Temporary Works Design Report

Saggart Reservoir

Slope Stability Check for Filling of Hurleys Field

Contractor	Coffey Construction
Project No.	2965
Design Report No:	NK-2965-REP- 050

Rev.	Date	Description	Designed by	Checked By
1	28/01/22	first issue	dg	nk
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Introduction

NK Engineering have been appointed by Coffey Construction to assess the slope stability of the proposed filling of the area adjacent to the reservoir site known as Hurleys Field.

The field shall be filled and compacted with surplus arisings from the reservoir site works to the profiles shown on Coffey Construction drawing J1387-PH-003 rev 02.

Design Basis

The excavation slope stability shall utilise GEO5 Slope Stability Analysis software to calculate the circular slip surface with the lowest stability rating.

Three cross sections shall be analysed to represent the range of fill profiles. These shall replicate Sections B-B, C-C & D-D on the above drawing.

In order to model the worst case scenarios, the ground shall be considered fully saturated. A surcharge loading of 10 kPa shall be applied at the high point of the fill profile to represent a worst case applied loadcase.

It is assumed that any topsoil shall be stripped and stockpiles prior to filling. On completion of the fill operations, the topsoil shall be spread over the formed surface and reseeded.

Slope Stability

The stability of the fill areas are assessed using GEO5 Slope Stability Analysis software to verify that a minimum factor of safety of 1.5 is achieved for all slip surfaces using the Bishop method of analysis.

The full analysis reports for each cross-section are contained in Appendix A.

Results Summary

- Fill profiles as per drawing J1387-PH-003 rev 02 are stable.
- Long term surcharge loading to top of fill areas not to exceed 10 kPa globally.
- There is no risk to sliding during heavy rain.

Appendix A - Slope Stability Analysis Reports

Slope stability analysis

Input data

Project

Date : 28/01/2022

Settings

Standard - safety factors

Stability analysis

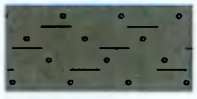
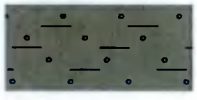
Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors		
Permanent design situation		
Safety factor :	SF_s =	1.50 [–]

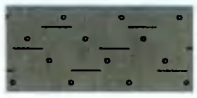
Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		0.00	22.50	40.00	19.37	80.00	15.30
		120.00	11.50	160.00	8.00	200.00	5.25
		240.00	2.90	250.00	2.75		
2		0.00	22.50	40.00	18.70	80.00	14.50
		120.00	9.90	160.00	6.50	200.00	3.75
		240.00	2.80	250.00	2.75		

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]
1	Imported Fill (cohesive)		24.50	26.00	18.00
2	Existing Cohesive Clay		24.50	40.00	18.00

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m³]	γ_s [kN/m³]	n [–]
1	Imported Fill (cohesive)		18.00		

No.	Name	Pattern	γ_{sat} [kN/m^3]	γ_s [kN/m^3]	n [–]
2	Existing Cohesive Clay		18.00		

Soil parameters

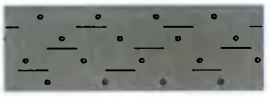
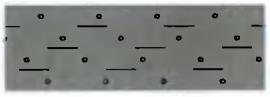
Imported Fill (cohesive)

Unit weight : γ = 18.00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.50 °
Cohesion of soil : c_{ef} = 26.00 kPa
Saturated unit weight : γ_{sat} = 18.00 kN/m^3

Existing Cohesive Clay

Unit weight : γ = 18.00 kN/m^3
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.50 °
Cohesion of soil : c_{ef} = 40.00 kPa
Saturated unit weight : γ_{sat} = 18.00 kN/m^3

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
1		40.00	18.70	80.00	14.50	Imported Fill (cohesive)
		120.00	9.90	160.00	6.50	
		200.00	3.75	240.00	2.80	
		250.00	2.75	240.00	2.90	
		200.00	5.25	160.00	8.00	
		120.00	11.50	80.00	15.30	
		40.00	19.37	0.00	22.50	
2		240.00	2.80	200.00	3.75	Existing Cohesive Clay
		160.00	6.50	120.00	9.90	
		80.00	14.50	40.00	18.70	
		0.00	22.50	0.00	-2.25	
		250.00	-2.25	250.00	2.75	

