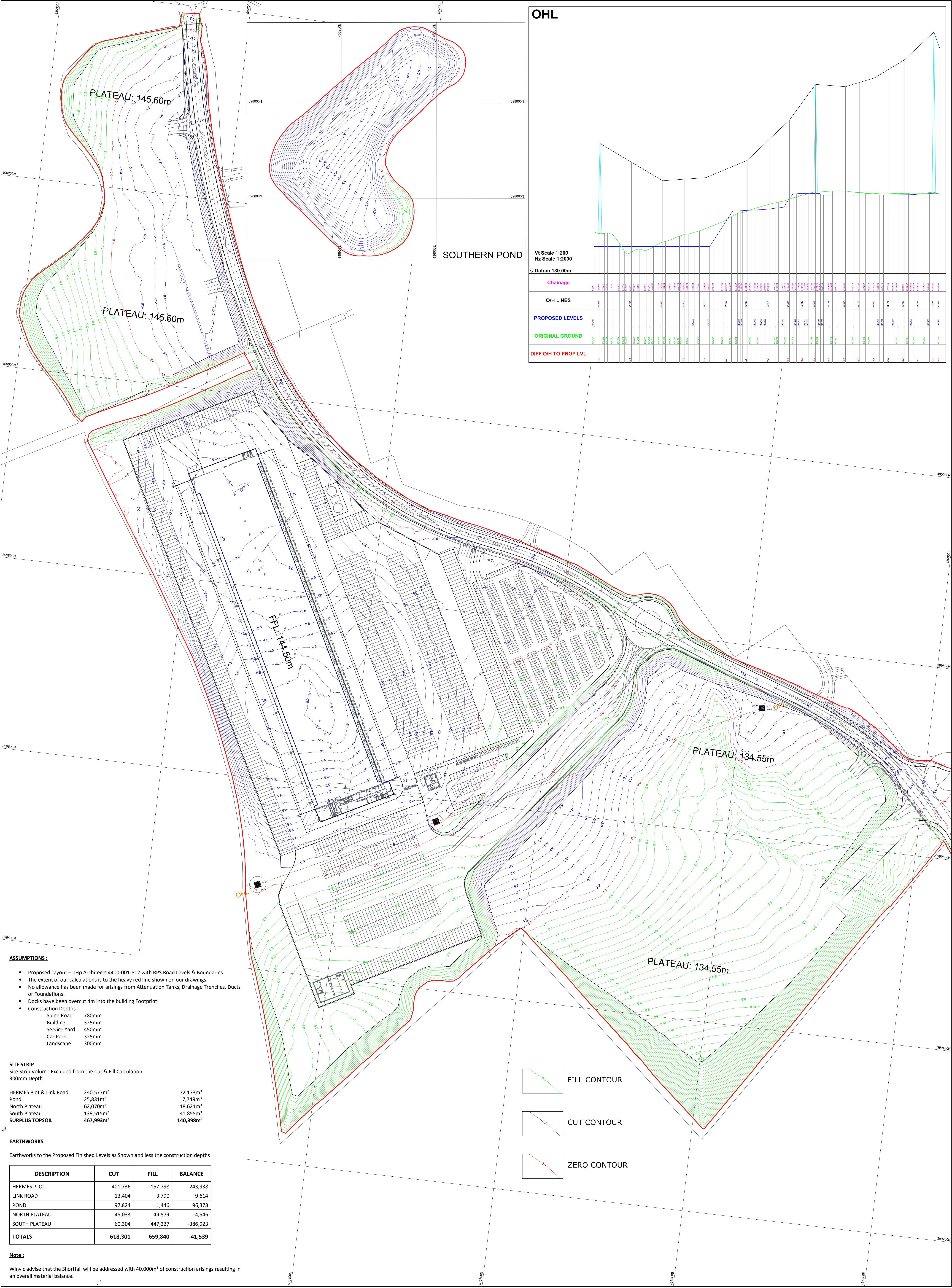




OHL

Vt Scale 1:200
Hz Scale 1:2000

Datum 130.00m

Chainage	1000	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1950	2000	2050	2100	2150	2200	2250	2300	2350	2400	2450	2500	2550	2600	2650	2700	2750	2800	2850	2900	2950	3000	3050	3100	3150	3200	3250	3300	3350	3400	3450	3500	3550	3600	3650	3700	3750	3800	3850	3900	3950	4000	4050	4100	4150	4200	4250	4300	4350	4400	4450	4500	4550	4600	4650	4700	4750	4800	4850	4900	4950	5000	5050	5100	5150	5200	5250	5300	5350	5400	5450	5500	5550	5600	5650	5700	5750	5800	5850	5900	5950	6000	6050	6100	6150	6200	6250	6300	6350	6400	6450	6500	6550	6600	6650	6700	6750	6800	6850	6900	6950	7000	7050	7100	7150	7200	7250	7300	7350	7400	7450	7500	7550	7600	7650	7700	7750	7800	7850	7900	7950	8000	8050	8100	8150	8200	8250	8300	8350	8400	8450	8500	8550	8600	8650	8700	8750	8800	8850	8900	8950	9000	9050	9100	9150	9200	9250	9300	9350	9400	9450	9500	9550	9600	9650	9700	9750	9800	9850	9900	9950	10000
O/H LINES	1000	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1950	2000	2050	2100	2150	2200	2250	2300	2350	2400	2450	2500	2550	2600	2650	2700	2750	2800	2850	2900	2950	3000	3050	3100	3150	3200	3250	3300	3350	3400	3450	3500	3550	3600	3650	3700	3750	3800	3850	3900	3950	4000	4050	4100	4150	4200	4250	4300	4350	4400	4450	4500	4550	4600	4650	4700	4750	4800	4850	4900	4950	5000	5050	5100	5150	5200	5250	5300	5350	5400	5450	5500	5550	5600	5650	5700	5750	5800	5850	5900	5950	6000	6050	6100	6150	6200	6250	6300	6350	6400	6450	6500	6550	6600	6650	6700	6750	6800	6850	6900	6950	7000	7050	7100	7150	7200	7250	7300	7350	7400	7450	7500	7550	7600	7650	7700	7750	7800	7850	7900	7950	8000	8050	8100	8150	8200	8250	8300	8350	8400	8450	8500	8550	8600	8650	8700	8750	8800	8850	8900	8950	9000	9050	9100	9150	9200	9250	9300	9350	9400	9450	9500	9550	9600	9650	9700	9750	9800	9850	9900	9950	10000
PROPOSED LEVELS	1000	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1950	2000	2050	2100	2150	2200	2250	2300	2350	2400	2450	2500	2550	2600	2650	2700	2750	2800	2850	2900	2950	3000	3050	3100	3150	3200	3250	3300	3350	3400	3450	3500	3550	3600	3650	3700	3750	3800	3850	3900	3950	4000	4050	4100	4150	4200	4250	4300	4350	4400	4450	4500	4550	4600	4650	4700	4750	4800	4850	4900	4950	5000	5050	5100	5150	5200	5250	5300	5350	5400	5450	5500	5550	5600	5650	5700	5750	5800	5850	5900	5950	6000	6050	6100	6150	6200	6250	6300	6350	6400	6450	6500	6550	6600	6650	6700	6750	6800	6850	6900	6950	7000	7050	7100	7150	7200	7250	7300	7350	7400	7450	7500	7550	7600	7650	7700	7750	7800	7850	7900	7950	8000	8050	8100	8150	8200	8250	8300	8350	8400	8450	8500	8550	8600	8650	8700	8750	8800	8850	8900	8950	9000	9050	9100	9150	9200	9250	9300	9350	9400	9450	9500	9550	9600	9650	9700	9750	9800	9850	9900	9950	10000
ORIGINAL GROUND	1000	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1950	2000	2050	2100	2150	2200	2250	2300	2350	2400	2450	2500	2550	2600	2650	2700	2750	2800	2850	2900	2950	3000	3050	3100	3150	3200	3250	3300	3350	3400	3450	3500	3550	3600	3650	3700	3750	3800	3850	3900	3950	4000	4050	4100	4150	4200	4250	4300	4350	4400	4450	4500	4550	4600	4650	4700	4750	4800	4850	4900	4950	5000	5050	5100	5150	5200	5250	5300	5350	5400	5450	5500	5550	5600	5650	5700	5750	5800	5850	5900	5950	6000	6050	6100	6150	6200	6250	6300	6350	6400	6450	6500	6550	6600	6650	6700	6750	6800	6850	6900	6950	7000	7050	7100	7150	7200	7250	7300	7350	7400	7450	7500	7550	7600	7650	7700	7750	7800	7850	7900	7950	8000	8050	8100	8150	8200	8250	8300	8350	8400	8450	8500	8550	8600	8650	8700	8750	8800	8850	8900	8950	9000	9050	9100	9150	9200	9250	9300	9350	9400	9450	9500	9550	9600	9650	9700	9750	9800	9850	9900	9950	10000
DIFF O/H TO PROP LVL	1000	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500	1550	1600	1650	1700	1750	1800	1850	1900	1950	2000	2050	2100	2150	2200	2250	2300	2350	2400	2450	2500	2550	2600	2650	2700	2750	2800	2850	2900	2950	3000	3050	3100	3150	3200	3250	3300	3350	3400	3450	3500	3550	3600	3650	3700	3750	3800	3850	3900	3950	4000	4050	4100	4150	4200	4250	4300	4350	4400	4450	4500	4550	4600	4650	4700	4750	4800	4850	4900	4950	5000	5050	5100	5150	5200	5250	5300	5350	5400	5450	5500	5550	5600	5650	5700	5750	5800	5850	5900	5950	6000	6050	6100	6150	6200	6250	6300	6350	6400	6450	6500	6550	6600	6650	6700	6750	6800	6850	6900	6950	7000	7050	7100	7150	7200	7250	7300	7350	7400	7450	7500	7550	7600	7650	7700	7750	7800	7850	7900	7950	8000	8050	8100	8150	8200	8250	8300	8350	8400	8450	8500	8550	8600	8650	8700	8750	8800	8850	8900	8950	9000	9050	9100	9150	9200	9250	9300	9350	9400	9450	9500	9550	9600	9650	9700	9750	9800	9850	9900	9950	10000

ASSUMPTIONS :

- Proposed Layout – pHP Architects 4400-001-P12 with RPS Road Levels & Boundaries
- The extent of our calculations is to the heavy red line shown on our drawings.
- No allowance has been made for arisings from Attenuation Tanks, Drainage Trenches, Ducts or Foundations.
- Docks have been overcut 4m into the building Footprint
- Construction Depths :
 - Spine Road 780mm
 - Building 325mm
 - Service Yard 450mm
 - Car Park 325mm
 - Landscape 300mm

SITE STRIP

Site Strip Volume Excluded from the Cut & Fill Calculation
300mm Depth

HERMES Plot & Link Road	240,577m ²	72,173m ³
Pond	25,833m ²	7,749m ³
North Plateau	62,070m ²	18,621m ³
South Plateau	139,515m ²	41,855m ³
SURPLUS TOPSOIL	467,993m²	140,398m³

EARTHWORKS

Earthworks to the Proposed Finished Levels as Shown and less the construction depths :

DESCRIPTION	CUT	FILL	BALANCE
HERMES PLOT	401,736	157,798	243,938
LINK ROAD	13,404	3,790	9,614
POND	97,824	1,446	96,378
NORTH PLATEAU	45,033	49,579	-4,546
SOUTH PLATEAU	60,304	447,227	-386,923
TOTALS	618,301	659,840	-41,539

Note :

Winvic advise that the Shortfall will be addressed with 40,000m³ of construction arisings resulting in an overall material balance.

- FILL CONTOUR
- CUT CONTOUR
- ZERO CONTOUR

ANNEX III

Slope stability analysis

Input data

Project

Task : Section E-E' Slope Stability
 Author : Fiona Connor / Adam Perks
 Date : 15/06/2020
 Project ID : Hoyland Common, Barnsley
 Project number : AG3080-19

Settings

United Kingdom - EN 1997

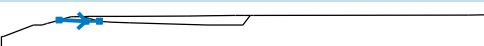
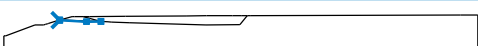
Stability analysis

Earthquake analysis : Standard
 Verification methodology : according to EN 1997
 Design approach : 1 - reduction of actions and soil parameters

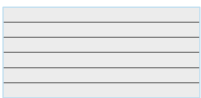
Partial factors on actions (A)						
Permanent design situation						
		Combination 1			Combination 2	
		Unfavourable	Favourable		Unfavourable	Favourable
Permanent actions :	$\gamma_G =$	1.35 [-]	1.00 [-]		1.00 [-]	1.00 [-]
Variable actions :	$\gamma_Q =$	1.50 [-]	0.00 [-]		1.30 [-]	0.00 [-]
Water load :	$\gamma_W =$	1.35 [-]			1.00 [-]	

Partial factors for soil parameters (M)						
Permanent design situation						
		Combination 1		Combination 2		
Partial factor on internal friction :	$\gamma_\phi =$	1.00 [-]		1.25 [-]		
Partial factor on effective cohesion :	$\gamma_c =$	1.00 [-]		1.25 [-]		
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00 [-]		1.40 [-]		

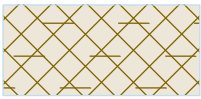
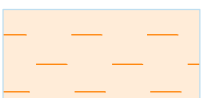
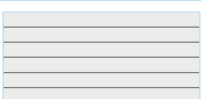
Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		-30.00	-0.70	-29.20	-0.70	-16.30	4.15
		-12.50	4.15	-11.72	4.42	-10.73	4.76
		-10.27	4.93	-6.76	5.92	-5.57	6.26
		-5.26	6.35	0.00	7.85	0.95	7.76
		4.84	7.81	7.66	7.86	23.53	7.99
		50.05	8.12	59.11	8.18	70.53	8.28
		74.60	8.29	76.95	8.29	78.26	8.29
		170.78	8.53	178.33	8.55		
2		4.84	7.81	12.14	5.84	12.67	5.70
		15.71	5.52	17.08	5.44	25.04	5.11
		58.79	4.19	73.72	4.25	76.95	8.29
3		-5.26	6.35	6.35	5.84	12.14	5.84
4		-5.57	6.26	-5.55	6.26	6.34	5.63
		12.67	5.70				

Soil parameters - effective stress state

No.	Name	Pattern	ϕ_{ef} [°]	c_{ef} [kPa]	γ [kN/m ³]
1	Made Ground - Opencast Backfill		15.00	0.00	18.00
2	Engineered Fill		24.00	0.00	20.50
3	Coal Measures CLAY		20.00	3.00	20.50
4	Coal Measures Siltstone / Mudstone / Sandstone		30.00	5.00	21.00
5	COAL		25.00	5.00	13.00

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m ³]	γ_s [kN/m ³]	n [–]
1	Made Ground - Opencast Backfill		20.00		
2	Engineered Fill		20.50		
3	Coal Measures CLAY		20.50		
4	Coal Measures Siltstone / Mudstone / Sandstone		21.00		
5	COAL		13.00		

Soil parameters
Made Ground - Opencast Backfill

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 15.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 20.00 \text{ kN/m}^3$

Engineered Fill

Unit weight : $\gamma = 20.50 \text{ kN/m}^3$
 Stress-state : effective

Angle of internal friction : $\phi_{ef} = 24.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 20.50 \text{ kN/m}^3$

Coal Measures CLAY

Unit weight : $\gamma = 20.50 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 20.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 20.50 \text{ kN/m}^3$

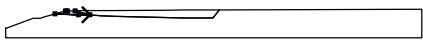
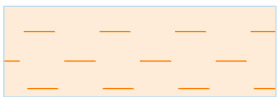
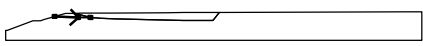
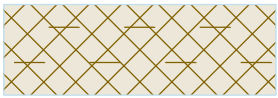
Coal Measures Siltstone / Mudstone / Sandstone

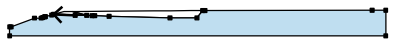
Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 30.00^\circ$
 Cohesion of soil : $c_{ef} = 5.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 21.00 \text{ kN/m}^3$

COAL

Unit weight : $\gamma = 13.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 25.00^\circ$
 Cohesion of soil : $c_{ef} = 5.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 13.00 \text{ kN/m}^3$

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		6.35	5.84	12.14	5.84	Coal Measures CLAY
		4.84	7.81	0.95	7.76	
		0.00	7.85	-5.26	6.35	
						
2		-5.55	6.26	6.34	5.63	COAL
		12.67	5.70	12.14	5.84	
		6.35	5.84	-5.26	6.35	
		-5.57	6.26			
3		12.14	5.84	12.67	5.70	Made Ground - Opencast Backfill
		15.71	5.52	17.08	5.44	
		25.04	5.11	58.79	4.19	
		73.72	4.25	76.95	8.29	
		74.60	8.29	70.53	8.28	
		59.11	8.18	50.05	8.12	
		23.53	7.99	7.66	7.86	
		4.84	7.81			
						

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
4		6.34	5.63	-5.55	6.26	Coal Measures Siltstone / Mudstone / Sandstone
		-5.57	6.26	-6.76	5.92	
		-10.27	4.93	-10.73	4.76	
		-11.72	4.42	-12.50	4.15	
		-16.30	4.15	-29.20	-0.70	
		-30.00	-0.70	-30.00	-5.70	
		178.33	-5.70	178.33	8.55	
		170.78	8.53	78.26	8.29	
		76.95	8.29	73.72	4.25	
		58.79	4.19	25.04	5.11	
		17.08	5.44	15.71	5.52	
		12.67	5.70			

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		-30.00	-1.85	-5.51	6.29	6.97	5.58
		12.56	5.69	16.43	5.51	36.27	4.90
		60.39	4.19	73.73	4.34	170.78	4.19
		178.33	4.18				

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

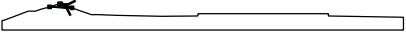
Settings of the stage of construction

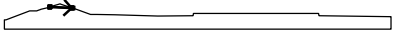
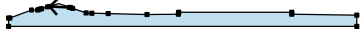
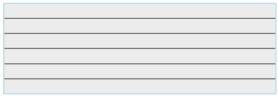
Design situation : permanent

Input data (Stage of construction 2)**Earth cut**

No.	Cut location	Coordinates of cut points [m]					
		x	z	x	z	x	z
1		0.00	7.85	0.45	7.81	2.99	6.97
		6.35	5.84	8.33	5.12	16.41	2.32
		19.85	2.23	29.58	1.99	52.74	1.39
		71.64	1.54	71.77	2.79	139.35	2.79
		139.47	1.54	178.33	1.03		

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		6.35	5.84	2.99	6.97	Coal Measures CLAY
		0.45	7.81	0.00	7.85	
		-5.26	6.35			

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
2		-5.55	6.26	6.34	5.63	COAL 
		6.91	5.64	6.35	5.84	
		-5.26	6.35	-5.57	6.26	
3		6.34	5.63	-5.55	6.26	Coal Measures Siltstone / Mudstone / Sandstone 
		-5.57	6.26	-6.76	5.92	
		-10.27	4.93	-10.73	4.76	
		-11.72	4.42	-12.50	4.15	
		-16.30	4.15	-29.20	-0.70	
		-30.00	-0.70	-30.00	-5.70	
		178.33	-5.70	178.33	1.03	
		139.47	1.54	139.35	2.79	
		71.77	2.79	71.64	1.54	
		52.74	1.39	29.58	1.99	
		19.85	2.23	16.41	2.32	
		8.33	5.12	6.91	5.64	

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		-30.00	-1.85	-5.42	6.28	6.97	5.58
		16.40	2.07	28.46	1.53	54.87	1.03
		72.07	1.28	103.23	1.18	166.62	0.89
		178.33	0.59				

Tensile crack

Tensile crack not input.

