APPENDIX 3. GRAPHS

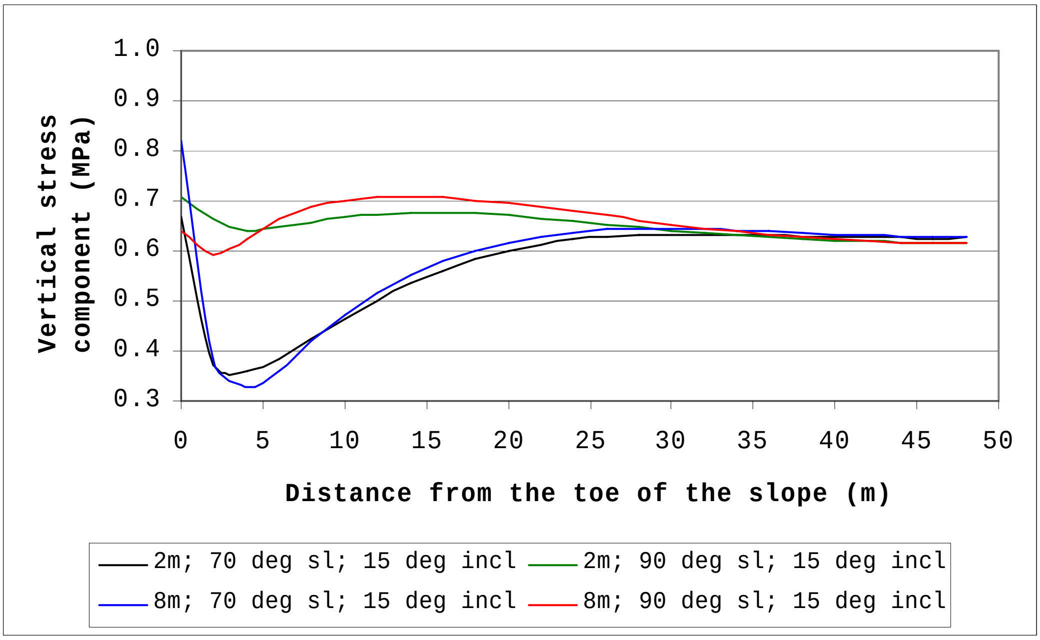


Figure A3.1

Vertical stress component along profile line with 2m- and 8m-thick shale layer and 70^0 and 90^0 slope angle, in the undulated strata formation with 15^0 inclination

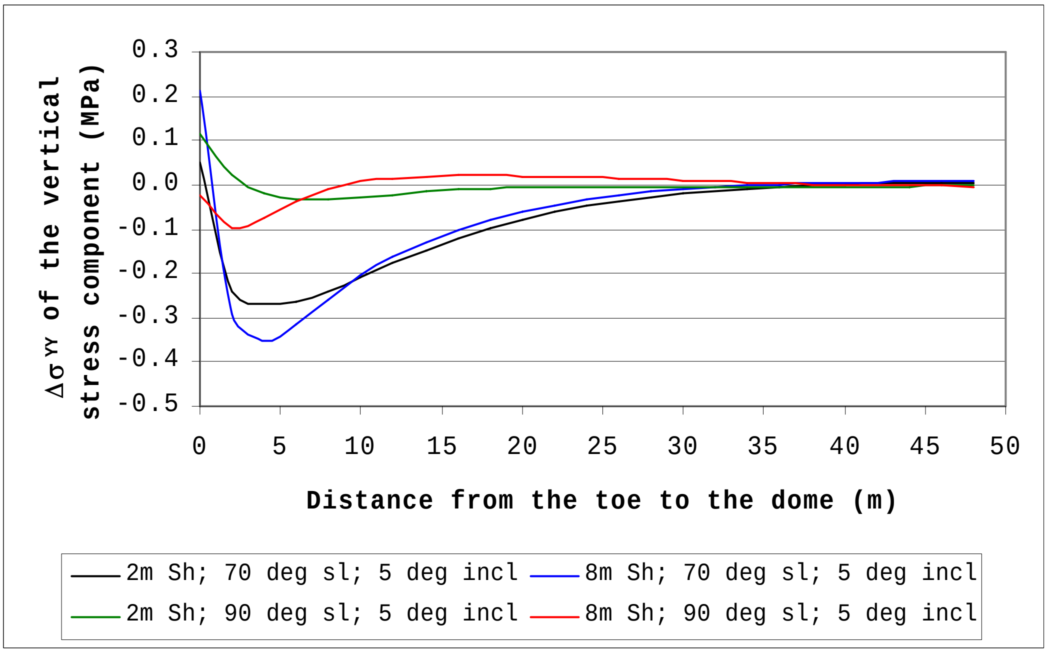


Figure A3.2

Vertical stress difference along profile line with 2m- and 8m-thick shale layer and 70^0 and 90^0 slope angle, in the undulated strata formation with 5^0 inclination

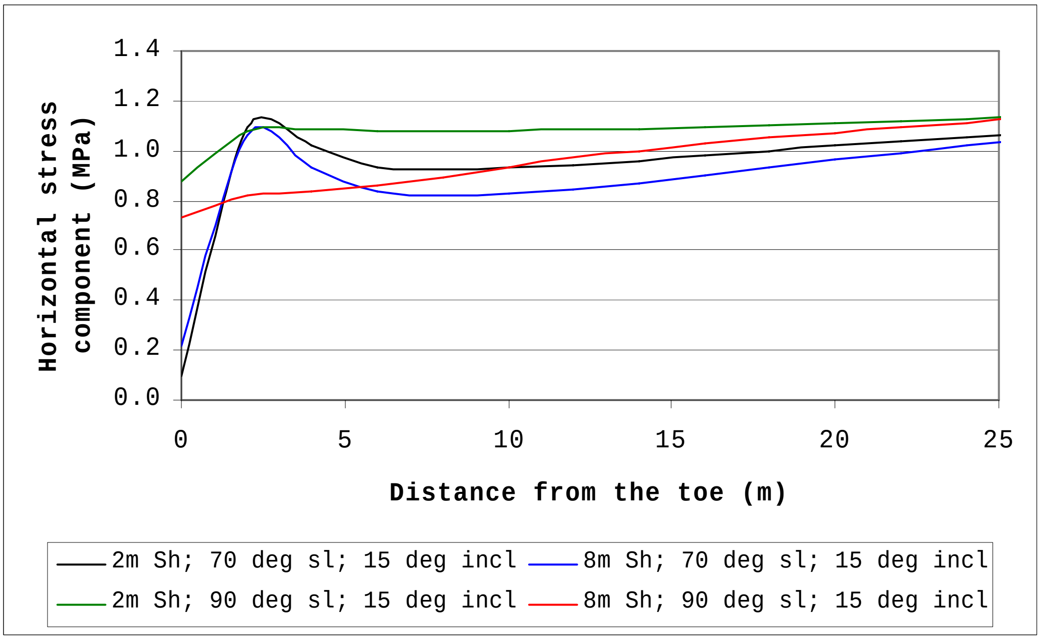


Figure A3.3

Resultant horizontal stress component of the slope with 2m- and 8m-thick embedded shale layer and 70^0 and 90^0-slope in the undulated strata formation with 15^0 layer inclinations

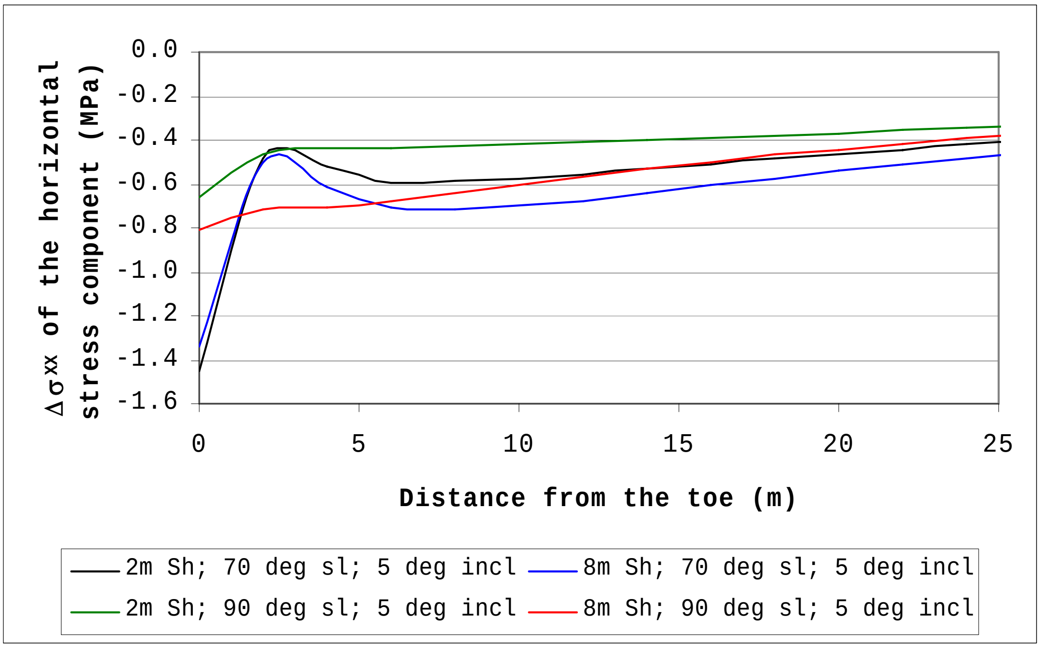


Figure A3.4

Horizontal stress component difference ($\Delta\sigma_{XX}$) of the slope with 2m- and 8m-thick embedded shale layer and 70^0 and 90^0 slope in the undulated strata formation with 5^0 layer inclinations

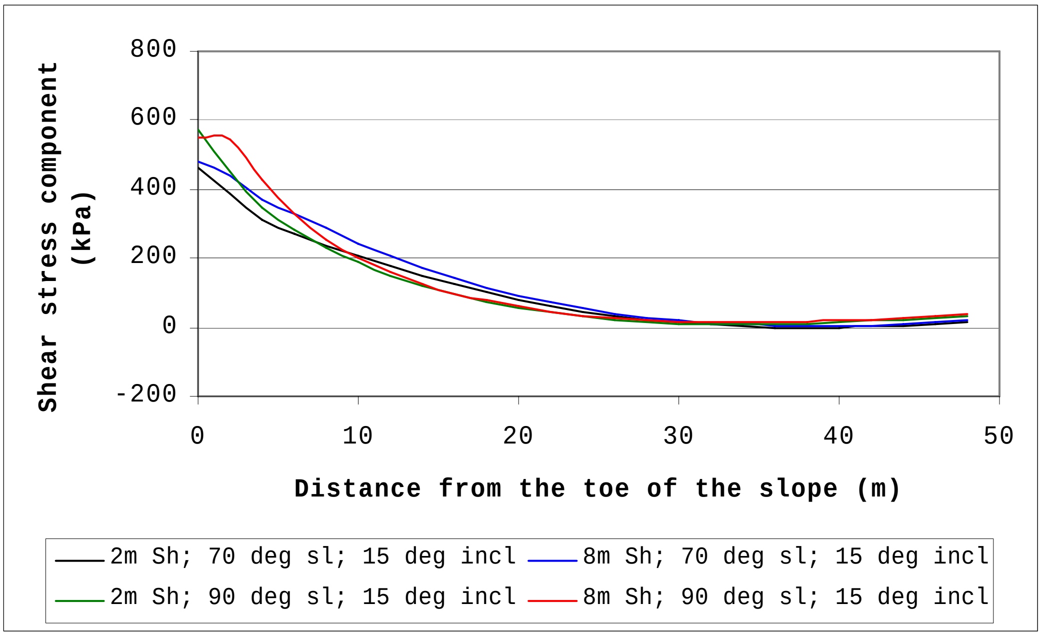


Figure A3.5

Shear stress component of the profile with 2m- and 8m-thick embedded shale layer, 70^0 and 90^0-slope angle in the undulated strata formation (15^0 inclination) in the model

