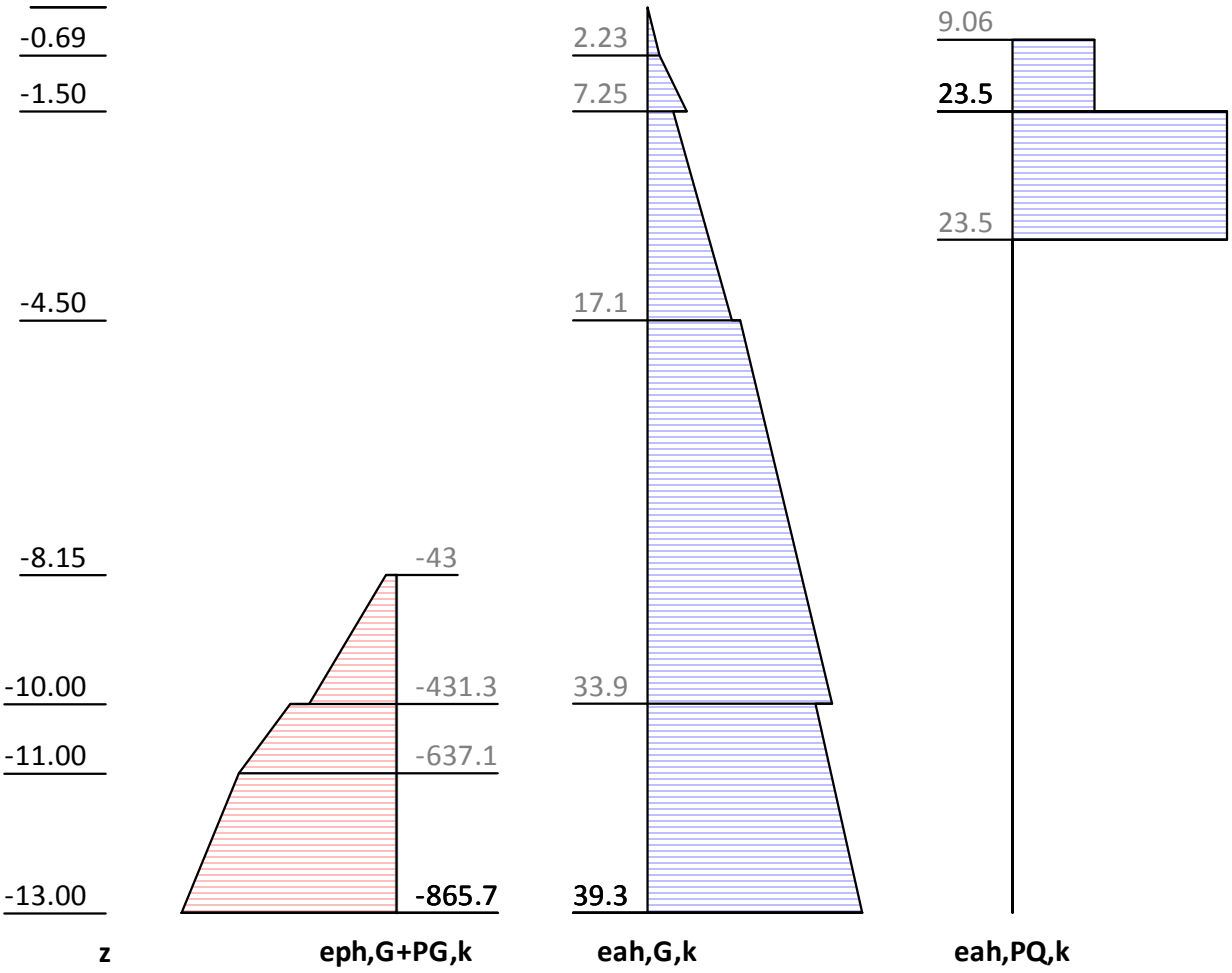
Μήκος τοίχου

Foot depth for statics: zf = -13.000

Stress analysis

Earth pressure, horizontal

Pressures characteristic, no redistribution, continous wall



z [m]	eph,G,k [kN/m2]	eah,G,k [kN/m2]	eah,PQ,k [kN/m2]	eah,d [kN/m2]
0.00		0.00		0.00
-0.47		1.52	0.00	2.04
-0.47		1.52	9.06	15.62
-1.50		7.25	9.06	23.37
-1.50		4.82	23.48	41.73
-3.34		11.39	23.48	50.60
-3.34		11.39	0.00	15.38
-4.50		15.54	0.00	20.98
-4.50		17.06	0.00	23.03
-8.15	-0.00	28.25	0.00	45.61
-8.15	-43.00	28.25	0.00	45.61
-10.00	-355.00	33.92	0.00	57.06
-10.00	-431.26	30.89	0.00	52.02
-13.00	-865.74	39.31	0.00	69.01

Eph,G,k:-2405.12, Eph,PG,k: 0.00 [kN/m]
Eah,G,k: 280.61, Eah,PG,k: 0.00, Eah,PQ,k: 52.53, Eah,d: 528.00

Earth pressure from water flow

Pressures characteristic, no redistribution, continous wall

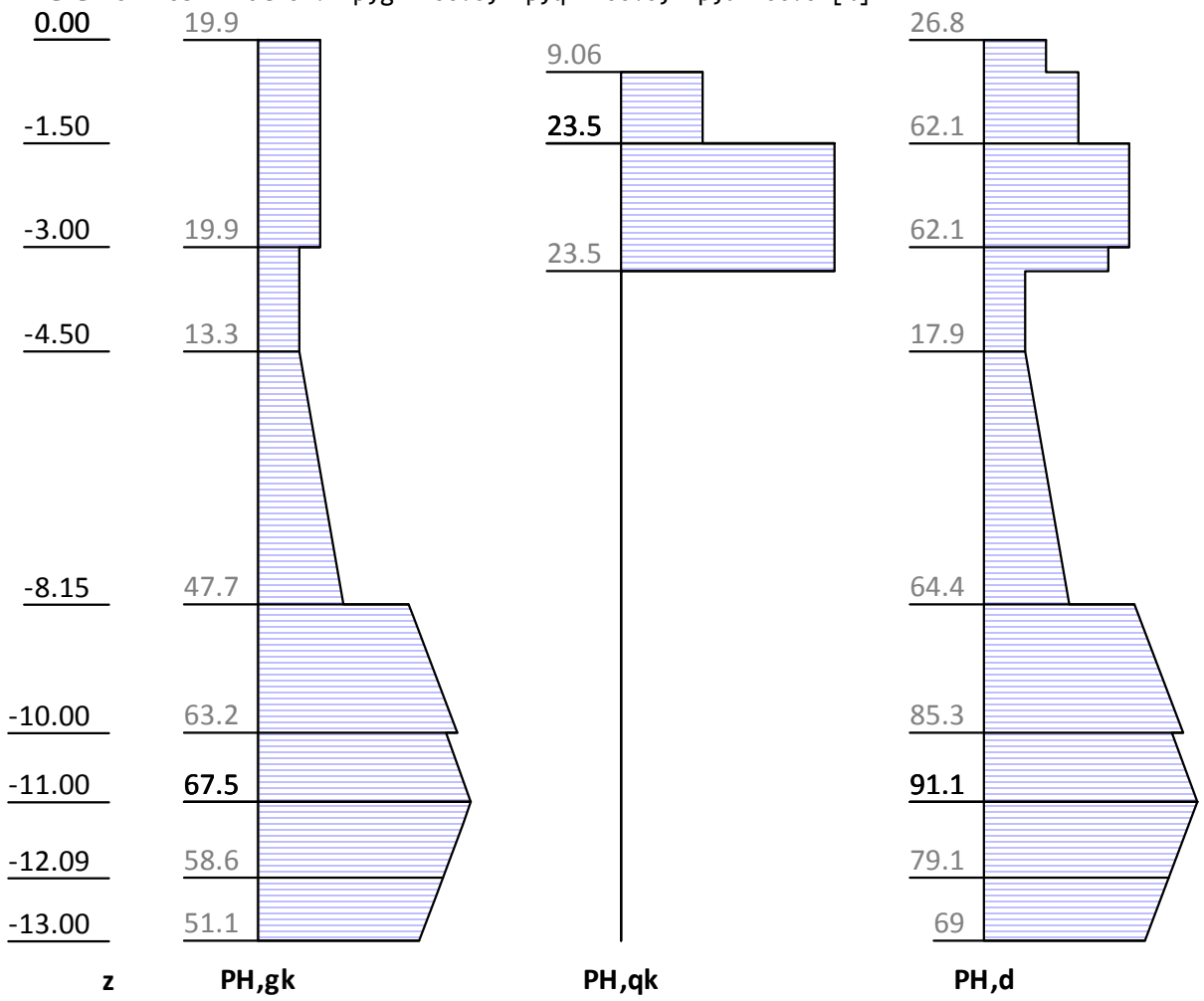
z [m]	eph,dynW,k [kN/m2]	eph,dynW+G+PG,k [kN/m2]	eah,dynW,k [kN/m2]	eah,dynW+G+PG,k [kN/m2]	Ip [-]	Ia [-]
-0.34			0.00			
-1.50			0.00			
-4.50			0.00			
-8.15	0.00	0.00	5.54	0.00		0.62
-8.15	0.00	-43.00	5.54	-43.00		0.62
-10.00	0.00	-355.00	8.35	-355.00		0.62
-10.00	0.00	-431.26	7.64	-431.26		0.62
-11.00	0.00	-637.07	9.03	-637.07		0.62
-13.00	113.25	-752.49	11.81	-752.49	0.62	0.62

Πίεση νερού

z [m]	Wp,st,k [kN/m2]	Wa,st,k [kN/m2]	Wp,dyn,k [kN/m2]	Wa,dyn,k [kN/m2]	W,tot,k [kN/m2]
-4.50		0.00		0.00	0.00
-11.00	0.00	65.00	0.00	-40.24	24.76
-13.00	-20.00	85.00	-12.38	-52.62	0.00

H-pressure on static system

Level of mobilization: Ep,gk 100.0, Ep,qk 100.0, Ep,d 100.0 [%]

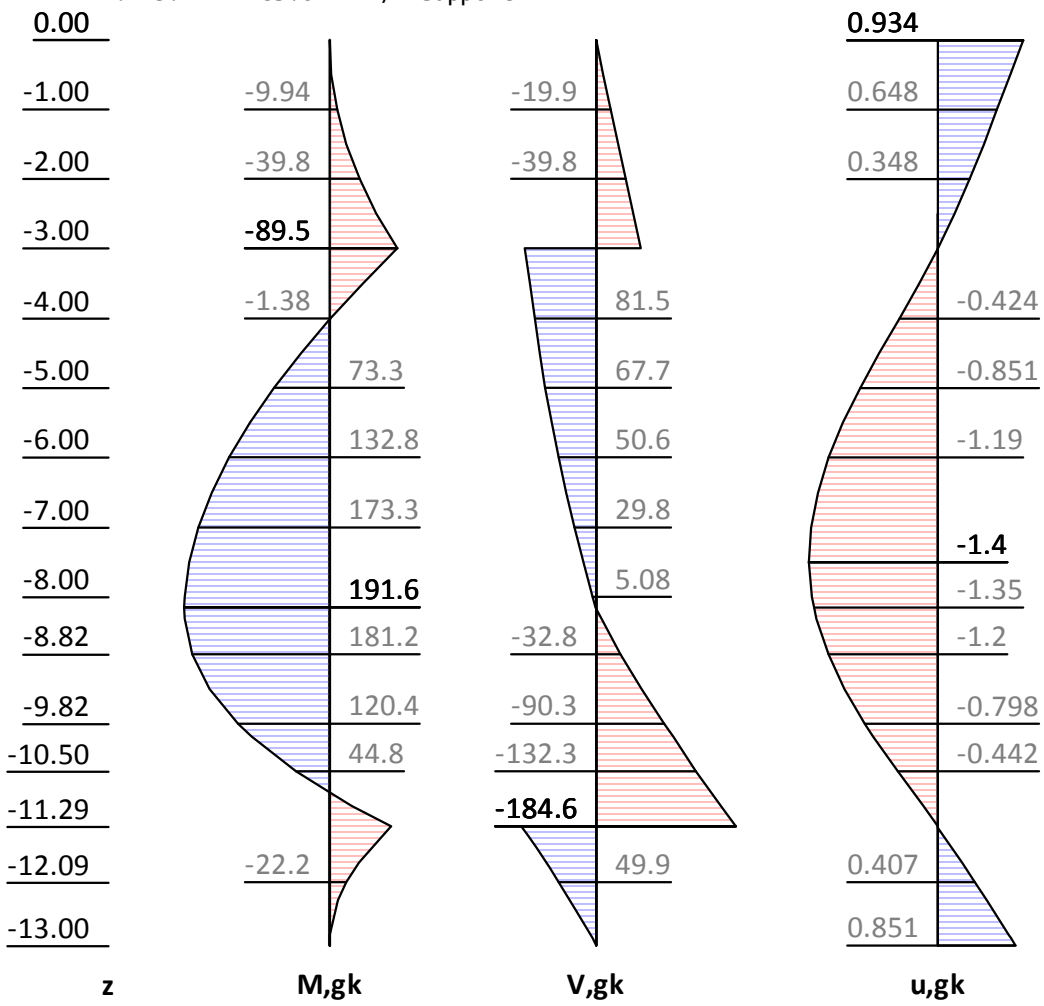


z [m]	PH,gk [kN/m2]	PH,qk [kN/m2]	PH,d [kN/m2]
0.00	19.88		26.84
-0.47	19.88	0.00	26.84
-0.47	19.88	9.06	40.42
-1.50	19.88	9.06	40.42
-1.50	19.88	23.48	62.06
-3.00	19.88	23.48	62.06
-3.00	13.26	23.48	53.12
-3.34	13.26	23.48	53.12
-3.34	13.26	0.00	17.90
-8.15	27.16	0.00	36.67
-8.15	47.69	0.00	64.38
-10.00	63.22	0.00	85.34
-10.00	59.48	0.00	80.30
-11.00	67.49	0.00	91.11
-13.00	51.11	0.00	69.01

V-pressure on static system

Internal forces: Permanent, characteristically

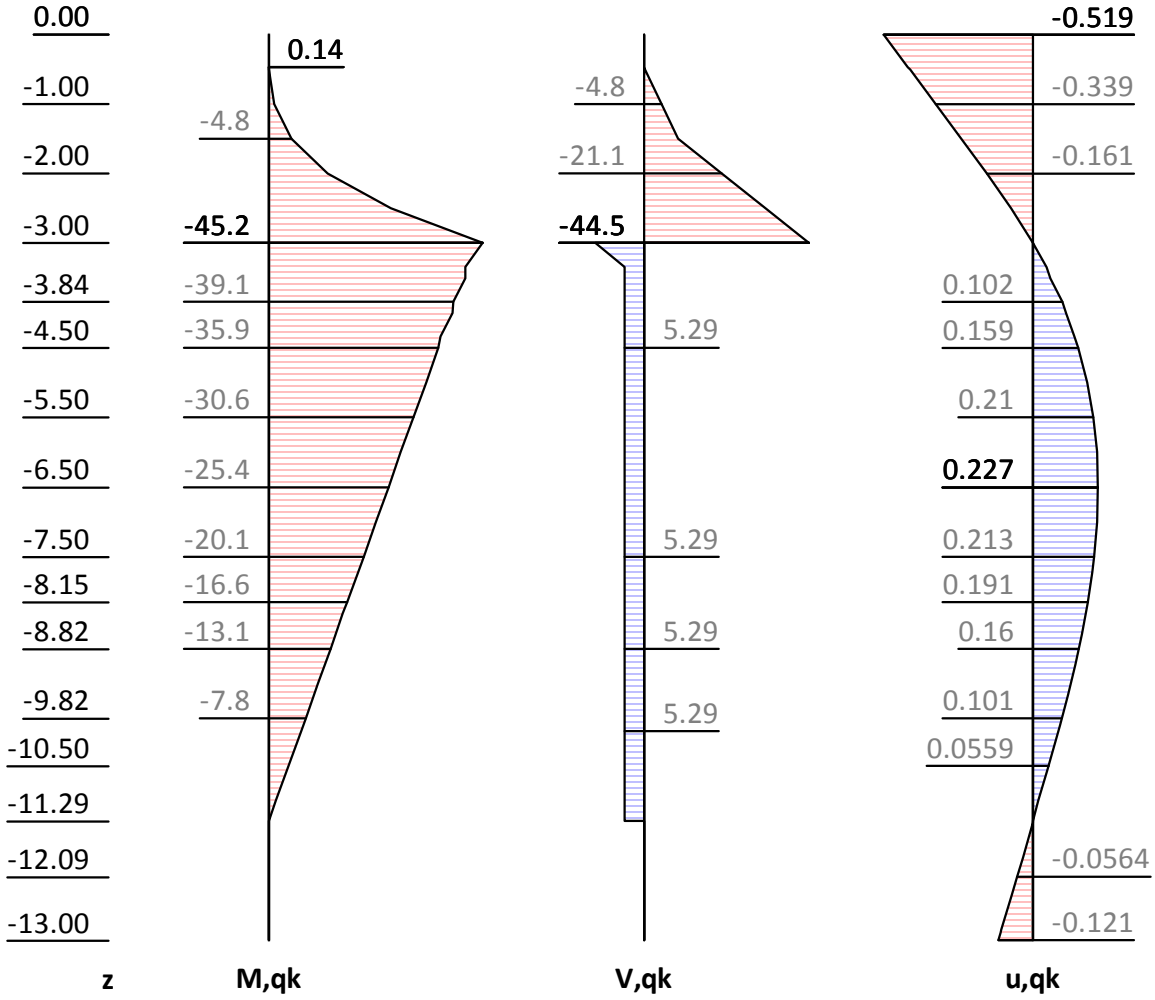
z= -0.500. Fx= -0.000 kN/m Support
z= -3.000. Fx=-154.355 kN/m Support
z= -11.295. Fx=-283.621 kN/m Support



z [m]	H,g,k [kN/m2]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [mm]
0.00	19.88	-0.00	0.00	0.00	0.93
-0.00	19.88	-0.00	0.00	-0.00	0.93
-3.00	19.88	-89.46	-59.64	-81.14	-0.00
-3.00	13.26	-89.46	94.72	-122.50	-0.00
-4.02	13.26	0.00	81.23	-147.97	-0.43
-7.50	24.69	185.28	17.89	-224.78	-1.40
-8.15	27.16	191.63	1.06	-236.09	-1.35
-8.15	47.69	191.63	1.06	-236.09	-1.35
-8.17	47.87	191.57	0.00	-236.66	-1.35
-10.00	63.22	103.12	-101.53	-287.82	-0.71
-10.00	59.48	103.12	-101.53	-287.82	-0.71
-10.80	65.90	-0.00	-152.01	-311.87	-0.27
-11.00	67.49	-29.49	-165.02	-317.95	-0.16
-11.29	65.11	-81.06	-184.57	-327.18	0.00
-11.29	65.11	-81.06	99.05	-327.18	0.00
-13.00	51.11	-0.00	0.00	-383.63	0.85
-13.00	51.11	0.00	0.00	-383.63	0.85

Internal forces: Variable, characteristically

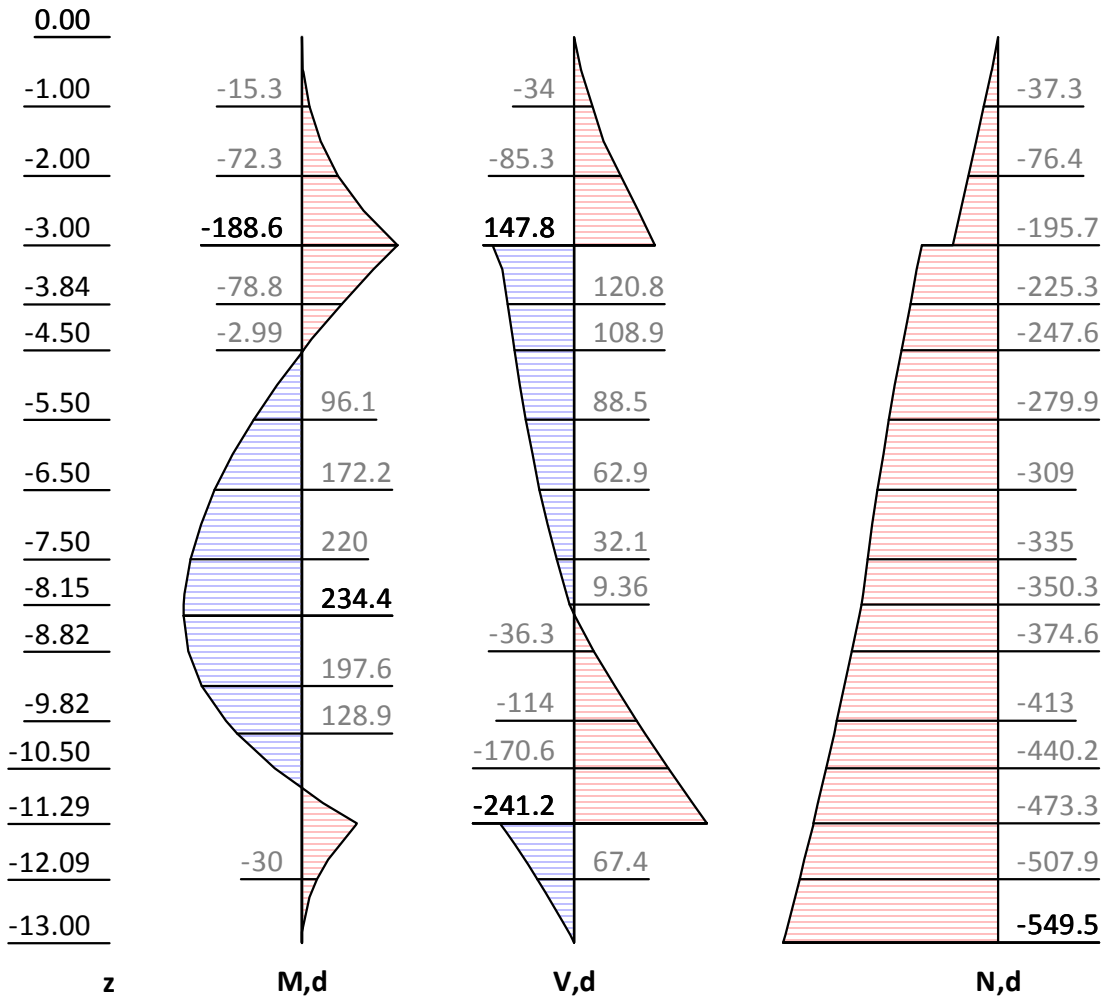
Method EB 82-4 (Q = [G+Q] - G).
z= -0.500. Fx= 0.000 kN/m Support
z= -3.000. Fx= -57.819 kN/m Support
z= -11.295. Fx= 5.287 kN/m Support

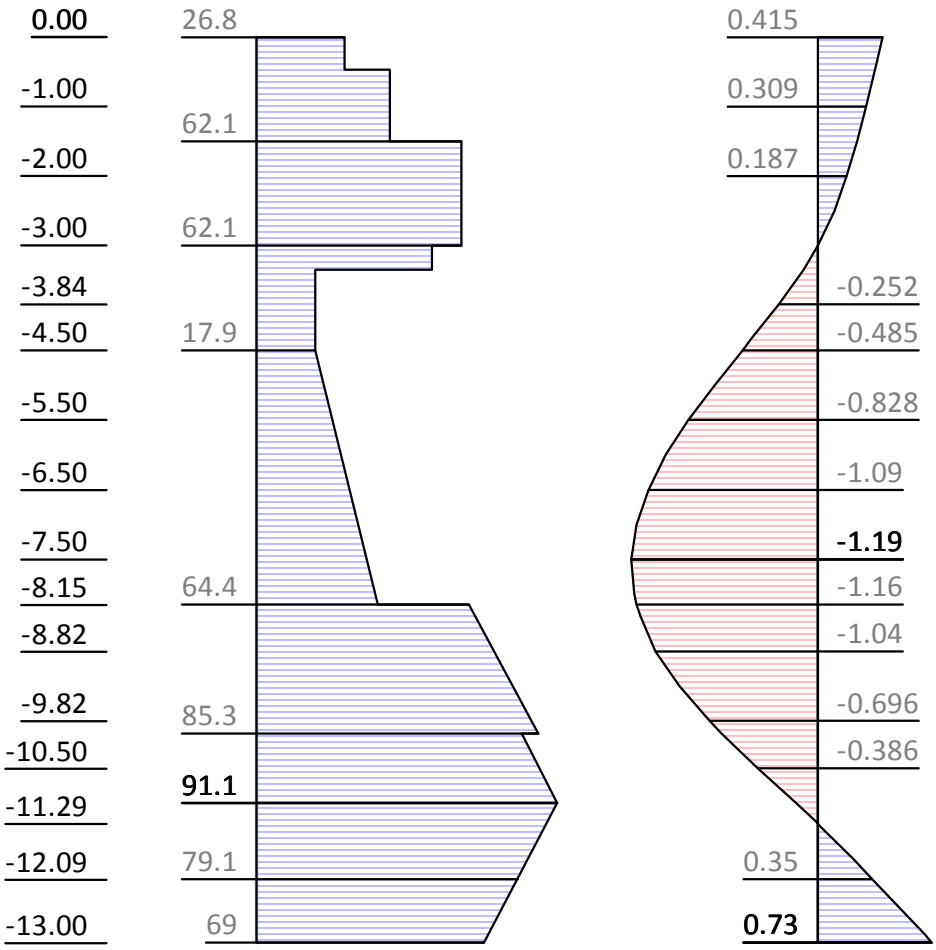


z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
0.00		0.00	-0.00	0.00	-0.52
-0.47	0.00	0.14	-0.00	-0.00	-0.43
-0.47	9.06	0.14	-0.00	-0.00	-0.43
-0.50	9.06	0.00	-0.26	-0.03	-0.43
-1.50	9.06	-4.80	-9.33	-0.99	-0.25
-1.50	23.48	-4.80	-9.33	-0.99	-0.25
-3.00	23.48	-45.21	-44.55	-4.71	-0.00
-3.00	23.48	-45.21	13.27	-20.20	-0.00
-3.34	23.48	-41.69	5.29	-21.05	0.05
-3.34	0.00	-41.69	5.29	-21.05	0.05
-4.34	0.00	-36.41	5.29	-21.05	0.15
-6.50	0.00	-25.35	5.29	-21.05	0.23
-7.00	0.00	-22.71	5.29	-21.05	0.22
-8.15	0.00	-16.63	5.29	-21.05	0.19
-8.32	0.00	-15.73	5.29	-21.05	0.18
-11.00	0.00	-1.56	5.29	-21.05	0.02
-11.29	0.00	-0.00	5.29	-21.05	0.00
-11.29	0.00	-0.00	0.00	-21.05	0.00
-11.31	0.00	-0.00	0.00	-21.05	-0.00
-12.09	0.00	-0.00	-0.00	-21.05	-0.06
-12.35	0.00	-0.00	0.00	-21.05	-0.07
-12.90	0.00	-0.00	0.00	-21.05	-0.11
-13.00	0.00	-0.00	-0.00	-21.05	-0.12

Internal forces: Design

z= -0.500. Fx= -0.000 kN/m Support
z= -3.000. Fx=-295.109 kN/m Support
z= -11.295. Fx=-374.958 kN/m Support


0.00
-1.00
-2.00
-3.00
-3.84
-4.50
-5.50
-6.50
-7.50
-8.15
-8.82
-9.82
-10.50
-11.29
-12.09
-13.00
-15.3
-72.3
-188.6
-78.8
-2.99
96.1
172.2
220
234.4
197.6
128.9
-30
-34
-85.3
147.8
120.8
108.9
88.5
62.9
32.1
9.36
-36.3
-114
-170.6
-241.2
67.4
-37.3
-76.4
-195.7
-225.3
-247.6
-279.9
-309
-335
-350.3
-374.6
-413
-440.2
-473.3
-507.9
-549.5
z
M,d
V,d
N,d



z [m]	H,d [kN/m2]	M,d [kN/m2]	V,d [kN/m2]	N,d [kN/m2]	u,g+q,k [mm]
0.00	26.84	0.00	-0.00	0.00	0.41
-0.47	26.84	-2.96	-12.61	-17.16	0.37
-0.47	40.42	-2.96	-12.61	-17.16	0.37
-1.50	40.42	-37.40	-54.25	-56.25	0.25
-1.50	62.06	-37.40	-54.25	-56.25	0.25
-3.00	62.06	-188.58	-147.33	-116.60	0.00
-3.00	62.06	-188.58	-147.33	-116.60	-0.00
-3.00	53.12	-188.58	147.77	-195.68	-0.00
-3.34	53.12	-141.41	129.71	-208.44	-0.09
-3.34	17.90	-141.41	129.71	-208.44	-0.09
-4.53	18.05	0.00	108.40	-248.58	-0.49
-7.50	33.33	220.03	32.09	-335.03	-1.19
-8.15	36.67	233.76	9.36	-350.29	-1.16
-8.15	64.38	233.76	9.36	-350.29	-1.16
-8.29	66.00	234.31	-0.00	-355.40	-1.14
-8.32	66.31	234.41	-1.75	-356.35	-1.14
-10.00	85.34	128.94	-129.14	-420.13	-0.62
-10.00	80.30	128.94	-129.14	-420.13	-0.62
-10.78	88.74	0.00	-195.49	-451.76	-0.25
-11.00	91.11	-42.15	-214.84	-460.80	-0.14
-11.29	87.90	-109.44	-241.24	-473.26	0.00
-11.29	87.90	-109.44	133.72	-473.26	0.00
-13.00	69.01	0.00	0.00	-549.47	0.73

Anchor forces with safety level of DS-P

z[m]	A,d[kN]	Fx,d[kN/m]
-0.50	0.0	-0.0
-3.00	275.0	-295.1

Checks of earth statics

Check or earth support

Check: Mobilizable earth resistance is sufficient for earth support force.
z: -11.29 m
Rd = Eph,k/γ,Re = 2291.88 / 1.400 = 1637.05 [kN/m]

Ed(Uh,d)/Rd = 374.96 / 1637.05 = 0.229 [-]. Passes requirement

Sum of H and V forces, (G)

Forces up to depth z:-13.00

Pos.	H	V
H/V pressure G+P+W,k	437.98	125.33
Wall weight		228.91
H/V pressure passive		0.00
Support z: -0.50		0.00
Support z: -3.00	-154.36	41.36
Bh,g,k z=-11.29	-283.62	
Bv,g,k = Bh,k * tan(δ,p=-23.33°)		-122.34
Σ	0.00	273.25 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than the downwards pointing vertical forces.

Vk >= Bvk: 395.60 >= 122.34 Passes requirement

Sum of H and V forces, (G+Q)

Forces up to depth z:-13.00

Pos.	H	V
H/V pressure G+P+W,k	490.51	130.88
Wall weight		228.91
H/V pressure passive		0.00
Support z: -0.50		0.00
Support z: -3.00	-212.17	56.85
Bh,g,k z=-11.29	-283.62	
Bv,g,k = Bh,k * tan(δ,p=-23.33°)		-122.34
Bh,q,k z=-11.29	5.29	
Bv,q,k = Bh,k * tan(δ,p=-23.33°)		2.28
Σ	-0.00	296.58 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than the downwards pointing vertical forces.

Vk >= Bvk: 416.64 >= 120.06 Passes requirement

Hydraulic heave

Safety factors: [HYD]
γ,G,stb: 0.900
γ,H: 1.600

Stream length l,tot=10.50 m. Sum(h,i/k,i)=105000.00 1/100s.

Στρώμα "Αργιλώδη ΧΑΛΙΚΙΑ- AMMO" z: -11.00 / -13.00, h= 2.00m
Ed=Σ(γW*h*i)*γ,H = 12.38* 1.600 = 19.81 (i=0.619)
Rd=Σ(γ*h)*γ,G,stb = 89.13* 0.900 = 80.21
Ed/Rd = 0.247 [-]

Anchor verification

Anchor - Stability of lower failure plane

Περίπτ.Φόρτισης: όλα τα φορτία BS-P
Αυτόμ. υπολογ. μήκους αγκυρίων:
All anchors are extended (if necessary)
Favourable variable loads in main failure body are not being considered.
Bottom of lower failure plane: z=-13.00 m

Iteration of failure mechanisms:
lA .....: Length of anchor from head to center of grout body.
W,k .....: Res. force from dead weight, loads, cohesion, ...
Q,k .....: Force in lower failure plane.
Ea1,k.....: Earth pressure onto vertical separation plane.
Ea2,k.....: Earth pressure between wall and main failure body.
Ra_cal,d ...: Dimesioning force of the resistance from the equilibrium of forces. Ra_cal,d corresponds to the max. possible anchor force of the force polygon.
Sum(A,d) ...: Acting anchor forces along the grout body fractions within the failure body. Sum(A,d) is gained from the anchor pull forces of the wall analysis.

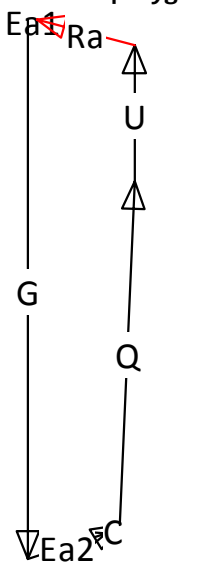
z [m]	ϑ1 [°]	ϑ2 [°]	lA [m]	W,k [kN/m]	Q,k [kN/m]	Ea1,k [kN/m]	Ea2,k [kN/m]	Ra_cal,d [kN/m]	Sum(A,d) [kN/m]	Ed/Rd [-]
-0.50	36.9	57.5	12.72	1672.1	1486.3	4.4	350.5	219.9	218.9	1.00
-3.00	31.3	61.0	11.81	1674.8	1455.3	40.3	350.5	306.3	305.4	1.00

Decisive failure body:
Γεωμετρία:
Foot point of lower failure plane x/z = 0.01/-13.00 m
Intersection lower/upper slid. plane x/z = 11.41/ -6.06 m
Intersection upper slid. plane/surface x/z = 14.77/ 0.00 m
Intersection separation plane/surface x/z = 11.41/ 0.00 m
Inclination lower failure plane ϑ1 = 31.34°
Inclination upper failure plane ϑ2 = 60.97°
Inclination separation plane ϑ12 = 90.00°

Loads / forces (char.)

		Fx [kN/m]	Fz [kN/m]	F [kN/m]	
Weight of main failure body	G,k:	0.0	-2281.9	2281.9	
Cohesion of lower failure plane	C,k:	57.0	34.7	66.7	
Pore water pressure on main body	U,k:	-0.1	573.3	573.3	
Earth pres. on separation plane	Ea1,k:	-40.3	-0.0	40.3	δ= 0.0°
Earth pr. between wall<->main body	Ea2,k:	333.1	109.0	350.5	
Force in lower failure plane	Q,k:	64.4	1453.8	1455.3	
Sum = possible anchor forces:	Ra_cal,k:	414.2	-111.0	428.9	

Force polygon



Acting anchor forces Ed: Sum(A,d) = 305.4 kN/m
Possible anchor forces Rd: Ra_cal,d = 428.9/1.400 = 306.3 kN/m

Verif. of lower failure plane Ed/Rd = 1.00 < 1.0: Έλεγχος εκπληρώθηκε.

Check of steel tension

l,tot ...[m]: Total length of anchor incl. excess length at head
As ....[mm2]: X-section are of steel member
Ri,d ...[kN]: Ultimate strength of tension member (γ,M=1.15)
A,d ....[kN]: Dimensioning force of the anchor from wall analysis

z[m]	Anchor type	l,tot	As	Ri,d		A,d	
-0.50	Strand;3x0.60";1570/1770	17.22	420	573.4	>	0.0	Passes requirement
-3.00	Strand;3x0.60";1570/1770	15.81	420	573.4	>	275.0	Passes requirement

Check of steel tension: Passes requirement

Check of anchor's soil friction

lVk .....: Length of grout body
DmVk ....: Diameter of grout body
τGr,k ...: Average applied skin friction along the grout body (from soil parameters)
Ra,k ....: Charact. pullout resistance of the anchor
γA .....: Partial safety factor of anchor pullout
Ra,d ....: = Ra,k / γA
A,d .....: Dimensioning force of the anchor from wall analysis

z [m]	lVk [m]	DmVk [mm]	τGr,k [kN/m²]	Ra,k [kN]	γA [-]	Ra,d [kN]		A,d [kN]	A,d/Ra,d [-]
-0.50	8.00	318	110	879.1	1.100	799.2	>	0.0	0.0
-3.00	8.00	318	110	879.1	1.100	799.2	>	275.0	0.3

Check of anchor's soil friction: Passes requirement

Υπολογ. κύκλου ολίσθησης

LC: όλα τα φορτία Type: BS-T (combination: [GEO] A2 M2 R3, BS-T)
Vertical variable loads only act if they are outside of R*sin(phi).
The automatic slip circle optimization only considers circles that intersect
the surface with an area of at least 0.25 m2.
The slip circle calculation only accepts circles including the wall.
The slipcircle calculation only allows circular failure planes
(no vertical tangents will occour).

Γεωμετ.κύκλου (μήκη και συντεταγμ. σε (m))
Κέντρο = (-1.95, 1.39), Ακτίνα = 14.53
Αρχ.σημ.= (-12.91, -8.15), Τελ.σημ. = (12.51, 0.00)

Γεωμετρία λωρίδων:

No	x	Width b	dxM	Weight	Load z-κατ.	Water-φορτ.	u*b	φ	c	θ
	[m]	[m]	[m]	[kN/m]	[kN/m]	[kN/m]	[kN/m]	[°]	[kN/m²]	[°]
1	-12.18	1.45	-10.23	25.4	0.0	0.0	-0.0	27.45	3.57	-31.27*
2	-10.73	1.45	-8.78	66.6	0.0	0.0	-0.0	29.26	3.57	-30.37*
3	-9.28	1.45	-7.33	98.3	0.0	0.0	-4.0	29.26	3.57	-30.29
4	-7.82	1.45	-5.87	122.6	0.0	0.0	-12.7	29.26	3.57	-23.85
5	-6.37	1.45	-4.42	140.6	0.0	0.0	-20.8	29.26	3.57	-17.72
6	-4.92	1.45	-2.97	153.1	0.0	0.0	-26.4	29.26	3.57	-11.79
7	-3.46	1.45	-1.52	160.6	0.0	0.0	-29.7	29.26	3.57	-5.99
8	-2.01	1.45	-0.06	163.1	0.0	0.0	-30.8	29.26	3.57	-0.25
9	-0.56	1.45	1.39	189.4	0.0	0.0	-77.1	29.26	3.57	5.49
10	0.89	1.45	2.84	399.7	0.0	0.0	-121.2	29.26	3.57	11.28
11	2.35	1.45	4.29	387.6	0.0	0.0	-115.8	29.26	3.57	17.20
12	3.80	1.45	5.75	370.1	0.0	0.0	-108.0	29.26	3.57	23.31
13	5.25	1.45	7.20	346.4	0.0	0.0	-97.4	29.26	3.57	29.71
14	6.71	1.45	8.65	315.4	0.0	0.0	-83.5	29.26	3.57	36.56
15	8.16	1.45	10.11	275.1	0.0	0.0	-65.4	27.45	3.57	44.08
16	9.61	1.45	11.56	221.6	0.0	0.0	-41.1	27.45	3.57	52.71
17	11.43	2.18	13.37	180.2	0.0	0.0	-20.3	0.08	35.71	67.00

*** Σημείωση: Στις λωρίδες σημειωμένες με '*'
περιορίστηκε το theta στο 45°-Phi/2.

Συνεισφ. κατακόρυφων φορτίων:

No	Weight	G*sin(θ)	(G-u*b)*tan(φ) + c*b	μ*sin(θ)* tan(φ)+cos(θ)	T
	[kN/m]	[kN/m]	[kN/m]	[-]	[kN/m]
1	25.35	-17.86	18.36	0.713407	25.73
2	66.61	-40.26	42.50	0.714382	59.49
3	98.32	-49.59	58.01	0.715470	81.08
4	122.59	-49.57	66.73	0.795925	83.84
5	140.62	-42.80	72.31	0.863230	83.77
6	153.13	-31.30	76.19	0.918917	82.92
7	160.56	-16.76	78.50	0.963908	81.44
8	163.15	-0.71	79.30	0.998707	79.40
9	189.37	18.11	68.08	1.023480	66.52
10	399.68	78.19	161.20	1.038088	155.28
11	387.63	114.59	157.46	1.042060	151.10
12	370.11	146.43	152.03	1.034514	146.95
13	346.43	171.70	144.69	1.013984	142.70
14	315.43	187.88	135.10	0.978057	138.14
15	275.13	191.39	114.15	0.907735	125.76
16	221.65	176.35	98.97	0.822336	120.36
17	180.15	165.84	77.95	0.391345	199.19
		1001.62			1823.66

Συνεισφ. αγκυρίων: Αθρ. ροπών ανατροπής : -491.0 kN*m/m
" " resisting : 349.9 kN*m/m

Δράση Ed = (1001.6*14.53-491.0)
Αντίσταση Rd = (1823.7*14.53+349.9)

SLIP-CIRCLE μ = Ed/Rd = 0.52 < 1.0: Έλεγχος εκπληρώθηκε.

ΠΑΡΑΡΤΗΜΑ

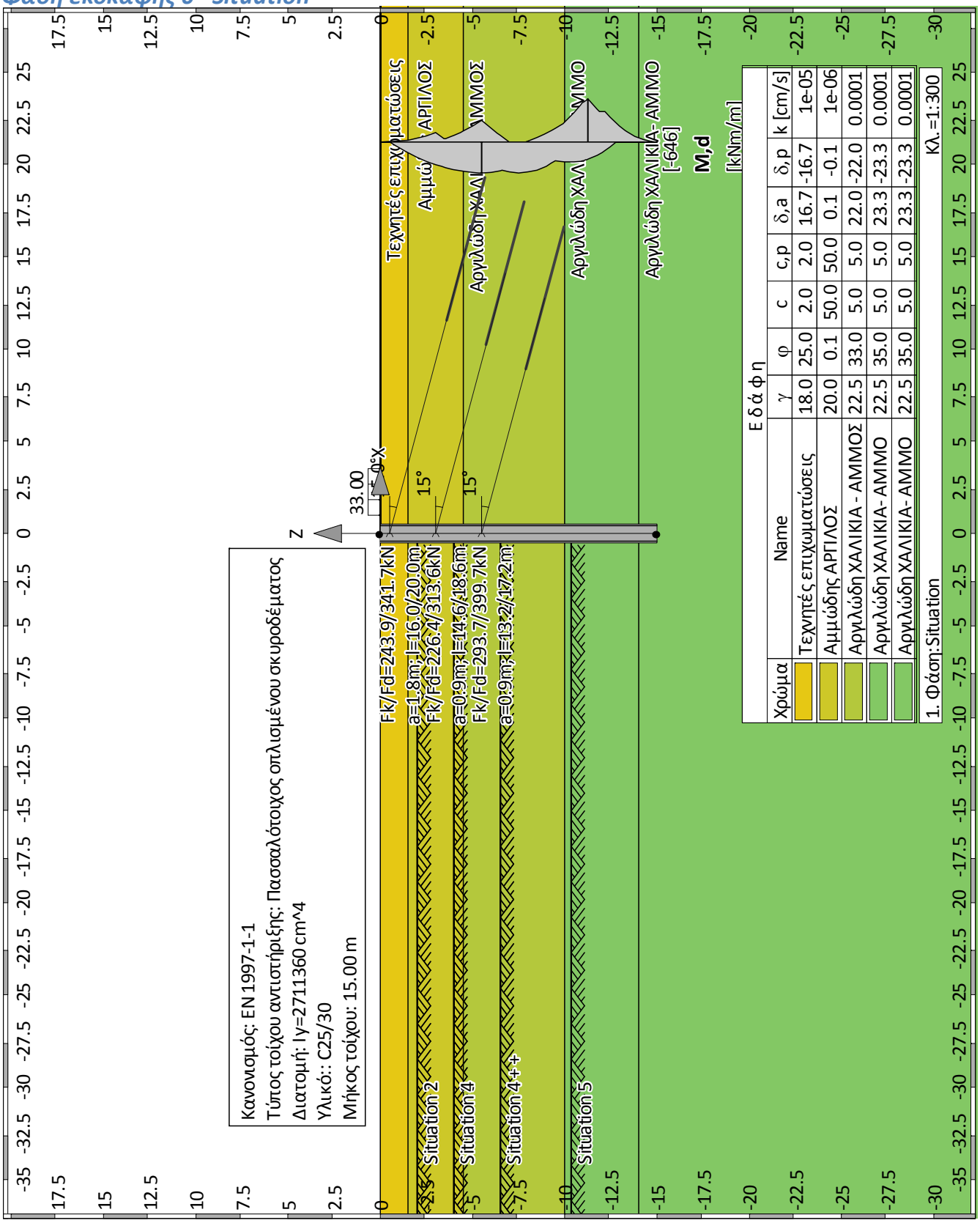
8.5 *Αποτελέσματα ανάλυσης*

8.5.3 Έλεγχος θραύσης πυθμένα

iii) Αντιστηριζόμενο ύψος 9,85m

Summary of all stages

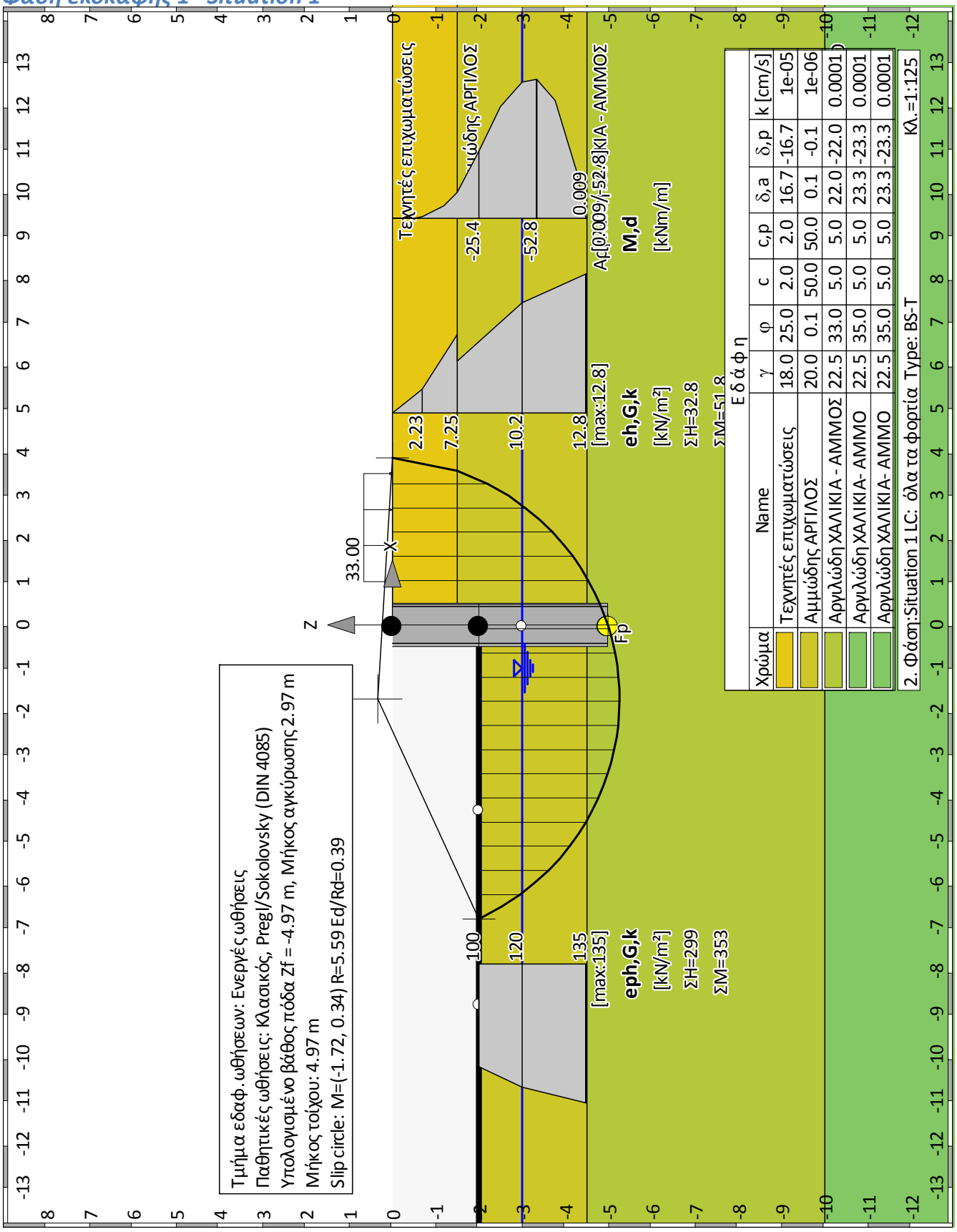
Φάση εκσκαφής 0 "Situation"



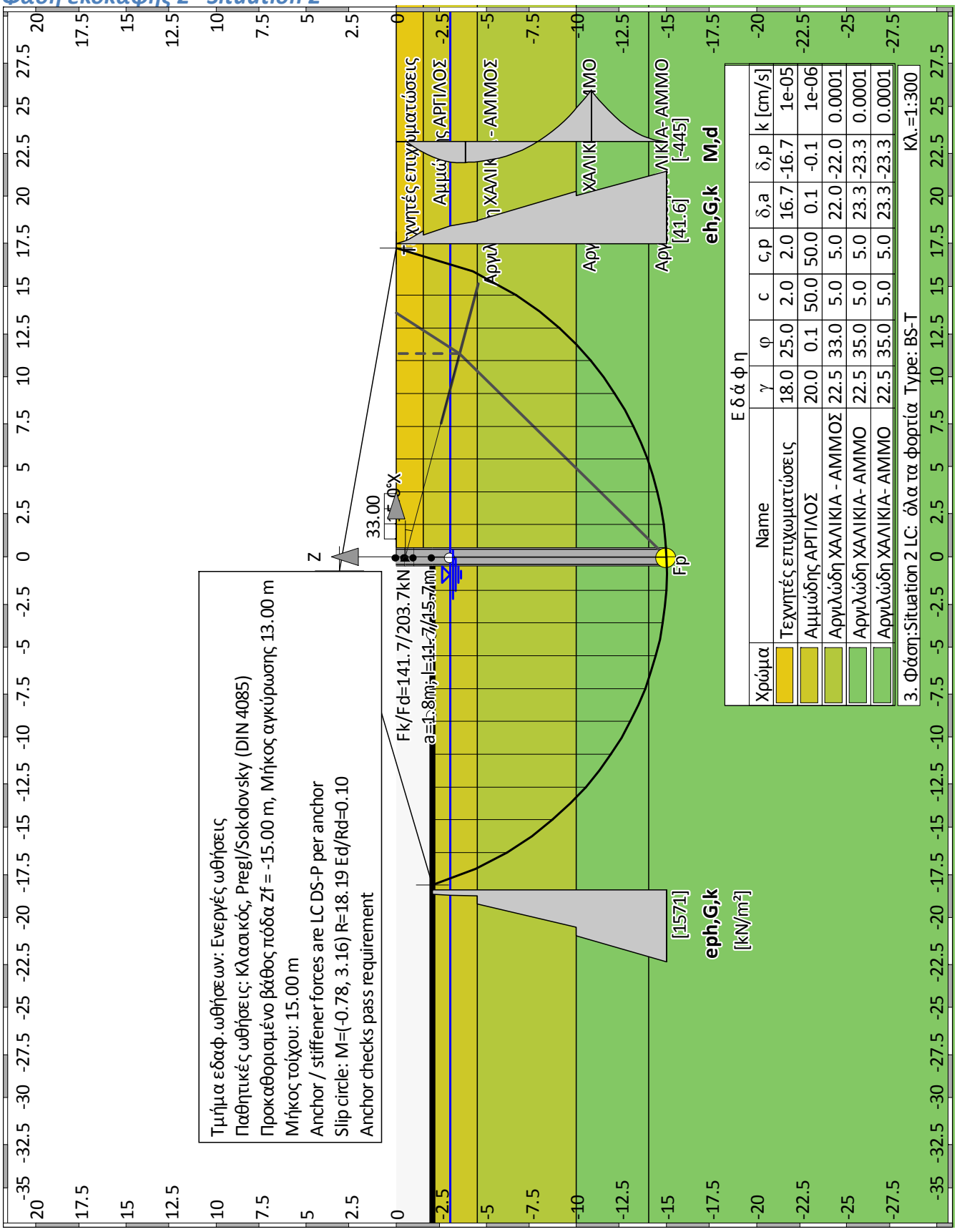
Χρώμα	Name	γ	φ	c	c,p	δ,a	δ,p	k [cm/s]
	Τεχνητές επιχωματώσεις	18.0	25.0	2.0	2.0	16.7	-16.7	1e-05
	Αμμώδης ΑΡΓΙΛΟΣ	20.0	0.1	50.0	50.0	0.1	-0.1	1e-06
	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ	22.5	33.0	5.0	5.0	22.0	-22.0	0.0001
	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ	22.5	35.0	5.0	5.0	23.3	-23.3	0.0001
	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ	22.5	35.0	5.0	5.0	23.3	-23.3	0.0001

Ε δ ά φ η

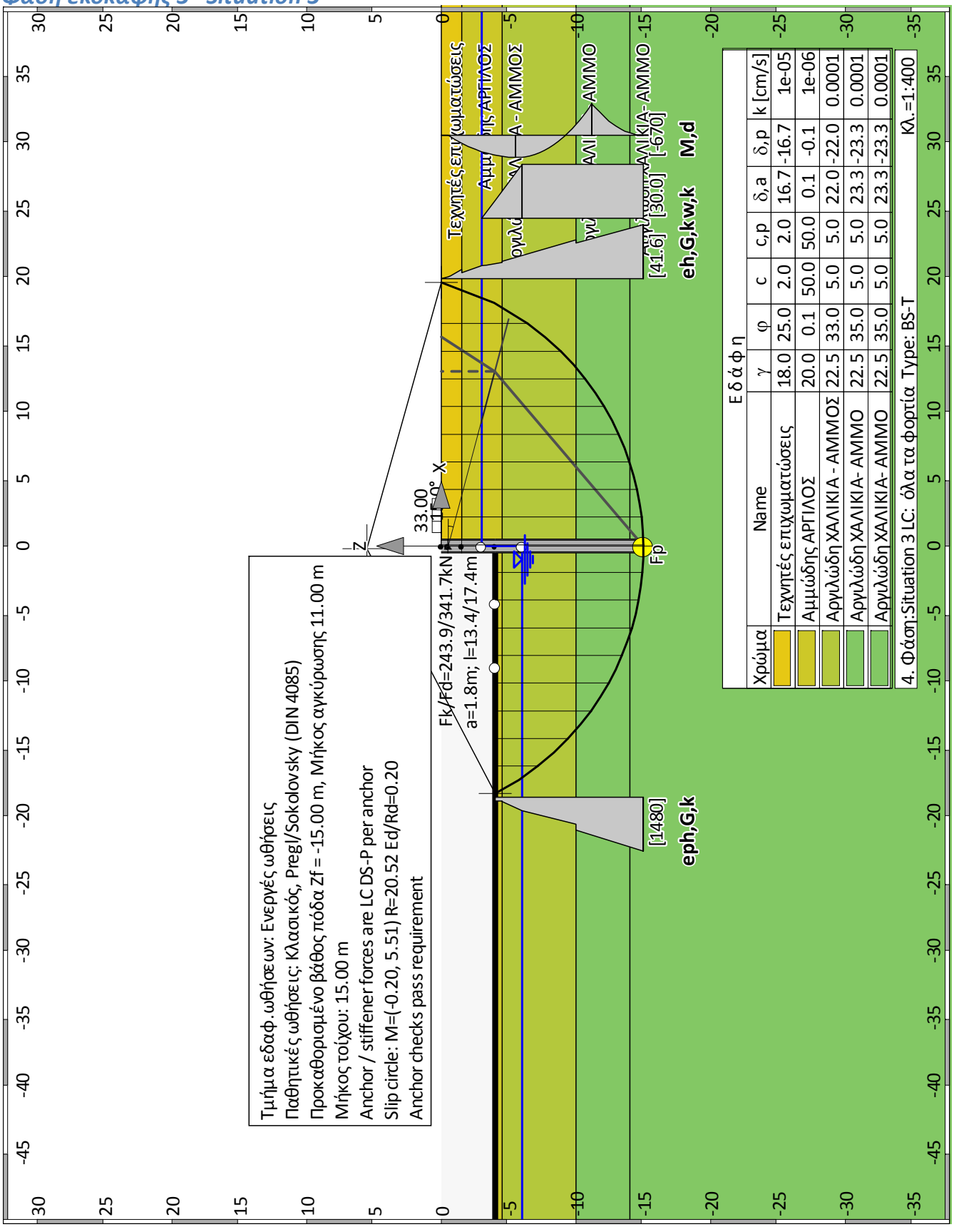
Φάση εκσκαφής 1 "Situation 1"