Surcharge

No.	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude q, q_1, f, F, x	q_2, z	unit
1	strip	variable	on terrain	x = 0.00	l = 50.00		0.00	10.00		kN/m^2

Surcharges

No.	Name
1	Construction Plant

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	22.50	40.00	19.37	80.00	15.30
		120.00	11.50	160.00	8.00	200.00	5.25
		240.00	2.90	250.00	2.75		

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

Circular slip surface

Slip surface parameters					
Center :	x =	117.54 [m]	Angles :	α_1 =	-41.56 [°]
	z =	154.84 [m]		α_2 =	31.86 [°]
Radius :	R =	176.89 [m]			
The slip surface after optimization.					

Slope stability verification (Bishop)

Sum of active forces : F_a = 7259.61 kN/m
Sum of passive forces : F_p = 28097.86 kN/m

Sliding moment : M_a = 1284153.21 kNm/m
Resisting moment : M_p = 4970230.34 kNm/m
Factor of safety = 3.87 > 1.50
Slope stability ACCEPTABLE

Slope stability analysis

Input data

Project

Date : 28/01/2022

Settings

Standard - safety factors

Stability analysis

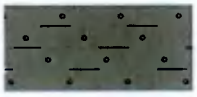
Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors		
Permanent design situation		
Safety factor :	SF_s =	1.50 [–]

Interface

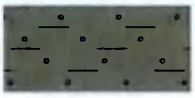
No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		0.00	14.90	40.00	12.85	80.00	12.20
		120.00	11.85	160.00	12.00	180.00	13.60
		250.00	19.20				
2		0.00	14.90	5.00	12.30	40.00	11.00
		80.00	10.20	120.00	10.90	160.00	12.00

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]
1	Imported Fill (cohesive)		24.50	26.00	18.00
2	Existing Cohesive Clay		24.50	40.00	18.00

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m³]	γ_s [kN/m³]	n [–]
1	Imported Fill (cohesive)		18.00		

No.	Name	Pattern	γ_{sat} [kN/m³]	γ_s [kN/m³]	n [–]
2	Existing Cohesive Clay		18.00		

Soil parameters

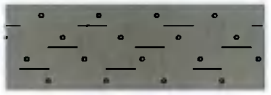
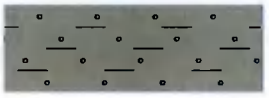
Imported Fill (cohesive)

Unit weight : γ = 18.00 kN/m³
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.50 °
Cohesion of soil : c_{ef} = 26.00 kPa
Saturated unit weight : γ_{sat} = 18.00 kN/m³

Existing Cohesive Clay

Unit weight : γ = 18.00 kN/m³
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.50 °
Cohesion of soil : c_{ef} = 40.00 kPa
Saturated unit weight : γ_{sat} = 18.00 kN/m³

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
1		5.00	12.30	40.00	11.00	Imported Fill (cohesive)
		80.00	10.20	120.00	10.90	
		160.00	12.00	120.00	11.85	
		80.00	12.20	40.00	12.85	
		0.00	14.90			
2		120.00	10.90	80.00	10.20	Existing Cohesive Clay
		40.00	11.00	5.00	12.30	
		0.00	14.90	0.00	5.20	
		250.00	5.20	250.00	19.20	
		180.00	13.60	160.00	12.00	

Surcharge

No.	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude q, q_1, f, F, x	q_2, z	unit
1	strip	variable	on terrain	x = 0.00	l = 120.00		0.00	10.00		kN/m²

Surcharges

No.	Name
1	Construction Plant

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	14.80	40.00	12.75	80.00	12.10
		120.00	11.75	160.00	11.90	180.00	13.50
		250.00	19.10				

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

Circular slip surface

Slip surface parameters					
Center :	x =	197.12 [m]	Angles :	α_1 =	-40.15 [°]
	z =	65.69 [m]		α_2 =	48.57 [°]
Radius :	R =	70.28 [m]			
The slip surface after optimization.					

