SMITH WILLIAMS CONSULTANTS, INC.

SCANNED

Appendix C.6.2

AGOSA Foundation Settlement Calculations

SWC
SMITH WILLIAMS CONSULTANTS, INC.

Project: CC&V Phase 5 VLF	Job No. 1125
Calculation Title: AGOSA Foundation Settlement	
Prepared By: JFL	Date: March 3, 2008
Checked By: DTW	Date: March 14, 2008

OBJECTIVE:

Assess the settlement and potential strain of geomembrane along the AGOSA slope as the Phase 5 VLF is loaded to 10,320 ft elevation (590 ft).

METHOD:

Use PLAXIS, a two-dimensional finite element program to assess stress and strains under the 590 ft ore height.

Apply the model to a cross-section that cuts through the AGOSA slope, where the ore height reaches 590 feet. This section is to also include the relocated Carlton Mill tailings which are beneath the AGOSA (see Figure 1).

ASSUMPTIONS:

- Since the focus of the analysis is the strain and deformation of the AGOSA overburden slope.
- Given the scale of the model, the geomembrane liner on the AGOSA slope cannot be modeled explicitly; however the liner strains can be estimated using the strains along the slope surface of interest (e.g. the geomembrane liner does not contribute to the strength).
- The overburden was modeled as a strain-hardening material with a friction angle of 32 degrees with zero cohesion. The unit weight of the ore was set to 125 pcf, which considered typical for the overburden materials. The strain-hardening model used in Plaxis takes the form of:

$$E = E^{ref}(\sigma / P^{ref})^m$$

Where E^{ref} is the initial (reference) elastic modulus, which was set at 824,000 psf. The reference pressure (P^{ref}) was set at 100 psf, and the power constant (m) was set to 0.50. The strain-hardening parameters were derived from an earlier deformation analysis conducted on the SGOSA. The modulus used agrees well with typical values for coarse-grained rockfill as presented in Hunter and Fell (2003) and Bowles (1982).

- The bedrock is modeled as a Mohr-Coulomb material with a friction angle of 40 degrees and zero cohesion. The unit weight of the bedrock is 140 pounds per cubic foot.
- The ore over the liner was modelled as a linear-elastic material with a density of 118 pcf (dry ore plus field capacity moisture content), a friction angle of 40 degrees, and no cohesion.

SMITH WILLIAMS CONSULTANTS, INC.

Project: CC&V Phase 5 VLF	Job No. 1125
Calculation Title: AGOSA Foundation Settlement	
Prepared By: JFL	Date: March 3, 2008
Checked By: DTW	Date:March 14, 2008

CALCULATIONS:

A finite element mesh was constructed for the section of interest. A medium-size mesh was used for the ore above the AGOSA and bedrock, since deformations of these materials are not critical to this analysis. The finite element mesh was refined for the AGOSA material to an maximum element size of approximately 20 feet.

The model was first used to calculate the initial conditions, with the current AGOSA, without ore. Then the ore height was sequentially increased until an elevation of 10,320 (e.g. 590 feet of ore) was reached. The model output report is attached, which includes the finite element mesh, material distribution, and basic results.

In order to assess the deformation and strain along the AGOSA slope, calculation points were placed within the model along the slope. These points were used to monitor the stresses and strains along the AGOSA slope boundary, where the VLF liner system will be located.

CONCLUSIONS:

The PLAXIS model results report is attached to this calculation sheet. In order to assess the potential strain and deformation in the VLF liner system, calculation points were added to the model along the AGOSA slope (see model output). Total displacements are used to determine the settlement of the AGOSA foundation under future loading conditions. Shear strains are used to assess movement along the AGOSA slope that may impact the liner system. Shear strains reflect extension of the geomembrane liner by settlement (in two dimensions).

Based on the model output, the total settlement of the AGOSA foundation is anticipated to settle approximately 1 feet due to the 590 ft ore loading. Data from the model and the calculation points show that after the VLF is loaded to 590 feet with ore, the global strain on the AGOSA liner system will be less than 5 %, which is acceptable for the VLF liner systems.

References

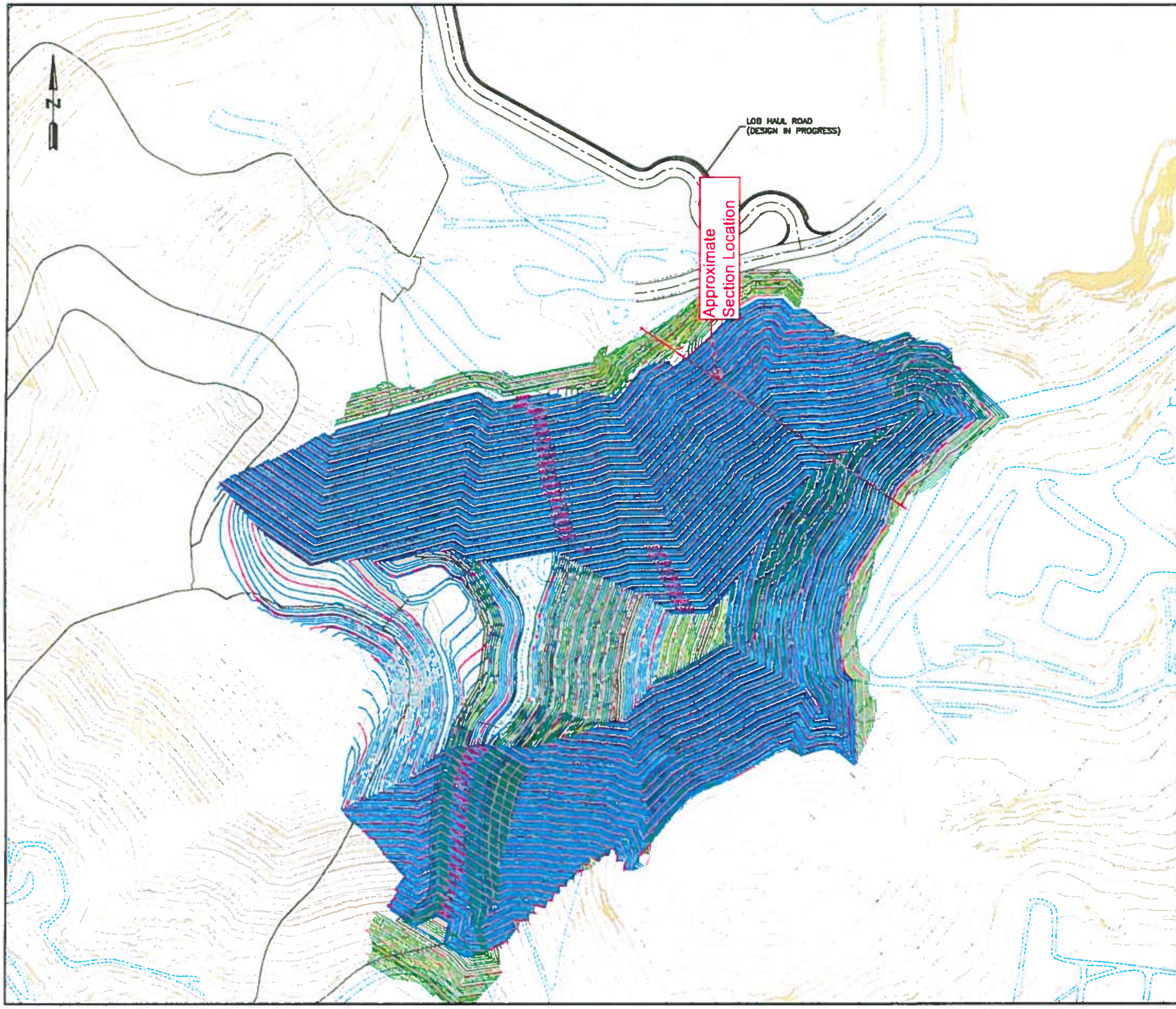
Bowles, J.E. 1982. *Foundation Analysis and Design*. Third Edition. New York: McGraw-Hill Book Company. 816 pp.