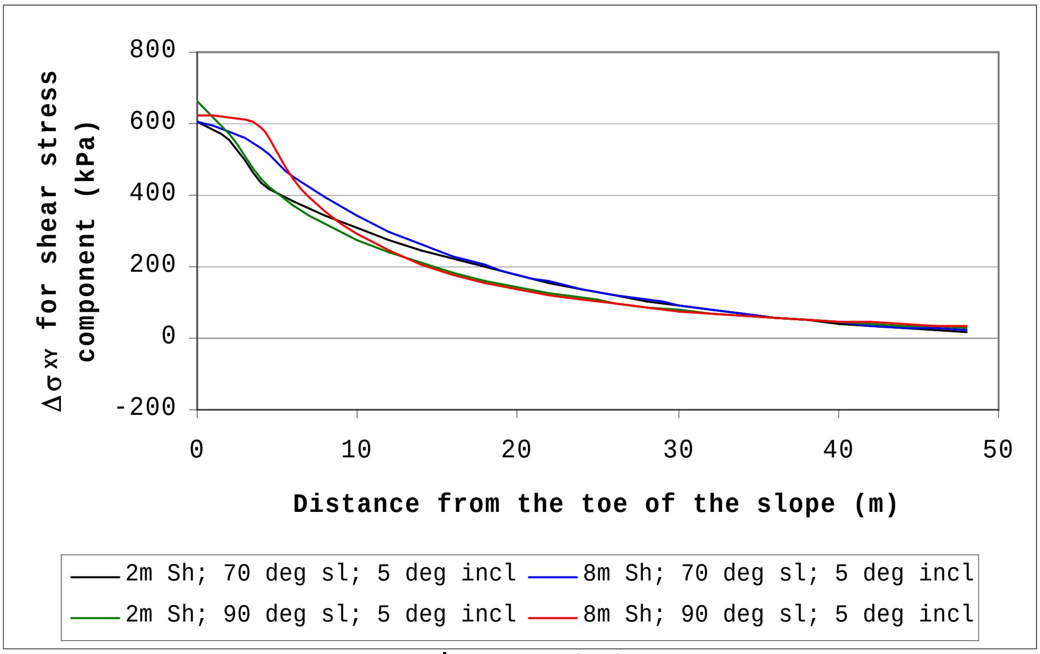


Figure A3.6

Shear stress difference ($\Delta\sigma_{XY}$) of the profile with 2m- and 8m-thick embedded shale layer, 70^0 and 90^0 slope angle in the anticline formation (5^0 layer inclinations) in the model

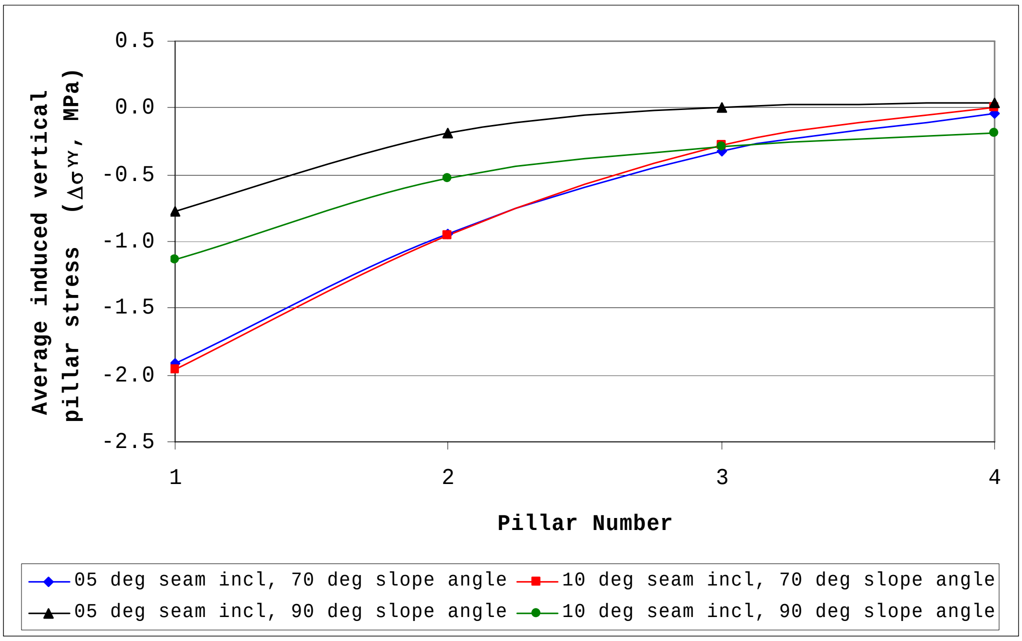


Figure A3.7

Vertical stress component difference ($\Delta\sigma_{YY}$) of the pillars with safety factor of 2.2 for the profiles with slope angles 70^0 and 90^0 and the undulated strata formation (layer inclinations 5^0 and 15^0) in the model

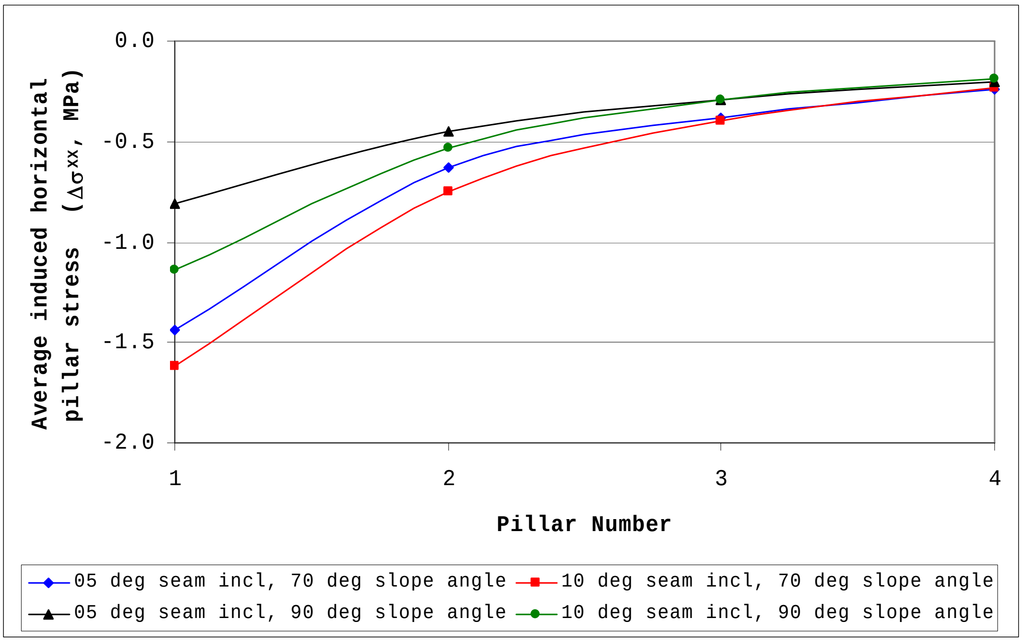


Figure A3.8

$\Delta\sigma_{XX}$ of the pillars with a pillar safety factor of 2.2 of profiles with 70^0 and 90^0 slope angle and undulated strata formation (5^0 and 15^0 layer inclination) in the model

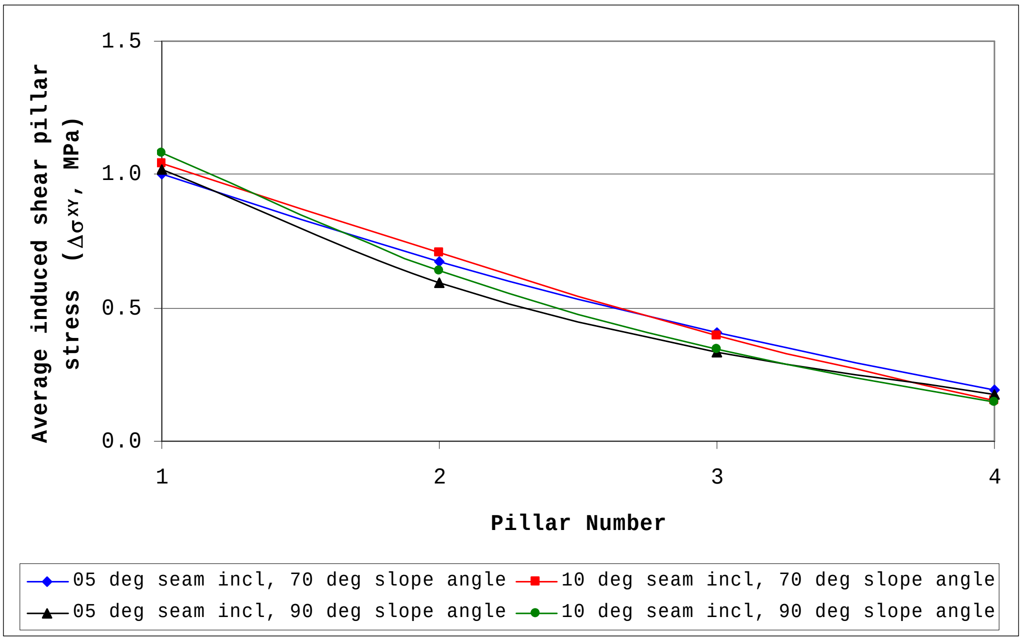


Figure A3.9

Shear stress component difference ($\Delta\sigma_{XY}$)of the pillars with a pillar safety factor of 2.2 in the profiles with 70^0 and 90^0 slope angle and undulated strata formation (5^0 and 15^0 layer inclination) in the model

