Slope stability analysis

Input data

Project

Task : Områdestabilitet Iddefjordsveien 907 Bakke Camping
Description : Vurdering av områdestabilitet knyttet til reguleringsplan Bakke Camping Halden kommune
Customer : Willy Bergsta
Author : Øyvind Karlsen
Date : 10.06.2025
Project ID : RIG-2025-068
Project number : RIG-2025-068

Settings

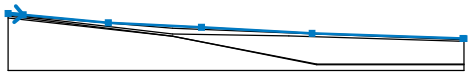
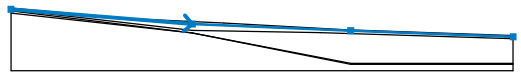
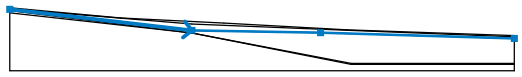
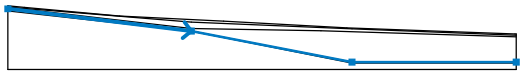
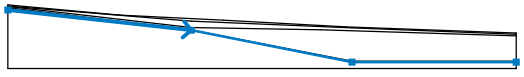
Norway - NS EN1997 / NA:2008 (17)

Stability analysis

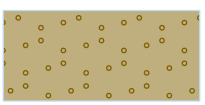
Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

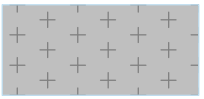
Safety factors			
Permanent design situation			
Safety factor :	SF_s =	1,40	[–]

Interface

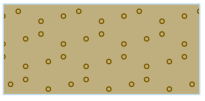
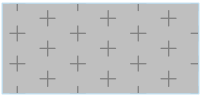
No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		0,00	17,50	13,05	16,30	87,00	9,50
		168,00	5,50	264,00	0,30	395,00	-4,30
		396,00	-4,34				
2		0,00	16,50	143,00	4,78	268,00	-0,43
		396,00	-5,30				
3		0,00	16,30	143,00	-0,22	244,00	-2,00
		396,00	-6,70				
4		0,00	15,20	143,00	-2,22	268,00	-26,31
		396,00	-26,31				
5		0,00	13,50	143,00	-2,25	268,00	-27,00
		396,00	-27,00				

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
1	Tørrskorpeleire		32,00	15,00	19,00
2	Morene Sandig/grusig		32,00	5,00	18,00

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m^3]
3	Fast fjell		40,00	300,00	27,00

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	n [–]
1	Tørrskorpeleire		19,50		
2	Morene Sandig/grusig		20,00		
3	Fast fjell		27,00		

Soil parameters - total stress state

No.	Name	Pattern	c_u [kPa]	γ [kN/m^3]
1	Bløt Leire		20,00	18,00

Soil parameters

Tørrskorpeleire

Unit weight : γ = 19,00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 32,00 °
Cohesion of soil : c_{ef} = 15,00 kPa
Saturated unit weight : γ_{sat} = 19,50 kN/m^3

Bløt Leire

Unit weight : γ = 18,00 kN/m^3
Stress-state : total
Cohesion of soil : c_u = 20,00 kPa

Morene Sandig/grusig

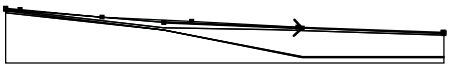
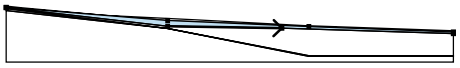
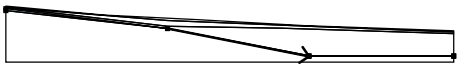
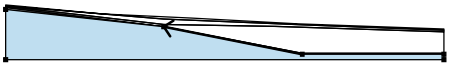
Unit weight : γ = 18,00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 32,00 °
Cohesion of soil : c_{ef} = 5,00 kPa
Saturated unit weight : γ_{sat} = 20,00 kN/m^3

Fast fjell

Unit weight : γ = 27,00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 40,00 °

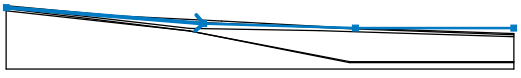
Cohesion of soil : c_{ef} = 300,00 kPa
Saturated unit weight : γ_{sat} = 27,00 kN/m^3

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
1		143,00	4,78	268,00	-0,43	Tørrskorpeleire
		396,00	-5,30	396,00	-4,34	
		395,00	-4,30	264,00	0,30	
		168,00	5,50	87,00	9,50	
		13,05	16,30	0,00	17,50	
		0,00	16,50			
2		143,00	-0,22	244,00	-2,00	Bløt Leire
		396,00	-6,70	396,00	-5,30	
		268,00	-0,43	143,00	4,78	
		0,00	16,50	0,00	16,30	
3		143,00	-2,22	268,00	-26,31	Morene Sandig/grusig
		396,00	-26,31	396,00	-6,70	
		244,00	-2,00	143,00	-0,22	
		0,00	16,30	0,00	15,20	
4		143,00	-2,25	268,00	-27,00	Morene Sandig/grusig
		396,00	-27,00	396,00	-26,31	
		268,00	-26,31	143,00	-2,22	
		0,00	15,20	0,00	13,50	
5		268,00	-27,00	143,00	-2,25	Fast fjell
		0,00	13,50	0,00	-32,00	
		396,00	-32,00	396,00	-27,00	

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m] x	z	x	z	x	z
1		0,00	16,00	154,00	3,50	272,50	0,00
		396,00	0,00				

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 1)

Analysis 1 (stage 1)

