

THE SHEAR STRENGTH OF ROCK MASSES

by

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the requirements for the degree of
Doctor of Philosophy



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The first section of this thesis (Chapter 2) describes the creation and analysis of a database on concrete and masonry dam incidents known as CONGDATA. The aim was to carry out as complete a study of concrete and masonry dam incidents as was practicable, with a greater emphasis than in other studies on the geology, mode of failure, and the warning signs that were observed. This analysis was used to develop a method of very approximately assessing probabilities of failure. This can be used in initial risk assessments of large concrete and masonry dams along with analysis of stability for various annual exceedance probability floods.

The second and main section of this thesis (Chapters 3-6) had its origins in the results of Chapter 2. It was found that failure through the foundation was common in the list of dams analysed and that information on how to assess the strength of the foundations of dams on rock masses was limited. This section applies to all applications of rock mass strength.

Methods used for assessing the shear strength of jointed rock masses are based on empirical criteria. As a general rule such criteria are based on laboratory scale specimens with very little, and often no, field validation.

The Hoek-Brown empirical rock mass failure criterion was developed in 1980 for hard rock masses. Since its development it has become almost universally accepted and is now used for all types of rock masses and in all stress regimes. This thesis uses case studies and databases of intact rock and rockfill triaxial tests collated by the author to review the current Hoek-Brown criterion. The results highlight the inability of the criterion to fit all types of intact rock and poor quality rock masses. This arose predominately due to the exponent, a , being restrained to approximately 0.5 to 0.6 and using rock type as a predictor of m_i . Modifications to the equations for determining the Hoek-Brown parameters are provided that overcome these problems.

In the course of reviewing the Hoek-Brown criterion new equations were derived for estimating the shear strength of intact rock and rockfill. Empirical slope design curves have also been developed.

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ABSTRACT

The first section of this thesis (Chapter 2) describes the creation and analysis of a database on concrete and masonry dam incidents known as *CONGDATA*. The aim was to carry out as complete a study of concrete and masonry dam incidents as was practicable, with a greater emphasis than in other studies on the geology, mode of failure, and the warning signs that were observed. This analysis was used to develop a method of very approximately assessing probabilities of failure. This can be used in initial risk assessments of large concrete and masonry dams along with analysis of stability for various annual exceedance probability floods.

The second and main section of this thesis (Chapters 3-6) had its origins in the results of Chapter 2 and the general interests of the author. It was found that failure through the foundation was common in the list of dams analysed and that information on how to assess the strength of the foundations of dams on rock masses was limited. This section applies to all applications of rock mass strength such as the stability of rock slopes.

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The Hoek-Brown empirical rock mass failure criterion was developed in 1980 for hard rock masses. Since its development it has become virtually universally accepted and is now used for all types of rock masses and in all stress regimes. This thesis uses case studies and databases of intact rock and rockfill triaxial tests collated by the author to review the current Hoek-Brown criterion. The results highlight the inability of the criterion to fit all types of intact rock and poor quality rock masses. This arose predominately due to the exponent a being restrained to approximately 0.5 to 0.62 and using rock type as a predictor of m_i . Modifications to the equations for determining the Hoek-Brown parameters are provided that overcome these problems.

In the course of reviewing the Hoek-Brown criterion new equations were derived for estimating the shear strength of intact rock and rockfill. Empirical slope design curves have also been developed for use as a preliminary tool for slope design.

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TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

1.1	THESIS OBJECTIVES	1.1
1.2	THE BACKGROUND TO THIS THESIS	1.2
1.3	THE CHAPTERS IN THIS THESIS	1.3
1.3.1	The analysis of concrete and masonry dam incidents	1.3
1.3.2	The shear strength of rock masses	1.4
1.4	PUBLISHED PAPERS/REPORTS	1.6

CHAPTER 2: THE ANALYSIS OF CONCRETE AND MASONRY DAM INCIDENTS

2.1	OUTLINE OF THIS CHAPTER	2.1
2.2	STRUCTURE AND ASSEMBLY OF CONGDATA DATABASE.....	2.4
2.2.1	Sources of Data	2.4
2.2.2	CONGDATA Layout	2.9
2.2.3	Data Entered into CONGDATA	2.12
2.2.3.1	<i>Definitions of Failures/Accidents</i>	2.12
2.2.3.2	<i>Types of Dams</i>	2.14
2.2.3.3	<i>Failure Types</i>	2.14
2.2.3.4	<i>Incident Time</i>	2.15
2.2.3.5	<i>Type of Foundation</i>	2.15
2.2.3.6	<i>Dam Height</i>	2.15
2.2.3.7	<i>Detection Methods</i>	2.16
2.2.3.8	<i>Classification of Causes of Incidents of Dams And Reservoirs</i>	2.17
2.2.3.9	<i>Classification of Remedial Measures</i>	2.22
2.2.4	Selection of Additional Variables.....	2.24
2.2.4.1	<i>Time of Incidents</i>	2.24
2.2.4.2	<i>Foundation Incident Mode</i>	2.25
2.2.4.3	<i>Dam Incident Mode</i>	2.26
2.2.4.4	<i>Comments on Incidents</i>	2.26