Φάση εκσκαφής 2 "Situation 2"



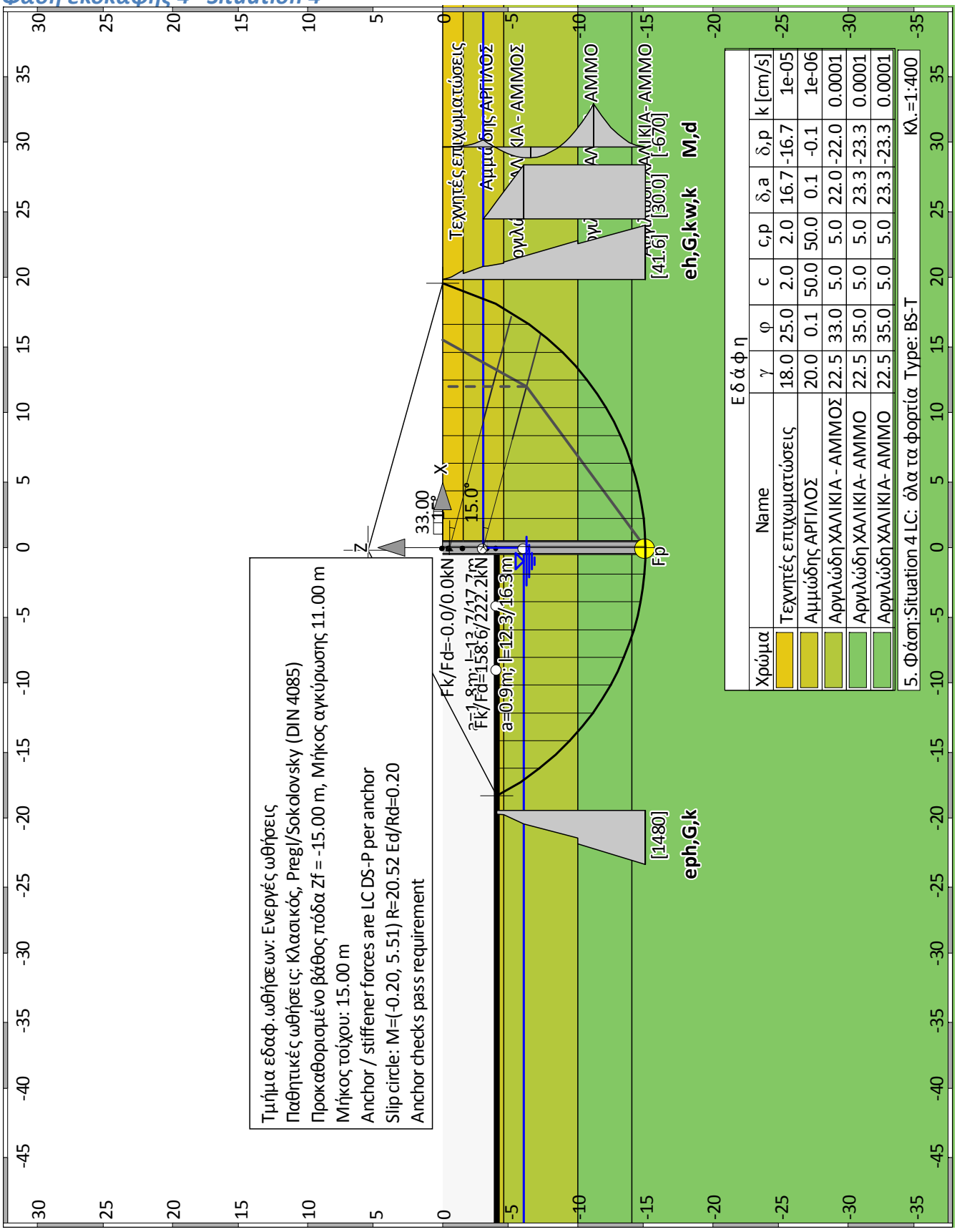
Φάση εκσκαφής 3 "Situation 3"



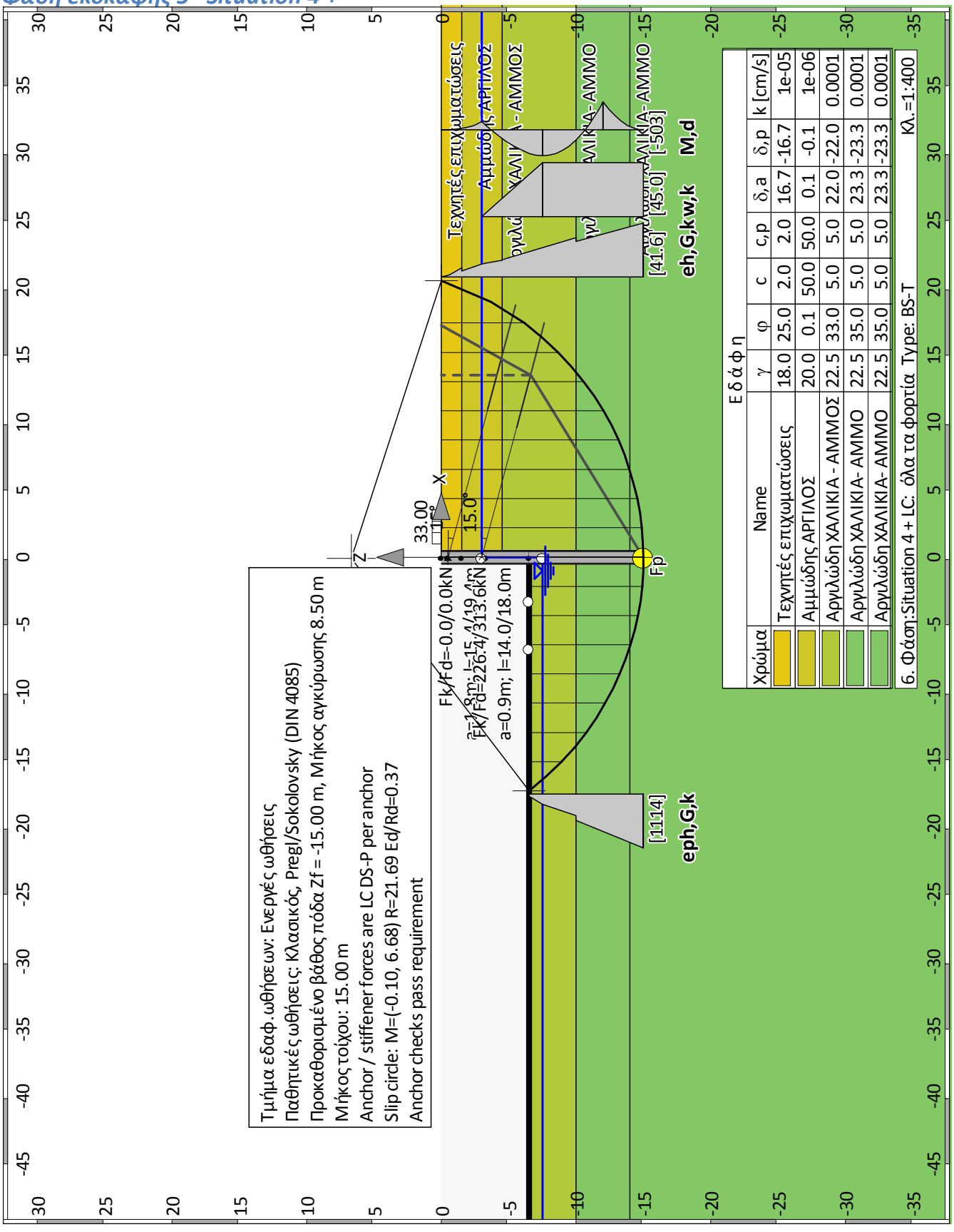
Χρώμα	Name	γ	φ	c	c,p	δ,a	δ,p	k [cm/s]
	Τεχνητές επιχωματώσεις	18.0	25.0	2.0	2.0	16.7	-16.7	1e-05
	Αμμώδης ΑΡΓΙΛΟΣ	20.0	0.1	50.0	50.0	0.1	-0.1	1e-06
	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ	22.5	33.0	5.0	5.0	22.0	-22.0	0.0001
	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ	22.5	35.0	5.0	5.0	23.3	-23.3	0.0001
	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ	22.5	35.0	5.0	5.0	23.3	-23.3	0.0001

Ε δ ά φ η

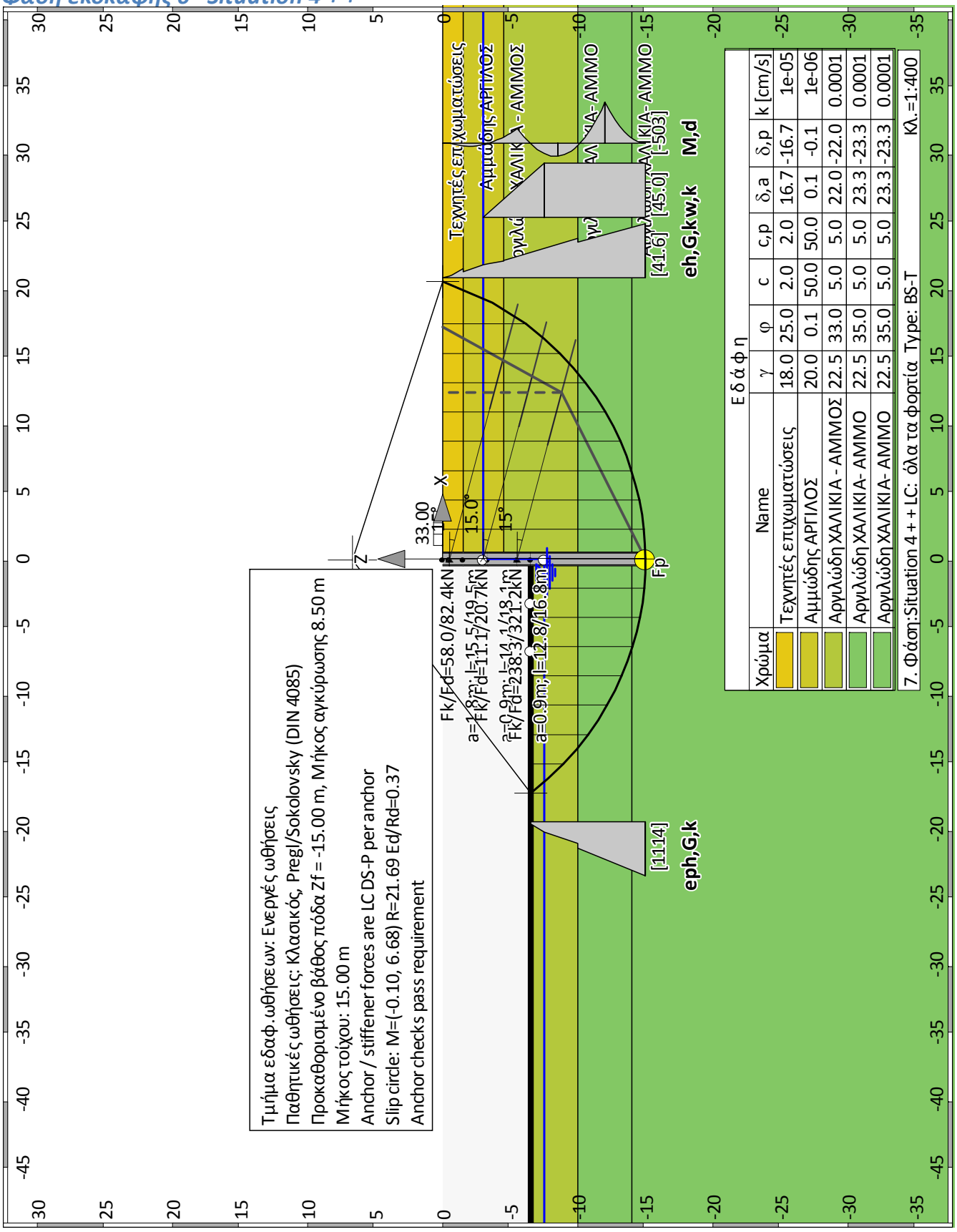
Φάση εκσκαφής 4 "Situation 4"



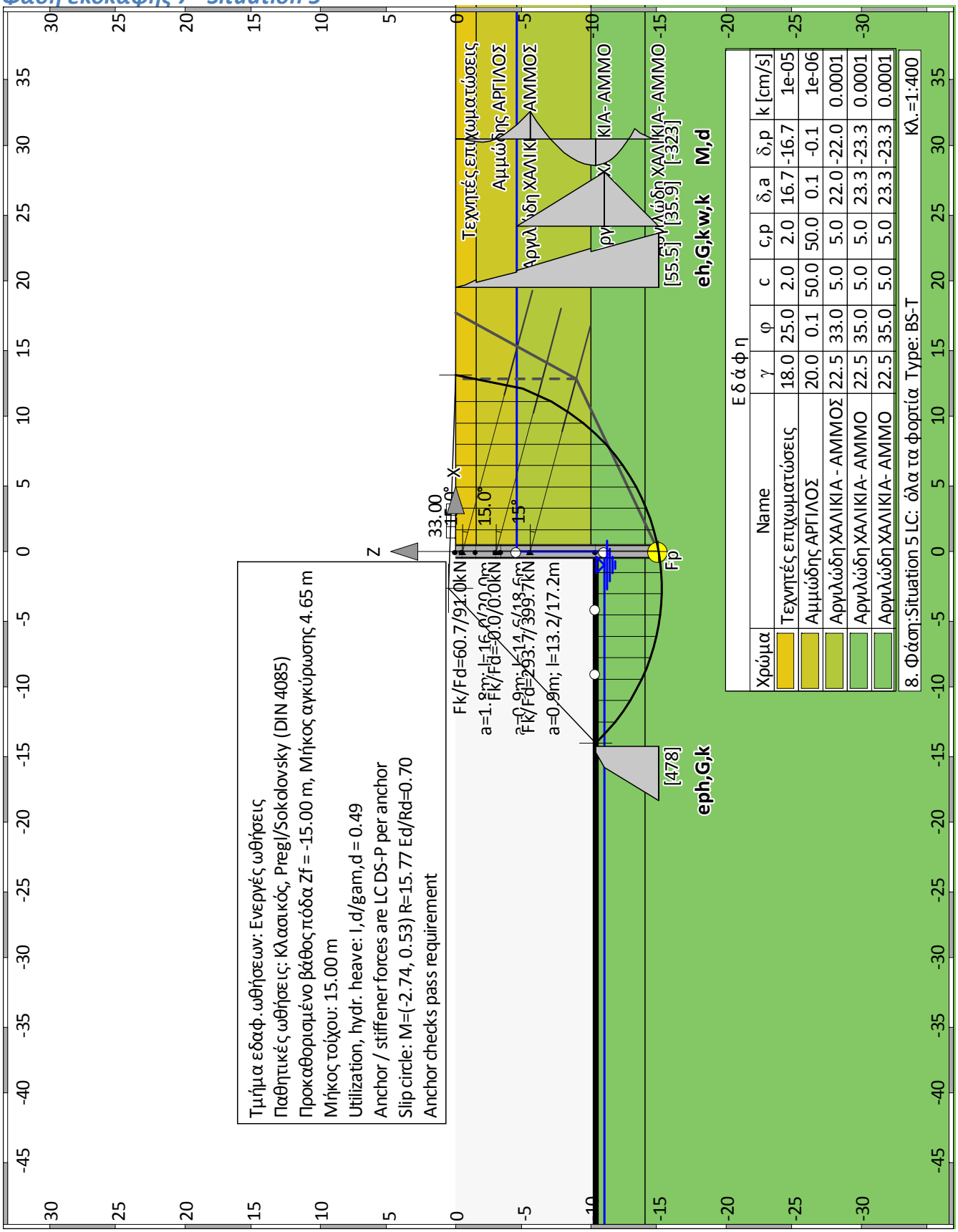
Φάση εκσκαφής 5 "Situation 4 +"



Φάση εκσκαφής 6 "Situation 4 + +"



Φάση εκσκαφής 7 "Situation 5"



Κανονισμόςγια Ανάλυση και Διαστασιολόγηση

Διαστασ. ωπλισμ.σκυροδ.: EN 1992-1-1
Γεωτεχν.Κανονισμός : EN 1997 (rev.12)_user
National Annex: EN 1997-1

Safety factors:

Earth pressure onto wall: [GEO] A1 M1 R2

γ-	G,dst	E0G	G,stb	Q,dst	Q,stb	phi	coe	cu	g
BS-P	1.350	1.350	1	1.500	0	1	1	1	1
BS-T	1.350	1.350	1	1.500	0	1	1	1	1
BS-T/A	1.350	1.350	1	1.500	0	1	1	1	1
BS-E	1	1	1	1	0	1	1	1	1

ΚΕ-μηχανισμός: [GEO] A2 M2 R3

γ-	G,dst g	G,stb a,t	W a,p	Q,dst Gt	Q,stb N	phi	coe	cu
BS-P	1	1	1	1.300	0	1.250	1.400	1.400
	1	1	1	1	1			
BS-T	1	1	1	1.300	0	1.250	1.400	1.400
	1	1	1	1	1			
BS-T/A	1	1	1	1.300	0	1.250	1.250	1.400
	1	1	1	1	1			
BS-E	1	1	1	1	0	1.250	1.400	1.400
	1	1	1	1	1			

Θραύση εδάφους: [GEO] A1 M1 R2

γ-	G,dst cu	E0G g	W Re	G,stb	Q,dst	Q,stb	phi	coe
BS-P	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.400					
BS-T	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.400					
BS-T/A	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.400					
BS-E	1	1	1	1	1	0	1	1
	1	1	1					

Ολίσθηση: [GEO] A1 M1 R2

γ-	G,dst cu	E0G g	W Rh	G,stb	Q,dst	Q,stb	phi	coe
BS-P	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.100					
BS-T	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.100					
BS-T/A	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.100					
BS-E	1	1	1	1	1	0	1	1
	1	1	1					

Θραύση εδάφους: [GEO] A1 M1 R2

γ-	G,dst cu	E0G g	W Rv	G,stb	Q,dst	Q,stb	phi	coe
BS-P	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.400					
BS-T	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.400					
BS-T/A	1.350	1.350	1.350	1	1.500	0	1	1
	1	1	1.400					
BS-E	1	1	1	1	1	0	1	1
	1	1	1					

Κύκλος ολίσθησης: [GEO] A2 M2 R3

	γ-g	G,dst Re	G,stb	Q,dst a,t	Q,stb a,p	W Gt	phi N	coe	cu
BS-P	1	1	1.300	0	1	1.250	1.400	1.400
	1	1	1	1	1	1		
BS-T	1	1	1.300	0	1	1.250	1.400	1.400
	1	1	1	1	1	1		
BS-T/A	1	1	1.300	0	1	1.250	1.250	1.400
	1	1	1	1	1	1		
BS-E	1	1	1	0	1	1.250	1.400	1.400
	1	1	1	1	1	1		

Hydraulic heave: [HYD] A1 M1 R1

	γ-	G,dst	G,stb	Q,dst	H
BS-P	1.350	0.900	1.500	1.800
BS-T	1.350	0.900	1.500	1.600
BS-T/A	1.350	0.900	1.500	1.500
BS-E	1	1	1	1

Failure of structural elements: [STR] A1 M1 R1

	γ-	M	Gtf	cd	N
BS-P	1.150	1.400	1.400	1.150
BS-T	1.150	1.300	1.300	1.150
BS-T/A	1.150	1.250	1.250	1.150
BS-E	1	1	1	1

Stability: [EQU] A1 M1 R1

	γ-	G,dst	G,stb	Q,dst	Q,stb	phi	coe	cu	g
BS-P	1	0.900	1.500	0	1.250	1.250	1.400	1
BS-T	1	0.900	1.500	0	1.250	1.250	1.400	1
BS-T/A	1	0.900	1.500	0	1.250	1.250	1.400	1
BS-E	1	1	1	0	1.250	1.400	1.400	1

γ,Re,red (EAB EB14-3): Ναι, η=0.80
γ,Re,red (EAB EB22-6): Ναι, E0h > 0%: η = 0.60 / 0.80

System values

Τοίχος

Τύπος τοίχου αντιστήριξης: Πασσαλότοιχος οπλισμένου σκυροδέματος
Διατομή: Iy=2711360 cm^4
Υλικό:: C25/30
Ίδιο βάρος: 25.000 [kN/m3]

Σημεία τοίχου

z [m]	d [m]	E [MN/m2]	Iy [cm4/m]	E*Iy [MNm2]	A [cm2/m]
0.00	100.0	31500.0	2711360	854.1	8400
-15.00	100.0	31500.0	2711360	854.1	8400

Φάση εκσκαφής 1 "[1] Situation 1"

LC: όλα τα φορτία Type: BS-T

Εδαφικό σύστημα με 5 Στρώσεις

Name		Τεχνητές επιχωματώσεις	Αμμώδης ΑΡΓΙΛΟΣ	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
γ	[kN/m3]	18	20	22.5
γ,R	[kN/m3]	18	20	22.5
γ'	[kN/m3]	8	10	12.5
γ,p	[kN/m3]	18	20	22.5
γ,R,passive	[kN/m3]	18	20	22.5
γ,pw	[kN/m3]	8	10	12.5
φ	[°]	25	0.1	33
c	[kN/m2]	2	50	5
c,u	[kN/m2]	10	50	5
c παθητικό	[kN/m2]	2	50	5
δ,a	[°]	16.66667	0.06666667	22
δ,p	[°]	-16.66667	-0.06666667	-22
δ,c	[°]	8.333333	0.03333333	11
k,agh	[-]	0.3456501	0.9955057	0.2452023
K,ach	[-]	1.043051	1.994195	0.8549058
K,0h	[-]	0.5773817	0.9982547	0.455361
K,pgh	[-]	3.908103	1.004519	7.495617
K,pch	[-]	5.180327	2.00583	8.599509
τ,gr	[kN/m2]	110	110	110
Ψ,A,max	[°]	90	90	90
k	[cm/s]	10e-06	1e-06	100e-06

Name		Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
γ	[kN/m3]	22.5	22.5
γ,R	[kN/m3]	22.5	22.5
γ'	[kN/m3]	12.5	12.5
γ,p	[kN/m3]	22.5	22.5
γ,R,passive	[kN/m3]	22.5	22.5
γ,pw	[kN/m3]	12.5	12.5
φ	[°]	35	35
c	[kN/m2]	5	5
c,u	[kN/m2]	5	5
c παθητικό	[kN/m2]	5	5
δ,a	[°]	23.33333	23.33333
δ,p	[°]	-23.33333	-23.33333
δ,c	[°]	11.66667	11.66667
k,agh	[-]	0.2244207	0.2244207
K,ach	[-]	0.8126539	0.8126539
K,0h	[-]	0.4264236	0.4264236
K,pgh	[-]	9.146943	9.146943
K,pch	[-]	10.104	10.104
τ,gr	[kN/m2]	110	110
Ψ,A,max	[°]	90	90
k	[cm/s]	100e-06	100e-06

Πορεία πρανούς:
x [m] 0.00 0.00
z [m] -2.00 0.00

Πορεία ανώτερου 2. στρώματος Αμμώδης ΑΡΓΙΛΟΣ:
x [m] 0.00 0.00
z [m] -2.00 -1.50

Πορεία ανώτερου 3. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ:
z= -4.50

Πορεία ανώτερου 4. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -10.00

Πορεία ανώτερου 5. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -14.00

Επιφ. φορτία:

Φορτία

xA [m]	zA [m]	xE [m]	zE [m]	PxA [kN/m²]	PzA [kN/m²]	PxE [kN/m²]	PzE [kN/m²]	Typ	LC-description Name
1.00	0.00	3.50	0.00	0.00	33.00	0.00	33.00	q	1

Κατανομή εδαφ.πιέσεων

Κατανομή εδαφ.πιέσεων	Name
Rectangular within a layer	

Στάθμη νερού:

x [m] 0.00
z [m] -3.00

Παράμετροι υπολογισμού

Earth pressure options

Τμήμα εδαφ.ωθήσεων: Ενεργές ωθήσεις.
Angle of slip plane: DIN 4085.
Split block loads into 1 sections.
Consideration of minimum earth pressure: φ,min = 40.000.
Negative earth pressure fractions are set to zero.

Redistribution of earth pressure

Shape of redistribution: No redistribution of earth pressure.
The earth pressure is getting redistb. to: Excavation level
The earth pressure below the excavation acts without redistrb.
The earth pressure from variable loads will be included in redistribution.

Παθητικές ωθήσεις

Method of calculation: Κλασικός, Pregl/Sokolovsky (DIN 4085).

Options for water pressure

Στήριξη πόδα

Πακτωμένη στήριξη κατά Blum

Earth pressure coefficients kh

φ	α	β	δ	k0gh	kagh	kach	kpgh	kpch	
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Τεχνητές επιχωματώσεις
25.0	0.0	0.0	16.7	--	0.346	1.043	--	--	"
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Αμμώδης ΑΡΓΙΛΟΣ
0.1	0.0	0.0	0.1	--	0.996	1.994	--	--	"
33.0	0.0	0.0	-22.0	--	--	--	7.496	-8.600	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
33.0	0.0	0.0	22.0	--	0.245	0.855	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"

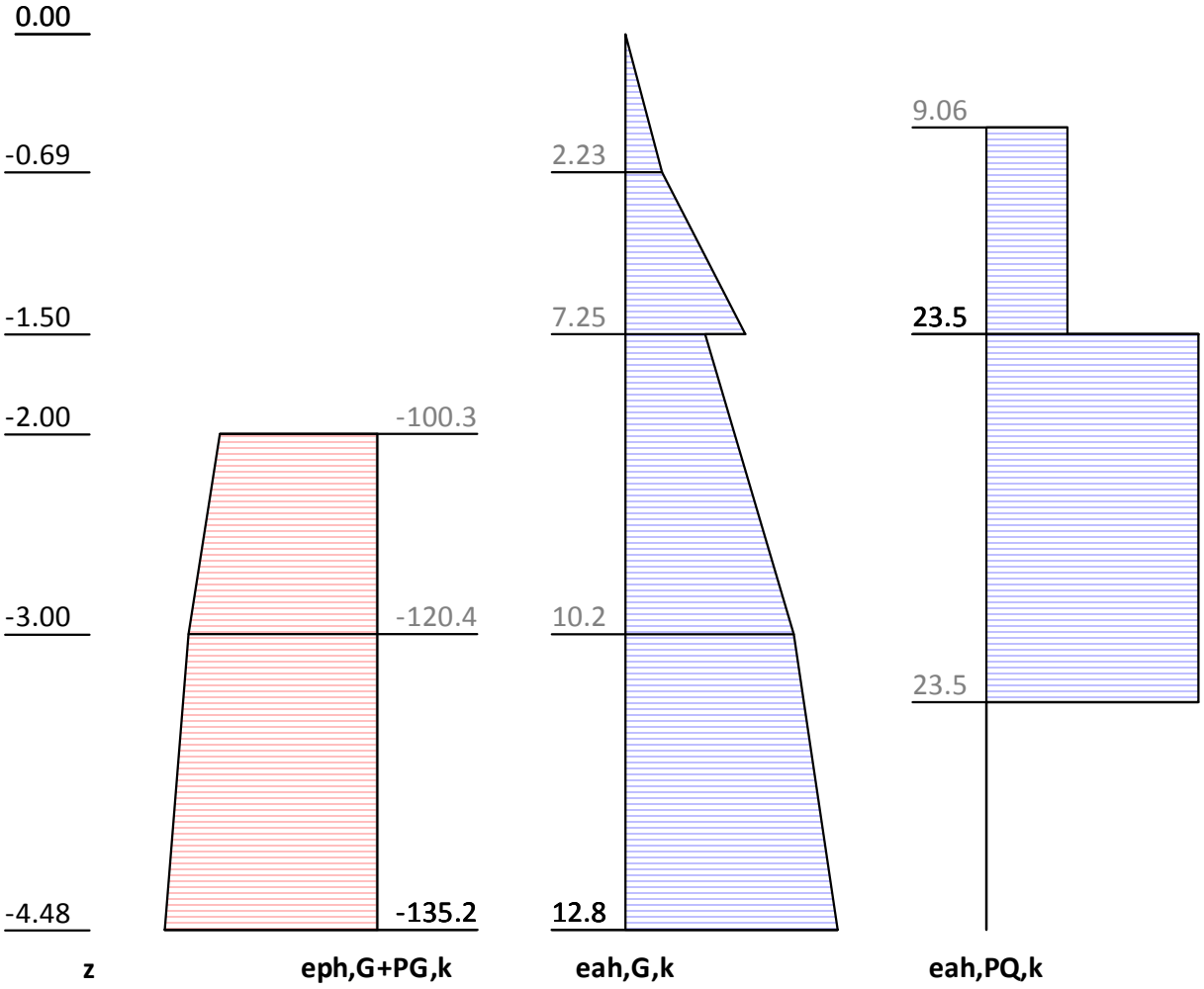
Μήκος τοίχου

```
N:   1 Z:   -3.000 M,Στήριξη πόδα,d:    51.74. Wall too short? Ναι
N:   2 Z:   -6.000 M,Στήριξη πόδα,d:  -401.07. Wall too short? Όχι
N:   3 Z:   -3.990 M,Στήριξη πόδα,d:    34.70. Wall too short? Ναι
N:   4 Z:   -5.337 M,Στήριξη πόδα,d:  -155.60. Wall too short? Όχι
N:   5 Z:   -4.434 M,Στήριξη πόδα,d:     3.70. Wall too short? Ναι
N:   6 Z:   -5.039 M,Στήριξη πόδα,d:   -82.64. Wall too short? Όχι
N:   7 Z:   -4.634 M,Στήριξη πόδα,d:   -16.37. Wall too short? Όχι
N:   8 Z:   -4.500 M,Στήριξη πόδα,d:   -13.22. Wall too short? Όχι
N:   9 Z:   -4.456 M,Στήριξη πόδα,d:     1.79. Wall too short? Ναι
N:  10 Z:   -4.486 M,Στήριξη πόδα,d:    -0.87. Wall too short? Όχι
N:  11 Z:   -4.466 M,Στήριξη πόδα,d:     0.92. Wall too short? Ναι
N:  12 Z:   -4.479 M,Στήριξη πόδα,d:    -0.27. Wall too short? Όχι
N:  13 Z:   -4.470 M,Στήριξη πόδα,d:     0.53. Wall too short? Ναι
N:  14 Z:   -4.476 M,Στήριξη πόδα,d:    -0.01. Wall too short? Όχι
Foot depth for statics: zf = -4.476
```

Stress analysis

Earth pressure, horizontal

Pressures characteristic, no redistribution, continous wall



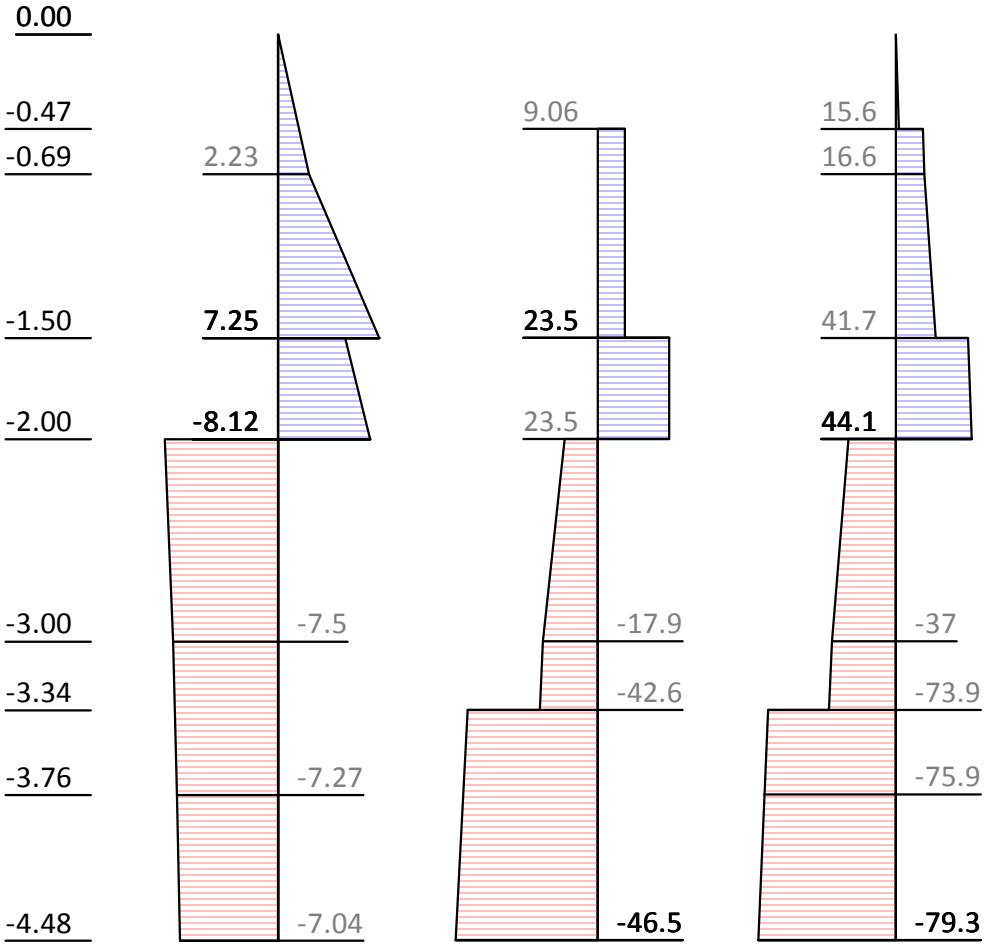
z [m]	eph,G,k [kN/m2]	eah,G,k [kN/m2]	eah,PQ,k [kN/m2]	eah,d [kN/m2]
0.00		0.00		0.00
-0.47		1.52	0.00	2.04
-0.47		1.52	9.06	15.62
-1.50		7.25	9.06	23.37
-1.50		4.82	23.48	41.73
-2.00	-0.00	6.61	23.48	44.14

z [m]	eph,G,k [kN/m2]	eah,G,k [kN/m2]	eah,PQ,k [kN/m2]	eah,d [kN/m2]
-2.00	-100.29	6.61	23.48	44.14
-3.34	-123.79	10.79	23.48	49.78
-3.34	-123.79	10.79	0.00	14.56
-4.48	-135.21	12.82	0.00	17.30

Eph,G,k: -298.99, Eph,PG,k: 0.00 [kN/m]
Eah,G,k: 32.82, Eah,PG,k: 0.00, Eah,PQ,k: 52.53, Eah,d: 123.10

H-pressure on static system

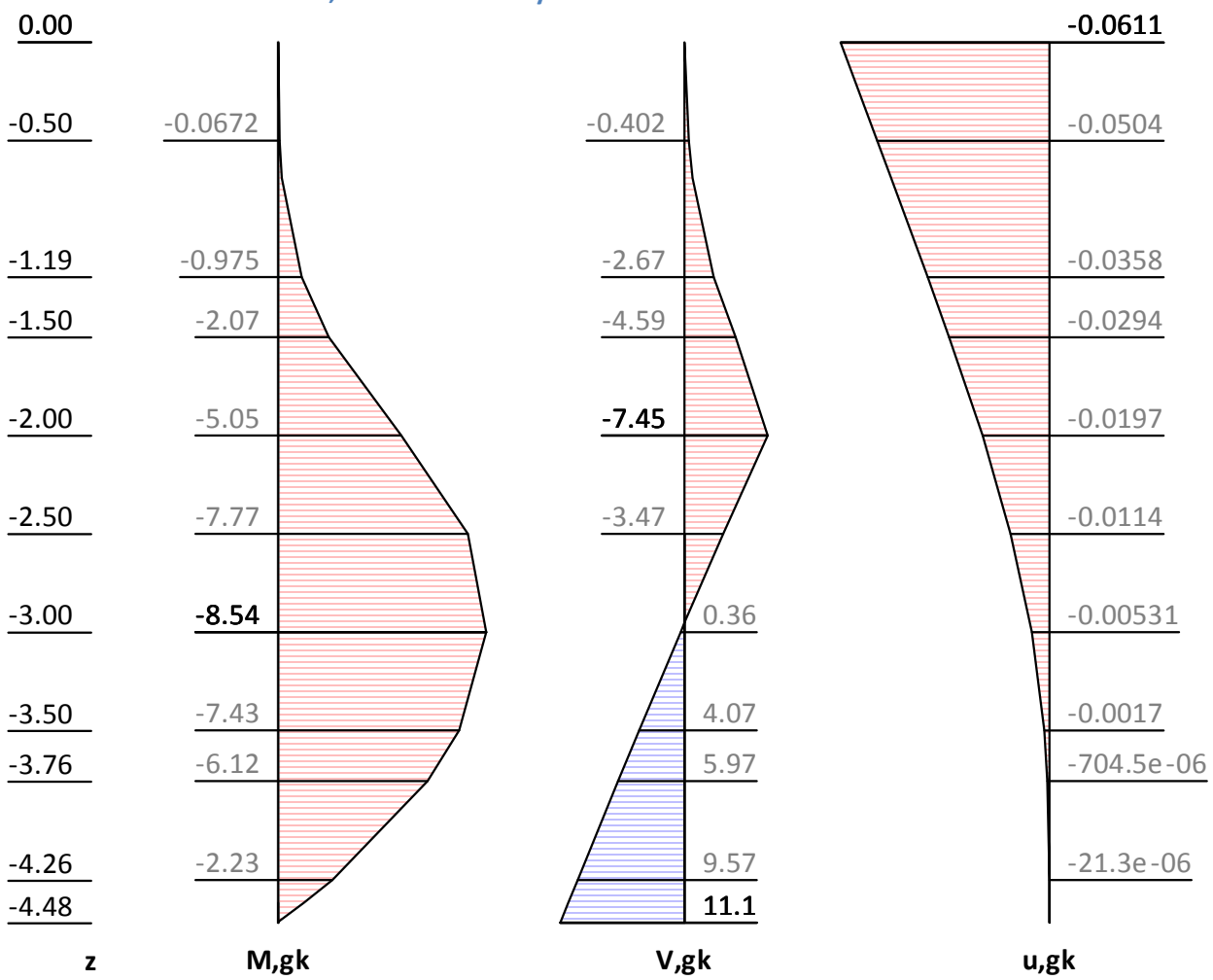
Level of mobilization: Ep,gk 14.7, Ep,qk 34.4, Ep,d 100.0 [%]



z [m]	PH,gk [kN/m2]	PH,qk [kN/m2]	PH,d [kN/m2]
0.00	0.00		0.00
-0.47	1.52	0.00	2.04
-0.47	1.52	9.06	15.62
-1.50	7.25	9.06	23.37
-1.50	4.82	23.48	41.73
-2.00	6.61	23.48	44.14
-2.00	-8.12	-11.02	-27.50
-3.34	-7.40	-19.10	-38.64
-3.34	-7.40	-42.58	-73.86
-4.48	-7.04	-46.51	-79.28

V-pressure on static system

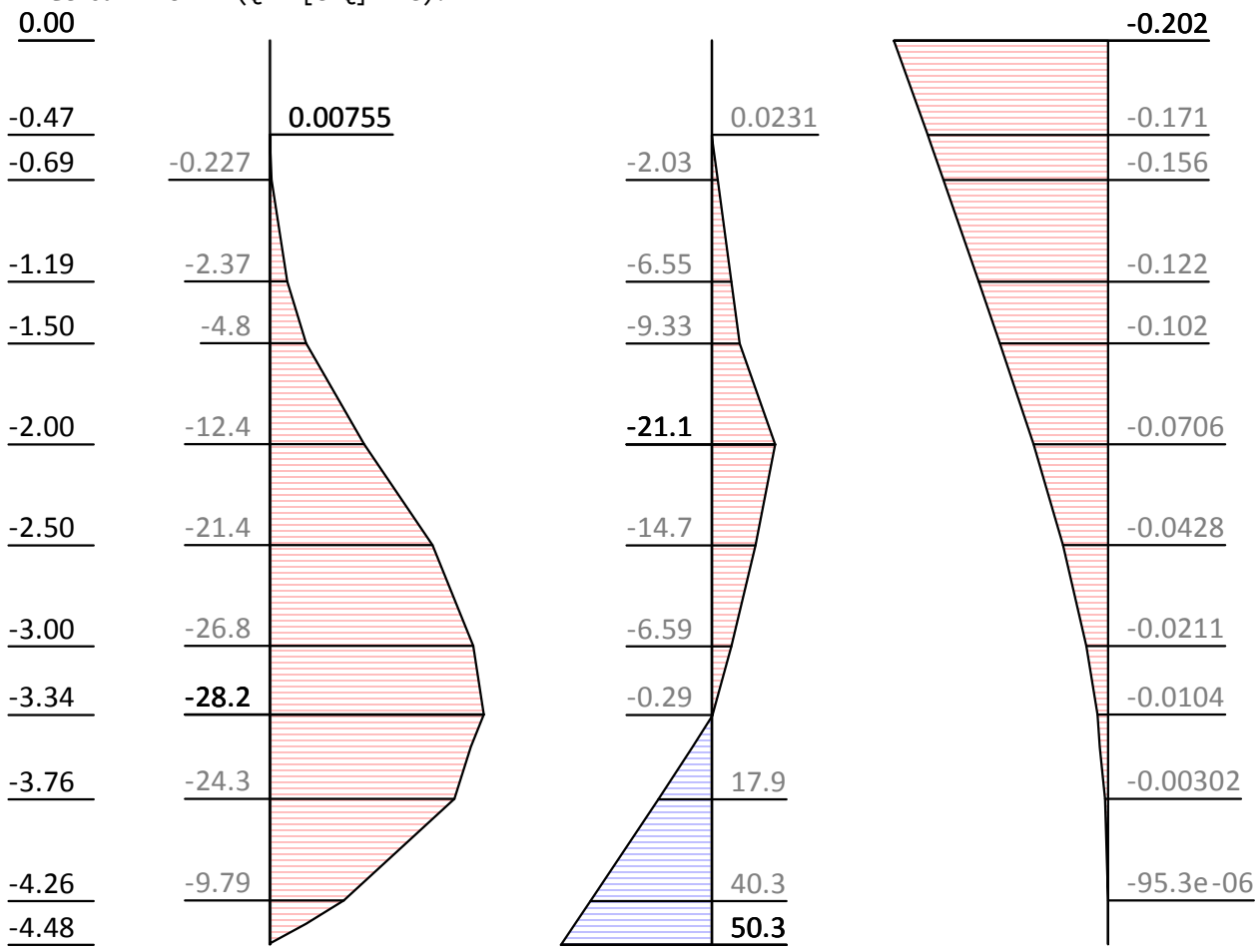
Internal forces: Permanent, characteristically



z [m]	H,g,k [kN/m2]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [mm]
0.00	0.00	0.00	0.00	0.00	-0.06
-1.50	7.25	-2.07	-4.59	-33.13	-0.03
-1.50	4.82	-2.07	-4.59	-33.13	-0.03
-2.00	6.61	-5.05	-7.45	-43.63	-0.02
-2.00	-8.12	-5.05	-7.45	-43.63	-0.02
-2.95	-7.53	-8.47	0.00	-63.64	-0.01
-3.00	-7.50	-8.54	0.36	-64.62	-0.01
-4.48	-7.04	-0.00	11.10	-83.21	-0.00
-4.48	-7.04	0.00	11.10	-83.21	0.00

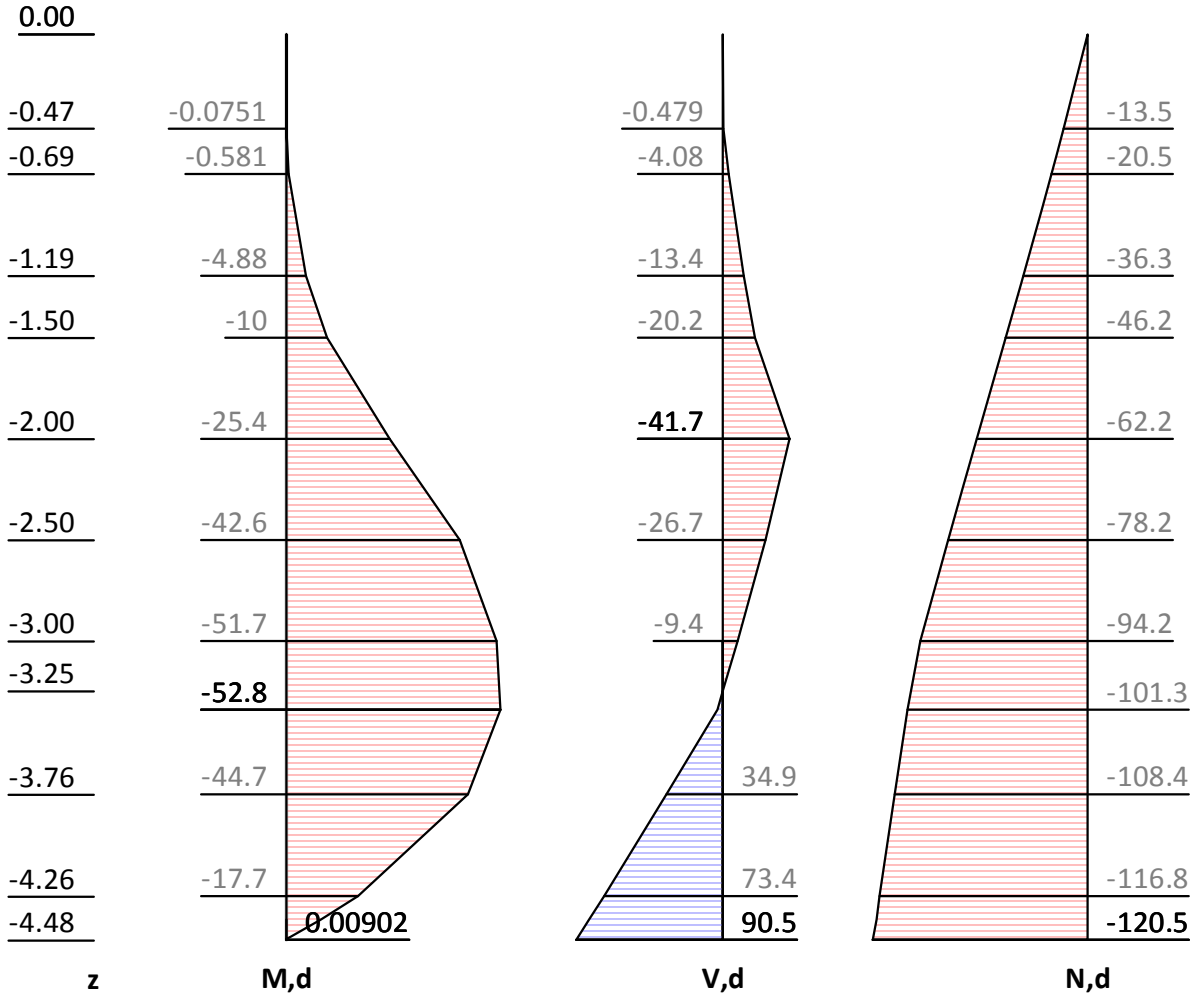
Internal forces: Variable, characteristically

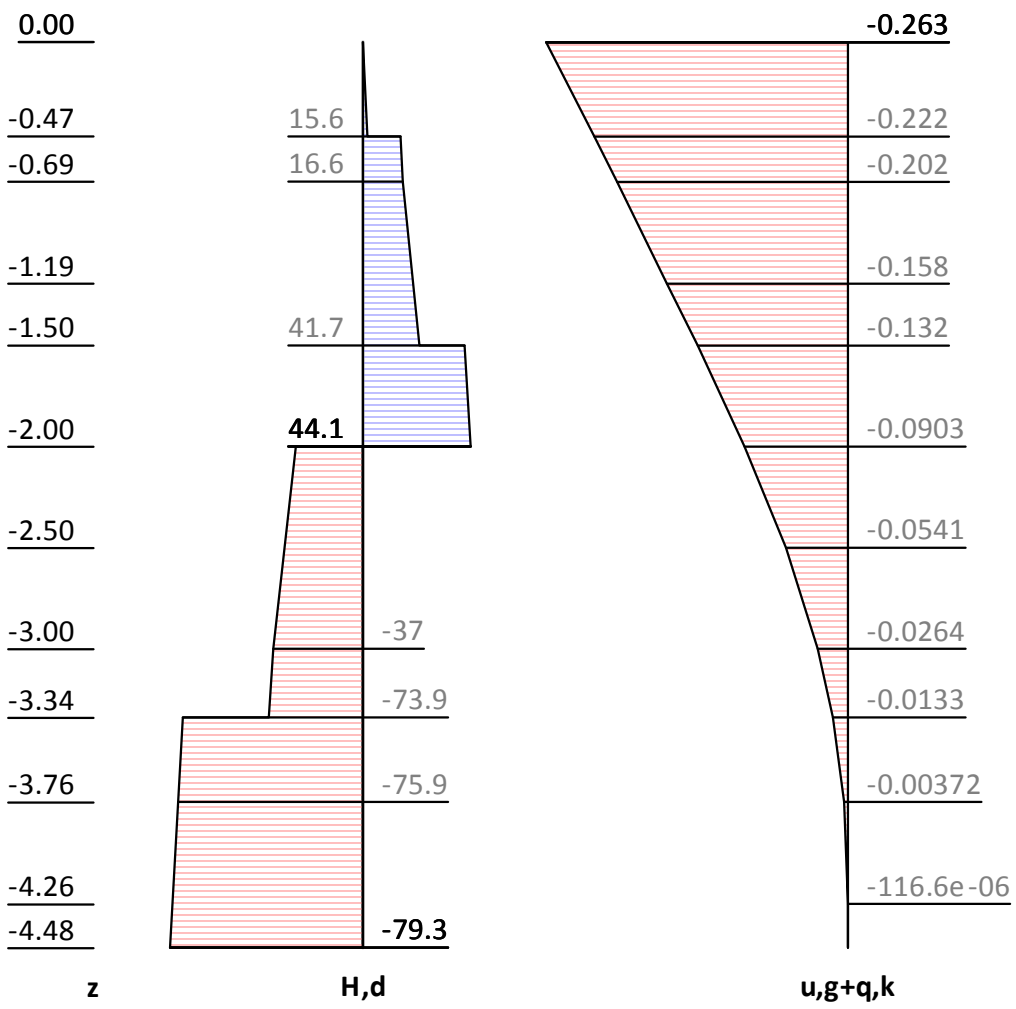
Method EB 82-4 (Q = [G+Q] - G).



z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
0.00		0.00	0.00	0.00	-0.20
-0.47	0.00	0.01	0.02	0.01	-0.17
-0.47	9.06	0.01	0.02	0.01	-0.17
-0.48	9.06	-0.00	-0.05	0.00	-0.17
-1.50	9.06	-4.80	-9.33	-0.99	-0.10
-1.50	23.48	-4.80	-9.33	-0.99	-0.10
-2.00	23.48	-12.40	-21.07	-2.23	-0.07
-2.00	-11.02	-12.40	-21.07	-2.23	-0.07
-3.34	-19.10	-28.20	-0.29	-5.50	-0.01
-3.34	-42.58	-28.20	-0.29	-5.50	-0.01
-3.35	-42.61	-28.12	-0.00	-5.50	-0.01
-4.48	-46.51	0.00	50.32	-5.44	-0.00
-4.48	-46.51	0.00	50.32	-5.44	0.00

Internal forces: Design

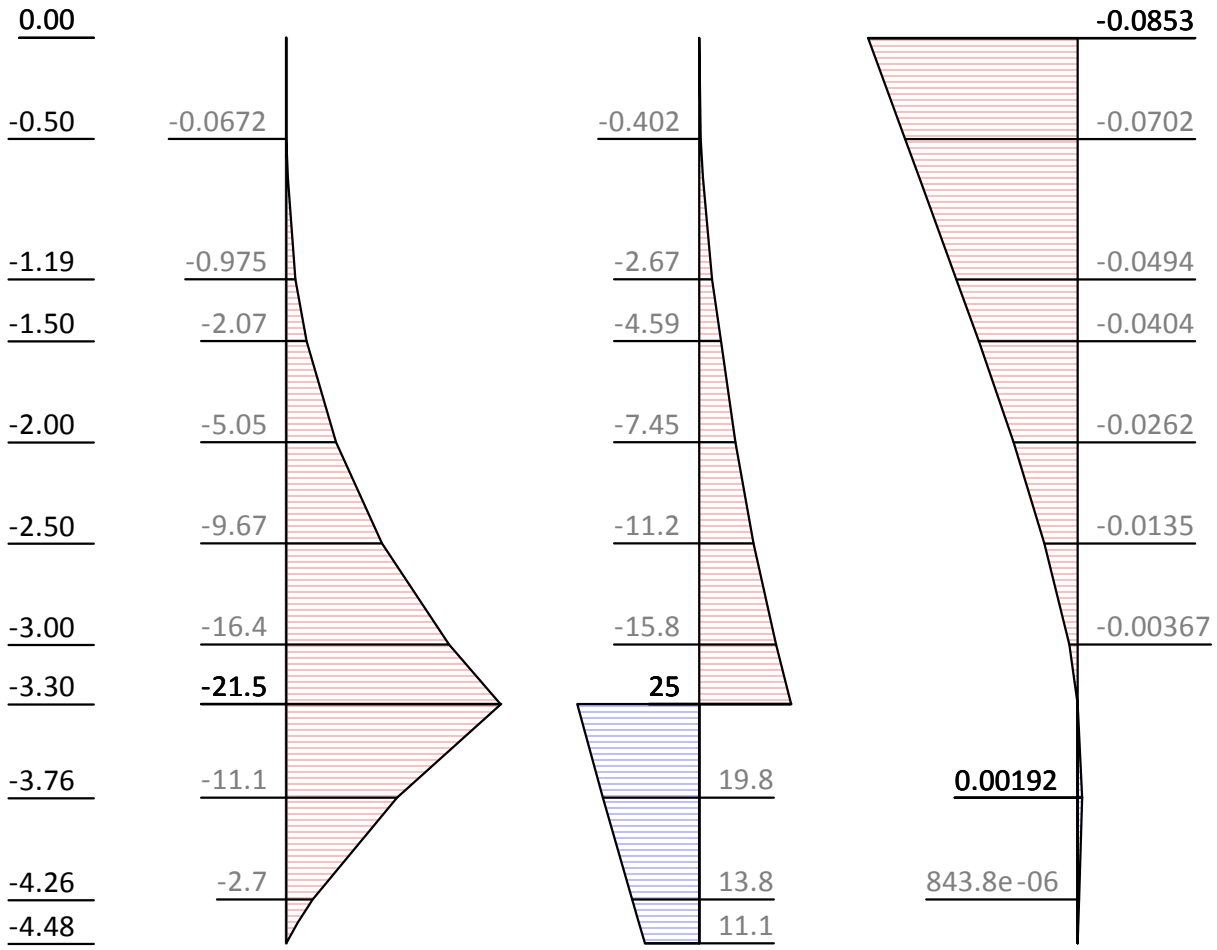




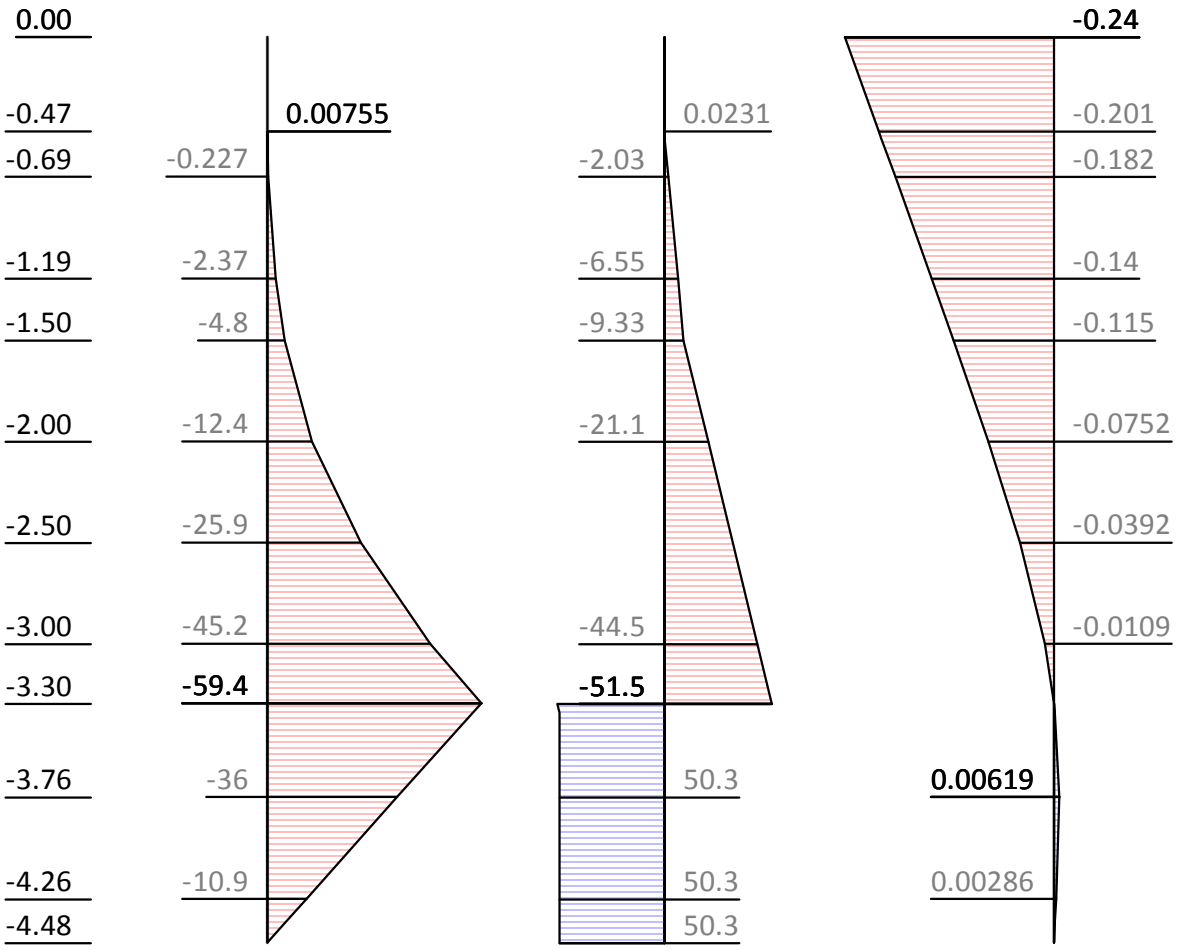
z [m]	H,d [kN/m2]	M,d [kN/m2]	V,d [kN/m2]	N,d [kN/m2]	u,g+q,k [mm]
0.00	0.00	0.00	-0.00	0.00	-0.26
-0.47	2.04	-0.08	-0.48	-13.54	-0.22
-0.47	15.62	-0.08	-0.48	-13.54	-0.22
-1.50	23.37	-10.00	-20.19	-46.20	-0.13
-1.50	41.73	-10.00	-20.19	-46.20	-0.13
-2.00	44.14	-25.42	-41.66	-62.25	-0.09
-2.00	-27.50	-25.42	-41.66	-62.25	-0.09
-3.34	-38.64	-52.77	3.46	-101.27	-0.01
-3.34	-73.86	-52.77	3.46	-101.27	-0.01
-4.48	-79.28	0.00	90.45	-120.49	-0.00
-4.48	-79.28	0.01	90.46	-120.49	0.00

Checks of earth statics

Substitute system according to Blum



z [m]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [kN/m2]
0.00	0.00	0.00	0.00	-0.09
-3.30	-21.54	-18.93	-68.37	0.00
-3.30	-21.54	24.98	-68.37	0.00
-3.76	-11.12	19.82	-74.23	0.00
-4.48	0.00	11.10	-83.26	0.00



z [m]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [kN/m2]
0.00	0.00	0.00	0.00	-0.24
-0.47	0.01	0.02	0.01	-0.20
-0.48	-0.00	-0.05	-0.00	-0.20
-3.30	-59.42	-51.50	-5.45	0.00
-3.30	-59.42	51.35	-5.45	0.00
-3.76	-36.04	50.32	-5.56	0.01
-4.48	0.00	50.32	-5.56	0.00

Bh,gk = -43.91; Ch,gk = 11.10 [kN/m]
Bh,qk = -102.85; Ch,qk = 50.32 [kN/m]
Bh,d = -213.56; Ch,d = 90.45 [kN/m]

Check of C-force (foot support)

```
z(C)                                          =   -4.48 [kN/m]
G,k = sum(γ*h)                                =   71.76 [kN/m]
P,k = sum(Pz,k(x=  0.1))                      =    0.00 [kN/m]
kpgh,C(phi=  0.1; δ,C=  0.0°)                 =   1.002 [-]
kpch,C                                        =   2.003 [-]
eph,C,gk =(G,k+P,k)*kpgh,C+2*c*sqrt(kpch,C)=  213.44 [kN/m2]
         = (71.76+0.00)*1.002+2*50.0*1.415
Ed = Ch,d                                     =   90.45 [kN/m2]
δ,t,EAU          = Ed/(2*eph,C,d)             =    0.30 [m]
δ,t,EAB          =  0.20 * t                  =    0.50 [m]
δ,t = δ,t,EAB                                 =    0.50 [m]
Rd = 2*δ,t*eph,C,gk/γ,Re
   = 2*0.50*213.44/1.4
                                              =  151.00 [kN/m2]
```

Ed/Rd = 0.599 [-]. Passes requirement

Check or earth support

Check: Mobilizable earth resistance is sufficient for earth support force.
z: -3.30 m
Rd = Eph,k/γ,Re = 298.99 / 1.400 = 213.57 [kN/m]

Ed(Bh,d)/Rd = 213.56 / 213.57 = 1.000 [-]. Passes requirement

Sum of H and V forces, (G)

Forces up to depth z:-4.48

Pos.	H	V
H/V pressure G+P+W,k	32.82	1.66
Wall weight		87.84
H/V pressure passive		0.00
Bh,g,k z=-3.30	-43.91	
Bv,g,k = Bh,k * tan(δ,p=-0.07°)		-0.05
Ch,g	11.10	
Cv,g = Ch*tan(δ,C=0.0°)		0.01
Σ	0.00	89.46 (downwards)

Simple check, EAB R 9-3a

Vk >= Bvk: 89.51 >= 0.05 Passes requirement

Sum of H and V forces, (G+Q)

Forces up to depth z:-4.48

Pos.	H	V
H/V pressure G+P+W,k	85.35	7.22
Wall weight		87.84
H/V pressure passive		0.00
Bh,g,k z=-3.30	-43.91	
Bv,g,k = Bh,k * tan(δ,p=-0.07°)		-0.05
Bh,q,k z=-3.30	-102.85	
Bv,q,k = Bh,k * tan(δ,p=-0.07°)		-0.12
Ch,g	11.10	
Cv,g = Ch*tan(δ,C=0.0°)		0.01
Ch,q	50.32	
Cv,q = Ch*tan(δ,C=0.0°)		0.03
Σ	-0.00	94.93 (downwards)

Simple check, EAB R 9-3a

Vk >= Bvk: 95.10 >= 0.17 Passes requirement

Υπολογ. κύκλου ολίσθησης

LC: όλα τα φορτία Type: BS-T (combination: [GEO] A2 M2 R3, BS-T)
Vertical variable loads only act if they are outside of R*sin(phi).
The automatic slip circle optimization only considers circles that intersect
the surface with an area of at least 0.25 m2.
The slip circle calculation only accepts circles including the wall.
The slipcircle calculation only allows circular failure planes
(no vertical tangents will occour).