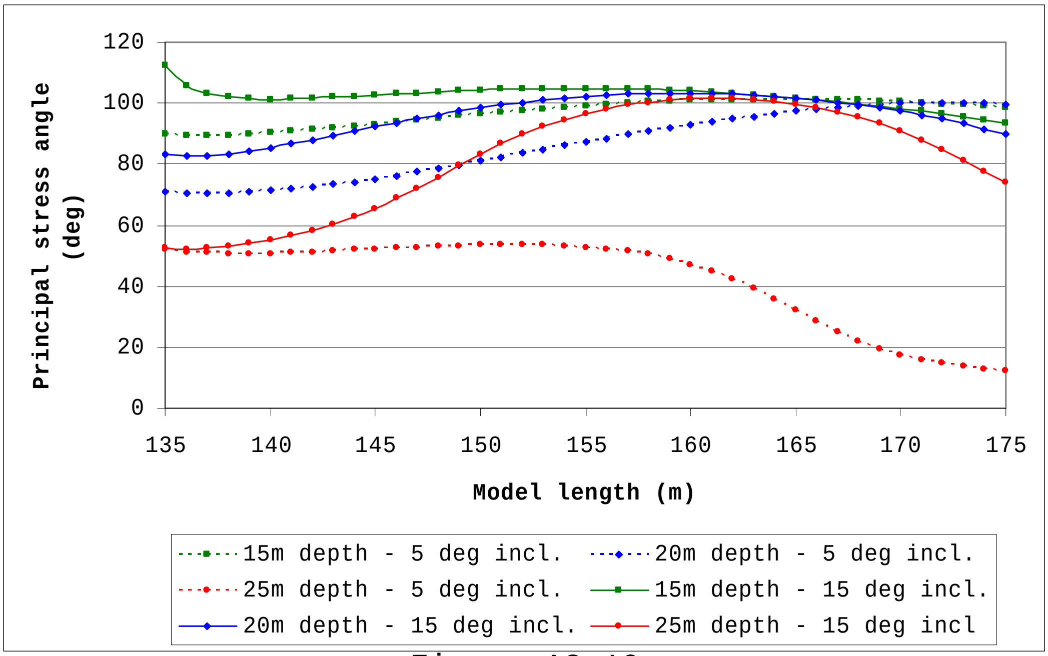
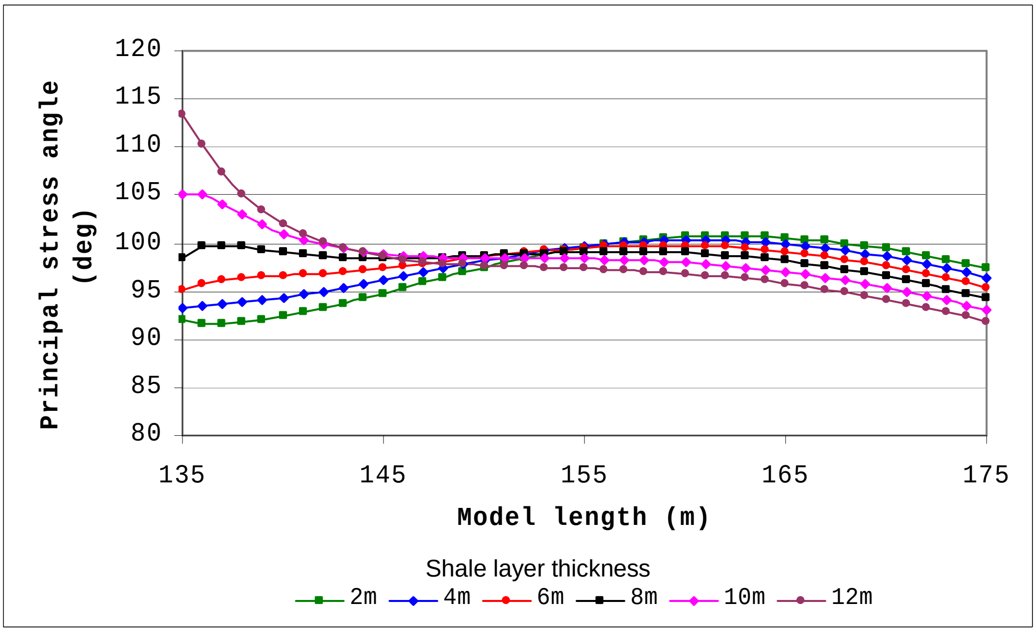


Figure A3.10

Inclination of the principal stress direction angles along the profile lines at 15m, 20m and 25m depth (Figure 5.3) in the homogeneous sandstone slope profile with 70^0 slope angle and different layer inclination

a)



b)

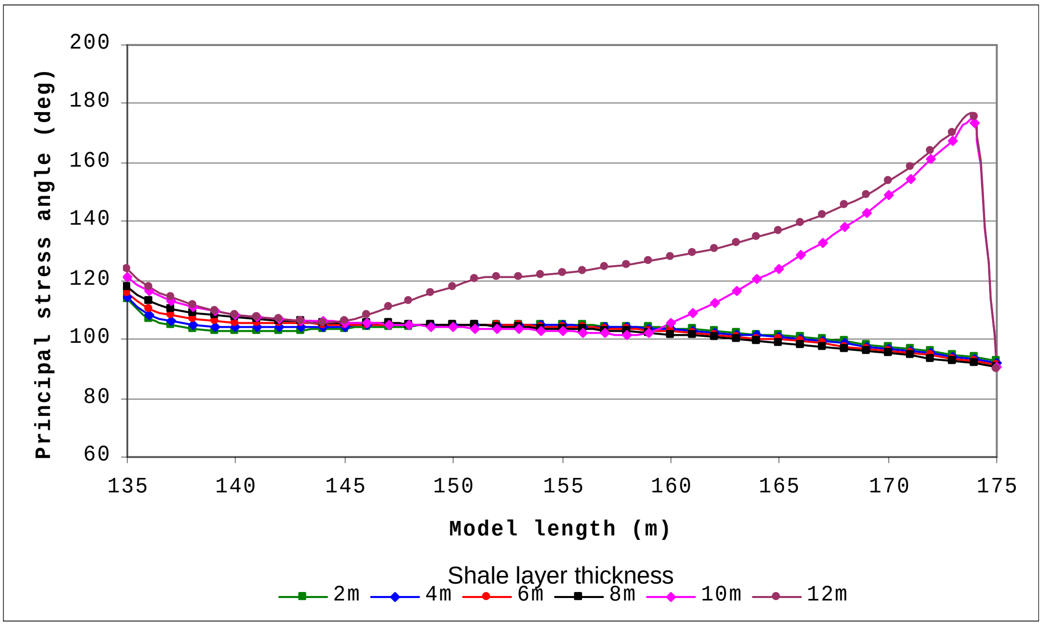
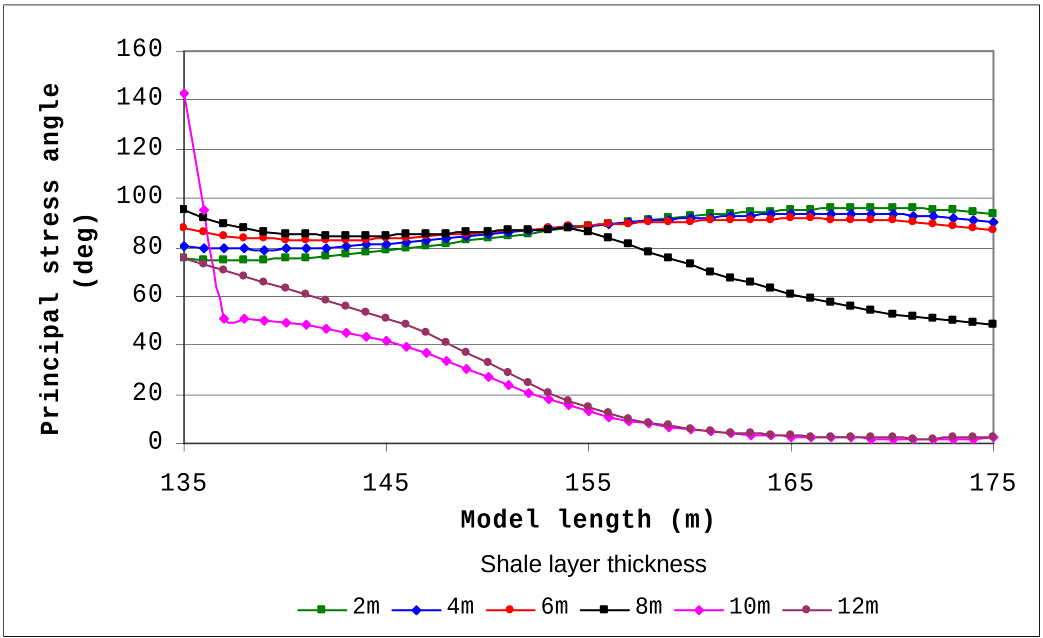


Figure A3.11

Inclination of the principal stress direction inclination angles along the profile line at 15m depth (Figure 5.3) in the profile with different embedded shale layer thickness at the undulated strata formation with: a) 5^0 layer inclination and b) 15^0 layer inclination

a)



b)

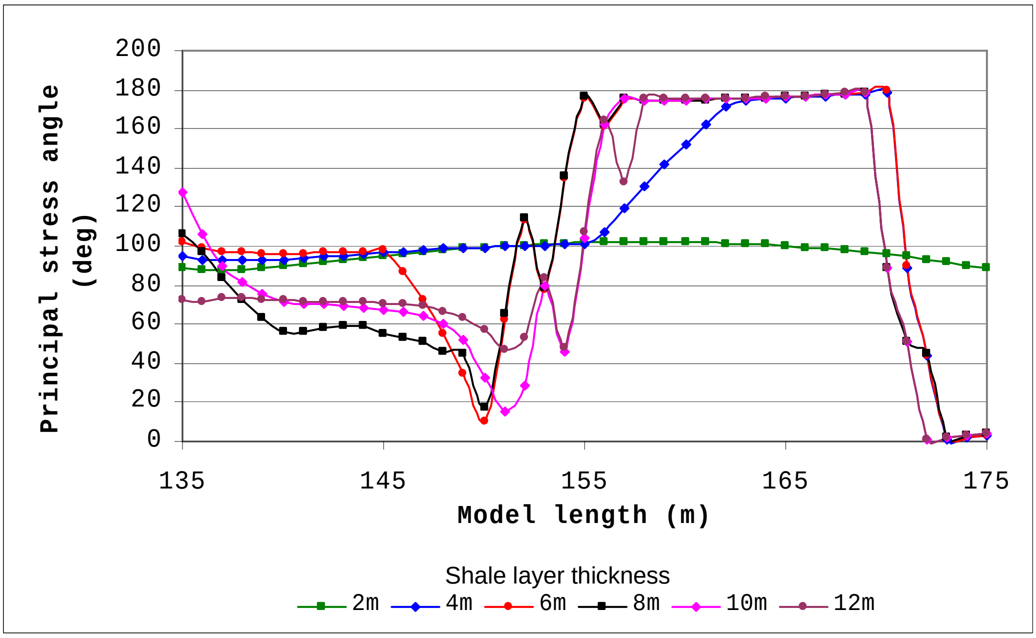
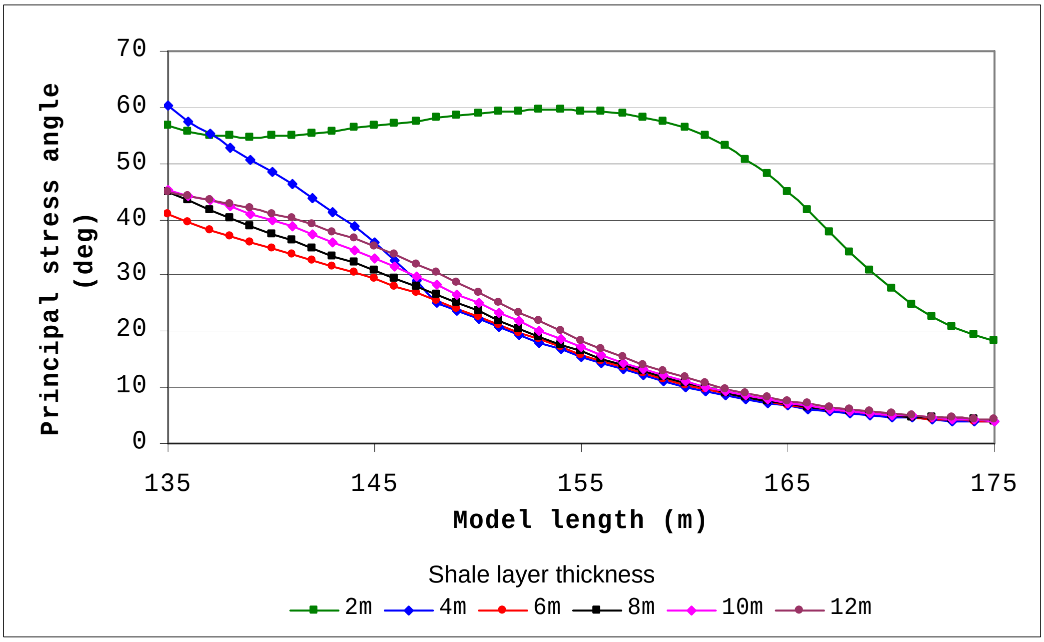