Hunter, G. and R. Fell, 2003. Rockfill Modulus and Settlement of Concrete Face Rockfill Dams, J. Geotech. And Geoenv. Vol. 129, No. 10. ASCE.

SMITH WILLIAMS CONSULTANTS, INC.

Project: CC&V Phase 5 VLF	Job No. 1125
Calculation Title: AGOSA Foundation Settlement	
Prepared By: JFL	Date: March 3, 2008
Checked By: DTW	Date: March 14, 2008

Figure 1 Plan



LEGEND:

- 5000 EXISTING GROUND SURFACE CONTOUR AND EL. FEET
- 5000 PROPOSED GROUND SURFACE CONTOUR AND EL. FEET
- 5000 PROPOSED GROUND SURFACE CONTOUR AND EL. FEET
- EXISTING DRAINAGES
- EXISTING ROAD

250 0 250 500

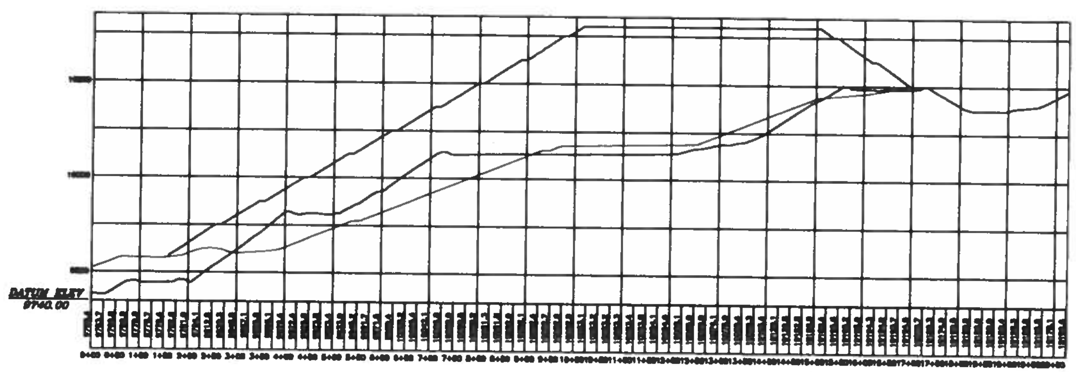
CLIENT	CRIPPLE CREEK AND VICTOR GOLD MINING COMPANY
PROJECT	PHASE 5 VLF
TITLE	AREQUA PHASE 5 110 MILLION TON VLF

SWC SMITH WILLIAMS CONSULTANTS, INC.

DESIGNED BY	BTW	CHECKED BY	JFL	DATE
DRAWN BY	BTW	APPROVED BY	JFL	10/97
FILENAME	1125F54	FIGURE No. 1		REV A

Figure 2 Section

Northeast Corner



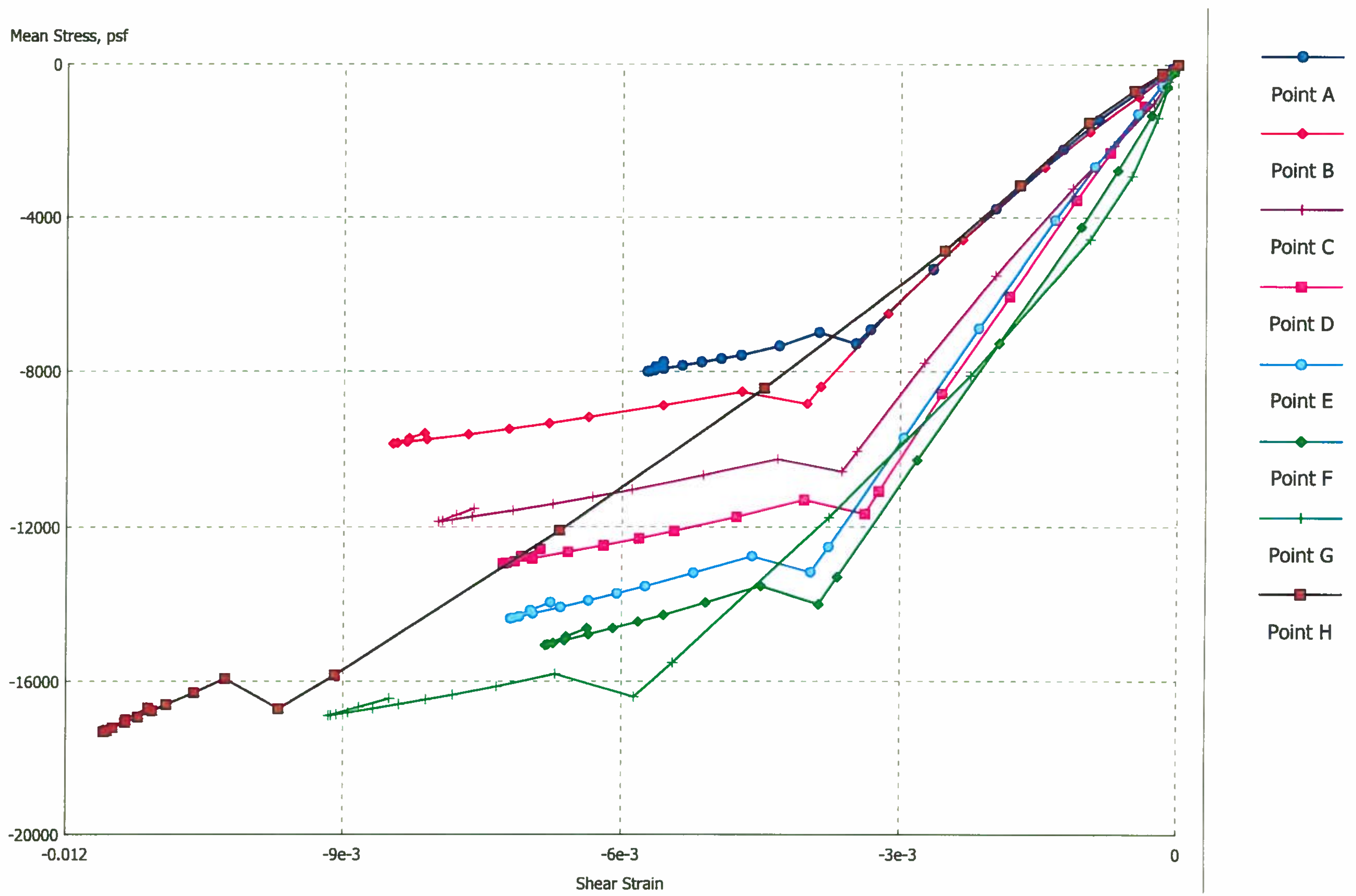
Red – Regraded/Liner Surface
White – Existing Ground
Green – Ore Surface

SMITH WILLIAMS CONSULTANTS, INC.