Γεωμετ.κύκλου (μήκη και συντεταγμ. σε (m))
Κέντρο = (-1.72, 0.34), Ακτίνα = 5.59
Αρχ.σημ.= (-6.79, -2.00), Τελ.σημ. = (3.86, 0.00)

Γεωμετρία λωρίδων:

No	x [m]	Width b [m]	dxM [m]	Weight [kN/m]	Load z-κατ. [kN/m]	Water-φορτ. [kN/m]	u*b [kN/m]	φ [°]	c [kN/m²]	θ [°]
1	-6.51	0.56	-4.80	5.9	0.0	0.0	-0.0	0.08	35.71	-44.96*
2	-5.96	0.56	-4.24	14.6	0.0	0.0	-1.7	0.08	35.71	-44.96*
3	-5.40	0.56	-3.68	20.9	0.0	0.0	-4.8	0.08	35.71	-41.18
4	-4.84	0.56	-3.12	25.7	0.0	0.0	-7.2	0.08	35.71	-33.95
5	-4.28	0.56	-2.56	29.6	0.0	0.0	-9.1	27.45	3.57	-27.29
6	-3.72	0.56	-2.00	32.7	0.0	0.0	-10.5	27.45	3.57	-21.01
7	-3.16	0.56	-1.44	35.0	0.0	0.0	-11.5	27.45	3.57	-14.98
8	-2.60	0.56	-0.89	36.5	0.0	0.0	-12.1	27.45	3.57	-9.12
9	-2.04	0.56	-0.33	37.3	0.0	0.0	-12.5	27.45	3.57	-3.35
10	-1.49	0.56	0.23	37.3	0.0	0.0	-12.5	27.45	3.57	2.38
11	-0.93	0.56	0.79	36.7	0.0	0.0	-12.2	27.45	3.57	8.14
12	-0.37	0.56	1.35	35.3	0.0	0.0	-11.6	27.45	3.57	13.98
13	0.19	0.56	1.91	50.5	0.0	0.0	-10.7	27.45	3.57	19.97
14	0.75	0.56	2.47	50.8	1.2	0.0	-9.3	27.45	3.57	26.20
15	1.31	0.56	3.03	47.1	24.0	0.0	-7.5	0.08	35.71	32.79
16	1.87	0.56	3.58	42.5	24.0	0.0	-5.2	0.08	35.71	39.91
17	2.42	0.56	4.14	36.5	24.0	0.0	-2.2	0.08	35.71	47.86
18	2.98	0.56	4.70	28.3	24.0	0.0	-0.2	0.08	35.71	57.30
19	3.56	0.60	5.28	16.0	10.2	0.0	-0.0	20.46	1.43	70.88

*** Σημείωση: Στις λωρίδες σημειωμένες με '*'
περιορίστηκε το theta στο 45°-Phi/2.

Συνεισφ. κατακόρυφων φορτίων:

No	Weight [kN/m]	G*sin(θ) [kN/m]	(G-u*b)*tan(φ) + c*b [kN/m]	μ*sin(θ)* tan(φ)+cos(θ) [-]	T [kN/m]
1	5.93	-5.09	19.96	0.707211	28.23
2	14.60	-11.07	19.97	0.707211	28.24
3	20.90	-13.76	19.98	0.752238	26.56
4	25.70	-14.35	19.98	0.829212	24.10
5	29.58	-13.56	12.66	0.794707	15.93
6	32.72	-11.73	13.56	0.860042	15.77
7	35.01	-9.05	14.22	0.913023	15.57
8	36.51	-5.79	14.65	0.954871	15.34
9	37.27	-2.18	14.87	0.986300	15.08
10	37.33	1.55	14.89	1.007651	14.77
11	36.69	5.19	14.70	1.018951	14.43
12	35.31	8.53	14.31	1.019913	14.03
13	50.54	17.26	22.71	1.009894	22.49
14	52.06	22.98	24.20	0.987773	24.50
15	71.04	38.47	20.04	0.840984	23.83
16	66.44	42.63	20.04	0.767457	26.11
17	60.44	44.82	20.04	0.671336	29.85
18	52.28	43.99	20.03	0.540685	37.04

No	Weight [kN/m]	G*sin(θ) [kN/m]	(G-u*b)*tan(φ) + c*b [kN/m]	μ*sin(θ)* tan(φ)+cos(θ) [-]	T [kN/m]
19	26.20	24.75	10.62	0.466572	22.77
		163.60			414.63

Δράση Ed = (163.6*5.59)
Αντίσταση Rd = (414.6*5.59 +0.0)

SLIP-CIRCLE μ = Ed/Rd = 0.39 < 1.0: Έλεγχος εκπληρώθηκε.

Φάση εκσκαφής 2 "[2] Situation 2"

LC: όλα τα φορτία Type: BS-T

Εδαφικό σύστημα με 5 Στρώσεις

Name		Τεχνητές επιχωματώσεις	Αμμώδης ΑΡΓΙΛΟΣ	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
γ	[kN/m3]	18	20	22.5
γ,R	[kN/m3]	18	20	22.5
γ'	[kN/m3]	8	10	12.5
γ,p	[kN/m3]	18	20	22.5
γ,R,passive	[kN/m3]	18	20	22.5
γ,pw	[kN/m3]	8	10	12.5
φ	[°]	25	0.1	33
c	[kN/m2]	2	50	5
c,u	[kN/m2]	10	50	5
c παθητικό	[kN/m2]	2	50	5
δ,a	[°]	16.66667	0.06666667	22
δ,p	[°]	-16.66667	-0.06666667	-22
δ,c	[°]	8.333333	0.03333333	11
k,agh	[-]	0.3456501	0.9955057	0.2452023
K,ach	[-]	1.043051	1.994195	0.8549058
K,0h	[-]	0.5773817	0.9982547	0.455361
K,pgh	[-]	3.908103	1.004519	7.495617
K,pch	[-]	5.180327	2.00583	8.599509
τ,gr	[kN/m2]	110	110	110
Ψ,A,max	[°]	90	90	90
k	[cm/s]	10e-06	1e-06	100e-06

Name		Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
γ	[kN/m3]	22.5	22.5
γ,R	[kN/m3]	22.5	22.5
γ'	[kN/m3]	12.5	12.5
γ,p	[kN/m3]	22.5	22.5
γ,R,passive	[kN/m3]	22.5	22.5
γ,pw	[kN/m3]	12.5	12.5
φ	[°]	35	35
c	[kN/m2]	5	5
c,u	[kN/m2]	5	5
c παθητικό	[kN/m2]	5	5
δ,a	[°]	23.33333	23.33333
δ,p	[°]	-23.33333	-23.33333
δ,c	[°]	11.66667	11.66667
k,agh	[-]	0.2244207	0.2244207
K,ach	[-]	0.8126539	0.8126539
K,0h	[-]	0.4264236	0.4264236
K,pgh	[-]	9.146943	9.146943
K,pch	[-]	10.104	10.104
τ,gr	[kN/m2]	110	110
Ψ,A,max	[°]	90	90
k	[cm/s]	100e-06	100e-06

Πορεία πρανούς:
x [m] 0.00 0.00
z [m] -2.00 0.00

Πορεία ανώτερου 2. στρώματος Αμμώδης ΑΡΓΙΛΟΣ:
x [m] 0.00 0.00
z [m] -2.00 -1.50

Πορεία ανώτερου 3. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ:
z= -4.50

Πορεία ανώτερου 4. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -10.00

Πορεία ανώτερου 5. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -14.00

Επιφ. φορτία:

Φορτία

xA [m]	zA [m]	xE [m]	zE [m]	PxA [kN/m²]	PzA [kN/m²]	PxE [kN/m²]	PzE [kN/m²]	Typ	LC-description Name
1.00	0.00	3.50	0.00	0.00	33.00	0.00	33.00	q	1

Κατανομή εδαφ.πιέσεων

Κατανομή εδαφ.πιέσεων	Name
Rectangular within a layer	

Στάθμη νερού:

x [m] 0.00
z [m] -3.00

Αγκύρια

z[m]	min.l[m]	Alpha[°]	C-H[kN/m]	P0[kN]	u0[m]
-0.50	0.00	15.00	αόριστ.	0.00	0.0000

Παράμετροι υπολογισμού

Earth pressure options

Τμήμα εδαφ.ωθήσεων: Ενεργές ωθήσεις.
Angle of slip plane: DIN 4085.
Split block loads into 1 sections.
Consideration of minimum earth pressure: φ,min = 40.000.
Negative earth pressure fractions are set to zero.

Redistribution of earth pressure

Shape of redistribution: Trapezoid.
The earth pressure is getting redistb. to: Excavation level
The earth pressure below the excavation acts without redistrb.
Levels of redistribution Z1: 0.000, Z2: -1.000 [m].
The earth pressure from variable loads will be included in redistribution.

Παθητικές ωθήσεις

Method of calculation: Κλασικός, Pregl/Sokolovsky (DIN 4085).

Options for water pressure

Στήριξη πόδα

Πόδας οριζοντίως μετακινούμενος

Αγκύρια

Anchor checks (lower failure plane): Ναι
Anchor forces with safety level of DS-P: Ναι
Verification of grout body pull out forces: Ναι
δ,a,Anchoring wall : used from soil layer.
δ,p,Anchoring wall : used from soil layer.

Earth pressure coefficients kh

φ	α	β	δ	k0gh	kagh	kach	kpgh	kpch	
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Τεχνητές επιχωματώσεις
25.0	0.0	0.0	16.7	--	0.346	1.043	--	--	"
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Αμμώδης ΑΡΓΙΛΟΣ
0.1	0.0	0.0	0.1	--	0.996	1.994	--	--	"
33.0	0.0	0.0	-22.0	--	--	--	7.496	-8.600	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
33.0	0.0	0.0	22.0	--	0.245	0.855	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"

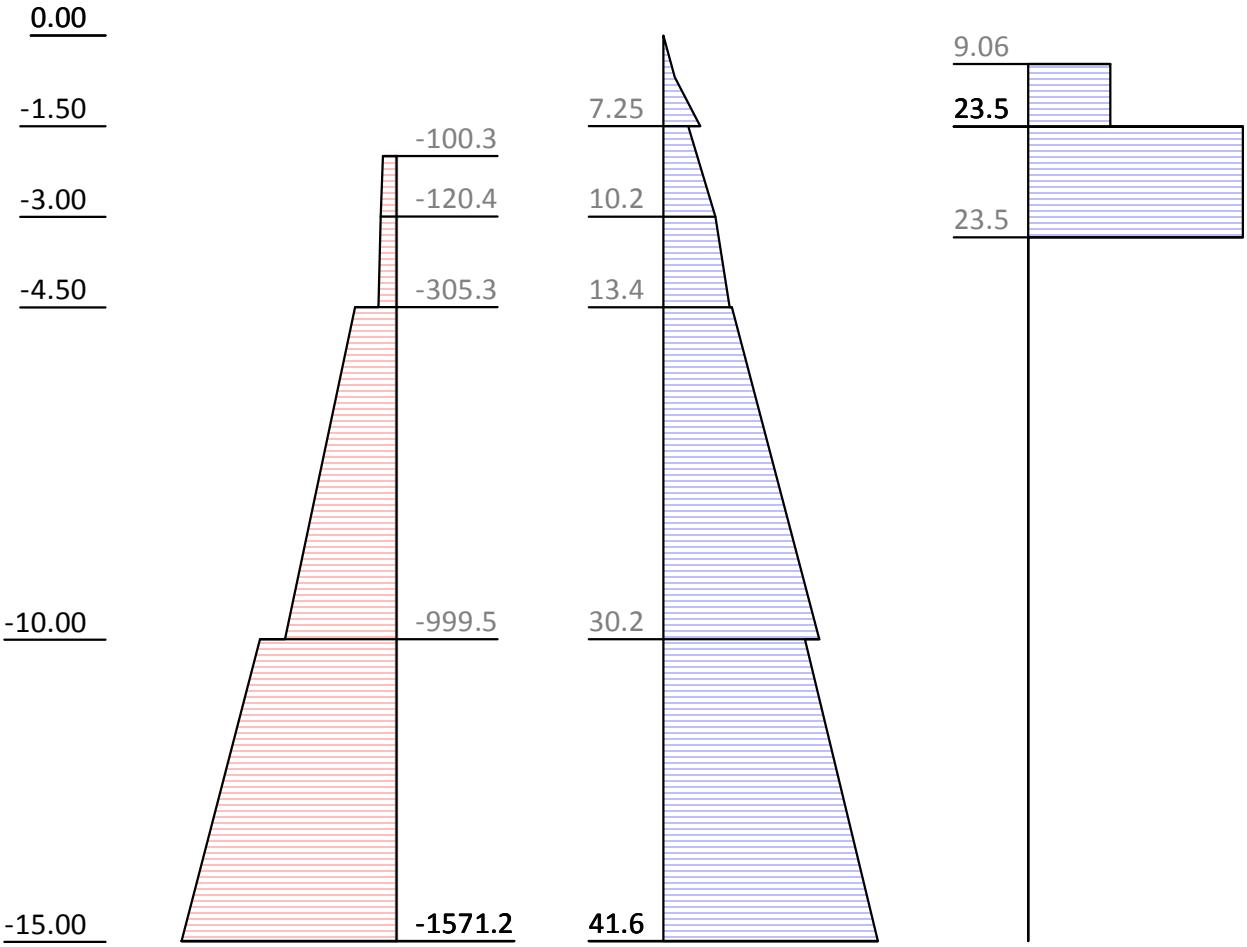
Μήκος τοίχου

Foot depth for statics: zf = -15.000

Stress analysis

Earth pressure, horizontal

Pressures characteristic, no redistribution, continous wall

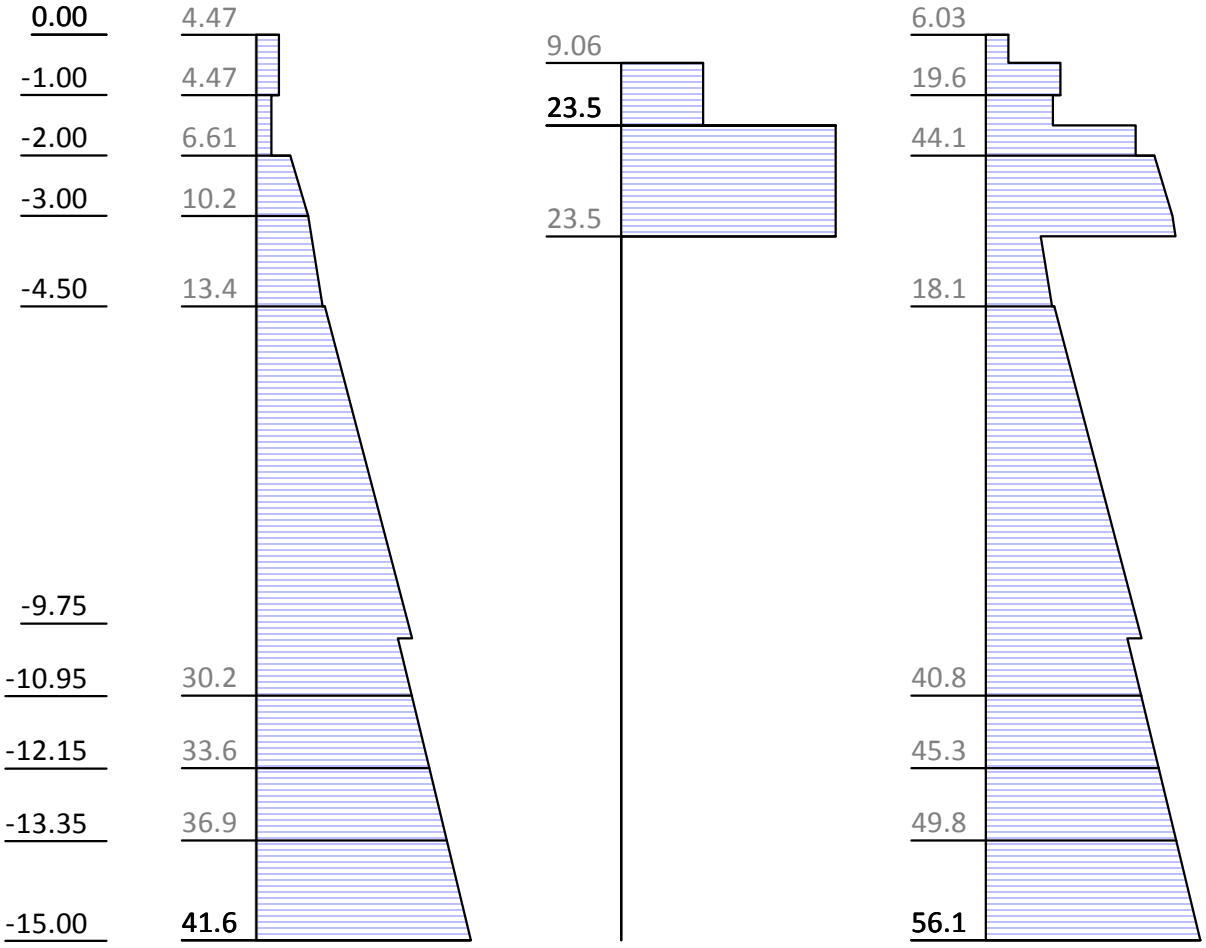


z [m]	eph,G,k [kN/m2]	eah,G,k [kN/m2]	eah,PQ,k [kN/m2]	eah,d [kN/m2]
0.00		0.00		0.00
-0.47		1.52	0.00	2.04
-0.47		1.52	9.06	15.62
-1.50		7.25	9.06	23.37
-1.50		4.82	23.48	41.73
-2.00	-0.00	6.61	23.48	44.14
-2.00	-100.29	6.61	23.48	44.14
-3.34	-123.80	10.79	23.48	49.78
-3.34	-123.80	10.79	0.00	14.56
-4.50	-135.45	12.86	0.00	17.36
-4.50	-305.34	13.38	0.00	18.06
-10.00	-820.67	30.24	0.00	40.82
-10.00	-999.52	27.52	0.00	37.16
-15.00	-1571.20	41.55	0.00	56.09

Eph,G,k:-9825.53, Eph,PG,k: 0.00 [kN/m]
Eah,G,k: 325.76, Eah,PG,k: 0.00, Eah,PQ,k: 52.53, Eah,d: 518.57

H-pressure on static system

Level of mobilization: Ep,gk 100.0, Ep,qk 100.0, Ep,d 100.0 [%]

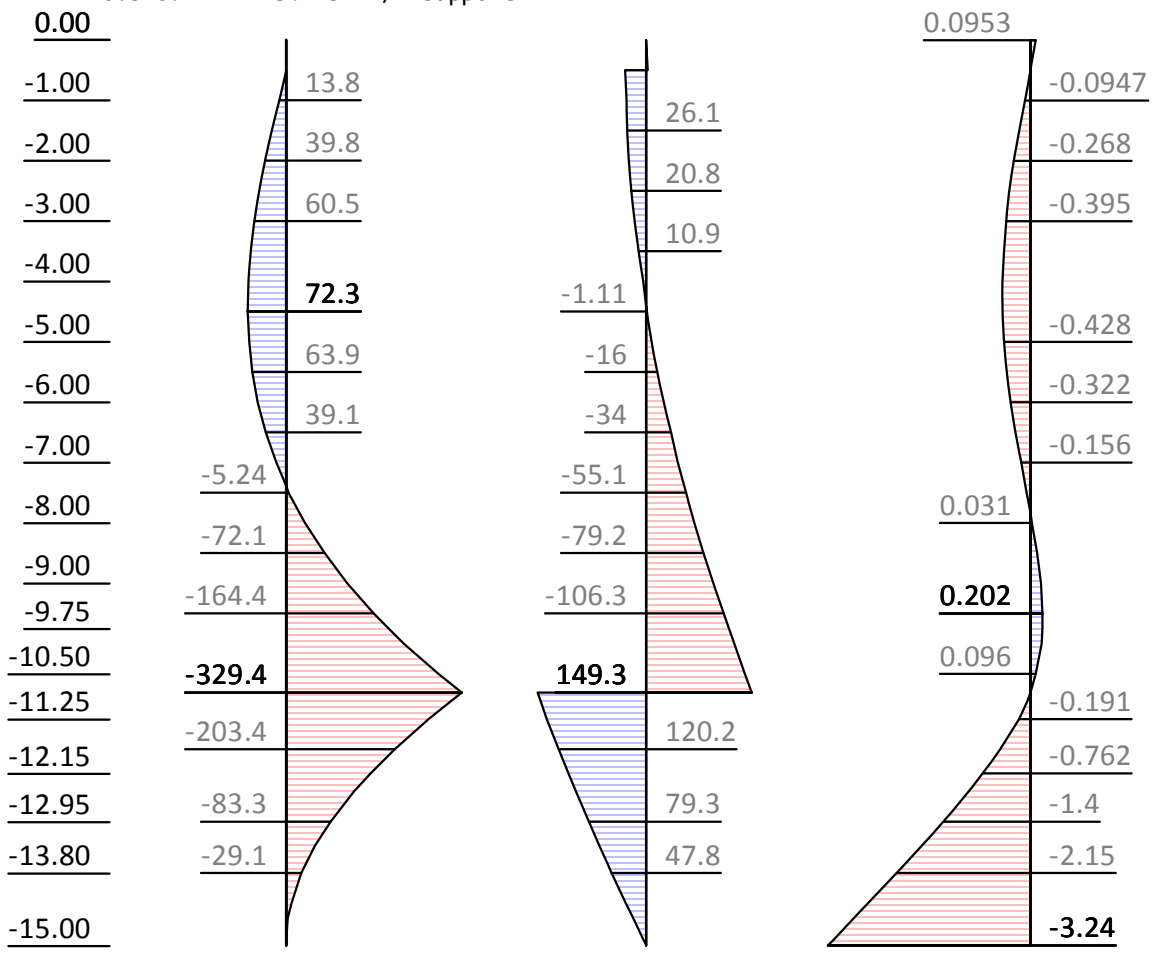


z [m]	PH,gk [kN/m2]	PH,qk [kN/m2]	PH,d [kN/m2]
0.00	4.47		6.03
-0.47	4.47	0.00	6.03
-0.47	4.47	9.06	19.62
-1.00	4.47	9.06	19.62
-1.00	2.98	9.06	17.61
-1.50	2.98	9.06	17.61
-1.50	2.98	23.48	39.25
-2.00	2.98	23.48	39.25
-2.00	6.61	23.48	44.14
-3.34	10.79	23.48	49.78
-3.34	10.79	0.00	14.56
-4.50	12.86	0.00	17.36
-4.50	13.38	0.00	18.06
-10.00	30.24	0.00	40.82
-10.00	27.52	0.00	37.16
-15.00	41.55	0.00	56.09

V-pressure on static system

Internal forces: Permanent, characteristically

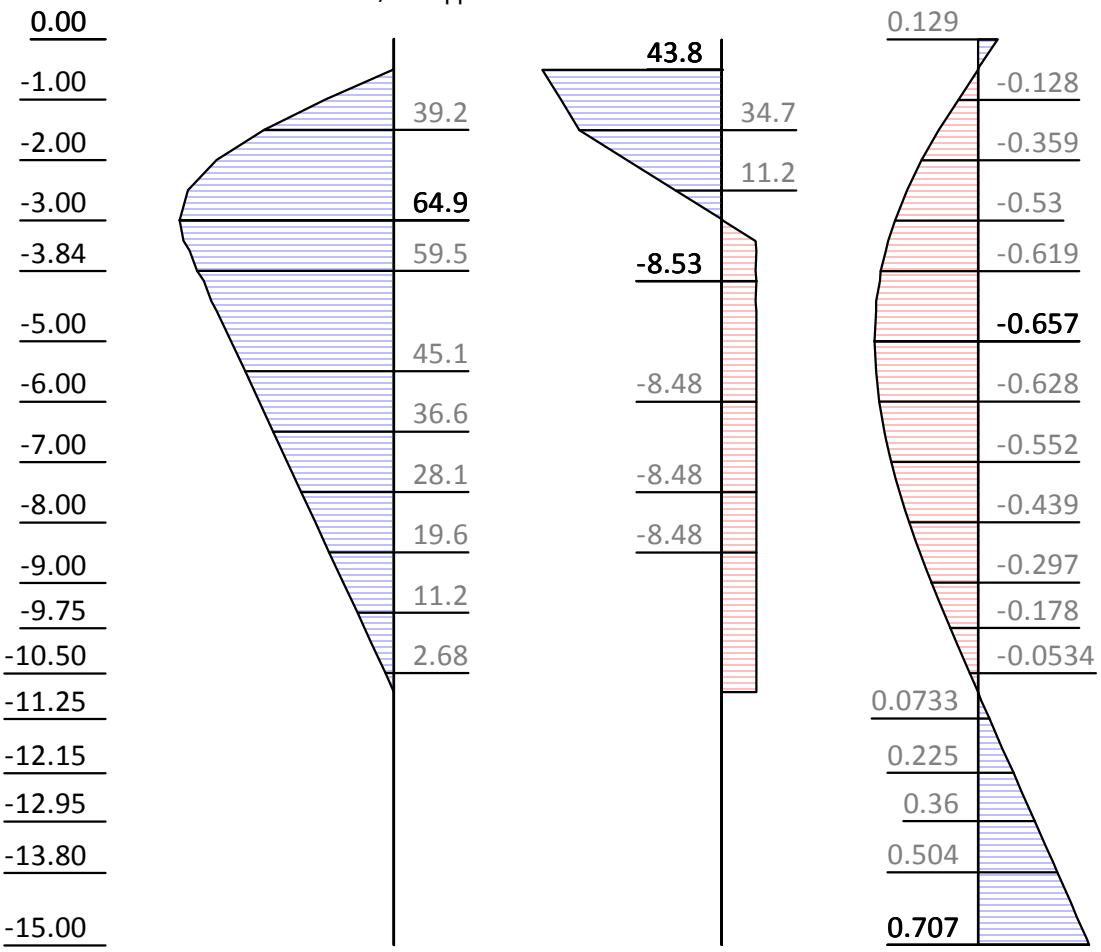
z= -0.500. Fx= -32.013 kN/m Support
z= -10.816. Fx=-293.745 kN/m Support



z [m]	H,g,k [kN/m2]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [mm]
0.00	4.47	0.00	-0.00	0.00	0.10
-0.50	4.47	-0.56	-2.23	-10.99	0.00
-0.50	4.47	-0.56	-2.23	-10.99	-0.00
-0.50	4.47	-0.56	29.78	-19.57	-0.00
-0.52	4.47	-0.00	29.69	-20.00	-0.00
-1.00	4.47	13.77	27.54	-30.56	-0.09
-1.00	2.98	13.77	27.54	-30.56	-0.09
-2.00	2.98	39.82	24.56	-52.21	-0.27
-2.00	6.61	39.82	24.56	-52.21	-0.27
-4.00	11.97	71.26	5.09	-85.83	-0.45
-4.41	12.70	72.10	-0.00	-91.01	-0.45
-4.50	12.86	72.28	-1.11	-92.14	-0.45
-4.50	13.38	72.28	-1.11	-92.14	-0.45
-7.39	22.25	0.00	-52.76	-149.48	-0.08
-7.83	23.60	-25.49	-62.84	-159.08	0.00
-9.50	28.71	-164.42	-106.33	-197.66	0.20
-10.00	30.24	-221.19	-121.06	-209.91	0.18
-10.00	27.52	-221.19	-121.06	-209.91	0.18
-10.82	29.82	-329.42	-144.46	-230.28	0.00
-10.82	29.82	-329.42	149.29	-230.28	0.00
-10.82	29.82	-329.42	149.29	-230.28	-0.00
-15.00	41.55	-0.00	-0.00	-347.40	-3.24

Internal forces: Variable, characteristically

Method EB 82-4 (Q = [G+Q] - G).
z= -0.500. Fx= -44.053 kN/m Support
z= -10.816. Fx= -8.480 kN/m Support

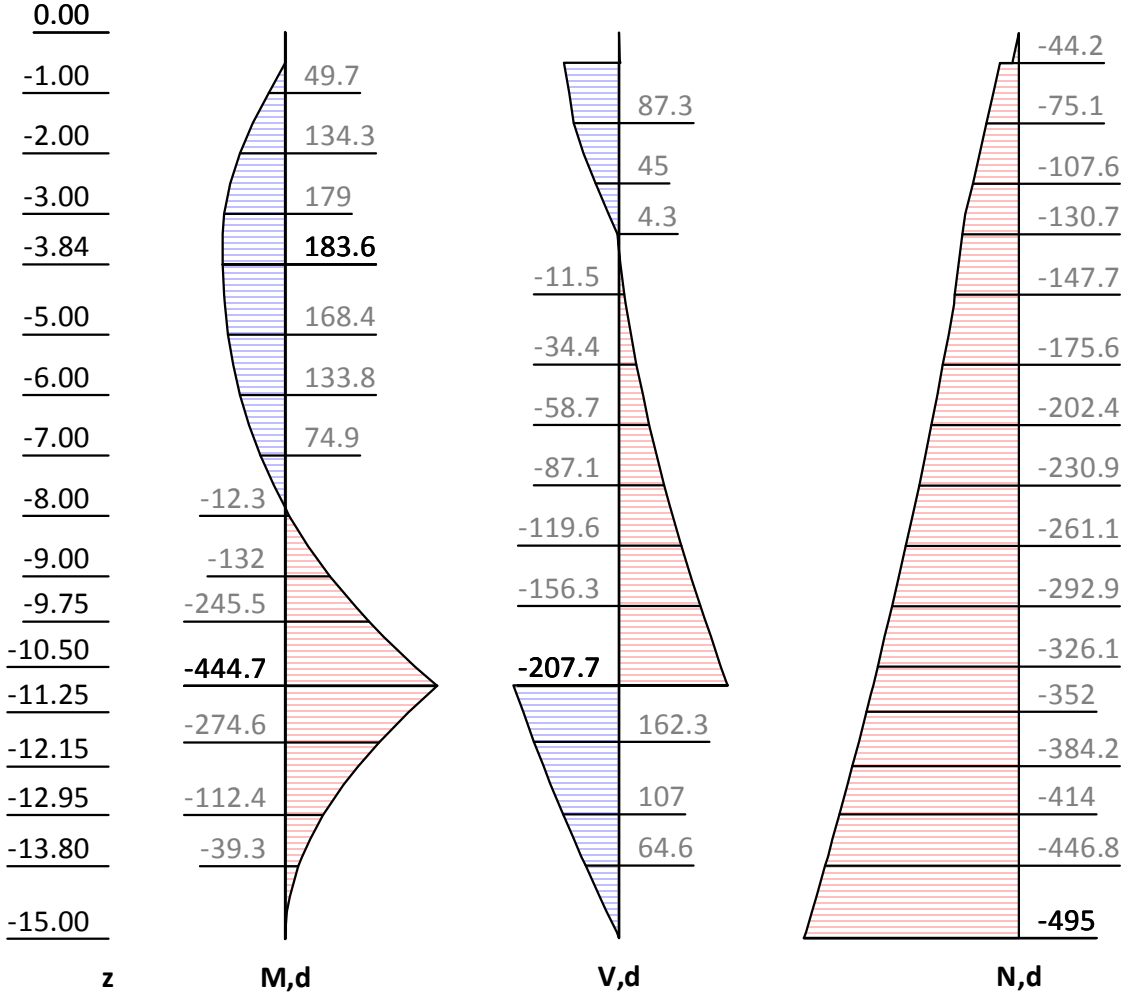


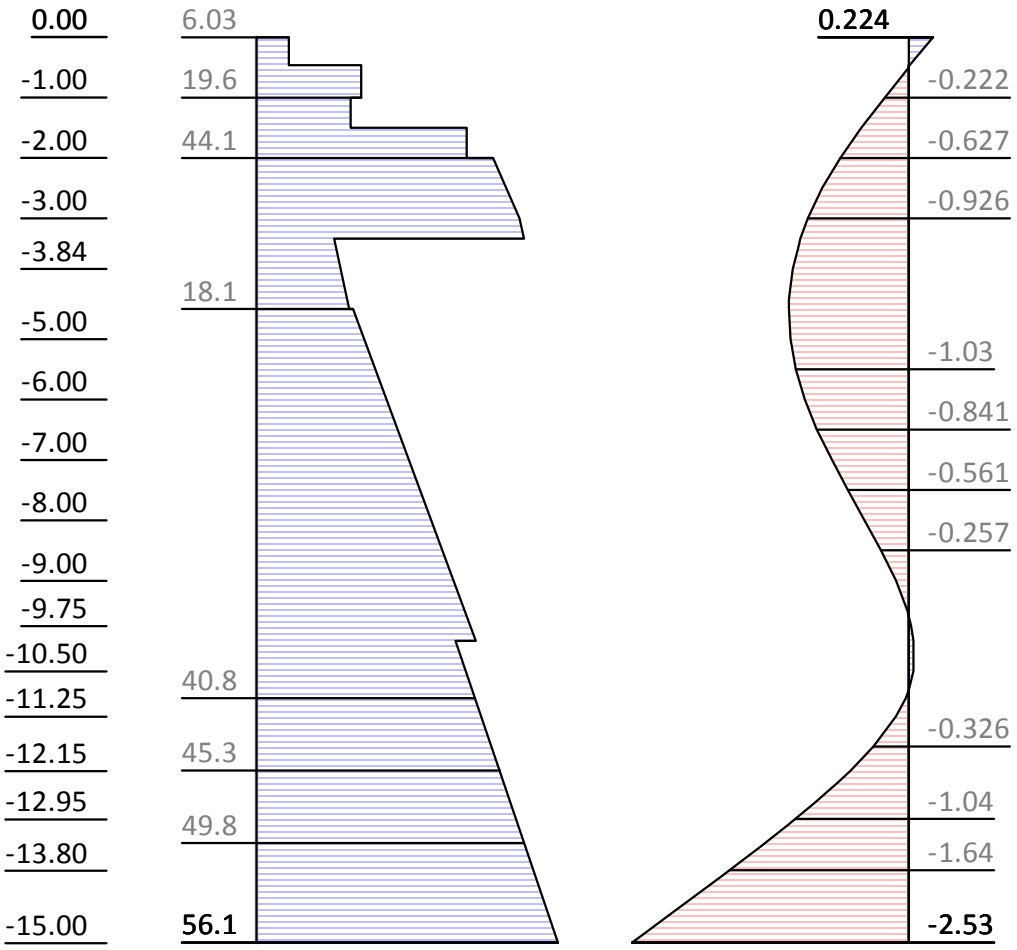
z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
0.00		-0.00	-0.00	0.00	0.13
-0.00		0.00	-0.00	0.00	0.13
-0.47	0.00	0.03	-0.00	0.00	0.01
-0.47	9.06	0.03	-0.00	-0.00	0.01
-0.50	9.06	0.00	-0.24	-0.03	0.00
-0.50	9.06	0.00	43.78	-11.83	-0.00
-1.50	9.06	39.25	34.72	-12.79	-0.25
-1.50	23.48	39.25	34.72	-12.79	-0.25
-2.98	23.48	64.81	-0.00	-16.46	-0.53
-3.00	23.48	64.92	-0.50	-16.52	-0.53
-3.34	23.48	63.69	-8.43	-17.36	-0.57
-3.34	0.00	63.69	-8.43	-17.36	-0.57
-3.50	0.00	61.74	-8.53	-17.36	-0.58
-4.00	0.00	57.47	-8.53	-17.36	-0.62
-5.00	0.00	49.32	-8.48	-17.36	-0.66
-10.00	0.00	6.92	-8.48	-17.36	-0.14
-10.82	0.00	0.00	-8.48	-17.36	0.00
-10.82	0.00	0.00	-0.00	-17.36	0.00
-10.95	0.00	0.00	-0.00	-17.36	0.02
-12.15	0.00	0.00	-0.00	-17.36	0.23
-13.80	0.00	0.00	-0.00	-17.36	0.50

z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
-14.55	0.00	0.00	-0.00	-17.36	0.63
-14.84	0.00	0.00	-0.00	-17.36	0.68
-14.90	0.00	-0.00	-0.00	-17.36	0.69
-14.94	0.00	-0.00	0.00	-17.36	0.70
-15.00	0.00	0.00	0.00	-17.36	0.71

Internal forces: Design

z= -0.500. Fx=-109.297 kN/m Support
z= -10.816. Fx=-409.275 kN/m Support





z [m]	H,d [kN/m2]	M,d [kN/m2]	V,d [kN/m2]	N,d [kN/m2]	u,g+q,k [mm]
0.00	6.03	0.00	-0.00	0.00	0.22
-0.00	6.03	0.00	-0.00	-0.00	0.22
-0.47	6.03	-0.67	-2.84	-13.95	0.01
-0.47	19.62	-0.67	-2.84	-13.95	0.01
-0.50	19.62	-0.76	-3.42	-14.88	0.00
-0.51	19.62	-0.00	105.72	-44.40	-0.00
-1.00	19.62	49.72	96.06	-59.72	-0.22
-1.00	17.61	49.72	96.06	-59.72	-0.22
-1.50	17.61	95.55	87.26	-75.05	-0.43
-1.50	39.25	95.55	87.26	-75.05	-0.43
-2.00	39.25	134.28	67.64	-91.53	-0.63
-2.00	44.14	134.28	67.64	-91.53	-0.63
-3.34	49.78	183.36	4.30	-130.68	-1.00
-3.34	14.56	183.36	4.30	-130.68	-1.00
-3.62	15.25	183.51	0.00	-135.50	-1.04
-3.84	15.77	183.63	-3.29	-139.19	-1.07
-4.50	17.36	177.92	-14.22	-150.43	-1.10
-4.50	18.06	177.92	-14.22	-150.43	-1.10
-7.87	32.01	-0.00	-98.73	-241.91	-0.45
-9.61	39.20	-222.78	-160.54	-296.46	-0.00
-10.00	40.82	-288.22	-176.15	-309.42	0.04
-10.00	37.16	-288.22	-176.15	-309.42	0.04
-10.82	40.26	-444.71	-207.74	-336.92	0.00
-10.82	40.26	-444.71	201.54	-336.92	0.00
-15.00	56.09	0.00	0.00	-495.03	-2.53

Anchor forces with safety level of DS-P

z[m]	A,d[kN]	Fx,d[kN/m]
-0.50	203.7	-109.3

Checks of earth statics

Check or earth support

Check: Mobilizable earth resistance is sufficient for earth support force.
z: -10.82 m
Rd = Eph,k/γ,Re = 9825.53 / 1.400 = 7018.24 [kN/m]

Ed(Uh,d)/Rd = 409.27 / 7018.24 = 0.058 [-]. Passes requirement

Sum of H and V forces, (G)

Forces up to depth z:-15.00

Pos.	H	V
H/V pressure G+P+W,k	325.76	124.61
Wall weight		214.21
H/V pressure passive		0.00
Support z: -0.50	-32.01	8.58
Bh,g,k z=-10.82	-293.74	
Bv,g,k = Bh,k * tan(δ,p=-23.33°)		-126.71
Σ	0.00	220.69 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than
the downwards pointing vertical forces.

Vk >= Bvk: 347.40 >= 126.71 Passes requirement

Sum of H and V forces, (G+Q)

Forces up to depth z:-15.00

Pos.	H	V
H/V pressure G+P+W,k	378.29	130.17
Wall weight		214.21
H/V pressure passive		0.00
Support z: -0.50	-76.07	20.38
Bh,g,k z=-10.82	-293.74	
Bv,g,k = Bh,k * tan(δ,p=-23.33°)		-126.71
Bh,q,k z=-10.82	-8.48	
Bv,q,k = Bh,k * tan(δ,p=-23.33°)		-3.66
Σ	0.00	234.39 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than
the downwards pointing vertical forces.

Vk >= Bvk: 364.76 >= 130.37 Passes requirement

Anchor verification

Anchor - Stability of lower failure plane

Περίπτ.Φόρτισης: όλα τα φορτία BS-P
Αυτόμ. υπολογ. μήκους αγκυρίων:
All anchors are extended (if necessary)
Favourable variable loads in main failure body are not being considered.
Bottom of lower failure plane: z=-15.00 m

Iteration of failure mechanisms:
lA .....: Length of anchor from head to center of grout body.
W,k .....: Res. force from dead weight, loads, cohesion, ...
Q,k .....: Force in lower failure plane.
Ea1,k.....: Earth pressure onto vertical separation plane.
Ea2,k.....: Earth pressure between wall and main failure body.
Ra_cal,d ...: Dimesioning force of the resistance from the equilibrium of forces. Ra_cal,d corresponds to the max. possible anchor force of the force polygon.
Sum(A,d) ...: Acting anchor forces along the grout body fractions within the failure body. Sum(A,d) is gained from the anchor pull forces of the wall analysis.

z [m]	ϑ1 [°]	ϑ2 [°]	lA [m]	W,k [kN/m]	Q,k [kN/m]	Ea1,k [kN/m]	Ea2,k [kN/m]	Ra_cal,d [kN/m]	Sum(A,d) [kN/m]	Ed/Rd [-]
-0.50	45.5	57.5	11.67	1466.8	1331.5	4.4	400.0	113.2	113.2	1.00

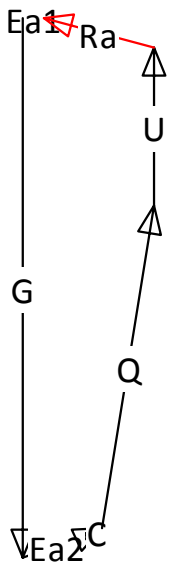
Decisive failure body:
Γεωμετρία:

Foot point of lower failure plane	x/z = 0.01/-15.00 m
Intersection lower/upper slid. plane	x/z = 11.27/ -3.52 m
Intersection upper slid. plane/surface	x/z = 13.52/ 0.00 m
Intersection separation plane/surface	x/z = 11.27/ 0.00 m
Inclination lower failure plane	ϑ1 = 45.54°
Inclination upper failure plane	ϑ2 = 57.50°
Inclination separation plane	ϑ12 = 90.00°

Loads / forces (char.)

		Fx [kN/m]	Fz [kN/m]	F [kN/m]	
Weight of main failure body	G,k:	0.0	-2187.6	2187.6	
Area loads on/in main failure body	F1,k:	0.0	-82.5	82.5	
Cohesion of lower failure plane	C,k:	99.6	101.5	142.1	
Pore water pressure on main body	U,k:	-0.5	705.2	705.2	
Earth pres. on separation plane	Ea1,k:	-4.4	-0.0	4.4	δ= 0.0°
Earth pr. between wall<->main body	Ea2,k:	378.3	129.9	400.0	
Force in lower failure plane	Q,k:	-319.8	1292.5	1331.5	
Sum = possible anchor forces:	Ra_cal,k:	153.1	-41.0	158.5	

Force polygon



Acting anchor forces Ed: Sum(A,d) = 113.2 kN/m
Possible anchor forces Rd: Ra_cal,d = 158.5/1.400 = 113.2 kN/m

Verif. of lower failure plane Ed/Rd = 1.00 < 1.0: Έλεγχος εκπληρώθηκε.

Check of steel tension

l,tot ...[m]: Total length of anchor incl. excess length at head
As ....[mm2]: X-section are of steel member
Ri,d ...[kN]: Ultimate strength of tension member (γ,M=1.15)
A,d ....[kN]: Dimensioning force of the anchor from wall analysis

z[m]	Anchor type	l,tot	As	Ri,d		A,d	
-0.50	Strand;3x0.60";1570/1770	15.67	420	573.4	>	203.7	Passes requirement

Check of steel tension: Passes requirement

Check of anchor's soil friction

lVk .....: Length of grout body
DmVk ....: Diameter of grout body
τGr,k ...: Average applied skin friction along the grout body (from soil parameters)
Ra,k ....: Charact. pullout resistance of the anchor
γA ......: Partial safety factor of anchor pullout
Ra,d ....: = Ra,k / γA
A,d .....: Dimensioning force of the anchor from wall analysis

z [m]	lVk [m]	DmVk [mm]	τGr,k [kN/m²]	Ra,k [kN]	γA [-]	Ra,d [kN]		A,d [kN]	A,d/Ra,d [-]
-0.50	8.00	318	110	879.1	1.100	799.2	>	203.7	0.3

Check of anchor's soil friction: Passes requirement

Υπολογ. κύκλου ολίσθησης

LC: όλα τα φορτία Type: BS-T (combination: [GEO] A2 M2 R3, BS-T)
Vertical variable loads only act if they are outside of R*sin(phi).
The automatic slip circle optimization only considers circles that intersect
the surface with an area of at least 0.25 m2.
The slip circle calculation only accepts circles including the wall.
The slipcircle calculation only allows circular failure planes
(no vertical tangents will occour).

Γεωμετ.κύκλου (μήκη και συντεταγμ. σε (m))
Κέντρο = (-0.78, 3.16), Ακτίνα = 18.19
Αρχ.σημ.= (-18.22, -2.00), Τελ.σημ. = (17.13, 0.00)

Γεωμετρία λωρίδων:

No	x	Width b	dxM	Weight	Load z-κατ.	Water-φορτ.	u*b	φ	c	θ
	[m]	[m]	[m]	[kN/m]	[kN/m]	[kN/m]	[kN/m]	[°]	[kN/m²]	[°]
1	-17.31	1.82	-16.53	88.2	0.0	0.0	-28.7	0.08	35.71	-44.96*
2	-15.50	1.82	-14.71	215.1	0.0	0.0	-80.4	27.45	3.57	-31.27*
3	-13.68	1.82	-12.89	302.4	0.0	0.0	-120.1	27.45	3.57	-31.27*
4	-11.86	1.82	-11.08	367.9	0.0	0.0	-149.5	29.26	3.57	-30.37*
5	-10.04	1.82	-9.26	418.2	0.0	0.0	-172.1	29.26	3.57	-30.37*
6	-8.22	1.82	-7.44	456.7	0.0	0.0	-189.3	29.26	3.57	-24.13
7	-6.40	1.82	-5.62	485.4	0.0	0.0	-202.1	29.26	3.57	-17.99
8	-4.58	1.82	-3.80	505.4	0.0	0.0	-211.0	29.26	3.57	-12.06
9	-2.76	1.82	-1.98	517.4	0.0	0.0	-216.4	29.26	3.57	-6.25
10	-0.94	1.82	-0.16	521.8	0.0	0.0	-218.3	29.26	3.57	-0.51
11	0.88	1.82	1.66	584.8	0.0	0.0	-217.0	29.26	3.57	5.23
12	2.70	1.82	3.48	575.4	0.0	0.0	-212.2	29.26	3.57	11.02
13	4.51	1.82	5.30	556.9	0.0	0.0	-204.0	29.26	3.57	16.93
14	6.33	1.82	7.12	529.8	0.0	0.0	-191.9	29.26	3.57	23.03
15	8.15	1.82	8.93	493.1	0.0	0.0	-175.5	29.26	3.57	29.42
16	9.97	1.82	10.75	445.1	0.0	0.0	-154.0	29.26	3.57	36.24
17	11.79	1.82	12.57	382.7	0.0	0.0	-125.9	27.45	3.57	43.72
18	13.61	1.82	14.39	300.0	0.0	0.0	-88.4	27.45	3.57	52.29
19	15.83	2.61	16.61	214.7	0.0	0.0	-48.0	0.08	35.71	65.92

*** Σημείωση: Στις λωρίδες σημειωμένες με '*'
περιορίστηκε το theta στο 45°-Phi/2.

Συνεισφ. κατακόρυφων φορτίων:

No	Weight	G*sin(θ)	(G-u*b)*tan(φ) + c*b	μ*sin(θ)* tan(φ)+cos(θ)	T
	[kN/m]	[kN/m]	[kN/m]	[-]	[kN/m]
1	88.17	-80.13	65.05	0.707504	91.94
2	215.06	-173.95	76.47	0.828416	92.31
3	302.43	-214.38	101.23	0.828416	122.19
4	367.89	-224.00	128.81	0.835160	154.24
5	418.20	-212.81	144.37	0.835160	172.86
6	456.73	-186.74	156.30	0.890276	175.56
7	485.40	-149.92	165.18	0.934246	176.81
8	505.38	-105.56	171.38	0.966543	177.31
9	517.38	-56.32	175.10	0.988114	177.21
10	521.77	-4.62	176.47	0.999477	176.56
11	584.77	53.29	212.52	1.000814	212.35
12	575.38	109.98	209.92	0.991998	211.61
13	556.86	162.12	204.17	0.972575	209.93
14	529.79	207.22	195.78	0.941685	207.91
15	493.13	242.19	184.43	0.897893	205.40
16	445.10	263.11	169.57	0.838841	202.15
17	382.67	264.48	139.88	0.757716	184.61
18	299.97	237.31	116.39	0.651694	178.60
19	214.72	196.03	93.54	0.408200	229.15
		--------			-------
		327.31			3358.70

Δράση Ed = (327.3*18.19)
Αντίσταση Rd = (3358.7*18.19 +0.0)

SLIP-CIRCLE μ = Ed/Rd = 0.10 < 1.0: Έλεγχος εκπληρώθηκε.