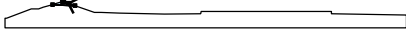
Earthquake

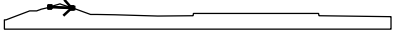
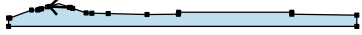
Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Input data (Stage of construction 3)**Assigning and surfaces**

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		6.35	5.84	2.99	6.97	Coal Measures CLAY 
		0.45	7.81	0.00	7.85	
		-5.26	6.35			

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
2		-5.55	6.26	6.34	5.63	COAL
		6.91	5.64	6.35	5.84	
		-5.26	6.35	-5.57	6.26	
3		6.34	5.63	-5.55	6.26	Coal Measures Siltstone / Mudstone / Sandstone
		-5.57	6.26	-6.76	5.92	
		-10.27	4.93	-10.73	4.76	
		-11.72	4.42	-12.50	4.15	
		-16.30	4.15	-29.20	-0.70	
		-30.00	-0.70	-30.00	-5.70	
		178.33	-5.70	178.33	1.03	
		139.47	1.54	139.35	2.79	
		71.77	2.79	71.64	1.54	
		52.74	1.39	29.58	1.99	
		19.85	2.23	16.41	2.32	
		8.33	5.12	6.91	5.64	

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		-30.00	-1.85	-5.42	6.28	6.97	5.58
		16.40	2.07	28.46	1.53	54.87	1.03
		72.07	1.28	103.23	1.18	166.62	0.89
		178.33	0.59				

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 3)**Analysis 1 (stage 3)****Circular slip surface**

Slip surface parameters					
Center :	x =	11.68 [m]	Angles :	$\alpha_1 =$	-57.89 [°]
	z =	15.21 [m]		$\alpha_2 =$	21.75 [°]
Radius :	R =	13.89 [m]			
Analysis of the slip surface without optimization.					

Slope stability verification (all methods)**Combination 1**

Bishop : Utilization = 77.2 % **ACCEPTABLE**
 Fellenius / Petterson : Utilization = 83.3 % **ACCEPTABLE**
 Spencer : Utilization = 76.3 % **ACCEPTABLE**

Janbu : Utilization = 76.2 % **ACCEPTABLE**
Morgenstern-Price : Utilization = 76.6 % **ACCEPTABLE**

Combination 2

Bishop : Utilization = 74.3 % **ACCEPTABLE**
Fellenius / Petterson : Utilization = 79.9 % **ACCEPTABLE**
Spencer : Utilization = 73.9 % **ACCEPTABLE**
Janbu : Utilization = 74.1 % **ACCEPTABLE**
Morgenstern-Price : Utilization = 74.1 % **ACCEPTABLE**

Slope stability analysis

Input data

Project

Task : Section F-F' Slope Stability
Author : Adam Perks
Date : 15/06/2020
Project ID : Hoyland Common, Barnsley
Project number : AG3080-19

Settings

United Kingdom - EN 1997

Stability analysis

Earthquake analysis : Standard
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

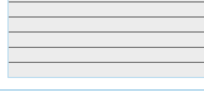
Partial factors on actions (A)						
Permanent design situation						
		Combination 1			Combination 2	
		Unfavourable	Favourable		Unfavourable	Favourable
Permanent actions :	$\gamma_G =$	1.35 [-]	1.00 [-]		1.00 [-]	1.00 [-]
Variable actions :	$\gamma_Q =$	1.50 [-]	0.00 [-]		1.30 [-]	0.00 [-]
Water load :	$\gamma_w =$	1.35 [-]			1.00 [-]	

Partial factors for soil parameters (M)						
Permanent design situation						
		Combination 1			Combination 2	
Partial factor on internal friction :	$\gamma_\phi =$	1.00 [-]			1.25 [-]	
Partial factor on effective cohesion :	$\gamma_c =$	1.00 [-]			1.25 [-]	
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00 [-]			1.40 [-]	

Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		-30.00	0.70	-29.20	0.70	-19.87	3.69
		-16.30	4.85	-12.50	4.85	-11.72	5.12
		-10.73	5.46	-10.27	5.63	-1.95	7.19
		1.00	7.44	8.64	7.14	23.94	7.25
		47.17	7.16	67.24	6.97	74.60	6.96
		121.29	6.89	147.41	6.86	233.14	6.74
2		-19.87	3.69	0.00	3.58	30.14	2.71
		74.60	2.18	121.17	1.63	121.25	5.16
		121.29	6.89				
3		147.41	6.86	147.42	5.16	147.45	1.65
		168.33	1.21	186.71	0.78	233.14	-0.06
4		121.25	5.16	147.42	5.16		

Soil parameters - effective stress state

No.	Name	Pattern	ϕ_{ef} [°]	c_{ef} [kPa]	γ [kN/m ³]
1	Made Ground - Opencast Backfill		15.00	0.00	18.00
2	Engineered Fill		24.00	0.00	20.50
3	Coal Measures CLAY		20.00	3.00	20.50
4	Coal Measures Siltstone / Mudstone / Sandstone		30.00	5.00	21.00
5	COAL		25.00	5.00	13.00

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m ³]	γ_s [kN/m ³]	n [–]
1	Made Ground - Opencast Backfill		20.00		
2	Engineered Fill		20.50		
3	Coal Measures CLAY		20.50		
4	Coal Measures Siltstone / Mudstone / Sandstone		21.00		
5	COAL		13.00		

Soil parameters

Made Ground - Opencast Backfill

Unit weight : $\gamma = 18.00$ kN/m³
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 15.00$ °
 Cohesion of soil : $c_{ef} = 0.00$ kPa
 Saturated unit weight : $\gamma_{sat} = 20.00$ kN/m³

Engineered Fill

Unit weight : $\gamma = 20.50$ kN/m³
 Stress-state : effective

Angle of internal friction : $\phi_{ef} = 24.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 20.50 \text{ kN/m}^3$

Coal Measures CLAY

Unit weight : $\gamma = 20.50 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 20.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 20.50 \text{ kN/m}^3$

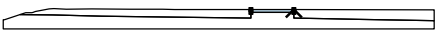
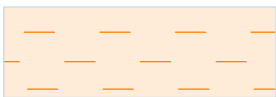
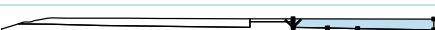
Coal Measures Siltstone / Mudstone / Sandstone

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 30.00^\circ$
 Cohesion of soil : $c_{ef} = 5.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 21.00 \text{ kN/m}^3$

COAL

Unit weight : $\gamma = 13.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 25.00^\circ$
 Cohesion of soil : $c_{ef} = 5.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 13.00 \text{ kN/m}^3$

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		147.42	5.16	147.41	6.86	Coal Measures CLAY 
		121.29	6.89	121.25	5.16	
2		0.00	3.58	30.14	2.71	Made Ground - Opencast Backfill 
		74.60	2.18	121.17	1.63	
		121.25	5.16	121.29	6.89	
		74.60	6.96	67.24	6.97	
		47.17	7.16	23.94	7.25	
		8.64	7.14	1.00	7.44	
		-1.95	7.19	-10.27	5.63	
		-10.73	5.46	-11.72	5.12	
		-12.50	4.85	-16.30	4.85	
		-19.87	3.69			
3		147.42	5.16	147.45	1.65	Made Ground - Opencast Backfill 
		168.33	1.21	186.71	0.78	
		233.14	-0.06	233.14	6.74	
		147.41	6.86			

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
4		121.25	5.16	121.17	1.63	Coal Measures Siltstone / Mudstone / Sandstone
		74.60	2.18	30.14	2.71	
		0.00	3.58	-19.87	3.69	
		-29.20	0.70	-30.00	0.70	
		-30.00	-5.06	233.14	-5.06	
		233.14	-0.06	186.71	0.78	
		168.33	1.21	147.45	1.65	
		147.42	5.16			

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		-30.00	5.71	-11.46	5.34	8.15	4.95
		33.22	5.00	62.65	4.95	74.60	4.95
		233.14	4.95				

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

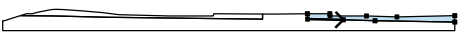
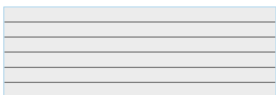
Input data (Stage of construction 2)

Earth cut

No.	Cut location	Coordinates of cut points [m]					
		x	z	x	z	x	z
1		5.47	7.27	16.15	6.56	27.23	5.58
		37.58	4.33	66.99	3.59	89.01	3.61
		92.57	3.55	92.82	4.80	129.53	4.71
		160.41	4.80	160.53	3.60	181.79	3.47
		199.51	3.03	233.14	3.76		

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		0.00	3.58	30.14	2.71	Made Ground - Opencast Backfill
		74.60	2.18	121.17	1.63	
		121.24	4.73	92.82	4.80	
		92.57	3.55	89.01	3.61	
		66.99	3.59	37.58	4.33	
		27.23	5.58	16.15	6.56	
		5.67	7.26	1.00	7.44	
		-1.95	7.19	-10.27	5.63	
		-10.73	5.46	-11.72	5.12	
		-12.50	4.85	-16.30	4.85	
		-19.87	3.69			

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
2		147.45	1.65	168.33	1.21	Made Ground - Opencast Backfill 
		186.71	0.78	233.14	-0.06	
		233.14	3.76	199.51	3.03	
		181.79	3.47	160.53	3.60	
		160.41	4.80	147.42	4.76	
3		121.17	1.63	74.60	2.18	Coal Measures Siltstone / Mudstone / Sandstone 
		30.14	2.71	0.00	3.58	
		-19.87	3.69	-29.20	0.70	
		-30.00	0.70	-30.00	-5.06	
		233.14	-5.06	233.14	-0.06	
		186.71	0.78	168.33	1.21	
		147.45	1.65	147.42	4.76	
		129.53	4.71	121.24	4.73	

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		-30.00	5.71	-11.46	5.34	8.15	4.95
		33.22	5.00	62.65	4.95	74.60	4.95
		233.14	4.95				

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

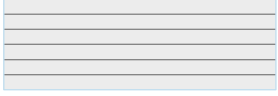
Settings of the stage of construction

Design situation : permanent

Input data (Stage of construction 3)

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		0.00	3.58	30.14	2.71	Made Ground - Opencast Backfill 
		74.60	2.18	121.17	1.63	
		121.24	4.73	92.82	4.80	
		92.57	3.55	89.01	3.61	
		66.99	3.59	37.58	4.33	
		27.23	5.58	16.15	6.56	
		5.67	7.26	1.00	7.44	
		-1.95	7.19	-10.27	5.63	
		-10.73	5.46	-11.72	5.12	
		-12.50	4.85	-16.30	4.85	
		-19.87	3.69			

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
2		147.45	1.65	168.33	1.21	Made Ground - Opencast Backfill 
		186.71	0.78	233.14	-0.06	
		233.14	3.76	199.51	3.03	
		181.79	3.47	160.53	3.60	
		160.41	4.80	147.42	4.76	
3		121.17	1.63	74.60	2.18	Coal Measures Siltstone / Mudstone / Sandstone 
		30.14	2.71	0.00	3.58	
		-19.87	3.69	-29.20	0.70	
		-30.00	0.70	-30.00	-5.06	
		233.14	-5.06	233.14	-0.06	
		186.71	0.78	168.33	1.21	
		147.45	1.65	147.42	4.76	
		129.53	4.71	121.24	4.73	

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		-30.00	-0.38	-10.40	5.34	31.64	4.59
		37.73	3.84	39.24	4.13	54.93	3.67
		70.44	3.47	92.33	3.40	199.65	2.87
		233.14	3.01				

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 3)

Analysis 1 (stage 3)

Circular slip surface

Slip surface parameters						
Center :	x =	33.50 [m]	Angles :	$\alpha_1 =$	-53.38 [°]	
	z =	9.67 [m]		$\alpha_2 =$	40.05 [°]	
Radius :	R =	6.99 [m]				
Analysis of the slip surface without optimization.						

Slope stability verification (all methods)

Combination 1

Bishop : Utilization = 81.6 % **ACCEPTABLE**
 Fellenius / Petterson : Utilization = 94.1 % **ACCEPTABLE**
 Spencer : Utilization = 81.4 % **ACCEPTABLE**
 Janbu : Utilization = 81.4 % **ACCEPTABLE**
 Morgenstern-Price : Utilization = 81.4 % **ACCEPTABLE**

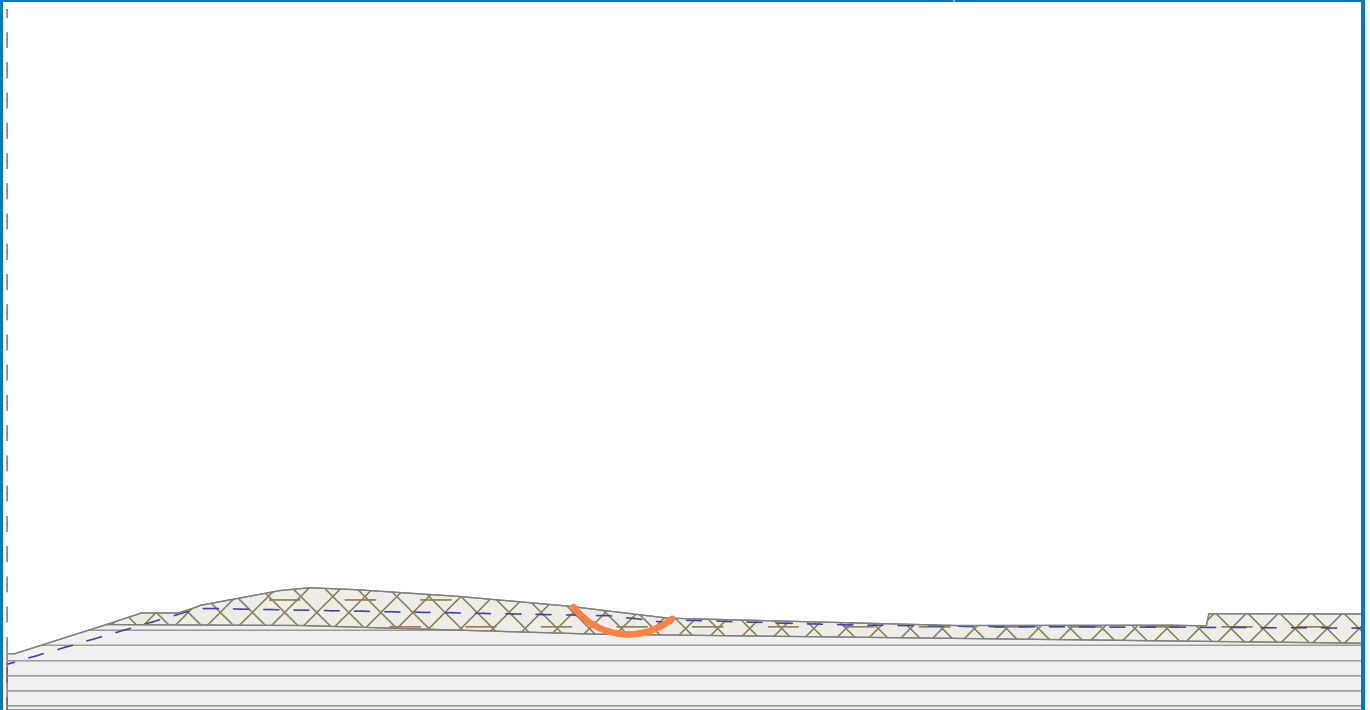
Combination 2

Bishop : Utilization = 64.1 % **ACCEPTABLE**

Fellenius / Petterson : Utilization = 73.5 % **ACCEPTABLE**
Spencer : Utilization = 64.1 % **ACCEPTABLE**
Janbu : Utilization = 64.1 % **ACCEPTABLE**
Morgenstern-Price : Utilization = 64.1 % **ACCEPTABLE**

Name :

Stage - analysis : 3 - 1



Made Ground - Opencast Backfill

Coal Measures Siltstone / Mudstone /
Sandstone

Analysis of the slip surface without optimization.