Project: CC&V Phase 5 VLF	Job No. 1125
Calculation Title: AGOSA Foundation Settlement	
Prepared By: JFL	Date: March 3, 2008
Checked By: DTW	Date: March 14, 2008

Figure 3 Shear Strain Plot

Plaxis 8.6



PLAXIS
Finite Element Code for Soil and Rock Analyses
Version 8.6.0.565

Project description		
AGOSA Slope		
Project name: AGOSA Slope.PLX	Date: 03/03/08	User name:

SMITH WILLIAMS CONSULTANTS, INC.

Project: CC&V Phase 5 VLF	Job No. 1125
Calculation Title: AGOSA Foundation Settlement	
Prepared By: JFL	Date: March 3, 2008
Checked By: DTW	Date: March 14, 2008

Plaxis Output

REPORT

03/03/2008

User: Smith Williams Consultants

Title: AGOSA Slope

Table of Contents

1. General Information

Table [1] units

Type	Unit
Length	ft
Force	lb
Time	day

Table [2] Model dimensions

	min.	max.
X	0.000	1700.000
Y	9560.951	10320.000

Table [3] Model

Model	Plane Strain
Element	15-Noded

2. Geometry

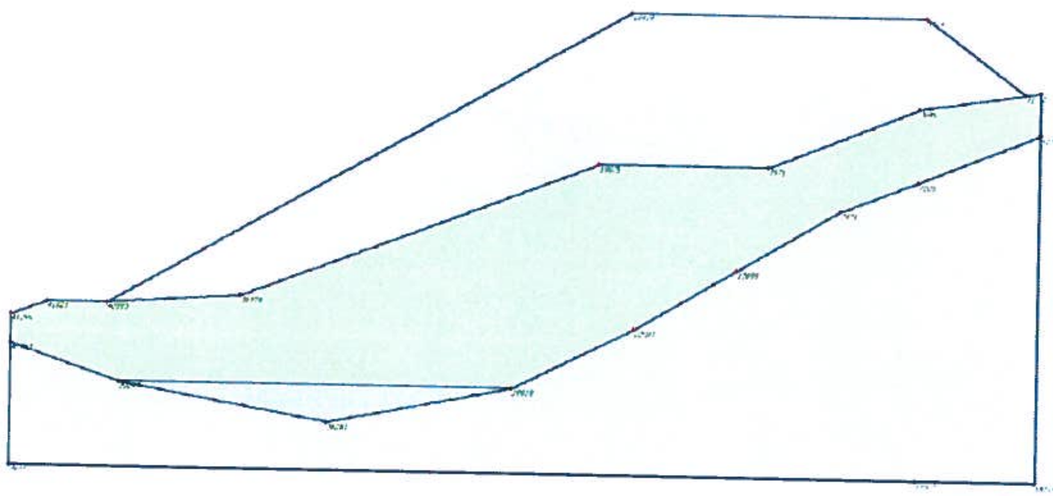


Fig. 1 Plot of geometry model with significant nodes

3. Mesh data

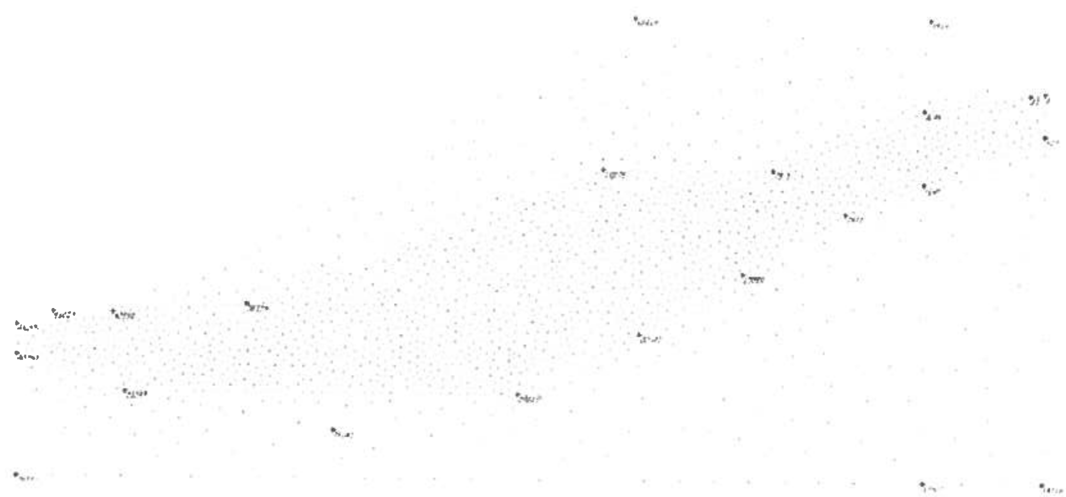


Fig. 2 Plot of the mesh with significant nodes

4. Material data

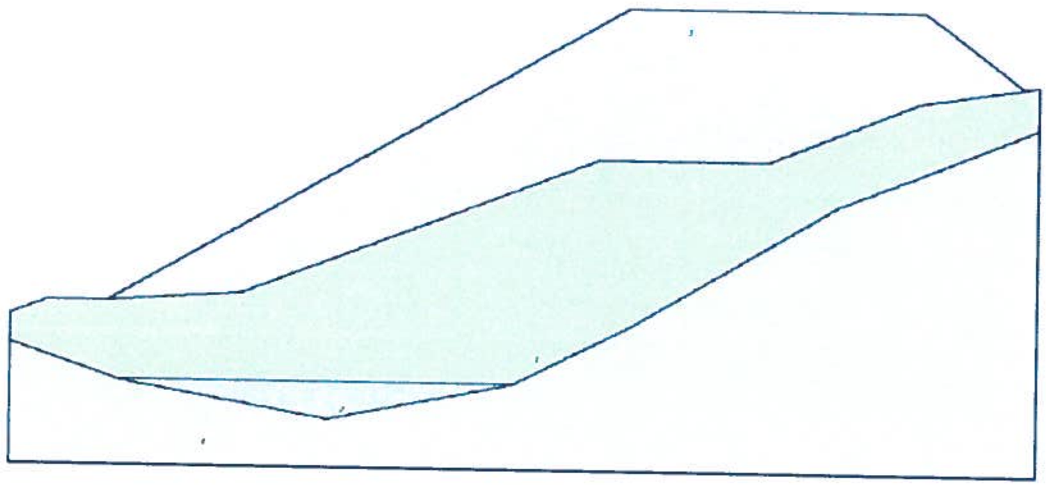


Fig. 3 Plot of geometry with material data sets

Table [4] Soil data sets parameters

Linear Elastic		**5 stiff ore**
Type		Drained
γ_{unsat}	[lb/ft³]	118.00
γ_{sat}	[lb/ft³]	118.00
k_x	[ft/day]	3.281
k_y	[ft/day]	3.281
e_{init}	[-]	0.500
c_k	[-]	1E15
E_{ref}	[lb/ft²]	600000.00
ν	[-]	0.200
G_{ref}	[lb/ft²]	250000.000
E_{oed}	[lb/ft²]	666666.667
E_{incr}	[lb/ft²/ft]	0.00
y_{ref}	[ft]	0.000
R_{inter}	[-]	0.670
Interface permeability		Neutral