Φάση εκσκαφής 3 "[3] Situation 3"

LC: όλα τα φορτία Type: BS-T

Εδαφικό σύστημα με 5 Στρώσεις

Name		Τεχνητές επιχωματώσεις	Αμμώδης ΑΡΓΙΛΟΣ	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
γ	[kN/m3]	18	20	22.5
γ,R	[kN/m3]	18	20	22.5
γ'	[kN/m3]	8	10	12.5
γ,p	[kN/m3]	18	20	22.5
γ,R,passive	[kN/m3]	18	20	22.5
γ,pw	[kN/m3]	8	10	12.5
φ	[°]	25	0.1	33
c	[kN/m2]	2	50	5
c,u	[kN/m2]	10	50	5
c παθητικό	[kN/m2]	2	50	5
δ,a	[°]	16.66667	0.06666667	22
δ,p	[°]	-16.66667	-0.06666667	-22
δ,c	[°]	8.333333	0.03333333	11
k,agh	[-]	0.3456501	0.9955057	0.2452023
K,ach	[-]	1.043051	1.994195	0.8549058
K,0h	[-]	0.5773817	0.9982547	0.455361
K,pgh	[-]	3.908103	1.004519	7.495617
K,pch	[-]	5.180327	2.00583	8.599509
τ,gr	[kN/m2]	110	110	110
Ψ,A,max	[°]	90	90	90
k	[cm/s]	10e-06	1e-06	100e-06

Name		Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
γ	[kN/m3]	22.5	22.5
γ,R	[kN/m3]	22.5	22.5
γ'	[kN/m3]	12.5	12.5
γ,p	[kN/m3]	22.5	22.5
γ,R,passive	[kN/m3]	22.5	22.5
γ,pw	[kN/m3]	12.5	12.5
φ	[°]	35	35
c	[kN/m2]	5	5
c,u	[kN/m2]	5	5
c παθητικό	[kN/m2]	5	5
δ,a	[°]	23.33333	23.33333
δ,p	[°]	-23.33333	-23.33333
δ,c	[°]	11.66667	11.66667
k,agh	[-]	0.2244207	0.2244207
K,ach	[-]	0.8126539	0.8126539
K,0h	[-]	0.4264236	0.4264236
K,pgh	[-]	9.146943	9.146943
K,pch	[-]	10.104	10.104
τ,gr	[kN/m2]	110	110
Ψ,A,max	[°]	90	90
k	[cm/s]	100e-06	100e-06

Πορεία πρανούς:
x [m] 0.00 0.00
z [m] -4.00 0.00

Πορεία ανώτερου 2. στρώματος Αμμώδης ΑΡΓΙΛΟΣ:
x [m] 0.00 0.00
z [m] -4.00 -1.50

Πορεία ανώτερου 3. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ:
z= -4.50

Πορεία ανώτερου 4. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -10.00

Πορεία ανώτερου 5. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -14.00

Επιφ. φορτία:

Φορτία

xA [m]	zA [m]	xE [m]	zE [m]	PxA [kN/m²]	PzA [kN/m²]	PxE [kN/m²]	PzE [kN/m²]	Typ	LC-description Name
1.00	0.00	3.50	0.00	0.00	33.00	0.00	33.00	q	1

Κατανομή εδαφ.πιέσεων

Κατανομή εδαφ.πιέσεων	Name
Rectangular within a layer	

Στάθμη νερού:

x [m]	0.00	0.00
z [m]	-6.00	-3.00

Αγκύρια

z[m]	min.l[m]	Alpha[°]	C-H[kN/m]	P0[kN]	u0[m]
-0.50	0.00	15.00	αόριστ.	0.00	0.0000

Παράμετροι υπολογισμού

Earth pressure options

Τμήμα εδαφ.ωθήσεων: Ενεργές ωθήσεις.
Angle of slip plane: DIN 4085.
Split block loads into 1 sections.
Consideration of minimum earth pressure: φ,min = 40.000.
Negative earth pressure fractions are set to zero.

Redistribution of earth pressure

Shape of redistribution: Trapezoid.
The earth pressure is getting redistb. to: Excavation level
The earth pressure below the excavation acts without redistrb.
Levels of redistribution Z1: 0.000, Z2: -2.000 [m].
The earth pressure from variable loads will be included in redistribution.

Παθητικές ωθήσεις

Method of calculation: Κλασικός, Pregl/Sokolovsky (DIN 4085).

Options for water pressure

Στήριξη πόδα

Πόδας οριζοντίως μετακινούμενος

Αγκύρια

Anchor checks (lower failure plane): Ναι
Anchor forces with safety level of DS-P: Ναι
Verification of grout body pull out forces: Ναι
δ,a,Anchoring wall : used from soil layer.
δ,p,Anchoring wall : used from soil layer.

Earth pressure coefficients kh

φ	α	β	δ	k0gh	kagh	kach	kpgh	kpch	
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Τεχνητές επιχωματώσεις
25.0	0.0	0.0	16.7	--	0.346	1.043	--	--	"
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Αμμώδης ΑΡΓΙΛΟΣ
0.1	0.0	0.0	0.1	--	0.996	1.994	--	--	"
33.0	0.0	0.0	-22.0	--	--	--	7.496	-8.600	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
33.0	0.0	0.0	22.0	--	0.245	0.855	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"

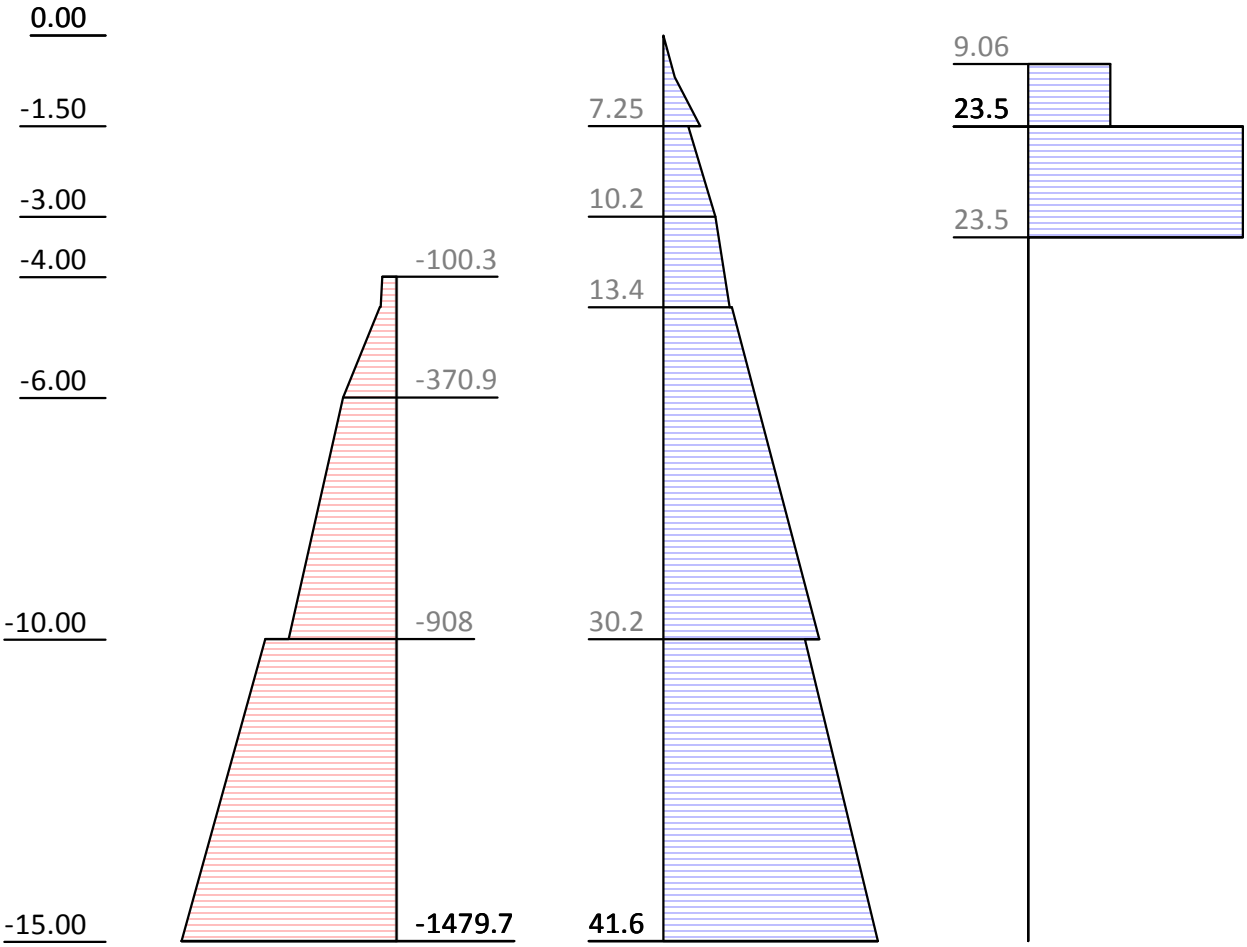
Μήκος τοίχου

Foot depth for statics: zf = -15.000

Stress analysis

Earth pressure, horizontal

Pressures characteristic, no redistribution, continous wall



z [m]	eph,G,k [kN/m2]	eah,G,k [kN/m2]	eah,PQ,k [kN/m2]	eah,d [kN/m2]
0.00		0.00		0.00
-0.47		1.52	0.00	2.04
-0.47		1.52	9.06	15.62
-1.50		7.25	9.06	23.37
-1.50		4.82	23.48	41.73
-3.34		10.79	23.48	49.78
-3.34		10.79	0.00	14.56
-4.00	-0.00	11.97	0.00	16.15
-4.00	-100.29	11.97	0.00	16.15
-4.50	-110.34	12.86	0.00	17.36
-4.50	-117.95	13.38	0.00	18.06
-10.00	-745.71	30.24	0.00	40.82
-10.00	-908.05	27.52	0.00	37.16
-15.00	-1479.73	41.55	0.00	56.09

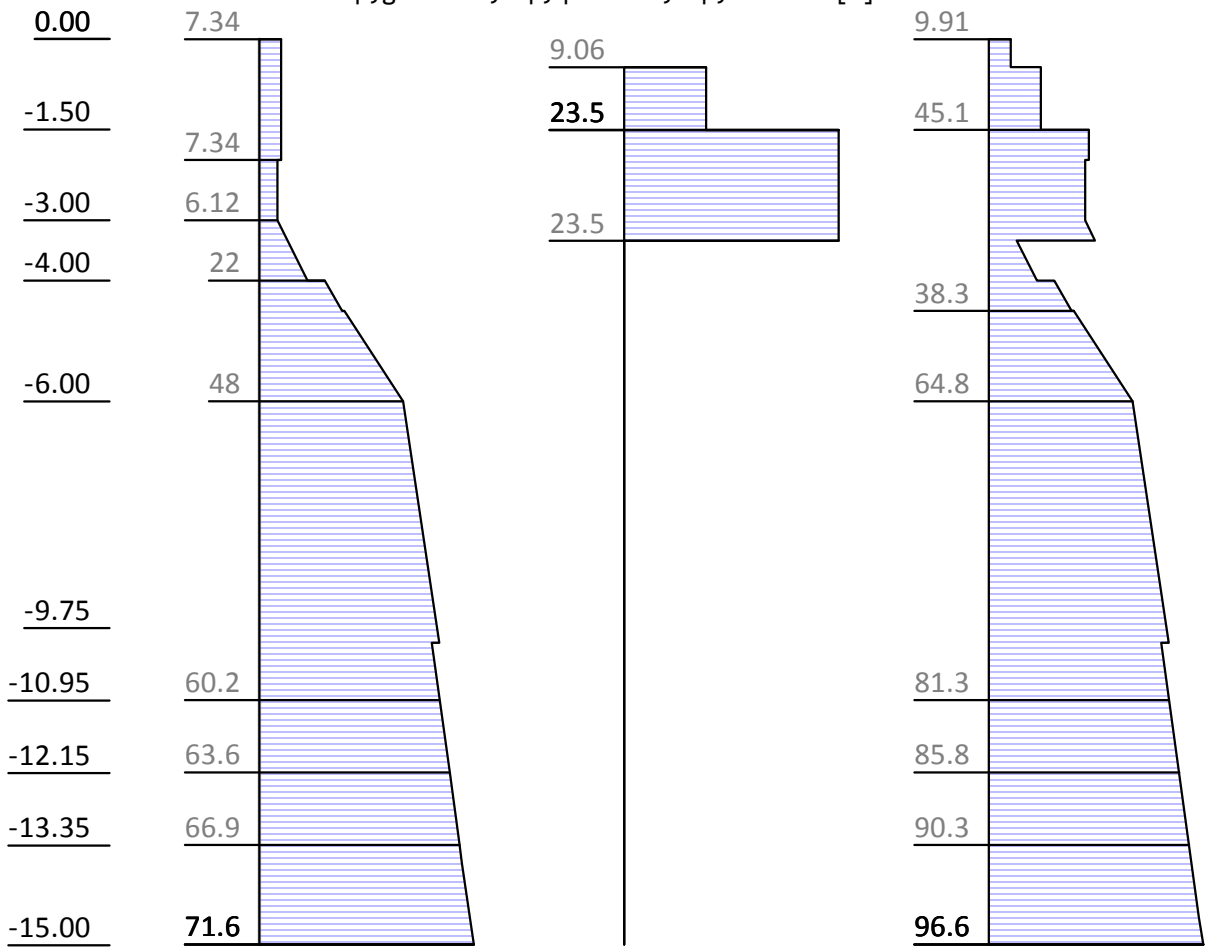
Eph,G,k:-8622.04, Eph,PG,k: 0.00 [kN/m]
Eah,G,k: 325.76, Eah,PG,k: 0.00, Eah,PQ,k: 52.53, Eah,d: 518.57

Πίεση νερού

z [m]	Wp,k [kN/m2]	Wa,k [kN/m2]	W,k [kN/m2]
-3.00		0.00	0.00
-6.00	0.00	30.00	30.00
-15.00	-90.00	120.00	30.00

H-pressure on static system

Level of mobilization: Ep,gk 100.0, Ep,qk 100.0, Ep,d 100.0 [%]

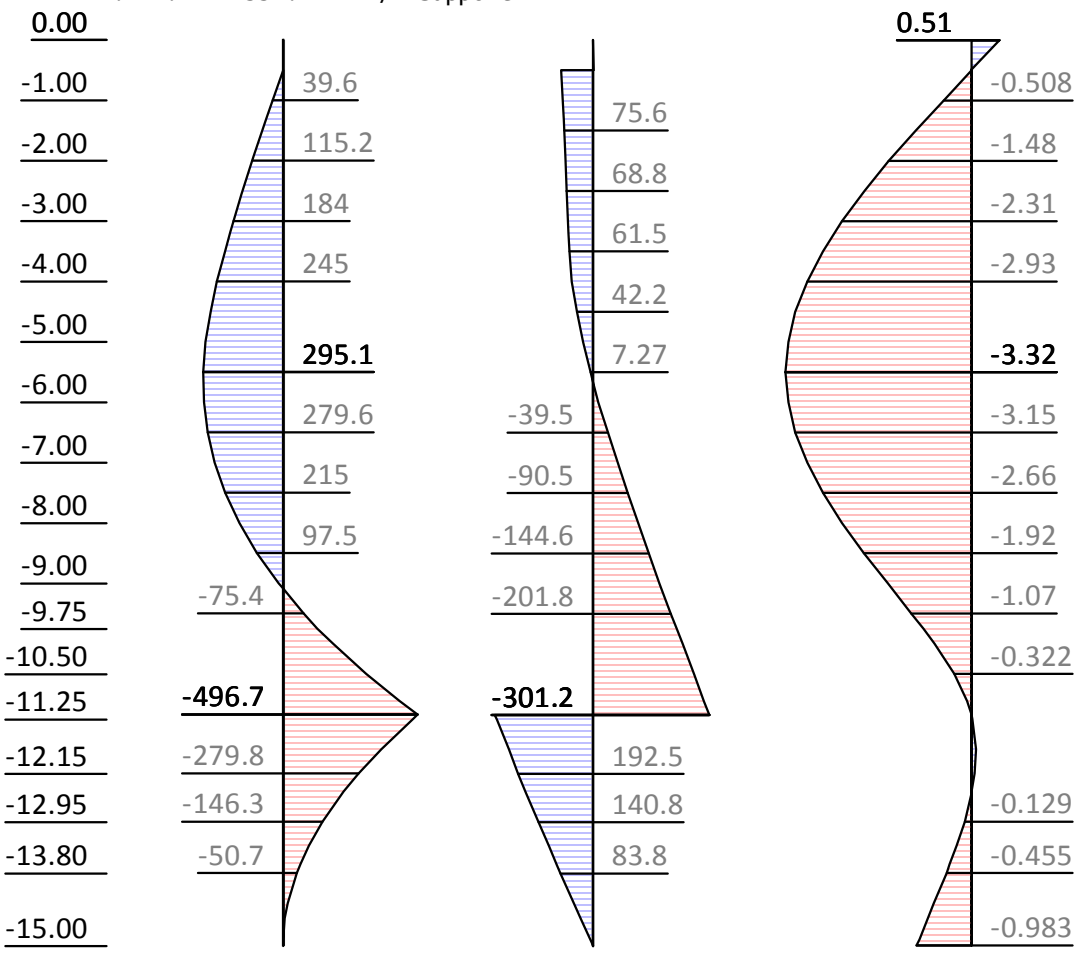


z [m]	PH,gk [kN/m2]	PH,qk [kN/m2]	PH,d [kN/m2]
0.00	7.34		9.91
-0.47	7.34	0.00	9.91
-0.47	7.34	9.06	23.50
-1.50	7.34	9.06	23.50
-1.50	7.34	23.48	45.13
-2.00	7.34	23.48	45.13
-2.00	6.12	23.48	43.48
-3.34	9.52	23.48	48.07
-3.34	9.52	0.00	12.85
-4.00	16.12	0.00	21.76
-4.00	21.97	0.00	29.65
-4.50	27.86	0.00	37.61
-4.50	28.38	0.00	38.31
-10.00	60.24	0.00	81.32
-10.00	57.52	0.00	77.66
-15.00	71.55	0.00	96.59

V-pressure on static system

Internal forces: Permanent, characteristically

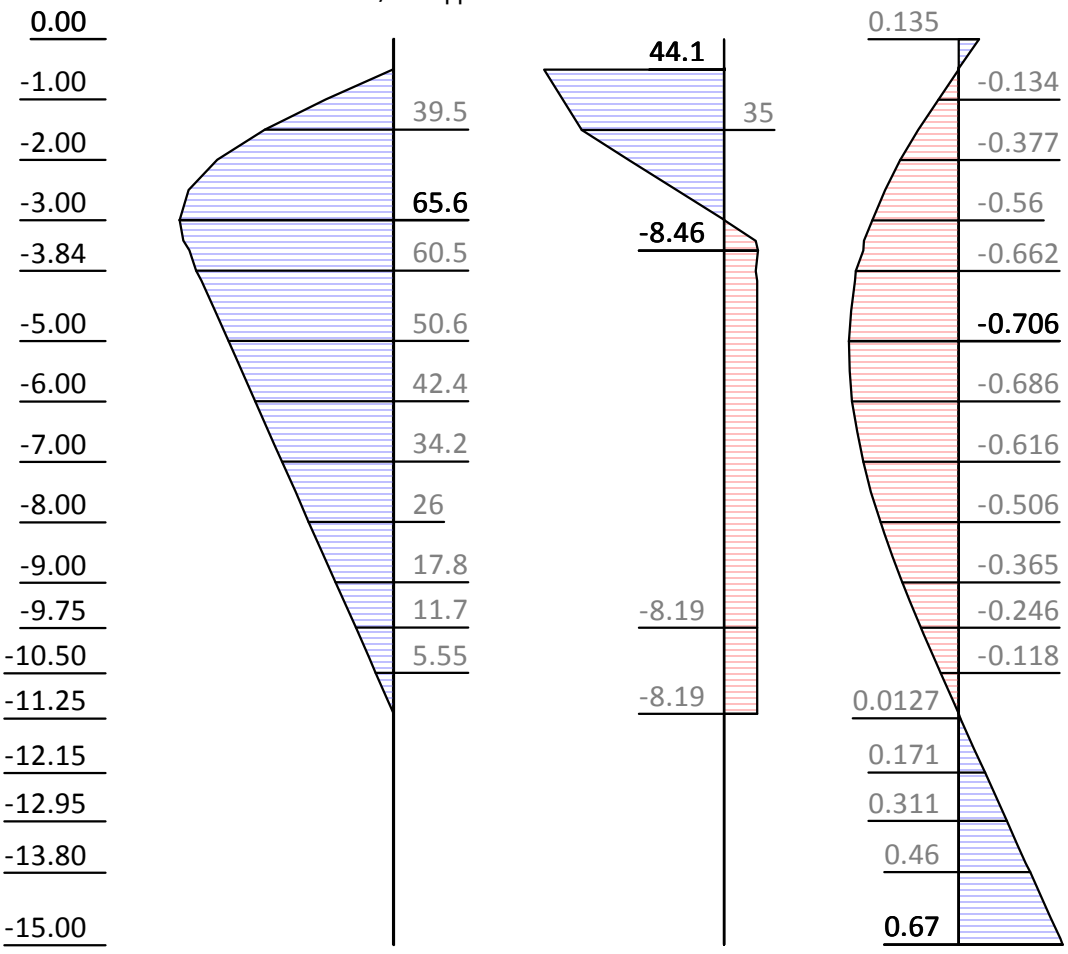
z= -0.500. Fx= -86.564 kN/m Support
z= -11.177. Fx=-554.194 kN/m Support



z [m]	H,g,k [kN/m2]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [mm]
0.00	7.34	-0.00	-0.00	0.00	0.51
-0.50	7.34	-0.92	-3.67	-10.73	0.00
-0.50	7.34	-0.92	-3.67	-10.73	-0.00
-0.50	7.34	-0.92	82.89	-33.92	-0.00
-0.51	7.34	-0.00	82.81	-34.16	-0.01
-2.00	7.34	115.16	71.88	-66.10	-1.48
-2.00	6.12	115.16	71.88	-66.10	-1.48
-4.00	16.12	245.02	54.65	-108.85	-2.93
-4.00	21.97	245.02	54.65	-108.85	-2.93
-4.50	27.86	269.35	42.19	-119.36	-3.14
-4.50	28.38	269.35	42.19	-119.36	-3.14
-5.50	41.45	295.15	7.27	-137.99	-3.32
-5.66	43.57	294.57	0.00	-141.17	-3.30
-9.10	57.47	-0.00	-178.50	-215.27	-1.42
-10.00	60.24	-183.47	-231.51	-237.12	-0.67
-10.00	57.52	-183.47	-231.51	-237.12	-0.67
-11.18	60.83	-496.66	-301.18	-266.78	0.00
-11.18	60.83	-496.66	253.02	-266.78	0.00
-11.75	62.43	-361.83	217.72	-281.81	0.09
-12.49	64.50	-219.02	170.91	-301.75	0.00
-15.00	71.55	-0.00	-0.00	-374.62	-0.98

Internal forces: Variable, characteristically

Method EB 82-4 (Q = [G+Q] - G).
z= -0.500. Fx= -44.340 kN/m Support
z= -11.177. Fx= -8.193 kN/m Support



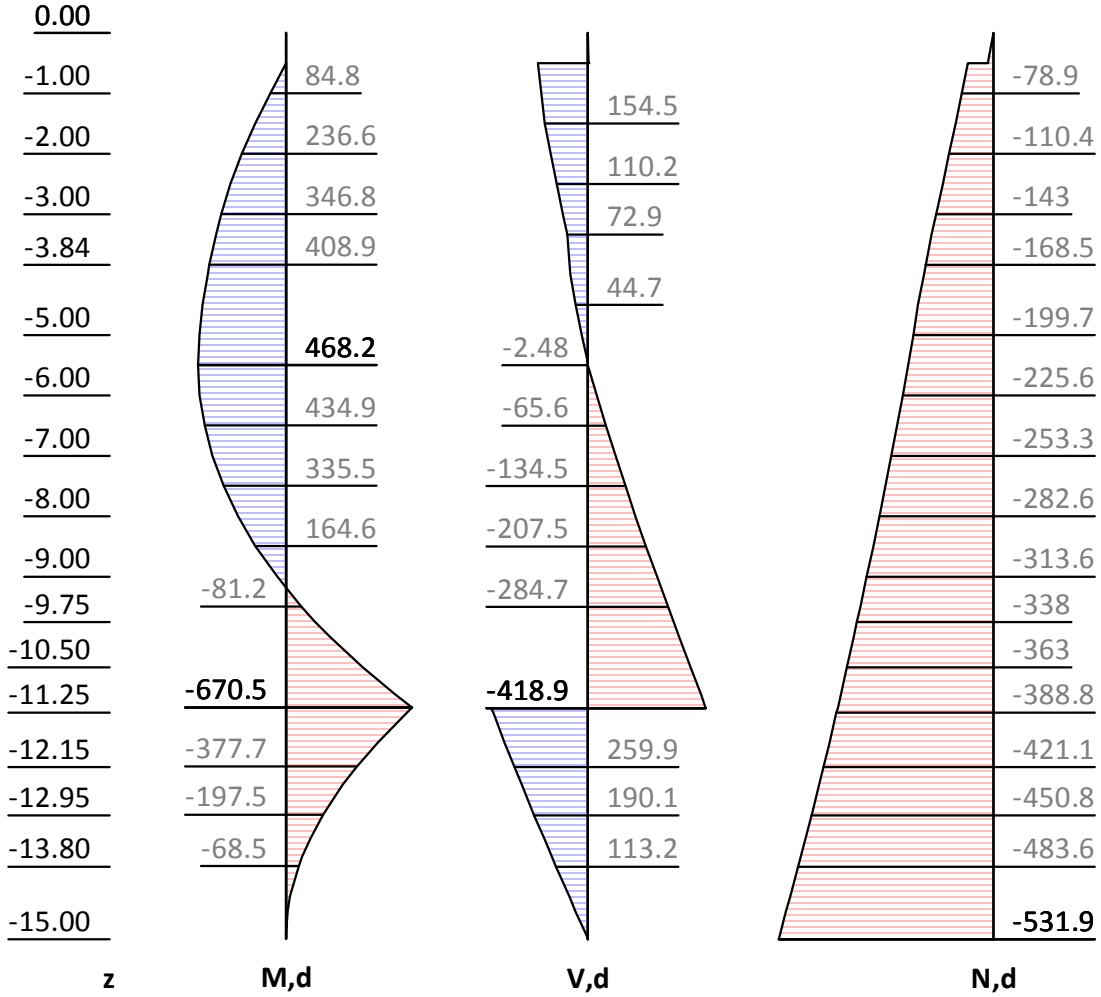
z **M,qk** **V,qk** **u,qk**

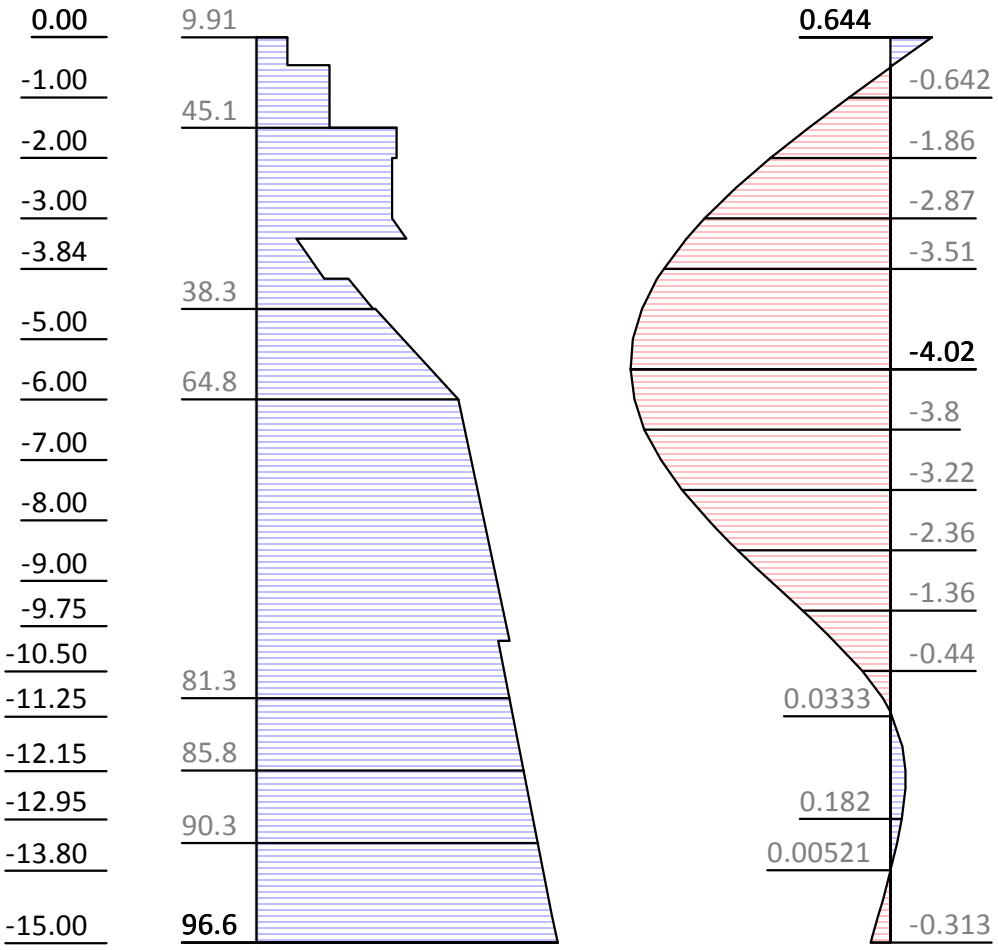
z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
0.00		0.00	-0.00	0.00	0.13
-0.47	0.00	0.05	-0.00	0.00	0.01
-0.47	9.06	0.05	0.00	-0.00	0.01
-0.47	9.06	0.05	-0.00	-0.00	0.01
-0.50	9.06	-0.00	-0.25	-0.03	0.00
-0.50	9.06	0.00	44.07	-11.91	-0.00
-1.50	9.06	39.54	35.01	-12.87	-0.26
-1.50	23.48	39.54	35.01	-12.87	-0.26
-2.99	23.48	65.59	-0.00	-16.57	-0.56
-3.00	23.48	65.64	-0.21	-16.59	-0.56
-3.34	23.48	64.45	-7.92	-17.44	-0.61
-3.34	0.00	64.45	-7.92	-17.44	-0.61
-3.50	0.00	62.58	-8.46	-17.44	-0.61
-3.84	0.00	60.49	-7.92	-17.44	-0.66
-4.50	0.00	54.71	-8.19	-17.44	-0.69
-5.00	0.00	50.61	-8.19	-17.44	-0.71
-6.00	0.00	42.42	-8.19	-17.44	-0.69
-7.00	0.00	34.22	-8.19	-17.44	-0.62
-8.00	0.00	26.03	-8.19	-17.44	-0.51
-9.50	0.00	13.74	-8.19	-17.44	-0.29
-10.95	0.00	1.86	-8.19	-17.44	-0.04
-11.18	0.00	-0.00	-8.19	-17.44	-0.00

z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
-11.18	0.00	-0.00	-8.19	-17.44	0.00
-11.18	0.00	-0.00	0.00	-17.44	0.00
-11.25	0.00	-0.00	0.00	-17.44	0.01
-13.65	0.00	-0.00	0.00	-17.44	0.43
-13.80	0.00	-0.00	-0.00	-17.44	0.46
-14.92	0.00	-0.00	0.00	-17.44	0.66
-15.00	0.00	0.00	0.00	-17.44	0.67

Internal forces: Design

z= -0.500. Fx=-183.371 kN/m Support
z= -11.177. Fx=-760.451 kN/m Support





z [m]	H,d [kN/m2]	M,d [kN/m2]	V,d [kN/m2]	N,d [kN/m2]	u,g+q,k [mm]
0.00	9.91	0.00	0.00	0.00	0.64
-0.00	9.91	-0.00	-0.00	-0.00	0.64
-0.47	9.91	-1.09	-4.66	-13.61	0.04
-0.47	23.50	-1.09	-4.66	-13.61	0.04
-0.50	23.50	-1.25	-5.36	-14.52	-0.00
-0.51	23.50	-0.00	177.84	-63.88	-0.01
-1.50	23.50	165.01	154.51	-94.05	-1.27
-1.50	45.13	165.01	154.51	-94.05	-1.27
-2.00	45.13	236.63	131.94	-110.40	-1.86
-2.00	43.48	236.63	131.94	-110.40	-1.86
-3.34	48.07	374.31	72.90	-154.06	-3.16
-3.34	12.85	374.31	72.90	-154.06	-3.16
-4.00	21.76	418.98	61.48	-173.11	-3.60
-4.00	29.65	418.98	61.48	-173.11	-3.60
-4.50	37.61	445.68	44.67	-187.29	-3.84
-4.50	38.31	445.68	44.67	-187.29	-3.84
-5.45	55.10	467.70	-0.00	-211.21	-4.01
-5.50	55.95	468.22	-2.48	-212.44	-4.02
-9.19	77.99	-0.00	-260.78	-319.88	-1.67
-10.00	81.32	-233.21	-324.83	-346.27	-0.87
-10.00	77.66	-233.21	-324.83	-346.27	-0.87
-11.18	82.13	-670.49	-418.88	-386.30	0.00
-11.18	82.13	-670.49	341.57	-386.30	0.00
-12.15	85.80	-377.68	259.91	-421.08	0.23
-13.82	92.12	-66.64	111.31	-484.42	0.00
-15.00	96.59	0.00	0.00	-531.89	-0.31
-15.00	96.59	0.00	-0.00	-531.89	-0.31

Anchor forces with safety level of DS-P

z[m]	A,d[kN]	Fx,d[kN/m]
-0.50	341.7	-183.4

Checks of earth statics

Check or earth support

Check: Mobilizable earth resistance is sufficient for earth support force.
z: -11.18 m
Rd = Eph,k/γ,Re = 8622.04 / 1.400 = 6158.60 [kN/m]

Ed(Uh,d)/Rd = 760.45 / 6158.60 = 0.123 [-]. Passes requirement

Sum of H and V forces, (G)

Forces up to depth z:-15.00

Pos.	H	V
H/V pressure G+P+W,k	640.76	124.61
Wall weight		226.81
H/V pressure passive		0.00
Support z: -0.50	-86.56	23.19
Bh,g,k z=-11.18	-554.19	
Bv,g,k = Bh,k * tan(δ,p=-23.33°)		-239.06
Σ	0.00	135.56 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than the downwards pointing vertical forces.

Vk >= Bvk: 374.62 >= 239.06 Passes requirement

Sum of H and V forces, (G+Q)

Forces up to depth z:-15.00

Pos.	H	V
H/V pressure G+P+W,k	693.29	130.17
Wall weight		226.81
H/V pressure passive		0.00
Support z: -0.50	-130.90	35.08
Bh,g,k z=-11.18	-554.19	
Bv,g,k = Bh,k * tan(δ,p=-23.33°)		-239.06
Bh,q,k z=-11.18	-8.19	
Bv,q,k = Bh,k * tan(δ,p=-23.33°)		-3.53
Σ	0.00	149.46 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than the downwards pointing vertical forces.

Vk >= Bvk: 392.05 >= 242.59 Passes requirement

Anchor verification

Anchor - Stability of lower failure plane

Περίπτ.Φόρτισης: όλα τα φορτία BS-P
Αυτόμ. υπολογ. μήκους αγκυρίων:
All anchors are extended (if necessary)
Favourable variable loads in main failure body are not being considered.
Bottom of lower failure plane: z=-15.00 m

Iteration of failure mechanisms:
lA .....: Length of anchor from head to center of grout body.
W,k .....: Res. force from dead weight, loads, cohesion, ...
Q,k .....: Force in lower failure plane.
Ea1,k.....: Earth pressure onto vertical separation plane.
Ea2,k.....: Earth pressure between wall and main failure body.
Ra_cal,d ...: Dimesioning force of the resistance from the equilibrium of forces. Ra_cal,d corresponds to the max. possible anchor force of the force polygon.
Sum(A,d) ...: Acting anchor forces along the grout body fractions within the failure body. Sum(A,d) is gained from the anchor pull forces of the wall analysis.

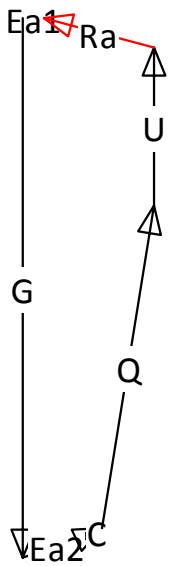
z [m]	ϑ1 [°]	ϑ2 [°]	lA [m]	W,k [kN/m]	Q,k [kN/m]	Ea1,k [kN/m]	Ea2,k [kN/m]	Ra_cal,d [kN/m]	Sum(A,d) [kN/m]	Ed/Rd [-]
-0.50	40.4	57.5	13.44	1749.3	1561.9	4.4	400.0	190.4	189.8	1.00

Decisive failure body:
Γεωμετρία:
Foot point of lower failure plane x/z = 0.01/-15.00 m
Intersection lower/upper slid. plane x/z = 12.98/ -3.98 m
Intersection upper slid. plane/surface x/z = 15.51/ 0.00 m
Intersection separation plane/surface x/z = 12.98/ 0.00 m
Inclination lower failure plane ϑ1 = 40.36°
Inclination upper failure plane ϑ2 = 57.50°
Inclination separation plane ϑ12 = 90.00°

Loads / forces (char.)

		Fx [kN/m]	Fz [kN/m]	F [kN/m]	
Weight of main failure body	G,k:	0.0	-2584.5	2584.5	
Area loads on/in main failure body	F1,k:	0.0	-82.5	82.5	
Cohesion of lower failure plane	C,k:	92.5	78.6	121.4	
Pore water pressure on main body	U,k:	-0.5	841.6	841.6	
Earth pres. on separation plane	Ea1,k:	-4.4	-0.0	4.4	δ= 0.0°
Earth pr. between wall<->main body	Ea2,k:	378.3	129.9	400.0	
Force in lower failure plane	Q,k:	-208.4	1548.0	1561.9	
Sum = possible anchor forces:	Ra_cal,k:	257.4	-69.0	266.5	

Force polygon



Acting anchor forces Ed: Sum(A,d) = 189.8 kN/m
Possible anchor forces Rd: Ra_cal,d = 266.5/1.400 = 190.4 kN/m

Verif. of lower failure plane Ed/Rd = 1.00 < 1.0: Έλεγχος εκπληρώθηκε.

Check of steel tension

l,tot ...[m]: Total length of anchor incl. excess length at head
As ....[mm2]: X-section are of steel member
Ri,d ...[kN]: Ultimate strength of tension member (γ,M=1.15)
A,d ....[kN]: Dimensioning force of the anchor from wall analysis

z[m]	Anchor type	l,tot	As	Ri,d		A,d	
-0.50	Strand;3x0.60";1570/1770	17.44	420	573.4	>	341.7	Passes requirement

Check of steel tension: Passes requirement

Check of anchor's soil friction

lVk .....: Length of grout body
DmVk ....: Diameter of grout body
τGr,k ...: Average applied skin friction along the grout body (from soil parameters)
Ra,k ....: Charact. pullout resistance of the anchor
γA ......: Partial safety factor of anchor pullout
Ra,d ....: = Ra,k / γA
A,d .....: Dimensioning force of the anchor from wall analysis

z [m]	lVk [m]	DmVk [mm]	τGr,k [kN/m²]	Ra,k [kN]	γA [-]	Ra,d [kN]		A,d [kN]	A,d/Ra,d [-]
-0.50	8.00	318	110	879.1	1.100	799.2	>	341.7	0.4

Check of anchor's soil friction: Passes requirement

Υπολογ. κύκλου ολίσθησης

LC: όλα τα φορτία Type: BS-T (combination: [GEO] A2 M2 R3, BS-T)
Vertical variable loads only act if they are outside of R*sin(phi).
The automatic slip circle optimization only considers circles that intersect
the surface with an area of at least 0.25 m2.
The slip circle calculation only accepts circles including the wall.
The slipcircle calculation only allows circular failure planes
(no vertical tangents will occour).

Γεωμετ.κύκλου (μήκη και συντεταγμ. σε (m))
Κέντρο = (-0.20, 5.51), Ακτίνα = 20.52
Αρχ.σημ.= (-18.38, -4.00), Τελ.σημ. = (19.57, 0.00)

Γεωμετρία λωρίδων:

No	x	Width b	dxM	Weight	Load z-κατ.	Water-φορτ.	u*b	φ	c	θ
	[m]	[m]	[m]	[kN/m]	[kN/m]	[kN/m]	[kN/m]	[°]	[kN/m²]	[°]
1	-17.35	2.05	-17.16	78.1	0.0	0.0	-12.0	27.45	3.57	-31.27*
2	-15.30	2.05	-15.11	199.6	0.0	0.0	-47.1	27.45	3.57	-31.27*
3	-13.25	2.05	-13.05	289.4	0.0	0.0	-87.6	29.26	3.57	-30.37*
4	-11.20	2.05	-11.00	358.1	0.0	0.0	-118.4	29.26	3.57	-30.37*
5	-9.15	2.05	-8.95	410.9	0.0	0.0	-142.0	29.26	3.57	-25.86
6	-7.09	2.05	-6.90	450.7	0.0	0.0	-159.8	29.26	3.57	-19.64
7	-5.04	2.05	-4.85	479.0	0.0	0.0	-172.4	29.26	3.57	-13.66
8	-2.99	2.05	-2.79	497.0	0.0	0.0	-180.4	29.26	3.57	-7.83
9	-0.94	2.05	-0.74	512.0	0.0	0.0	-214.9	29.26	3.57	-2.07
10	1.11	2.05	1.31	661.9	0.0	0.0	-245.1	29.26	3.57	3.66
11	3.17	2.05	3.36	651.0	0.0	0.0	-240.2	29.26	3.57	9.43
12	5.22	2.05	5.41	630.2	0.0	0.0	-231.0	29.26	3.57	15.30
13	7.27	2.05	7.47	598.9	0.0	0.0	-216.9	29.26	3.57	21.34
14	9.32	2.05	9.52	555.7	0.0	0.0	-197.7	29.26	3.57	27.64
15	11.37	2.05	11.57	498.8	0.0	0.0	-172.2	29.26	3.57	34.32
16	13.43	2.05	13.62	424.9	0.0	0.0	-139.0	27.45	3.57	41.59
17	15.48	2.05	15.67	327.9	0.0	0.0	-95.2	27.45	3.57	49.80
18	18.04	3.07	18.23	230.3	0.0	0.0	-52.4	0.08	35.71	62.69

*** Σημείωση: Στις λωρίδες σημειωμένες με '*'
περιορίστηκε το theta στο 45°-Phi/2.

Συνεισφ. κατακόρυφων φορτίων:

No	Weight	G*sin(θ)	(G-u*b)*tan(φ) + c*b	μ*sin(θ)* tan(φ)+cos(θ)	T
	[kN/m]	[kN/m]	[kN/m]	[-]	[kN/m]
1	78.06	-65.27	41.63	0.799733	52.05
2	199.63	-146.95	86.56	0.799733	108.24
3	289.39	-184.09	120.38	0.805038	149.54
4	358.13	-192.01	141.62	0.805038	175.92
5	410.94	-179.23	157.97	0.850080	185.83
6	450.67	-151.49	170.28	0.903431	188.48
7	479.01	-113.12	179.07	0.944756	189.54
8	496.98	-67.66	184.64	0.975144	189.35
9	512.02	-18.51	173.78	0.995219	174.61
10	661.87	42.26	240.81	1.005249	239.55
11	651.00	106.67	237.43	1.005191	236.21
12	630.23	166.29	230.99	0.994686	232.23
13	598.87	217.90	221.27	0.972997	227.41
14	555.72	257.77	207.90	0.938870	221.44
15	498.84	281.27	190.30	0.890250	213.76
16	424.94	282.09	155.86	0.818157	190.51
17	327.86	250.43	128.22	0.726274	176.54
18	230.26	204.60	109.77	0.458995	239.14
		690.94			3390.34

Δράση Ed = (690.9*20.52)
Αντίσταση Rd = (3390.3*20.52 +0.0)

SLIP-CIRCLE μ = Ed/Rd = 0.20 < 1.0: Έλεγχος εκπληρώθηκε.

Φάση εκσκαφής 4 "[4] Situation 4"

LC: όλα τα φορτία Type: BS-T

Εδαφικό σύστημα με 5 Στρώσεις

Name		Τεχνητές επιχωματώσεις	Αμμώδης ΑΡΓΙΛΟΣ	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
γ	[kN/m3]	18	20	22.5
γ,R	[kN/m3]	18	20	22.5
γ'	[kN/m3]	8	10	12.5
γ,p	[kN/m3]	18	20	22.5
γ,R,passive	[kN/m3]	18	20	22.5
γ,pw	[kN/m3]	8	10	12.5
φ	[°]	25	0.1	33
c	[kN/m2]	2	50	5
c,u	[kN/m2]	10	50	5
c παθητικό	[kN/m2]	2	50	5
δ,a	[°]	16.66667	0.06666667	22
δ,p	[°]	-16.66667	-0.06666667	-22
δ,c	[°]	8.333333	0.03333333	11
k,agh	[-]	0.3456501	0.9955057	0.2452023
K,ach	[-]	1.043051	1.994195	0.8549058
K,0h	[-]	0.5773817	0.9982547	0.455361
K,pgh	[-]	3.908103	1.004519	7.495617
K,pch	[-]	5.180327	2.00583	8.599509
τ,gr	[kN/m2]	110	110	110
Ψ,A,max	[°]	90	90	90
k	[cm/s]	10e-06	1e-06	100e-06

Name		Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
γ	[kN/m3]	22.5	22.5
γ,R	[kN/m3]	22.5	22.5
γ'	[kN/m3]	12.5	12.5
γ,p	[kN/m3]	22.5	22.5
γ,R,passive	[kN/m3]	22.5	22.5
γ,pw	[kN/m3]	12.5	12.5
φ	[°]	35	35
c	[kN/m2]	5	5
c,u	[kN/m2]	5	5
c παθητικό	[kN/m2]	5	5
δ,a	[°]	23.33333	23.33333
δ,p	[°]	-23.33333	-23.33333
δ,c	[°]	11.66667	11.66667
k,agh	[-]	0.2244207	0.2244207
K,ach	[-]	0.8126539	0.8126539
K,0h	[-]	0.4264236	0.4264236
K,pgh	[-]	9.146943	9.146943
K,pch	[-]	10.104	10.104
τ,gr	[kN/m2]	110	110
Ψ,A,max	[°]	90	90
k	[cm/s]	100e-06	100e-06

Πορεία πρανούς:
x [m] 0.00 0.00
z [m] -4.00 0.00

Πορεία ανώτερου 2. στρώματος Αμμώδης ΑΡΓΙΛΟΣ:
x [m] 0.00 0.00
z [m] -4.00 -1.50

Πορεία ανώτερου 3. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ:
z= -4.50

Πορεία ανώτερου 4. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -10.00

Πορεία ανώτερου 5. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -14.00

Επιφ. φορτία:

Φορτία

xA [m]	zA [m]	xE [m]	zE [m]	PxA [kN/m²]	PzA [kN/m²]	PxE [kN/m²]	PzE [kN/m²]	Typ	LC-description Name
1.00	0.00	3.50	0.00	0.00	33.00	0.00	33.00	q	1

Κατανομή εδαφ.πιέσεων

Κατανομή εδαφ.πιέσεων	Name
Rectangular within a layer	

Στάθμη νερού:

x [m]	0.00	0.00
z [m]	-6.00	-3.00

Αγκύρια

z[m]	min.l[m]	Alpha[°]	C-H[kN/m]	P0[kN]	u0[m]
-0.50	0.00	15.00	0.00	0.00	0.0000
-3.00	0.00	15.00	αόριστ.	0.00	0.0000

Παράμετροι υπολογισμού

Earth pressure options

Τμήμα εδαφ.ωθήσεων: Ενεργές ωθήσεις.
Angle of slip plane: DIN 4085.
Split block loads into 1 sections.
Consideration of minimum earth pressure: φ,min = 40.000.
Negative earth pressure fractions are set to zero.

Redistribution of earth pressure

Shape of redistribution: Triangle (perpend. to wall).
The earth pressure is getting redistb. to: Excavation level
The earth pressure below the excavation acts without redistrb.
Levels of redistribution Z1: -0.500, Z2: -3.000 [m].
The earth pressure from variable loads will be included in redistribution.

Παθητικές ωθήσεις

Method of calculation: Κλασικός, Pregl/Sokolovsky (DIN 4085).

Options for water pressure

Στήριξη πόδα

Πόδας οριζοντίως μετακινούμενος

Αγκύρια

Anchor checks (lower failure plane): Ναι
Anchor forces with safety level of DS-P: Ναι
Verification of grout body pull out forces: Ναι
δ,a,Anchoring wall : used from soil layer.
δ,p,Anchoring wall : used from soil layer.