Figure A3.12

Inclination of the principal stress direction inclination angles along the part of profile line at 20m depth (Figure 5.3) in the profile with different embedded shale layer thickness at the undulated strata formation with: a) 5^0 layer inclination and b) 15^0 layer inclination

a)



b)

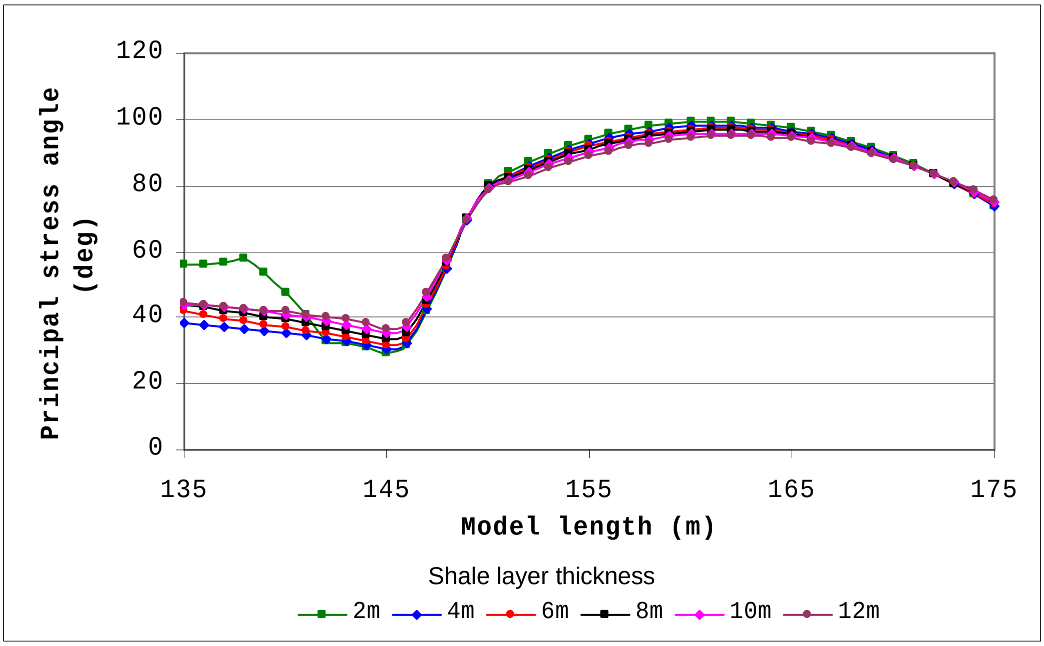


Figure A3.13

Inclination of the principal stress direction angles along the profile line at 25m depth in the profile with different embedded shale layer thickness at the undulated strata formation with: a) 5^0 layer inclination and b) 15^0 layer inclination

APPENDIX 4. SLOPE STABILITY CALCULATIONS

Table A4.1 *Example 1b*: Safety factor calculations along the bottom contact

Step No	Parameter	Value	Equation No
Inner shear failure surface (ISFS)			
Step 1	Average friction angle, deg	26	5.2
Step 2	Inclination angle of the ISFS, deg	45	-
Step 3	Average cohesion of the ISFS, MN/m^2	0.307	5.3
Step 4	Length of the ISFS, m	16.69	-
Step 5	Inner side of the active block construction	-	-
Outer shear failure surface (OSFS)			
Step 6	Average friction angle, deg	28	5.2
Step 7	Inclination angle of the OSFS, deg	45	-
Step 8	Average cohesion of the OSFS, MN/m^2	0.344	5.3
Step 9	Length of the ISFS, m	17.28	-
Step 10	Outer side of the active block construction	-	-
General parameters			
Step 11	Frictional zone load, MN/m^2	11.527	5.4
Step 12	Frictional zone length, m	29.0	-
Step 13	Frictional zone inclination angle, deg	16	-
Step 14	Cohesive zone load, MN/m^2	2.084	5.4
Step 15	Cohesive zone length, m	12.0	-
Step 16	Cohesive zone inclination angle, deg	12	-
Step 17	Active block load, MN	12.486	5.4
Step 18	Active block wedge angle, deg	10	-
Step 19	Passive block reaction forces to the inner failure surface, MN	-0.567	5.28

Step 20	Pore water pressure calculations		5.24-5.27
Step 21	Safety factor of the inner shear failure surface (condition of existence)	0.914	5.32
Step 22	Reaction force along the outer shear failure surface, MN	5.619	5.33
Step 23	Outer shear failure surface safety factor	0.709	5.35
Step 24	Basal shear surface safety factor	0.750	5.36
Step 25	Slope stability safety factor	0.777	5.37

Table A4.2 *Example 2a*: Safety factor calculations along the upper contact surface before initial failure

Step No	**Parameter**	**Value**	**Equation No**
Inner shear failure surface (ISFS)			
Step 1	Average friction angle, deg	28	5.2
Step 2	Inclination angle of the ISFS, deg	45	-
Step 3	Average cohesion of the ISFS, MN/m^2	0.238	5.3
Step 4	Length of the ISFS, m	9.24	-
Step 5	Inner side of the active block construction	-	-
Outer shear failure surface (OSFS)			
Step 6	Average friction angle, deg	28	5.2
Step 7	Inclination angle of the OSFS, deg	45	-
Step 8	Average cohesion of the OSFS, MN/m^2	0.228	5.3
Step 9	Length of the ISFS, m	11.55	-
Step 10	Outer side of the active block construction	-	-
General parameters			
Step 11	Frictional zone load, MN/m^2	4.524	5.4
Step 12	Frictional zone length, m	27	-

Step 13	Frictional zone inclination angle, deg	12	-
Step 14	Cohesive zone load, MN/m^2	0.964	5.4
Step 15	Cohesive zone length, m	10.0	-
Step 16	Cohesive zone inclination angle, deg	10	-
Step 17	Active block load, MN	9.194	5.4
Step 18	Active block wedge angle, deg	8	-
Step 19	Passive block reaction forces to the inner failure surface, MN	0.674	5.28
Step 20	Pore water pressure calculations	Above the phreatic level	
Step 21	Safety factor of the inner shear failure surface (condition of existence)	1.010	5.32
Step 22	Reaction force along the outer shear failure surface, MN	1.923	5.33
Step 23	Outer shear failure surface safety factor	0.955	5.35
Step 24	Basal shear surface safety factor	1.108	5.36
Step 25	Slope stability safety factor	1.062	5.37

Table A4.3 *Example 2b*: Safety factor calculations along the bottom contact surface before initial failure

Step No	**Parameter**	**Value**	**Equation No**
Inner shear failure surface (ISFS)			
Step 1	Average friction angle, deg	26	5.2
Step 2	Inclination angle of the ISFS, deg	45	-
Step 3	Average cohesion of the ISFS, MN/m^2	0.323	5.3
Step 4	Length of the ISFS, m	16.17	-
Step 5	Inner side of the active block construction	-	-

Outer shear failure surface (OSFS)			
Step 6	Average friction angle, deg	26	5.2
Step 7	Inclination angle of the OSFS, deg	45	-
Step 8	Average cohesion of the OSFS, MN/m^2	0.326	5.3
Step 9	Length of the ISFS, m	19.25	-
Step 10	Outer side of the active block construction	-	-
General parameters			
Step 11	Frictional zone load, MN/m^2	10.704	5.4
Step 12	Frictional zone length, m	29	-
Step 13	Frictional zone inclination angle, deg	14	-
Step 14	Cohesive zone load, MN/m^2	1.614	5.4
Step 15	Cohesive zone length, m	10.0	-
Step 16	Cohesive zone inclination angle, deg	12	-
Step 17	Active block load, MN	11.679	5.4
Step 18	Active block wedge angle, deg	10	-
Step 19	Passive block reaction forces to the inner failure surface, MN	-0.243	5.28
Step 20	Pore water pressure calculations		5.24-5.27
Step 21	Safety factor of the inner shear failure surface (condition of existence)	1.036	5.32
Step 22	Reaction force along the outer shear failure surface, MN	5.064	5.33
Step 23	Outer shear failure surface safety factor	0.927	5.35
Step 24	Basal shear surface safety factor	0.917	5.36
Step 25	Slope stability safety factor	0.945	5.37

Table A4.4 *Example 2c*: Safety factor calculations along the upper contact surface before major collapse

Step No	Parameter	Value	Equation No
Inner shear failure surface (ISFS)			
Step 1	Average friction angle, deg	28	5.2
Step 2	Inclination angle of the ISFS, deg	45	-
Step 3	Average cohesion of the ISFS, MN/m^2	0.249	5.3
Step 4	Length of the ISFS, m	8.47	-
Step 5	Inner side of the active block construction	-	-
Outer shear failure surface (OSFS)			
Step 6	Average friction angle, deg	28	5.2
Step 7	Inclination angle of the OSFS, deg	45	-
Step 8	Average cohesion of the OSFS, MN/m^2	0.269	5.3
Step 9	Length of the OSFS, m	10.40	-
Step 10	Outer side of the active block construction	-	-
General parameters			
Step 11	Frictional zone load, MN/m^2	5.821	5.4
Step 12	Frictional zone length, m	32	-
Step 13	Frictional zone inclination angle, deg	11	-
Step 14	Cohesive zone load, MN/m^2	0.882	5.4
Step 15	Cohesive zone length, m	7	-
Step 16	Cohesive zone inclination angle, deg	8	-
Step 17	Active block load, MN	5.093	5.4
Step 18	Active block wedge angle, deg	7	-
Step 19	Passive block reaction forces to the inner failure surface, MN	0.392	5.28
Step 20	Pore water pressure calculations	Above the phreatic level	