2.2.4.5	<i>Description of the Failure or Accident</i>	2.26
2.2.4.6	<i>Additional Geological Information</i>	2.26
2.2.4.7	<i>Dam Dimensions</i>	2.28
2.2.4.8	<i>Valley Shape</i>	2.29
2.2.4.9	<i>Radius of Curvature</i>	2.29
2.2.4.10	<i>Monitoring and Surveillance Data</i>	2.31
2.2.4.11	<i>Warning Rating</i>	2.32
2.2.4.12	<i>Warning Time</i>	2.32
2.2.4.13	<i>Other Design Factors</i>	2.32
2.2.5	<i>Assumptions Made in Assembling the Database</i>	2.33
2.2.6	<i>Data on the Population of Dams</i>	2.36
2.3	RESULTS OF ANALYSIS OF THE DATABASE	2.40
2.3.1	<i>Summary of Incidents</i>	2.40
2.3.2	<i>Year Commissioned of Dams Experiencing Incidents</i>	2.45
2.3.3	<i>Height</i>	2.54
2.3.4	<i>Age at Failure</i>	2.60
2.3.5	<i>Incident Causes</i>	2.78
2.3.6	<i>Monitoring and Surveillance Data</i>	2.85
2.3.6.1	<i>Using ICOLD Terms</i>	2.85
2.3.6.2	<i>Details of Warnings</i>	2.89
2.3.7	<i>Remedial Measures</i>	2.98
2.3.8	<i>Geology</i>	2.101
2.3.8.1	<i>Geology of Dam Foundations Experiencing Incidents</i>	2.101
2.3.8.2	<i>Geology of the Population of Dams</i>	2.106
2.3.9.3	<i>Geology - Comparison Between Incidents and Population</i>	2.112
2.3.9	<i>Other Design Factors in Failed Dams</i>	2.123
2.4	METHOD OF FIRST ORDER PROBABILITY ASSESSMENT	2.132
2.4.1	<i>Probability of Failure</i>	2.132
2.4.1.1	<i>Introduction</i>	2.132
2.4.1.2	<i>Population of Dams</i>	2.133
2.4.1.3	<i>Dam Year</i>	2.135
2.4.1.4	<i>Probabilities of Failure</i>	2.135
2.4.1.5	<i>Gravity Dams - Separation of Concrete and Masonry Dams</i>	2.146

2.4.2 General Approach for Estimating the Probability of Failure for Individual Gravity Dams	2.153
2.4.3 Details of the Method for Estimating the Probability of Failure for Individual Gravity Dams	2.154
2.4.4 Gravity Dam Probability Multiplication Factors.....	2.158
2.4.4.1 Soil/Rock Foundation Factor, f_{SF} and f_{PF}	2.158
2.4.4.2 Geology Types - Sliding on Rock, f_{SG}	2.161
2.4.4.3 Geology Type - Piping on Rock, f_{GE}	2.164
2.4.4.4 Height on Width Ratio, f_{HW}	2.164
2.4.4.5 Other Observations, f_O	2.169
2.4.4.6 Surveillance, f_S	2.169
2.4.5 Results.....	2.170
2.5 DISCUSSION AND CONCLUSIONS.....	2.172

CHAPTER 3: THE SHEAR STRENGTH OF INTACT ROCK

3.1 INTRODUCTION.....	3.1
3.2 FAILURE CRITERIA FOR INTACT ROCK.....	3.2
3.3 LABORATORY TEST DATABASE FOR INTACT ROCK.....	3.12
3.4 AN ANALYSIS OF THE ANALYSIS OF DATA	3.14
3.5 HOEK-BROWN CRITERION FOR INTACT ROCK.....	3.24
3.6 GENERALISED CRITERION FOR INTACT ROCK	3.32
3.7 GLOBAL PREDICTION.....	3.49
3.8 COMPARISON OF CRITERIA	3.60
3.9 SYSTEMATIC ERROR IN HOEK-BROWN CRITERION.....	3.64
3.10 APPLICATION TO SLOPE ENGINEERING	3.73
3.11 CONCLUSION	3.77

CHAPTER 4: THE SHEAR STRENGTH OF ROCKFILL

4.1 OUTLINE OF THIS CHAPTER	4.1
4.2 FACTORS AFFECTING THE SHEAR STRENGTH OF ROCKFILL	4.2

4.2.1	Confining Pressure.....	4.2
4.2.2	Particle Strength.....	4.6
4.2.3	Uniformity Coefficient	4.8
4.2.4	Density.....	4.10
4.2.5	Maximum Particle Size.....	4.12
4.2.5.1	<i>Increasing d_{max} with Constant D</i>	4.13
4.2.5.2	<i>Increasing d_{max} with Constant d_{max}/D</i>	4.13
4.2.6	Silt and Sand Fines versus Gravel and Larger Particle Content.....	4.14
4.2.7	Particle Angularity.....	4.16
4.2.8	Other Factors.....	4.17
4.2.9	Summary of Factors Affecting the Secant Friction Angle	4.18
4.3	SHEAR STRENGTH CRITERIA	4.19
4.4	DATABASE OF TRIAXIAL SHEAR TESTS.....	4.26
4.5	DATABASE ANALYSIS	4.29
4.5.1	Analysis Methodology.....	4.29
4.5.2	Secant Friction Angle, ϕ_{sec} , Versus Normal Stress, σ_n	4.30
4.5.2.1	<i>General Assessment of Database</i>	4.30
4.5.2.2	<i>Statistical Analysis of Database</i>	4.40
4.5.3	Maximum Principal Stress, σ'_1 , versus Minimum Principal Stress, σ'_3	4.41
4.5.3.1	<i>Secant Friction Angle Versus Normal Stress</i>	4.58
4.5.4	Hoek-Brown Criterion.....	4.61
4.6	CONCLUSION.....	4.64
CHAPTER 5: EMPIRICAL ROCK SLOPE DESIGN		
5.1	INTRODUCTION.....	5.1
5.2	REVIEW OF THE ROCK MASS RATING SYSTEMS	5.2
5.2.1	Methods for Estimating the Basic Rock Mass Rating.....	5.3
5.2.1.1	<i>The Rock Mass Rating, RMR, and Geological Strength Index, GSI</i>	5.3
5.2.1.2	<i>Mining Rock Mass Rating, MRMR</i>	5.6
5.2.1.3	<i>Rock Mass Strength, RMS</i>	5.9
5.2.1.4	<i>Slope Rock Mass Rating, SRMR</i>	5.11
5.2.1.5	<i>Modified Rock Mass Classification, M-RMR</i>	5.14