Mohr-Coulomb		2 Consolidated Tailings	3 Bedrock	4 Bedrock
Type		Drained	Drained	Drained
γ_{unsat}	[lb/ft³]	108.00	140.00	140.00
γ_{sat}	[lb/ft³]	130.00	140.00	140.00
k_x	[ft/day]	1.640	1.640	1.640
k_y	[ft/day]	1.640	1.640	1.640
e_{init}	[-]	1.000	0.500	0.500
c_k	[-]	1E15	1E15	1E15
E_{ref}	[lb/ft²]	700000.000	2000000000.000	2000000000.000
ν	[-]	0.300	0.250	0.250
G_{ref}	[lb/ft²]	269230.769	800000000.000	800000000.000
E_{oed}	[lb/ft²]	942307.692	2400000000.000	2400000000.000
c_{ref}	[lb/ft²]	0.00	0.00	0.00
φ	[°]	29.00	40.00	40.00
ψ	[°]	3.00	3.00	3.00
E_{inc}	[lb/ft²/ft]	0.00	0.00	0.00
y_{ref}	[ft]	0.000	0.000	0.000
$c_{increment}$	[lb/ft²/ft]	0.00	0.00	0.00
$T_{str.}$	[lb/ft²]	0.00	0.00	0.00
$R_{inter.}$	[-]	0.70	1.00	1.00
Interface permeability		Neutral	Neutral	Neutral

Hardening Soil		1 Overburden	6 rockfill
Type		Drained	Drained
γ_{unsat}	[lb/ft³]	125.00	118.00
γ_{sat}	[lb/ft³]	125.00	118.00
k_x	[ft/day]	3.281	3.281
k_y	[ft/day]	3.281	3.281
e_{init}	[-]	0.50	0.50
e_{min}	[-]	0.00	0.00
e_{max}	[-]	999.00	999.00
c_k	[-]	1E15	1E15
E_{50}^{ref}	[lb/ft²]	1000000.00	130000.00
E_{oed}^{ref}	[lb/ft²]	823745.91	130000.00
power (m)	[-]	0.50	0.32
c_{ref}	[lb/ft²]	0.00	0.00
φ	[°]	32.00	32.00
ψ	[°]	2.00	2.00
E_{ur}^{ref}	[lb/ft²]	4000000.00	461538.46
$\nu_{ur}^{(nu)}$	[-]	0.200	0.200
p^{ref}	[lb/ft²]	100.00	100.00
$c_{increment}$	[lb/ft²]	0.00	0.00
y_{ref}	[ft]	0.00	0.00
R_f	[-]	0.90	0.90
$T_{str.}$	[lb/ft²]	0.00	0.00
R_{inter}	[-]	0.67	0.67
δ_{inter}	[ft]	0.00	0.00
Interface permeability		Neutral	Neutral

5. Results for phase 1

5.1. Deformations

5.1.1. Plot of total displacements

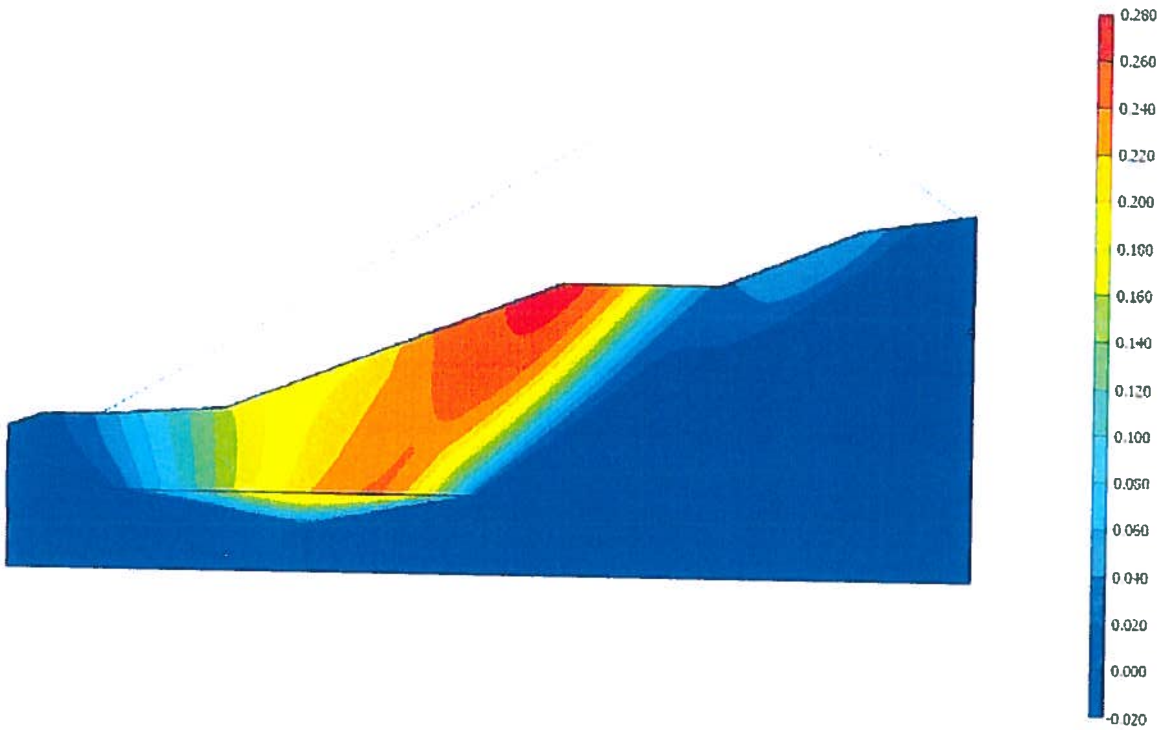


Fig. 4 Plot of total displacements (shadings)
- Step no: 11 - (Phase: 1)