Earth pressure coefficients kh

φ	α	β	δ	k0gh	kagh	kach	kpgh	kpch	
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Τεχνητές επιχωματώσεις
25.0	0.0	0.0	16.7	--	0.346	1.043	--	--	"
0.1	0.0	0.0	-0.1	--	--	--	1.005	-2.006	Αμμώδης ΑΡΓΙΛΟΣ
0.1	0.0	0.0	0.1	--	0.996	1.994	--	--	"
33.0	0.0	0.0	-22.0	--	--	--	7.496	-8.600	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
33.0	0.0	0.0	22.0	--	0.245	0.855	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"

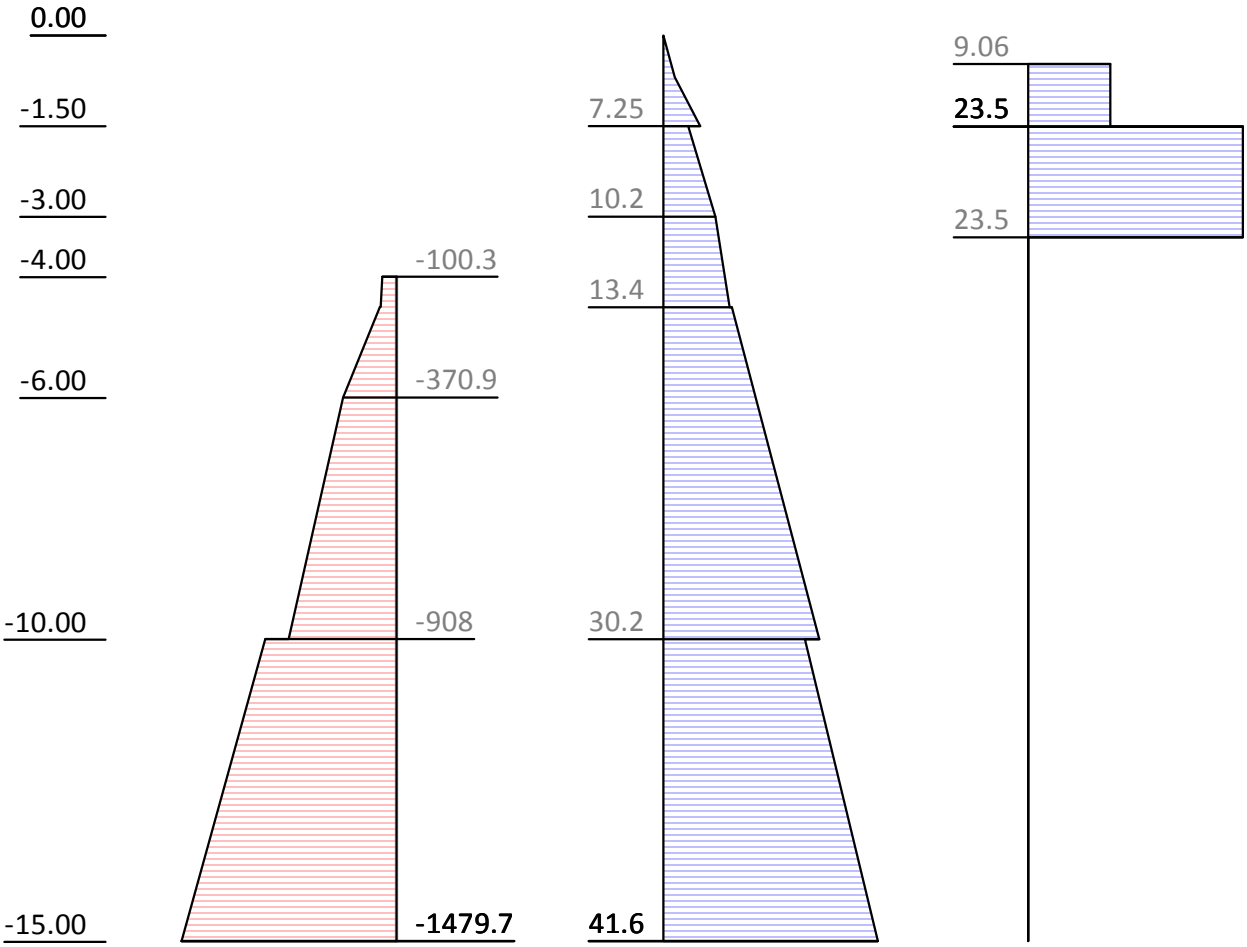
Μήκος τοίχου

Foot depth for statics: zf = -15.000

Stress analysis

Earth pressure, horizontal

Pressures characteristic, no redistribution, continous wall



z [m]	eph,G,k [kN/m2]	eah,G,k [kN/m2]	eah,PQ,k [kN/m2]	eah,d [kN/m2]
0.00		0.00		0.00
-0.47		1.52	0.00	2.04
-0.47		1.52	9.06	15.62
-1.50		7.25	9.06	23.37
-1.50		4.82	23.48	41.73
-3.34		10.79	23.48	49.78
-3.34		10.79	0.00	14.56
-4.00	-0.00	11.97	0.00	16.15
-4.00	-100.29	11.97	0.00	16.15
-4.50	-110.34	12.86	0.00	17.36
-4.50	-117.95	13.38	0.00	18.06
-10.00	-745.71	30.24	0.00	40.82
-10.00	-908.05	27.52	0.00	37.16
-15.00	-1479.73	41.55	0.00	56.09

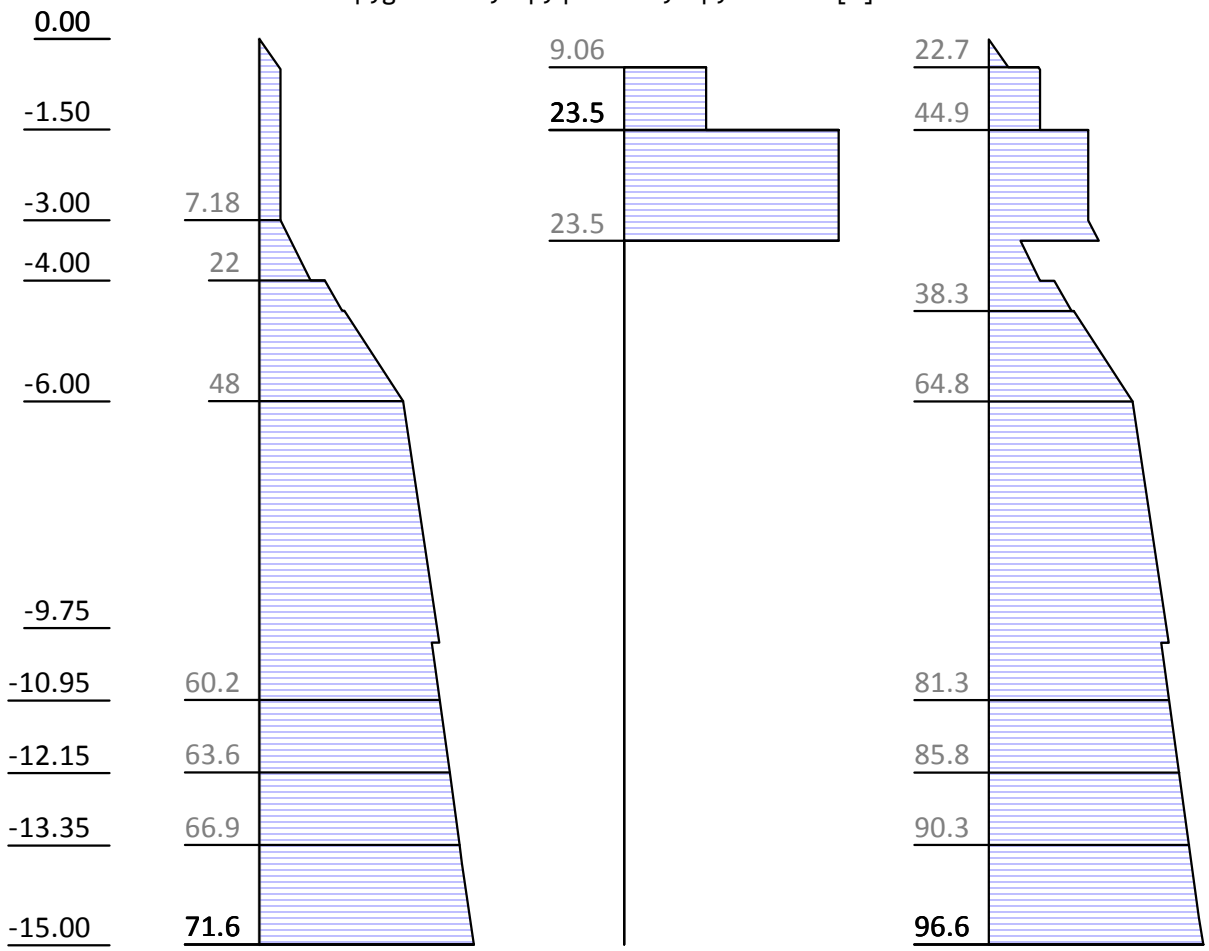
Eph,G,k:-8622.04, Eph,PG,k: 0.00 [kN/m]
Eah,G,k: 325.76, Eah,PG,k: 0.00, Eah,PQ,k: 52.53, Eah,d: 518.57

Πίεση νερού

z [m]	Wp,k [kN/m2]	Wa,k [kN/m2]	W,k [kN/m2]
-3.00		0.00	0.00
-6.00	0.00	30.00	30.00
-15.00	-90.00	120.00	30.00

H-pressure on static system

Level of mobilization: Ep,gk 100.0, Ep,qk 100.0, Ep,d 100.0 [%]

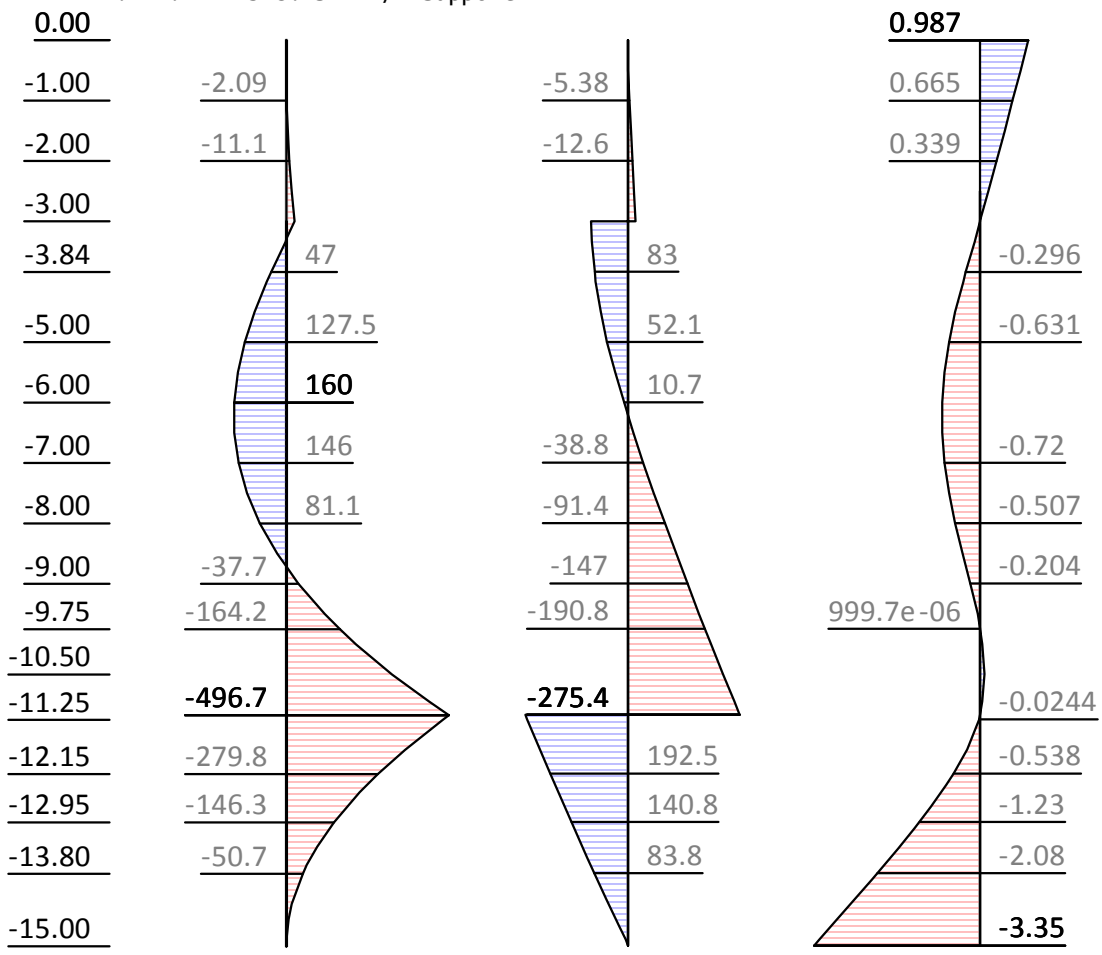


z [m]	PH,gk [kN/m2]	PH,qk [kN/m2]	PH,d [kN/m2]
0.00	0.00		0.00
-0.47	6.75	0.00	9.11
-0.47	6.75	9.06	22.69
-1.50	7.18	9.06	23.28
-1.50	7.18	23.48	44.91
-3.34	10.58	23.48	49.50
-3.34	10.58	0.00	14.28
-4.00	17.18	0.00	23.19
-4.00	21.97	0.00	29.65
-4.50	27.86	0.00	37.61
-4.50	28.38	0.00	38.31
-10.00	60.24	0.00	81.32
-10.00	57.52	0.00	77.66
-15.00	71.55	0.00	96.59

V-pressure on static system

Internal forces: Permanent, characteristically

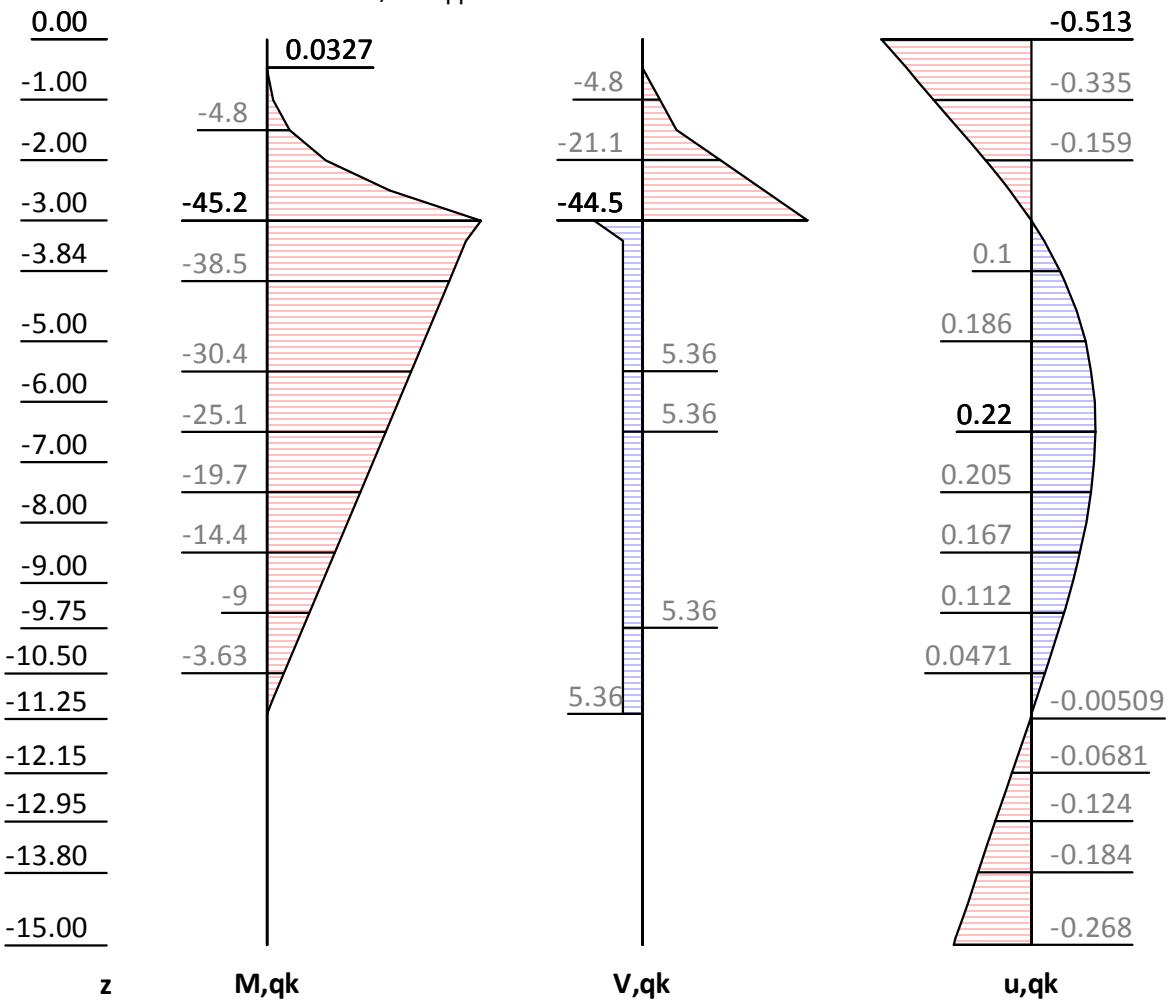
z= -0.500. Fx= -0.000 kN/m Support
z= -3.000. Fx=-112.326 kN/m Support
z= -11.177. Fx=-528.432 kN/m Support



z [m]	H,g,k [kN/m2]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [mm]
0.00	0.00	-0.00	0.00	-0.00	0.99
-0.00	0.00	-0.00	0.00	-0.00	0.99
-3.00	7.18	-27.22	-19.74	-64.03	-0.00
-3.00	7.18	-27.22	92.59	-94.13	-0.00
-3.30	10.16	0.00	89.94	-100.51	-0.11
-4.00	17.18	60.11	80.41	-115.50	-0.35
-4.00	21.97	60.11	80.41	-115.50	-0.35
-4.50	27.86	97.33	67.95	-126.01	-0.50
-4.50	28.38	97.33	67.95	-126.01	-0.50
-6.00	47.98	159.98	10.68	-154.41	-0.77
-6.22	48.65	159.58	-0.00	-158.83	-0.77
-8.72	56.30	-0.00	-131.01	-212.96	-0.29
-9.75	59.46	-163.49	-190.54	-237.51	0.00
-10.00	60.24	-213.80	-205.75	-243.78	0.05
-10.00	57.52	-213.80	-205.75	-243.78	0.05
-10.50	58.93	-323.94	-234.86	-256.16	0.10
-11.18	60.83	-496.66	-275.41	-273.43	0.00
-11.18	60.83	-496.66	253.02	-273.43	0.00
-15.00	71.55	0.00	0.00	-381.27	-3.35

Internal forces: Variable, characteristically

Method EB 82-4 (Q = [G+Q] - G).
z= -0.500. Fx= 0.000 kN/m Support
z= -3.000. Fx= -57.895 kN/m Support
z= -11.177. Fx= 5.363 kN/m Support

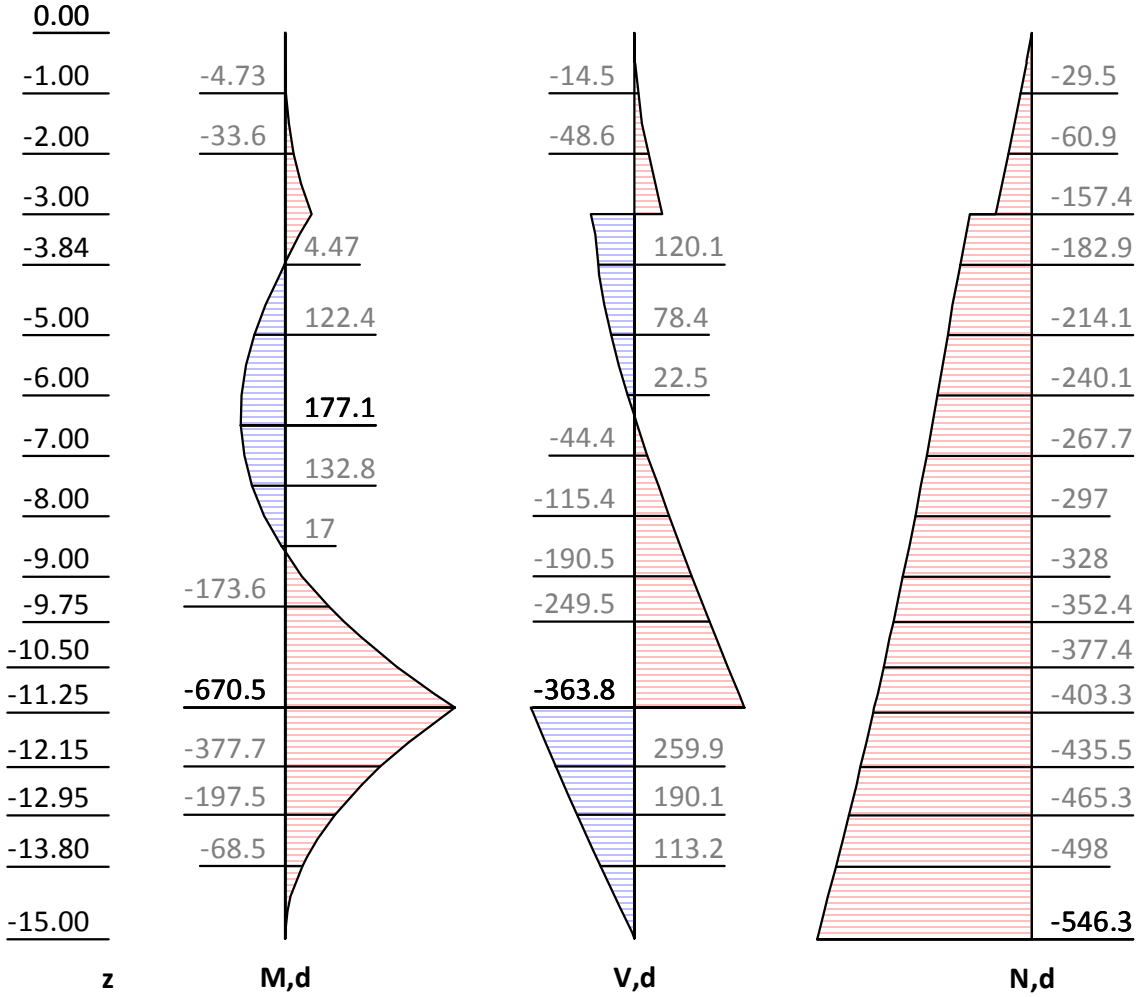


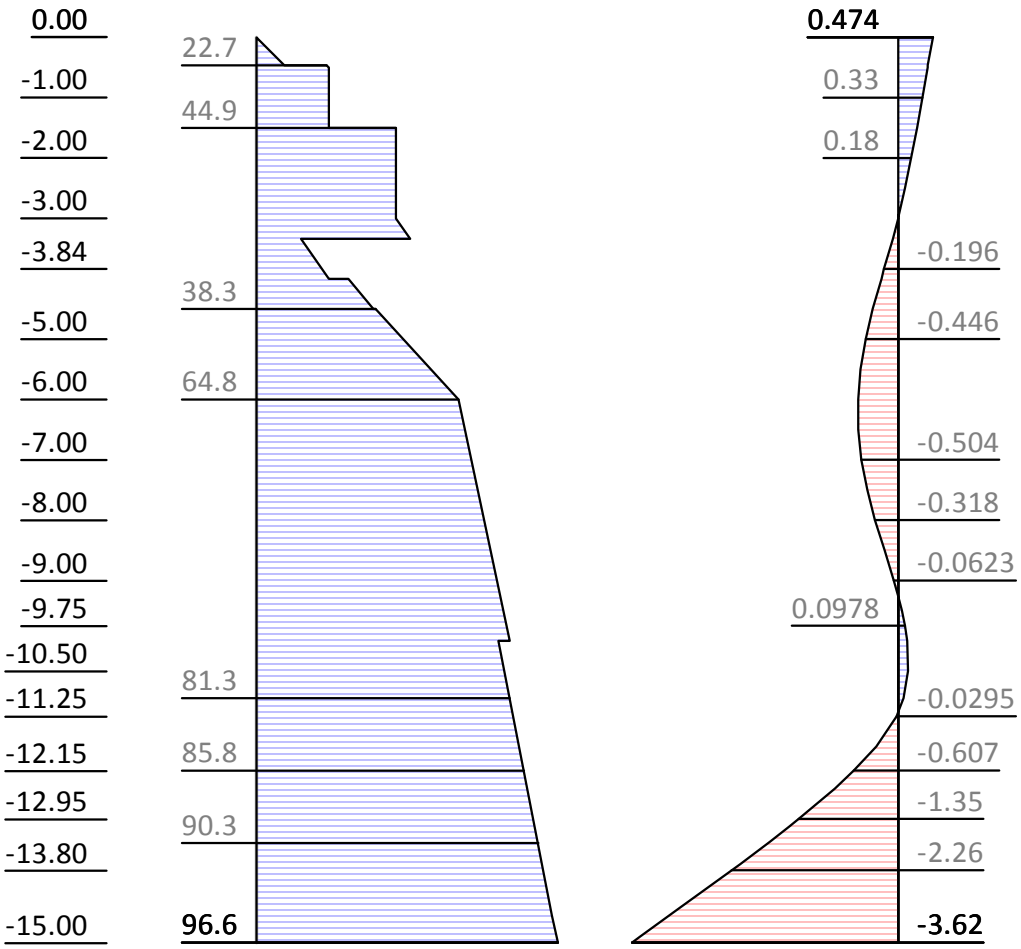
z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
0.00		0.00	-0.00	0.00	-0.51
-0.00		0.00	0.00	0.00	-0.51
-0.47	0.00	0.03	0.10	0.01	-0.43
-0.47	9.06	0.03	0.10	0.01	-0.43
-0.48	9.06	0.02	0.00	-0.00	-0.43
-0.50	9.06	0.00	-0.23	-0.02	-0.42
-1.50	9.06	-4.80	-9.33	-0.99	-0.25
-1.50	23.48	-4.80	-9.33	-0.99	-0.25
-3.00	23.48	-45.21	-44.55	-4.71	-0.00
-3.00	23.48	-45.21	13.35	-20.23	-0.00
-3.34	23.48	-42.03	5.36	-21.07	0.04
-3.34	0.00	-42.03	5.36	-21.07	0.04
-3.84	0.00	-39.35	5.36	-21.07	0.10
-4.50	0.00	-35.81	5.36	-21.07	0.16
-5.50	0.00	-30.45	5.36	-21.07	0.21
-6.50	0.00	-25.08	5.36	-21.07	0.22
-7.00	0.00	-22.40	5.36	-21.07	0.22
-8.00	0.00	-17.04	5.36	-21.07	0.19
-9.50	0.00	-9.00	5.36	-21.07	0.11
-10.95	0.00	-1.22	5.36	-21.07	0.02
-11.18	0.00	-0.00	5.36	-21.07	0.00

z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
-11.18	0.00	0.00	5.36	-21.07	0.00
-11.18	0.00	0.00	-0.00	-21.07	0.00
-13.80	0.00	0.00	-0.00	-21.07	-0.18
-14.90	0.00	0.00	-0.00	-21.07	-0.26
-14.94	0.00	-0.00	0.00	-21.07	-0.26
-15.00	0.00	-0.00	0.00	-21.07	-0.27

Internal forces: Design

z= -0.500. Fx= -0.000 kN/m Support
z= -3.000. Fx=-238.483 kN/m Support
z= -11.177. Fx=-705.338 kN/m Support





z [m]	H,d [kN/m2]	M,d [kN/m2]	V,d [kN/m2]	N,d [kN/m2]	u,g+q,k [mm]
0.00	0.00	0.00	-0.00	0.00	0.47
-0.00	0.00	0.00	-0.00	-0.00	0.47
-0.47	9.11	-0.34	-2.14	-13.44	0.41
-0.47	22.69	-0.34	-2.14	-13.44	0.41
-1.50	23.28	-14.88	-26.11	-44.64	0.26
-1.50	44.91	-14.88	-26.11	-44.64	0.26
-3.00	44.91	-104.56	-93.47	-93.51	-0.00
-3.00	44.91	-104.56	145.01	-157.41	-0.00
-3.34	49.50	-57.94	128.96	-168.49	-0.08
-3.34	14.28	-57.94	128.96	-168.49	-0.08
-3.80	20.55	-0.00	120.77	-181.88	-0.19
-4.00	23.19	23.42	116.60	-187.53	-0.23
-4.00	29.65	23.42	116.60	-187.53	-0.23
-4.50	37.61	77.68	99.78	-201.72	-0.35
-4.50	38.31	77.68	99.78	-201.72	-0.35
-6.00	64.77	174.32	22.47	-240.06	-0.55
-6.34	66.18	176.23	0.00	-249.36	-0.55
-6.50	66.84	177.11	-10.45	-253.69	-0.55
-8.60	75.53	-0.00	-159.99	-315.46	-0.17
-9.27	78.31	-125.61	-211.74	-336.81	0.00
-10.00	81.32	-298.10	-269.71	-360.70	0.13
-10.00	77.66	-298.10	-269.71	-360.70	0.13
-10.50	79.55	-442.76	-309.02	-377.43	0.14
-11.18	82.13	-670.49	-363.77	-400.73	0.00
-11.18	82.13	-670.49	341.57	-400.73	0.00
-15.00	96.59	0.00	0.00	-546.32	-3.62

Anchor forces with safety level of DS-P

z[m]	A,d[kN]	Fx,d[kN/m]
-0.50	0.0	-0.0
-3.00	222.2	-238.5

Checks of earth statics

Check or earth support

Check: Mobilizable earth resistance is sufficient for earth support force.
z: -11.18 m
Rd = Eph,k/γ,Re = 8622.04 / 1.400 = 6158.60 [kN/m]

Ed(Uh,d)/Rd = 705.34 / 6158.60 = 0.115 [-]. Passes requirement

Sum of H and V forces, (G)

Forces up to depth z:-15.00

Pos.	H	V
H/V pressure G+P+W,k	640.76	124.36
Wall weight		226.81
H/V pressure passive		0.00
Support z: -0.50		0.00
Support z: -3.00	-112.33	30.10
Bh,g,k z=-11.18	-528.43	
Bv,g,k = Bh,k * tan(δ,p=-23.33°)		-227.94
Σ	0.00	153.32 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than the downwards pointing vertical forces.

Vk >= Bvk: 381.27 >= 227.94 Passes requirement

Sum of H and V forces, (G+Q)

Forces up to depth z:-15.00

Pos.	H	V
H/V pressure G+P+W,k	693.29	129.92
Wall weight		226.81
H/V pressure passive		0.00
Support z: -0.50		0.00
Support z: -3.00	-170.22	45.61
Bh,g,k z=-11.18	-528.43	
Bv,g,k = Bh,k * tan(δ,p=-23.33°)		-227.94
Bh,q,k z=-11.18	5.36	
Bv,q,k = Bh,k * tan(δ,p=-23.33°)		2.31
Σ	-0.00	176.71 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than the downwards pointing vertical forces.

Vk >= Bvk: 402.34 >= 225.63 Passes requirement

Anchor verification

Anchor - Stability of lower failure plane

Περίπτ.Φόρτισης: όλα τα φορτία BS-P
Αυτόμ. υπολογ. μήκους αγκυρίων:
All anchors are extended (if necessary)
Favourable variable loads in main failure body are not being considered.
Bottom of lower failure plane: z=-15.00 m

Iteration of failure mechanisms:
lA .....: Length of anchor from head to center of grout body.
W,k .....: Res. force from dead weight, loads, cohesion, ...
Q,k .....: Force in lower failure plane.
Ea1,k.....: Earth pressure onto vertical separation plane.
Ea2,k.....: Earth pressure between wall and main failure body.
Ra_cal,d ...: Dimesioning force of the resistance from the equilibrium of forces. Ra_cal,d corresponds to the max. possible anchor force of the force polygon.
Sum(A,d) ...: Acting anchor forces along the grout body fractions within the failure body. Sum(A,d) is gained from the anchor pull forces of the wall analysis.

z [m]	ϑ1 [°]	ϑ2 [°]	lA [m]	W,k [kN/m]	Q,k [kN/m]	Ea1,k [kN/m]	Ea2,k [kN/m]	Ra_cal,d [kN/m]	Sum(A,d) [kN/m]	Ed/Rd [-]
-0.50	40.4	57.5	13.42	1746.7	1559.8	4.4	400.0	189.6	189.2	1.00
-3.00	36.5	60.9	12.32	1802.0	1582.6	36.3	400.0	247.9	246.9	1.00

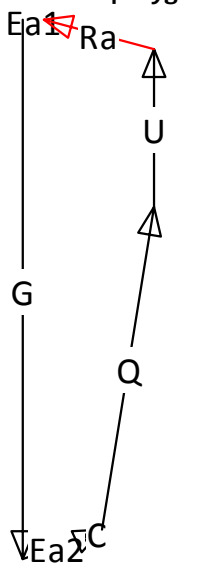
Decisive failure body:
Γεωμετρία:

Foot point of lower failure plane	x/z = 0.01/-15.00 m
Intersection lower/upper slid. plane	x/z = 11.90/ -6.19 m
Intersection upper slid. plane/surface	x/z = 15.34/ 0.00 m
Intersection separation plane/surface	x/z = 11.90/ 0.00 m
Inclination lower failure plane	ϑ1 = 36.53°
Inclination upper failure plane	ϑ2 = 60.94°
Inclination separation plane	ϑ12 = 90.00°

Loads / forces (char.)

		Fx [kN/m]	Fz [kN/m]	F [kN/m]	
Weight of main failure body	G,k:	0.0	-2665.9	2665.9	
Area loads on/in main failure body	F1,k:	0.0	-82.5	82.5	
Cohesion of lower failure plane	C,k:	59.5	44.1	74.0	
Pore water pressure on main body	U,k:	-0.5	903.3	903.3	
Earth pres. on separation plane	Ea1,k:	-36.3	-0.0	36.3	δ= 0.0°
Earth pr. between wall<->main body	Ea2,k:	378.3	129.9	400.0	
Force in lower failure plane	Q,k:	-65.8	1581.2	1582.6	
Sum = possible anchor forces:	Ra_cal,k:	335.2	-89.8	347.1	

Force polygon



Acting anchor forces Ed: Sum(A,d) = 246.9 kN/m
Possible anchor forces Rd: Ra_cal,d = 347.1/1.400 = 247.9 kN/m

Verif. of lower failure plane Ed/Rd = 1.00 < 1.0: Έλεγχος εκπληρώθηκε.

Check of steel tension

l,tot ...[m]: Total length of anchor incl. excess length at head
As ....[mm2]: X-section are of steel member
Ri,d ...[kN]: Ultimate strength of tension member (γ,M=1.15)
A,d ....[kN]: Dimensioning force of the anchor from wall analysis

z[m]	Anchor type	l,tot	As	Ri,d		A,d	
-0.50	Strand;3x0.60";1570/1770	17.70	420	573.4	>	0.0	Passes requirement
-3.00	Strand;3x0.60";1570/1770	16.32	420	573.4	>	222.2	Passes requirement

Check of steel tension: Passes requirement

Check of anchor's soil friction

lVk .....: Length of grout body
DmVk ....: Diameter of grout body
τGr,k ...: Average applied skin friction along the grout body (from soil parameters)
Ra,k ....: Charact. pullout resistance of the anchor
γA ......: Partial safety factor of anchor pullout
Ra,d ....: = Ra,k / γA
A,d .....: Dimensioning force of the anchor from wall analysis

z [m]	lVk [m]	DmVk [mm]	τGr,k [kN/m²]	Ra,k [kN]	γA [-]	Ra,d [kN]		A,d [kN]	A,d/Ra,d [-]
-0.50	8.00	318	110	879.1	1.100	799.2	>	0.0	0.0
-3.00	8.00	318	110	879.1	1.100	799.2	>	222.2	0.3

Check of anchor's soil friction: Passes requirement

Υπολογ. κύκλου ολίσθησης

LC: όλα τα φορτία Type: BS-T (combination: [GEO] A2 M2 R3, BS-T)
Vertical variable loads only act if they are outside of R*sin(phi).
The automatic slip circle optimization only considers circles that intersect
the surface with an area of at least 0.25 m2.
The slip circle calculation only accepts circles including the wall.
The slipcircle calculation only allows circular failure planes
(no vertical tangents will occour).

Γεωμετ.κύκλου (μήκη και συντεταγμ. σε (m))
Κέντρο = (-0.20, 5.51), Ακτίνα = 20.52
Αρχ.σημ.= (-18.38, -4.00), Τελ.σημ. = (19.57, 0.00)

Γεωμετρία λωρίδων:

No	x	Width b	dxM	Weight	Load z-κατ.	Water-φορτ.	u*b	φ	c	θ
	[m]	[m]	[m]	[kN/m]	[kN/m]	[kN/m]	[kN/m]	[°]	[kN/m²]	[°]
1	-17.35	2.05	-17.16	78.1	0.0	0.0	-12.0	27.45	3.57	-31.27*
2	-15.30	2.05	-15.11	199.6	0.0	0.0	-47.1	27.45	3.57	-31.27*
3	-13.25	2.05	-13.05	289.4	0.0	0.0	-87.6	29.26	3.57	-30.37*
4	-11.20	2.05	-11.00	358.1	0.0	0.0	-118.4	29.26	3.57	-30.37*
5	-9.15	2.05	-8.95	410.9	0.0	0.0	-142.0	29.26	3.57	-25.86
6	-7.09	2.05	-6.90	450.7	0.0	0.0	-159.8	29.26	3.57	-19.64
7	-5.04	2.05	-4.85	479.0	0.0	0.0	-172.4	29.26	3.57	-13.66
8	-2.99	2.05	-2.79	497.0	0.0	0.0	-180.4	29.26	3.57	-7.83
9	-0.94	2.05	-0.74	512.0	0.0	0.0	-214.9	29.26	3.57	-2.07
10	1.11	2.05	1.31	661.9	0.0	0.0	-245.1	29.26	3.57	3.66
11	3.17	2.05	3.36	651.0	0.0	0.0	-240.2	29.26	3.57	9.43
12	5.22	2.05	5.41	630.2	0.0	0.0	-231.0	29.26	3.57	15.30
13	7.27	2.05	7.47	598.9	0.0	0.0	-216.9	29.26	3.57	21.34
14	9.32	2.05	9.52	555.7	0.0	0.0	-197.7	29.26	3.57	27.64
15	11.37	2.05	11.57	498.8	0.0	0.0	-172.2	29.26	3.57	34.32
16	13.43	2.05	13.62	424.9	0.0	0.0	-139.0	27.45	3.57	41.59
17	15.48	2.05	15.67	327.9	0.0	0.0	-95.2	27.45	3.57	49.80
18	18.04	3.07	18.23	230.3	0.0	0.0	-52.4	0.08	35.71	62.69

*** Σημείωση: Στις λωρίδες σημειωμένες με '*'
περιορίστηκε το theta στο 45°-Phi/2.

Συνεισφ. κατακόρυφων φορτίων:

No	Weight	G*sin(θ)	(G-u*b)*tan(φ) + c*b	μ*sin(θ)* tan(φ)+cos(θ)	T
	[kN/m]	[kN/m]	[kN/m]	[-]	[kN/m]
1	78.06	-65.27	41.63	0.799733	52.05
2	199.63	-146.95	86.56	0.799733	108.24
3	289.39	-184.09	120.38	0.805038	149.54
4	358.13	-192.01	141.62	0.805038	175.92
5	410.94	-179.23	157.97	0.850080	185.83
6	450.67	-151.49	170.28	0.903431	188.48
7	479.01	-113.12	179.07	0.944756	189.54
8	496.98	-67.66	184.64	0.975144	189.35
9	512.02	-18.51	173.78	0.995219	174.61
10	661.87	42.26	240.81	1.005249	239.55
11	651.00	106.67	237.43	1.005191	236.21
12	630.23	166.29	230.99	0.994686	232.23
13	598.87	217.90	221.27	0.972997	227.41
14	555.72	257.77	207.90	0.938870	221.44
15	498.84	281.27	190.30	0.890250	213.76
16	424.94	282.09	155.86	0.818157	190.51
17	327.86	250.43	128.22	0.726274	176.54
18	230.26	204.60	109.77	0.458995	239.14
		690.94			3390.34

Δράση Ed = (690.9*20.52)
Αντίσταση Rd = (3390.3*20.52 +0.0)

SLIP-CIRCLE μ = Ed/Rd = 0.20 < 1.0: Έλεγχος εκπληρώθηκε.

Φάση εκσκαφής 5 "[5] Situation 4 +"

LC: όλα τα φορτία Type: BS-T

Εδαφικό σύστημα με 5 Στρώσεις

Name		Τεχνητές επιχωματώσεις	Αμμώδης ΑΡΓΙΛΟΣ	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
γ	[kN/m3]	18	20	22.5
γ,R	[kN/m3]	18	20	22.5
γ'	[kN/m3]	8	10	12.5
γ,p	[kN/m3]	18	20	22.5
γ,R,passive	[kN/m3]	18	20	22.5
γ,pw	[kN/m3]	8	10	12.5
φ	[°]	25	0.1	33
c	[kN/m2]	2	50	5
c,u	[kN/m2]	10	50	5
c παθητικό	[kN/m2]	2	50	5
δ,a	[°]	16.66667	0.06666667	22
δ,p	[°]	-16.66667	-0.06666667	-22
δ,c	[°]	8.333333	0.03333333	11
k,agh	[-]	0.3456501	0.9955057	0.2452023
K,ach	[-]	1.043051	1.994195	0.8549058
K,0h	[-]	0.5773817	0.9982547	0.455361
K,pgh	[-]	3.908103	1.004519	7.495617
K,pch	[-]	5.180327	2.00583	8.599509
τ,gr	[kN/m2]	110	110	110
Ψ,A,max	[°]	90	90	90
k	[cm/s]	10e-06	1e-06	100e-06

Name		Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
γ	[kN/m3]	22.5	22.5
γ,R	[kN/m3]	22.5	22.5
γ'	[kN/m3]	12.5	12.5
γ,p	[kN/m3]	22.5	22.5
γ,R,passive	[kN/m3]	22.5	22.5
γ,pw	[kN/m3]	12.5	12.5
φ	[°]	35	35
c	[kN/m2]	5	5
c,u	[kN/m2]	5	5
c παθητικό	[kN/m2]	5	5
δ,a	[°]	23.33333	23.33333
δ,p	[°]	-23.33333	-23.33333
δ,c	[°]	11.66667	11.66667
k,agh	[-]	0.2244207	0.2244207
K,ach	[-]	0.8126539	0.8126539
K,0h	[-]	0.4264236	0.4264236
K,pgh	[-]	9.146943	9.146943
K,pch	[-]	10.104	10.104
τ,gr	[kN/m2]	110	110
Ψ,A,max	[°]	90	90
k	[cm/s]	100e-06	100e-06

Πορεία πρανούς:
x [m] 0.00 0.00
z [m] -6.50 0.00

Πορεία ανώτερου 2. στρώματος Αμμώδης ΑΡΓΙΛΟΣ:
x [m] 0.00 0.00
z [m] -6.50 -1.50

Πορεία ανώτερου 3. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ:
x [m] 0.00 0.00
z [m] -6.50 -4.50

Πορεία ανώτερου 4. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -10.00

Πορεία ανώτερου 5. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -14.00

Επιφ. φορτία:

Φορτία

xA [m]	zA [m]	xE [m]	zE [m]	PxA [kN/m²]	PzA [kN/m²]	PxE [kN/m²]	PzE [kN/m²]	Typ	LC-description Name
1.00	0.00	3.50	0.00	0.00	33.00	0.00	33.00	q	1

Κατανομή εδαφ.πιέσεων

Κατανομή εδαφ.πιέσεων	Name
Rectangular within a layer	

Στάθμη νερού:

x [m]	0.00	0.00
z [m]	-7.50	-3.00

Αγκύρια

z[m]	min.l[m]	Alpha[°]	C-H[kN/m]	P0[kN]	u0[m]
-0.50	0.00	15.00	0.00	0.00	0.0000
-3.00	0.00	15.00	αόρισ.	0.00	0.0000

Παράμετροι υπολογισμού

Earth pressure options

Τμήμα εδαφ.ωθήσεων: Ενεργές ωθήσεις.
Angle of slip plane: DIN 4085.
Split block loads into 1 sections.
Consideration of minimum earth pressure: φ,min = 40.000.
Negative earth pressure fractions are set to zero.

Redistribution of earth pressure

Shape of redistribution: Trapezoid.
The earth pressure is getting redistb. to: Excavation level
The earth pressure below the excavation acts without redistrb.
Levels of redistribution Z1: 0.000, Z2: -3.000 [m].
The earth pressure from variable loads will be included in redistribution.

Παθητικές ωθήσεις

Method of calculation: Κλασικός, Pregl/Sokolovsky (DIN 4085).

Options for water pressure

Στήριξη πόδα

Πόδας οριζοντίως μετακινούμενος

Αγκύρια

Anchor checks (lower failure plane): Ναι
Anchor forces with safety level of DS-P: Ναι
Verification of grout body pull out forces: Ναι
δ,a,Anchoring wall : used from soil layer.
δ,p,Anchoring wall : used from soil layer.

Earth pressure coefficients kh

φ	α	β	δ	k0gh	kagh	kach	kpgh	kpch	
33.0	0.0	0.0	-22.0	--	--	--	7.496	-8.600	Τεχνητές επιχωματώσεις
25.0	0.0	0.0	16.7	--	0.346	1.043	--	--	"
0.1	0.0	0.0	0.1	--	0.996	1.994	--	--	Αμμώδης ΑΡΓΙΛΟΣ
33.0	0.0	0.0	-22.0	--	--	--	7.496	-8.600	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
33.0	0.0	0.0	22.0	--	0.245	0.855	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"

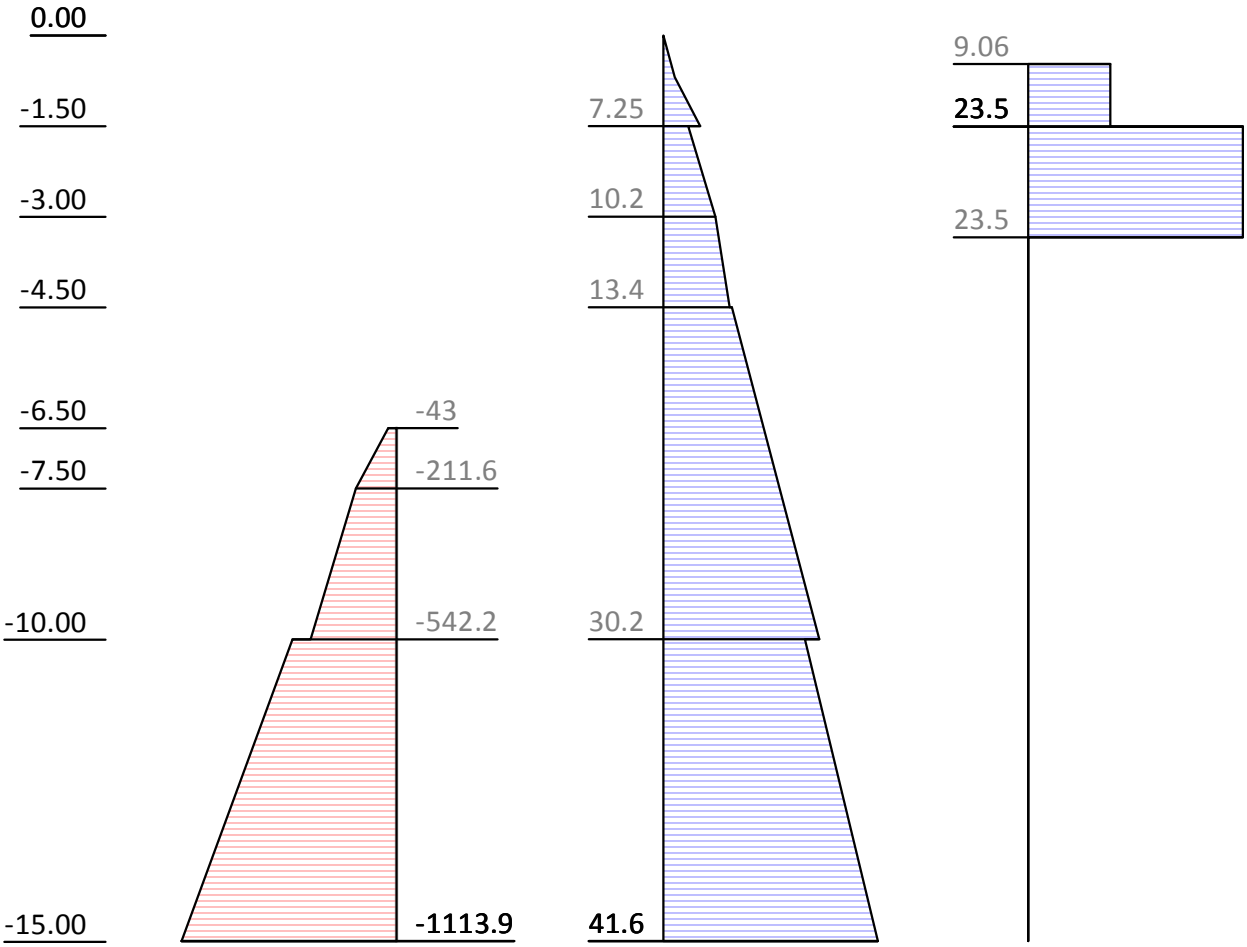
Μήκος τοίχου

Foot depth for statics: zf = -15.000

Stress analysis

Earth pressure, horizontal

Pressures characteristic, no redistribution, continous wall



z [m]	eph,G,k [kN/m2]	eah,G,k [kN/m2]	eah,PQ,k [kN/m2]	eah,d [kN/m2]
0.00		0.00		0.00
-0.47		1.52	0.00	2.04
-0.47		1.52	9.06	15.62
-1.50		7.25	9.06	23.37
-1.50		4.82	23.48	41.73
-3.34		10.79	23.48	49.78
-3.34		10.79	0.00	14.56
-4.50		12.86	0.00	17.36
-4.50		13.38	0.00	18.06
-6.50	-0.00	19.51	0.00	26.34
-6.50	-43.00	19.51	0.00	26.34
-10.00	-445.89	30.24	0.00	40.82
-10.00	-542.17	27.52	0.00	37.16
-15.00	-1113.85	41.55	0.00	56.09

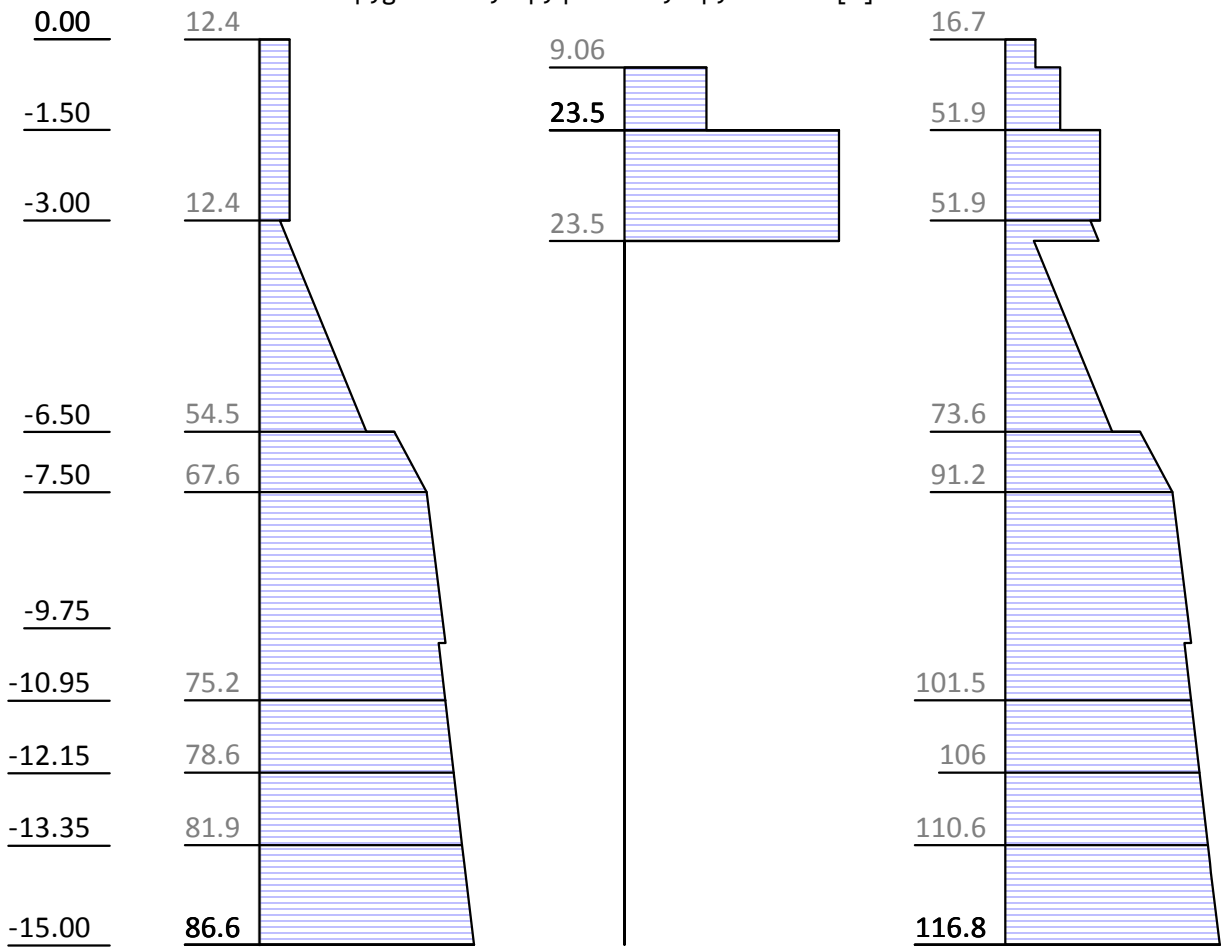
Eph,G,k:-5089.29, Eph,PG,k: 0.00 [kN/m]
Eah,G,k: 325.76, Eah,PG,k: 0.00, Eah,PQ,k: 52.53, Eah,d: 518.57

Πίεση νερού

z [m]	Wp,k [kN/m2]	Wa,k [kN/m2]	W,k [kN/m2]
-3.00		0.00	0.00
-7.50	0.00	45.00	45.00
-13.80	-63.00	108.00	45.00
-15.00	-75.00	120.00	45.00

H-pressure on static system

Level of mobilization: Ep,gk 100.0, Ep,qk 100.0, Ep,d 100.0 [%]

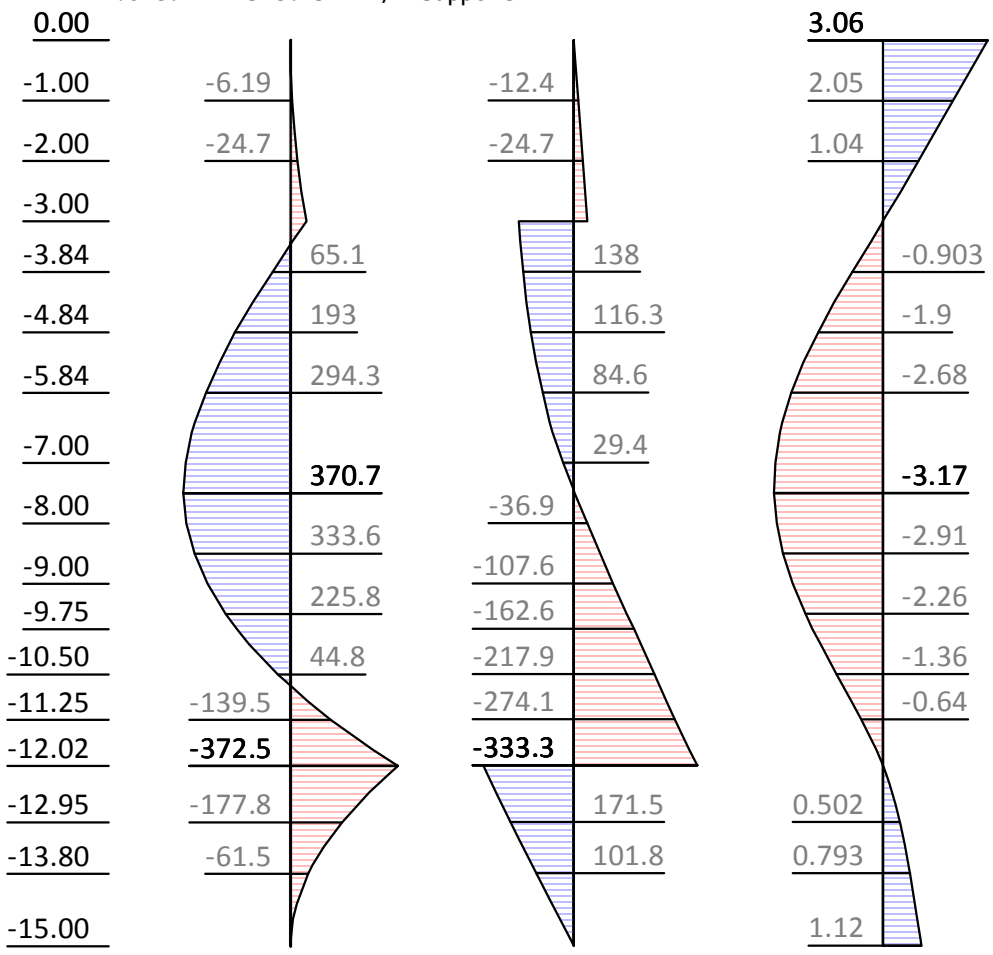


z [m]	PH,gk [kN/m2]	PH,qk [kN/m2]	PH,d [kN/m2]
0.00	12.37		16.71
-0.47	12.37	0.00	16.71
-0.47	12.37	9.06	30.29
-1.50	12.37	9.06	30.29
-1.50	12.37	23.48	51.93
-3.00	12.37	23.48	51.93
-3.00	8.25	23.48	46.36
-3.34	11.65	23.48	50.95
-3.34	11.65	0.00	15.73
-6.50	43.25	0.00	58.39
-6.50	54.51	0.00	73.59
-10.00	75.24	0.00	101.57
-10.00	72.52	0.00	97.91
-15.00	86.55	0.00	116.84

V-pressure on static system

Internal forces: Permanent, characteristically

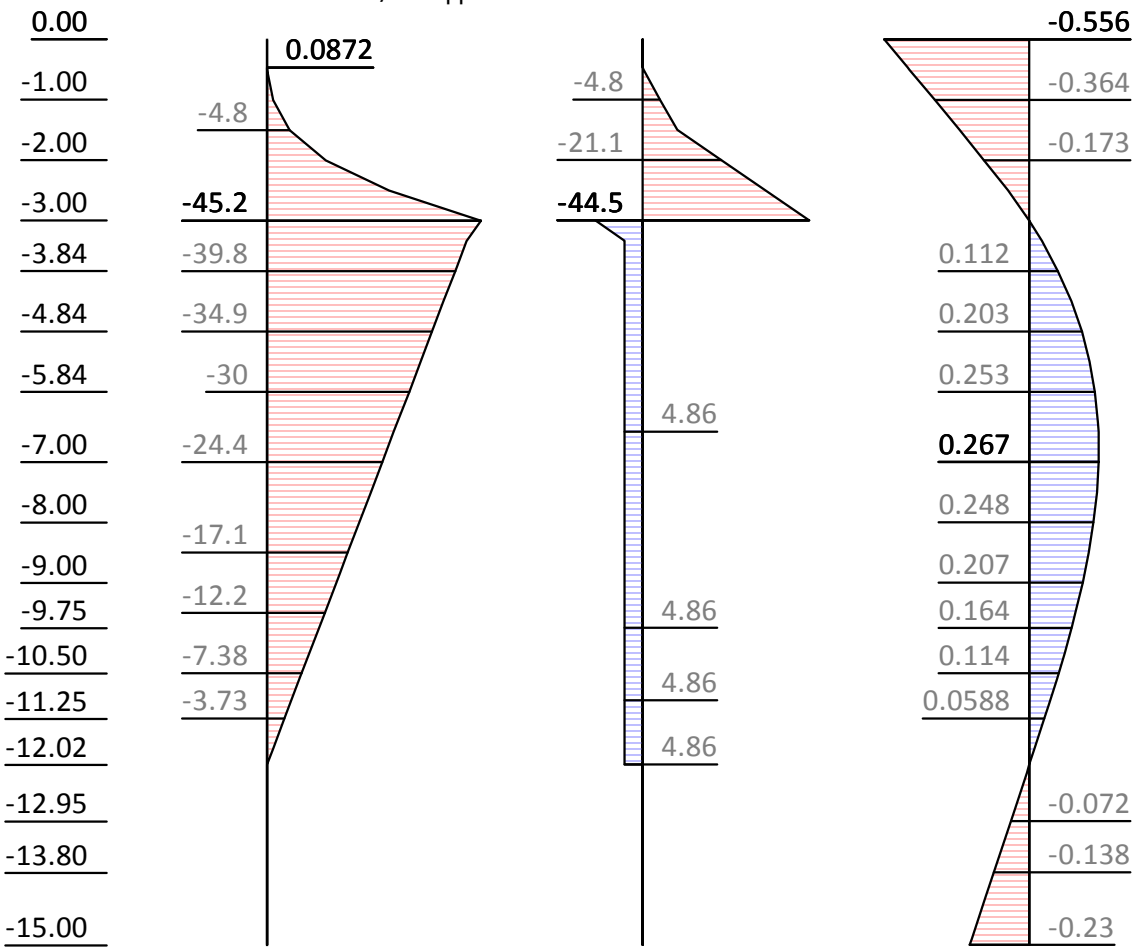
z= -0.500. Fx= -0.000 kN/m Support
z= -3.000. Fx=-185.554 kN/m Support
z= -12.018. Fx=-578.954 kN/m Support



z [m]	H,g,k [kN/m2]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [mm]
0.00	12.37	-0.00	0.00	-0.00	3.06
-0.00	12.37	-0.00	0.00	-0.00	3.06
-3.00	12.37	-55.69	-37.12	-71.27	-0.00
-3.00	8.25	-55.69	148.43	-120.99	-0.00
-3.38	12.06	0.00	144.47	-129.65	-0.41
-6.50	43.25	341.80	58.29	-187.65	-3.01
-6.50	54.51	341.80	58.29	-187.65	-3.01
-7.46	67.02	370.08	-0.00	-207.84	-3.17
-7.50	67.58	370.66	-2.75	-208.75	-3.17
-10.00	75.24	144.62	-181.27	-266.92	-1.83
-10.00	72.52	144.62	-181.27	-266.92	-1.83
-10.69	74.46	-0.00	-232.14	-284.16	-1.18
-12.02	78.19	-372.53	-333.30	-318.76	0.00
-12.02	78.19	-372.53	245.66	-318.76	0.00
-15.00	86.55	-0.00	0.00	-404.42	1.12
-15.00	86.55	0.00	0.00	-404.42	1.12

Internal forces: Variable, characteristically

Method EB 82-4 (Q = [G+Q] - G).
z= -0.500. Fx= 0.000 kN/m Support
z= -3.000. Fx= -57.396 kN/m Support
z= -12.018. Fx= 4.863 kN/m Support