5.2.1.6 Basic Quality, BQ	5.17
5.2.2 Adjustment Factors to basic rock mass ratings	5.19
5.3 A REVIEW OF SLOPE DESIGN METHODS WHICH ARE BASED ON ROCK MASS RATINGS	5.25
5.3.1 Correlations with Shear Strength Parameters and Slope Angles	5.25
5.3.2 Available Slope Performance Curves	5.30
5.3.3 Pells Sullivan Meynink Slope Performance Curves	5.36
5.4 ANALYSIS OF CASE STUDY DATA	5.39
5.4.1 Case Studies Used	5.39
5.4.2 Correlations of MRMR, SRMR and RMS with GSI	5.40
5.4.3 General Assessment of the Parameters in GSI	5.51
5.4.4 Development of Generalised Slope Design Curves	5.54
5.4.4.1 Use of MRMR in Haines and Terbrugge Method	5.54
5.4.4.2 Revised Method Using MRMR	5.54
5.4.4.3 Method Based on the Use of the Geological Strength Index, GSI	5.55
5.5 CONCLUSION	5.62
 CHAPTER 6: THE SHEAR STRENGTH OF ROCK MASSES	
6.1 INTRODUCTION	6.1
6.2 ESTIMATING THE SHEAR STRENGTH OF A ROCK MASS	6.3
6.2.1 Predicting Rock Mass Strength from Discontinuities	6.3
6.2.2 Predicting Rock Mass Strength using Empirical Formulae	6.8
6.2.3 Predicting Rock Mass Strength using the Hoek-Brown Criterion	6.8
6.3 A DISCUSSION OF THE HOEK-BROWN CRITERION WITH PARTICULAR REFERENCE TO SLOPES	6.16
6.3.1 Calculation of GSI	6.16
6.3.1.1 Intact Strength	6.16
6.3.1.2 RQD	6.17
6.3.1.3 Defect spacing	6.18
6.3.1.4 Joint condition	6.18
6.3.1.7 GSI from published figures	6.20
6.3.1.8 A Note on Schistose Rocks	6.20

6.3.2	Estimation of Parameters from GSI.....	6.26
6.3.2.1	<i>The Rock Mass Disturbance Factor, D.....</i>	6.26
6.3.2.2	<i>The Variation of the Hoek-Brown Parameters with GSI.....</i>	6.27
6.4	VALIDATION OF THE HOEK-BROWN CRITERION	6.30
6.4.1	Chichester Dam.....	6.30
6.4.2	Nattai North Escarpment Failure	6.30
6.4.3	Katoomba Escarpment Failure.....	6.35
6.4.4	Aviemore Dam Insitu Shear Tests	6.39
6.4.5	Discussion of the Results of the Analysis.....	6.43
6.5	A NEW ESTIMATION OF ROCK MASS STRENGTH	6.46
6.5.1	Development of a Modified Criterion	6.46
6.5.1.1	<i>Exponent ‘a’.....</i>	6.47
6.5.1.2	<i>Parameter ‘m’.....</i>	6.47
6.5.1.3	<i>Parameter ‘s’.....</i>	6.48
6.5.2	Development of the Equations to Estimate the Parameters in the Hoek-Brown Criterion.....	6.49
6.5.2.1	<i>A New Equation for ‘m_b’.....</i>	6.50
6.5.2.2	<i>A New Equation for ‘s_b’.....</i>	6.54
6.5.2.3	<i>A New Equation for ‘a_b’.....</i>	6.56
6.5.2.4	<i>The Overall Equation.....</i>	6.61
6.5.3	Summary of Method	6.69
 CHAPTER 7: CONCLUSIONS AND RECOMMENDATIONS		
7.1	CONCLUSIONS.....	7.1
7.1.1	The Analysis of Concrete and Masonry Dams	7.1
7.1.2	The Shear Strength of Intact Rock.....	7.3
7.1.3	The Shear Strength of Rockfill.....	7.4
7.1.4	Empirical Slope Design	7.4
7.1.5	The Shear Strength of Rock Masses.....	7.5
7.2	RECOMMENDATIONS FOR FURTHER RESEARCH.....	7.7
7.2.1	The Analysis of Concrete and Masonry Dams	7.7
7.2.2	The Shear Strength of Rock Masses.....	7.7