5.1.2. Plot of horizontal displacements

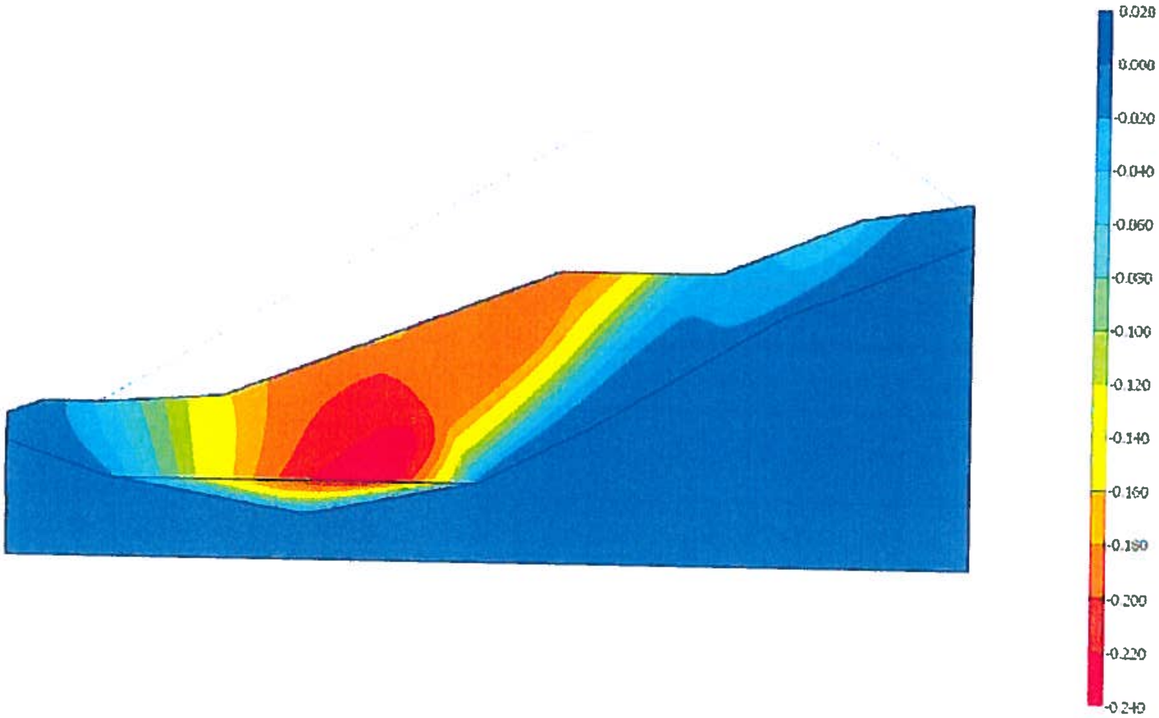


Fig. 5 Plot of horizontal displacements (shadings)
- Step no: 11 - (Phase: 1)

5.1.3. Plot of vertical displacements

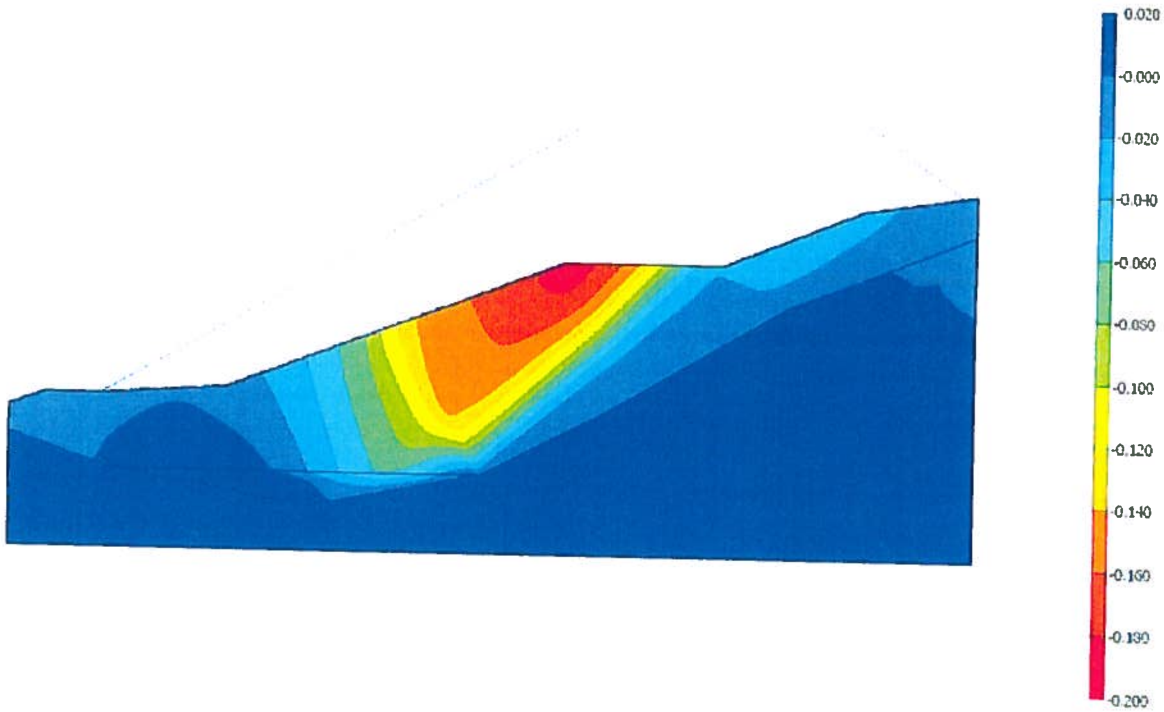


Fig. 6 Plot of vertical displacements (shadings)
- Step no: 11 - (Phase: 1)

5.1.4. Plot of total strains

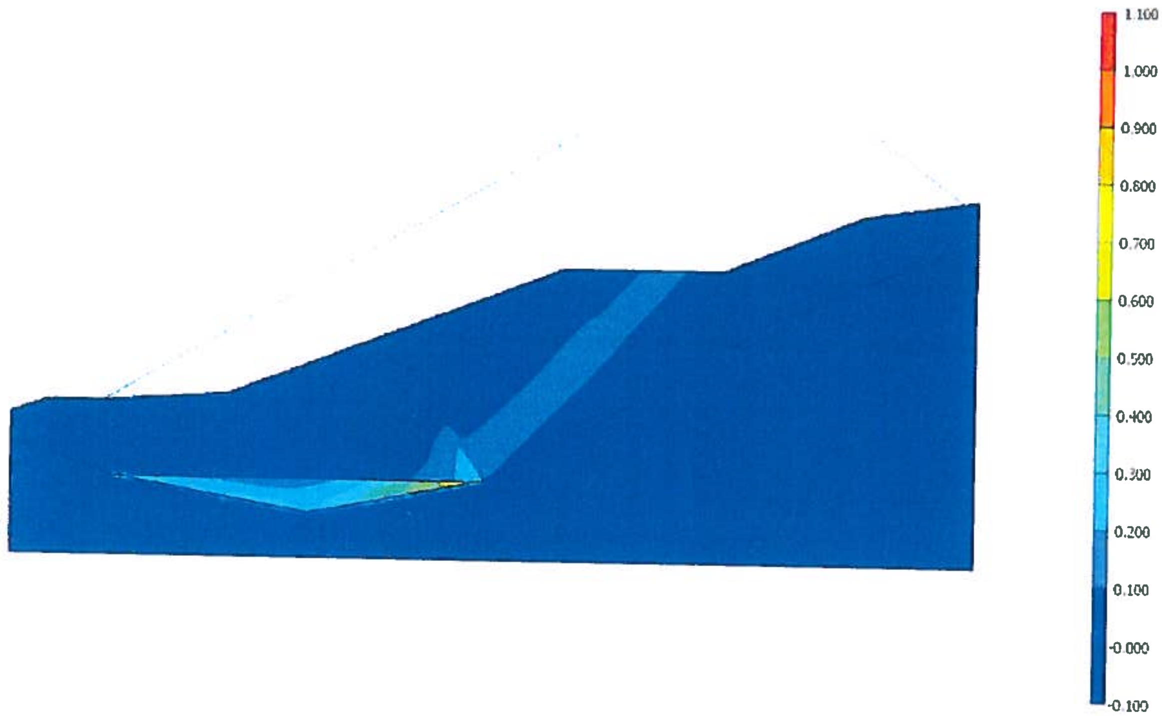


Fig. 7 Plot of total strains (shear shadings)
- Step no: 11 - (Phase: 1)