Slope stability verification (all methods)**Combination 1**

Bishop : Utilization = 81.6 % **ACCEPTABLE**
Fellenius / Petterson : Utilization = 94.1 % **ACCEPTABLE**
Spencer : Utilization = 81.4 % **ACCEPTABLE**
Janbu : Utilization = 81.4 % **ACCEPTABLE**
Morgenstern-Price : Utilization = 81.4 % **ACCEPTABLE**

Combination 2

Bishop : Utilization = 64.1 % **ACCEPTABLE**
Fellenius / Petterson : Utilization = 73.5 % **ACCEPTABLE**
Spencer : Utilization = 64.1 % **ACCEPTABLE**
Janbu : Utilization = 64.1 % **ACCEPTABLE**
Morgenstern-Price : Utilization = 64.1 % **ACCEPTABLE**

Slope stability analysis

Input data

Project

Task : Section R-R' Slope Stability - Plot 1 Western Margin with M1
 Author : Adam Perks
 Date : 12/06/2020
 Project ID : Hoyland Common, Barnsley
 Project number : AG3080-19

Settings

United Kingdom - EN 1997

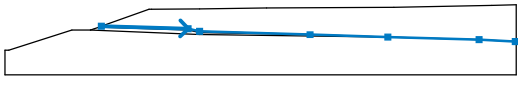
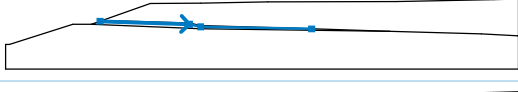
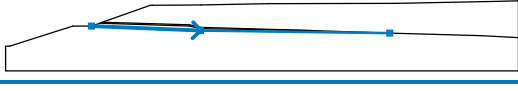
Stability analysis

Earthquake analysis : Standard
 Verification methodology : according to EN 1997
 Design approach : 1 - reduction of actions and soil parameters

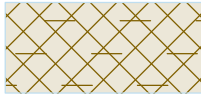
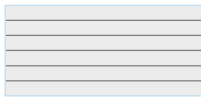
Partial factors on actions (A)					
Permanent design situation					
		Combination 1		Combination 2	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions :	$\gamma_G =$	1.35 [-]	1.00 [-]	1.00 [-]	1.00 [-]
Variable actions :	$\gamma_Q =$	1.50 [-]	0.00 [-]	1.30 [-]	0.00 [-]
Water load :	$\gamma_w =$	1.35 [-]		1.00 [-]	

Partial factors for soil parameters (M)			
Permanent design situation			
		Combination 1	Combination 2
Partial factor on internal friction :	$\gamma_\phi =$	1.00 [-]	1.25 [-]
Partial factor on effective cohesion :	$\gamma_c =$	1.00 [-]	1.25 [-]
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00 [-]	1.40 [-]

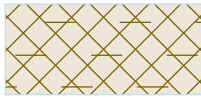
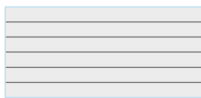
Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		-30.00	141.00	-29.20	141.00	-16.30	145.15
		-12.50	145.15	-11.72	145.42	-10.73	145.76
		-10.27	145.93	-0.50	149.40	0.00	149.40
		9.80	149.44	23.50	149.68	49.60	149.80
		69.60	150.20	74.60	150.30		
2		-10.27	145.93	7.50	145.40	9.80	144.89
		32.41	144.20	48.35	143.72	67.00	143.16
		74.39	142.79	74.60	142.78		
3		-10.73	145.76	7.50	145.15	9.80	144.64
		32.41	144.20				
4		-12.50	145.15	9.80	144.24	48.35	143.72

Soil parameters - effective stress state

No.	Name	Pattern	ϕ_{ef} [°]	c_{ef} [kPa]	γ [kN/m ³]
1	Made Ground - Opencast Backfill		19.00	0.00	18.00
2	Engineered Fill		24.00	0.00	20.50
3	Coal Measures CLAY		20.00	3.00	20.50
4	Coal Measures Siltstone / Mudstone / Sandstone		30.00	5.00	21.00
5	COAL		25.00	5.00	13.00

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m ³]	γ_s [kN/m ³]	n [—]
1	Made Ground - Opencast Backfill		20.00		
2	Engineered Fill		20.50		
3	Coal Measures CLAY		20.50		
4	Coal Measures Siltstone / Mudstone / Sandstone		21.00		
5	COAL		13.00		

Soil parameters

Made Ground - Opencast Backfill

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 19.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 20.00 \text{ kN/m}^3$

Engineered Fill

Unit weight : $\gamma = 20.50 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 24.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 20.50 \text{ kN/m}^3$

Coal Measures CLAY

Unit weight : $\gamma = 20.50 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 20.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 20.50 \text{ kN/m}^3$

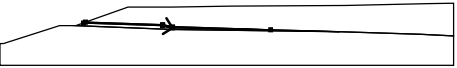
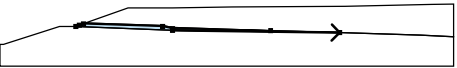
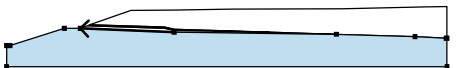
Coal Measures Siltstone / Mudstone / Sandstone

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 30.00^\circ$
 Cohesion of soil : $c_{ef} = 5.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 21.00 \text{ kN/m}^3$

COAL

Unit weight : $\gamma = 13.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 25.00^\circ$
 Cohesion of soil : $c_{ef} = 5.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 13.00 \text{ kN/m}^3$

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		7.50	145.15	9.80	144.64	COAL
		32.41	144.20	9.80	144.89	
		7.50	145.40	-10.27	145.93	
		-10.73	145.76			
2		9.80	144.24	48.35	143.72	Coal Measures CLAY
		32.41	144.20	9.80	144.64	
		7.50	145.15	-10.73	145.76	
		-11.72	145.42	-12.50	145.15	
3		7.50	145.40	9.80	144.89	Made Ground - Opencast Backfill
		32.41	144.20	48.35	143.72	
		67.00	143.16	74.39	142.79	
		74.60	142.78	74.60	150.30	
		69.60	150.20	49.60	149.80	
		23.50	149.68	9.80	149.44	
		0.00	149.40	-0.50	149.40	
		-10.27	145.93			
4		9.80	144.24	-12.50	145.15	Coal Measures Siltstone / Mudstone / Sandstone
		-16.30	145.15	-29.20	141.00	
		-30.00	141.00	-30.00	136.00	
		74.60	136.00	74.60	142.78	
		74.39	142.79	67.00	143.16	
		48.35	143.72			

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		-30.00	140.48	-29.20	140.68	-8.94	145.70
		9.80	146.15	74.60	144.13		

Tensile crack

Tensile crack not input.

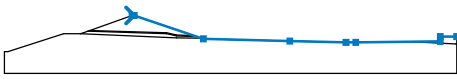
Earthquake

Earthquake not included.

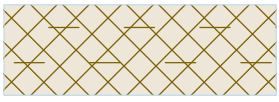
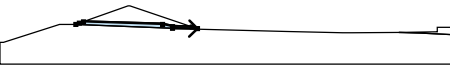
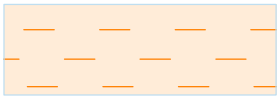
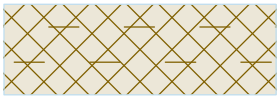
Settings of the stage of construction

Design situation : permanent

Input data (Stage of construction 2)**Earth cut**

No.	Cut location	Coordinates of cut points [m]					
		x	z	x	z	x	z
1		-0.50	149.40	0.00	149.40	16.00	144.00
		36.00	143.50	49.00	143.18	51.25	143.18
		70.80	143.42	70.80	144.50	74.60	144.50

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		7.50	145.40	9.80	144.89	Made Ground - Opencast Backfill 
		13.72	144.77	0.00	149.40	
		-0.50	149.40	-10.27	145.93	
2		7.50	145.15	9.80	144.64	COAL 
		14.37	144.55	13.72	144.77	
		9.80	144.89	7.50	145.40	
		-10.27	145.93	-10.73	145.76	
3		9.80	144.24	15.52	144.16	Coal Measures CLAY 
		14.37	144.55	9.80	144.64	
		7.50	145.15	-10.73	145.76	
		-11.72	145.42	-12.50	145.15	
4		67.00	143.16	74.39	142.79	Made Ground - Opencast Backfill 
		74.60	142.78	74.60	144.50	
		70.80	144.50	70.80	143.42	
		61.96	143.31			

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
5		74.39	142.79	67.00	143.16	Coal Measures Siltstone / Mudstone / Sandstone
		61.96	143.31	51.25	143.18	
		49.00	143.18	36.00	143.50	
		16.00	144.00	15.52	144.16	
		9.80	144.24	-12.50	145.15	
		-16.30	145.15	-29.20	141.00	
		-30.00	141.00	-30.00	136.00	
		74.60	136.00	74.60	142.78	

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		-30.00	140.48	-29.20	140.68	-8.94	145.70
		9.80	146.15	74.60	144.13		

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

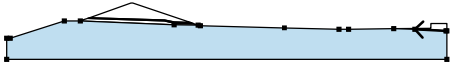
Settings of the stage of construction

Design situation : permanent

Input data (Stage of construction 3)**Assigning and surfaces**

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		7.50	145.40	9.80	144.89	Made Ground - Opencast Backfill
		13.72	144.77	0.00	149.40	
		-0.50	149.40	-10.27	145.93	
2		7.50	145.15	9.80	144.64	COAL
		14.37	144.55	13.72	144.77	
		9.80	144.89	7.50	145.40	
		-10.27	145.93	-10.73	145.76	
3		9.80	144.24	15.52	144.16	Coal Measures CLAY
		14.37	144.55	9.80	144.64	
		7.50	145.15	-10.73	145.76	
		-11.72	145.42	-12.50	145.15	
4		67.00	143.16	74.39	142.79	Made Ground - Opencast Backfill
		74.60	142.78	74.60	144.50	
		70.80	144.50	70.80	143.42	
		61.96	143.31			

APPLIED GEOLOGY	Applied Geology	Hoyland Common, Barnsley
	Adam Perks	AG3080-19
Section R-R' Slope Stability - Plot 1 Western Margin with M1		

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
5		74.39	142.79	67.00	143.16	Coal Measures Siltstone / Mudstone / Sandstone
		61.96	143.31	51.25	143.18	
		49.00	143.18	36.00	143.50	
		16.00	144.00	15.52	144.16	
		9.80	144.24	-12.50	145.15	
		-16.30	145.15	-29.20	141.00	
		-30.00	141.00	-30.00	136.00	
		74.60	136.00	74.60	142.78	

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		-30.00	140.48	-29.20	140.68	-8.94	145.70
		9.58	143.52	15.97	142.69	38.98	142.89
		60.59	142.75	74.60	142.94		

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 3)

Analysis 1 (stage 3)

Circular slip surface

Slip surface parameters					
Center :	x =	10.13 [m]	Angles :	α_1 =	-42.42 [°]
	z =	161.03 [m]		α_2 =	6.54 [°]
Radius :	R =	15.75 [m]			
Analysis of the slip surface without optimization.					

Slope stability verification (all methods)

Combination 1

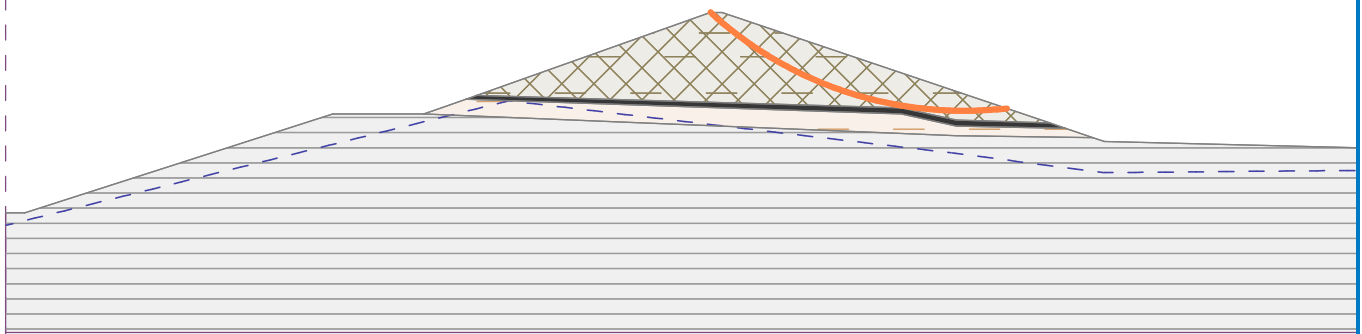
Bishop :	Utilization = 96.9 %	ACCEPTABLE
Fellenius / Petterson :	Utilization = 101.0 %	NOT ACCEPTABLE
Spencer :	Utilization = 96.9 %	ACCEPTABLE
Janbu :	Utilization = 96.9 %	ACCEPTABLE
Morgenstern-Price :	Utilization = 96.9 %	ACCEPTABLE

Combination 2

Bishop :	Utilization = 111.8 %	NOT ACCEPTABLE
Fellenius / Petterson :	Utilization = 116.4 %	NOT ACCEPTABLE
Spencer :	Utilization = 111.8 %	NOT ACCEPTABLE
Janbu :	Utilization = 111.8 %	NOT ACCEPTABLE
Morgenstern-Price :	Utilization = 111.8 %	NOT ACCEPTABLE

Name :

Stage - analysis : 3 - 1



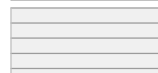
Made Ground - Opencast Backfill



Coal Measures CLAY



COAL

Coal Measures Siltstone / Mudstone /
Sandstone

Analysis of the slip surface without optimization.

Slope stability verification (all methods)**Combination 1**

Bishop : Utilization = 96.9 % **ACCEPTABLE**
Fellenius / Petterson : Utilization = 101.0 % **NOT ACCEPTABLE**
Spencer : Utilization = 96.9 % **ACCEPTABLE**
Janbu : Utilization = 96.9 % **ACCEPTABLE**
Morgenstern-Price : Utilization = 96.9 % **ACCEPTABLE**

Combination 2

Bishop : Utilization = 111.8 % **NOT ACCEPTABLE**
Fellenius / Petterson : Utilization = 116.4 % **NOT ACCEPTABLE**
Spencer : Utilization = 111.8 % **NOT ACCEPTABLE**
Janbu : Utilization = 111.8 % **NOT ACCEPTABLE**
Morgenstern-Price : Utilization = 111.8 % **NOT ACCEPTABLE**

Slope stability analysis

Input data

Project

Task : Section R-R' Slope Stability
 Description : 1.5m high retaining structure + 1v:4h slope above
 Customer : Newlands Developments
 Author : Adam Perks
 Date : 12/06/2020
 Project ID : Hoyland Common, Barnsley
 Project number : AG3080-19

Settings

United Kingdom - EN 1997

Stability analysis

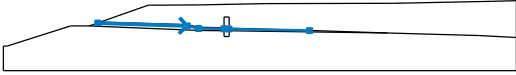
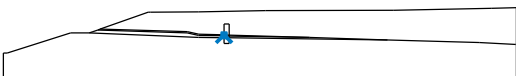
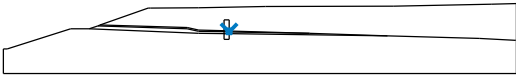
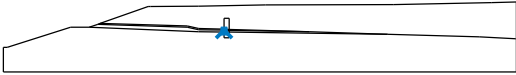
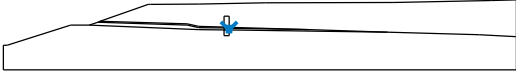
Earthquake analysis : Standard
 Verification methodology : according to EN 1997
 Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)					
Permanent design situation					
		Combination 1		Combination 2	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions :	$\gamma_G =$	1.35 [-]	1.00 [-]	1.00 [-]	1.00 [-]
Variable actions :	$\gamma_Q =$	1.50 [-]	0.00 [-]	1.30 [-]	0.00 [-]
Water load :	$\gamma_w =$	1.35 [-]		1.00 [-]	

Partial factors for soil parameters (M)			
Permanent design situation			
		Combination 1	Combination 2
Partial factor on internal friction :	$\gamma_\phi =$	1.00 [-]	1.25 [-]
Partial factor on effective cohesion :	$\gamma_c =$	1.00 [-]	1.25 [-]
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00 [-]	1.40 [-]

Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		-30.00	141.00	-29.20	141.00	-16.30	145.15
		-12.50	145.15	-11.72	145.42	-10.73	145.76
		-10.27	145.93	-0.50	149.40	0.00	149.40
		9.80	149.44	23.50	149.68	49.60	149.80
		69.60	150.20	74.60	150.30		
2		15.00	144.73	15.00	147.00	16.00	147.00
		16.00	144.70				
3		-10.27	145.93	7.50	145.40	9.80	144.89
		15.00	144.73	16.00	144.70	32.41	144.20
		48.35	143.72	67.00	143.16	74.39	142.79
		74.60	142.78				

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
4		-10.73	145.76	7.50	145.15	9.80	144.64
		15.00	144.54	16.00	144.52	32.41	144.20
5		-12.50	145.15	9.80	144.24	15.00	144.17
		15.00	144.16	16.00	144.16	48.35	143.72
6		15.00	144.54	15.00	144.73		
7		16.00	144.70	16.00	144.52		
8		15.00	144.17	15.00	144.54		
9		16.00	144.52	16.00	144.16		
10		15.00	144.16	15.00	143.00	16.00	143.00
		16.00	144.16				