REFERENCES

APPENDICES

APPENDIX A – CONGDATA DATABASE CD-ROM

APPENDIX B – DAM LIST - FAILURES A.1

APPENDIX C – POPULATION OF DAMS A.3

APPENDIX D – CAUSES OF INCIDENTS..... A.11

APPENDIX E – SHEAR STRENGTH OF INTACT ROCK DATABASE CD-ROM

APPENDIX F – SHEAR STRENGTH OF ROCKFILL DATABASE CD-ROM

TABLE OF FIGURES

Figure 1.1. Thesis structure.....	1.2
Figure 2.1. Definition of dimensions in <i>CONGDATA</i>	2.30
Figure 2.2. Definition of dimensions in <i>CONGDATA</i> - section across river.....	2.31
Figure 2.3. The distribution of reported dam incidents vs country.....	2.43
Figure 2.4. Reported incidents as percentage of country's dam population from ICOLD (1984)	2.44
Figure 2.5. Year commissioned vs concrete gravity dam incidents	2.47
Figure 2.6. Year commissioned vs masonry gravity dam incidents	2.48
Figure 2.7. Year commissioned vs all dam incidents	2.49
Figure 2.8. Year commissioned for world population data obtained from ICOLD (1979)	2.50
Figure 2.9. Year commissioned vs percentage of gravity dams constructed in the USA	2.51
Figure 2.10. Year commissioned - failures/population per period	2.52
Figure 2.11. <i>CONGDATA</i> - height ranges for all dam significant incidents	2.55
Figure 2.12. <i>CONGDATA</i> - Height ranges for concrete gravity dam significant incidents.....	2.56
Figure 2.13. <i>CONGDATA</i> - height ranges for masonry gravity dam significant incidents.....	2.57
Figure 2.14. Height of failed dams - failures/population (%).....	2.59
Figure 2.15. World dams - height ranges for all concrete & masonry dams	2.60
Figure 2.16. Age at incident - all dams	2.64
Figure 2.17. Age at incident - concrete gravity dams	2.65
Figure 2.18. Age at incident - masonry gravity dams	2.66
Figure 2.19. Time to significant incident - gravity dam incidents/population (%).....	2.67
Figure 2.20. Time to significant incident - all dam incidents/population (%).....	2.67
Figure 2.21. Failure mode: age at failure versus year commissioned (all dams).....	2.73
Figure 2.22. Over topping: age at failure versus year commissioned (all dams).....	2.74
Figure 2.23. Dam type: age at failure versus year commissioned	2.75
Figure 2.24. Age at significant incident versus year commissioned.....	2.76
Figure 2.25. Age at significant incident versus year commissioned.....	2.77
Figure 2.26. Causes of significant incidents (rock & unknown foundations)	2.84

Figure 2.27. Causes of significant incidents (soil foundations).....	2.85
Figure 2.28. Warning types - gravity dams	2.86
Figure 2.29. Warning Types - All Dams	2.87
Figure 2.30. Most common remedial measures - all dam incidents	2.99
Figure 2.31. Foundation incidents age, type and year commissioned - all dams	2.104
Figure 2.32. Foundation incidents geology - all incidents.....	2.105
Figure 2.33. Geology for incidents in the foundation and dam population – all dams	2.115
Figure 2.34. Geology for incidents in the foundation and dam population – concrete gravity dams.....	2.116
Figure 2.35. Geology for incidents in the foundation and dam population – masonry gravity dams	2.117
Figure 2.36. Foundation geology type as a percentage of the geology population – all dams.....	2.118
Figure 2.37. Foundation geology type as a percentage of the geology population – gravity dams	2.119
Figure 2.38. Foundation geology type as a percentage of geology population – arch dams	2.120
Figure 2.39. Foundation geology type as a percentage of geology population – buttress dams	2.121
Figure 2.40. Foundation incident geology and population – mode of failure/accident	2.122
Figure 2.41. Average failure stresses for dams with failure through the foundation.	2.131
Figure 2.42. Average failure stresses for Bhandardara Dam.....	2.131
Figure 2.43. h_d/W versus year commissioned.....	2.166
Figure 2.44. h_d/W versus h_d	2.167
Figure 2.45. h_d/W factors	2.168
Figure 2.46. Range of annual probability of failure for concrete gravity dams	2.170
Figure 2.47. Range of annual probability of failure for masonry gravity dams	2.171
Figure 3.1. Generalised failure criterion.....	3.2
Figure 3.2. Comparison of test results with theoretically based failure criteria (Johnston & Chiu, 1984)	3.3
Figure 3.3. Comparison of Hoek-Brown criterion (solid) and Johnston criterion (dashed) for Melbourne mudstone (Johnston, 1985).....	3.4

Figure 3.4. Fits to artificial data (a) full range (b) low stress range	3.20
Figure 3.5. m_i from literature against m_i from test results and Hoek-Brown Equation.....	3.26
Figure 3.6. Rock type against m_i from test results and Hoek-Brown equation.....	3.28
Figure 3.7. Unconfined compressive strength against that predicted by the Hoek-Brown equation	3.30
Figure 3.8. Uniaxial tensile strength against that predicted by the Hoek-Brown equation.....	3.31
Figure 3.9. m_i from literature against m_i from test results and generalised equation.....	3.34
Figure 3.10. m_i from literature against a m_i from test results and generalised equation.....	3.36
Figure 3.11. Rock type against a m_i from test results and generalised equation.....	3.37
Figure 3.12. Unconfined compressive strength against that predicted by generalised equation.....	3.39
Figure 3.13. Uniaxial tensile strength against that predicted by generalised equation.....	3.41
Figure 3.14. a against m_i	3.43
Figure 3.15. a against m_i categorised by s_c	3.45
Figure 3.16. Family of failure envelopes.....	3.46
Figure 3.17. Results showing failure envelopes crossing	3.47
Figure 3.18. Residuals for global fit with a constant against s_c/s_t categorised by $-s_c/s_t$	3.50
Figure 3.19. Residuals for global fit with variable α against s_c/s_t categorised by $-s_c/s_t$	3.52
Figure 3.20. Three dimensional plot of global fit.....	3.54
Figure 3.21. s_c/s_t with fits for variable a against s_c/s_t categorised by $-s_c/s_t$ for high stress.....	3.56
Figure 3.22. s_c/s_t with fits for variable a against s_c/s_t categorised by $-s_c/s_t$ for low stress	3.57
Figure 3.23. a against m_i showing cases with measured or reported s_c and s_t	3.59
Figure 3.24. s_c/s_t with fits for published m_i against s_c/s_t categorised by m_i for high stress.....	3.62