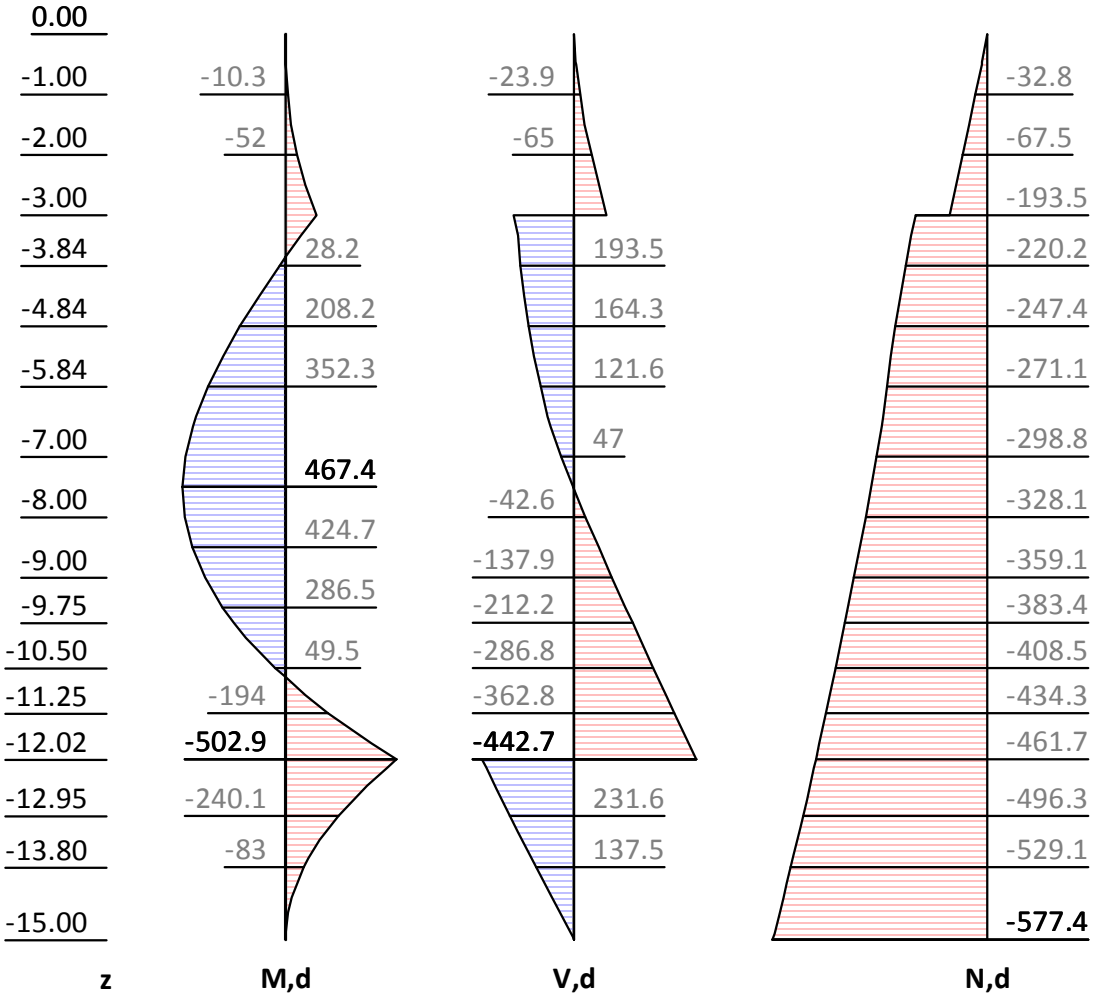
z **M,qk** **V,qk** **u,qk**

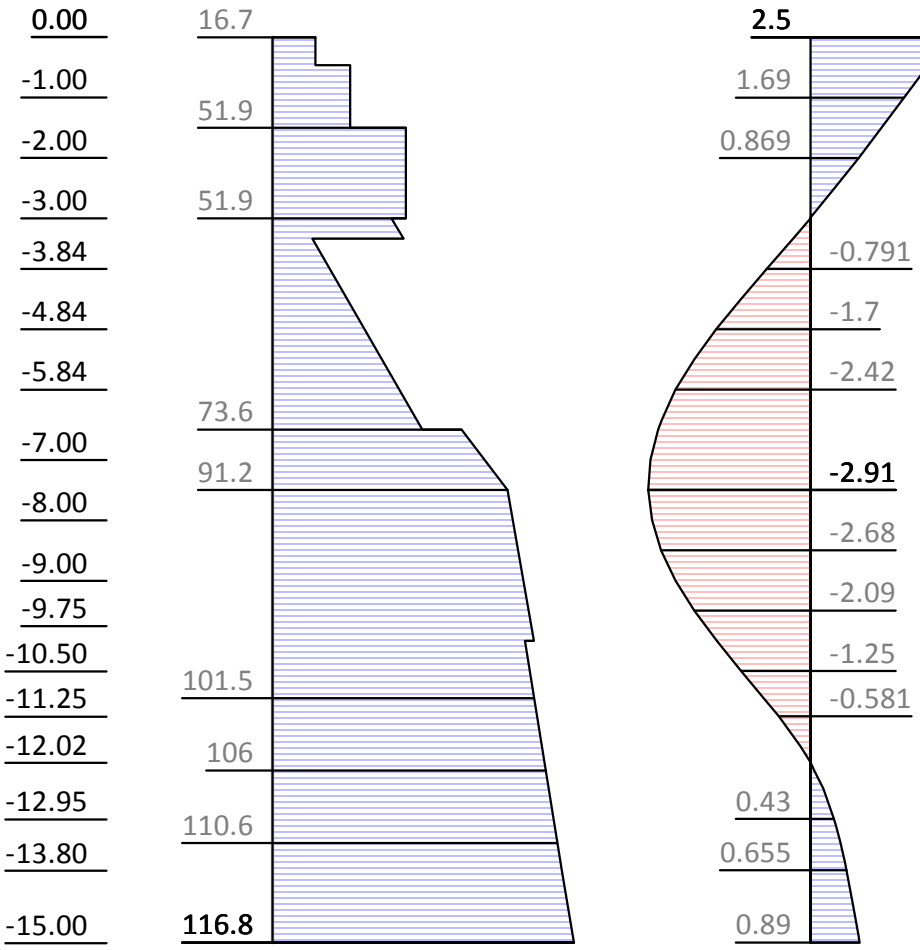
z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
0.00		0.00	-0.00	0.00	-0.56
-0.47	0.00	0.09	-0.00	0.00	-0.47
-0.47	9.06	0.09	-0.00	0.00	-0.47
-0.47	9.06	0.09	-0.00	-0.00	-0.47
-0.50	9.06	-0.00	-0.26	-0.03	-0.46
-1.50	9.06	-4.80	-9.33	-0.99	-0.27
-1.50	23.48	-4.80	-9.33	-0.99	-0.27
-3.00	23.48	-45.21	-44.55	-4.71	-0.00
-3.00	23.48	-45.21	12.85	-20.09	-0.00
-3.34	23.48	-42.20	4.86	-20.94	0.05
-3.34	0.00	-42.20	4.86	-20.94	0.05
-7.00	0.00	-24.40	4.86	-20.94	0.27
-8.00	0.00	-19.54	4.86	-20.94	0.25
-10.00	0.00	-9.81	4.86	-20.94	0.15
-12.02	0.00	-0.00	4.86	-20.94	0.00
-12.02	0.00	-0.00	0.00	-20.94	0.00
-13.35	0.00	-0.00	0.00	-20.94	-0.10
-13.65	0.00	-0.00	0.00	-20.94	-0.13
-13.80	0.00	-0.00	0.00	-20.94	-0.14
-14.55	0.00	-0.00	0.00	-20.94	-0.20
-14.75	0.00	-0.00	0.00	-20.94	-0.21

z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
-14.90	0.00	0.00	0.00	-20.94	-0.22
-15.00	0.00	-0.00	-0.00	-20.94	-0.23

Internal forces: Design

z= -0.500. Fx= -0.000 kN/m Support
z= -3.000. Fx=-336.592 kN/m Support
z= -12.018. Fx=-774.293 kN/m Support





z [m]	H,d [kN/m2]	M,d [kN/m2]	V,d [kN/m2]	N,d [kN/m2]	u,g+q,k [mm]
0.00	16.71	-0.00	-0.00	0.00	2.50
-0.47	16.71	-1.85	-7.85	-15.07	2.12
-0.47	30.29	-1.85	-7.85	-15.07	2.12
-1.50	30.29	-26.00	-39.05	-49.59	1.28
-1.50	51.93	-26.00	-39.05	-49.59	1.28
-3.00	51.93	-143.00	-116.94	-103.28	0.00
-3.00	51.93	-143.00	-116.94	-103.28	-0.00
-3.00	46.36	-143.00	219.65	-193.47	-0.00
-3.34	50.95	-71.08	203.11	-205.22	-0.32
-3.34	15.73	-71.08	203.11	-205.22	-0.32
-3.70	20.57	0.00	196.25	-215.93	-0.66
-6.50	58.39	421.18	85.99	-284.73	-2.74
-6.50	73.59	421.18	85.99	-284.73	-2.74
-7.50	91.23	467.43	3.58	-313.22	-2.91
-7.54	91.39	466.67	0.00	-314.37	-2.91
-10.00	101.57	180.52	-237.42	-391.75	-1.69
-10.00	97.91	180.52	-237.42	-391.75	-1.69
-10.66	100.41	-0.00	-302.94	-413.95	-1.10
-12.02	105.56	-502.92	-442.66	-461.73	0.00
-12.02	105.56	-502.92	331.64	-461.73	0.00
-15.00	116.84	-0.00	-0.00	-577.37	0.89
-15.00	116.84	0.00	-0.00	-577.37	0.89

Anchor forces with safety level of DS-P

z[m]	A,d[kN]	Fx,d[kN/m]
-0.50	0.0	-0.0
-3.00	313.6	-336.6

Checks of earth statics

Check or earth support

Check: Mobilizable earth resistance is sufficient for earth support force.
z: -12.02 m
Rd = Eph,k/γ,Re = 5089.29 / 1.400 = 3635.21 [kN/m]

Ed(Uh,d)/Rd = 774.29 / 3635.21 = 0.213 [-]. Passes requirement

Sum of H and V forces, (G)

Forces up to depth z:-15.00

Pos.	H	V
H/V pressure G+P+W,k	764.51	124.36
Wall weight		233.11
H/V pressure passive		0.00
Support z: -0.50		0.00
Support z: -3.00	-185.55	49.72
Bh,g,k z=-12.02	-578.95	
Bv,g,k = Bh,k * tan(δ,p=-23.33°)		-249.74
Σ	0.00	157.45 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1

Vertical component of earth resistance is less than the downwards pointing vertical forces.

Vk >= Bvk: 407.19 >= 249.74 Passes requirement

Sum of H and V forces, (G+Q)

Forces up to depth z:-15.00

Pos.	H	V
H/V pressure G+P+W,k	817.04	129.92
Wall weight		233.11
H/V pressure passive		0.00
Support z: -0.50		0.00
Support z: -3.00	-242.95	65.10
Bh,g,k z=-12.02	-578.95	
Bv,g,k = Bh,k * tan(δ,p=-23.33°)		-249.74
Bh,q,k z=-12.02	4.86	
Bv,q,k = Bh,k * tan(δ,p=-23.33°)		2.10
Σ	-0.00	180.49 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1

Vertical component of earth resistance is less than the downwards pointing vertical forces.

Vk >= Bvk: 428.12 >= 247.64 Passes requirement

Anchor verification

Anchor - Stability of lower failure plane

Περίπτ.Φόρτισης: όλα τα φορτία BS-P
Αυτόμ. υπολογ. μήκους αγκυρίων:
All anchors are extended (if necessary)
Favourable variable loads in main failure body are not being considered.
Bottom of lower failure plane: z=-15.00 m

Iteration of failure mechanisms:
lA .....: Length of anchor from head to center of grout body.
W,k .....: Res. force from dead weight, loads, cohesion, ...
Q,k .....: Force in lower failure plane.
Ea1,k.....: Earth pressure onto vertical separation plane.
Ea2,k.....: Earth pressure between wall and main failure body.
Ra_cal,d ...: Dimesioning force of the resistance from the equilibrium of forces. Ra_cal,d corresponds to the max. possible anchor force of the force polygon.
Sum(A,d) ...: Acting anchor forces along the grout body fractions within the failure body. Sum(A,d) is gained from the anchor pull forces of the wall analysis.

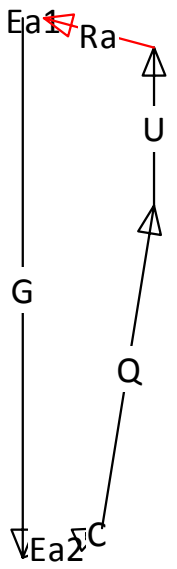
z [m]	ϑ1 [°]	ϑ2 [°]	lA [m]	W,k [kN/m]	Q,k [kN/m]	Ea1,k [kN/m]	Ea2,k [kN/m]	Ra_cal,d [kN/m]	Sum(A,d) [kN/m]	Ed/Rd [-]
-0.50	37.4	57.5	14.56	1934.5	1716.2	4.4	400.0	250.3	249.9	1.00
-3.00	31.8	61.1	14.00	1997.6	1741.6	46.1	400.0	349.1	348.3	1.00

Decisive failure body:
Γεωμετρία:
Foot point of lower failure plane x/z = 0.01/-15.00 m
Intersection lower/upper slid. plane x/z = 13.52/ -6.62 m
Intersection upper slid. plane/surface x/z = 17.18/ 0.00 m
Intersection separation plane/surface x/z = 13.52/ 0.00 m
Inclination lower failure plane ϑ1 = 31.80°
Inclination upper failure plane ϑ2 = 61.06°
Inclination separation plane ϑ12 = 90.00°

Loads / forces (char.)

		Fx [kN/m]	Fz [kN/m]	F [kN/m]	
Weight of main failure body	G,k:	0.0	-3093.6	3093.6	
Cohesion of lower failure plane	C,k:	67.5	41.9	79.5	
Pore water pressure on main body	U,k:	-0.5	1055.2	1055.2	
Earth pres. on separation plane	Ea1,k:	-46.1	-0.0	46.1	δ= 0.0°
Earth pr. between wall<->main body	Ea2,k:	378.3	129.9	400.0	
Force in lower failure plane	Q,k:	72.9	1740.1	1741.6	
Sum = possible anchor forces:	Ra_cal,k:	472.1	-126.5	488.8	

Force polygon



Acting anchor forces Ed: Sum(A,d) = 348.3 kN/m
Possible anchor forces Rd: Ra_cal,d = 488.8/1.400 = 349.1 kN/m

Verif. of lower failure plane Ed/Rd = 1.00 < 1.0: Έλεγχος εκπληρώθηκε.

Check of steel tension

l,tot ...[m]: Total length of anchor incl. excess length at head
As ....[mm2]: X-section are of steel member
Ri,d ...[kN]: Ultimate strength of tension member (γ,M=1.15)
A,d ....[kN]: Dimensioning force of the anchor from wall analysis

z[m]	Anchor type	l,tot	As	Ri,d		A,d	
-0.50	Strand;3x0.60";1570/1770	19.37	420	573.4	>	0.0	Passes requirement
-3.00	Strand;3x0.60";1570/1770	18.00	420	573.4	>	313.6	Passes requirement

Check of steel tension: Passes requirement

Check of anchor's soil friction

lVk .....: Length of grout body
DmVk ....: Diameter of grout body
τGr,k ...: Average applied skin friction along the grout body (from soil parameters)
Ra,k ....: Charact. pullout resistance of the anchor
γA ......: Partial safety factor of anchor pullout
Ra,d ....: = Ra,k / γA
A,d .....: Dimensioning force of the anchor from wall analysis

z [m]	lVk [m]	DmVk [mm]	τGr,k [kN/m²]	Ra,k [kN]	γA [-]	Ra,d [kN]		A,d [kN]	A,d/Ra,d [-]
-0.50	8.00	318	110	879.1	1.100	799.2	>	0.0	0.0
-3.00	8.00	318	110	879.1	1.100	799.2	>	313.6	0.4

Check of anchor's soil friction: Passes requirement

Υπολογ. κύκλου ολίσθησης

LC: όλα τα φορτία Type: BS-T (combination: [GEO] A2 M2 R3, BS-T)
Vertical variable loads only act if they are outside of R*sin(phi).
The automatic slip circle optimization only considers circles that intersect
the surface with an area of at least 0.25 m2.
The slip circle calculation only accepts circles including the wall.
The slipcircle calculation only allows circular failure planes
(no vertical tangents will occour).

Γεωμετ.κύκλου (μήκη και συντεταγμ. σε (m))
Κέντρο = (-0.10, 6.68), Ακτίνα = 21.69
Αρχ.σημ.= (-17.32, -6.50), Τελ.σημ. = (20.54, 0.00)

Γεωμετρία λωρίδων:

No	x	Width b	dxM	Weight	Load z-κατ.	Water-φορτ.	u*b	φ	c	θ
	[m]	[m]	[m]	[kN/m]	[kN/m]	[kN/m]	[kN/m]	[°]	[kN/m²]	[°]
1	-16.24	2.17	-16.14	63.8	0.0	0.0	-15.5	27.45	3.57	-31.27*
2	-14.07	2.17	-13.97	166.4	0.0	0.0	-51.0	27.45	3.57	-31.27*
3	-11.90	2.17	-11.80	244.9	0.0	0.0	-86.1	29.26	3.57	-30.37*
4	-9.73	2.17	-9.64	305.2	0.0	0.0	-113.1	29.26	3.57	-26.37
5	-7.56	2.17	-7.47	350.7	0.0	0.0	-133.4	29.26	3.57	-20.13
6	-5.39	2.17	-5.30	383.3	0.0	0.0	-148.0	29.26	3.57	-14.13
7	-3.23	2.17	-3.13	404.3	0.0	0.0	-157.4	29.26	3.57	-8.29
8	-1.06	2.17	-0.96	418.1	0.0	0.0	-210.7	29.26	3.57	-2.53
9	1.11	2.17	1.21	700.0	0.0	0.0	-259.2	29.26	3.57	3.20
10	3.28	2.17	3.38	688.7	0.0	0.0	-254.2	29.26	3.57	8.96
11	5.45	2.17	5.55	666.5	0.0	0.0	-244.2	29.26	3.57	14.82
12	7.62	2.17	7.72	632.4	0.0	0.0	-229.0	29.26	3.57	20.84
13	9.79	2.17	9.89	585.3	0.0	0.0	-208.0	29.26	3.57	27.12
14	11.96	2.17	12.06	523.1	0.0	0.0	-180.1	29.26	3.57	33.77
15	14.13	2.17	14.23	442.2	0.0	0.0	-143.8	27.45	3.57	40.98
16	16.30	2.17	16.39	336.2	0.0	0.0	-96.0	27.45	3.57	49.10
17	18.96	3.16	19.06	222.8	0.0	0.0	-50.0	0.08	35.71	61.47

*** Σημείωση: Στις λωρίδες σημειωμένες με '*'
περιορίστηκε το theta στο 45°-Phi/2.

Συνεισφ. κατακόρυφων φορτίων:

No	Weight	G*sin(θ)	(G-u*b)*tan(φ) + c*b	μ*sin(θ)* tan(φ)+cos(θ)	T
	[kN/m]	[kN/m]	[kN/m]	[-]	[kN/m]
1	63.84	-47.51	32.84	0.754062	43.55
2	166.42	-107.21	67.74	0.754062	89.83
3	244.86	-133.25	96.66	0.757076	127.67
4	305.18	-135.56	115.33	0.803086	143.61
5	350.66	-120.69	129.42	0.866956	149.29
6	383.30	-93.60	139.54	0.918686	151.89
7	404.29	-58.29	146.05	0.959411	152.23
8	418.05	-18.47	123.92	0.989786	125.20
9	700.03	39.07	254.69	1.010107	252.14
10	688.75	107.31	251.19	1.020355	246.18
11	666.45	170.48	244.27	1.020198	239.43
12	632.39	225.01	233.71	1.008932	231.64
13	585.30	266.79	219.12	0.985353	222.38
14	523.09	290.74	199.87	0.947488	210.94
15	442.22	290.01	162.77	0.882061	184.53
16	336.21	254.11	132.56	0.801313	165.43
17	222.80	195.75	113.02	0.478023	236.42
		1124.70			2972.36

Συνεισφ. αγκυρίων: Αθρ. ροπών ανατροπής : -296.6 kN*m/m
" " resisting : 116.5 kN*m/m

Δράση Ed = (1124.7*21.69-296.6)
Αντίσταση Rd = (2972.4*21.69+116.5)

SLIP-CIRCLE μ = Ed/Rd = 0.37 < 1.0: Έλεγχος εκπληρώθηκε.

Φάση εκσκαφής 6 "[6] Situation 4 + +"

LC: όλα τα φορτία Type: BS-T

Εδαφικό σύστημα με 5 Στρώσεις

Name		Τεχνητές επιχωματώσεις	Αμμώδης ΑΡΓΙΛΟΣ	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
γ	[kN/m3]	18	20	22.5
γ,R	[kN/m3]	18	20	22.5
γ'	[kN/m3]	8	10	12.5
γ,p	[kN/m3]	18	20	22.5
γ,R,passive	[kN/m3]	18	20	22.5
γ,pw	[kN/m3]	8	10	12.5
φ	[°]	25	0.1	33
c	[kN/m2]	2	50	5
c,u	[kN/m2]	10	50	5
c παθητικό	[kN/m2]	2	50	5
δ,a	[°]	16.66667	0.06666667	22
δ,p	[°]	-16.66667	-0.06666667	-22
δ,c	[°]	8.333333	0.03333333	11
k,agh	[-]	0.3456501	0.9955057	0.2452023
K,ach	[-]	1.043051	1.994195	0.8549058
K,0h	[-]	0.5773817	0.9982547	0.455361
K,pgh	[-]	3.908103	1.004519	7.495617
K,pch	[-]	5.180327	2.00583	8.599509
τ,gr	[kN/m2]	110	110	110
Ψ,A,max	[°]	90	90	90
k	[cm/s]	10e-06	1e-06	100e-06

Name		Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
γ	[kN/m3]	22.5	22.5
γ,R	[kN/m3]	22.5	22.5
γ'	[kN/m3]	12.5	12.5
γ,p	[kN/m3]	22.5	22.5
γ,R,passive	[kN/m3]	22.5	22.5
γ,pw	[kN/m3]	12.5	12.5
φ	[°]	35	35
c	[kN/m2]	5	5
c,u	[kN/m2]	5	5
c παθητικό	[kN/m2]	5	5
δ,a	[°]	23.33333	23.33333
δ,p	[°]	-23.33333	-23.33333
δ,c	[°]	11.66667	11.66667
k,agh	[-]	0.2244207	0.2244207
K,ach	[-]	0.8126539	0.8126539
K,0h	[-]	0.4264236	0.4264236
K,pgh	[-]	9.146943	9.146943
K,pch	[-]	10.104	10.104
τ,gr	[kN/m2]	110	110
Ψ,A,max	[°]	90	90
k	[cm/s]	100e-06	100e-06

Πορεία πρανούς:
x [m] 0.00 0.00
z [m] -6.50 0.00

Πορεία ανώτερου 2. στρώματος Αμμώδης ΑΡΓΙΛΟΣ:
x [m] 0.00 0.00
z [m] -6.50 -1.50

Πορεία ανώτερου 3. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ:
x [m] 0.00 0.00
z [m] -6.50 -4.50

Πορεία ανώτερου 4. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -10.00

Πορεία ανώτερου 5. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -14.00

Επιφ. φορτία:

Φορτία

xA [m]	zA [m]	xE [m]	zE [m]	PxA [kN/m²]	PzA	PxE	PzE	Typ	LC-description Name
1.00	0.00	3.50	0.00	0.00	33.00	0.00	33.00	q	1

Κατανομή εδαφ.πιέσεων

Κατανομή εδαφ.πιέσεων	Name
Rectangular within a layer	

Στάθμη νερού:

x [m]	0.00	0.00
z [m]	-7.50	-3.00

Αγκύρια

z[m]	min.l[m]	Alpha[°]	C-H[kN/m]	P0[kN]	u0[m]
-0.50	0.00	15.00	αόρισ.	0.00	0.0000
-3.00	0.00	15.00	αόρισ.	0.00	0.0000
-5.50	0.00	15.00	αόρισ.	0.00	0.0000

Παράμετροι υπολογισμού

Earth pressure options

Τμήμα εδαφ.ωθήσεων: Ενεργές ωθήσεις.
Angle of slip plane: DIN 4085.
Split block loads into 1 sections.
Consideration of minimum earth pressure: φ,min = 40.000.
Negative earth pressure fractions are set to zero.

Redistribution of earth pressure

Shape of redistribution: Triangle (perpend. to wall).
The earth pressure is getting redistb. to: Excavation level
The earth pressure below the excavation acts without redistrb.
Levels of redistribution Z1: -3.000, Z2: -5.500 [m].
The earth pressure from variable loads will be included in redistribution.

Παθητικές ωθήσεις

Method of calculation: Κλασικός, Pregl/Sokolovsky (DIN 4085).

Options for water pressure

Στήριξη πόδα

Πόδας οριζοντίως μετακινούμενος

Αγκύρια

Anchor checks (lower failure plane): Ναι
Anchor forces with safety level of DS-P: Ναι
Verification of grout body pull out forces: Ναι
δ,a,Anchoring wall : used from soil layer.
δ,p,Anchoring wall : used from soil layer.

Earth pressure coefficients kh

φ	α	β	δ	k0gh	kagh	kach	kpgh	kpch	
33.0	0.0	0.0	-22.0	--	--	--	7.496	-8.600	Τεχνητές επιχωματώσεις
25.0	0.0	0.0	16.7	--	0.346	1.043	--	--	"
0.1	0.0	0.0	0.1	--	0.996	1.994	--	--	Αμμώδης ΑΡΓΙΛΟΣ
33.0	0.0	0.0	-22.0	--	--	--	7.496	-8.600	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
33.0	0.0	0.0	22.0	--	0.245	0.855	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"

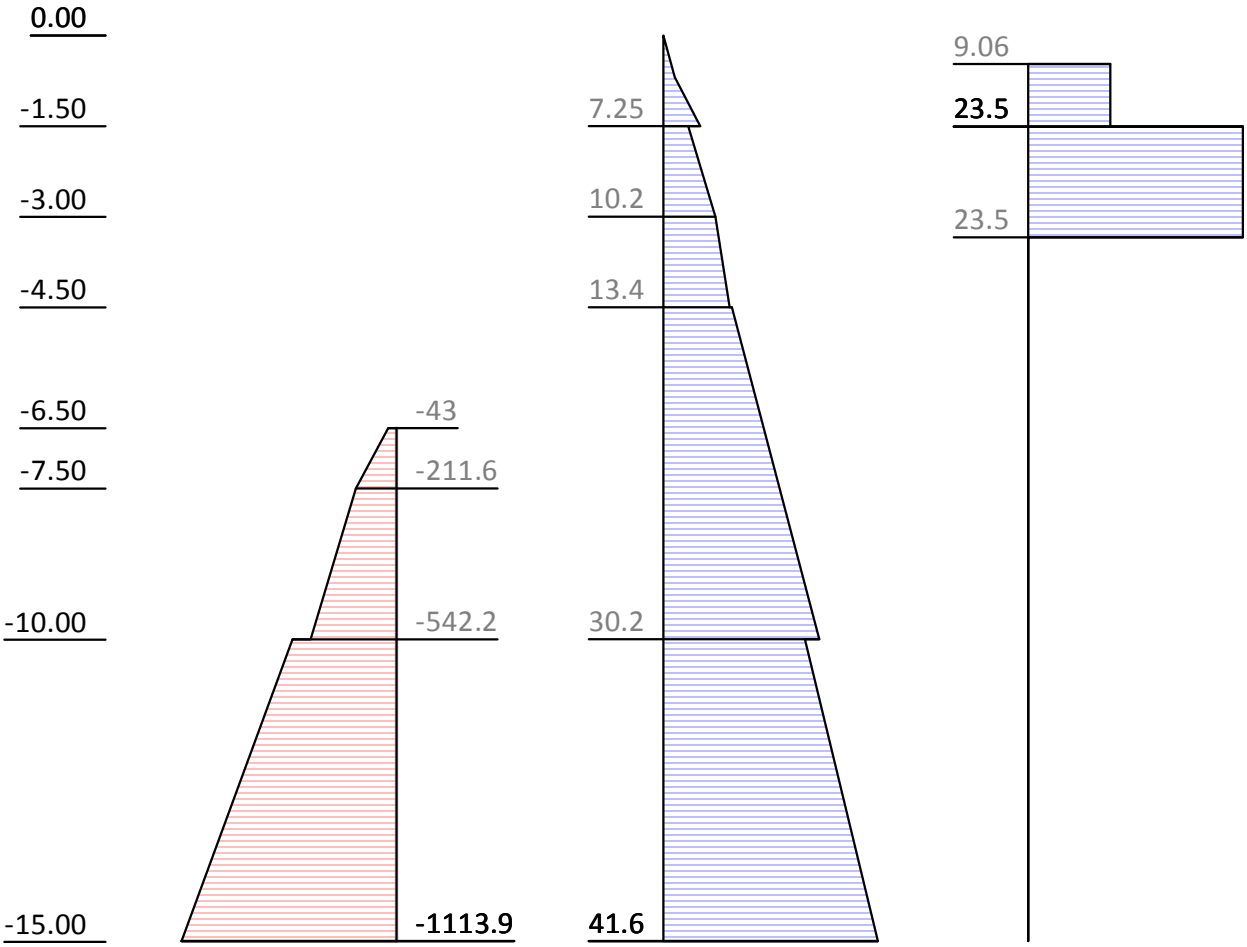
Μήκος τοίχου

Foot depth for statics: zf = -15.000

Stress analysis

Earth pressure, horizontal

Pressures characteristic, no redistribution, continous wall



z [m]	eph,G,k [kN/m2]	eah,G,k [kN/m2]	eah,PQ,k [kN/m2]	eah,d [kN/m2]
0.00		0.00		0.00
-0.47		1.52	0.00	2.04
-0.47		1.52	9.06	15.62
-1.50		7.25	9.06	23.37
-1.50		4.82	23.48	41.73
-3.34		10.79	23.48	49.78
-3.34		10.79	0.00	14.56
-4.50		12.86	0.00	17.36
-4.50		13.38	0.00	18.06
-6.50	-0.00	19.51	0.00	26.34
-6.50	-43.00	19.51	0.00	26.34
-10.00	-445.89	30.24	0.00	40.82
-10.00	-542.17	27.52	0.00	37.16
-15.00	-1113.85	41.55	0.00	56.09

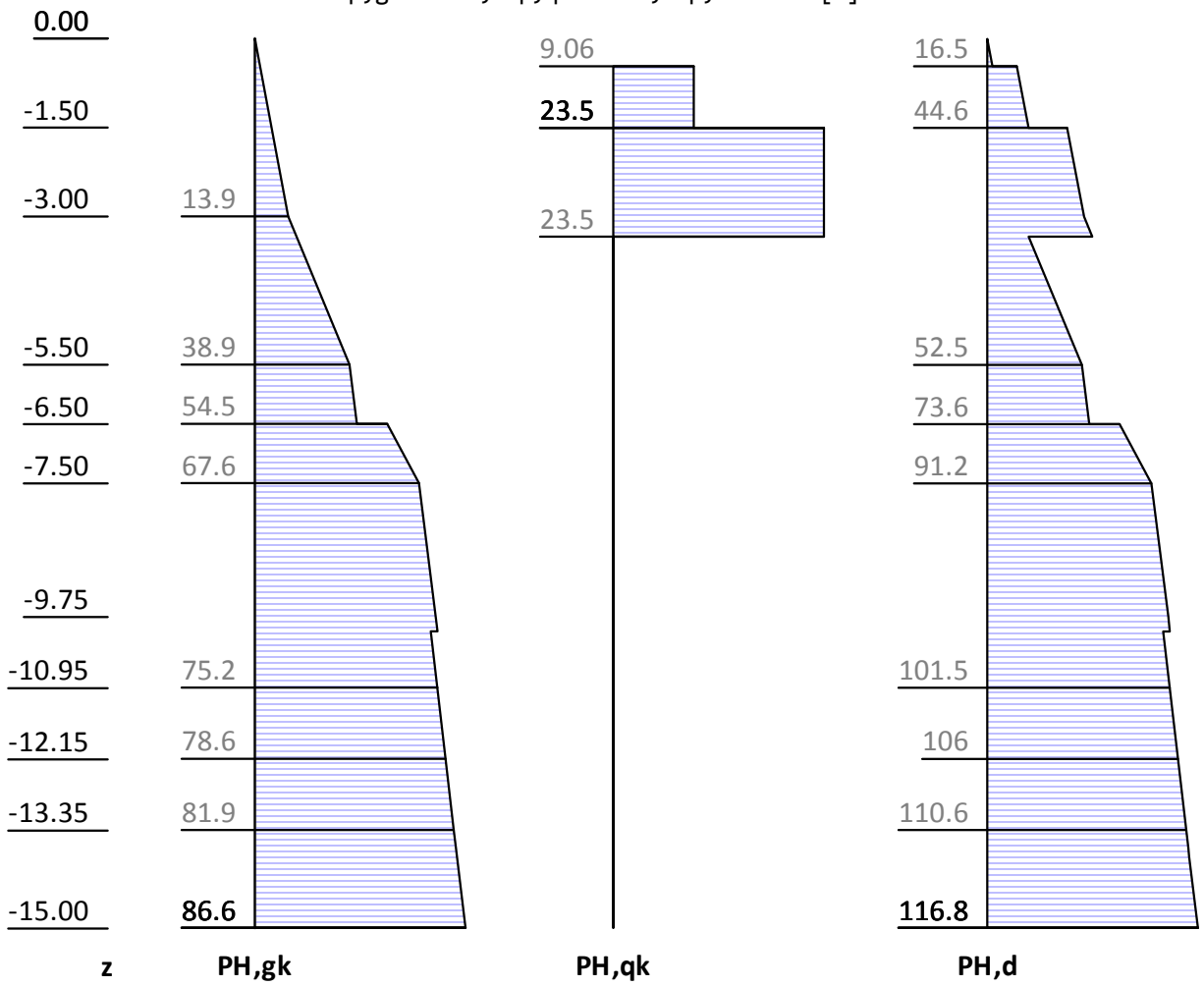
Eph,G,k:-5089.29, Eph,PG,k: 0.00 [kN/m]
Eah,G,k: 325.76, Eah,PG,k: 0.00, Eah,PQ,k: 52.53, Eah,d: 518.57

Πίεση νερού

z [m]	Wp,k [kN/m2]	Wa,k [kN/m2]	W,k [kN/m2]
-3.00		0.00	0.00
-7.50	0.00	45.00	45.00
-13.80	-63.00	108.00	45.00
-15.00	-75.00	120.00	45.00

H-pressure on static system

Level of mobilization: Ep,gk 100.0, Ep,qk 100.0, Ep,d 100.0 [%]

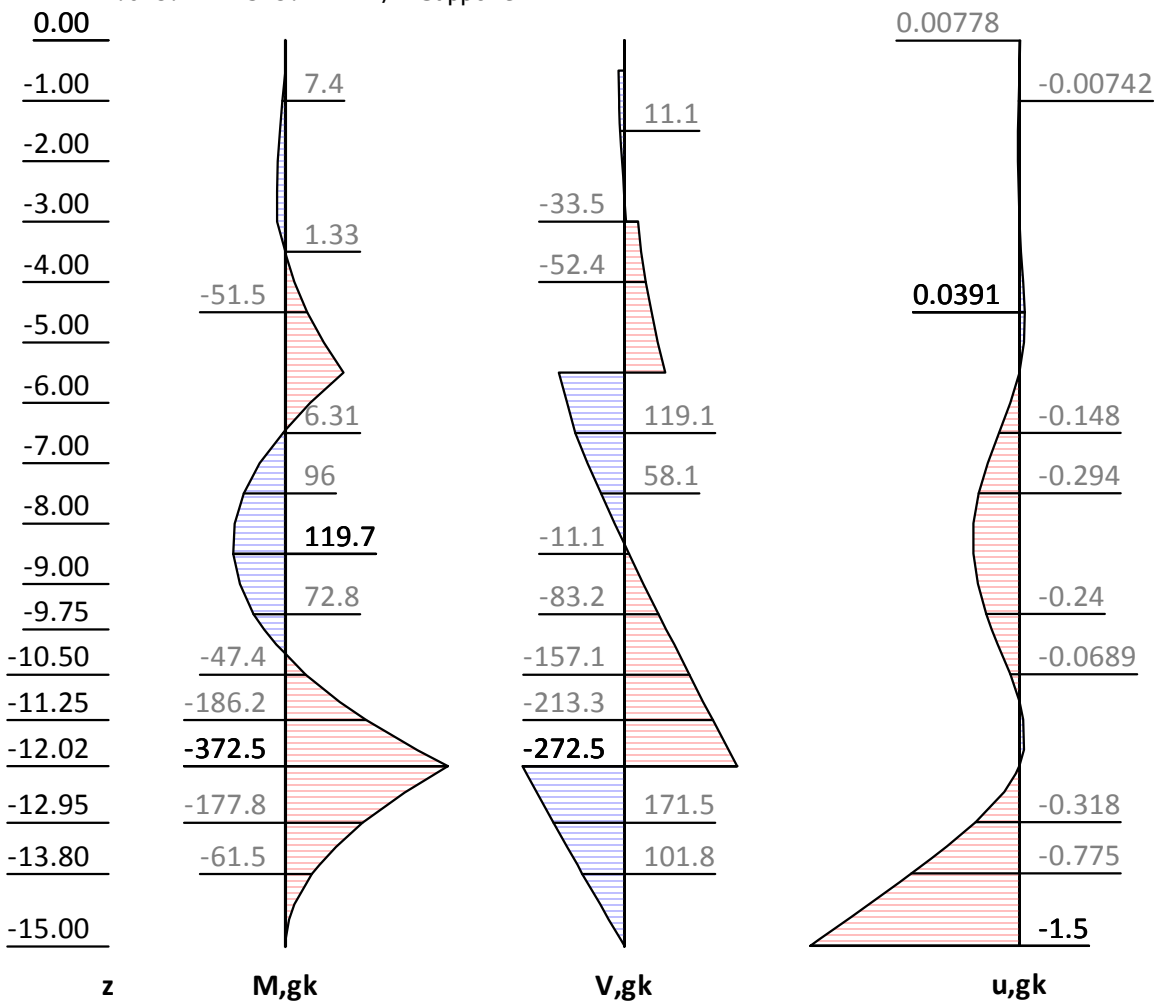


z [m]	PH,gk [kN/m2]	PH,qk [kN/m2]	PH,d [kN/m2]
0.00	0.00		0.00
-0.47	2.18	0.00	2.94
-0.47	2.18	9.06	16.52
-1.50	6.95	9.06	22.97
-1.50	6.95	23.48	44.60
-3.34	17.30	23.48	58.57
-3.34	17.30	0.00	23.35
-6.50	41.95	0.00	56.63
-6.50	54.51	0.00	73.59
-10.00	75.24	0.00	101.57
-10.00	72.52	0.00	97.91
-15.00	86.55	0.00	116.84

V-pressure on static system

Internal forces: Permanent, characteristically

z= -0.500. Fx= -16.352 kN/m Support
z= -3.000. Fx= 29.033 kN/m Support
z= -5.500. Fx=-259.040 kN/m Support
z= -12.018. Fx=-518.149 kN/m Support

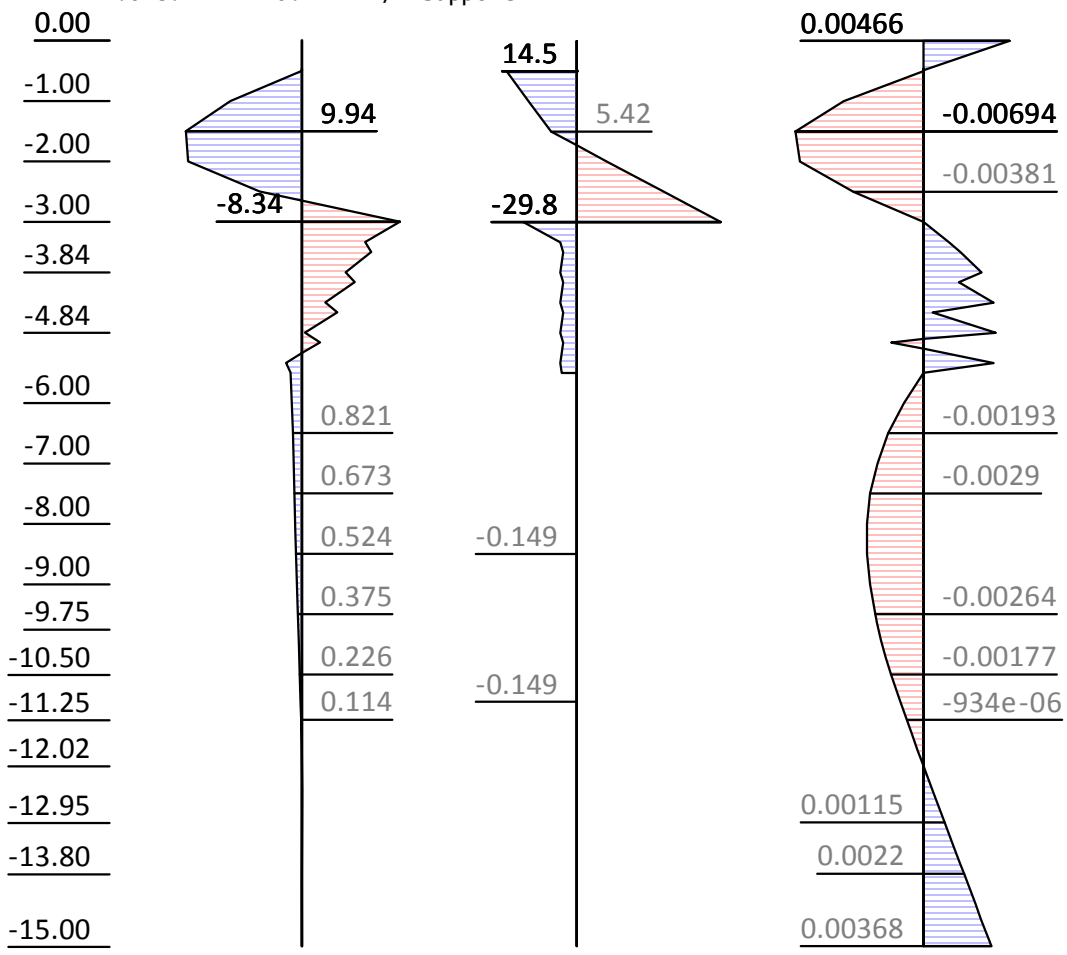


z [m]	H,g,k [kN/m2]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [mm]
0.00	0.00	0.00	0.00	0.00	0.01
-0.00	0.00	-0.00	0.00	-0.00	0.01
-0.50	2.32	-0.10	-0.58	-10.63	0.00
-0.51	2.35	0.00	15.75	-15.15	-0.00
-2.00	9.27	18.35	7.09	-48.48	-0.01
-2.50	11.58	20.64	1.88	-60.16	-0.01
-2.65	12.26	20.46	-0.00	-63.68	-0.01
-3.00	13.90	20.03	-4.49	-72.10	0.00
-3.00	13.90	20.03	-33.53	-64.33	0.00
-3.53	19.18	-0.00	-42.33	-76.59	0.02
-4.50	28.90	-51.52	-65.62	-96.77	0.04
-5.50	38.90	-133.26	-99.52	-114.20	0.00
-5.50	38.90	-133.26	-99.52	-114.20	-0.00
-5.50	38.90	-133.26	159.52	-183.60	-0.00
-6.45	41.80	-0.00	121.10	-197.86	-0.14
-6.50	41.95	6.31	119.10	-198.57	-0.15
-6.50	54.51	6.31	119.10	-198.57	-0.15
-8.34	70.16	118.63	0.00	-238.43	-0.33
-8.50	70.64	119.68	-11.06	-242.01	-0.33
-10.00	75.24	21.95	-120.46	-277.84	-0.16

z [m]	H,g,k [kN/m2]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [mm]
-10.00	72.52	21.95	-120.46	-277.84	-0.16
-10.16	72.97	0.00	-132.05	-281.76	-0.13
-10.96	75.20	-126.76	-191.05	-301.78	-0.00
-11.75	77.43	-302.42	-251.68	-322.52	0.03
-12.02	78.19	-372.53	-272.49	-329.68	0.00
-12.02	78.19	-372.53	245.66	-329.68	0.00
-15.00	86.55	-0.00	-0.00	-415.33	-1.50

Internal forces: Variable, characteristically

Method EB 82-4 (Q = [G+Q] - G).
z= -0.500. Fx= -14.747 kN/m Support
z= -3.000. Fx= -40.968 kN/m Support
z= -5.500. Fx= 3.332 kN/m Support
z= -12.018. Fx= -0.149 kN/m Support

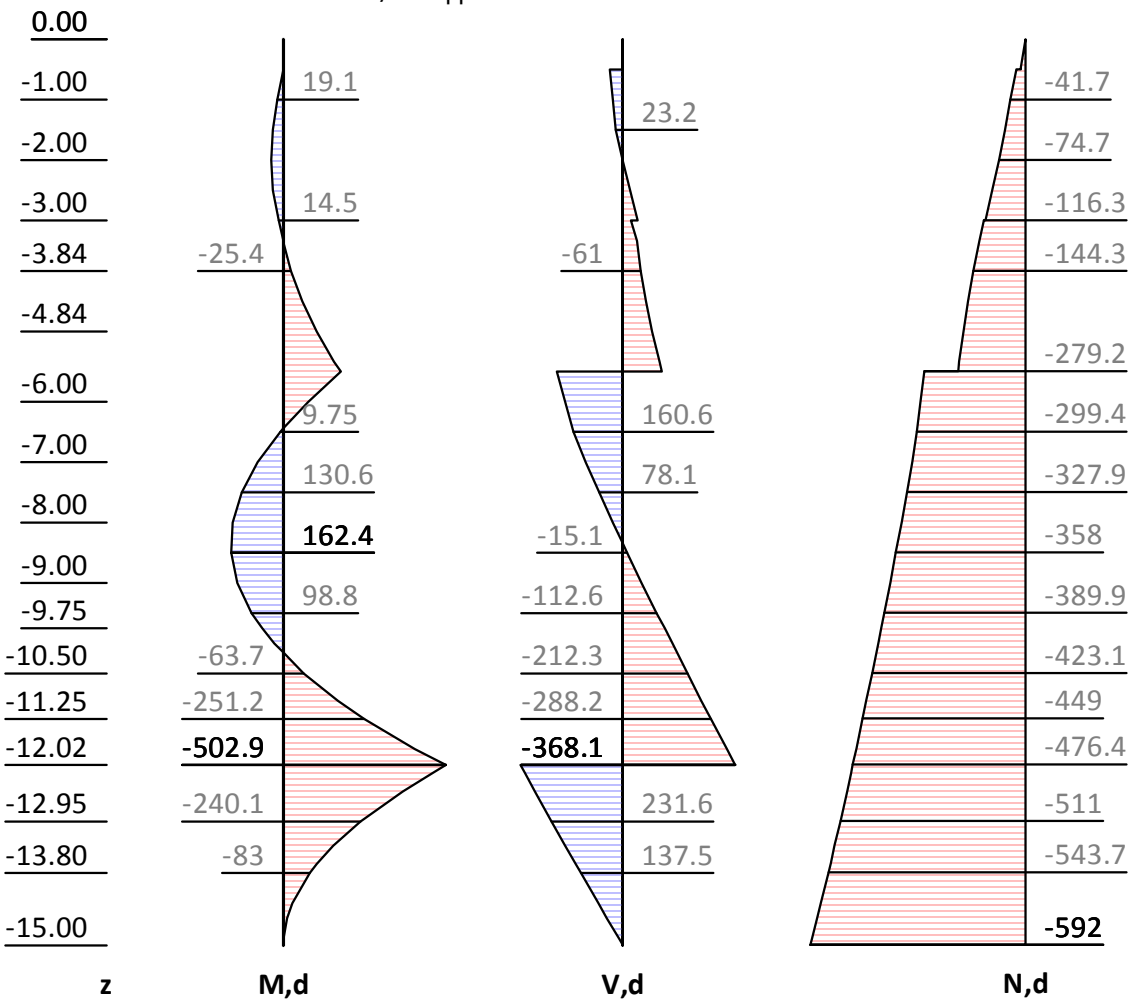


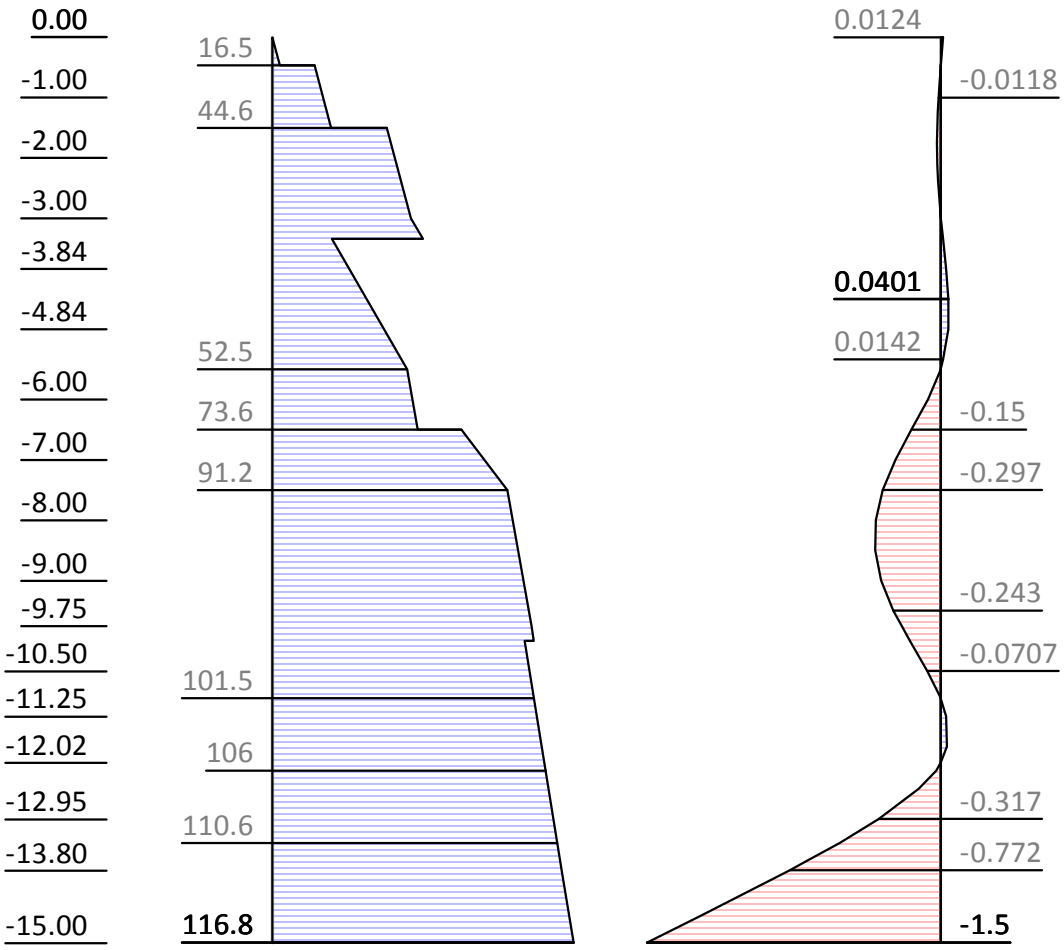
z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
0.00		0.00	-0.00	0.00	0.00
-0.00		0.00	0.00	0.00	0.00
-0.47	0.00	0.01	0.03	0.01	0.00
-0.47	9.06	0.01	0.03	0.01	0.00
-0.48	9.06	0.01	-0.03	-0.00	0.00
-0.49	9.06	-0.00	-0.19	-0.02	0.00
-0.50	9.06	-0.00	14.47	-3.98	-0.00
-1.50	9.06	9.94	5.42	-4.94	-0.01
-1.50	23.48	9.94	5.42	-4.94	-0.01
-1.73	23.48	9.83	0.00	-5.51	-0.01

z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
-2.65	23.48	0.00	-21.60	-7.80	-0.00
-3.00	23.48	-8.34	-29.80	-8.66	-0.00
-3.00	23.48	-8.34	11.17	-19.64	-0.00
-3.00	23.48	-8.34	11.17	-19.64	0.00
-3.34	23.48	-5.45	3.45	-20.77	0.00
-3.34	0.00	-5.45	3.45	-20.77	0.00
-3.50	0.00	-5.94	2.91	-20.75	0.00
-3.84	0.00	-3.75	3.44	-21.27	0.00
-4.00	0.00	-4.50	2.90	-21.21	0.00
-4.34	0.00	-2.03	3.44	-21.64	0.00
-4.50	0.00	-3.04	2.90	-21.54	0.00
-4.84	0.00	-0.29	3.45	-21.89	0.00
-4.95	0.00	-1.18	3.07	-21.79	0.00
-5.00	0.00	-1.59	2.90	-21.74	-0.00
-5.11	0.00	-0.63	3.07	-21.82	0.00
-5.18	0.00	0.00	3.19	-21.87	0.00
-5.34	0.00	1.40	3.44	-21.99	0.00
-5.50	0.00	0.97	3.18	-21.91	0.00
-5.50	0.00	0.97	-0.15	-21.02	0.00
-7.00	0.00	0.75	-0.15	-21.02	-0.00
-7.50	0.00	0.67	-0.15	-21.02	-0.00
-8.50	0.00	0.52	-0.15	-21.02	-0.00
-9.50	0.00	0.37	-0.15	-21.02	-0.00
-9.75	0.00	0.34	-0.15	-21.02	-0.00
-10.50	0.00	0.23	-0.15	-21.02	-0.00
-12.02	0.00	0.00	-0.15	-21.02	-0.00
-12.02	0.00	-0.00	-0.15	-21.02	0.00
-12.02	0.00	-0.00	0.00	-21.02	0.00
-12.45	0.00	-0.00	0.00	-21.02	0.00
-13.35	0.00	-0.00	0.00	-21.02	0.00
-13.65	0.00	-0.00	0.00	-21.02	0.00
-13.76	0.00	-0.00	0.00	-21.02	0.00
-13.80	0.00	0.00	0.00	-21.02	0.00
-14.90	0.00	-0.00	-0.00	-21.02	0.00
-14.99	0.00	0.00	-0.00	-21.02	0.00
-15.00	0.00	0.00	-0.00	-21.02	0.00

Internal forces: Design

z= -0.500. Fx= -44.196 kN/m Support
z= -3.000. Fx= -22.258 kN/m Support
z= -5.500. Fx=-344.706 kN/m Support
z= -12.018. Fx=-699.724 kN/m Support





z [m]	H,d [kN/m2]	M,d [kN/m2]	V,d [kN/m2]	N,d [kN/m2]	u,g+q,k [mm]
0.00	0.00	0.00	0.00	-0.00	0.01
-0.47	2.94	-0.11	-0.69	-13.48	0.00
-0.47	16.52	-0.11	-0.69	-13.48	0.00
-0.50	16.71	-0.14	-1.19	-14.40	-0.00
-0.50	16.73	0.00	42.94	-26.35	-0.00
-1.50	22.97	33.47	23.17	-57.44	-0.02
-1.50	44.60	33.47	23.17	-57.44	-0.02
-2.00	47.73	39.32	0.08	-74.72	-0.02
-2.00	47.74	39.30	0.00	-74.78	-0.02
-3.00	53.98	14.53	-50.77	-110.34	-0.00
-3.00	53.98	14.53	-28.51	-116.30	-0.00
-3.00	53.98	14.53	-28.51	-116.30	0.00
-3.34	58.57	1.63	-47.65	-128.65	0.01
-3.34	23.35	1.63	-47.65	-128.65	0.01
-3.37	23.76	-0.00	-48.45	-129.59	0.01
-4.34	36.85	-59.99	-77.76	-158.62	0.04
-5.50	52.51	-178.44	-129.58	-186.82	-0.00
-5.50	52.51	-178.44	215.13	-279.18	-0.00
-6.44	56.40	-0.00	163.66	-298.28	-0.14
-6.50	56.63	9.75	160.56	-299.38	-0.15
-6.50	73.59	9.75	160.56	-299.38	-0.15
-8.34	94.70	160.96	0.00	-353.12	-0.34
-8.50	95.36	162.35	-15.15	-358.03	-0.34
-10.00	101.57	30.08	-162.85	-406.40	-0.16
-10.00	97.91	30.08	-162.85	-406.40	-0.16
-10.16	98.51	0.00	-178.70	-411.77	-0.13
-10.97	101.57	-174.31	-259.43	-439.16	-0.00

z [m]	H,d [kN/m2]	M,d [kN/m2]	V,d [kN/m2]	N,d [kN/m2]	u,g+q,k [mm]
-11.75	104.53	-408.21	-339.99	-466.72	0.03
-12.02	105.56	-502.92	-368.09	-476.38	0.00
-12.02	105.56	-502.92	331.64	-476.38	0.00
-15.00	116.84	-0.00	-0.00	-592.02	-1.50

Anchor forces with safety level of DS-P

z[m]	A,d[kN]	Fx,d[kN/m]
-0.50	82.4	-44.2
-3.00	20.7	-22.3
-5.50	321.2	-344.7

Checks of earth statics

Check or earth support

Check: Mobilizable earth resistance is sufficient for earth support force.
z: -12.02 m
Rd = Eph,k/γ,Re = 5089.29 / 1.400 = 3635.21 [kN/m]

Ed(Uh,d)/Rd = 699.72 / 3635.21 = 0.192 [-]. Passes requirement

Sum of H and V forces, (G)

Forces up to depth z:-15.00

Pos.	H	V
H/V pressure G+P+W,k	764.51	124.61
Wall weight		233.11
H/V pressure passive		-0.00
Support z: -0.50	-16.35	4.38
Support z: -3.00	29.03	-7.78
Support z: -5.50	-259.04	69.41
Bh,g,k z=-12.02	-518.15	
Bv,g,k = Bh,k * tan(δ,p=-23.33°)		-223.51
Σ	0.00	200.23 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1

Vertical component of earth resistance is less than the downwards pointing vertical forces.