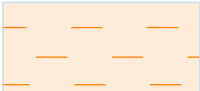
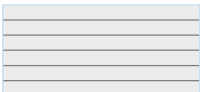
Soil parameters - effective stress state

No.	Name	Pattern	Φ_{ef} [°]	C_{ef} [kPa]	γ [kN/m ³]
1	Made Ground - Opencast Backfill		19.00	0.00	18.00
2	Engineered Fill		24.00	0.00	20.50
3	Coal Measures CLAY		20.00	3.00	20.50
4	Coal Measures Siltstone / Mudstone / Sandstone		30.00	5.00	21.00
5	COAL		25.00	5.00	13.00

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m ³]	γ_s [kN/m ³]	n [—]
1	Made Ground - Opencast Backfill		20.00		

APPLIED GEOLOGY	AG3080-19	Hoyland Common, Barnsley
	Section R-R' Slope Stability Newlands Developments	1.5m high retaining structure + 1v:4h slope above Adam Perks

No.	Name	Pattern	γ_{sat} [kN/m ³]	γ_s [kN/m ³]	n [–]
2	Engineered Fill		20.50		
3	Coal Measures CLAY		20.50		
4	Coal Measures Siltstone / Mudstone / Sandstone		21.00		
5	COAL		13.00		

Soil parameters

Made Ground - Opencast Backfill

Unit weight : γ = 18.00 kN/m³
 Stress-state : effective
 Angle of internal friction : ϕ_{ef} = 19.00 °
 Cohesion of soil : c_{ef} = 0.00 kPa
 Saturated unit weight : γ_{sat} = 20.00 kN/m³

Engineered Fill

Unit weight : γ = 20.50 kN/m³
 Stress-state : effective
 Angle of internal friction : ϕ_{ef} = 24.00 °
 Cohesion of soil : c_{ef} = 0.00 kPa
 Saturated unit weight : γ_{sat} = 20.50 kN/m³

Coal Measures CLAY

Unit weight : γ = 20.50 kN/m³
 Stress-state : effective
 Angle of internal friction : ϕ_{ef} = 20.00 °
 Cohesion of soil : c_{ef} = 3.00 kPa
 Saturated unit weight : γ_{sat} = 20.50 kN/m³

Coal Measures Siltstone / Mudstone / Sandstone

Unit weight : γ = 21.00 kN/m³
 Stress-state : effective
 Angle of internal friction : ϕ_{ef} = 30.00 °
 Cohesion of soil : c_{ef} = 5.00 kPa
 Saturated unit weight : γ_{sat} = 21.00 kN/m³

COAL

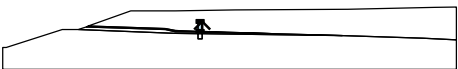
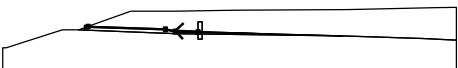
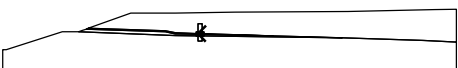
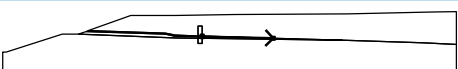
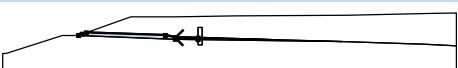
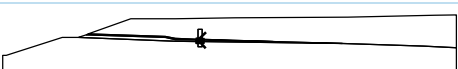
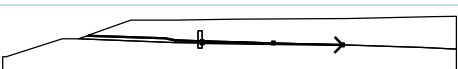
Unit weight : γ = 13.00 kN/m³
 Stress-state : effective
 Angle of internal friction : ϕ_{ef} = 25.00 °
 Cohesion of soil : c_{ef} = 5.00 kPa
 Saturated unit weight : γ_{sat} = 13.00 kN/m³

APPLIED GEOLOGY	AG3080-19	Hoyland Common, Barnsley
	Section R-R' Slope Stability Newlands Developments	1.5m high retaining structure + 1v:4h slope above Adam Perks

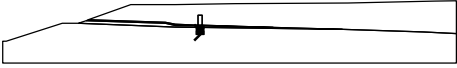
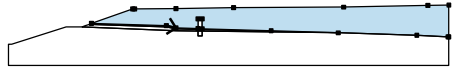
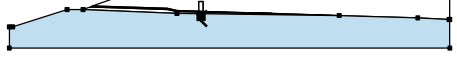
Rigid bodies

No.	Name	Sample	γ [kN/m ³]
1	Gravity retaining wall		25.00

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		16.00	144.70	16.00	147.00	Gravity retaining wall
		15.00	147.00	15.00	144.73	
2		15.00	144.73	9.80	144.89	COAL
		7.50	145.40	-10.27	145.93	
		-10.73	145.76	7.50	145.15	
		9.80	144.64	15.00	144.54	
3		16.00	144.70	15.00	144.73	Gravity retaining wall
		15.00	144.54	16.00	144.52	
4		16.00	144.52	32.41	144.20	COAL
		16.00	144.70			
5		15.00	144.54	9.80	144.64	Coal Measures CLAY
		7.50	145.15	-10.73	145.76	
		-11.72	145.42	-12.50	145.15	
		9.80	144.24	15.00	144.17	
6		16.00	144.52	15.00	144.54	Gravity retaining wall
		15.00	144.17	15.00	144.16	
		16.00	144.16			
7		16.00	144.16	48.35	143.72	Coal Measures CLAY
		32.41	144.20	16.00	144.52	

APPLIED GEOLOGY	AG3080-19	Hoyland Common, Barnsley
	Section R-R' Slope Stability	1.5m high retaining structure + 1v:4h slope above
	Newlands Developments	Adam Perks

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
8		15.00	143.00	16.00	143.00	Gravity retaining wall
		16.00	144.16	15.00	144.16	
9		7.50	145.40	9.80	144.89	Made Ground - Opencast Backfill
		15.00	144.73	15.00	147.00	
		16.00	147.00	16.00	144.70	
		32.41	144.20	48.35	143.72	
		67.00	143.16	74.39	142.79	
		74.60	142.78	74.60	150.30	
		69.60	150.20	49.60	149.80	
		23.50	149.68	9.80	149.44	
		0.00	149.40	-0.50	149.40	
10		16.00	143.00	15.00	143.00	Coal Measures Siltstone / Mudstone / Sandstone
		15.00	144.16	15.00	144.17	
		9.80	144.24	-12.50	145.15	
		-16.30	145.15	-29.20	141.00	
		-30.00	141.00	-30.00	136.00	
		74.60	136.00	74.60	142.78	
		74.39	142.79	67.00	143.16	
		48.35	143.72	16.00	144.16	

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		-30.00	140.48	-29.20	140.68	-8.94	145.70
		9.52	146.06	15.63	143.67	38.98	142.89
		60.59	142.75	74.60	142.94		

Settings of the stage of construction

Design situation : permanent

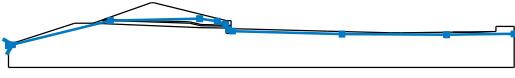
Input data (Stage of construction 2)

Earth cut

No.	Cut location	Coordinates of cut points [m]					
		x	z	x	z	x	z
1		0.00	149.40	15.00	145.65	16.00	145.65
		16.00	144.00	36.00	143.50	49.00	143.18
		51.25	143.18	70.80	143.42	70.80	144.50
		74.60	144.50				

Water

Water type : GWT

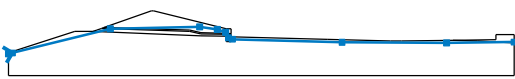
No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		-30.00	140.48	-29.20	140.68	-8.94	145.70
		9.52	146.06	13.17	145.53	14.90	144.97
		15.46	143.82	16.27	143.52	38.98	142.89
		60.59	142.75	74.60	142.94		

Settings of the stage of construction

Design situation : permanent

Input data (Stage of construction 3)**Water**

Water type : GWT

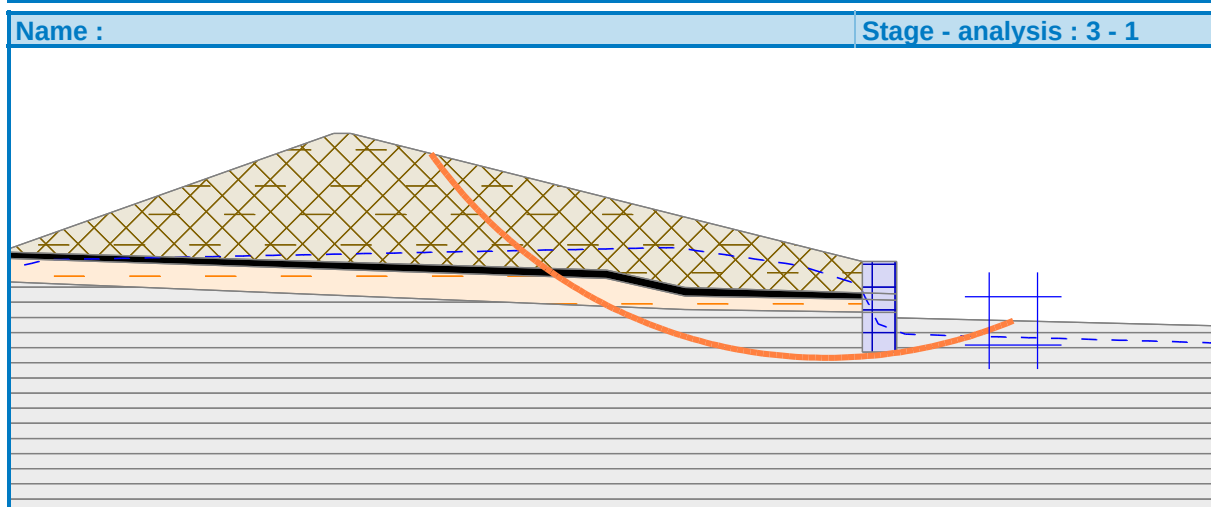
No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		-30.00	140.48	-29.20	140.68	-8.94	145.70
		9.52	146.06	13.17	145.53	14.90	144.97
		15.46	143.82	16.27	143.52	38.98	142.89
		60.59	142.75	74.60	142.94		

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 3) – Global Stability of Wall Check**Analysis 1 (stage 3)****Circular slip surface**

Slip surface parameters					
Center :	x =	13.96 [m]	Angles :	$\alpha_1 =$	-54.52 [°]
	z =	157.09 [m]		$\alpha_2 =$	22.49 [°]
Radius :	R =	14.26 [m]			
Slip surface first determined via optimization with Bishop then without optimization with all methods.					

**Slope stability verification (all methods)****Combination 1**Bishop : Utilization = 66.2 % **ACCEPTABLE**Fellenius / Petterson : Utilization = 71.5 % **ACCEPTABLE**

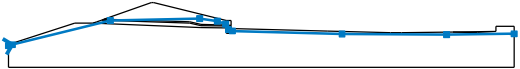
Spencer : Utilization = 64.9 % **ACCEPTABLE**
 Janbu : Utilization = 64.9 % **ACCEPTABLE**
 Morgenstern-Price : Utilization = 64.9 % **ACCEPTABLE**

Combination 2

Bishop : Utilization = 65.3 % **ACCEPTABLE**
 Fellenius / Petterson : Utilization = 69.7 % **ACCEPTABLE**
 Spencer : Utilization = 64.4 % **ACCEPTABLE**
 Janbu : Utilization = 64.4 % **ACCEPTABLE**
 Morgenstern-Price : Utilization = 64.4 % **ACCEPTABLE**

Input data (Stage of construction 4)**Water**

Water type : GWT

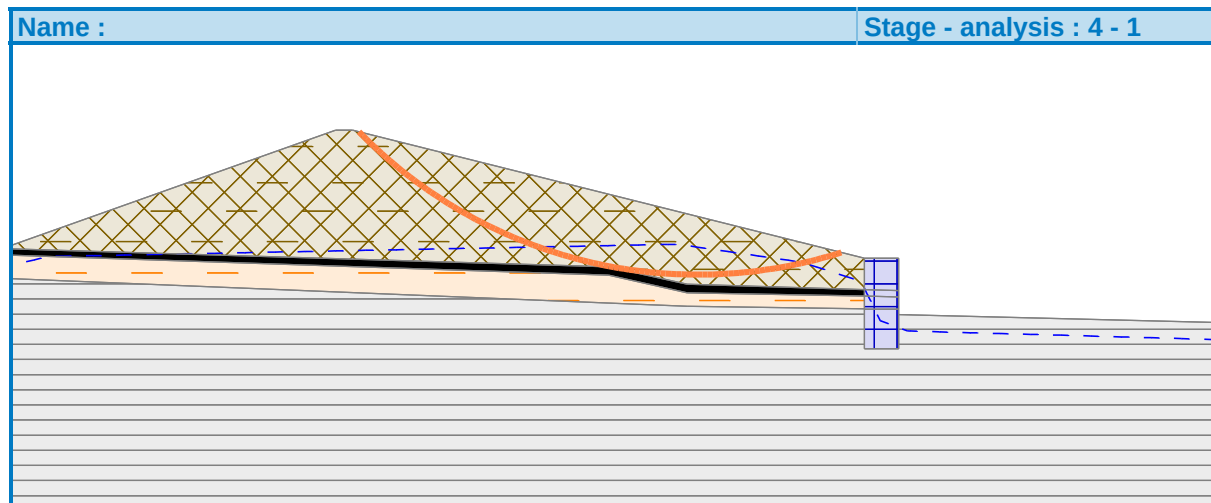
No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		-30.00	140.48	-29.20	140.68	-8.94	145.70
		9.52	146.06	13.17	145.53	14.90	144.97
		15.46	143.82	16.27	143.52	38.98	142.89
		60.59	142.75	74.60	142.94		

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 4) – Stability of Upper Slope Check**Analysis 1 (stage 4)****Circular slip surface**

Slip surface parameters						
Center :	x =	10.12 [m]	Angles :	$\alpha_1 =$	-45.68 [°]	
	z =	159.05 [m]		$\alpha_2 =$	17.61 [°]	
Radius :	R =	13.88 [m]				
Slip surface first determined via optimization with Bishop then without optimization with all methods.						

**Slope stability verification (all methods)****Combination 1**

Bishop : Utilization = 82.6 % **ACCEPTABLE**
 Fellenius / Petterson : Utilization = 87.9 % **ACCEPTABLE**
 Spencer : Utilization = 82.6 % **ACCEPTABLE**

Janbu : Utilization = 82.6 % **ACCEPTABLE**
Morgenstern-Price : Utilization = 82.6 % **ACCEPTABLE**

Combination 2

Bishop : Utilization = 88.3 % **ACCEPTABLE**
Fellenius / Petterson : Utilization = 94.0 % **ACCEPTABLE**
Spencer : Utilization = 88.4 % **ACCEPTABLE**
Janbu : Utilization = 88.4 % **ACCEPTABLE**
Morgenstern-Price : Utilization = 88.4 % **ACCEPTABLE**

Slope stability analysis

Input data

Project

Task : Section R-R' Slope Stability
 Description : 2.5m high retaining structure + 1v:5h slope above
 Customer : Newlands Developments
 Author : Adam Perks
 Date : 12/06/2020
 Project ID : Hoyland Common, Barnsley
 Project number : AG3080-19

Settings

United Kingdom - EN 1997

Stability analysis

Earthquake analysis : Standard
 Verification methodology : according to EN 1997
 Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)					
Permanent design situation					
		Combination 1		Combination 2	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions :	$\gamma_G =$	1.35 [-]	1.00 [-]	1.00 [-]	1.00 [-]
Variable actions :	$\gamma_Q =$	1.50 [-]	0.00 [-]	1.30 [-]	0.00 [-]
Water load :	$\gamma_w =$	1.35 [-]		1.00 [-]	

Partial factors for soil parameters (M)			
Permanent design situation			
		Combination 1	Combination 2
Partial factor on internal friction :	$\gamma_\phi =$	1.00 [-]	1.25 [-]
Partial factor on effective cohesion :	$\gamma_c =$	1.00 [-]	1.25 [-]
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00 [-]	1.40 [-]

Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		-30.00	141.00	-29.20	141.00	-16.30	145.15
		-12.50	145.15	-11.72	145.42	-10.73	145.76
		-10.27	145.93	-0.50	149.40	0.00	149.40
		9.80	149.44	23.50	149.68	49.60	149.80
		69.60	150.20	74.60	150.30		
2		15.00	144.73	15.00	146.50	16.00	146.50
		16.00	144.70				
3		-10.27	145.93	7.50	145.40	9.80	144.89
		15.00	144.73	16.00	144.70	32.41	144.20
		48.35	143.72	67.00	143.16	74.39	142.79
		74.60	142.78				

APPLIED GEOLOGY	AG3080-19	Hoyland Common, Barnsley
	Section R-R' Slope Stability Newlands Developments	2.5m high retaining structure + 1v:5h slope above Adam Perks

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
4		-10.73	145.76	7.50	145.15	9.80	144.64
		15.00	144.54	16.00	144.52	32.41	144.20
5		-12.50	145.15	9.80	144.24	15.00	144.17
		15.00	144.16	16.00	144.16	48.35	143.72
6		15.00	144.54	15.00	144.73		
7		16.00	144.70	16.00	144.52		
8		15.00	144.17	15.00	144.54		
9		16.00	144.52	16.00	144.16		
10		15.00	144.16	15.00	143.00	16.00	143.00
		16.00	144.16				

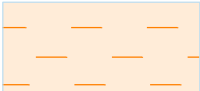
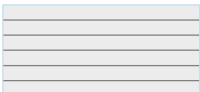
Soil parameters - effective stress state

No.	Name	Pattern	Φ_{ef} [°]	C_{ef} [kPa]	γ [kN/m ³]
1	Made Ground - Opencast Backfill		19.00	0.00	18.00
2	Engineered Fill		24.00	0.00	20.50
3	Coal Measures CLAY		20.00	3.00	20.50
4	Coal Measures Siltstone / Mudstone / Sandstone		30.00	5.00	21.00
5	COAL		25.00	5.00	13.00