Figure 3.25. σ'_3/s_c with fits for published m_I against σ'_3/s_c categorised by m_I for low stress	3.63
Figure 3.26. Pattern of residuals for Hoek-Brown fits	3.64
Figure 3.28. Hoek-Brown fits to artificial data.....	3.67
Figure 3.29. Hoek-Brown fits to actual data.....	3.69
Figure 3.30. Residuals for Hoek-Brown fits for weak rock against $\sigma'_3/s_{c_{max}}$ categorised by a	3.71
Figure 3.31. Residuals for generalised fits for weak rock against $\sigma'_3/s_{c_{max}}$ categorised by a	3.72
Figure 3.32. Residuals against σ'_3 for various fits	3.75
Figure 4.1. Methods for representing the shear strength envelope.....	4.4
Figure 4.2. Variation of secant friction angle, ϕ_{sec} , with respect to cell confining stress, σ'_3 , for (a) dense and (b) medium dense crushed basalt from triaxial tests (Al-Hussaini, 1983).....	4.5
Figure 4.3. Average strength of rockfills from large-scale direct shear tests (Anagnosti & Popovic, 1982).....	4.5
Figure 4.4. Variation of secant friction angle, ϕ_{sec} , with normal stress s_n (Indraratna et al., 1993)	4.6
Figure 4.5. Shear strength and grain size curves for crushed (a) limestone and (b) marble (Anagnosti and Popovic, 1982).....	4.7
Figure 4.6. Shear strength and grain size curves for crushed flysch sandstone-marl rockfill (Anagnosti and Popovic, 1982).....	4.7
Figure 4.7. Shear strength and grain size curves for different gradings of limestone gravel (Anagnosti and Popovic, 1982)	4.9
Figure 4.8. Shear strength and grain size curves for (a) crystalline schist and (b) sandstone gravels (Anagnosti and Popovic, 1982).....	4.9
Figure 4.9. Scalped rockfill gradings (Marachi et al, 1969).....	4.11
Figure 4.10. Strength porosity relationships with $\sigma_3 = 88\text{kPa}$ (Marachi et al, 1969).....	4.11
Figure 4.12. Void ratio vs angle of friction (modified from Nakayama et al., 1982).....	4.12
Figure 4.13. Friction angle vs maximum particle size (Thiers & Donovan, 1981).....	4.13
Figure 4.14. Effect of gravel content on ϕ for silty gravel based on USBR (1966)	4.15
Figure 4.15. Effect of gravel content on ϕ for clayey gravel based on USBR (1961)	4.15

Figure 4.16. –4.76mm content vs secant angle of friction (Nakayama et al., 1982) ...	4.16
Figure 4.17. Gonzalez (1985) shear strength of rockfill equations.....	4.22
Figure 4.18. Friction angle, f , vs normal stress, s_n	4.23
Figure 4.19. Frequency distributions for coefficients B versus porosity (Sarac & Popovic, 1985).....	4.23
Figure 4.20. Dependence between coefficient A and gravel unit weight (Sarac & Popovic, 1985).....	4.24
Figure 4.21. Dependence between coefficient A and mean grain diameter, d_{50} (Sarac & Popovic, 1985).....	4.24
Figure 4.22. Secant friction angle, ϕ_{sec} vs normal stress, σ_n	4.33
Figure 4.23. Secant friction angle, ϕ_{sec} vs normal stress, σ_n , sorted on angularity rating.....	4.34
Figure 4.24. Secant friction angle, ϕ_{sec} vs normal stress, σ_n , sorted on rock type = basalt.....	4.35
Figure 4.25. Secant friction angle, ϕ_{sec} vs normal stress, σ_n , sorted on coefficient of uniformity, c_u	4.36
Figure 4.26. Secant friction angle, ϕ_{sec} vs normal stress, σ_n , sorted on maximum particle size, d_{max}	4.37
Figure 4.27. Secant friction angle, ϕ_{sec} vs normal stress, σ_n , sorted on percent fines (passing 0.075mm) content.....	4.38
Figure 4.28. Secant friction angle, ϕ_{sec} vs normal stress, σ_n , sorted on unconfined compressive strength of the rock substance, UCS (MPa).....	4.39
Figure 4.29. RFI_e versus void ratio.....	4.43
Figure 4.30. RFI_{UCS} versus unconfined compressive strength.....	4.43
Figure 4.31. RFI_{FINES} versus percent fines.....	4.44
Figure 4.32 Residuals versus unconfined compressive strength of intact rock.....	4.46
Figure 4.33. Residuals versus d_{max}	4.47
Figure 4.34. Residuals versus void ratio.....	4.48
Figure 4.35. Residuals versus angularity rating.....	4.49
Figure 4.36. Residuals versus fines content.....	4.50
Figure 4.37. Residuals versus sample diameter.....	4.51
Figure 4.38. Effect of unconfined compressive strength on σ'_1	4.52
Figure 4.39. Effect of angularity on σ'_1 (7 = sub-angular to angular; 8 = angular).....	4.52

Figure 4.40. Effect of fines content on σ'_1	4.53
Figure 4.41. Effect of maximum particle size on σ'_1	4.53
Figure 4.42. Effect of initial void ratio on σ'_1	4.54
Figure 4.43. σ'_1 vs σ'_3 showing data used in analysis and RFI relationship.....	4.55
Figure 4.44. σ'_1 vs σ'_3 showing all data and RFI relationship.....	4.56
Figure 4.45. σ'_1 vs σ'_3 showing all data and RFI relationship (σ'_3 up to 1.5MPa).....	4.57
Figure 4.46. Effect of unconfined compressive strength on ϕ_{sec}	4.59
Figure 4.47. Effect of angularity on ϕ_{sec} (7 = sub-angular to angular; 8 = angular)....	4.59
Figure 4.48. Effect of fines content on ϕ_{sec}	4.60
Figure 4.49. Effect of maximum particle size on ϕ_{sec}	4.60
Figure 4.50. Effect of initial void ratio on ϕ_{sec}	4.61
Figure 4.51. Statistical analysis results using Hoek-Brown formula and for $a = 0.6$ and $a = 0.95$	4.63
Figure 5.1. Estimate of GSI based on geological descriptions. (Hoek, 2000).....	5.7
Figure 5.2. SRMR strength correlation (a) Island Copper Mine (b) Getchell Mine (Robertson, 1988).....	5.14
Figure 5.3. Example of Planar Failure Case with High SMR.....	5.21
Figure 5.4. Slope height, H, vs slope height factor, ξ (after Chen, 1995)	5.22
Figure 5.5. RMR versus slope angle (Orr, 1996).....	5.27
Figure 5.6. Observed cases (ESMR) vs (a) SMR, (b) CSMR (Chen, 1995)	5.29
Figure 5.7. Upper bound slope height versus slope angle curve for rock masses (Hoek & Bray, 1981).....	5.31
Figure 5.8. Slope angle versus slope height with regression curves (modified after McMahon, 1976).....	5.33
Figure 5.9. Slope height vs slope angle for MRMR (Haines & Terbrugge, 1991)....	5.34
Figure 5.10. Haines & Terbrugge (1991) slope design replotted on basis of slope angle versus slope height showing Haines & Terbrugge (1991) slope data.	5.35
Figure 5.11. Slope performance curves for case studies (Duran & Douglas, 1999)....	5.37
Figure 5.12. Correlations of GSI with MRMR, SRMR, RMS rating (mod. Duran and Douglas, 2002).....	5.42
Figure 5.13. GSI versus slope height for failed and stable slopes.....	5.51