Vk >= Bvk: 423.73 >= 223.51 Passes requirement

Sum of H and V forces, (G+Q)

Forces up to depth z:-15.00

Pos.	H	V
H/V pressure G+P+W,k	817.04	130.17
Wall weight		233.11
H/V pressure passive		0.00
Support z: -0.50	-31.10	8.33
Support z: -3.00	-11.94	3.20
Support z: -5.50	-255.71	68.52
Bh,g,k z=-12.02	-518.15	
Bv,g,k = Bh,k * tan(δ,p=-23.33°)		-223.51
Bh,q,k z=-12.02	-0.15	
Bv,q,k = Bh,k * tan(δ,p=-23.33°)		-0.06
Σ	0.00	219.75 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than
the downwards pointing vertical forces.

Vk >= Bvk: 443.33 >= 223.57 Passes requirement

Anchor verification

Anchor - Stability of lower failure plane

Περίπτ.Φόρτισης: όλα τα φορτία BS-P
Αυτόμ. υπολογ. μήκους αγκυρίων:
All anchors are extended (if necessary)
Favourable variable loads in main failure body are not being considered.
Bottom of lower failure plane: z=-15.00 m

Iteration of failure mechanisms:
lA .....: Length of anchor from head to center of grout body.
W,k .....: Res. force from dead weight, loads, cohesion, ...
Q,k .....: Force in lower failure plane.
Ea1,k.....: Earth pressure onto vertical separation plane.
Ea2,k.....: Earth pressure between wall and main failure body.
Ra_cal,d ...: Dimesioning force of the resistance from the equilibrium of forces. Ra_cal,d corresponds to the max. possible anchor force of the force polygon.
Sum(A,d) ...: Acting anchor forces along the grout body fractions within the failure body. Sum(A,d) is gained from the anchor pull forces of the wall analysis.

z [m]	ϑ1 [°]	ϑ2 [°]	lA [m]	W,k [kN/m]	Q,k [kN/m]	Ea1,k [kN/m]	Ea2,k [kN/m]	Ra_cal,d [kN/m]	Sum(A,d) [kN/m]	Ed/Rd [-]
-0.50	38.3	57.5	14.19	1872.3	1664.0	4.4	400.0	229.4	229.2	1.00
-3.00	33.9	61.0	13.23	1869.2	1628.7	41.5	400.0	302.1	301.3	1.00
-5.50	26.7	61.3	12.76	1995.6	1728.3	106.3	400.0	421.9	421.4	1.00

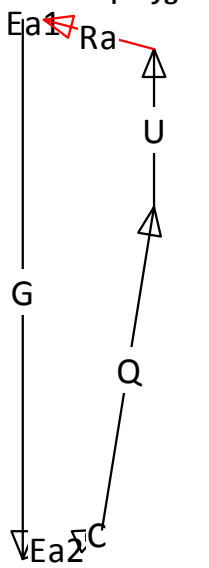
Decisive failure body:
Γεωμετρία:

Foot point of lower failure plane	x/z =	0.01/-15.00 m
Intersection lower/upper slid. plane	x/z =	12.32/ -8.80 m
Intersection upper slid. plane/surface	x/z =	17.14/ 0.00 m
Intersection separation plane/surface	x/z =	12.32/ 0.00 m
Inclination lower failure plane	ϑ1	= 26.72°
Inclination upper failure plane	ϑ2	= 61.30°
Inclination separation plane	ϑ12	= 90.00°

Loads / forces (char.)

		Fx [kN/m]	Fz [kN/m]	F [kN/m]	
Weight of main failure body	G,k:	0.0	-3121.6	3121.6	
Cohesion of lower failure plane	C,k:	61.6	31.0	68.9	
Pore water pressure on main body	U,k:	-0.5	1096.0	1096.0	
Earth pres. on separation plane	Ea1,k:	-106.3	-0.0	106.3	δ= 0.0°
Earth pr. between wall<->main body	Ea2,k:	378.3	129.9	400.0	
Force in lower failure plane	Q,k:	237.6	1711.9	1728.3	
Sum = possible anchor forces:	Ra_cal,k:	570.6	-152.9	590.7	

Force polygon



Acting anchor forces Ed: Sum(A,d) = 421.4 kN/m
Possible anchor forces Rd: Ra_cal,d = 590.7/1.400 = 421.9 kN/m

Verif. of lower failure plane Ed/Rd = 1.00 < 1.0: Έλεγχος εκπληρώθηκε.

Check of steel tension

l,tot ...[m]: Total length of anchor incl. excess length at head
As ....[mm2]: X-section are of steel member
Ri,d ...[kN]: Ultimate strength of tension member (γ,M=1.15)
A,d ....[kN]: Dimensioning force of the anchor from wall analysis

z[m]	Anchor type	l,tot	As	Ri,d		A,d	
-0.50	Strand;3x0.60";1570/1770	19.52	420	573.4	>	82.4	Passes requirement
-3.00	Strand;3x0.60";1570/1770	18.14	420	573.4	>	20.7	Passes requirement
-5.50	Strand;4x0.60";1570/1770	16.76	560	764.5	>	321.2	Passes requirement

Check of steel tension: Passes requirement

Check of anchor's soil friction

lVk .....: Length of grout body
DmVk ....: Diameter of grout body
τGr,k ...: Average applied skin friction along the grout body (from soil parameters)
Ra,k ....: Charact. pullout resistance of the anchor
γA ......: Partial safety factor of anchor pullout
Ra,d ....: = Ra,k / γA
A,d .....: Dimensioning force of the anchor from wall analysis

z [m]	lVk [m]	DmVk [mm]	τGr,k [kN/m²]	Ra,k [kN]	γA [-]	Ra,d [kN]		A,d [kN]	A,d/Ra,d [-]
-0.50	8.00	318	110	879.1	1.100	799.2	>	82.4	0.1
-3.00	8.00	318	110	879.1	1.100	799.2	>	20.7	0.0
-5.50	8.00	318	110	879.1	1.100	799.2	>	321.2	0.4

Check of anchor's soil friction: Passes requirement

Υπολογ. κύκλου ολίσθησης

LC: όλα τα φορτία Type: BS-T (combination: [GEO] A2 M2 R3, BS-T)
Vertical variable loads only act if they are outside of R*sin(phi).
The automatic slip circle optimization only considers circles that intersect
the surface with an area of at least 0.25 m2.
The slip circle calculation only accepts circles including the wall.
The slipcircle calculation only allows circular failure planes
(no vertical tangents will occour).

Γεωμετ.κύκλου (μήκη και συντεταγμ. σε (m))
Κέντρο = (-0.10, 6.68), Ακτίνα = 21.69
Αρχ.σημ.= (-17.32, -6.50), Τελ.σημ. = (20.54, 0.00)

Γεωμετρία λωρίδων:

No	x	Width b	dxM	Weight	Load z-κατ.	Water-φορτ.	u*b	φ	c	θ
	[m]	[m]	[m]	[kN/m]	[kN/m]	[kN/m]	[kN/m]	[°]	[kN/m²]	[°]
1	-16.24	2.17	-16.14	63.8	0.0	0.0	-15.5	27.45	3.57	-31.27*
2	-14.07	2.17	-13.97	166.4	0.0	0.0	-51.0	27.45	3.57	-31.27*
3	-11.90	2.17	-11.80	244.9	0.0	0.0	-86.1	29.26	3.57	-30.37*
4	-9.73	2.17	-9.64	305.2	0.0	0.0	-113.1	29.26	3.57	-26.37
5	-7.56	2.17	-7.47	350.7	0.0	0.0	-133.4	29.26	3.57	-20.13
6	-5.39	2.17	-5.30	383.3	0.0	0.0	-148.0	29.26	3.57	-14.13
7	-3.23	2.17	-3.13	404.3	0.0	0.0	-157.4	29.26	3.57	-8.29
8	-1.06	2.17	-0.96	418.1	0.0	0.0	-210.7	29.26	3.57	-2.53
9	1.11	2.17	1.21	700.0	0.0	0.0	-259.2	29.26	3.57	3.20
10	3.28	2.17	3.38	688.7	0.0	0.0	-254.2	29.26	3.57	8.96
11	5.45	2.17	5.55	666.5	0.0	0.0	-244.2	29.26	3.57	14.82
12	7.62	2.17	7.72	632.4	0.0	0.0	-229.0	29.26	3.57	20.84
13	9.79	2.17	9.89	585.3	0.0	0.0	-208.0	29.26	3.57	27.12
14	11.96	2.17	12.06	523.1	0.0	0.0	-180.1	29.26	3.57	33.77
15	14.13	2.17	14.23	442.2	0.0	0.0	-143.8	27.45	3.57	40.98
16	16.30	2.17	16.39	336.2	0.0	0.0	-96.0	27.45	3.57	49.10
17	18.96	3.16	19.06	222.8	0.0	0.0	-50.0	0.08	35.71	61.47

*** Σημείωση: Στις λωρίδες σημειωμένες με '*'
περιορίστηκε το theta στο 45°-Phi/2.

Συνεισφ. κατακόρυφων φορτίων:

No	Weight	G*sin(θ)	(G-u*b)*tan(φ) + c*b	μ*sin(θ)* tan(φ)+cos(θ)	T
	[kN/m]	[kN/m]	[kN/m]	[-]	[kN/m]
1	63.84	-47.51	32.84	0.756061	43.44
2	166.42	-107.21	67.74	0.756061	89.59
3	244.86	-133.25	96.66	0.759175	127.32
4	305.18	-135.56	115.33	0.804930	143.28
5	350.66	-120.69	129.42	0.868385	149.04
6	383.30	-93.60	139.54	0.919699	151.73
7	404.29	-58.29	146.05	0.960009	152.14
8	418.05	-18.47	123.92	0.989970	125.17
9	700.03	39.07	254.69	1.009875	252.19
10	688.75	107.31	251.19	1.019708	246.33
11	666.45	170.48	244.27	1.019136	239.68
12	632.39	225.01	233.71	1.007454	231.98
13	585.30	266.79	219.12	0.983461	222.81
14	523.09	290.74	199.87	0.945180	211.46
15	442.22	290.01	162.77	0.879536	185.06
16	336.21	254.11	132.56	0.798402	166.03
17	222.80	195.75	113.02	0.478014	236.43
		1124.70			2973.68

Συνεισφ. αγκυρίων: Αθρ. ροπών ανατροπής : -727.8 kN*m/m
" " resisting : 217.8 kN*m/m

Δράση Ed = (1124.7*21.69-727.8)
Αντίσταση Rd = (2973.7*21.69+217.8)

SLIP-CIRCLE μ = Ed/Rd = 0.37 < 1.0: Έλεγχος εκπληρώθηκε.

Φάση εκσκαφής 7 "[7] Situation 5"

LC: όλα τα φορτία Type: BS-T

Εδαφικό σύστημα με 5 Στρώσεις

Name		Τεχνητές επιχωματώσεις	Αμμώδης ΑΡΓΙΛΟΣ	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
γ	[kN/m3]	18	20	22.5
γ,R	[kN/m3]	18	20	22.5
γ'	[kN/m3]	8	10	12.5
γ,p	[kN/m3]	18	20	22.5
γ,R,passive	[kN/m3]	18	20	22.5
γ,pw	[kN/m3]	8	10	12.5
φ	[°]	25	0.1	33
c	[kN/m2]	2	50	5
c,u	[kN/m2]	10	50	5
c παθητικό	[kN/m2]	2	50	5
δ,a	[°]	16.66667	0.06666667	22
δ,p	[°]	-16.66667	-0.06666667	-22
δ,c	[°]	8.333333	0.03333333	11
k,agh	[-]	0.3456501	0.9955057	0.2452023
K,ach	[-]	1.043051	1.994195	0.8549058
K,0h	[-]	0.5773817	0.9982547	0.455361
K,pgh	[-]	3.908103	1.004519	7.495617
K,pch	[-]	5.180327	2.00583	8.599509
τ,gr	[kN/m2]	110	110	110
Ψ,A,max	[°]	90	90	90
k	[cm/s]	10e-06	1e-06	100e-06

Name		Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
γ	[kN/m3]	22.5	22.5
γ,R	[kN/m3]	22.5	22.5
γ'	[kN/m3]	12.5	12.5
γ,p	[kN/m3]	22.5	22.5
γ,R,passive	[kN/m3]	22.5	22.5
γ,pw	[kN/m3]	12.5	12.5
φ	[°]	35	35
c	[kN/m2]	5	5
c,u	[kN/m2]	5	5
c παθητικό	[kN/m2]	5	5
δ,a	[°]	23.33333	23.33333
δ,p	[°]	-23.33333	-23.33333
δ,c	[°]	11.66667	11.66667
k,agh	[-]	0.2244207	0.2244207
K,ach	[-]	0.8126539	0.8126539
K,0h	[-]	0.4264236	0.4264236
K,pgh	[-]	9.146943	9.146943
K,pch	[-]	10.104	10.104
τ,gr	[kN/m2]	110	110
Ψ,A,max	[°]	90	90
k	[cm/s]	100e-06	100e-06

Πορεία πρανούς:
x [m] 0.00 0.00
z [m] -10.35 0.00

Πορεία ανώτερου 2. στρώματος Αμμώδης ΑΡΓΙΛΟΣ:
x [m] 0.00 0.00
z [m] -10.35 -1.50

Πορεία ανώτερου 3. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ:
x [m] 0.00 0.00
z [m] -10.35 -4.50

Πορεία ανώτερου 4. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
x [m] 0.00 0.00
z [m] -10.35 -10.00

Πορεία ανώτερου 5. στρώματος Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ:
z= -14.00

Επιφ. φορτία:

Φορτία

xA [m]	zA [m]	xE [m]	zE [m]	PxA [kN/m²]	PzA	PxE	PzE]	Typ	LC-description Name
1.00	0.00	3.50	0.00	0.00	33.00	0.00	33.00	q	1

Κατανομή εδαφ.πιέσεων

Κατανομή εδαφ.πιέσεων	Name
Rectangular within a layer	

Στάθμη νερού:

x [m] 0.00 0.00
z [m] -11.00 -4.50

Αγκύρια

z[m]	min.l[m]	Alpha[°]	C-H[kN/m]	P0[kN]	u0[m]
-0.50	0.00	15.00	αόρισ.	0.00	0.0000
-3.00	0.00	15.00	0.00	0.00	0.0000
-5.50	0.00	15.00	αόρισ.	0.00	0.0000

Παράμετροι υπολογισμού

Earth pressure options

Τμήμα εδαφ.ωθήσεων: Ενεργές ωθήσεις.
Angle of slip plane: DIN 4085.
Split block loads into 1 sections.
Consideration of minimum earth pressure: φ,min = 40.000.
Negative earth pressure fractions are set to zero.

Redistribution of earth pressure

Shape of redistribution: Triangle (perpend. to wall).
The earth pressure is getting redistb. to: Excavation level
The earth pressure below the excavation acts without redistrb.
Levels of redistribution Z1: -3.000, Z2: -5.500 [m].
The earth pressure from variable loads will be included in redistribution.

Παθητικές ωθήσεις

Method of calculation: Κλασικός, Pregl/Sokolovsky (DIN 4085).

Options for water pressure

Additional water and earth pressure from ground water flow is calculated.
Negative flow pressure is set to zero.
The proof of the basic hydraulic heave is performed.

Στήριξη πόδα

Πόδας οριζοντίως μετακινούμενος

Αγκύρια

Anchor checks (lower failure plane): Ναι
Anchor forces with safety level of DS-P: Ναι
Verification of grout body pull out forces: Ναι
δ,a,Anchoring wall : used from soil layer.
δ,p,Anchoring wall : used from soil layer.

Earth pressure coefficients kh

φ	α	β	δ	k0gh	kagh	kach	kpgh	kpch	
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Τεχνητές επιχωματώσεις
25.0	0.0	0.0	16.7	--	0.346	1.043	--	--	"
0.1	0.0	0.0	0.1	--	0.996	1.994	--	--	Αμμώδης ΑΡΓΙΛΟΣ
33.0	0.0	0.0	22.0	--	0.245	0.855	--	--	Αργιλώδη ΧΑΛΙΚΙΑ - ΑΜΜΟΣ
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"
35.0	0.0	0.0	-23.3	--	--	--	9.147	-10.104	Αργιλώδη ΧΑΛΙΚΙΑ- ΑΜΜΟ
35.0	0.0	0.0	23.3	--	0.224	0.813	--	--	"

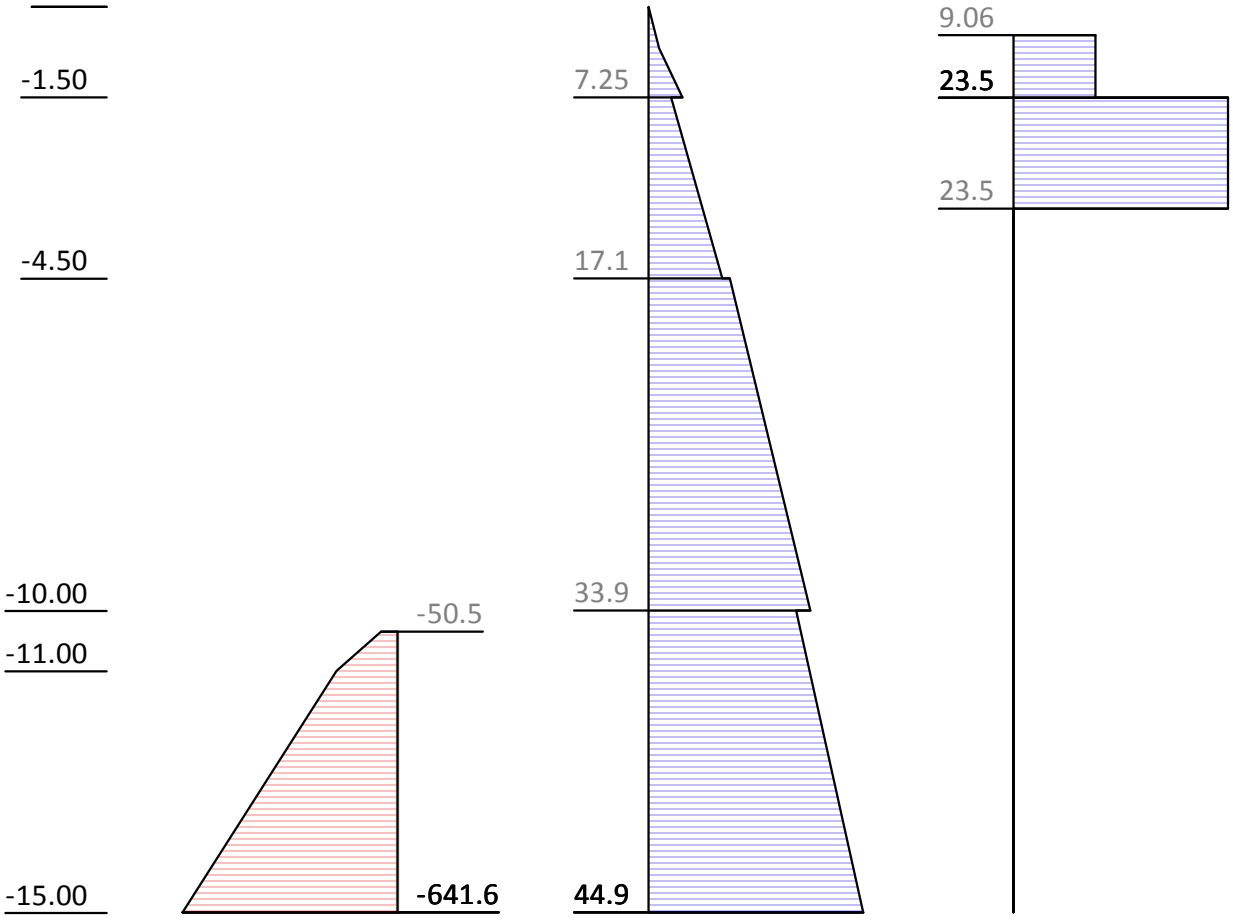
Μήκος τοίχου

Foot depth for statics: zf = -15.000

Stress analysis

Earth pressure, horizontal

Pressures characteristic, no redistribution, continous wall



z [m]	eph,G,k [kN/m2]	eah,G,k [kN/m2]	eah,PQ,k [kN/m2]	eah,d [kN/m2]
0.00		0.00		0.00
-0.47		1.52	0.00	2.04
-0.47		1.52	9.06	15.62
-1.50		7.25	9.06	23.37
-1.50		4.82	23.48	41.73
-3.34		11.39	23.48	50.60
-3.34		11.39	0.00	15.38
-4.50		15.54	0.00	20.98

z [m]	eph,G,k [kN/m2]	eah,G,k [kN/m2]	eah,PQ,k [kN/m2]	eah,d [kN/m2]
-4.50		17.06	0.00	23.03
-10.00		33.92	0.00	53.95
-10.00		30.89	0.00	49.17
-10.35	-0.00	31.87	0.00	50.97
-10.35	-50.52	31.87	0.00	50.97
-15.00	-641.64	44.92	0.00	74.90

Eph,G,k:-1728.19, Eph,PG,k: 0.00 [kN/m]
Eah,G,k: 364.83, Eah,PG,k: 0.00, Eah,PQ,k: 52.53, Eah,d: 648.09

Earth pressure from water flow

Pressures characteristic, no redistribution, continous wall

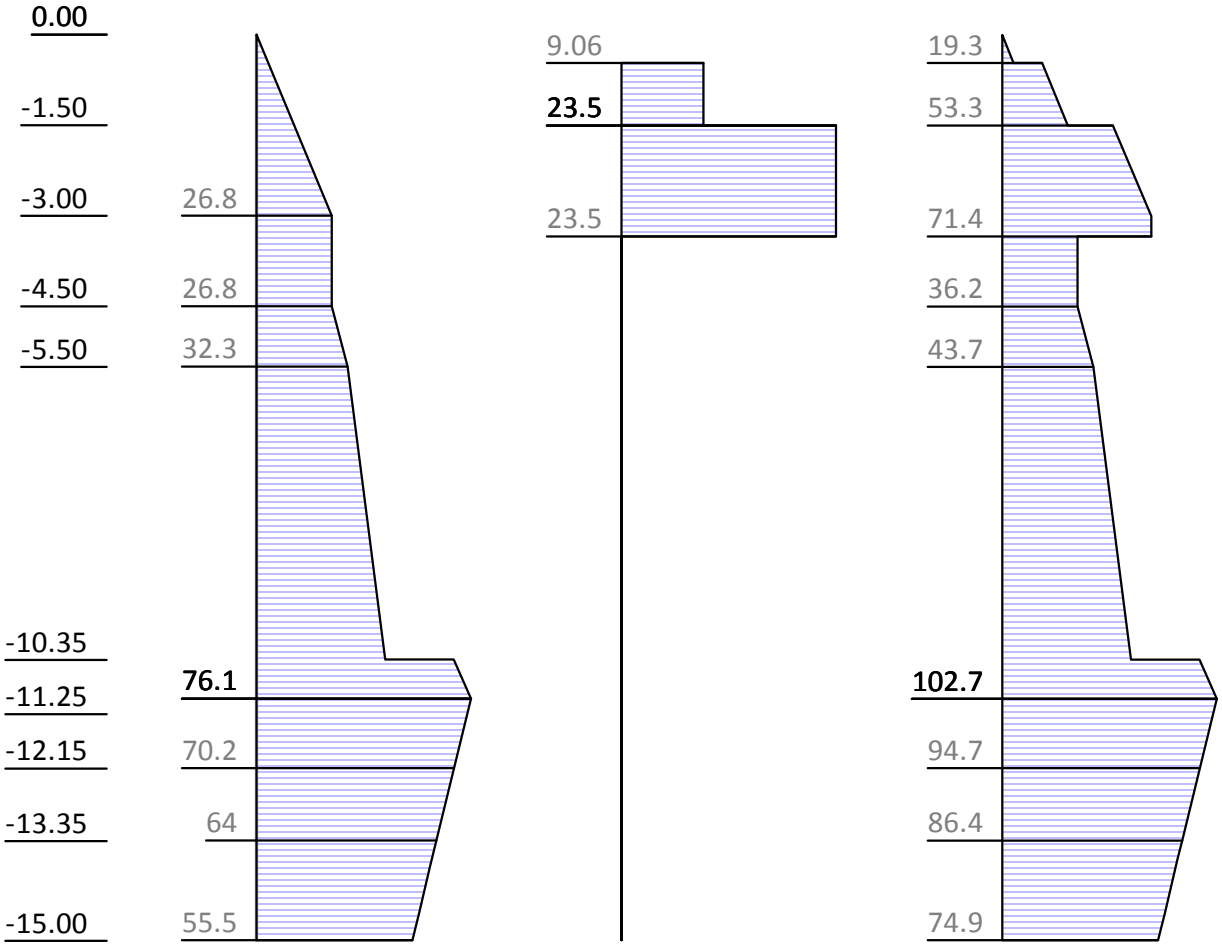
z [m]	eph,dynW,k [kN/m2]	eph,dynW+G+PG,k [kN/m2]	eah,dynW,k [kN/m2]	eah,dynW+G+PG,k [kN/m2]	Ip [-]	Ia [-]
-0.34			0.00			
-1.50			0.00			
-4.50			0.00			
-10.00			6.05			0.45
-10.00			5.53			0.45
-10.35	0.00	0.00	5.89	0.00		0.45
-10.35	0.00	-50.52	5.89	-50.52		0.45
-11.00	0.00	-184.29	6.54	-184.29		0.45
-14.00	123.01	-404.29	9.56	-404.29	0.45	0.45
-15.00	164.01	-477.63	10.56	-477.63	0.45	0.45

Πίεση νερού

z [m]	Wp,st,k [kN/m2]	Wa,st,k [kN/m2]	Wp,dyn,k [kN/m2]	Wa,dyn,k [kN/m2]	W,tot,k [kN/m2]
-4.50		0.00		0.00	0.00
-11.00	0.00	65.00	0.00	-29.14	35.86
-15.00	-40.00	105.00	-17.93	-47.07	0.00

H-pressure on static system

Level of mobilization: Ep,gk 100.0, Ep,qk 100.0, Ep,d 100.0 [%]

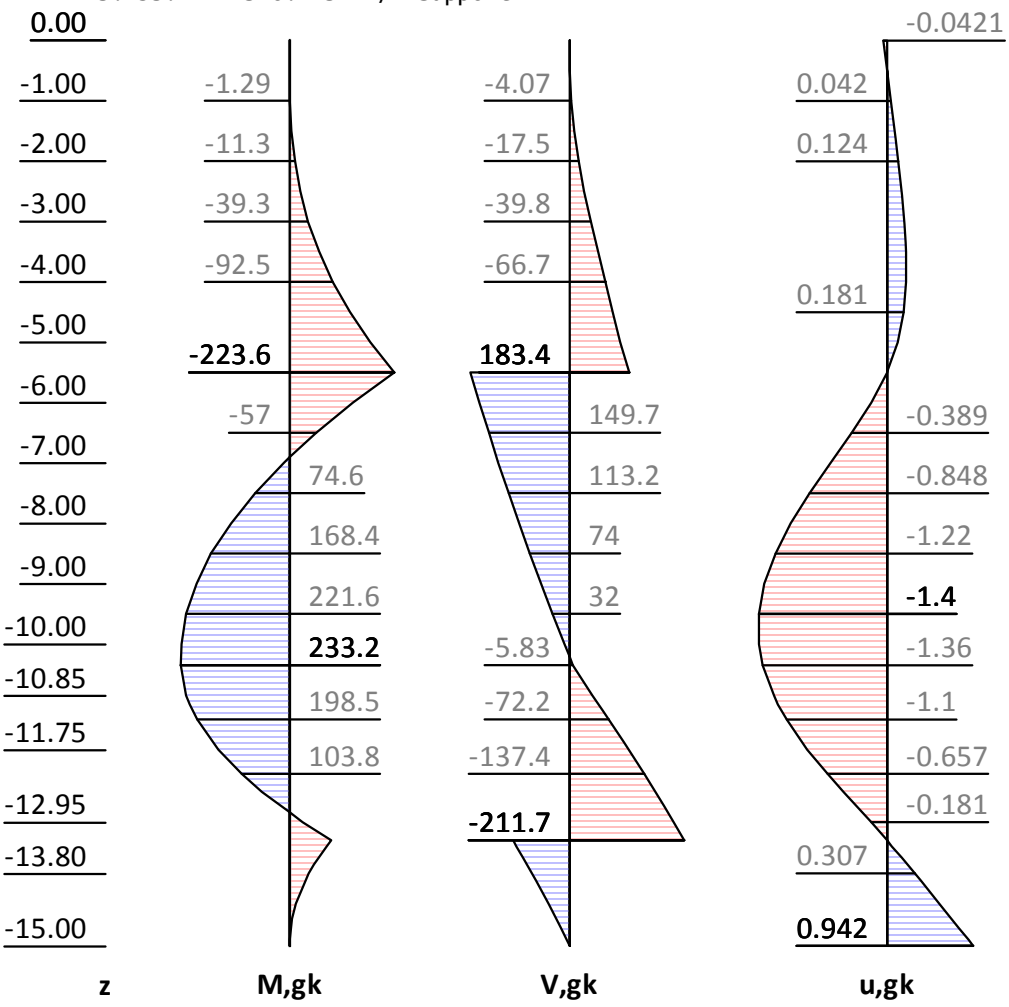


z [m]	PH,gk [kN/m2]	PH,qk [kN/m2]	PH,d [kN/m2]
0.00	0.00		0.00
-0.47	4.20	0.00	5.67
-0.47	4.20	9.06	19.26
-1.50	13.42	9.06	31.70
-1.50	13.42	23.48	53.33
-3.34	26.83	23.48	71.44
-3.34	26.83	0.00	36.22
-10.35	45.69	0.00	61.68
-10.35	70.03	0.00	94.54
-11.00	76.10	0.00	102.73
-15.00	55.48	0.00	74.90

V-pressure on static system

Internal forces: Permanent, characteristically

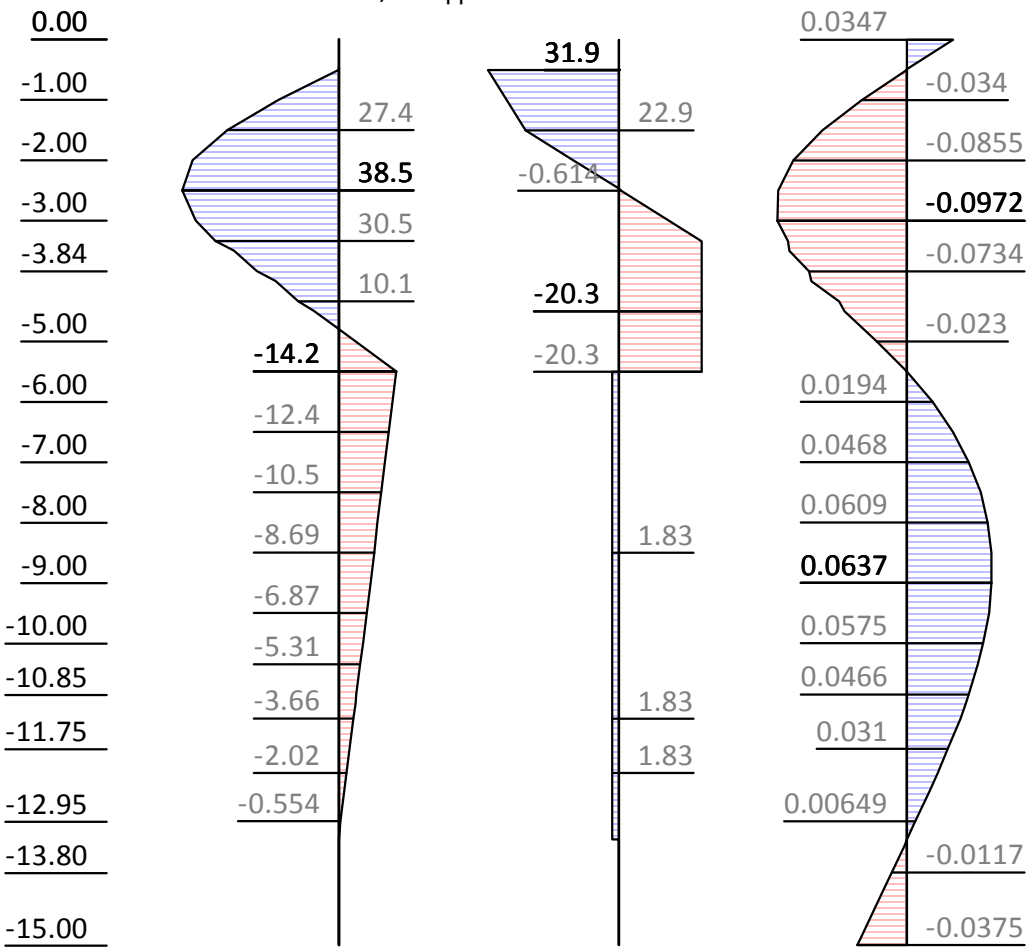
```
z=  -0.500. Fx=  -0.398 kN/m Support
z=  -3.000. Fx=  -0.000 kN/m Support
z=  -5.500. Fx=-293.099 kN/m Support
z= -13.253. Fx=-316.473 kN/m Support
```



z [m]	H,g,k [kN/m2]	M,g,k [kN/m2]	V,g,k [kN/m2]	N,g,k [kN/m2]	u,g,k [mm]
0.00	0.00	0.00	-0.00	-0.00	-0.04
-0.50	4.47	-0.19	-1.12	-10.88	0.00
-0.50	4.47	-0.19	-0.72	-10.99	0.00
-3.50	26.83	-62.54	-53.26	-92.04	0.21
-5.50	32.35	-223.63	-109.68	-152.46	0.00
-5.50	32.35	-223.63	-109.68	-152.46	-0.00
-5.50	32.35	-223.63	183.42	-231.00	-0.00
-6.90	36.21	-0.00	135.19	-270.73	-0.58
-9.50	43.35	221.59	32.00	-330.38	-1.40
-10.22	45.34	232.78	-0.00	-343.71	-1.37
-10.35	45.69	233.18	-5.83	-345.99	-1.36
-10.35	70.03	233.18	-5.83	-345.99	-1.36
-11.00	76.10	214.17	-53.32	-365.12	-1.19
-12.79	66.87	-0.00	-181.10	-421.40	-0.28
-13.25	64.50	-89.25	-211.68	-436.78	0.00
-13.25	64.50	-89.25	104.79	-436.78	0.00
-15.00	55.48	0.00	0.00	-498.09	0.94

Internal forces: Variable, characteristically

Method EB 82-4 (Q = [G+Q] - G).
z= -0.500. Fx= -32.201 kN/m Support
z= -3.000. Fx= 0.000 kN/m Support
z= -5.500. Fx= -22.161 kN/m Support
z= -13.253. Fx= 1.829 kN/m Support

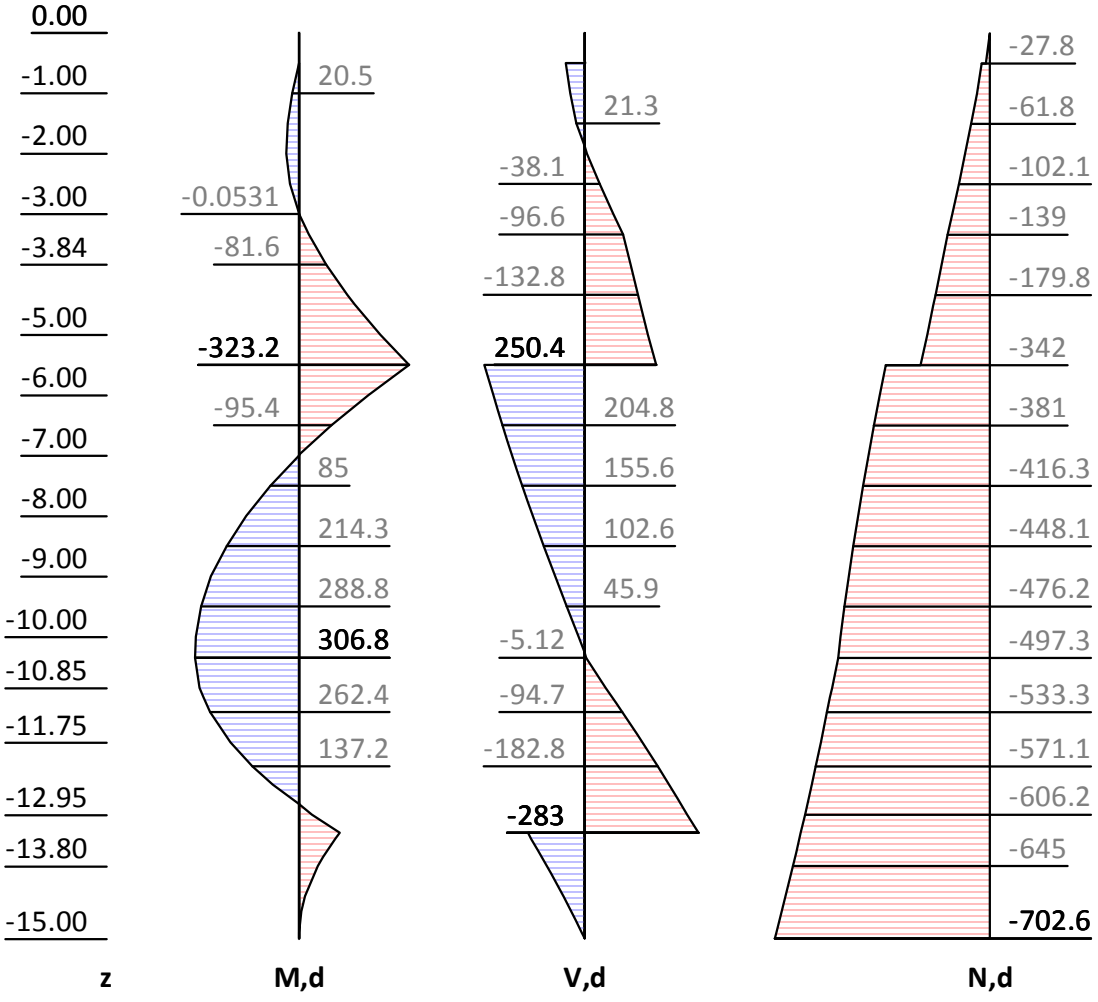


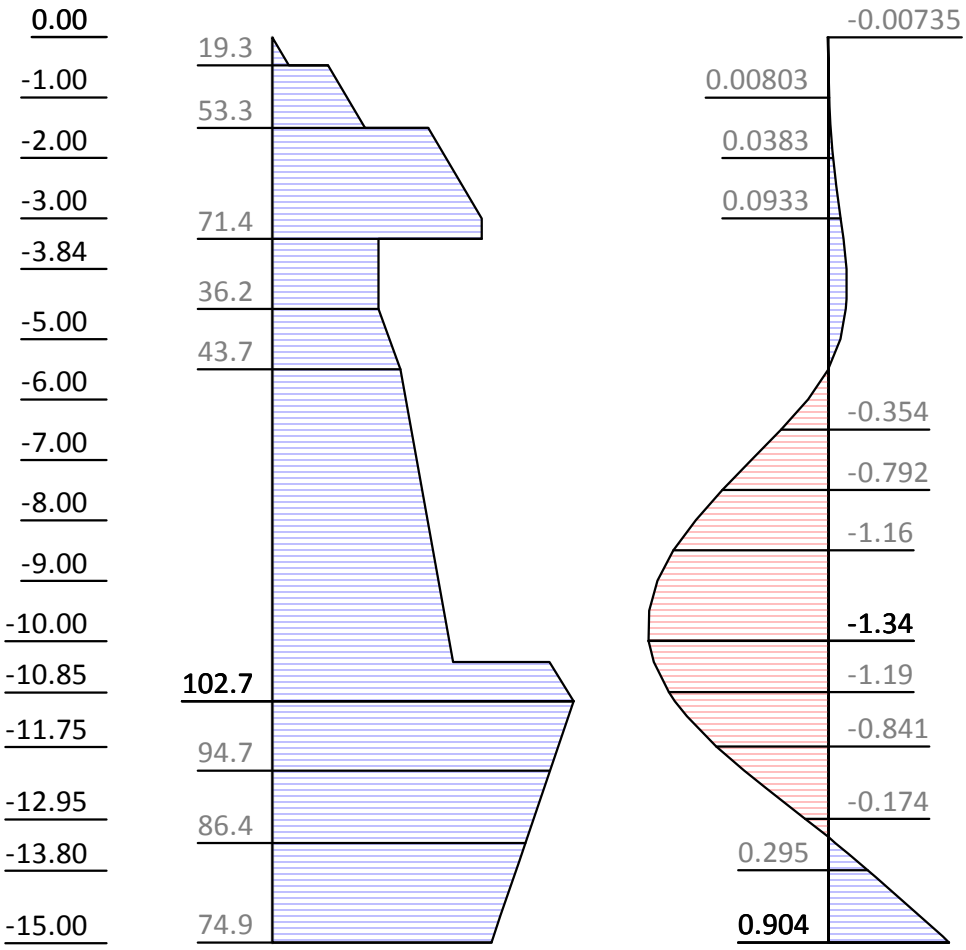
z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
0.00		0.00	0.00	0.00	0.03
-0.47	0.00	0.02	0.06	0.02	0.00
-0.47	9.06	0.02	0.06	0.02	0.00
-0.48	9.06	0.02	-0.00	0.01	0.00
-0.48	9.06	0.01	-0.08	-0.00	0.00
-0.50	9.06	0.00	-0.22	-0.02	0.00
-0.50	9.06	0.00	31.93	-8.66	-0.00
-1.50	9.06	27.40	22.87	-9.61	-0.06
-1.50	23.48	27.40	22.87	-9.61	-0.06
-2.47	23.48	38.36	-0.00	-12.04	-0.10
-2.50	23.48	38.50	-0.61	-12.10	-0.10
-3.00	23.48	35.29	-12.35	-13.34	-0.10
-3.34	23.48	30.48	-20.33	-14.18	-0.09
-3.34	0.00	30.48	-20.33	-14.18	-0.09
-4.50	0.00	6.15	-20.33	-14.18	-0.05
-4.80	0.00	0.00	-20.33	-14.18	-0.03
-5.50	0.00	-14.18	-20.33	-14.18	-0.00
-5.50	0.00	-14.18	1.83	-20.12	-0.00
-5.50	0.00	-14.18	1.83	-20.12	0.00
-7.50	0.00	-10.52	1.83	-20.12	0.06

z [m]	H,q,k [kN/m2]	M,q,k [kN/m2]	V,q,k [kN/m2]	N,q,k [kN/m2]	u,q,k [mm]
-8.50	0.00	-8.69	1.83	-20.12	0.06
-9.00	0.00	-7.78	1.83	-20.12	0.06
-9.50	0.00	-6.87	1.83	-20.12	0.06
-10.35	0.00	-5.31	1.83	-20.12	0.05
-13.25	0.00	-0.00	1.83	-20.12	0.00
-13.25	0.00	-0.00	0.00	-20.12	0.00
-13.25	0.00	-0.00	0.00	-20.12	-0.00
-13.35	0.00	-0.00	0.00	-20.12	-0.00
-13.65	0.00	-0.00	0.00	-20.12	-0.01
-14.30	0.00	-0.00	0.00	-20.12	-0.02
-14.84	0.00	0.00	0.00	-20.12	-0.03
-14.90	0.00	0.00	0.00	-20.12	-0.04
-14.96	0.00	0.00	-0.00	-20.12	-0.04
-15.00	0.00	-0.00	-0.00	-20.12	-0.04

Internal forces: Design

z= -0.500. Fx= -48.839 kN/m Support
z= -3.000. Fx= -0.000 kN/m Support
z= -5.500. Fx=-428.925 kN/m Support
z= -13.253. Fx=-424.494 kN/m Support





z [m]	H,d [kN/m2]	M,d [kN/m2]	V,d [kN/m2]	N,d [kN/m2]	u,g+q,k [mm]
0.00	0.00	0.00	0.00	0.00	-0.01
-0.47	5.67	-0.21	-1.33	-13.78	-0.00
-0.47	19.26	-0.21	-1.33	-13.78	-0.00
-0.50	19.62	-0.26	-1.92	-14.74	-0.00
-0.50	19.62	-0.26	46.92	-27.82	-0.00
-0.51	19.70	0.00	46.78	-28.03	0.00
-1.50	31.70	34.84	21.26	-61.76	0.02
-1.50	53.33	34.84	21.26	-61.76	0.02
-1.88	57.89	37.62	0.00	-76.60	0.03
-2.00	59.37	38.52	-6.92	-81.43	0.04
-3.00	71.43	0.00	-72.25	-123.82	0.09
-3.34	71.44	-28.77	-96.61	-139.00	0.11
-3.34	36.22	-28.77	-96.61	-139.00	0.11
-4.34	36.22	-143.50	-132.83	-179.79	0.14
-5.50	43.67	-323.18	-178.57	-227.10	-0.00
-5.50	43.67	-323.18	250.36	-342.03	-0.00
-7.00	49.22	0.00	180.89	-398.95	-0.57
-10.00	60.38	304.43	16.21	-488.90	-1.34
-10.27	61.37	306.25	-0.00	-495.26	-1.32
-10.35	61.68	306.82	-5.12	-497.28	-1.31
-10.35	94.54	306.82	-5.12	-497.28	-1.31
-11.00	102.73	282.94	-69.24	-523.09	-1.15
-12.78	90.32	0.00	-241.24	-598.83	-0.27
-13.25	87.07	-120.49	-283.02	-619.84	0.00
-13.25	87.07	-120.49	141.47	-619.84	0.00
-15.00	74.90	-0.00	0.00	-702.61	0.90

Anchor forces with safety level of DS-P

z[m]	A,d[kN]	Fx,d[kN/m]
-0.50	91.0	-48.8
-3.00	0.0	-0.0
-5.50	399.7	-428.9

Checks of earth statics

Check or earth support

Check: Mobilizable earth resistance is sufficient for earth support force.
z: -13.25 m
Rd = Eph,k/γ,Re = 1400.16 / 1.400 = 1000.11 [kN/m]

Ed(Uh,d)/Rd = 424.49 / 1000.11 = 0.424 [-]. Passes requirement

Sum of H and V forces, (G)

Forces up to depth z:-15.00

Pos.	H	V
H/V pressure G+P+W,k	609.97	163.87
Wall weight		254.11
H/V pressure passive		0.00
Support z: -0.50	-0.40	0.11
Support z: -3.00		0.00
Support z: -5.50	-293.10	78.54
Bh,g,k z=-13.25	-316.47	
Bv,g,k = Bh,k * tan(δ,p=-23.33°)		-136.51
Σ	-0.00	360.11 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than
the downwards pointing vertical forces.

Vk >= Bvk: 496.62 >= 136.51 Passes requirement

Sum of H and V forces, (G+Q)

Forces up to depth z:-15.00

Pos.	H	V
H/V pressure G+P+W,k	662.50	169.43
Wall weight		254.11
H/V pressure passive		0.00
Support z: -0.50	-32.60	8.73
Support z: -3.00		0.00
Support z: -5.50	-315.26	84.47
Bh,g,k z=-13.25	-316.47	
Bv,g,k = Bh,k * tan(δ,p=-23.33°)		-136.51
Bh,q,k z=-13.25	1.83	
Bv,q,k = Bh,k * tan(δ,p=-23.33°)		0.79
Σ	0.00	381.02 (downwards)

Average anchor inclination α,A = 15.00° >= 15°.

Verification of vertical forces due to EAB R 9 not required (R 9-5).

Check EAB R 9-1
Vertical component of earth resistance is less than
the downwards pointing vertical forces.

Vk >= Bvk: 516.75 >= 135.72 Passes requirement

Hydraulic heave

Safety factors: [HYD]
γ,G,stb: 0.900
γ,H: 1.600

Stream length l,tot=14.50 m. Sum(h,i/k,i)=145000.00 1/100s.

Στρώμα "Αργιλώδη ΧΑΛΙΚΙΑ- AMMO" z: -11.00 / -14.00, h= 3.00m
Ed=Σ(γW*h*i)*γ,H = 13.45* 1.600 = 21.52 (i=0.448)
Rd=Σ(γ*h)*γ,G,stb = 52.13* 0.900 = 46.91
Ed/Rd = 0.459 [-]

Στρώμα "Αργιλώδη ΧΑΛΙΚΙΑ- AMMO" z: -14.00 / -15.00, h= 1.00m
Ed=Σ(γW*h*i)*γ,H = 17.93* 1.600 = 28.69 (i=0.448)
Rd=Σ(γ*h)*γ,G,stb = 64.63* 0.900 = 58.16
Ed/Rd = 0.493 [-]

Anchor verification

Anchor - Stability of lower failure plane

Περίπτ.Φόρτισης: όλα τα φορτία BS-P
Αυτόμ. υπολογ. μήκους αγκυρίων:
All anchors are extended (if necessary)
Favourable variable loads in main failure body are not being considered.
Bottom of lower failure plane: z=-15.00 m

Iteration of failure mechanisms:
lA .....: Length of anchor from head to center of grout body.
W,k .....: Res. force from dead weight, loads, cohesion, ...
Q,k .....: Force in lower failure plane.
Ea1,k.....: Earth pressure onto vertical separation plane.
Ea2,k.....: Earth pressure between wall and main failure body.
Ra_cal,d ...: Dimesioning force of the resistance from the equilibrium of forces. Ra_cal,d corresponds to the max. possible anchor force of the force polygon.
Sum(A,d) ...: Acting anchor forces along the grout body fractions within the failure body. Sum(A,d) is gained from the anchor pull forces of the wall analysis.

z [m]	ϑ1 [°]	ϑ2 [°]	lA [m]	W,k [kN/m]	Q,k [kN/m]	Ea1,k [kN/m]	Ea2,k [kN/m]	Ra_cal,d [kN/m]	Sum(A,d) [kN/m]	Ed/Rd [-]
-0.50	38.0	57.5	14.31	2100.0	1867.3	4.4	441.9	254.0	252.9	1.00
-3.00	33.4	61.1	13.40	2091.8	1823.7	51.2	441.9	336.6	336.0	1.00
-5.50	25.5	61.3	13.21	2268.7	1969.6	129.6	441.9	491.3	490.6	1.00

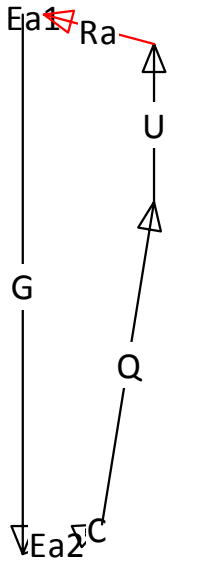
Decisive failure body:
Γεωμετρία:
Foot point of lower failure plane x/z = 0.01/-15.00 m
Intersection lower/upper slid. plane x/z = 12.76/ -8.92 m
Intersection upper slid. plane/surface x/z = 17.64/ 0.00 m
Intersection separation plane/surface x/z = 12.76/ 0.00 m
Inclination lower failure plane ϑ1 = 25.50°
Inclination upper failure plane ϑ2 = 61.33°
Inclination separation plane ϑ12 = 90.00°

Loads / forces (char.)

		Fx [kN/m]	Fz [kN/m]	F [kN/m]	
Weight of main failure body	G,k:	0.0	-3249.4	3249.4	
Cohesion of lower failure plane	C,k:	63.8	30.4	70.6	
Pore water pressure on main body	U,k:	-0.5	951.2	951.2	
Earth pres. on separation plane	Ea1,k:	-129.6	-0.0	129.6	δ= 0.0°
Earth pr. between wall<->main body	Ea2,k:	417.4	145.4	441.9	
Force in lower failure plane	Q,k:	313.4	1944.5	1969.6	

		Fx [kN/m]	Fz [kN/m]	F [kN/m]
Sum = possible anchor forces:	Ra_cal,k:	664.3	-178.0	687.8

Force polygon



Acting anchor forces Ed: Sum(A,d) = 490.6 kN/m
Possible anchor forces Rd: Ra_cal,d = 687.8/1.400 = 491.3 kN/m

Verif. of lower failure plane Ed/Rd = 1.00 < 1.0: Έλεγχος εκπληρώθηκε.

Check of steel tension

l,tot ...[m]: Total length of anchor incl. excess length at head
As ....[mm2]: X-section are of steel member
Ri,d ...[kN]: Ultimate strength of tension member (γ,M=1.15)
A,d ....[kN]: Dimensioning force of the anchor from wall analysis

z[m]	Anchor type	l,tot	As	Ri,d		A,d	
-0.50	Strand;3x0.60";1570/1770	19.97	420	573.4	>	91.0	Passes requirement
-3.00	Strand;3x0.60";1570/1770	18.59	420	573.4	>	0.0	Passes requirement
-5.50	Strand;4x0.60";1570/1770	17.21	560	764.5	>	399.7	Passes requirement

Check of steel tension: Passes requirement

Check of anchor's soil friction

lVk .....: Length of grout body
DmVk ....: Diameter of grout body
τGr,k ...: Average applied skin friction along the grout body (from soil parameters)
Ra,k ....: Charact. pullout resistance of the anchor
γA .....: Partial safety factor of anchor pullout
Ra,d ....: = Ra,k / γA
A,d .....: Dimensioning force of the anchor from wall analysis

z [m]	lVk [m]	DmVk [mm]	τGr,k [kN/m²]	Ra,k [kN]	γA [-]	Ra,d [kN]		A,d [kN]	A,d/Ra,d [-]
-0.50	8.00	318	110	879.1	1.100	799.2	>	91.0	0.1
-3.00	8.00	318	110	879.1	1.100	799.2	>	0.0	0.0
-5.50	8.00	318	110	879.1	1.100	799.2	>	399.7	0.5

Check of anchor's soil friction: Passes requirement

Υπολογ. κύκλου ολίσθησης

LC: όλα τα φορτία Type: BS-T (combination: [GEO] A2 M2 R3, BS-T)
Vertical variable loads only act if they are outside of R*sin(phi).
The automatic slip circle optimization only considers circles that intersect
the surface with an area of at least 0.25 m2.
The slip circle calculation only accepts circles including the wall.
The slipcircle calculation only allows circular failure planes
(no vertical tangents will occour).