Step 21	Safety factor of the inner shear failure surface (condition of existence)	1.149	5.32
Step 22	Reaction force along the outer shear failure surface, MN	1.674	5.33
Step 23	Outer shear failure surface safety factor	0.935	5.35
Step 24	Basal shear surface safety factor	1.318	5.36
Step 25	Slope stability safety factor	1.224	5.37

Table A4.5 *Example 2d*: Safety factor calculations along the bottom contact surface before major collapse

Step No	**Parameter**	**Value**	**Equation No**
Inner shear failure surface (ISFS)			
Step 1	Average friction angle, deg	26	5.2
Step 2	Inclination angle of the ISFS, deg	45	-
Step 3	Average cohesion of the ISFS, MN/m^2	0.315	5.3
Step 4	Length of the ISFS, m	1615	-
Step 5	Inner side of the active block construction	-	-
Outer shear failure surface (OSFS)			
Step 6	Average friction angle, deg	26	5.2
Step 7	Inclination angle of the OSFS, deg	45	-
Step 8	Average cohesion of the OSFS, MN/m^2	0.322	5.3
Step 9	Length of the ISFS, m	19.23	-
Step 10	Outer side of the active block construction	-	-
General parameters			
Step 11	Frictional zone load, MN/m^2	13.589	5.4
Step 12	Frictional zone length, m	34	-
Step 13	Frictional zone inclination angle, deg	14	-

Step 14	Cohesive zone load, MN/m^2	1.674	5.4
Step 15	Cohesive zone length, m	11	-
Step 16	Cohesive zone inclination angle, deg	11	-
Step 17	Active block load, MN	10.374	5.4
Step 18	Active block wedge angle, deg	9	-
Step 19	Passive block reaction forces to the inner failure surface, MN	-0.420	5.28
Step 20	Pore water pressure calculations		5.24-5.27
Step 21	Safety factor of the inner shear failure surface (condition of existence)	1.161	5.32
Step 22	Reaction force along the outer shear failure surface, MN	4.619	5.33
Step 23	Outer shear failure surface safety factor	0.884	5.35
Step 24	Basal shear surface safety factor	0.883	5.36
Step 25	Slope stability safety factor	0.939	5.37

Table A4.6 *Example T-1*: Safety factor calculations along the upper contact plane of the test profile (5^0 flatter slope angle compared to the slope angle of the profile before major collapse)

Step No	**Parameter**	**Value**	**Equation No**
Inner shear failure surface (ISFS)			
Step 1	Average friction angle, deg	28	5.2
Step 2	Inclination angle of the ISFS, deg	45	-
Step 3	Average cohesion of the ISFS, MN/m^2	0.260	5.3
Step 4	Length of the ISFS, m	10.40	-
Step 5	Inner side of the active block construction	-	-

Outer shear failure surface (OSFS)			
Step 6	Average friction angle, deg	28	5.2
Step 7	Inclination angle of the OSFS, deg	45	-
Step 8	Average cohesion of the OSFS, MN/m^2	0.250	5.3
Step 9	Length of the ISFS, m	13.48	-
Step 10	Outer side of the active block construction	-	-
General parameters			
Step 11	Frictional zone load, MN/m^2	6.195	5.4
Step 12	Frictional zone length, m	41	-
Step 13	Frictional zone inclination angle, deg	11	-
Step 14	Cohesive zone load, MN/m^2	4.886	5.4
Step 15	Cohesive zone length, m	19	-
Step 16	Cohesive zone inclination angle, deg	6	-
Step 17	Active block load, MN	6.425	5.4
Step 18	Active block wedge angle, deg	3	-
Step 19	Passive block reaction forces to the inner failure surface, MN	1.742	5.28
Step 20	Pore water pressure calculations	Above the phreatic level	
Step 21	Safety factor of the inner shear failure surface (condition of existence)	1.710	5.32
Step 22	Reaction force along the outer shear failure surface, MN	0.852	5.33
Step 23	Outer shear failure surface safety factor	1.222	5.35
Step 24	Basal shear surface safety factor	2.029	5.36
Step 25	Slope stability safety factor	1.860	5.37

Table A4.7 *Example T-2*: Safety factor calculations along the bottom contact plane of the test profile (5^0 flatter slope angle compared to the slope angle of the profile before major collapse)

Step No	**Parameter**	**Value**	**Equation No**
Inner shear failure surface (ISFS)			
Step 1	Average friction angle, deg	26	5.2
Step 2	Inclination angle of the ISFS, deg	45	-
Step 3	Average cohesion of the ISFS, MN/m^2	0.321	5.3
Step 4	Length of the ISFS, m	17.31	-
Step 5	Inner side of the active block construction	-	-
Outer shear failure surface (OSFS)			
Step 6	Average friction angle, deg	26	5.2
Step 7	Inclination angle of the OSFS, deg	45	-
Step 8	Average cohesion of the OSFS, MN/m^2	0.302	5.3
Step 9	Length of the ISFS, m	18.86	-
Step 10	Outer side of the active block construction	-	-
General parameters			
Step 11	Frictional zone load, MN/m^2	14.547	5.4
Step 12	Frictional zone length, m	43	-
Step 13	Frictional zone inclination angle, deg	12	-
Step 14	Cohesive zone load, MN/m^2	7.374	5.4
Step 15	Cohesive zone length, m	22.0	-
Step 16	Cohesive zone inclination angle, deg	6	-
Step 17	Active block load, MN	10.521	5.4
Step 18	Active block wedge angle, deg	4	-
Step 19	Passive block reaction forces to the inner failure surface, MN	1.463	5.28

Step 20	Pore water pressure calculations		5.24-5.27
Step 21	Safety factor of the inner shear failure surface (condition of existence)	1.658	5.32
Step 22	Reaction force along the outer shear failure surface, MN	2.688	5.33
Step 23	Outer shear failure surface safety factor	1.527	5.35
Step 24	Basal shear surface safety factor	1.378	5.36
Step 25	Slope stability safety factor	1.454	5.37

APPENDIX 5. SAFETY FACTORS FOR OPENCAST MINING

UNITED STATES

1. FEDERAL REGISTER – 1977

		Minimum FOS
I.	End of construction	1.3
II.	Partial pool with steady seepage saturation	1.5
III.	Steady seepage from spillway or decent crest	1.5
IV.	Earthquake (cases II and III with seismic loading)	1.0

2. D'APPOLONIA CONSULTING ENGINEERS, Inc. – 1975

Suggested minimum FOS with hazard potential

	High	Moderate	Low
Designs based on shear strength parameters measured in laboratory	1.5	1.4	1.3
Designs that consider maximum seismic acceleration expected at the site	1.2	1.1	1.0

CANADA

MINES BRANCH – 1972

Suggested minimum FOS with hazard potential

		High	Low
1.	Design is based on peak shear strength parameters	1.5	1.3
2.	Design is based on residual shear strength parameters	1.3	1.2
3.	For horizontal sliding on the base of dyke in seismic areas assuming shear strength of fine refuse in impoundment reduced to zero	1.3	1.3

REFERENCES

1. Al-Ostaz A. and Jasiuk I. (1997), "Crack initiation and propagation in materials with randomly distributed holes", *Eng. Fracture Mechanics,* Vol. 58, pp. 395-420.
2. Anderson M.G. and Richards K.S. (1992), "Slope stability – geotechnical engineering and geomorphology", *Reprinted, John Wiley & Sons*, pp.22-23.
3. Andersson H. (1977), "Analysis of a model for void growth and coalescence ahead of a moving crack tip", *J Mech Phys Solids*, pp.25.
4. Andrade C., Bard E.O., Garrido H. and Campana J. (2000), "Slope Stability in Surface Mining", Ch. 48, pp. 427-434. W. A. Hustrulid, M. K. McCarter and D.J.A. Van Zyl, Eds. Littleton, Colorado: SME
5. Ashby M.F. and Hallam S.D. (1986), "The failure of brittle solids containing small cracks under compressive stress states", *Acta Metall*, 34(3), pp.497–510.
6. Atkinson B.K. (1987), "Fracture mechanics of rock", *London: Academic Press*.
7. Atkinson B.K. and Meredith P.G. (1987), "The theory of subcritical crack growth with applications to minerals and rocks", *Atkinson, B. K., ed., Fracture Mechanics of Rock, Academic Press,* San Diego, USA.
8. Baer, G. (1991), "Mechanisms of dike propagation in layered rocks and in massive porous sedimentary rocks", *Journal of Geophysical Research* 96, 11,911-11,929.
9. Bai T. and Pollard D.D. (2000-a), "Closely spaced fractures in the layered rocks: initiation

mechanism and propagation kinematics”, *Journal of Structural Geology*, 22, pp. 1,409-1,425.

10. Bai T. and Pollard D.D. (2000-b), “Fracture spacing in layered rocks: a new explanation based on the stress transition”, *Journal of Structural Geology*, 22, pp. 43-57.
11. Barenblatt G.I. (1962), “The mathematical theory of equilibrium cracks in brittle fracture”, *Advances in Applied Mechanics*, 7.
12. Barker L.M. (1979), “Theory for determining K_{IC} from small non-LEFM specimens, supported by experiments on aluminum”, *Int J Fracture*, 15, pp.515-36.
13. Barla G. and Chiriotti E. (1995), “Insights into the Behaviour of the Large Deep Seated Gravitational Slope Deformation of Rosone, in the Piemont Region (Italy)”, Felsbau, 13(6), pp. 425-432.
14. Bartlett W.M., Friedman M. and Logan J.M. (1981), “Experimental folding and faulting in rocks under confining pressure”, Part IX, *Wrench faults in limestone layers*, Technophysics 79, pp. 255-277.
15. Barton N.R. (1971), “A model study of the behavior of excavated slopes”, *Ph.D. Thesis*, University of London, Imperial College of Science and Technology.
16. Bassett R.H. (1970), Discussion. Proc. I.C.E. Conf. "Behaviour of piles", London, pp. 208-210
17. Batzle M.L., Simmons G. and Siegfried R.W. (1980), “Microcrack closure in rocks under stress: direct observation”, *J Geophys Res*, 85, pp.7072–90.
18. Bazant Z.P. and Xiang Y. (1997), “Size effect in compression fracture: splitting crack band

propagation", *J Engineering Mechanics*, 123(2), pp.162-73.