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m ³]	γ_s [kN/m ³]	n [—]
1	Made Ground - Opencast Backfill		20.00		

APPLIED GEOLOGY	AG3080-19	Hoyland Common, Barnsley
	Section R-R' Slope Stability Newlands Developments	2.5m high retaining structure + 1v:5h slope above Adam Perks

No.	Name	Pattern	γ_{sat} [kN/m ³]	γ_s [kN/m ³]	n [–]
2	Engineered Fill		20.50		
3	Coal Measures CLAY		20.50		
4	Coal Measures Siltstone / Mudstone / Sandstone		21.00		
5	COAL		13.00		

Soil parameters

Made Ground - Opencast Backfill

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 19.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 20.00 \text{ kN/m}^3$

Engineered Fill

Unit weight : $\gamma = 20.50 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 24.00^\circ$
 Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 20.50 \text{ kN/m}^3$

Coal Measures CLAY

Unit weight : $\gamma = 20.50 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 20.00^\circ$
 Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 20.50 \text{ kN/m}^3$

Coal Measures Siltstone / Mudstone / Sandstone

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 30.00^\circ$
 Cohesion of soil : $c_{ef} = 5.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 21.00 \text{ kN/m}^3$

COAL

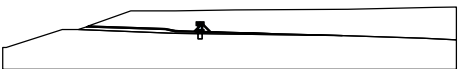
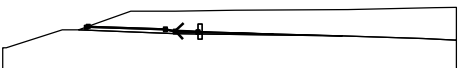
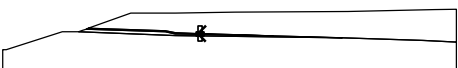
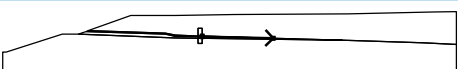
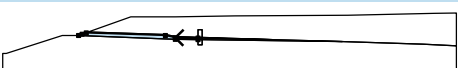
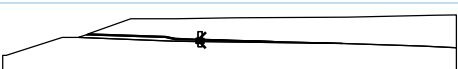
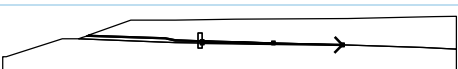
Unit weight : $\gamma = 13.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 25.00^\circ$
 Cohesion of soil : $c_{ef} = 5.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 13.00 \text{ kN/m}^3$

APPLIED GEOLOGY	AG3080-19	Hoyland Common, Barnsley
	Section R-R' Slope Stability Newlands Developments	2.5m high retaining structure + 1v:5h slope above Adam Perks

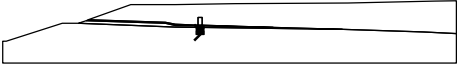
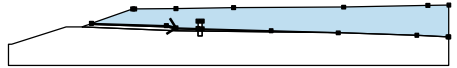
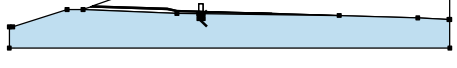
Rigid bodies

No.	Name	Sample	γ [kN/m ³]
1	Gravity retaining wall		25.00

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		16.00	144.70	16.00	146.50	Gravity retaining wall
		15.00	146.50	15.00	144.73	
2		15.00	144.73	9.80	144.89	COAL
		7.50	145.40	-10.27	145.93	
		-10.73	145.76	7.50	145.15	
		9.80	144.64	15.00	144.54	
3		16.00	144.70	15.00	144.73	Gravity retaining wall
		15.00	144.54	16.00	144.52	
4		16.00	144.52	32.41	144.20	COAL
		16.00	144.70			
5		15.00	144.54	9.80	144.64	Coal Measures CLAY
		7.50	145.15	-10.73	145.76	
		-11.72	145.42	-12.50	145.15	
		9.80	144.24	15.00	144.17	
6		16.00	144.52	15.00	144.54	Gravity retaining wall
		15.00	144.17	15.00	144.16	
		16.00	144.16			
7		16.00	144.16	48.35	143.72	Coal Measures CLAY
		32.41	144.20	16.00	144.52	

APPLIED GEOLOGY	AG3080-19	Hoyland Common, Barnsley
	Section R-R' Slope Stability	2.5m high retaining structure + 1v:5h slope above
	Newlands Developments	Adam Perks

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
8		15.00	143.00	16.00	143.00	Gravity retaining wall
		16.00	144.16	15.00	144.16	
9		7.50	145.40	9.80	144.89	Made Ground - Opencast Backfill
		15.00	144.73	15.00	146.50	
		16.00	146.50	16.00	144.70	
		32.41	144.20	48.35	143.72	
		67.00	143.16	74.39	142.79	
		74.60	142.78	74.60	150.30	
		69.60	150.20	49.60	149.80	
		23.50	149.68	9.80	149.44	
		0.00	149.40	-0.50	149.40	
10		16.00	143.00	15.00	143.00	Coal Measures Siltstone / Mudstone / Sandstone
		15.00	144.16	15.00	144.17	
		9.80	144.24	-12.50	145.15	
		-16.30	145.15	-29.20	141.00	
		-30.00	141.00	-30.00	136.00	
		74.60	136.00	74.60	142.78	
		74.39	142.79	67.00	143.16	
		48.35	143.72	16.00	144.16	

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		-30.00	140.48	-29.20	140.68	-8.94	145.70
		9.52	146.06	15.63	143.67	38.98	142.89
		60.59	142.75	74.60	142.94		

Settings of the stage of construction

Design situation : permanent

Input data (Stage of construction 2)

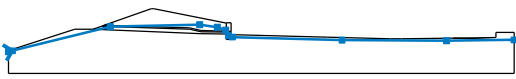
Earth cut

No.	Cut location	Coordinates of cut points [m]					
		x	z	x	z	x	z
1		0.00	149.40	15.00	146.40	15.00	146.50
		16.00	146.50	16.00	144.00	36.00	143.50
		49.00	143.18	51.25	143.18	70.80	143.42
		70.80	144.50	74.60	144.50		

Water

Water type : GWT

APPLIED GEOLOGY	AG3080-19	Hoyland Common, Barnsley
	Section R-R' Slope Stability Newlands Developments	2.5m high retaining structure + 1v:5h slope above Adam Perks

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		-30.00	140.48	-29.20	140.68	-8.94	145.70
		9.52	146.06	13.17	145.53	14.90	144.97
		15.46	143.82	16.27	143.52	38.98	142.89
		60.59	142.75	74.60	142.94		

Settings of the stage of construction

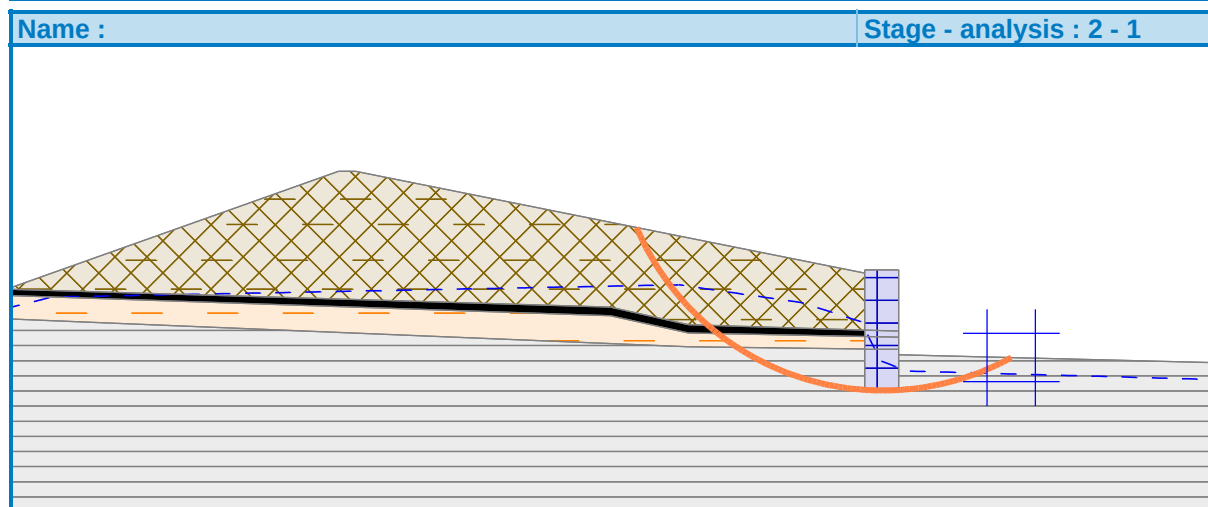
Design situation : permanent

Results (Stage of construction 2) – Global Stability of Wall Check

Analysis 1 (stage 2)

Circular slip surface

Slip surface parameters					
Center :	x =	15.53 [m]	Angles :	$\alpha_1 =$	-66.95 [°]
	z =	150.83 [m]		$\alpha_2 =$	28.69 [°]
Radius :	R =	7.88 [m]			
Slip surface first determined via optimization with Bishop then without optimization with all methods.					



Slope stability verification (all methods)

Combination 1

Bishop : Utilization = 67.0 % **ACCEPTABLE**
Fellenius / Petterson : Utilization = 75.6 % **ACCEPTABLE**
Spencer : Utilization = 65.5 % **ACCEPTABLE**
Janbu : Utilization = 65.6 % **ACCEPTABLE**
Morgenstern-Price : Utilization = 65.6 % **ACCEPTABLE**

Combination 2

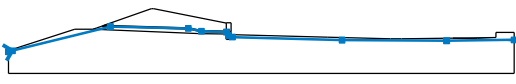
Bishop : Utilization = 68.4 % **ACCEPTABLE**
Fellenius / Petterson : Utilization = 75.8 % **ACCEPTABLE**
Spencer : Utilization = 67.4 % **ACCEPTABLE**
Janbu : Utilization = 67.5 % **ACCEPTABLE**
Morgenstern-Price : Utilization = 67.5 % **ACCEPTABLE**

Input data (Stage of construction 3)

Water

Water type : GWT

APPLIED GEOLOGY	AG3080-19	Hoyland Common, Barnsley
	Section R-R' Slope Stability Newlands Developments	2.5m high retaining structure + 1v:5h slope above Adam Perks

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		-30.00	140.48	-29.20	140.68	-8.94	145.70
		7.18	145.31	9.89	144.73	15.09	144.56
		15.46	143.82	16.27	143.52	38.98	142.89
		60.59	142.75	74.60	142.94		

Settings of the stage of construction

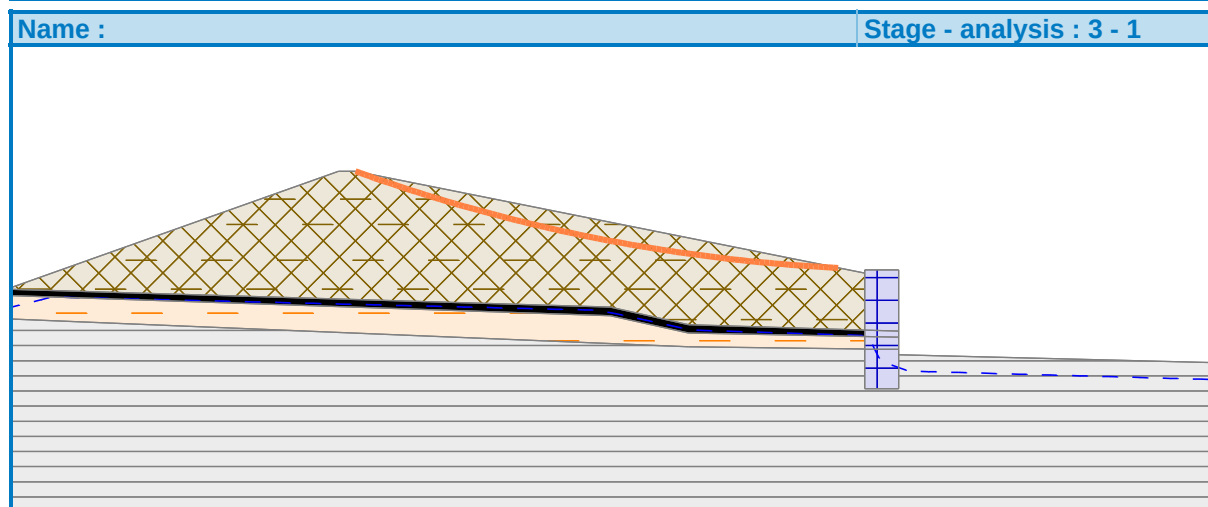
Design situation : permanent

Results (Stage of construction 3) –Stability of Upper Slope Check

Analysis 1 (stage 3)

Circular slip surface

Slip surface parameters					
Center :	x =	16.61 [m]	Angles :	α_1 =	-19.82 [°]
	z =	195.48 [m]		α_2 =	-2.80 [°]
Radius :	R =	48.98 [m]			
Slip surface first determined via optimization with Bishop then without optimization with all methods.					



Slope stability verification (all methods)

Combination 1

Bishop : Utilization = 57.7 % **ACCEPTABLE**
 Fellenius / Petterson : Utilization = 57.9 % **ACCEPTABLE**
 Spencer : Utilization = 57.7 % **ACCEPTABLE**
 Janbu : Utilization = 57.7 % **ACCEPTABLE**
 Morgenstern-Price : Utilization = 57.7 % **ACCEPTABLE**

Combination 2

Bishop : Utilization = 71.9 % **ACCEPTABLE**
 Fellenius / Petterson : Utilization = 72.3 % **ACCEPTABLE**
 Spencer : Utilization = 71.9 % **ACCEPTABLE**
 Janbu : Utilization = 71.9 % **ACCEPTABLE**
 Morgenstern-Price : Utilization = 71.9 % **ACCEPTABLE**

Slope stability analysis

Input data

Project

Task : Section O-O' Slopes
Author : Fiona Connor
Date : 15/06/2020
Project ID : Hoyland Common, Barnsley
Project number : AG3080-19

Settings

United Kingdom - EN 1997

Stability analysis

Earthquake analysis : Standard
Verification methodology : according to EN 1997
Design approach : 1 - reduction of actions and soil parameters

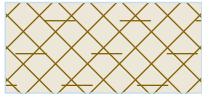
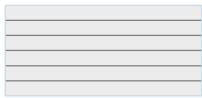
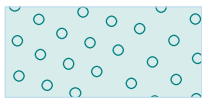
Partial factors on actions (A)						
Permanent design situation						
		Combination 1		Combination 2		
		Unfavourable	Favourable	Unfavourable	Favourable	
Permanent actions :	$\gamma_G =$	1.35 [-]	1.00 [-]	1.00 [-]	1.00 [-]	
Variable actions :	$\gamma_Q =$	1.50 [-]	0.00 [-]	1.30 [-]	0.00 [-]	
Water load :	$\gamma_w =$	1.35 [-]		1.00 [-]		

Partial factors for soil parameters (M)				
Permanent design situation				
		Combination 1		Combination 2
Partial factor on internal friction :	$\gamma_\phi =$	1.00 [-]		1.25 [-]
Partial factor on effective cohesion :	$\gamma_c =$	1.00 [-]		1.25 [-]
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00 [-]		1.40 [-]

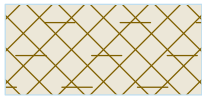
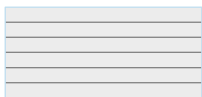
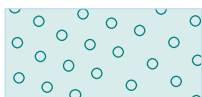
Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		0.00	9.93	27.13	10.00	29.67	13.25
2		0.00	13.25	29.67	13.25	36.67	11.00
		39.67	10.77	51.88	10.50	71.73	10.27
		86.33	10.25	105.10	9.50	125.39	9.49
		142.67	10.25	148.00	10.48		
3		0.00	7.32	51.30	1.34	61.10	0.21
		65.60	0.07	74.23	3.27	80.88	7.11
		83.03	8.34	86.33	10.25		
4		80.88	7.11	104.79	6.29	125.73	6.29
		142.67	6.66	148.00	6.78		

Soil parameters - effective stress state

No.	Name	Pattern	ϕ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]
1	Made Ground - Opencast Backfill		19.00	0.00	18.00
2	Engineered Fill		24.00	0.00	20.50
3	Coal Measures CLAY		20.00	3.00	20.50
4	Coal Measures Siltstone / Mudstone / Sandstone		30.00	5.00	21.00
5	COAL		25.00	5.00	13.00
6	M1 construction		38.50	0.00	21.00

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m³]	γ_s [kN/m³]	n [-]
1	Made Ground - Opencast Backfill		20.00		
2	Engineered Fill		20.50		
3	Coal Measures CLAY		20.50		
4	Coal Measures Siltstone / Mudstone / Sandstone		21.00		
5	COAL		13.00		
6	M1 construction		21.00		

Soil parameters

Made Ground - Opencast Backfill

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\phi_{ef} = 19.00^\circ$

Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 20.00 \text{ kN/m}^3$

Engineered Fill

Unit weight : $\gamma = 20.50 \text{ kN/m}^3$
Stress-state : effective
Angle of internal friction : $\phi_{ef} = 24.00^\circ$
Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 20.50 \text{ kN/m}^3$

Coal Measures CLAY

Unit weight : $\gamma = 20.50 \text{ kN/m}^3$
Stress-state : effective
Angle of internal friction : $\phi_{ef} = 20.00^\circ$
Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 20.50 \text{ kN/m}^3$

Coal Measures Siltstone / Mudstone / Sandstone

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
Stress-state : effective
Angle of internal friction : $\phi_{ef} = 30.00^\circ$
Cohesion of soil : $c_{ef} = 5.00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 21.00 \text{ kN/m}^3$

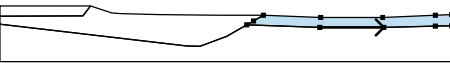
COAL

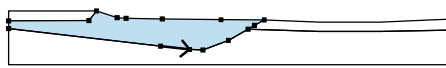
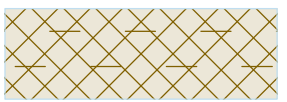
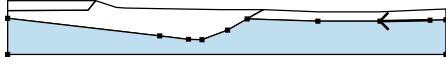
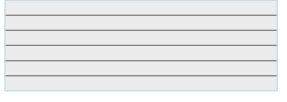
Unit weight : $\gamma = 13.00 \text{ kN/m}^3$
Stress-state : effective
Angle of internal friction : $\phi_{ef} = 25.00^\circ$
Cohesion of soil : $c_{ef} = 5.00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 13.00 \text{ kN/m}^3$

M1 construction

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
Stress-state : effective
Angle of internal friction : $\phi_{ef} = 38.50^\circ$
Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 21.00 \text{ kN/m}^3$

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		0.00	13.25	0.00	9.93	M1 construction
		27.13	10.00	29.67	13.25	
2		104.79	6.29	125.73	6.29	Coal Measures CLAY
		142.67	6.66	148.00	6.78	
		148.00	10.48	142.67	10.25	
		125.39	9.49	105.10	9.50	
		86.33	10.25	83.03	8.34	
		80.88	7.11			

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
3		51.30	1.34	61.10	0.21	Made Ground - Opencast Backfill 
		65.60	0.07	74.23	3.27	
		80.88	7.11	83.03	8.34	
		86.33	10.25	71.73	10.27	
		51.88	10.50	39.67	10.77	
		36.67	11.00	29.67	13.25	
		27.13	10.00	0.00	9.93	
		0.00	7.32			
4		142.67	6.66	125.73	6.29	Coal Measures Siltstone / Mudstone / Sandstone 
		104.79	6.29	80.88	7.11	
		74.23	3.27	65.60	0.07	
		61.10	0.21	51.30	1.34	
		0.00	7.32	0.00	-4.93	
		148.00	-4.93	148.00	6.78	

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	4.55	90.29	5.30	131.92	5.07
		142.67	5.30	148.00	5.41		

Tensile crack

Tensile crack not input.