Figure 5.14. GSI defect spacing rating versus slope height for failed and stable slopes.....	5.52
Figure 5.15. GSI defect condition rating versus slope height for failed and stable slopes.....	5.52
Figure 5.16. GSI RQD rating versus slope height for failed and stable slopes.....	5.53
Figure 5.17. GSI UCS rating versus slope height for failed and stable slopes.....	5.53
Figure 5.18. Haines & Terbrugge (1991) slope design curves & slope data (Figure 5.10) with additional case studies (Duran & Douglas, 1999).....	5.56
Figure 5.19. Suggested slope design curves for MRMR (Duran & Douglas, 1999)...	5.57
Figure 5.20. Slope height vs slope angle case study data and the author's proposed design curves for a dry slope.....	5.58
Figure 5.21. Slope height vs slope angle case study data and a comparison of design curves for a dry slope.....	5.59
Figure 5.22. Slope height vs slope angle case study data and the author's proposed design curves for moderate pressures.....	5.60
Figure 5.23. Slope height vs slope angle case study data and a comparison of design curves for moderate pressures.....	5.61
Figure 6.1. Heavily jointed rock mass.....	6.1
Figure 6.2. Example of shear failure through rock mass at the toe of a slope - Nattai Escarpment Failure.....	6.2
Figure 6.3. Assessment of Barton and Bandis (1982) JRC_0 vs JRC_n	6.7
Figure 6.4. Values of the parameter m_i for intact rock (Hoek, 1999).....	6.11
Figure 6.5. Estimation of GSI (Hoek, 1997).....	6.12
Figure 6.6. History of the Hoek-Brown criterion (Hoek, 2002).....	6.13
Figure 6.7. Scale effect of Intact Rock (Hoek and Brown, 1980).....	6.17
Figure 6.8. Slope failure block size.....	6.19
Figure 6.9. Effect of scale on defect properties.....	6.19
Figure 6.10. GSI Table (Hoek et al, 1998).....	6.22
Figure 6.11. E_d versus GSI case study data and Hoek et al (1995) equation for $\sigma_c \geq 100\text{MPa}$ and $\sigma_c = 10\text{MPa}$	6.24
Figure 6.12. E_d test from case studies versus E_d pred from Hoek et al (1995) equation.....	6.25
Figure 6.13. Variation of a , s and m_b/m_i with GSI.....	6.28
Figure 6.14. Typical section of the Nattai North failure (Pells et al, 1987).....	6.31

Figure 6.15. Illustration of the failure mechanism at Nattai North (Helgstedt, 1997).....	6.32
Figure 6.16. Katoomba Escarpment Failure	6.36
Figure 6.17. Katoomba Escarpment Failure, column prior to collapse.....	6.37
Figure 6.18. Direct Shear Test Set up (Foster & Fairless, 1994).....	6.41
Figure 6.19. Example of mesh used (Helgstedt, 1997).....	6.44
Figure 6.20. Close up of the simulated jack (Helgstedt, 1997)	6.44
Figure 6.21. Back analysis results using Figure 6.5 for GSI.....	6.45
Figure 6.22. Test results for tectonised quartzitic sandstone (Habimana et al, 2002).....	6.52
Figure 6.23. The author's statistical fits to Habimana et al (2002) data.....	6.53
Figure 6.24. m_b versus GSI	6.54
Figure 6.25. GSI for an intact or massive rock structure (Hoek, 1999).....	6.55
Figure 6.26. s_b versus GSI	6.56
Figure 6.27. α_b versus GSI	6.57
Figure 6.28. Graphical representation of the equations for α and m	6.58
Figure 6.29. Transition of α and m from intact rock to rock mass	6.59
Figure 6.30. Original and modified relationships for α_i and m_i	6.60
Figure 6.31. Shear strength curves for tectonised quartzitic sandstone (Habimana et al, 2002).....	6.61
Figure 6.32. Results of analysis of Habimana et al (2002) data using the new equation and parameters from equations	6.63
Figure 6.33. Results of global analysis of Habimana et al (2002) data using new equations.....	6.64
Figure 6.34. Non-dimensionalised plot of new shear strength curves for $m_i = 40$ and varying GSI.....	6.65
Figure 6.35. Non-dimensionalised plot of new shear strength curves for $m_i = 4$ and varying GSI.....	6.66
Figure 6.1. Comparison of the author's criterion and the Hoek-Brown criterion (Hoek, 2002) for $m_i = 40$	6.67
Figure 6.2. Comparison of the author's criterion and the Hoek-Brown criterion (Hoek, 2002) for $m_i = 4$	6.68