19. Becker A. and Gross M. (1988), "About the Dugdale crack under mixed mode loading", *Int J Fracture*, 37.
20. Becker A. and Gross M. (1996). "Mechanism for joint saturation in mechanically layered rocks: an example from southern Israel". Tectonophysics 257, 223-237.
21. Bhagat RB (1985), "Mode I fracture toughness of coal", Int J Min Eng, 3, pp. 229–36.
22. Bieniawski Z.T. (1967), "Mechanism of brittle fracture of rock", Part II- experimental study, *Int. J. Rock Mech. Min. Sci. and Geotech.* Abstr., 4, pp. 407-423.
23. Bishop A.W. (1955), "The use of the clip circle in the stability analysis of earth slopes", *Geotechnique, 5,* pp. 7-17
24. Bishop A.W., Webb D.L. and Lewin P.I. (1965), "Undisturbed samples of London clay from the Ashford common shaft; strength-effective stress relationships", Geotechnique 15, 1, pp. 1-31.
25. Boyd G.L. (1983), "Geomechanics research applied to open strip coal mining in Australia", Surface mining and quarrying, Second international Surface mining and quarrying symposium, Bristol, UK, pp. 193-204.
26. Brace W.F. (1978), "Volume changes during fracture and frictional sliding: a review". *PAGEOGH 116*, pp.603–614.
27. Brady B.H.G. and Brown E.T. (1993), "Rock Mechanics for Underground Mining", *2nd edn. Chapman & Hall, London*, 571 pp.59– 108.

28. Broek D. (1996), "Elementary engineering fracture mechanics", *4th ed. Dordrecht: Kluwer Academic Publishers.*

29. Bromhead E.N. (1992), "The stability of slopes", Surrey University Press, Chapman and Hall, New York, pp. 109-165

30. Broms, B.B. (1971), "Lateral earth pressure due to compaction of cohesionless soils", Proc. 4th COSMFF, Budapest, 1, pp. 373-384.

31. Brooker E.W. and Ireland H.O. (1965), "Earth pressure at rest related to the stress history", Can. Geot. J., 2, 1, p. 1-15.

32. Bui H.D. and Ehrlacher A. (1981), "Propagation of damage in elastic and plastic solids", *In: Francois D, Bathias C, Bilby BA, editors. Proceedings of the 5th International Conference of Fracture, Cannes, France*, pp.533-551.

33. Bui H.D., Ehrlacher A. and Renard C. (1984), "The steady state propagation of a damaged zone of an elastic brittle solid", In: Valluri S.V., Taplin D.M.R and Rao P.R. (Eds). *Proceedings of the 6th International Conference of Fracture, New Delhi, India*, pp.1061-1067.

34. Cairncross B. (1989), "Paleodepositional environments and tectono-sedimentary controls of the postglacial Permian coals, Karoo Basin, South Africa", *International Journal of Coal Geology*, v. 12, pp. 365-380.

35. CANMET, Mining research Laboratories (1997), *"Pit Slope Manual"*, CANMET.

36. Carpinteri A., Tomasso A.D. and Fanelli M. (1986), "Influence of material parameters and geometry on cohesive crack propagation", In "Fracture toughness and fracture energy of concrete",

Wittmann F.H. (Ed*), Elsevier Science Publishers, Amsterdam*, pp.117-135.

37. Carranza-Torres C., Fairhurst C. and Lorig L. (1997), "Insights on the Stability of Large Excavations from Analytical and Numerical Models," *Felsbau*, 15(1), pp. 45-63.

38. Cherepanov G.P. (Ed) (1998), "Fracture, a topical encyclopedia of current knowledge*". Malabar, FL. Krieger Publishing Company*.

39. Collieries Research Laboratory (1972), "Design tables for bord and pillar workings in coal mines", *Chamber of Mines of South Africa.*

40. Cox H.L. (1952), "The elasticity and strength of paper and other fibrous materials", British Journal of Applied Physics, 3, pp. 72-79.

41. Dey T.N. and Wang C.Y. (1981), "Some mechanisms of microcrack growth and interaction in compressive rock failure*". Int J Rock Mech Min Sci Geomech Abstr,* 18, pp.199–209.

42. DIGS, (1996), CSIR – Miningtek, Boundary element code.

43. Dugdale D.S. (1960), "Yielding of steel sheets containing slits", *J Mech Phys Solids*, 8.

44. Dyskin A.V. and Germanovich L.N. (1993), "Model of rock burst caused by cracks growing near free surface", In: Young P (ed.), "Rockbursts and seismicity in mines 93", Rotterdam, Balkema, pp. 169-175.

45. El Bied A., Sulema J. and Martineaub F. (2002), "Microstructure of shear zones in Fontainebleau sandstone", *International Journal of Rock Mechanics and Mining Sciences*, 39, pp. 917–932.

46. Eberhardt E., Stead D. and Stimpson B. (1999), "Quantifying progressive pre-peak brittle fracture

damage in rock during uniaxial compression", *Int. J. Rock Mech. Min. Sci. Geomech. Abstr., 36*, pp. 361–380.

47. Ewy R.T. and Cook N.G.W. (1990), "Deformation and fracture around cylindrical openings in rock", *Part II, Int J Rock Mech Min Sci and Geomech Abstr*, 27, pp.409-427.

48. Fairhurst C. and Cook N.G.W. (1966), "The phenomenon of rock splitting parallel to the direction of maximum compression in the neighborhood of a surface", Proceedings of the 1st Congress International Society for Rock Mechanics, Lisbon, p. 687-692.

49. Feda J. (1992), "Creep of soils and related phenomena", *Elsevier*.

50. Feda, J (1978), "Stress in subsoil and methods of final settlement calculation", Development in Geotechnical Engineering 18, Elsevier, p. 20-33.

51. Fellenius W. (1936), "Calculation of the stability of earth dams", *Trans. 2nd Congr. On Large Dams, Washington, 4,* pp. 445-459

52. Feng X.Q. and Yu S.W. (1995), "Micromechanical modeling of tensile response of elastic-brittle materials", *Int J Solids Struct*, 32.

53. FLAC^{2D}, Itasca Consulting Group (1999), "Fast Lagrangian Analysis of Continua".

54. Fredrich J.T., Evans B. and Wong T.F. (1990), "Effects of grain size on brittle and semi brittle strength: implications for micromechanical modeling of failure in compression", *J. Geophys. Res.*, 95, pp.10907-10920.

55. Fueten F. and Goodchild J.S., (2001), "Quartz c-axis orientation using the rotating polarizer microscope", J. of Str. Geol., 23, pp. 895-902.

56. Gammond J.F. (1983), "Displacement features associated with fault zones: a comparison between observed examples and experimental models", *Journal of Structural Geology* 5, pp. 33-45.

57. Germanovich L.N. (1984), "Stress state in the vicinity of a drill-hole cut by flame", *Soviet mining sciences, vol. 20. New York: Consultants Bureau and Plenum Publishing Corp*, pp.245-53.

58. Germanovich L.N. (1997), "Thermal spalling of rock". In*: Advances in fracture research, vol. 6. Amsterdam, Oxford: Pergamon*, pp.2771-82.

59. Germanovich L.N. and Dyskin A.V. (2000), "Fracture mechanisms and instability of openings in compression", *Int. J. Rock Mech. Min. Sci.*, 37, pp.263-284.

60. Germanovich L.N., Salganik R.L., Dyskin A.V. and Lee K.K. (1994), "Mechanisms of brittle fracture of rock with multiple pre-existing cracks in compression", Pure and Applied Geophysics (PAGEOPH), 143 (13), pp. 117-149.

61. Griffith A.A. (1921), "The phenomena of rupture and flow in solids", *Phil Trans Royal Soc London, Ser*, A221, pp.163–98.

62. Griffith A.A. (1924), "The theory of rupture", *Proceeding of First International Congress Applied Mechanics*, 1st Delft, pp.55–63.

63. Griffiths D.V. and Lane P.A. (1999), "Slope stability analysis by finite elements", Geotechnique 49, No: 3, pp. 387-403.

64. Gross M., Fischer M., Engelder T. and Greenfield R. (1995). "Factors controlling joint spacing in interbedded sedimentary rocks; integrating numerical models with field observations from the Monterey Formation, USA". In: Ameen, M.S. (Ed.).

Fractography. Geological Society Special Publication, Geological Society, London, pp. 215-233.

65. Haimson B.C. and Herrick C.G. (1986), "Borehole breakouts - a new tool for estimating in-situ stress", *Proceedings of the International Symposium on Rock Stress Measurements", Stockholm, 1-3 September*, pp.271-80.

66. Haimson B.C. and Song I. (1993), "Laboratory study of borehole breakouts in Cordova Cream: a case of shear failure mechanism", *Int J Rock Mech Min Sci and Geomech Abstr.*, 30, pp.1047-56.

67. Haimson B.C. and Song I (1998), "Borehole breakouts in Berea sandstone: two porocity-dependent distinct shapes and mechanisms of formation", SPE/ISRM Eurock '98, Trondheim, Norway, vol. 1, p. 229-238.

68. Hallbauer D.K., Wagner H. and Cook N.G.W. (1973), "Some observations concerning the microscopic and mechanical behavior of quartzite specimens in stiff triaxial compression tests", *Int J Rock Mech Min Sci Geomech Abstr,* 10, pp.713–26.

69. Hao T.H., Zhang X.T. and Hwang K.C. (1991), "The anti-plane shear field in an infinite slab of an elasto-damaged material with a semi-infinite crack", *Acta Mechanica Sinica*, 7.

70. Hardy, M.P. (1973), "Fracture mechanics applied to rock", PhD thesis, University of Minessota.

71. Hatzor Y.H. and Palchic V. (1997), "The influence of grain size and porosity on crack initiation stress and critical flaw length in dolomites", *Int. J. Rock Mech. Min. Sci.*, 34(5), pp.805-816.

72. Helgeson D.E. and Aydin A. (1991), "Characteristics of joint propagation across layer

interfaces in sedimentary rocks". *Journal of Structural Geology* 13, 897-991.

73. Helsing J. (1999), "Stress intensity factors for a crack in front of an inclusion". *Eng Fract Mech*, 64: pp.245–53.
74. Hilleborg A. (1985), "The theoretical basis of a method to determine the fracture energy G_F of concrete", *Materials and structures*, 18, No 106, pp.291-296.
75. Hobbs D.W. (1967), "The formation of tension joints in sedimentary rock: an explanation", *Geological Magazine,* 104, pp. 550-556.
76. Hoek E. (1986), "Slope stability analysis", *Lecture at Santiago Technical University*, Chapter 7 - A slope stability problems in Hong Kong, pp.92-104.
77. Hoek E. and Bieniawski Z.T. (1965), "Brittle fracture propagation in rock under compression." *Int J Fract Mech*, 1, pp.137–55.
78. Hoek E. and Bray J.W. (1981), "Rock slope engineering", IMM, London.
79. Hoek E. and Bray J.W. (1991), "Rock slope engineering", *Elsevier, Preprinted*, pp.161.
80. Horii H. and Nemat-Nasser S. (1985), "Compression-induced microcrack growth in brittle solids: axial splitting and shear failure", *J Geophys Res* 90, pp.3105-25.
81. Horii H. and Nemat-Nasser S. (1986), "Brittle failure in compression: splitting, faulting and brittle-ductile transition". *Phil Trans Roy Soc London*, A319, pp.163–98.
82. Horii H., Hasegawa A. and Nishino F. (1987), "Process zone model and influencing factors in fracture of concrete", *SEM/RILEM, Int. Conf. On*

fracture of concrete and rock, Houston, Texas, Shah and Swarts (Eds), pp.299-307.