5.2. Stresses

5.2.5. Plot of effective stresses

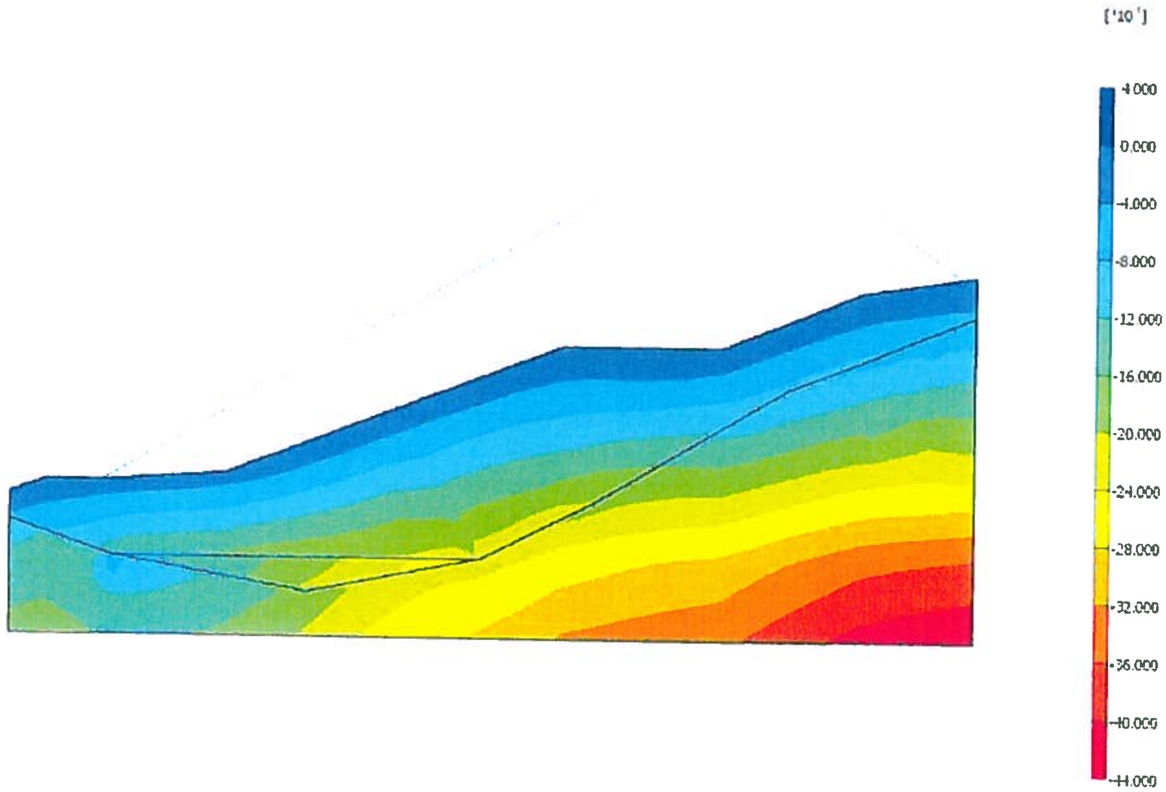


Fig. 8 Plot of effective stresses (mean shadings)
- Step no: 11 - (Phase: 1)

6. Results for phase 2

6.3. Deformations

6.3.6. Plot of total displacements

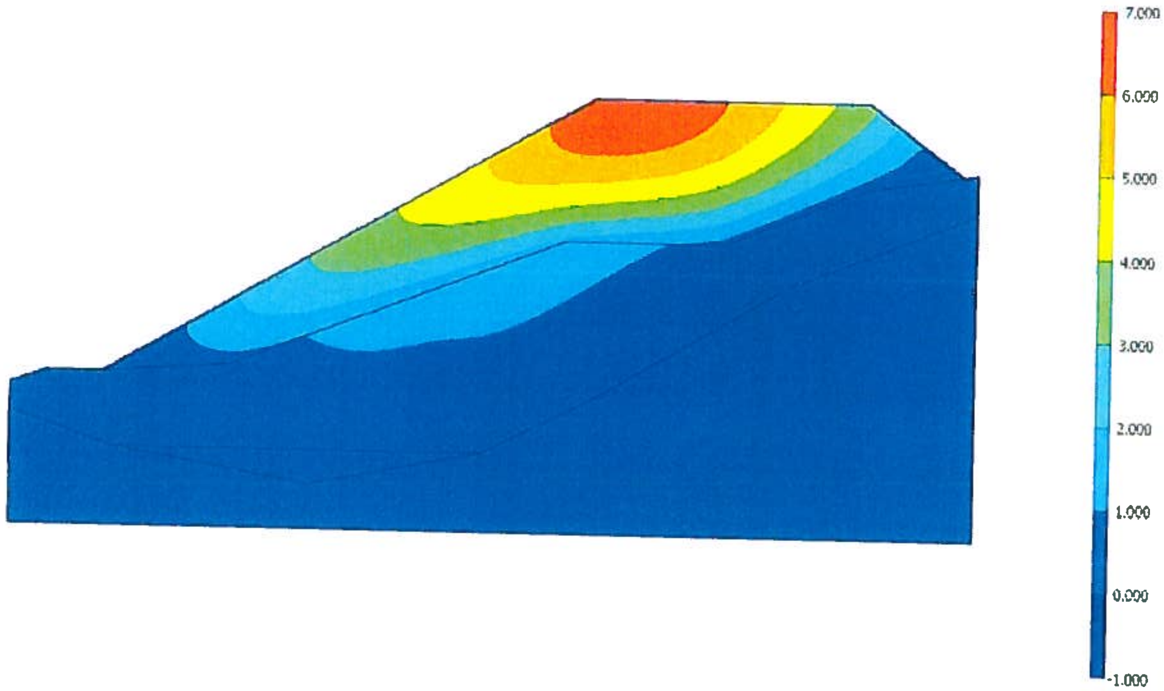


Fig. 9 Plot of total displacements (shadings)
- Step no: 18 - (Phase: 2)