Slope stability verification (Bishop)

Sum of active forces : F_a = 1552.51 kN/m
Sum of passive forces : F_p = 9511.11 kN/m

Sliding moment : M_a = 109110.64 kNm/m
Resisting moment : M_p = 668440.72 kNm/m
Factor of safety = 6.13 > 1.50
Slope stability ACCEPTABLE

Slope stability analysis

Input data

Project

Date : 28/01/2022

Settings

Standard - safety factors

Stability analysis

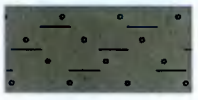
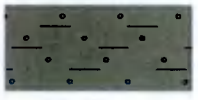
Earthquake analysis : Standard
Verification methodology : Safety factors (ASD)

Safety factors		
Permanent design situation		
Safety factor :	SF_s =	1.50 [–]

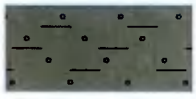
Interface

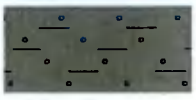
No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		0.00	14.90	40.00	12.85	80.00	12.20
		120.00	11.85	160.00	12.00	180.00	13.60
		250.00	19.20				
2		0.00	8.33	40.00	8.50	80.00	8.00
		95.00	7.80	120.00	9.20	160.00	12.00

Soil parameters - effective stress state

No.	Name	Pattern	φ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]
1	Imported Fill (cohesive)		24.50	26.00	18.00
2	Existing Cohesive Clay		24.50	40.00	18.00

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m³]	γ_s [kN/m³]	n [–]
1	Imported Fill (cohesive)		18.00		

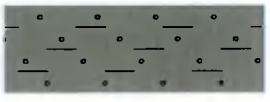
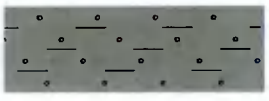
No.	Name	Pattern	γ_{sat} [kN/m³]	γ_s [kN/m³]	n [–]
2	Existing Cohesive Clay		18.00		

Soil parameters

Imported Fill (cohesive)
Unit weight : γ = 18.00 kN/m³
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.50 °
Cohesion of soil : c_{ef} = 26.00 kPa
Saturated unit weight : γ_{sat} = 18.00 kN/m³

Existing Cohesive Clay
Unit weight : γ = 18.00 kN/m³
Stress-state : effective
Angle of internal friction : φ_{ef} = 24.50 °
Cohesion of soil : c_{ef} = 40.00 kPa
Saturated unit weight : γ_{sat} = 18.00 kN/m³

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m] x	z	x	z	Assigned soil
1		40.00	8.50	80.00	8.00	Imported Fill (cohesive)
		95.00	7.80	120.00	9.20	
		160.00	12.00	120.00	11.85	
		80.00	12.20	40.00	12.85	
		0.00	14.90	0.00	8.33	
2		120.00	9.20	95.00	7.80	Existing Cohesive Clay
		80.00	8.00	40.00	8.50	
		0.00	8.33	0.00	2.80	
		250.00	2.80	250.00	19.20	
		180.00	13.60	160.00	12.00	

Surcharge

No.	Type	Type of action	Location z [m]	Origin x [m]	Length l [m]	Width b [m]	Slope α [°]	Magnitude q, q_1, f, F, x	Magnitude q_2, z	unit
1	strip	variable	on terrain	x = 0.00	l = 50.00		0.00	10.00		kN/m²

Surcharges

No.	Name
1	Construction Plant

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	14.80	40.00	12.75	80.00	12.10
		120.00	11.75	160.00	11.90	180.00	13.50
		250.00	19.10				

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

Circular slip surface

Slip surface parameters					
Center :	x =	51.41 [m]	Angles :	α_1 =	-47.67 [°]
	z =	61.54 [m]		α_2 =	44.37 [°]
Radius :	R =	69.27 [m]			
The slip surface after optimization.					

Slope stability verification (Bishop)

Sum of active forces : F_a = 764.96 kN/m
Sum of passive forces : F_p = 9988.68 kN/m

Sliding moment : M_a = 52988.99 kNm/m
Resisting moment : M_p = 691915.69 kNm/m
Factor of safety = 13.06 > 1.50
Slope stability ACCEPTABLE