Circular slip surface

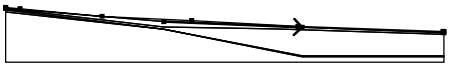
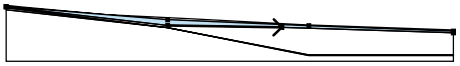
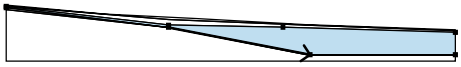
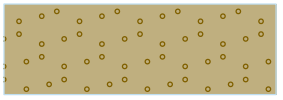
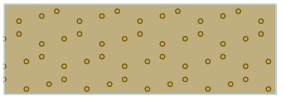
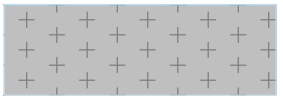
Slip surface parameters							
Center :	x =	288,17	[m]	Angles :	α_1 =	-8,33	[°]
	z =	1839,32	[m]		α_2 =	1,98	[°]
Radius :	R =	1843,21	[m]				
Analysis of the slip surface without optimization.							

Slope stability verification (all methods)

Bishop : FS = 8,03 > 1,40 **ACCEPTABLE**
Fellenius / Petterson : FS = 8,03 > 1,40 **ACCEPTABLE**
Spencer : FS = 8,04 > 1,40 **ACCEPTABLE**
Janbu : FS = 8,04 > 1,40 **ACCEPTABLE**
Morgenstern-Price : FS = 8,04 > 1,40 **ACCEPTABLE**

Input data (Stage of construction 2)

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		143,00	4,78	268,00	-0,43	Tørrskorpeleire
		396,00	-5,30	396,00	-4,34	
		395,00	-4,30	264,00	0,30	
		168,00	5,50	87,00	9,50	
		13,05	16,30	0,00	17,50	
		0,00	16,50			
2		143,00	-0,22	244,00	-2,00	Bløt Leire
		396,00	-6,70	396,00	-5,30	
		268,00	-0,43	143,00	4,78	
		0,00	16,50	0,00	16,30	
3		143,00	-2,22	268,00	-26,31	Morene Sandig/grusig
		396,00	-26,31	396,00	-6,70	
		244,00	-2,00	143,00	-0,22	
		0,00	16,30	0,00	15,20	
4		143,00	-2,25	268,00	-27,00	Morene Sandig/grusig
		396,00	-27,00	396,00	-26,31	
		268,00	-26,31	143,00	-2,22	
		0,00	15,20	0,00	13,50	
5		268,00	-27,00	143,00	-2,25	Fast fjell
		0,00	13,50	0,00	-32,00	
		396,00	-32,00	396,00	-27,00	

Surcharge

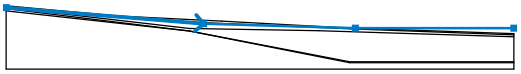
No.	Surcharge		Type	Type of action	Location	Origin	Length	Width	Slope	Magnitude		
	new	change			z [m]	x [m]	l [m]	b [m]	α [°]	q, q_1, f, F	q_2	unit
1	Yes		strip	permanent	on terrain	x = 154,00	l = 80,00		0,00	10,00		kN/m^2

Surcharges

No.	Name
1	Campingvogner og tilfeldig last

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0,00	16,00	154,00	3,50	272,50	0,00
		396,00	0,00				

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 2)

Analysis 1 (stage 2)

Circular slip surface

Slip surface parameters							
Center :	x =	288,17	[m]	Angles :	α_1 =	-8,33	[°]
	z =	1839,32	[m]		α_2 =	1,98	[°]
Radius :	R =	1843,21	[m]				
Analysis of the slip surface without optimization.							

Slope stability verification (all methods)

Bishop : FS = 8,01 > 1,40 **ACCEPTABLE**
Fellenius / Petterson : FS = 8,01 > 1,40 **ACCEPTABLE**
Spencer : FS = 8,02 > 1,40 **ACCEPTABLE**
Janbu : FS = 8,02 > 1,40 **ACCEPTABLE**
Morgenstern-Price : FS = 8,02 > 1,40 **ACCEPTABLE**

Analysis 2 (stage 2)

Circular slip surface

Slip surface parameters							
Center :	x =	288,17	[m]	Angles :	α_1 =	-8,33	[°]
	z =	1839,32	[m]		α_2 =	1,98	[°]
Radius :	R =	1843,21	[m]				
Analysis of the slip surface without optimization.							

Slope stability verification (all methods)

Bishop : FS = 8,01 > 1,40 **ACCEPTABLE**
Fellenius / Petterson : FS = 8,01 > 1,40 **ACCEPTABLE**
Spencer : FS = 8,02 > 1,40 **ACCEPTABLE**
Janbu : FS = 8,02 > 1,40 **ACCEPTABLE**
Morgenstern-Price : FS = 8,02 > 1,40 **ACCEPTABLE**

Analysis 3 (stage 2)

Circular slip surface

Slip surface parameters							
Center :	x =	215,32	[m]	Angles :	α_1 =	-9,92	[°]
	z =	1087,88	[m]		α_2 =	2,91	[°]
Radius :	R =	1089,21	[m]				
The slip surface after optimization.							

Slope stability verification (Bishop)

Sum of active forces : F_a = 931,64 kN/m
Sum of passive forces : F_p = 4862,82 kN/m

Sliding moment : M_a = 1014746,47 kNm/m
Resisting moment : M_p = 5296628,91 kNm/m
Factor of safety = 5,22 > 1,40
Slope stability ACCEPTABLE