6.3.7. Plot of horizontal displacements

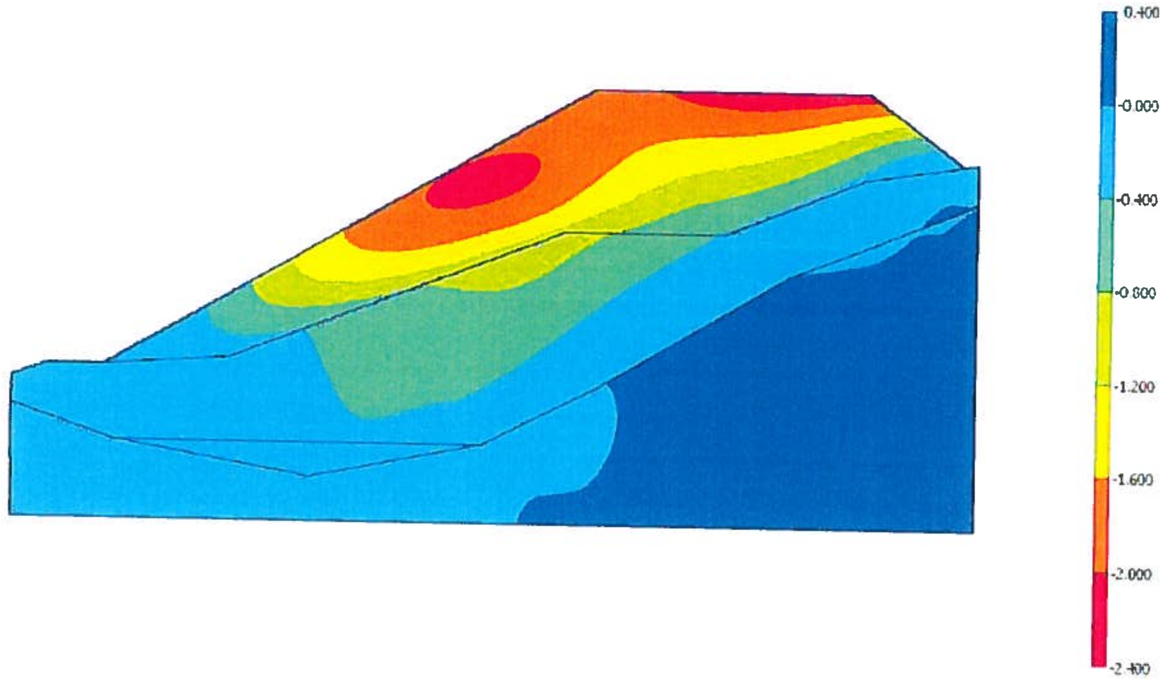


Fig. 10 Plot of horizontal displacements (shadings)
- Step no: 18 - (Phase: 2)

6.3.8. Plot of vertical displacements

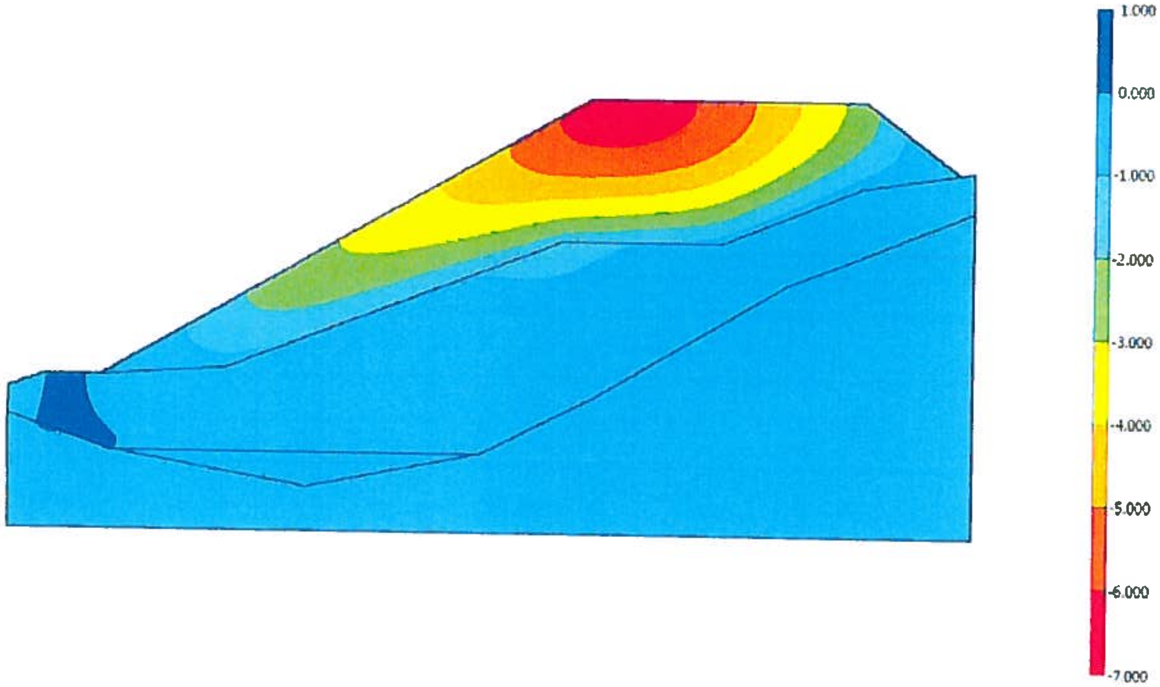


Fig. 11 Plot of vertical displacements (shadings)
- Step no: 18 - (Phase: 2)

6.3.9. Plot of total strains

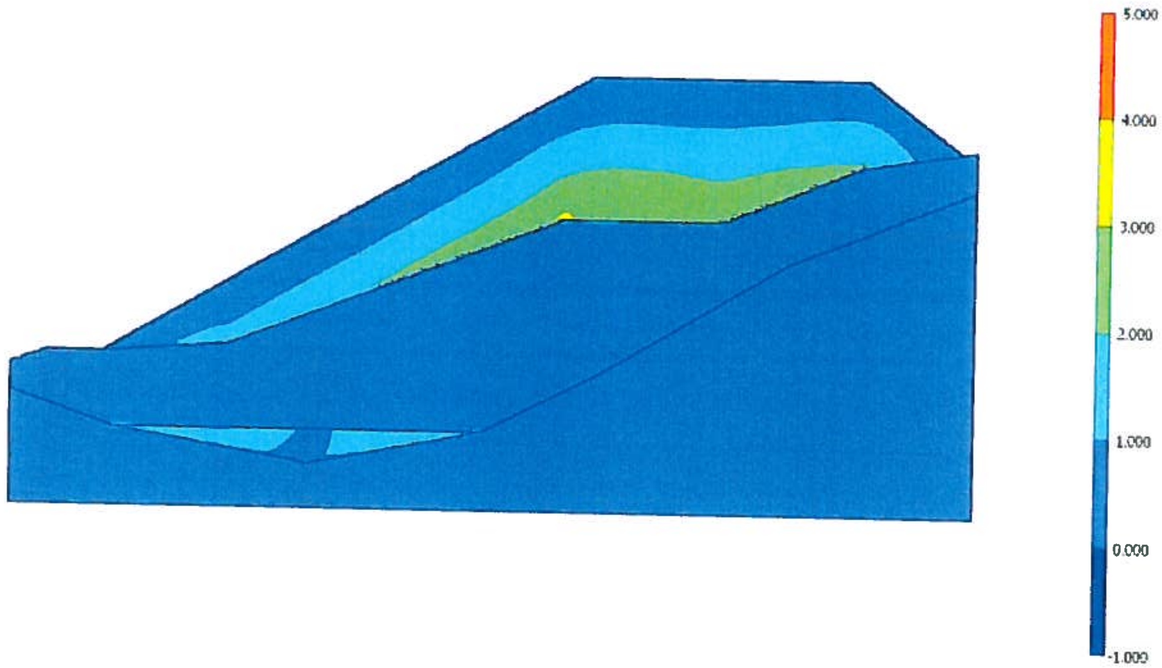


Fig. 12 Plot of total strains (shear shadings)
- Step no: 18 - (Phase: 2)

