

# Contents

	Certificate	ii
	Certificate	iii
	Declaration by the Candidate	iv
	Copyright Transfer Certificate	v
	Acknowledgement	vi
	Dedication	vii
	Abstract	viii
	Contents	ix
	List of Tables	xii
	List of Figures	xiii
1	Introduction	1
1.1	General	1
1.2	Background	6
1.3	Objective and Scope	10
1.4	Methodology	11
1.5	Organisation of the Thesis	11
2	Literature Review	13
2.1	General	13
2.2	Prevailing Understanding	14
2.3	Global Experience	21
2.4	Mechanical Stability of Pillar	26
2.5	Strain Softening Behaviour of Pillars	30
2.6	Effect of Interface on Pillar Behaviour	32
2.7	Mechanism of Fluid Flow through Porous Media	33
2.8	Regulatory and Operational Provisions in Indian Coal Mines	40
2.9	Summary	41

3	Methodology	45
3.1	General	45
3.2	Preparatory Work	46
3.3	Numerical Modelling	47
3.4	Modelling Scheme	59
3.5	Parametric Study	62
3.6	Development of Design Criteria and their Validation	62
3.7	Summary	62
4	Simulation of the Strain-Strain Behaviour of Coal Pillars	65
4.1	General	65
4.2	Laboratory Test	65
4.3	Numerical Simulation of Laboratory Observed Behaviour	68
4.4	Parametric Study	69
4.5	Statistical Model for Strain-Softening Parameters	76
4.6	Summary	80
5	Parametric study	83
5.1	General	83
5.2	Effect of Cover Depth	85
5.3	Effect of Pillar Width	90
5.4	Effect of In-situ Permeability	92
5.5	Effect of Water Head	97
5.6	Effect of Rockmass Strength	98
5.7	Effect of Flow Regimes	99
5.8	Summary	101
6	Design Criteria	103
6.1	General	103
6.2	Evaluation of Mechanical Performance	103
6.3	Evaluation of Hydraulic Performance	107
6.4	Seepage Rate Severity Classification	124
6.5	Adequacy of Barrier Pillar Width	125
6.6	Development of Design Criteria	131

6.7	Suggested Approach for the Rational Design of PWBP	136
6.8	Suggested Approach for Adequacy of the Existing PWBP	138
6.9	Summary	140
7	Model Validation	143
7.1	General	143
7.2	Satgram Incline Mine	144
7.3	Lower Kenda Mine	152
7.4	Summary	159
8	Discussion	163
9	Conclusion	177
10	Limitations and Scope for Future Work	181
	References	183
	Annexure I: Numerical Modelling Results of ZoPVS	192
	Annexure II: Numerical Modelling Results of Seepage through Pillar Only	194
	Annexure III: Numerical Modelling Results of Seepage through Roof Only	201
	Annexure IV: Parametric Modelling Results of Seepage through Floor Only	209
	Annexure V: Parametric Modelling Results of Seepage through Pillar and Roof	217
	Annexure VI: Parametric Modelling Results of Seepage through Pillar and Floor	239
	Annexure VII: Parametric Modelling Results of Seepage through Pillar System	261
	Annexure VIII: Achievements	283