Γεωμετ.κύκλου (μήκη και συντεταγμ. σε (m))
Κέντρο = (-2.74, 0.53), Ακτίνα = 15.77
Αρχ.σημ.= (-14.16,-10.35), Τελ.σημ. = (13.03, 0.00)

Γεωμετρία λωρίδων:

No	x	Width b	dxM	Weight	Load z-κατ.	Water-φορτ.	u*b	φ	c	θ
	[m]	[m]	[m]	[kN/m]	[kN/m]	[kN/m]	[kN/m]	[°]	[kN/m²]	[°]
1	-13.37	1.58	-10.64	27.4	0.0	0.0	-6.3	29.26	3.57	-30.37*
2	-11.80	1.58	-9.06	72.3	0.0	0.0	-21.3	29.26	3.57	-30.37*
3	-10.22	1.58	-7.48	106.9	0.0	0.0	-36.8	29.26	3.57	-28.32
4	-8.64	1.58	-5.91	133.2	0.0	0.0	-48.5	29.26	3.57	-21.98
5	-7.06	1.58	-4.33	152.4	0.0	0.0	-57.1	29.26	3.57	-15.92
6	-5.49	1.58	-2.75	165.3	0.0	0.0	-62.9	29.26	3.57	-10.04
7	-3.91	1.58	-1.17	172.3	0.0	0.0	-66.0	29.26	3.57	-4.26
8	-2.33	1.58	0.40	173.7	0.0	0.0	-66.6	29.26	3.57	1.47
9	-0.75	1.58	1.98	177.1	0.0	0.0	-116.0	29.26	3.57	7.22
10	0.82	1.58	3.56	504.3	0.0	0.0	-162.8	29.26	3.57	13.04
11	2.40	1.58	5.14	488.2	0.0	0.0	-155.6	29.26	3.57	19.01
12	3.98	1.58	6.71	465.5	0.0	0.0	-145.5	29.26	3.57	25.19
13	5.56	1.58	8.29	435.2	0.0	0.0	-131.9	29.26	3.57	31.71
14	7.13	1.58	9.87	395.6	0.0	0.0	-114.2	29.26	3.57	38.73
15	8.71	1.58	11.45	344.1	0.0	0.0	-91.0	29.26	3.57	46.52
16	10.29	1.58	13.02	274.7	0.0	0.0	-59.3	27.45	3.57	55.65
17	12.05	1.95	14.79	190.2	0.0	0.0	-25.3	27.45	3.57	69.64

*** Σημείωση: Στις λωρίδες σημειωμένες με '*'
περιορίστηκε το theta στο 45°-Phi/2.

Συνεισφ. κατακόρυφων φορτίων:

No	Weight	G*sin(θ)	(G-u*b)*tan(φ) + c*b	μ*sin(θ)* tan(φ)+cos(θ)	T
	[kN/m]	[kN/m]	[kN/m]	[-]	[kN/m]
1	27.42	-18.49	17.48	0.663133	26.35
2	72.32	-41.54	34.20	0.663133	51.58
3	106.88	-50.70	44.90	0.693054	64.78
4	133.17	-49.85	53.04	0.779487	68.04
5	152.40	-41.81	59.00	0.853311	69.14
6	165.31	-28.82	63.00	0.915848	68.79
7	172.33	-12.81	65.18	0.967878	67.35
8	173.70	4.46	65.61	1.009799	64.97
9	177.10	22.25	39.86	1.041685	38.27
10	504.32	113.80	196.93	1.063301	185.21
11	488.24	159.00	191.95	1.074066	178.71
12	465.50	198.14	184.90	1.072945	172.33
13	435.16	228.75	175.51	1.058241	165.85
14	395.64	247.53	163.29	1.027126	158.98
15	344.10	249.70	147.43	0.974567	151.27
16	274.74	226.84	117.54	0.866517	135.65
17	190.17	178.30	92.62	0.691167	134.01
		1384.74			1801.30

Συνεισφ. αγκυρίων: Αθρ. ροπών ανατροπής : -1362.0 kN*m/m
" " resisting : 652.3 kN*m/m

Δράση Ed = (1384.7*15.77-1362.0)
Αντίσταση Rd = (1801.3*15.77+652.3)

SLIP-CIRCLE μ = Ed/Rd = 0.70 < 1.0: Έλεγχος εκπληρώθηκε.

ΠΑΡΑΡΤΗΜΑ

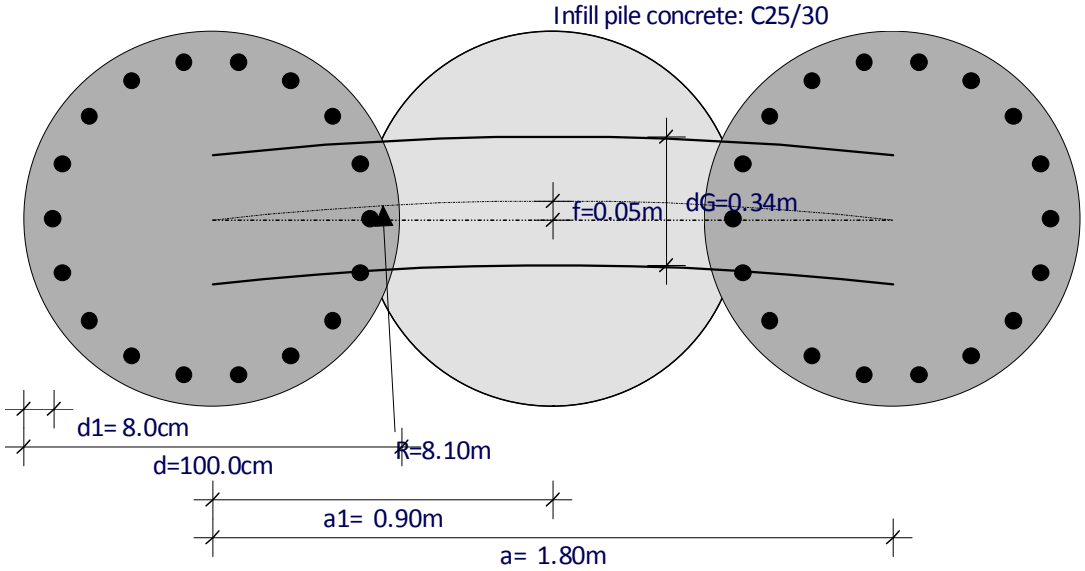
8.6 *Διαστασιολόγηση Φρεατοπασσάλων*

i) Αντιστηριζόμενο ύψος 6,35m

Dimensioning results

M=1: 20.0

Reinf. pile concrete: C25/30 B500S, Layout 1-1-1



Pile Wall Design

System: Overlapping pile layout

Concrete design due to EC 2 (EN 1992-1-1). Material C25/30, B500S
EI = 1706.84 MNm² (per m wall)

Requirements class:	Class C
Buildding type:	Superstructure, engin. superstructure
Structural element:	Circular cross section

Exposure class:
- XC=none
- XD=none
- XS=none

ULS-proof:

Min. longitudinal reinforcement	No
Min. shear reinforcement	No
Dimensioning of the wall as a compr. member	No

SLS-proof:
- Crack width proof is not preformed.

Internal forces in ULS/SLS, influence width a=1.80 [m]:

z [m]		design [kN,m]	rare [kN,m]	freq [kN,m]	perm [kN,m]	gk [kN,m]	qk [kN,m]	BauZ
-9.2	M	-396.75	-293.58	-293.03	-291.36	-290.81	-2.78	1
	N	-701.88	-513.33	-501.48	-465.95	-454.11	-59.22	
	V	-537.87	-396.12	-391.98	-379.54	-375.40	-20.73	
-6.5	M	306.94	224.48	219.28	203.70	198.51	25.97	1
	N	-536.51	-391.42	-380.63	-348.25	-337.46	-53.96	
	V	-22.92	-16.95	-16.91	-16.80	-16.76	-0.20	

Required longitudinal reinforcements in ULS:

z [m]	as1 [cm2/m]	as2 [cm2/m]	epsS [o/oo]	epsC [o/oo]	zi [m]	BauZ
-9.2	5.24	0.00	-1.56	20.72	0.54	1
-6.5	3.78	0.00	22.50	-3.42	0.54	1

Required shear reinforcements in ULS:

z [m]	asw [cm2/m]	Vsd [kN]	VRdct [kN]	VRdmax [kN]	VRd,s [kN]	rho [%]	theta [°]	BauZ
-9.2	9.10	-537.87	222.01	955.89	537.87	0.116	21.8	1
-6.5	0.00	-22.92	206.25	941.76	0.00	0.000	45.0	1

Maximum of required reinforcements:

	z [m]	as [cm2/pile]	chosen
as1 (Ring):	-9.2	5.24	
asw:	-9.2	9.10	

Design of the Pile Infill(Bending, ULS)

Load due to weight of soil + wide area loads g = 134.39 [kN/m²]
due to block loads p = 22.85 [kN/m²]
Reduction factor for g corresp.Figure EB 47-1: 1.000
Multiplication-factor H-Pressure: 1.000
Pile infill: rise f = 0.05 [m]
span l = a = 1.80 [m]
radius of vault R = 8.10 [m]
edge angle of descent Phi = 6.40 [°]
thickness of vault dG = 0.34 [m]
Internal forces: MaxM = q*l²/8 = 157.24*1.80²/8 = 63.68 [kNm/m]
force along vault = MaxM/f = 63.68/ 0.05 = 1273.60 [kN/m]
Proof: max. comprehensive strength = 25*0.85/1.80 = 11.81 [MN/m²] (B35)
comprehensive strength = 3.75 < 11.81 [MN/m²]
Safety against slipping out = tan(45°)/tan(6.40°) = 8.9

ΠΑΡΑΡΤΗΜΑ

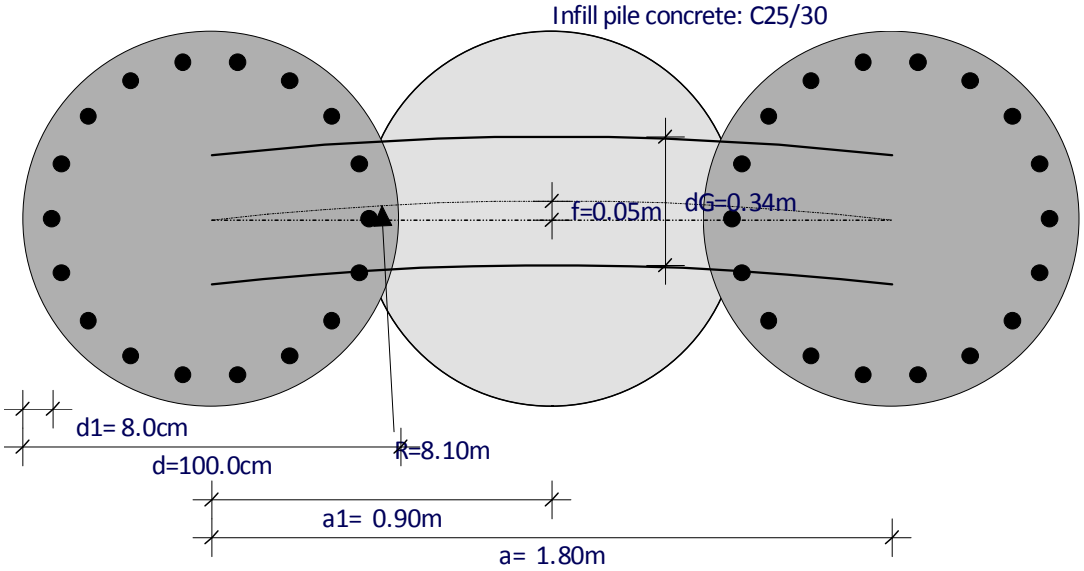
8.6 *Διαστασιολόγηση Φρεατοπασσάλων*

ii) Αντιστηριζόμενο ύψος 7,65m

Dimensioning results

M=1: 20.0

Reinf. pile concrete: C25/30 B500S, Layout 1-1-1



Pile Wall Design

System: Overlapping pile layout

Concrete design due to EC 2 (EN 1992-1-1). Material C25/30, B500S
EI = 1706.84 MNm² (per m wall)

Requirements class:	Class C
Buildding type:	Superstructure, engin. superstructure
Structural element:	Circular cross section

Exposure class:
XC=none
XD=none
XS=none

ULS-proof:

Min. longitudinal reinforcement	No
Min. shear reinforcement	No
Dimensioning of the wall as a compr. member	No

SLS-proof:
Crack width proof is not preformed.

Internal forces in ULS/SLS, influence width a=1.80 [m]:

z [m]		design [kN,m]	rare [kN,m]	freq [kN,m]	perm [kN,m]	gk [kN,m]	qk [kN,m]	BauZ
-10.8	M	-652.22	-483.12	-483.12	-483.12	-483.12	-0.00	1
	N	-771.02	-566.89	-559.29	-536.46	-528.86	-38.04	
	V	-754.04	-559.67	-561.68	-567.73	-569.74	10.07	
-7.3	M	562.11	420.35	427.52	449.01	456.17	-35.82	1
	N	-605.86	-444.56	-436.95	-414.13	-406.52	-38.04	
	V	-10.99	-9.26	-11.28	-17.32	-19.34	10.07	

Required longitudinal reinforcements in ULS:

z [m]	as1 [cm2/m]	as2 [cm2/m]	epsS [o/oo]	epsC [o/oo]	zi [m]	BauZ
-10.8	19.85	0.00	-2.01	15.16	0.56	1
-7.3	17.77	0.00	15.60	-3.50	0.55	1

Required shear reinforcements in ULS:

z [m]	asw [cm2/m]	Vsd [kN]	VRdct [kN]	VRdmax [kN]	VRd,s [kN]	rho [%]	theta [°]	BauZ
-10.8	13.26	-754.04	245.74	1049.17	754.04	0.169	23.0	1
-7.3	0.00	-10.99	218.23	992.58	0.00	0.000	45.0	1

Maximum of required reinforcements:

	z [m]	***as*** [cm2/pile]	***chosen***
as1 (Ring):	-10.8	19.85	
asw:	-10.8	13.26	

Design of the Pile Infill(Bending, ULS)

Load due to weight of soil + wide area loads g = 156.76 [kN/m²]
due to block loads p = 0.00 [kN/m²]
Reduction factor for g corresp.Figure EB 47-1: 1.000
Multiplication-factor H-Pressure: 1.000
Pile infill: rise f = 0.05 [m]
span l = a = 1.80 [m]
radius of vault R = 8.10 [m]
edge angle of descent Phi = 6.40 [°]
thickness of vault dG = 0.34 [m]
Internal forces: MaxM = q*l²/8 = 156.76*1.80²/8 = 63.49 [kNm/m]
force along vault = MaxM/f = 63.49/ 0.05 = 1269.80 [kN/m]
Proof: max. comprehensive strength = 25*0.85/1.80 = 11.81 [MN/m²] (B35)
comprehensive strength = 3.73 < 11.81 [MN/m²]
Safety against slipping out = tan(45°)/tan(6.40°) = 8.9

ΠΑΡΑΡΤΗΜΑ

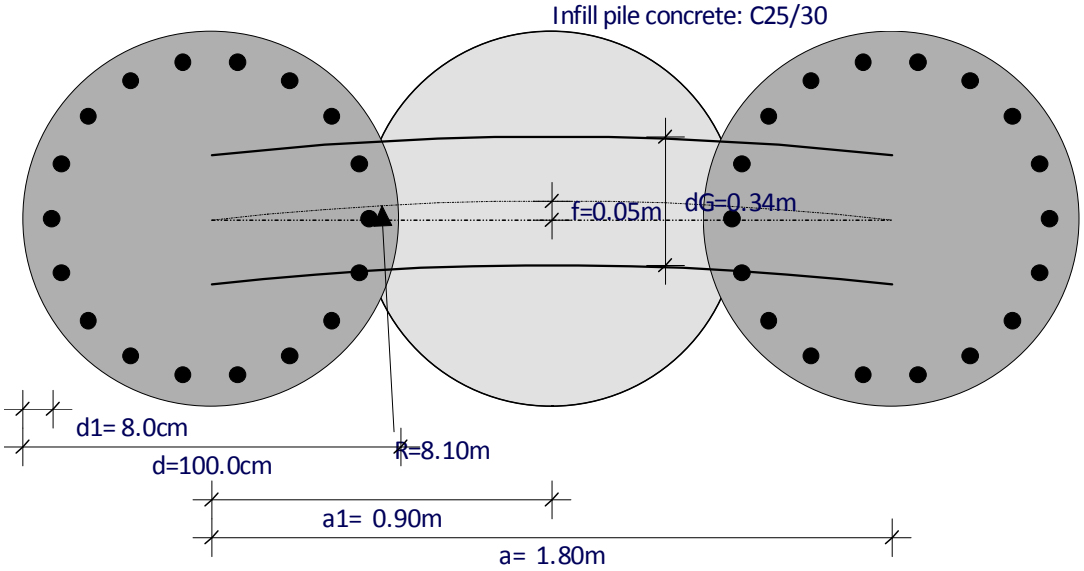
8.6 *Διαστασιολόγηση Φρεατοπασσάλων*

iii) Αντιστηριζόμενο ύψος 9,35m

Dimensioning results

M=1: 20.0

Reinf. pile concrete: C25/30 B500S, Layout 1-1-1



Pile Wall Design

System: Overlapping pile layout

Concrete design due to EC 2 (EN 1992-1-1). Material C25/30, B500S
EI = 1706.84 MNm² (per m wall)

Requirements class:	Class C
Buildding type:	Superstructure, engin. superstructure
Structural element:	Circular cross section

Exposure class:
- XC=none
- XD=none
- XS=none

ULS-proof:

Min. longitudinal reinforcement	No
Min. shear reinforcement	No
Dimensioning of the wall as a compr. member	No

SLS-proof:
- Crack width proof is not preformed.

Internal forces in ULS/SLS, influence width a=1.80 [m]:

z [m]		design [kN,m]	rare [kN,m]	freq [kN,m]	perm [kN,m]	gk [kN,m]	qk [kN,m]	BauZ
-13.1	M	-532.61	-394.53	-394.53	-394.53	-394.53	-0.00	1
	N	-985.07	-725.65	-718.40	-696.65	-689.40	-36.25	
	V	-860.88	-638.07	-638.75	-640.79	-641.47	3.40	
-9.8	M	809.70	601.05	603.32	610.16	612.43	-11.38	1
	N	-877.28	-645.81	-638.56	-616.81	-609.56	-36.25	
	V	14.85	10.62	9.94	7.90	7.22	3.40	

```
  -5.5 M  -803.59     0.00     0.00     0.00     0.00     0.00 1
       N  -368.96     0.00     0.00     0.00     0.00     0.00
       V   686.09     0.00     0.00     0.00     0.00     0.00

Required longitudinal reinforcements in ULS:
    z      as1      as2   epsS    epsC    zi BauZ
  [m]  [cm2/m]  [cm2/m] [o/oo]  [o/oo]   [m]
-------------------------------------------------
-13.1     7.26     0.00  -1.94  16.06   0.55 1
 -9.8    28.02     0.00  11.74  -3.50   0.56 1
 -5.5    38.49     0.00  -2.04  14.75   0.56 1

Required shear reinforcements in ULS:
    z      asw      Vsd    VRdct   VRdmax     VRd,s   rho theta BauZ
  [m]  [cm2/m]     [kN]     [kN]     [kN]      [kN]   [%]   [°]
-----------------------------------------------------------------------
-13.1    19.59  -860.88   262.18  1024.09   860.88  0.249  28.7 1
 -9.8     0.00    14.85   270.35  1114.58     0.00  0.000  45.0 1
 -5.5    11.35   686.09   206.59  1061.47   686.09  0.145  21.8 1

Maximum of required reinforcements:
                z       as    chosen
              [m]  [cm2/pile]
-----------------------------------------------
as1 (Ring):  -5.5    38.49
asw:        -13.1    19.59
```

Design of the Pile Infill(Bending, ULS)

```
Load due to weight of soil + wide area loads g = 166.36 [kN/m²]
                        due to block loads p =   0.00 [kN/m²]
Reduction factor for g  corresp.Figure  EB 47-1:   1.000
Multiplication-factor H-Pressure:   1.000
Pile infill:     rise             f =   0.05 [m]
                 span    l = a =   1.80 [m]
                 radius of vault     R =   8.10 [m]
                 edge angle of descent Phi =   6.40 [°]
                 thickness of vault     dG =   0.34 [m]
Internal forces: MaxM = q*l²/8 = 166.36*1.80²/8 =  67.38 [kNm/m]
                 force along vault = MaxM/f =  67.38/  0.05 = 1347.50 [kN/m]
Proof: max. comprehensive strength =  25*0.85/1.80 = 11.81 [MN/m²] (B35)
            comprehensive strength = 3.96 < 11.81 [MN/m²]
          Safety against slipping out = tan(45°)/tan(6.40°) = 8.9
```

ΠΑΡΑΡΤΗΜΑ

8.6 *Διαστασιολόγηση Φρεατοπασσάλων*

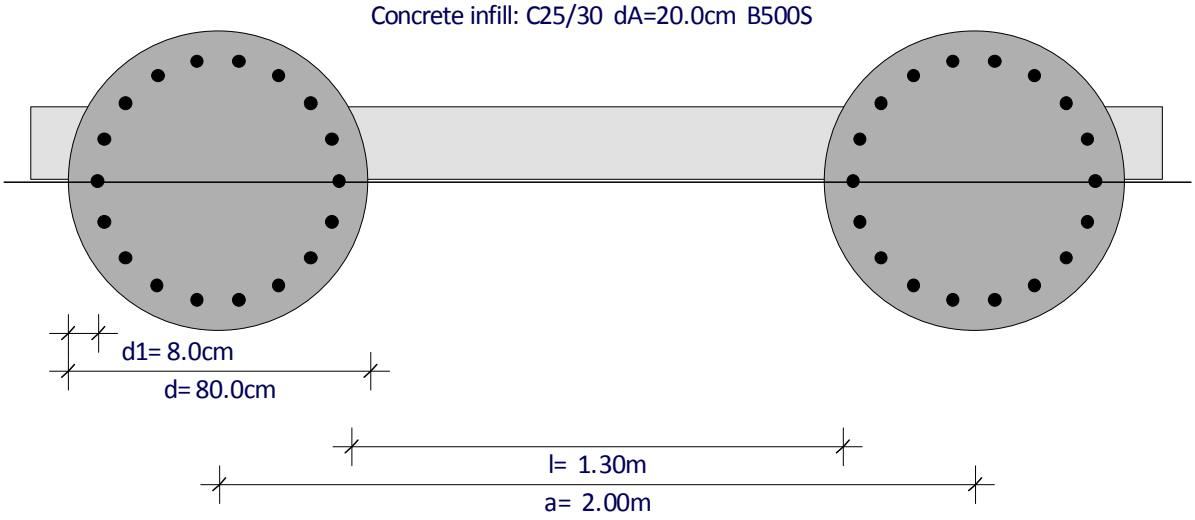
iv) Αντιστηριζόμενο ύψος 3,50m

Dimensioning results

M=1: 20.0

Pile concrete: C25/30 B500S

Concrete infill: C25/30 dA=20.0cm B500S



Design of the pile wall

System: Tangent pile layout, straight infill

Concrete design due to EC 2 (EN 1992-1-1). Material C25/30, B500S
EI = 316.43 MNm² (per m wall)

Requirements class:	Class C
Buildding type:	Superstructure, engin. superstructure
Structural element:	Circular cross section

Exposure class:
XC=none
XD=none
XS=none

ULS-proof:

Min. longitudinal reinforcement	No
Min. shear reinforcement	No

Dimensioning of the wall as a compr. member No

SLS-proof:
Crack width proof is not preformed.

Internal forces in ULS/SLS, influence width a=2.00 [m]:

z [m]		design [kN,m]	rare [kN,m]	freq [kN,m]	perm [kN,m]	gk [kN,m]	qk [kN,m]	BauZ
-5.7	M	1.14	4.33	3.86	2.45	1.97	2.36	1
	N	-330.62	-242.28	-237.61	-223.62	-218.96	-23.32	
	V	177.20	126.15	113.62	76.03	63.50	62.65	(Blum 50%)
-4.2	M	-223.37	-157.35	-143.20	-100.73	-86.58	-70.77	1
	N	-249.64	-182.96	-179.48	-169.03	-165.55	-17.40	
	V	-34.41	-23.21	-20.72	-13.24	-10.75	-12.46	
-5.7	M	1.14	0.00	0.00	0.00	0.00	0.00	1
	N	-0.00	0.00	0.00	0.00	0.00	0.00	
	V	177.20	0.00	0.00	0.00	0.00	0.00	(Blum 50%)

Required longitudinal reinforcements in ULS:

z [m]	as1 [cm2/m]	as2 [cm2/m]	epsS [o/oo]	epsC [o/oo]	zi [m]	BauZ
-5.7	0.00	0.00	22.50	-2.95	0.41	1
-4.2	9.54	0.00	-1.09	20.56	0.42	1
-5.7	0.00	0.00	22.50	-0.44	0.39	1

Required shear reinforcements in ULS:

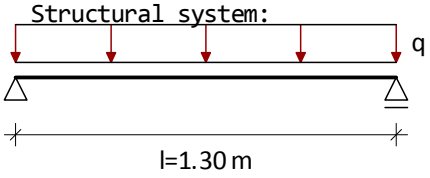
z [m]	asw [cm2/m]	Vsd [kN]	VRdct [kN]	VRdmax [kN]	VRd,s [kN]	rho [%]	theta [°]	BauZ
-5.7	3.98	177.20	148.22	637.63	177.20	0.079	21.8	1
-4.2	0.00	-34.41	139.87	657.63	0.00	0.000	45.0	1
-5.7	4.14	177.20	114.13	612.06	177.20	0.082	21.8	1

Maximum of required reinforcements:

	z [m]	***as*** [cm2/pile]	***chosen***
as1 (Ring):	-4.2	9.54	
asw:	-5.7	4.14	

Design of the Concrete Infill(Bending, ULS)

Structural system:



Single span beam l =1.30 [m]
unif. distr. q = 95.17 [kN/m²]
(q from '1' at Z=-5.69 m = 95.17 [kN/m2])

Load due to weight of the soil + wide area loads g = 142.76 [kN/m²]
due to block loads p = 0.00 [kN/m²]
Reduction factor for g corresp.Figure EB 47-1: 0.667
Multiplication-factor H-Pressure: 1.000
Internal forces: Max M = q*l²/8 = 95.17*1.30²/8 = 20.11 [kNm/m]
Bending design: EN 1992-1-1 conc.: C25/30 dA= 0.20 co= 0.03 cu= 0.03 [m] B500S
nec. comp. reinf.: none
nec. tens. reinf.: As2 = 2.90 [cm²/m]
chosen: 0 layer(s) (= 0.00 [cm²/m])

I n f i l l a s v a u l t (arch, ULS)

Pile infill: rise f = 0.100 [m]
thickness of vault dG = 0.100 [m]
span l = a = 1.30 [m]
Internal forces: MaxM = q*l²/8 = 95.17*1.30²/8 = 20.11 [kNm/m]
(q from '1' at Z=-5.69 m = 95.17 [kN/m2])
force along vault = MaxM/f = 20.11/ 0.100 = 201.10 [kN/m]
Proof : max. comprehensive strength = 8.33 [MN/m²] (due to user-input)
comprehensive strength = 2.01 < 8.33 [MN/m²]

ΠΑΡΑΡΤΗΜΑ

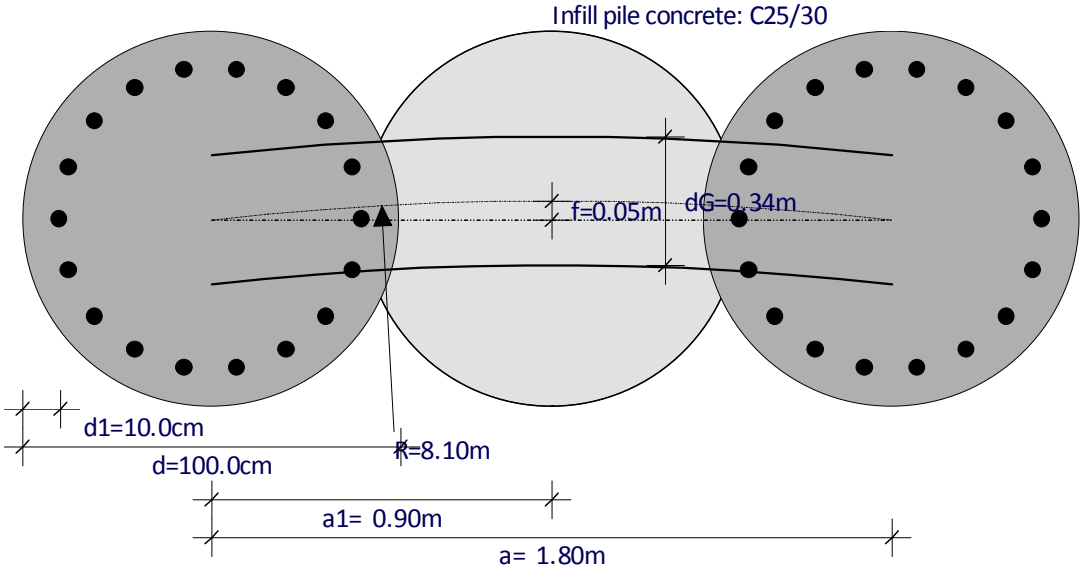
8.7 *Διαστασιολόγηση Αγκυρίων και Δοκού Ισορροπίας*

i) Αντιστηριζόμενο ύψος 6,35m

Dimensioning results

M=1: 20.0

Reinf. pile concrete: C25/30 B500S, Layout 1-1-1



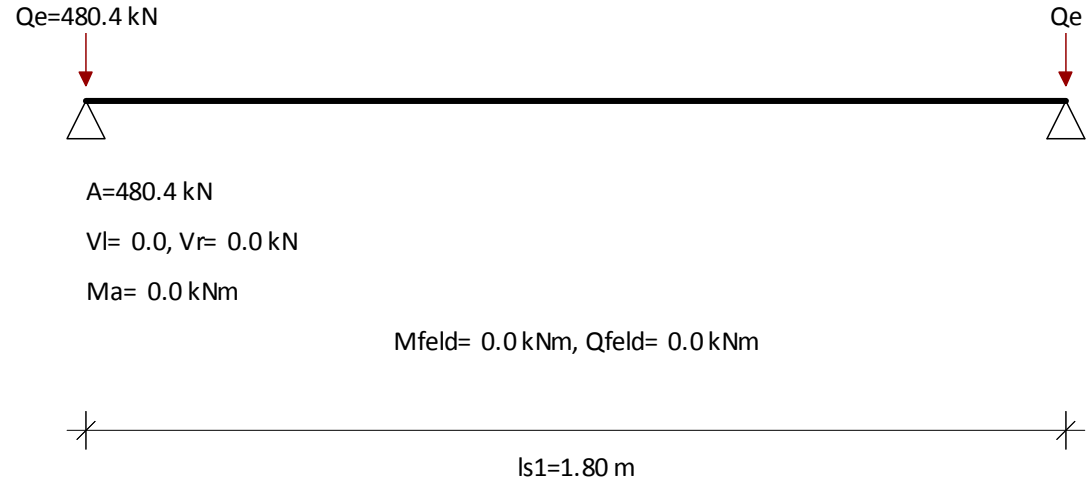
Anchor design

```
z ..............: Anchor depth
a ..............: Anchor distance
Alpha ..........: Anchor declination
Ah,d ...........: Horizontal support per m wall
Lf , gamM ......: Loadcase, safety-factor
Fa,d ...........: Anchor force (design value)
Ri,d ...........: Anchor force resistance
Lvp ............: Length grouth body
Uebs ...........: Additional length
Lges ...........: Total length of anchor (incl. Uebs + Lvp/2)
```

Num	z [m]	Alpha [°]	a [m]	Ah,d [kN/m]	Lf	gamM	Fa,d [kN]	Ri,d [kN]	Lvp [m]	Uebs [m]	Lges [m]	Ok?
1	-0.50	15.0	1.80	77.6	1	1.15	144.6	573.4	8.00	0.00	14.62	Yes
2	-3.00	15.0	1.80	251.3	1	1.15	468.3	573.4	8.00	0.00	13.09	Yes

Num	Anchor type
1	Strand, 3x0.60", 1570/1770
2	Strand, 3x0.60", 1570/1770

Dimensioning of the Waling Num. 2 Level z= -3.00 m




```
Load ............: single loads Pe=464.04 [kN] every at= 1.80 [m]
Inclination ....: 15.00 [°]
Loadfactor .....: 1.000 [-]
Result. Qe .....: 464.04*1.000/cos(15.00)=480.41 [kN]
                  (odd number, symmetrical to mid of the beam)
All loads and forces are dimensioning values.

Stat. system ...: Single span beam:  span ls1= 1.80 [m]
                                          lk = 0.00 [m] (left)
                                          lk = 0.00 [m] (right)

Internal Forces.: Support:  A = 480.41 [kN]
                            Vl=   0.00 [kN]
                            Vr=   0.00 [kN]
                            Ma=   0.00 [kNm]
                  Field:    Mf=   0.00 [kNm]
                            Vf=   0.00 [kN]
Normal Force        N =   0.00 [kN]
Dimensioning Code: EN 1993 (EC 3)
Safety factors:
   gamma,M0:  1.00, gamma,M1:  1.10
Steel cross section: (all values are per profile/s)
   Distance of beams =  1.00 m
   Cross section     = 2 x U 220
   A: 74.80 cm2 Iy: 5380.00 cm4 Wy,el: 490.00 cm3 Wy,pl: 583.20 cm3

   Steel: E = 210000 N/mm2, fyk = 275 N/mm2
   Cross section class = 1 ('' z=0.00: Myd=0.00, Ny=0.00
                            alpha=0.50 eps=0.92 psi=100000.00; cs/s=19.67; ct/t=4.96)

   Shear buckling of the web (w,b): hw/s/(72*eps) = 195.00/9.00/72*0.92 =  32.6 %.
      No further investg. req.
   Buckling is not checked.
```

Actions, Reactions:
- Md: Design moment, action
- Nd: Design normal force, action
- Vd: Design shear force, action
- M,c,Rd: Design resistance for bending moment, without any reductions.
- M,cRd,red: Final design resistance for bending moment
- N,c,Rd: Design resistance for normal force component
- V,c,Rd: Design resistance for shear force
- Ed,MN,el: Design actions for elastic M and N interaction (M/W+N/A)
- Rd,MN,el: Design resistance for elastic M and N interaction
- Ed,V,el: Design actions for elastic shear stress (V/Av)
- Rd,V,el: Design resistance for elastic shear force

Utilizations:
- X,pl: Plastic utilization, if applicable
- X,el: Elastic util. (only critical is plastic calculation is impossible)
- w,b: Shear-buckling of the web
- MN,bk: Buckling due to moment and normal force

Md M,c,Rd Ed,MN,el	Nd McRd,red Rd,MN,el	Vd [kN, m] N,c,Rd Ed,V,el	 V,c,Rd Rd,V,el	Utilization ratios[%] M,pl MN,el	 N,pl V,el	 V,pl	 w,b	 MN,bk
0.00	0.00	0.00						
160.38	160.38	2057.00	623.97	0.0	0.0	0.0	---	---
0.00	275.00	0.00	275.00	0.0	0.0			

Steel checks passed requirements

ΠΑΡΑΡΤΗΜΑ

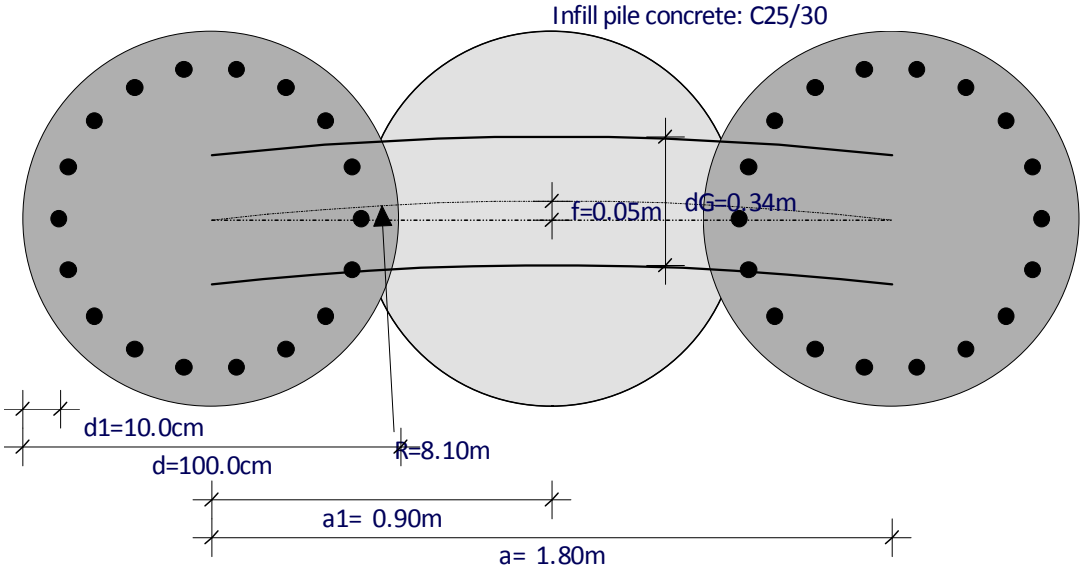
8.7 *Διαστασιολόγηση Αγκυρίων και Δοκού Ισορροπίας*

ii) Αντιστηριζόμενο ύψος 7,65m

Dimensioning results

M=1: 20.0

Reinf. pile concrete: C25/30 B500S, Layout 1-1-1



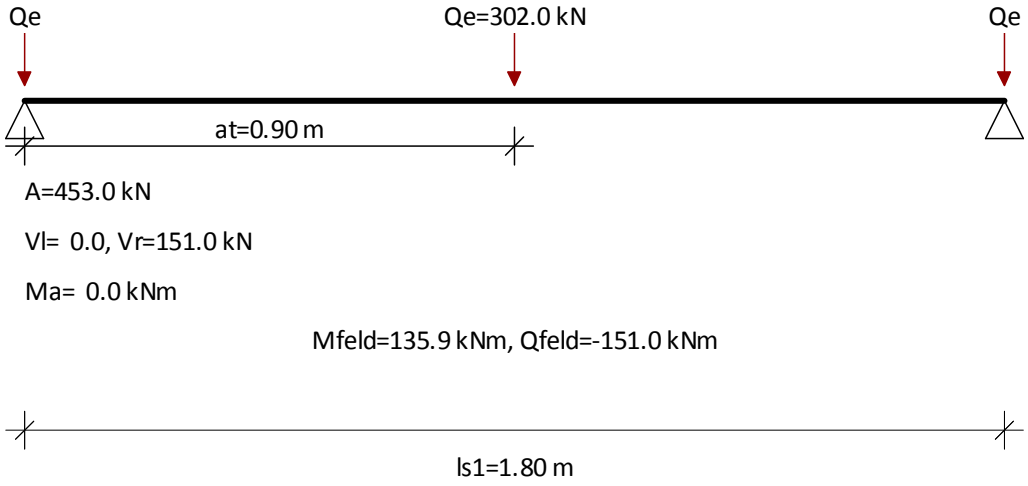
Anchor design

```
z ..............: Anchor depth
a ..............: Anchor distance
Alpha ..........: Anchor declination
Ah,d ...........: Horizontal support per m wall
Lf , gamM ......: Loadcase, safety-factor
Fa,d ...........: Anchor force (design value)
Ri,d ...........: Anchor force resistance
Lvp ............: Length grouth body
Uebs ...........: Additional length
Lges ...........: Total length of anchor (incl. Uebs + Lvp/2)
```

Num	z [m]	Alpha [°]	a [m]	Ah,d [kN/m]	Lf	gamM	Fa,d [kN]	Ri,d [kN]	Lvp [m]	Uebs [m]	Lges [m]	Ok?
1	-0.50	15.0	1.80	82.2	1	1.15	153.2	573.4	8.00	0.00	15.87	Yes
2	-3.00	15.0	0.90	324.1	1	1.15	302.0	573.4	8.00	0.00	14.27	Yes

Num	Anchor type
1	Strand, 3x0.60", 1570/1770
2	Strand, 3x0.60", 1570/1770

Dimensioning of the Waling Num. 2 Level z= -3.00 m




```
Load ............: single loads Pe=291.73 [kN] every at= 0.90 [m]
Inclination ....: 15.00 [°]
Loadfactor .....: 1.000 [-]
Result. Qe .....: 291.73*1.000/cos(15.00)=302.02 [kN]
                  (even number, symmetrical to mid of the beam)
All loads and forces are dimensioning values.

Stat. system ...: Single span beam:  span ls1= 1.80 [m]
                                        lk = 0.00 [m] (left)
                                        lk = 0.00 [m] (right)

Internal Forces.: Support:  A = 453.03 [kN]
                            Vl=   0.00 [kN]
                            Vr= 151.01 [kN]
                            Ma=   0.00 [kNm]
                  Field:    Mf= 135.91 [kNm]
                            Vf=-151.01 [kN]
Normal Force        N =   0.00 [kN]
Dimensioning Code: EN 1993 (EC 3)
Safety factors:
   gamma,M0:  1.00, gamma,M1:  1.10
Steel cross section: (all values are per profile/s)
   Distance of beams =  1.00 m
   Cross section     = 2 x U 220
   A: 74.80 cm2 Iy: 5380.00 cm4 Wy,el: 490.00 cm3 Wy,pl: 583.20 cm3

   Steel: E = 210000 N/mm2, fyk = 275 N/mm2
   Cross section class = 1 ('' z=0.00: Myd=135.91, Ny=0.00
                            alpha=0.50 eps=0.92 psi=-1.00; cs/s=19.67; ct/t=4.96)

   Shear buckling of the web (w,b): hw/s/(72*eps) = 195.00/9.00/72*0.92 =  32.6 %.
      No further investg. req.
   Buckling is not checked.
```

Actions, Reactions:
- Md: Design moment, action
- Nd: Design normal force, action
- Vd: Design shear force, action
- M,c,Rd: Design resistance for bending moment, without any reductions.
- M,cRd,red: Final design resistance for bending moment
- N,c,Rd: Design resistance for normal force component
- V,c,Rd: Design resistance for shear force
- Ed,MN,el: Design actions for elastic M and N interaction (M/W+N/A)
- Rd,MN,el: Design resistance for elastic M and N interaction
- Ed,V,el: Design actions for elastic shear stress (V/Av)
- Rd,V,el: Design resistance for elastic shear force

Utilizations:
- X,pl: Plastic utilization, if applicable
- X,el: Elastic util. (only critical is plastic calculation is impossible)
- w,b: Shear-buckling of the web
- MN,bk: Buckling due to moment and normal force

Md M,c,Rd Ed,MN,el	Nd McRd,red Rd,MN,el	Vd [kN, m] N,c,Rd Ed,V,el	V,c,Rd Rd,V,el	Utilization ratios[%] M,pl MN,el	N,pl V,el	V,pl	w,b	MN,bk
135.91	0.00	-151.01						
160.38	160.38	2057.00	623.97	84.7	0.0	24.2	---	---
277.36	275.00	38.42	275.00	101.7	5.9			
0.00	0.00	-151.01						
160.38	160.38	2057.00	623.97	0.0	0.0	24.2	---	---
0.00	275.00	38.42	275.00	0.0	5.9			
0.00	0.00	151.01						
160.38	160.38	2057.00	623.97	0.0	0.0	24.2	---	---
0.00	275.00	38.42	275.00	0.0	5.9			

Steel checks passed requirements.

ΠΑΡΑΡΤΗΜΑ

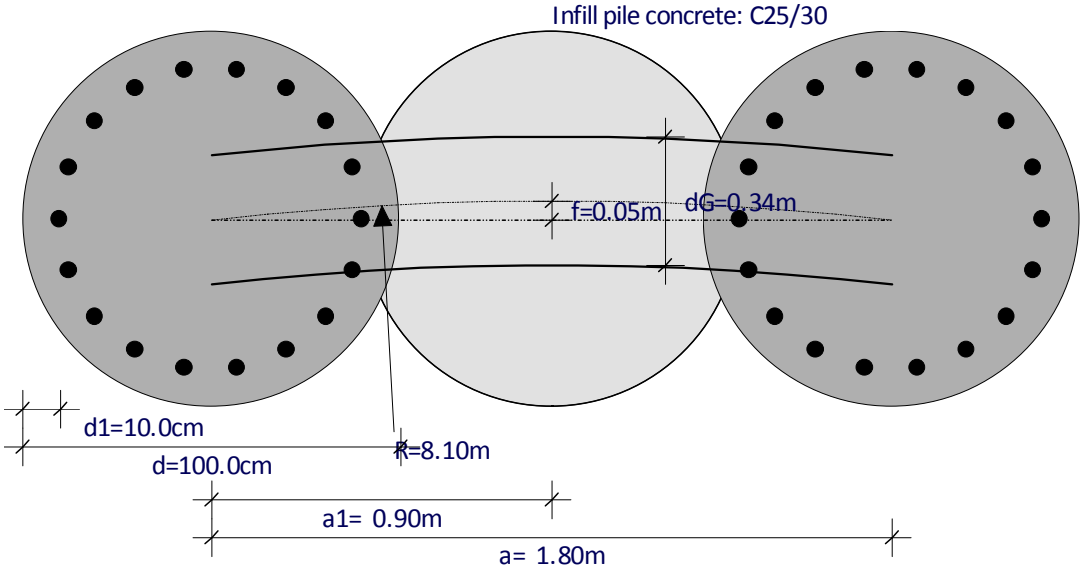
8.7 *Διαστασιολόγηση Αγκυρίων και Δοκού Ισορροπίας*

iii) Αντιστηριζόμενο ύψος 9,85m

Dimensioning results

M=1: 20.0

Reinf. pile concrete: C25/30 B500S, Layout 1-1-1



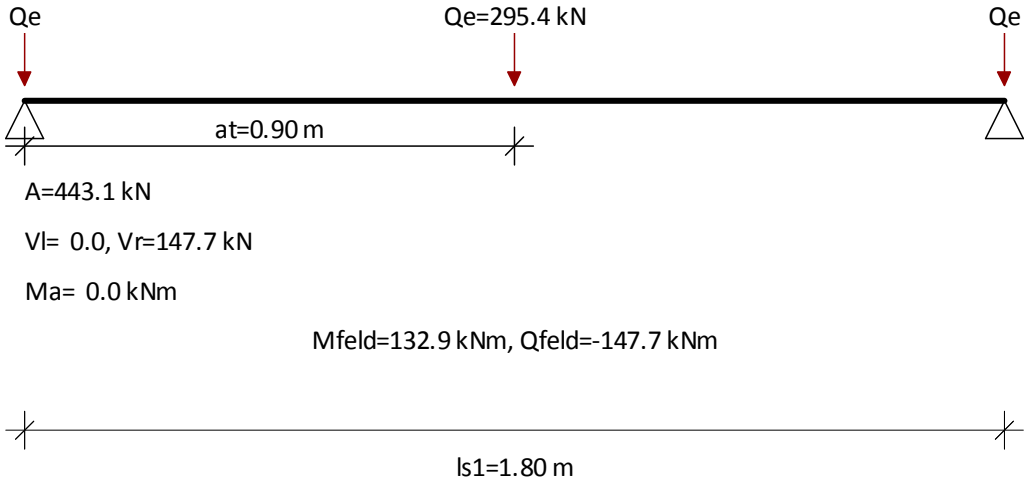
Anchor design

```
z ..............: Anchor depth
a ..............: Anchor distance
Alpha ..........: Anchor declination
Ah,d ...........: Horizontal support per m wall
Lf , gamM ......: Loadcase, safety-factor
Fa,d ...........: Anchor force (design value)
Ri,d ...........: Anchor force resistance
Lvp ............: Length grouth body
Uebs ...........: Additional length
Lges ...........: Total length of anchor (incl. Uebs + Lvp/2)
```

Num	z [m]	Alpha [°]	a [m]	Ah,d [kN/m]	Lf	gamM	Fa,d [kN]	Ri,d [kN]	Lvp [m]	Uebs [m]	Lges [m]	Ok?
1	-0.50	15.0	1.80	137.2	1	1.15	255.7	573.4	8.00	0.00	20.87	Yes
2	-3.00	15.0	0.90	317.1	1	1.15	295.5	573.4	8.00	0.00	19.27	Yes
3	-5.50	15.0	0.90	581.6	1	1.15	541.9	764.5	8.00	0.00	17.67	Yes

Num	Anchor type
1	Strand, 3x0.60", 1570/1770
2	Strand, 3x0.60", 1570/1770
3	Strand, 4x0.60", 1570/1770

Dimensioning of the Waling Num. 2 Level z= -3.00 m



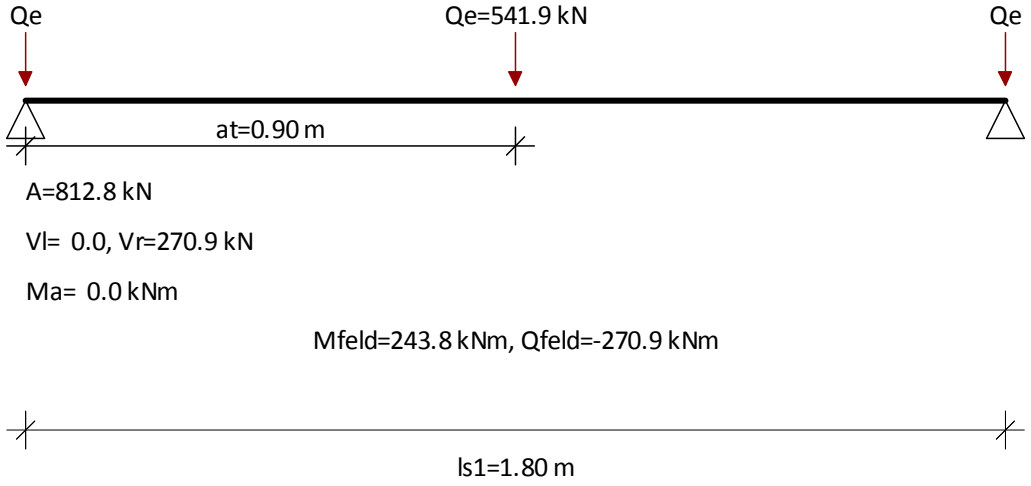

```
Load ............: single loads Pe=285.36 [kN] every at= 0.90 [m]
Inclination ....: 15.00 [°]
Loadfactor .....: 1.000 [-]
Result. Qe .....: 285.36*1.000/cos(15.00)=295.43 [kN]
                  (even number, symmetrical to mid of the beam)
All loads and forces are dimensioning values.

Stat. system ...: Single span beam:  span ls1= 1.80 [m]
                                          lk = 0.00 [m] (left)
                                          lk = 0.00 [m] (right)

Internal Forces.: Support:  A = 443.14 [kN]
                            Vl=   0.00 [kN]
                            Vr= 147.71 [kN]
                            Ma=   0.00 [kNm]
                  Field:    Mf= 132.94 [kNm]
                            Vf=-147.71 [kN]
Normal Force        N =   0.00 [kN]
Dimensioning Code: EN 1993 (EC 3)
Safety factors:
   gamma,M0:  1.00, gamma,M1:  1.10
Steel cross section: (all values are per profile/s)
   Distance of beams =  1.00 m
   Cross section     = 2 x U 220
   A: 74.80 cm2 Iy: 5380.00 cm4 Wy,el: 490.00 cm3 Wy,pl: 583.20 cm3

   Steel: E = 210000 N/mm2, fyk = 275 N/mm2
   Cross section class = 1 ('' z=0.00: Myd=132.94, Ny=0.00
                            alpha=0.50 eps=0.92 psi=-1.00; cs/s=19.67; ct/t=4.96)

   Shear buckling of the web (w,b): hw/s/(72*eps) = 195.00/9.00/72*0.92 =  32.6 %.
      No further investg. req.
   Buckling is not checked.
```

```
Actions, Reactions:
   Md:        Design moment, action
   Nd:        Design normal force, action
   Vd:        Design shear force, action
   M,c,Rd:    Design resistance for bending moment, without any reductions.
   M,cRd,red: Final design resistance for bending moment
   N,c,Rd:    Design resistance for normal force component
   V,c,Rd:    Design resistance for shear force
   Ed,MN,el:  Design actions for elastic M and N interaction (M/W+N/A)
   Rd,MN,el:  Design resistance for elastic M and N interaction
   Ed,V,el:   Design actions for elastic shear stress (V/Av)
   Rd,V,el:   Design resistance for elastic shear force
Utilizations:
   X,pl:      Plastic utilization, if applicable
   X,el:      Elastic util. (only critical is plastic calculation is impossible)
   w,b:       Shear-buckling of the web
   MN,bk:     Buckling due to moment and normal force
```

Md	Nd	Vd [kN, m]	Utilization ratios[%]				
M,c,Rd	McRd,red	N,c,Rd	V,c,Rd	M,pl	N,pl	V,pl	w,b	MN,bk
Ed,MN,el	Rd,MN,el	Ed,V,el	Rd,V,el	MN,el	V,el			
132.94	0.00	-147.71						
160.38	160.38	2057.00	623.97	82.9	0.0	23.7	---	---
271.31	275.00	37.59	275.00	97.3	5.6			
0.00	0.00	-147.71						
160.38	160.38	2057.00	623.97	0.0	0.0	23.7	---	---
0.00	275.00	37.59	275.00	0.0	5.6			
0.00	0.00	147.71						
160.38	160.38	2057.00	623.97	0.0	0.0	23.7	---	---
0.00	275.00	37.59	275.00	0.0	5.6			

Steel checks passed requirements.

Dimensioning of the Waling Num. 3 Level z= -5.50 m




```
Load ...........: single loads Pe=523.42 [kN] every at= 0.90 [m]
Inclination ....: 15.00 [°]
Loadfactor .....: 1.000 [-]
Result. Qe .....: 523.42*1.000/cos(15.00)=541.89 [kN]
                  (even number, symmetrical to mid of the beam)
All loads and forces are dimensioning values.
```

```
Stat. system ...: Single span beam:  span ls1= 1.80 [m]
                                          lk = 0.00 [m] (left)
                                          lk = 0.00 [m] (right)

Internal Forces.: Support:  A = 812.83 [kN]
                            Vl=   0.00 [kN]
                            Vr= 270.94 [kN]
                            Ma=   0.00 [kNm]
                  Field:    Mf= 243.85 [kNm]
                            Vf=-270.94 [kN]
Normal Force        N =   0.00 [kN]
Dimensioning Code: EN 1993 (EC 3)
Safety factors:
   gamma,M0:  1.00, gamma,M1:  1.10
Steel cross section: (all values are per profile/s)
   Distance of beams =  1.00 m
   Cross section     = 2 x U 280
   A: 107.00 cm2 Iy: 12560.00 cm4 Wy,el: 896.00 cm3 Wy,pl: 1064.36 cm3

   Steel: E = 210000 N/mm2, fyk = 275 N/mm2
   Cross section class = 1 ('' z=0.00: Myd=243.85, Ny=0.00
                            alpha=0.50 eps=0.92 psi=-1.00; cs/s=23.00; ct/t=5.00)

   Shear buckling of the web (w,b): hw/s/(72*eps) = 250.00/10.00/72*0.92 =  37.6 %.
      No further investg. req.
   Buckling is not checked.

Actions, Reactions:
   Md:        Design moment, action
   Nd:        Design normal force, action
   Vd:        Design shear force, action
   M,c,Rd:    Design resistance for bending moment, without any reductions.
   M,cRd,red: Final design resistance for bending moment
   N,c,Rd:    Design resistance for normal force component
   V,c,Rd:    Design resistance for shear force
   Ed,MN,el:  Design actions for elastic M and N interaction (M/W+N/A)
   Rd,MN,el:  Design resistance for elastic M and N interaction
   Ed,V,el:   Design actions for elastic shear stress (V/Av)
   Rd,V,el:   Design resistance for elastic shear force
Utilizations:
   X,pl:      Plastic utilization, if applicable
   X,el:      Elastic util. (only critical is plastic calculation is impossible)
   w,b:       Shear-buckling of the web
   MN,bk:     Buckling due to moment and normal force
```

Md	Nd	Vd	[kN, m]	Utilization ratios[%]				
M,c,Rd	McRd,red	N,c,Rd	V,c,Rd	M,pl	N,pl	V,pl	w,b	MN,bk
Ed,MN,el	Rd,MN,el	Ed,V,el	Rd,V,el	MN,el	V,el			
243.85	0.00	-270.94						
292.70	292.70	2942.50	889.12	83.3	0.0	30.5	---	---
272.15	275.00	48.38	275.00	97.9	9.3			
0.00	0.00	-270.94						
292.70	292.70	2942.50	889.12	0.0	0.0	30.5	---	---
0.00	275.00	48.38	275.00	0.0	9.3			
0.00	0.00	270.94						
292.70	292.70	2942.50	889.12	0.0	0.0	30.5	---	---
0.00	275.00	48.38	275.00	0.0	9.3			

Steel checks passed requirements.