TABLE OF TABLES

Table 2.1.	Bibliography for failed dams in <i>CONGDATA</i>	2.6
Table 2.2.	CONGDATA parameters	2.10
Table 2.3.	Causes of incidents of concrete dams	2.18
Table 2.4.	Causes of incidents of masonry dams	2.19
Table 2.5.	Causes of incidents to appurtenant works	2.20
Table 2.6.	Causes of incidents of reservoirs.....	2.21
Table 2.7.	Causes of incidents downstream of dam.....	2.21
Table 2.8.	Classification of remedial measures.....	2.23
Table 2.9.	Number of dam incidents in database by type	2.40
Table 2.10.	Number of significant dam incidents in database by type.....	2.40
Table 2.11.	Number of dam incidents reported in each country	2.42
Table 2.12.	Year commissioned - failures vs population per period.....	2.53
Table 2.13.	Year commissioned - accidents vs population per period.....	2.54
Table 2.14.	Percent of concrete & masonry dam fails vs population for height	2.58
Table 2.15.	Percent of concrete & masonry accidents vs population for height.....	2.58
Table 2.16.	No. of dam foundation sliding & piping failures vs age at failure.....	2.62
Table 2.17.	No. of structural (shear or tensile) failures vs age at failure	2.63
Table 2.18.	Time to significant incident - incident/population of dams surviving period (%).....	2.68
Table 2.19.	Time to significant incident.....	2.69
Table 2.20.	Details of dam failure water levels.....	2.70
Table 2.21.	Failure types	2.78
Table 2.22.	Main causes of incidents in all dams	2.79
Table 2.23.	Main causes of incidents in concrete gravity dams	2.80
Table 2.24.	Main causes of incidents in masonry gravity dams	2.80
Table 2.25.	Main failure causes for dams with soil foundations	2.81
Table 2.26.	Main significant incident causes for dams with rock or unknown foundations	2.82
Table 2.27.	Warning types vs dam type - failures	2.88
Table 2.28.	Warning types vs dam type - accidents	2.88
Table 2.29.	Warning types vs dam type - major repairs.....	2.89
Table 2.30.	Warning ratings for failed dams	2.90

Table 2.31. Details of dam failures and descriptions of warnings	2.91
Table 2.32. Details of dam significant accidents and descriptions of warnings.....	2.95
Table 2.33. Remedial measures - all dam incidents	2.100
Table 2.34. Geology for dams with failure in the foundation.....	2.102
Table 2.35. Geology for dams with accidents in the foundation.....	2.103
Table 2.36. Foundation geology for Australia, New Zealand, Portugal and USBR (percent and <i>number</i> for each group)	2.109
Table 2.37. Foundation geology for Australia, New Zealand, Portugal & USBR dams - totalled Figures	2.111
Table 2.38. Failed dams with grouted foundation.....	2.123
Table 2.39. Crest length/height for failed dams and population	2.125
Table 2.40. Upstream and downstream slopes for failed dams	2.126
Table 2.41. H_d/W for failed dams	2.128
Table 2.42. Back analysed shear strengths for failed dams (mod. from Rich, 1995).....	2.129
Table 2.43. Calculated normal stresses along the failure plane of back analysed gravity dams	2.130
Table 2.44. Number of dams as at 1992	2.133
Table 2.45. Population of dams by dam type and year commissioned	2.134
Table 2.46. Number of dams (excluding China) in the population.....	2.134
Table 2.47. Annual probability of failure (1992, exc. China) - all failure types.....	2.136
Table 2.48. Probability of failure (as at 1992, exc. China, non-annualised) - all failure types	2.137
Table 2.49. Annual probability of failure (as at 1992, excluding China) - sliding failures.....	2.138
Table 2.50. Probability of failure (as at 1992, excluding China, non-annualised) - sliding failures	2.139
Table 2.51. Annual probability of failure (as at 1992, excluding China) - piping failures.....	2.140
Table 2.52. Probability of failure (as at 1992, excluding China, non-annualised) - piping failures.....	2.141
Table 2.53. Annual probability of failure (as at 1992, excluding China) - tension/shear failures through dam body.....	2.142

Table 2.54. Probability of failure (as at 1992, excluding China, non-annualised) - tension/shear failures through dam body.....	2.143
Table 2.55. Number of failures during overtopping where the failure mode was unknown.....	2.144
Table 2.56. No. of failures where the failure mode was unknown (no overtopping)	2.145
Table 2.57. Distribution of concrete and masonry gravity dams in the USA.....	2.146
Table 2.58. Distribution of concrete and masonry gravity dams chosen for analysis	2.148
Table 2.59. Summary of annualised probabilities of failure for gravity dams (exc. China)	2.148
Table 2.60. Suggested values for annualised probabilities of failure for gravity dams (excluding China).....	2.149
Table 2.61. Annualised probabilities of failure for gravity dams - all failures	2.150
Table 2.62. Annualised probabilities of failure for gravity dams - sliding failures ..	2.150
Table 2.63. Annualised probabilities of failure for gravity dams - piping failures ..	2.151
Table 2.64. Annualised probabilities of failure for gravity dams - dam body tension/shear failures	2.151
Table 2.65. Number of failures during overtopping where failure mode was unknown.....	2.152
Table 2.66. Number of failures where failure mode was unknown	2.152
Table 2.67. Foundation types - USBR.....	2.158
Table 2.68. Foundation types - Australia/New Zealand.....	2.158
Table 2.69. Foundation types - Portugal	2.159
Table 2.70. Gravity dam foundation types - combined	2.159
Table 2.71. Foundations for gravity dam failures by sliding or piping	2.159
Table 2.72. Gravity dam factors for piping and sliding failure on soil and rock, f_{SF} and f_{PF}	2.160
Table 2.73. Foundation types - accidents	2.160
Table 2.74. Weighting factors used for weighted average (ICOLD (1984) dam population).....	2.161
Table 2.75. Adopted gravity dam factors for sliding on a rock foundation, f_{SG}	2.162
Table 2.76. Gravity dam factors for sliding on a rock foundation.....	2.163