83. Hoyaux, B. and Ladanyi, B. (1972), "Basic and applied rock mech.", Port City Press, Baltimore, pp. 621-631.
84. Huang Q. and Angelier J. (1989), "Fracture spacing and its relation to bed thickness", *Geological Magazine*, 126, pp. 355-362.
85. Hugman R.H.H. and Friedman M. (1979), "Effects of texture and composition on mechanical behavior of experimentally deformed carbonate rocks", *Am. Assoc. Petr. Geol. Bull.*, 63, pp.1478-1489.
86. Ingraffea R.A. and Gerstle W.H. (1984), "Non-linear fracture models for discrete fracture propagation", *Application of fracture mechanics to cementitious composites, Shah S.P. (Ed), Martinus Nijhoff, The Hague*, pp.247-285.
87. Itasca Consulting Group, 1999: "FISH in FLAC", Complete guide FISH.
88. Jaeger J.C. and Cook N.G.W. (1979), "Fundamentals of Rock Mechanics", 3rd Ed. New York, Chapman and Hall.
89. Janbu N. (1954), "Application of composite slip surfaces for stability analysis", *Proc. Europ. Conf. Stability of Earth Slopes,* V.3.
90. Janbu N. (1957), "Stability analysis of slopes with dimensionless parameters", *Harvard University Soil Mech. Series,* No 46
91. Janson J. (1977), "Dugdale crack in a material with continuous damage formation", *Eng. Fracture Mech*, 9.
92. Ji S. and Saruwatari K. (1998). "A revised model for the relationship between joint spacing and

layer thickness”, *Journal of Structural Geology,* 20, 1495-1508.

93. Jiang J. and Xie Q. (1988), “Finite element analysis of the stresses in slopes”, *Numerical methods in Geomechanics,* Innsbruck, Swoboda (ed.), Balkema, Rotterdam, pp. 1375-1383.
94. Kachanov L.M. (1988), “Delamination buckling of composite materials”, *Dordrecht, Boston, London, Kluwer*.
95. Kanninen M.F. and Popelar C.P. (1985), “Advanced fracture mechanics”, *London: Oxford University Press*.
96. Karparov K.N. (1998), "Fracture toughness estimation on some rocks encountered in South African mining environment", *Unpublished MSc Thesis, University of the Witwatersrand, Johannesburg, RSA*.
97. Kemeny J.M. and Cook N.G.W. (1987), “Crack models for the failure of rock under compression”, *Proc. of the Second International Conference on Constitutive Laws for Engineering Materials*, vol.2, pp.879–87.
98. Kitahara,Y. Tokue,T. Motojima,M. (1986), "The observed results of displacements during the excavation of slope and the numerical analysis of its stability" pp. 691-697.
99. Kovari K. and Fritz P. (1978), “Special contribution: Slope stability with plane, wedge and polygonal sliding surfaces”, Symp. on rock mechanics related to dam foundations, Rio de Janeiro.
100. Krajcinovic D. (1997), “Damage Mechanics”, *Elsevier, Amsterdam*.

101. Kranz R.L. (1979), “Crack–crack and crack–pore interactions in stressed granite”, *Int J Rock Mech Min Sci Geomech Abstr*, 16, pp.37–47.
102. Kulatilake P.H.S.W., Wathugala D.N., and Stephansson O. (1993), “Joint network modeling with a validation exercise in Strip mine”, Sweden, *Int. J. Rock Mech. Min. Sci. and Geomech. Abstr.*, 30(5), 503-526.
103. Kulhawy F.H., Duncan J.M. and Bolton Seed H. (1973), Finite element analyses of stresses and movements in embankments during construction”, *Report No: TE-69-4,* U.S. Army Corp. Engineers, Waterways Experiment Station.
104. Labuz J.F., Shah S.P. and Dowding C.H. (1987), “The fracture process zone in granite: evidence and effect”, *Int. J. Rock Mech. and Min. Sci. and Geotech. Abstr.*, 24, No: 4, pp.235-246.
105. Ladd, C.C. (1964), "Stress-strain modulus of clay in undrained shear", J. SM Div. ASCE 90, 5, p. 103-132
106. Lambe, T.W. and Whitman, R.V. (1979), "Soil mechanics, SI version", John Wiley & Sons, p. 99-100.
107. Leung C.K.Y. and Li V.C. (1987), “Determination on fracture toughness parameters of quasi-brittle materials with laboratory-size specimens”, *SEM/RILEM, Int. Conf. On fracture of concrete and rock, Houston, Texas, Shah and Swarts (Eds)* pp.695-709.
108. Lipetzky P. and Knesl Z. (1995), “Crack–particle interaction in two-phase composites”, *Part II Crack defection. Int J Fract*, pp.81–92.
109. Lipetzky P. and Schmauder S. (1994), “Crack–particle interaction in two-phase composites”,

Part I: Particle shape effects. Int J Fract, pp.345–58.

110. Lockner D.A. (1993). "The role of acoustic emissions in the study of rock fracture", *Int. J. Rock Mech. Min. Sci. and Geomech. Abs.*, 7, pp.883-889.
111. Lowe J. and Karafiath L. (1960), "Stability of earth dams upon draw down", *Proc. 1st Pan-Am. Conf. Soil Mech. Found. Eng., Mexico, 2,* pp. 537-560.
112. Malgot J., Baliak F. and Mahr T., (1986), "Prediction of the influence of underground coal mining on slope stability in the Vtacnik mountains", Bulletin of the international association of engineering geology, 33, pp. 57-65
113. Mandal N., Chakraborty C. and Samanta S.K. (2001), "Flattening in shear zones under constant volume: a theoretical evaluation", *J. of Structural Geology*, 23, pp. 1771-1780.
114. Markgraaff J. (1986), "Elastic behavior of quartz during stress induced Dauphine twinning", *Phys. Chem. Minerals*, Vol. 13, pp.102-112.
115. Martin C.D. and Chandler N.A. (1994), "The progressive fracture of Lae du Bonnet granite", *Int. J. Rock Mech. Min. Sci. and Geotech. Abstr*., 31, pp.643-659.
116. Mattushek M. (2005), Personal Communication, Divisional Geologist, New Vaal Colliery.
117. McKinnon S.D. and de la Barra I.G. (1998), "Fracture initiation, growth and effect on stress field: a numerical investigation", *Journal of Structural Geology*, Vol. 20, No. 12, pp. 1673-1689.

118. Mitchell J.K. (1976), “Fundamentals of soil behavior”, *J. Wiley and Sons*.

119. Morgenstern N.R. and Price V.A. (1967), “The analysis of the stability of general slip surfaces”, *Geotechnique,* 15, pp. 79-93.

120. Mou Y. and Han R.P.S. (1994), “Damage zones based on Dugdale model for materials”. *Int J Fracture*, 68.

121. Muller W.H. and Schmauder S. (1993), “Stress-intensity factor of r-cracks in fiber-reinforced composites under thermal and mechanical loading”. *Int J Fract*, 59, pp.307–43.

122. Myer L.R., Kemeny J.M., Zheng Z., Suarez R., Ewy R.T. and Cook N.G.W. (1992), “Extensile cracking in porous rock under differential compressive stress”, Applied Mechanics Review; 45(8), pp. 263-280.

123. Narr W. and Suppe J. (1991), “Joint spacing in sedimentary rocks”, *Journal of Structural Geology,* 13, 1037-1048.

124. Nemat-Nasser S. and Horii H. (1982), “Compression-induced nonlinear crack extension with application to splitting, exfoliation, and rockburst*”. J Geophys Res*, 87(B8), pp.6805–21.

125. Nemat-Nasser S. and Hori M. (1993), “Micromechanics: overall properties of heterogeneous materials”, *Amsterdam, North-Holland*.

126. Okland D. and Cook J.M. (1998), “Bedding-related instability in high-angle wells”, *In: SPE/ISRM Eurock '98*, pp.413-22.

127. Olson J.E. (1993), “Effects of subcritical crack growth and mechanical crack interaction”, *J. of Geoph. Res.*, 98(B7), pp.12251-12265.

128. Olson J.E. (1997), "Natural fracture pattern characterization using mechanical based model constrained by geologic data – moving closer to a predictive tool". *Int. J. Rock Mech. & Min. Sci.*, 34(3/4), 391, Paper No. 237.

129. Olson J.E. and Pollard D.D. (1989), "Inferring paleostresses from natural fracture patterns: A new method", *Geology*, 17, 345-348.

130. Olsson W.A. (1974), "Grain size dependence of yield stress in marble", *J. Geophys. Res.*, 79, pp.4859-4862.

131. Olsson W.A. and Peng S.S. (1976), "Microcrack nucleation in marble", *Int J Rock Mech Min Sci Geomech Abstr*, 13, pp.53–9.

132. Ortlepp W.D. and Stacey T.R. (1994), "Rockburst mechanisms in tunnels and shafts", *In: Tunnelling and Underground Space Technology,* 9(1), pp.59-65.

133. Ortlepp W.D. (1997): *Rock Fracture and Rockbursts: an illustrative study.* Monograph Series M9, South African Institute of Mining and Metallurgy, Johannesburg.

134. Ouchterlony F.D. (coordinator) (1988), "Suggested methods for determining the fracture toughness of rock", ISRM, *Int J Rock Mech Sci & Geomech Abstr*, 25, pp.71-96.

135. Palchik V. and Hatzor Y.H. (2002), "Crack damage stress as a composite function of porosity and elastic matrix stiffness in dolomites and limestones", *Eng. Geol.*, 63, pp.233-245.

136. Papaioannou S.G. and Hilton P.D. (1974), "A finite element method for calculation stress intensity factors and its application to composites", *Eng Fract. Mech.*, 6, pp.807–23.

137. Papamichos E. and Vardoulakis I.G. (1989), "The coupling effect of surface instabilities and surface parallel Griffith cracks in rock", In: Maury V. and Fourmaintraux D. (ed.), *"Rock at great depth", Rotterdam: Balkema*, pp. 481-487.

138. Parker A.P. (1999), "Stability of arrays of multiple edge cracks", *Engineering Fracture mechanics*, 62, pp. 577-591.

139. Paterson M.S. (1978), "Experimental Rock Deformation – The Brittle Field", *Springer-Verlag, New York*, 254 pp.

140. Peng S. and Johnson A.M. (1972), "Crack growth and faulting in cylindrical specimens of Chelmsford granite", *Int J Rock Mech Min Sci Geomech Abstr*, 9, pp.37–86.

141. Petch N.J. (1953), "The cleavage strength of polycrystals", *J. Iron Steel Inst.*, pp.25-28.

142. Poisel R. and Eppensteiner W. (1988),"A contribution to the systematics of rock mass movements", *LANDSLIDES* - Proc. Of the 5th Int. Symp. On landslides, Lausanne, 10-15 July, pp. 1353-1359.

143. Pollard D.D. and Aydin A. (1988), "Progress in understanding jointing over the past century", *Geological Society of America*, Bulletin, 100, pp. 1181-1204.

144. Pollard D.D. and Segall P. (1987), "Theoretical displacements and stresses near fractures in rocks: with applications to faults, joints, veins, dikes and solution surfaces". In: Atkinson, B.K. ed., *Fracture Mechanics of Rock*. Academic Press, London, 277-349.