Earthquake

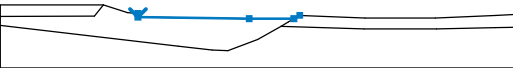
Earthquake not included.

Settings of the stage of construction

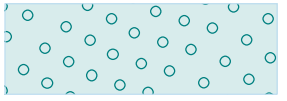
Design situation : permanent

Input data (Stage of construction 2)

Earth cut

No.	Cut location	Coordinates of cut points [m]					
		x	z	x	z	x	z
1		39.67	10.77	39.67	9.77	71.73	9.27
		84.61	9.26	86.33	10.25		

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		27.13	10.00	29.67	13.25	M1 construction 
		0.00	13.25	0.00	9.93	

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
2		104.79	6.29	125.73	6.29	Coal Measures CLAY
		142.67	6.66	148.00	6.78	
		148.00	10.48	142.67	10.25	
		125.39	9.49	105.10	9.50	
		86.33	10.25	83.03	8.34	
		80.88	7.11			
3		51.30	1.34	61.10	0.21	Made Ground - Opencast Backfill
		65.60	0.07	74.23	3.27	
		80.88	7.11	83.03	8.34	
		86.33	10.25	84.61	9.26	
		71.73	9.27	39.67	9.77	
		39.67	10.77	36.67	11.00	
		29.67	13.25	27.13	10.00	
		0.00	9.93	0.00	7.32	
4		142.67	6.66	125.73	6.29	Coal Measures Siltstone / Mudstone / Sandstone
		104.79	6.29	80.88	7.11	
		74.23	3.27	65.60	0.07	
		61.10	0.21	51.30	1.34	
		0.00	7.32	0.00	-4.93	
		148.00	-4.93	148.00	6.78	

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	4.55	90.29	5.30	131.92	5.07
		142.67	5.30	148.00	5.41		

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

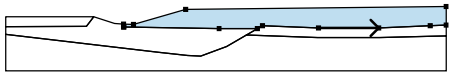
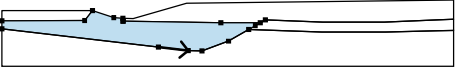
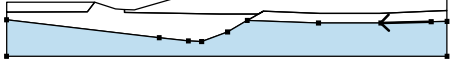
Design situation : permanent

Input data (Stage of construction 3)

Embankment interface

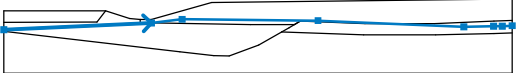
No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		39.67	10.77	42.98	10.70	60.52	15.70
		148.00	16.70				

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		27.13	10.00	29.67	13.25	M1 construction
		0.00	13.25	0.00	9.93	
2		105.10	9.50	125.39	9.49	Engineered Fill
		142.67	10.25	148.00	10.48	
		148.00	16.70	60.52	15.70	
		42.98	10.70	39.67	10.77	
		39.67	9.77	39.72	9.77	
		71.73	9.27	84.61	9.26	
		86.33	10.25			
3		104.79	6.29	125.73	6.29	Coal Measures CLAY
		142.67	6.66	148.00	6.78	
		148.00	10.48	142.67	10.25	
		125.39	9.49	105.10	9.50	
		86.33	10.25	83.03	8.34	
		80.88	7.11			
4		51.30	1.34	61.10	0.21	Made Ground - Opencast Backfill
		65.60	0.07	74.23	3.27	
		80.88	7.11	83.03	8.34	
		86.33	10.25	84.61	9.26	
		71.73	9.27	39.72	9.77	
		39.67	9.77	39.67	10.77	
		36.67	11.00	29.67	13.25	
		27.13	10.00	0.00	9.93	
		0.00	7.32			
5		142.67	6.66	125.73	6.29	Coal Measures Siltstone / Mudstone / Sandstone
		104.79	6.29	80.88	7.11	
		74.23	3.27	65.60	0.07	
		61.10	0.21	51.30	1.34	
		0.00	7.32	0.00	-4.93	
		148.00	-4.93	148.00	6.78	

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	7.75	42.96	9.71	51.89	10.78
		91.47	10.40	133.94	8.62	142.56	8.76
		145.10	8.76	148.00	8.91		

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 3)

Analysis 1 (stage 3)

Circular slip surface

Slip surface parameters					
Center :	x =	48.65 [m]	Angles :	$\alpha_1 =$	-48.42 [°]
	z =	20.19 [m]		$\alpha_2 =$	71.39 [°]
Radius :	R =	14.02 [m]			
Analysis of the slip surface without optimization.					

Slope stability verification (all methods)

Combination 1

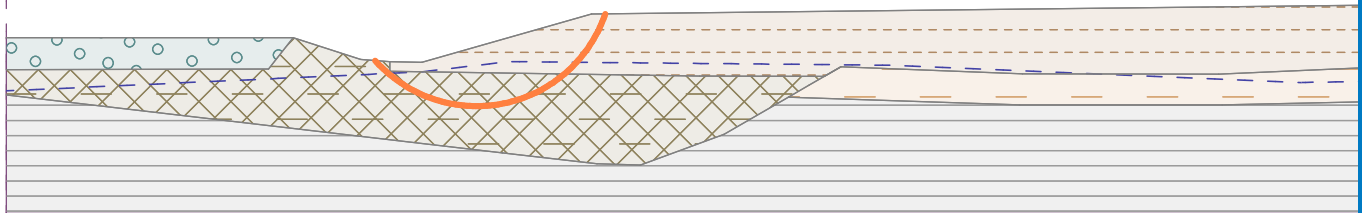
Bishop :	Utilization = 83.1 %	ACCEPTABLE
Fellenius / Petterson :	Utilization = 105.2 %	NOT ACCEPTABLE
Spencer :	Utilization = 83.0 %	ACCEPTABLE
Janbu :	Utilization = 82.8 %	ACCEPTABLE
Morgenstern-Price :	Utilization = 82.8 %	ACCEPTABLE

Combination 2

Bishop :	Utilization = 76.1 %	ACCEPTABLE
Fellenius / Petterson :	Utilization = 96.0 %	ACCEPTABLE
Spencer :	Utilization = 76.4 %	ACCEPTABLE
Janbu :	Utilization = 76.2 %	ACCEPTABLE
Morgenstern-Price :	Utilization = 76.2 %	ACCEPTABLE

Name :

Stage - analysis : 3 - 1



M1 construction



Coal Measures CLAY



Coal Measures Siltstone / Mudstone /
Sandstone



Engineered Fill



Made Ground - Opencast Backfill

Analysis of the slip surface without optimization.

Slope stability verification (all methods)

Combination 1

Bishop : Utilization = 83.1 % **ACCEPTABLE**
 Fellenius / Petterson : Utilization = 105.2 % **NOT ACCEPTABLE**
 Spencer : Utilization = 83.0 % **ACCEPTABLE**
 Janbu : Utilization = 82.8 % **ACCEPTABLE**
 Morgenstern-Price : Utilization = 82.8 % **ACCEPTABLE**

Combination 2

Bishop : Utilization = 76.1 % **ACCEPTABLE**
 Fellenius / Petterson : Utilization = 96.0 % **ACCEPTABLE**
 Spencer : Utilization = 76.4 % **ACCEPTABLE**
 Janbu : Utilization = 76.2 % **ACCEPTABLE**
 Morgenstern-Price : Utilization = 76.2 % **ACCEPTABLE**

Slope stability analysis

Input data

Project

Task : Section O-O' Slope Stability
 Description : Slope at 1v:5h with 1m deep re-engineering of backfill beneath
 Customer : Newlands Developments
 Author : Adam Perks
 Date : 15/06/2020
 Project ID : Hoyland Common, Barnsley
 Project number : AG3080-19

Settings

United Kingdom - EN 1997

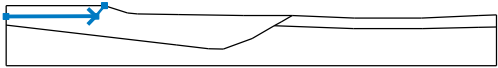
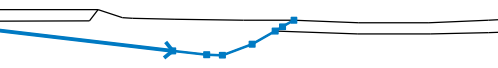
Stability analysis

Earthquake analysis : Standard
 Verification methodology : according to EN 1997
 Design approach : 1 - reduction of actions and soil parameters

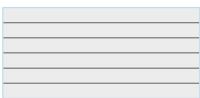
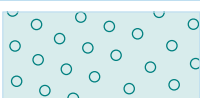
Partial factors on actions (A)					
Permanent design situation					
		Combination 1		Combination 2	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions :	$\gamma_G =$	1.35 [-]	1.00 [-]	1.00 [-]	1.00 [-]
Variable actions :	$\gamma_Q =$	1.50 [-]	0.00 [-]	1.30 [-]	0.00 [-]
Water load :	$\gamma_w =$	1.35 [-]		1.00 [-]	

Partial factors for soil parameters (M)			
Permanent design situation			
		Combination 1	Combination 2
Partial factor on internal friction :	$\gamma_\phi =$	1.00 [-]	1.25 [-]
Partial factor on effective cohesion :	$\gamma_c =$	1.00 [-]	1.25 [-]
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00 [-]	1.40 [-]

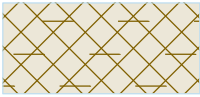
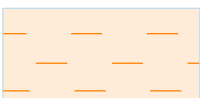
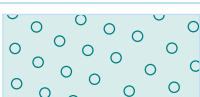
Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		0.00	9.93	27.13	10.00	29.67	13.25
2		0.00	13.25	29.67	13.25	36.67	11.00
		39.67	10.77	51.88	10.50	71.73	10.27
		86.33	10.25	105.10	9.50	125.39	9.49
		142.67	10.25	148.00	10.48		
3		0.00	7.32	51.30	1.34	61.10	0.21
		65.60	0.07	74.23	3.27	80.88	7.11
		83.03	8.34	86.33	10.25		
4		80.88	7.11	104.79	6.29	125.73	6.29
		142.67	6.66	148.00	6.78		

Soil parameters - effective stress state

No.	Name	Pattern	Φ_{ef} [°]	C_{ef} [kPa]	γ [kN/m ³]
1	Made Ground - Opencast Backfill		19.00	0.00	18.00
2	Engineered Fill		24.00	0.00	20.50
3	Coal Measures CLAY		20.00	3.00	20.50
4	Coal Measures Siltstone / Mudstone / Sandstone		30.00	5.00	21.00
5	COAL		25.00	5.00	13.00
6	M1 construction		38.50	0.00	21.00

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m ³]	γ_s [kN/m ³]	n [—]
1	Made Ground - Opencast Backfill		20.00		
2	Engineered Fill		20.50		
3	Coal Measures CLAY		20.50		
4	Coal Measures Siltstone / Mudstone / Sandstone		21.00		
5	COAL		13.00		
6	M1 construction		21.00		

Soil parameters
Made Ground - Opencast Backfill

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
 Stress-state : effective

Angle of internal friction : $\phi_{ef} = 19.00^\circ$
Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 20.00 \text{ kN/m}^3$

Engineered Fill

Unit weight : $\gamma = 20.50 \text{ kN/m}^3$
Stress-state : effective
Angle of internal friction : $\phi_{ef} = 24.00^\circ$
Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 20.50 \text{ kN/m}^3$

Coal Measures CLAY

Unit weight : $\gamma = 20.50 \text{ kN/m}^3$
Stress-state : effective
Angle of internal friction : $\phi_{ef} = 20.00^\circ$
Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 20.50 \text{ kN/m}^3$

Coal Measures Siltstone / Mudstone / Sandstone

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
Stress-state : effective
Angle of internal friction : $\phi_{ef} = 30.00^\circ$
Cohesion of soil : $c_{ef} = 5.00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 21.00 \text{ kN/m}^3$

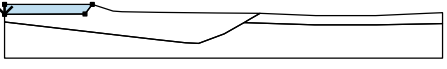
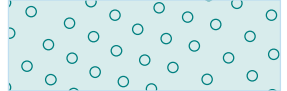
COAL

Unit weight : $\gamma = 13.00 \text{ kN/m}^3$
Stress-state : effective
Angle of internal friction : $\phi_{ef} = 25.00^\circ$
Cohesion of soil : $c_{ef} = 5.00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 13.00 \text{ kN/m}^3$

M1 construction

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
Stress-state : effective
Angle of internal friction : $\phi_{ef} = 38.50^\circ$
Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 21.00 \text{ kN/m}^3$

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		0.00	13.25	0.00	9.93	M1 construction
		27.13	10.00	29.67	13.25	
						

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
2		104.79	6.29	125.73	6.29	Coal Measures CLAY
		142.67	6.66	148.00	6.78	
		148.00	10.48	142.67	10.25	
		125.39	9.49	105.10	9.50	
		86.33	10.25	83.03	8.34	
		80.88	7.11			
3		51.30	1.34	61.10	0.21	Made Ground - Opencast Backfill
		65.60	0.07	74.23	3.27	
		80.88	7.11	83.03	8.34	
		86.33	10.25	71.73	10.27	
		51.88	10.50	39.67	10.77	
		36.67	11.00	29.67	13.25	
		27.13	10.00	0.00	9.93	
		0.00	7.32			
4		142.67	6.66	125.73	6.29	Coal Measures Siltstone / Mudstone / Sandstone
		104.79	6.29	80.88	7.11	
		74.23	3.27	65.60	0.07	
		61.10	0.21	51.30	1.34	
		0.00	7.32	0.00	-4.93	
		148.00	-4.93	148.00	6.78	

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	4.55	90.29	5.30	131.92	5.07
		142.67	5.30	148.00	5.41		

Settings of the stage of construction

Design situation : permanent

Input data (Stage of construction 2)

Earth cut

No.	Cut location	Coordinates of cut points [m]					
		x	z	x	z	x	z
1		39.67	10.77	39.67	9.77	71.73	9.27
		84.61	9.26	86.33	10.25		

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	4.55	90.29	5.30	131.92	5.07
		142.67	5.30	148.00	5.41		

Settings of the stage of construction

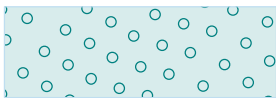
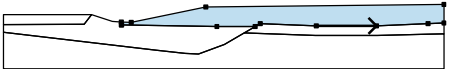
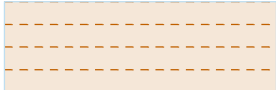
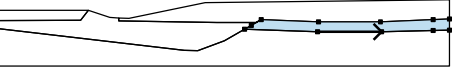
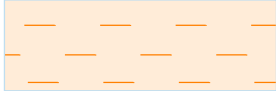
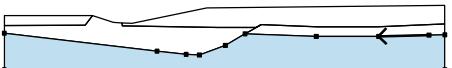
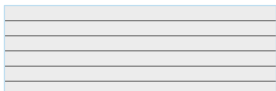
Design situation : permanent

Input data (Stage of construction 3)

Embankment interface

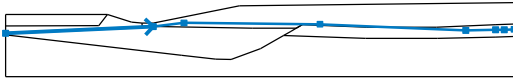
No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		39.67	10.77	42.98	10.70	68.00	15.79
		148.00	16.70				