Table 2.77. Multiplication factors for structural height/width ratio of gravity dams, $f_{H/W}$	2.165
Table 2.78. Monitoring and surveillance multiplication factors, f_s	2.169
Table 3.1. Various intact rock failure criteria.....	3.6
Table 3.2. Empirical estimates of exponents for the equations in Table 3.1.....	3.10
Table 3.3. Suggested values of constant k (Yudhbir et al, 1983 and Bieniawski, 1974).....	3.10
Table 3.4. Values of M and B for a range of materials (Johnston, 1991)	3.10
Table 3.5. Intact rock database descriptors	3.13
Table 3.6. Results of different regression methods on artificial data.....	3.19
Table 3.7. Error in approximating s_{ut} as $-s_c/(m_i+1)$	3.42
Table 3.8. Comparison of predictions	3.60
Table 3.9. Errors in fitting Hoek-Brown criterion to materials with $a \neq 0.5$	3.65
Table 3.10. Variation of s_c and m_i with s_{3max} for exact simulated results	3.66
Table 3.11. Variation of s_c and m_i with $s_{\zeta_{max}}$ for data set 434.....	3.68
Table 3.12. Triaxial component of strength	3.73
Table 3.13. Comparison of predictions for weak rocks at low stress.....	3.74
Table 4.1. Increase in ϕ with d_{max}/D from Marsal (1973) data for different σ_n	4.13
Table 4.2. Reduction in ϕ with particle size, d_{max} , from Marsal (1973) data	4.13
Table 4.3. Summary of factors affecting the secant friction angle.....	4.18
Table 4.4. Parameters obtained using De Mello (1977) (Charles, 1991).....	4.19
Table 4.5. Various shear strength criteria for rockfill	4.20
Table 4.6. List of parameters in triaxial shear strength database	4.27
Table 4.7. Summary of basic statistics from the rockfill database.....	4.28
Table 4.8. Changes in ϕ_{sec} on Figure 4.46 to Figure 4.50 for $\sigma_n=1\text{MPa}$ and $\sigma_n = 0.5\text{MPa}$	4.58
Table 4.9. Results from the statistical analysis of the rockfill database using the Hoek-Brown equation	4.62
Table 5.1. Comparison of weightings for various rock mass rating methods	5.2
Table 5.2. Rock mass rating (Bieniawski, 1989).....	5.5
Table 5.3. Geological strength index, GSI (Hoek et al, 1995)	5.6
Table 5.4. MRMR (Laubscher, 1977)	5.8
Table 5.5. Defect condition rating for MRMR (Laubscher, 1977).....	5.8

Table 5.6.	RMS Classification and Ratings (mod. Selby, 1980).....	5.10
Table 5.7.	SRK Geomechanics Classification or Slope Rock Mass Rating (SRMR)	5.13
Table 5.8.	SRMR strength correlation (Robertson, 1988).....	5.14
Table 5.9.	Joint condition index I_{JC} (Ünal, 1996).....	5.16
Table 5.10.	Ratings for joint condition parameters (Ünal, 1996).....	5.17
Table 5.11.	The basic quality, BQ, rock mass classes (Lin, 1998)	5.18
Table 5.12.	Adjustment rating for joints (after Romana, 1985)	5.20
Table 5.13.	Adjustment Rating for methods of excavation of slopes (after Romana, 1985)	5.20
Table 5.14.	Tentative description of SMR classes (after Romana, 1985).....	5.21
Table 5.15.	Discontinuity condition factor λ (Chen, 1995).....	5.22
Table 5.16.	Blasting adjustment, A_b (Ünal, 1996)	5.23
Table 5.17.	Major plane of weakness adjustment, A_w (Ünal, 1996).....	5.23
Table 5.18.	Rock mass properties for RMR_{76} (Bieniawski, 1976).....	5.25
Table 5.19.	Stable slope angle versus MRMR (Laubscher, 1977).....	5.26
Table 5.20.	Case records for SMR (after Romana, 1985)	5.28
Table 5.21.	Parameters for McMahon's (1976) slope relationship	5.32
Table 5.22.	Summary of slope data from case studies	5.39
Table 5.23.	Correlation between rating methods – author's case studies.....	5.41
Table 5.24.	Summary of best estimate GSI data for mine cases	5.43
Table 5.25.	Summary of defect condition for GSI	5.44
Table 5.26.	Summary of best estimate of Laubscher's MRMR data for mine cases.....	5.45
Table 5.27.	Summary of best estimate of SRMR data for mine cases	5.47
Table 5.28.	Summary of best estimate of RMS data for mine cases.....	5.49
Table 6.1.	Estimation of Hoek-Brown co-efficients	6.9
Table 6.2.	Rock mass deformability case studies.....	6.23
Table 6.3.	Guidelines for estimating disturbance factor D (Hoek et al, 2002).....	6.26
Table 6.4.	Maximum and minimum values of Hoek-Brown parameters using Figure 6.10.....	6.29
Table 6.5.	Joint orientation, spacing and persistence for Nattai North	6.34
Table 6.6.	Summary of parameters used for the Nattai North Escarpment Failure.....	6.34

Table 6.7.	Summary of Hoek-Brown parameters for Nattai using RMR and the Hoek-Brown chart	6.35
Table 6.8.	UDEC output: average shear and normal stresses along the predicted failure plane	6.35
Table 6.9.	Summary of parameters used for the Katoomba Escarpment Failure.....	6.38
Table 6.10.	Summary of Hoek-Brown parameters for the Claystone in the Katoomba Escarpment Failure using RMR and the Hoek-Brown chart.....	6.38
Table 6.11.	Summary of the Joint Properties from the Joint Survey carried out by Read et al (1996)	6.40
Table 6.12.	Hoek Parameters for Aviemore Shear Tests using RMR, and the Hoek-Brown Chart	6.40
Table 6.13.	Intact material parameters	6.43
Table 6.14.	Defect and Interface Material Parameters	6.43
Table 6.15.	Results of statistical analysis of Habimana et al (2002) test data.....	6.50