145. Price N.J. (1966), "Fault and Joint Development in Brittle and Semi-Brittle Rocks", *Pergamon Press, Oxford.*

146. Renshaw C.E. (1994), "Are large differential stresses required for straight fracture propagation paths?", *Journal of Structural Geology*, 16 (6), 817-822.

147. Riedel W. (1929), "Zur mechanik geologisher brucherscheinungen", Zentralblatt fur Mineralogie, Geologie und Paleontologie B, p. 354-368 (Abhandlung).

148. Rives T., Razack M., Petit, J.P. and Rawnsley K.D. (1992), "Joint spacing: analogue and numerical simulations", *Journal of Structural Geology*, 14(8/9), 925-937.

149. Sammis C.G. and Ashby M.F. (1986), "The failure of brittle porous solids under compressive stress states", *Acta Metall*, 34(3), pp.511–26.

150. Santarelli F.J. and Brown E.T. (1989), "Failure of three sedimentary rocks in triaxial and hollow cylinder compression tests", *Int J Rock Mech Min Sci and Geomech Abstr*, 26, pp.401-13.

151. Scavia C. (1999), "The displacement discontinuity method for the analysis of rock structures: a fracture mechanic", In: *Aliabadi M.H. (Ed.) "Fracture of Rock". Boston: WIT press, Computational Mechanics Publications*, pp.39–82.

152. Scavia C. and Castelli M. (1996), In: Barla G., editor. "Analysis of the propagation of natural discontinuities in rock bridges", *EUROCK'98. Rotterdam: Balkema*, pp.445–51.

153. Schmidt R.A. (1980), "A microcrack model and its significance to hydraulic fracturing and fracture

toughness testing”, *Proc. 21st US Symp. On Rock Mech.*, pp.581-590.

154. Schock R.N., Heard H.C. and Stevens D.R. (1973), “Stress–strain behavior of a granodiorite and two graywackes on compression to 20 kilobars.”, *J. Geophys. Res.*, pp.5922– 5941.

155. Shen B. and Duncan Fama M.E., 1999, “Review of highwall mining experience in Australia and case studies”, CSIRO, *Exploration and mining report 616F*.

156. Shen B. and Stephanson O. (1993), “Numerical analysis of mixed mode I and mixed mode II fracture propagation”, *Int J Rock Mech Min Sci and Geomech Abstr*, 30, pp.861-7.

157. Shen B. and Stephanson O. (1994), “Modification of the G-criterion for crack propagation subjected to compression”, *Eng Fract Mech*, 47(2), pp.177-89.

158. Shen B., Tan X., Li C. and Stephanson O. (1997), “Simulation of borehole breakouts using fracture mechanics model”, In*: Sugawara K, Obara Y (Eds.) “Rock Stress”, Proc. of the International Symposium on Rock Stress, Kumamoto, Japan, 7-10 October, Balkema, Rotterdam*, pp.289-98.

159. Sih G.C., Hilton P.D. and Wei R.P. (1970), “Exploratory development fracture mechanics of composite systems”, *Air Force Technical Report*, AFML-TR-70-112.

160. Singh D.P. (1979), "A study of frictional properties of rock", *4th congress Int. Soc. Rock Mech., Montreux,* pp. 301-305

161. Singh T.N. and Singh D.P. (1992), "Assessing stability of voids in multi seam opencast mining", Colliery guardian, July, pp. 159-164

162. Skempton, A.W. (1961), “Horizontal stress in overconsolidated Eocene clay”, Proc. 5th ICOSMFE, Paris, 1, p. 351-357.
163. Snyman C.P. and Barclay J. (1989), “The coalification of South African Coal”, Int. J. of Coal Geology, v.13, pp. 375-390.
164. Spencer E.E. (1967), “A method of the analysis of the stability of embankments assuming parallel inter-slice forces”, *Geotechnique,* 17, pp. 11-26.
165. SRK (1995), “Failure analysis of the North Pit Failure, Colliery A-1”, *unpublished.*
166. Stacey T.R. (1981): A simple extension strain criterion for fracture of brittle rock. *Int. J. Rock. Mech. Min. Sci. & Geomech. Abstr.* Vol. 18, pp. 469-474.
167. Stacey, T.R. (1970), “Planning Open-pit mines”, J.G. Ince & Son, Johannesburg, pp. 199-207;
168. Stacey, T.R. (1973), “A three-dimensional consideration of stresses surrounding open-pit mine slopes”, I. J. Rock Mech. & Min. Sci., 10.
169. Stead D. and Scoble M.J. (1983), "Rock slope stability assessment in British surface coal mines", *Second international Surface mining and quarrying symposium*, 4–6 October, Bristol, UK, pp. 205-216
170. Stead D., Eberhardt E., Coggan J. and Benko B. (2001), “Advanced numerical techniques in rock slope stability analysis – Applications and limitations”, *Landslides – Causes, Impacts and Countermeasures*, Davos, Switzerland, pp. 615-624.
171. Steif P.S. (1984), “Crack extension under compressive loading”, *Eng. Fract. Mech.*, 20(3), pp.463–73.

172. Sturman J.M. (1984), "Influence of slope stability on economics of opencast coal mining in the east and north midlands of England", Surface mining and quarrying, 2nd Int. Surface mining and quarrying symposium, Bristol, UK, pp. 217-224

173. Sultan H.A. and Seed B.H. (1967), “Stability of sloping core earth dams”, *J. Soil Mech. Found. Div., Proc. ASCE.*

174. Sylvester A.G. (1988), “Strike-slip faults”, *Geological Society of America*, Bulletin 100, pp. 1666-1703.

175. Tada H., Paris P.C. and Irwin G.R. (1985), “The stress analysis of cracks handbook”, *2nd ed. St. Louis, Paris Production Incorporated*.

176. Tamate O. (1968), “The effect of a circular inclusion on the stresses around a line crack in a sheet under tension”, *Int J Fract*, 4, pp.257–66.

177. Tapponnier P. and Brace W.F. (1976), “Development of stress-induced microcracks in Westerly granite”, *Int J Rock Mech Min Sci Geomech Abstr*, 13, pp.103–12.

178. Tchalenko, J.S. and Ambraseys, N.N. (1970), “Structural analysis of the Dasht-e Bayaz (Iran) earthquake fractures”, *Geological Society of America*, Bulletin 81, pp. 41-60.

179. Terzaghi, K. (1961), “Discussion of Prof. A. W. Skempton’s paper - Horizontal stress in overconsolidated Eocene clay”, Proc. 5th ICOSMFE, Paris, 3, p. 144-145.

180. Timoshenko, S. (1934), “Theory of elasticity”, McGraw-Hill book company, New York, pp. 333-339.

181. Tsang Y.W. (1984), “The effect of tortuosity on fluid flow through a single fracture”. *Water Resources Research* 20, 1209-1215.

182. Ugular, A.C. (1999), "Stresses in plates and shells", 2nd Edition, McGraw-Hill, p. 39.

183. Van den Hoek P.J., Smit D.J., Kooijman A.P., de Bree P.H. and Kenter C.J. (1994), "Size dependency of hollow-cylinder stability", *Rock Mechanics in Petroleum Engineering, Proceedings of EUROCK '94, Delft, Netherlands, SPE/ISRM International Conference, 29-31 August. Balkema, Rotterdam and Brookfield*, pp.191-8.

184. Van der Merwe N. (1998), "Practical coal mining strata control", *ITASCA Africa*.

185. Van der Merwe, J.N. (2002-a), Personal conversation.

186. Van der Merwe, J.N. (2002-b), "Horizontal stress: The root of all evil?", Proc. 19th Conf. On Ground Control in Mining, Teheran.

187. Vardoulakis I.G. and Papamichos E. (1991), "Surface instabilities in elastic anisotropic media with surface-parallel Griffth cracks", *Int J Rock Mech Min Sci and Geomech Abstr*, 28(2/3), pp.163-73.

188. Vasarhelyi B. and Bobet A (2000), "Modeling of crack initiation, propagation and coalescence in uniaxial compression", *Rock Mech Rock Eng*, 33(2), pp.119–39.

189. Vermeer P.A. and de Borst R. (1984), "Non-associated plasticity for soil, concrete and rock", *Heron* Vol. 29, No. 3, Delft University of Technology, Delft, The Netherlands.

190. Vermeer P.A. (1990), "The orientation of shear bands in biaxial tests", *Geotechnique* 40, pp. 223-236.

191. Wang C., Libardi N. and Baldo J.B. (1998), "Analysis of crack extension paths and toughening

in two-phase brittle particulate composites by the boundary element method". *Int J Fract*, 94, pp.177-88.

192. Whittaker B.N., Singh R.N. and Sun G. (1992), "Rock fracture mechanics – principles, design and applications", *Elsevier, Amsterdam*.
193. Wong H.C., Chau K.T. and Wang P. (1995), "Microcracking in coarse and fine grain marble", *Proc. 35th US Symp. On Rock Mech., Lake Tahoe, Balkema, Rotterdam*, pp.477-482.
194. Wong R.H.C., Chau K.T., C.A. Tang C.A. and Lin P. (2001-a), "Analysis of crack coalescence in rock-like materials containing three flaws-Part I: experimental approach", *Int. Journal of Rock Mechanics and Mining Sciences,* 38, pp. 909–924
195. Wong R.H.C., Chau K.T., C.A. Tang C.A. and Lin P. (2001-b), "Analysis of crack coalescence in rock-like materials containing three flaws-Part II: numerical approach", *Int. Journal of Rock Mechanics and Mining Sciences,* 38, pp. 925–939
196. Wong R.H.C., Tang C.A., Chau K.T. and Lin P. (2002), "Splitting failure in brittle rocks containing pre-existing flaws under uniaxial compression", *Eng. Fracture Mech.*, 69 (2002), pp.1853-1871.
197. Wong T.F. (1982), "Micromechanics of faulting in westerly granite". *Int J Rock Mech Min Sci, Geomech Abstr*, 19, pp.49–64.
198. Wright S.K., Kulhawy F.H. and Duncan J.M., (1973), "Accuracy of equilibrium slope stability analysis", J. of the Soil Mech. and Found. Div., ASCE, Vol. 99, No SM10, pp. 783-791
199. Wu H. and Pollard D.D. (1995), "An experimental study of the relationship between joint spacing

and layer thickness”, *Journal of Structural Geology*, 17, pp. 887-905.

200. Xia L., Shih C.F. and Hutchinson J.W. (1995), “A computational approach to ductile crack growth under large scale yielding conditions”, *J Mech Phys Solids*, 43.

201. Yu S.W. and Fan X.J. (1992), “Temperature fields at crack tip in a damaging medium”, *ZAMM*, 72.

202. Zhang Ch. and Gross D. (1994), “Ductile crack analysis by a cohesive damage zone model”, *Engineering Fracture Mech.*, 47.

203. Zheng Z. (1998), “Integrated borehole stability analysis - Against tradition”, *ISPE/ISRM Eurock '98, Trondheim, Norway*, vol. 1, pp. 395-402.

204. Zheng Z., Kemeny J. and Cook N.G.W. (1989), “Analysis of borehole break-outs”, *J. Geophys. Res., B94*, pp. 7171-7182.