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		27.13	10.00	29.67	13.25	M1 construction 
		0.00	13.25	0.00	9.93	
2		105.10	9.50	125.39	9.49	Engineered Fill 
		142.67	10.25	148.00	10.48	
		148.00	16.70	68.00	15.79	
		42.98	10.70	39.67	10.77	
		39.67	9.77	39.72	9.77	
		71.73	9.27	84.61	9.26	
		86.33	10.25			
3		104.79	6.29	125.73	6.29	Coal Measures CLAY 
		142.67	6.66	148.00	6.78	
		148.00	10.48	142.67	10.25	
		125.39	9.49	105.10	9.50	
		86.33	10.25	83.03	8.34	
		80.88	7.11			
4		51.30	1.34	61.10	0.21	Made Ground - Opencast Backfill 
		65.60	0.07	74.23	3.27	
		80.88	7.11	83.03	8.34	
		86.33	10.25	84.61	9.26	
		71.73	9.27	39.72	9.77	
		39.67	9.77	39.67	10.77	
		36.67	11.00	29.67	13.25	
		27.13	10.00	0.00	9.93	
		0.00	7.32			
5		142.67	6.66	125.73	6.29	Coal Measures Siltstone / Mudstone / Sandstone 
		104.79	6.29	80.88	7.11	
		74.23	3.27	65.60	0.07	
		61.10	0.21	51.30	1.34	
		0.00	7.32	0.00	-4.93	
		148.00	-4.93	148.00	6.78	

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	7.75	42.96	9.71	51.89	10.78
		91.47	10.40	133.94	8.62	142.56	8.76
		145.10	8.76	148.00	8.91		

Settings of the stage of construction

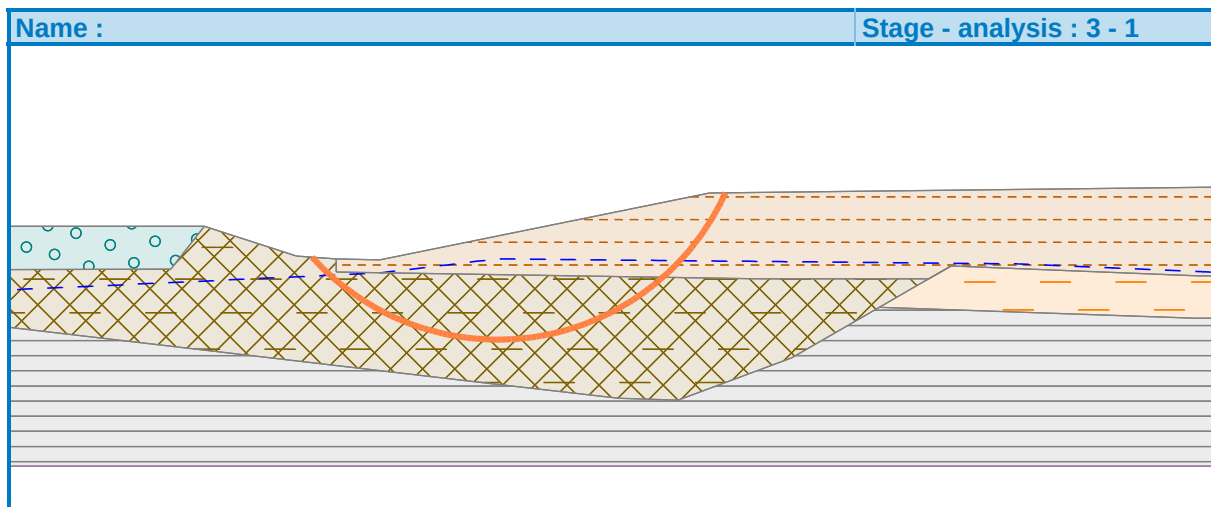
Design situation : permanent

Results (Stage of construction 3)

Analysis 1 (stage 3)

Circular slip surface

Slip surface parameters					
Center :	x =	51.93 [m]	Angles :	$\alpha_1 =$	-47.90 [°]
	z =	23.62 [m]		$\alpha_2 =$	65.65 [°]
Radius :	R =	18.96 [m]			
Slip surface first determined via optimization with Bishop then without optimization with all methods.					



Slope stability verification (all methods)

Combination 1

Bishop : Utilization = 74.3 % **ACCEPTABLE**
 Fellenius / Petterson : Utilization = 91.8 % **ACCEPTABLE**
 Spencer : Utilization = 74.3 % **ACCEPTABLE**
 Janbu : Utilization = 74.1 % **ACCEPTABLE**
 Morgenstern-Price : Utilization = 74.1 % **ACCEPTABLE**

Combination 2

Bishop : Utilization = 63.7 % **ACCEPTABLE**
 Fellenius / Petterson : Utilization = 78.4 % **ACCEPTABLE**
 Spencer : Utilization = 63.9 % **ACCEPTABLE**
 Janbu : Utilization = 63.7 % **ACCEPTABLE**
 Morgenstern-Price : Utilization = 63.7 % **ACCEPTABLE**

Slope stability analysis

Input data

Project

Task : Section P-P' Slope Stability
 Author : Fiona Connor
 Date : 15/06/2020
 Project ID : Hoyland Common, Barnsley
 Project number : AG3080-19

Settings

United Kingdom - EN 1997

Stability analysis

Earthquake analysis : Standard
 Verification methodology : according to EN 1997
 Design approach : 1 - reduction of actions and soil parameters

Partial factors on actions (A)					
Permanent design situation					
		Combination 1		Combination 2	
		Unfavourable	Favourable	Unfavourable	Favourable
Permanent actions :	$\gamma_G =$	1.35 [-]	1.00 [-]	1.00 [-]	1.00 [-]
Variable actions :	$\gamma_Q =$	1.50 [-]	0.00 [-]	1.30 [-]	0.00 [-]
Water load :	$\gamma_w =$	1.35 [-]		1.00 [-]	

Partial factors for soil parameters (M)			
Permanent design situation			
		Combination 1	Combination 2
Partial factor on internal friction :	$\gamma_\phi =$	1.00 [-]	1.25 [-]
Partial factor on effective cohesion :	$\gamma_c =$	1.00 [-]	1.25 [-]
Partial factor on undrained shear strength :	$\gamma_{cu} =$	1.00 [-]	1.40 [-]

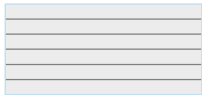
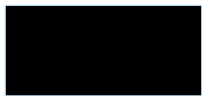
Interface

No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		0.00	0.11	26.56	0.55	68.52	1.24
		96.31	1.42	105.76	1.49	111.36	1.41
		136.44	1.10				
2		96.31	1.42	100.81	-0.08	111.36	1.41
3		0.00	-1.00	16.54	-0.78	31.11	-0.72
		52.96	-0.78	58.36	-0.50	90.76	-0.22
		100.81	-0.18	116.86	-0.16	136.44	-0.47

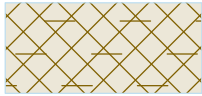
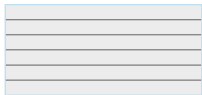
Soil parameters - effective stress state

No.	Name	Pattern	Φ_{ef} [°]	C_{ef} [kPa]	γ [kN/m ³]
1	Made Ground - Opencast Backfill		15.00	0.00	18.00
2	Engineered Fill		24.00	0.00	20.50

APPLIED GEOLOGY	Applied Geology Fiona Connor Section P-P' Slope Stability	Hoyland Common, Barnsley AG3080-19
----------------------------	---	---------------------------------------

No.	Name	Pattern	ϕ_{ef} [°]	c_{ef} [kPa]	γ [kN/m³]
3	Coal Measures CLAY		20.00	3.00	20.50
4	Coal Measures Siltstone / Mudstone / Sandstone		30.00	5.00	21.00
5	COAL		25.00	5.00	13.00

Soil parameters - uplift

No.	Name	Pattern	γ_{sat} [kN/m³]	γ_s [kN/m³]	n [–]
1	Made Ground - Opencast Backfill		20.00		
2	Engineered Fill		20.50		
3	Coal Measures CLAY		20.50		
4	Coal Measures Siltstone / Mudstone / Sandstone		21.00		
5	COAL		13.00		

Soil parameters

Made Ground - Opencast Backfill

Unit weight : $\gamma = 18.00 \text{ kN/m}^3$
Stress-state : effective
Angle of internal friction : $\phi_{ef} = 15.00^\circ$
Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 20.00 \text{ kN/m}^3$

Engineered Fill

Unit weight : $\gamma = 20.50 \text{ kN/m}^3$
Stress-state : effective
Angle of internal friction : $\phi_{ef} = 24.00^\circ$
Cohesion of soil : $c_{ef} = 0.00 \text{ kPa}$
Saturated unit weight : $\gamma_{sat} = 20.50 \text{ kN/m}^3$

Coal Measures CLAY

Unit weight : $\gamma = 20.50 \text{ kN/m}^3$
Stress-state : effective
Angle of internal friction : $\phi_{ef} = 20.00^\circ$

Cohesion of soil : $c_{ef} = 3.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 20.50 \text{ kN/m}^3$

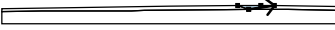
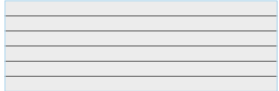
Coal Measures Siltstone / Mudstone / Sandstone

Unit weight : $\gamma = 21.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 30.00^\circ$
 Cohesion of soil : $c_{ef} = 5.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 21.00 \text{ kN/m}^3$

COAL

Unit weight : $\gamma = 13.00 \text{ kN/m}^3$
 Stress-state : effective
 Angle of internal friction : $\varphi_{ef} = 25.00^\circ$
 Cohesion of soil : $c_{ef} = 5.00 \text{ kPa}$
 Saturated unit weight : $\gamma_{sat} = 13.00 \text{ kN/m}^3$

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		100.81	-0.08	111.36	1.41	Made Ground - Opencast Backfill 
		105.76	1.49	96.31	1.42	
2		16.54	-0.78	31.11	-0.72	Coal Measures CLAY 
		52.96	-0.78	58.36	-0.50	
		90.76	-0.22	100.81	-0.18	
		116.86	-0.16	136.44	-0.47	
		136.44	1.10	111.36	1.41	
		100.81	-0.08	96.31	1.42	
		68.52	1.24	26.56	0.55	
		0.00	0.11	0.00	-1.00	
3		116.86	-0.16	100.81	-0.18	Coal Measures Siltstone / Mudstone / Sandstone 
		90.76	-0.22	58.36	-0.50	
		52.96	-0.78	31.11	-0.72	
		16.54	-0.78	0.00	-1.00	
		0.00	-6.00	136.44	-6.00	
		136.44	-0.47			

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	-1.64	16.67	-1.51	44.22	-1.55
		101.52	-1.53	136.44	-1.53		

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

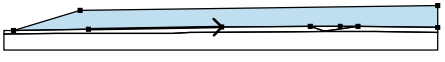
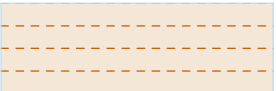
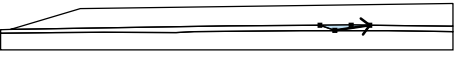
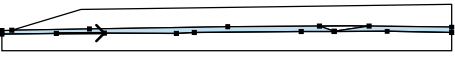
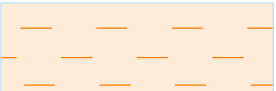
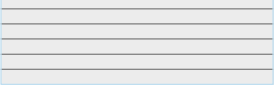
Settings of the stage of construction

Design situation : permanent

Input data (Stage of construction 2)**Embankment interface**

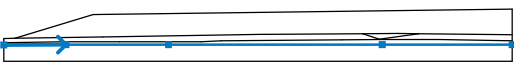
No.	Interface location	Coordinates of interface points [m]					
		x	z	x	z	x	z
1		3.01	0.16	24.01	6.50	136.44	8.00

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		26.56	0.55	68.52	1.24	Engineered Fill 
		96.31	1.42	105.76	1.49	
		111.36	1.41	136.44	1.10	
		136.44	8.00	24.01	6.50	
		3.01	0.16			
2		100.81	-0.08	111.36	1.41	Made Ground - Opencast Backfill 
		105.76	1.49	96.31	1.42	
3		16.54	-0.78	31.11	-0.72	Coal Measures CLAY 
		52.96	-0.78	58.36	-0.50	
		90.76	-0.22	100.81	-0.18	
		116.86	-0.16	136.44	-0.47	
		136.44	1.10	111.36	1.41	
		100.81	-0.08	96.31	1.42	
		68.52	1.24	26.56	0.55	
		3.01	0.16	0.00	0.11	
4		0.00	-1.00			Coal Measures Siltstone / Mudstone / Sandstone 
		116.86	-0.16	100.81	-0.18	
		90.76	-0.22	58.36	-0.50	
		52.96	-0.78	31.11	-0.72	
		16.54	-0.78	0.00	-1.00	
		0.00	-6.00	136.44	-6.00	
		136.44	-0.47			

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	-1.64	16.67	-1.51	44.22	-1.55
		101.52	-1.53	136.44	-1.53		

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Input data (Stage of construction 3)

Assigning and surfaces

No.	Surface position	Coordinates of surface points [m]				Assigned soil
		x	z	x	z	
1		26.56	0.55	68.52	1.24	Engineered Fill
		96.31	1.42	105.76	1.49	
		111.36	1.41	136.44	1.10	
		136.44	8.00	24.01	6.50	
		3.01	0.16			
2		100.81	-0.08	111.36	1.41	Made Ground - Opencast Backfill
		105.76	1.49	96.31	1.42	
3		16.54	-0.78	31.11	-0.72	Coal Measures CLAY
		52.96	-0.78	58.36	-0.50	
		90.76	-0.22	100.81	-0.18	
		116.86	-0.16	136.44	-0.47	
		136.44	1.10	111.36	1.41	
		100.81	-0.08	96.31	1.42	
		68.52	1.24	26.56	0.55	
		3.01	0.16	0.00	0.11	
4		0.00	-1.00			Coal Measures Siltstone / Mudstone / Sandstone
		116.86	-0.16	100.81	-0.18	
		90.76	-0.22	58.36	-0.50	
		52.96	-0.78	31.11	-0.72	
		16.54	-0.78	0.00	-1.00	
		0.00	-6.00	136.44	-6.00	
		136.44	-0.47			

Water

Water type : GWT

No.	GWT location	Coordinates of GWT points [m]					
		x	z	x	z	x	z
1		0.00	-1.64	16.67	-1.51	44.22	-1.55
		101.52	-1.53	136.44	-1.53		

Tensile crack

Tensile crack not input.

Earthquake

Earthquake not included.

Settings of the stage of construction

Design situation : permanent

Results (Stage of construction 3)

Analysis 1 (stage 3)

Circular slip surface

APPLIED GEOLOGY	Applied Geology	Hoyland Common, Barnsley
	Fiona Connor	AG3080-19
	Section P-P' Slope Stability	

Slip surface parameters							
Center :	x =	6.20	[m]	Angles :	α_1 =	-7.06	[°]
	z =	37.17	[m]		α_2 =	34.85	[°]
Radius :	R =	37.31	[m]				
Analysis of the slip surface without optimization.							

Slope stability verification (all methods)

Combination 1

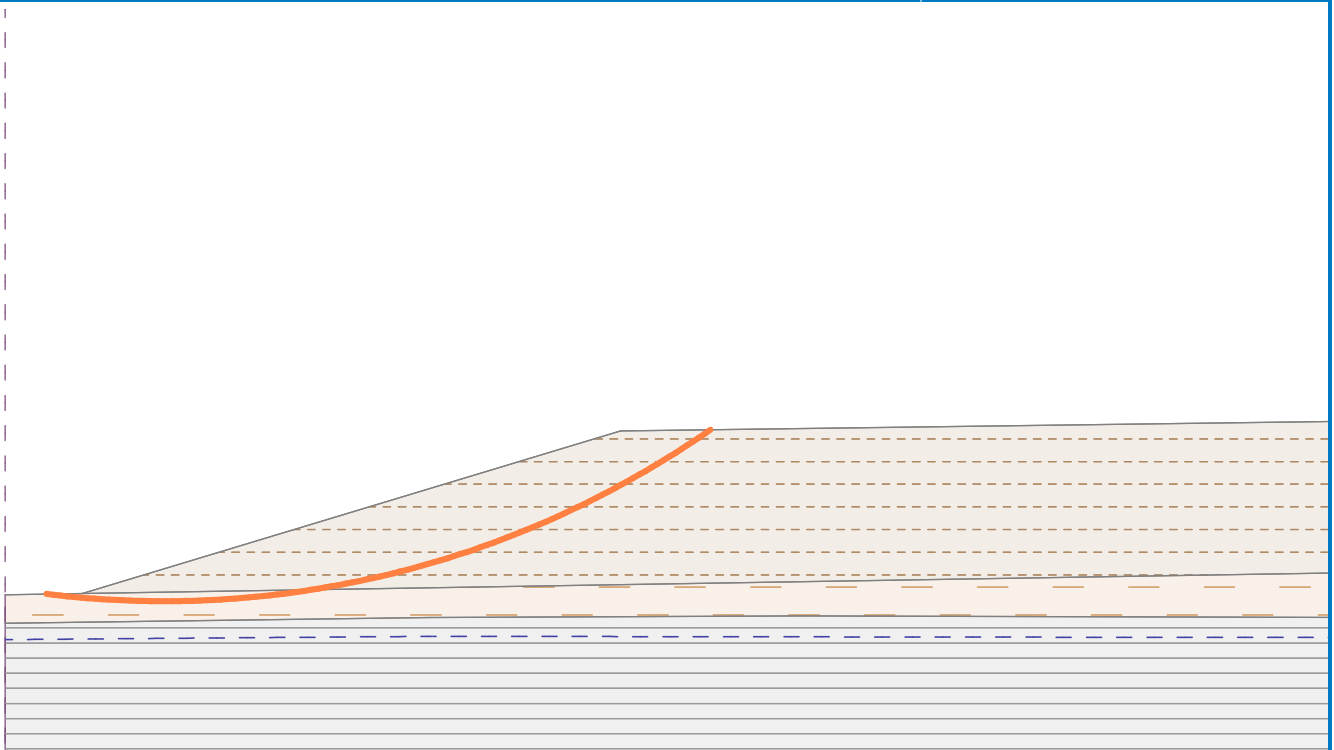
Bishop : Utilization = 61.7 % **ACCEPTABLE**
 Fellenius / Petterson : Utilization = 63.6 % **ACCEPTABLE**
 Spencer : Utilization = 61.9 % **ACCEPTABLE**
 Janbu : Utilization = 61.9 % **ACCEPTABLE**
 Morgenstern-Price : Utilization = 61.9 % **ACCEPTABLE**

Combination 2

Bishop : Utilization = 72.7 % **ACCEPTABLE**
 Fellenius / Petterson : Utilization = 74.9 % **ACCEPTABLE**
 Spencer : Utilization = 72.9 % **ACCEPTABLE**
 Janbu : Utilization = 72.9 % **ACCEPTABLE**
 Morgenstern-Price : Utilization = 73.0 % **ACCEPTABLE**

Name :

Stage - analysis : 3 - 1



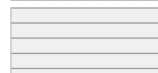
Engineered Fill



Coal Measures CLAY



Made Ground - Opencast Backfill

Coal Measures Siltstone / Mudstone /
Sandstone

Analysis of the slip surface without optimization.