6.4. Stresses

6.4.10. Plot of effective stresses

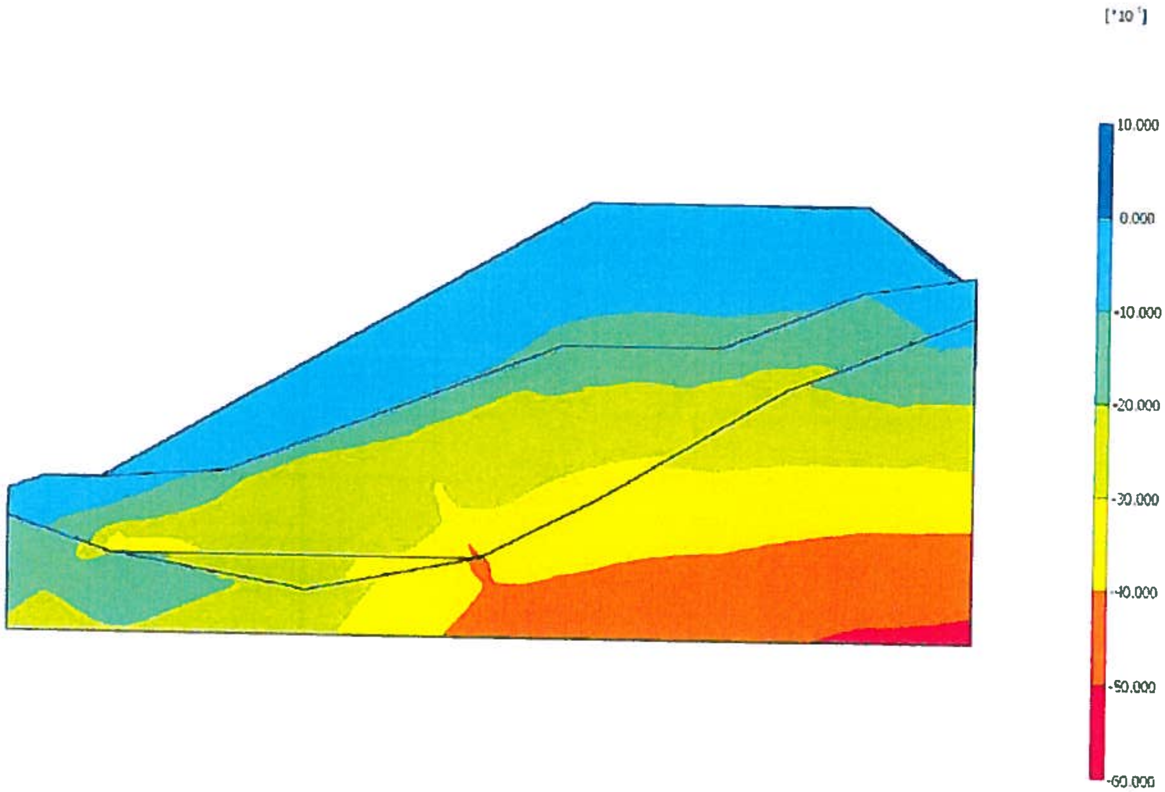
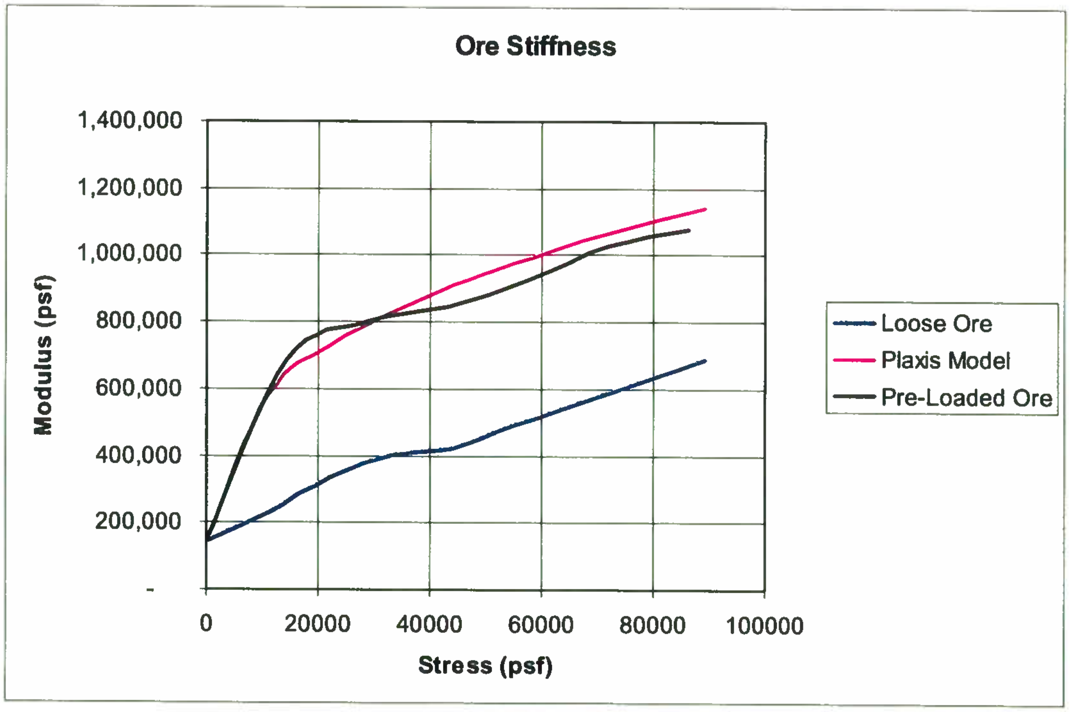


Fig. 13 Plot of effective stresses (mean shadings)
- Step no: 18 - (Phase: 2)

Project: CC&V Phase 5 VLF	Job No. 1125
Calculation Title: Phase Iv a Ore Slope Settlement	
Prepared By: JFL	Date: February 29 2008
Checked By: DTW	Date: March 14 2008



Ore Compressibility Curve

- The bedrock is modeled as a Mohr-Coulomb material with a friction angle of 40 degrees and zero cohesion. The unit weight of the bedrock is 140 pounds per cubic foot.

CALCULATIONS:

A finite element mesh was constructed for the section of interest. A medium-size mesh was used for the ore above the Phase IVa 9770 bench and bedrock, since deformations of these materials are not critical to this analysis. Within the Phase IVa ore, the finite element mesh was refined to an maximum element size of approximately 20 feet.

The model was first used to calculate the initial conditions, with the current Phase IVa ore slope. Then the ore height was sequentially increased until an elevation of 10,320 (e.g. 590 feet of ore) was reached. The model output report is attached, which includes the finite element mesh, material distribution, and basic results.