Slope stability verification (all methods)**Combination 1**

Bishop : Utilization = 61.7 % **ACCEPTABLE**
Fellenius / Petterson : Utilization = 63.6 % **ACCEPTABLE**
Spencer : Utilization = 61.9 % **ACCEPTABLE**
Janbu : Utilization = 61.9 % **ACCEPTABLE**
Morgenstern-Price : Utilization = 61.9 % **ACCEPTABLE**

Combination 2

Bishop : Utilization = 72.7 % **ACCEPTABLE**
Fellenius / Petterson : Utilization = 74.9 % **ACCEPTABLE**
Spencer : Utilization = 72.9 % **ACCEPTABLE**
Janbu : Utilization = 72.9 % **ACCEPTABLE**
Morgenstern-Price : Utilization = 73.0 % **ACCEPTABLE**

ANNEX IV

Summary of relevant soil parameters from Applied Geology GIR

- Uncorrected plasticity index ranged from 18% to 38% with an average of 24%;
- Liquid limits ranged from 36% to 65%;
- Plastic limits ranged from 18% to 26%;
- Moisture contents ranged from 8% to 28%;
- Fines content ranged from 22% to 88%;
- SPT N ranged from 4 to 26 with average around 12 (ignoring high values due to likely obstructions);
- No UT100s were recovered – QUDs on undisturbed weathered coal measures clay gave shear strengths of 40 and 52 kN/m² on two samples.

AG Small Shear Box Test

- Undertaken on recompacted weathered coal measures clay at optimum mc and using 2.5kg rammer. Confining pressures of 50, 100 & 200 kN/m² used;
- ϕ'_p was 24.5° based on straight line (some cohesion indicated);
- ϕ'_r was 19.5° based on straight line (some cohesion indicated).

AG CPT results

The interpreted friction angle values displayed on the CPT plots are based on the Kulhawy and Mayne (1990) method, which is intended for use with granular soils. This method is also sensitive to larger grain size particles (such as coarse gravel and cobble sized coal measure rock fragments present in the Opencast Backfill), which increase tip resistance and artificially raise friction angle. The granular material in the Opencast Backfill is considered to be present as discrete pockets and 'lumps', which are not contiguous and are chaotically distributed. Hence the CPT interpreted values, that are often >30°, are not considered to represent the materials as a whole and little reliance is drawn from these values.

Other Sources and Publications

In the process of determining the design friction angle for the Made Ground-Opencast Backfill a series of published works and sources were reviewed to provide context. Whilst none of the materials in the published sources can be a direct analogue to the materials on this site, their properties have provided a useful framework.

No.	Source / Publication	Range of friction angle values	Notes / Description
1	BS8002:2015	For PI = 24%, ϕ'_{cv} is c. 25° For PI = 38%, ϕ'_{cv} is c. 22.5°	Gives values for ϕ'_{cv} based on plasticity - values for natural undisturbed clays.
2	BRE: FB75 Building on Fill	For a cohesive fill, ϕ'_{cv} is stated as being between 20° and 30° (Table 5).	p44 suggests for non-engineered fills ϕ'_{cv} is appropriate. For a granular fill, ϕ'_{cv} is stated as being close to the angle of repose.
3	Clarke, BG: Engineering Properties of Glacial Tills, 2018	15° to 40° overall and generally in range 15° to 30° for the relevant range of PI.	From Fig 16.
4	Sorenson & Okkels: Correlation between drained shear strength and plasticity index of undisturbed overconsolidated clays, 2013	Suggests ϕ'_{nc} lower bound = 20° to 25° for PI in range 20-40%.	Values are for normally consolidated reconstituted clays. A similar range is also quoted for over consolidated clays. The values are valid for soils with <80% fines. Also states that a 'mobilised' angle of shearing resistance, which is lower than estimated peak values, may be applicable.
5	Stard & Eid, Slope stability analyses in stiff fissured clays, 1997	Quotes various residual friction angles as follows: Lias Clay failures – 14.5°; Carsington Dam failure – 12°; London Clay failures – 14.2°.	Reports differences between 'fully softened' friction angle and residual friction angle is in the range 4 – 8° for the relevant range of liquid limits (40-60%).
6	R K Taylor, Composition and engineering properties of British colliery discards, NCBs, 1983	<u>Triaxial & shear box</u> Coarse discards: ϕ' in the range 22.5-38.5°; Fine discards: 19-50° but with outliers: 16°, 53° & 60°; Tailings: 19-43° with outliers of 16° and 46°. <u>Section 4.9 'shear strengths at large deformations (failures)'</u> : Coarse discard material at Aberfan - ϕ'_p of 39.5° dropped to 17.5-18.5° for failed slope; Littleton Tip - ϕ'_r of 20.5°; Askern Colliery shear tests (0-400kN/m ² pressures) ϕ'_r : 18-22°; Other values of ϕ'_r are quoted as 26.6°, 18.3° & 26.6°.	In summary, ϕ'_r ranged from 9° to 37° with an average of 17.5° for UK discards based on 31 tests.

Discussion

Up to approximately one quarter of the materials are predominantly granular and many of the clay 'lumps' and pockets encountered were of firm through to stiff consistency suggesting that peak or near peak values of friction angle may be valid locally. It is also likely that some of the materials have experienced greater strain and softening and residual strength parameters are more appropriate. When assessing an averaged global design value for the Opencast Backfill peak values of friction angle of say $>20^\circ$ are not considered appropriate due to the disturbance to the original soil structure and the likelihood that a significant proportion of the clays would be strain and / or water softened to some degree. Fully residual values are considered to be too conservative given the expected beneficial effects of the granular proportion and firm to stiff, peak or near peak, clays.

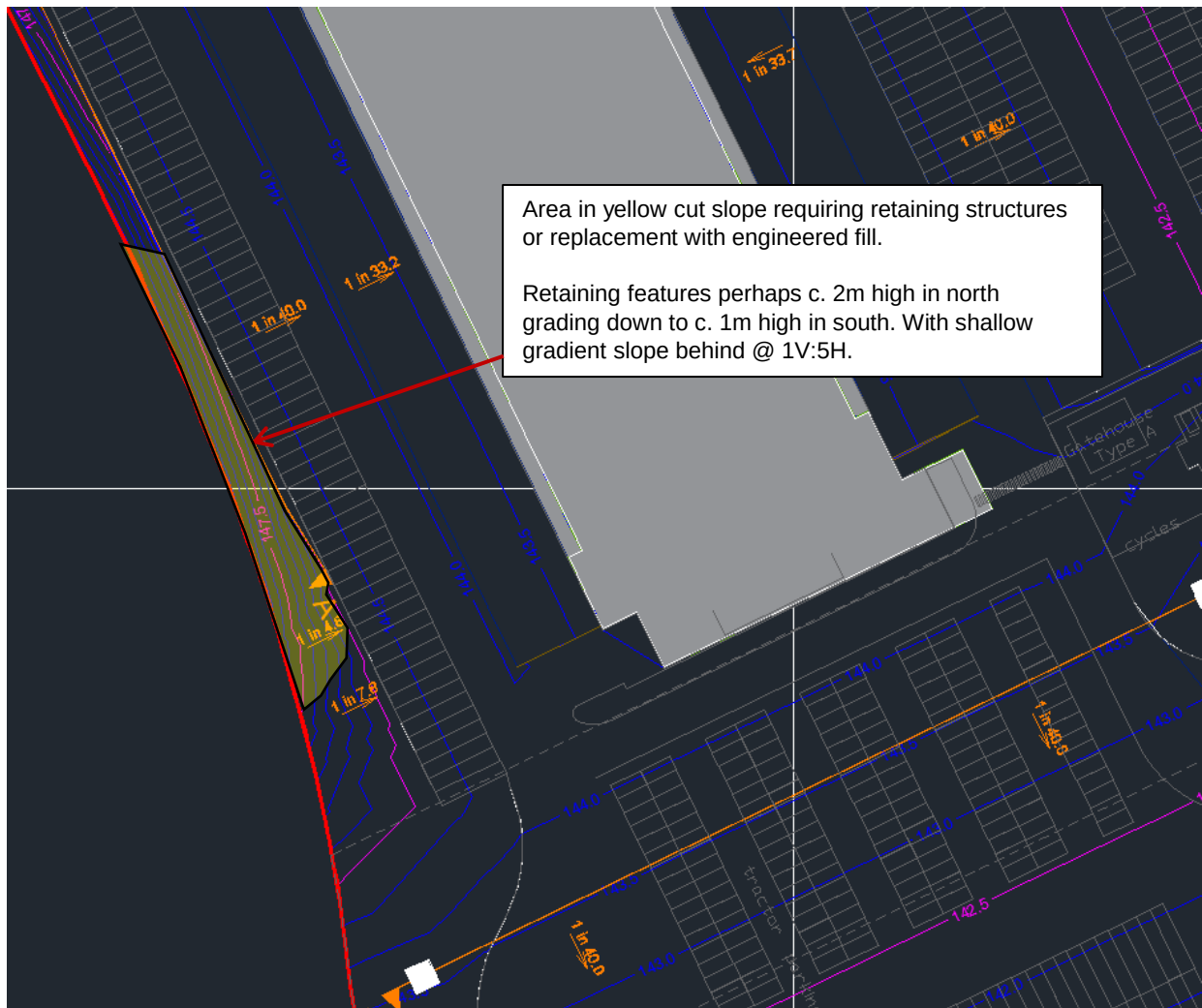
In conclusion, from study of the laboratory tested properties of the Made Ground-Opencast Backfill, together with context from published values for other similar (but not identical) Made Ground fills, 'mobilised' or strain softened friction angles are considered most appropriate. Such values are considered to fall within the range of $>15^\circ$ and $<20^\circ$. Hence, a design value of 19° has been chosen with 17° also considered as part of sensitivity checks.

Plot	Section Line	Post cut/fill slope geometry and geology	Undrained Stability (% optimisation)
Plot 1	E-E'	16m long slope at 5.5m high at a gradient of 1v:3h. Upper slope is Coal Measures clay and lower slope is rock.	Shallow slip in clay – 6.8% (Cu: 60) Deeper slip through rock – 6.1% (Ci: 300)
	F-F'	35m long slope at 3m high at a total gradient of 1v:11.5h. Slip circle analysed consists of 'mini slope' at slightly steeper gradient near foot of slope comprising 7.5m long slope 0.9m high at a gradient of 1v:8h. whole slope comprises Opencast Backfill overlying Coal Measures rock.	13.2% (Cu: 30, 50, 40)
	O-O'	17.5m long slope at 5m high at a gradient of 1v:3.5h. Slope is an engineered fill embankment on top of Opencast Backfill with top 1m re-engineered.	64.8% (Cu: 30, 50, 40)
	P-P'	21m long slope at 6.5m high at a gradient of 1v:3.2h. Slope is an engineered fill embankment on to natural Coal Measures clay then rock.	19.8%
	Q-Q'	22m long slope at 6.5m high at a gradient of 1v:3.4h. Slope is an engineered fill embankment on to natural Coal Measures clay then rock.	24.7%
	R-R'	15.5m long cut slope at 5.25m high at a gradient of 1v:3h. c. ¾ of slope is formed of cut Opencast Backfill with the bottom c. ¼ made up of a coal seam and CM clay then rock. Long term slope at 1v:3h gradient is not stable and retaining wall or re-engineering required.	28.0% (Cu: 30, 50, 40)
Plot 1 / Plot 2 Boundary	T-T'	23m long slope at 5.7m high at a gradient of 1v:4h. Slope crest is Engineered Fill and rest of slope is cut Opencast Backfill on top of further backfill materials. No surcharge as east of slope toe is the no build zone of Plot 2.	63.5% (Cu: 30, 50, 40)
Plot 2	J-J'	27m long slope at 9m high at a gradient of 1v:3h. Engineered embankment with underlying Opencast Backfill removed and re-engineered. Surcharge mound on top of embankment, surcharge 6m high 3m from embankment crest at 1v:2.5h gradient.	Before addition of surcharge – 46.1% (Cu: 30, 50, 40) After addition of surcharge – 84.7% (Cu: 30, 50, 40)
	K-K'	80m long slope at 13m high at a gradient of 1v:4.5h. Engineered embankment with underlying Opencast Backfill removed and re-engineered. Surcharge mound on top of embankment, surcharge 6.7m high 3m from embankment crest at 1v:2.5h gradient.	Before addition of surcharge – 43.1% (Cu: 30, 50, 40) 67.8% (Cu: 40, 70, 50) After addition of surcharge – 103.9% (Cu: 30, 50, 40) 86.3% (Cu: 40, 70, 50)
	L-L'	Design Option 1 – 1v:5h slope and 1m re-engineer Opencast beneath slope: Engineered fill embankment on Opencast Backfill. 28m long slope at 9.5m high. Surcharge mound on top of embankment, surcharge 7m high 3m from embankment crest at 1v:2.5h gradient.	Before addition of surcharge – 70.8% (Cu: 30, 50, 40) 58.9% (Cu: 40, 70, 50) After addition of surcharge – 102.8% (Cu: 30, 50, 40) 85.9% (Cu: 40, 70, 50)
		Design Option 2 – 1v:4h slope and half depth shear key: Engineered fill embankment on Opencast Backfill. 38m long slope at 9.5m high. Engineered fill embankment over half depth shear key and then Opencast Backfill. Surcharge mound on top of embankment, surcharge 7m high 3m from embankment crest at 1v:2.5h gradient.	Before addition of surcharge – 84.5% (Cu: 30, 50, 40) 68.6% (Cu: 40, 70, 50) After addition of surcharge – 112.8% (Cu: 30, 50, 40) 92.7% (Cu: 40, 70, 50)

Plot	Section Line	Post cut/fill slope geometry and geology	Undrained Stability (% optimisation)
Plot 2 continued	M-M'	40m long slope at 7m high at a gradient of 1v:h. Engineered embankment with underlying Opencast Backfill removed and re-engineered. Surcharge mound on top of embankment, surcharge 7.6m high 3m from embankment crest at 1v:2.5h gradient.	Before addition of surcharge – 60.7% (Cu: 30, 50, 40) 53.5% (Cu: 40, 70, 50) After addition of surcharge – 110.5% (Cu: 30, 50, 40) 91.4% (Cu: 40, 70, 50)
	S-S'	Design Option 1 – 1v:5h slope and 1m re-engineer Opencast beneath slope: Engineered fill embankment on Opencast Backfill. 46m long slope at 9.2m high. Surcharge mound on top of embankment, surcharge 7.6m high 3m from embankment crest at 1v:2.5h gradient.	Before addition of surcharge – 75.6% (Cu: 30, 50, 40) 62.3% (Cu: 40, 70, 50) After addition of surcharge – 105.3% (Cu: 30, 50, 40) 88.4% (Cu: 40, 70, 50)
		Design Option 2 – 1v:4h slope and half depth shear key: Engineered fill embankment on Opencast Backfill. 36.8m long slope at 9.2m high. Engineered fill embankment over half depth shear key and then Opencast Backfill. Surcharge mound on top of embankment, surcharge 7.6m high 3m from embankment crest at 1v:2.5h gradient.	Before addition of surcharge – 83.2% (Cu: 30, 50, 40) 68.8% (Cu: 40, 70, 50) After addition of surcharge – 111.7% (Cu: 30, 50, 40) 93.1% (Cu: 40, 70, 50)
Pond	North Slope	Upper slope: 19m long slope at 6.3m high at gradient of 1v:3h. Upper slope comprises cut Opencast Backfill which has been removed and re-engineered in first 6-10m laterally of slope face. Lower slope at 1v:4h in rock.	30.6% (Cu: 30, 50, 40)
	East Slope	23m long slope at 5.5m high at gradient of 1v:4h. Slope comprises cut Opencast Backfill which has been removed and re-engineered in first 5-17m laterally of slope face. Rock present beneath slope.	20.6% (Cu: 30, 50, 40)
	West Slope	Upper slope: 25m long slope at 6.5m high at gradient of 1v:3.6h. Upper slope comprises cut Opencast Backfill which has been removed and re-engineered in first 5-10m laterally of slope face. Lower slope at 1v:6.75h in rock.	17.7% (Cu: 30, 50, 40)

Notes:

All slopes stable in short term condition. Values of utilisation of >100% for SE embankment slope in Plot 2 are based on worst case undrained shear strength parameters for the Opencast Backfill as per the values noted above. When allowing for some improvement of these parameters (as shown) utilisation falls below 100%. Pore pressures will need to be monitored and rate of filling controlled to maintain short term stability of slopes, in particular with the SE embankment slope of Plot 2.



Approximate co-ordinates for northern extent of area: 435249.316, 3996563962

Approximate co-ordinates for southern extent of area: 435285.603, 399569.566

Approximately 95m long section from northwest to southeast.