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Anglo American

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OPEN RISK - AN UPDATE ON THE USE OF A PIT HIGHWALL RISK RATING SYSTEM

John Hoelle

ABSTRACT: Open Risk is a semi-quantitative risk rating system that takes into account the relative differences in the importance of hazards as experienced at each mine site as a result of different combinations of geotechnical factors and mining conditions. Open Risk provides an unbiased, standard quantified assessment of risks (as input parameters are quantifiable); that rates the likelihood of failure and stability and the consequences/severity of failure. The program is used by technical personnel as a pit inspection tool at several Anglo American coal mines in Australia to assist in evaluating hazards around high walls and to assist in rectifying or avoiding these hazards. The results of the system (severity and likelihood) are approximately analogous with the Anglo American 5 by 5 Risk Rating matrix (consequences and likelihood). The results from these pit inspections indicate a consistency across different personnel and different pits.

INTRODUCTION

Anglo American's Metallurgical Coal business unit operates five open cut operations located in Central Queensland and New South Wales, NSW, Australia. In order to accomplish the vision of zero harm, Anglo American has implemented pro-active ground control management strategies for a safe and effective production of open cut and underground reserves (Hoelle, 2010). In order to prevent these unexpected failures, Anglo American has initiated a project to evaluate and implement a risk rating system, called Open Risk, that was developed by Canbulat *et al.*, 2004 for Anglo American's Thermal Coal in South Africa. The background and development of the program has been presented in several previous papers (Canbulat, *et al.*, 2004; Hoelle and Canbulat, 2012; Canbulat, *et al.*, 2013). The input parameters and the controls used in the program have been modified for local conditions in order to ensure that the results are representative of the environment in which the open cuts operate in Australia. The ultimate aim of this implementation is to minimise the risk to personnel and machinery by identifying the risks and by recommending a set of generic controls.

DESCRIPTION OF PROGRAM AND USE

Prior to the introduction of Open Risk at the mine sites, a number of check sheets have been used. The one that was used most recently is the check sheet shown in Figure 1. While the check sheets were valuable in evaluating an individual pit at a specific time period, the evaluations were somewhat subjective and relied on the experience of the evaluator. While the check sheet is objective, there was not an easy method to create a comparison between different sites and to compare changes over time in the same pit.

The Open Risk program and method has been used by a number of personnel at the five Anglo American mines. The personnel were trained in the system, which consisted of the background as to why the program was initiated, an explanation of each of the components and a field trial. The field trial for the groups indicated that the results obtained from the several personnel are close but not identical. Once personnel became familiar with the process, approximately 10 minutes are required to fill out the sheet for a section of high wall in a pit. Another 10 minutes are required to input the data in the program. The input sheets are shown in Figures 2 and 3. It should be emphasised that the evaluation using Open Risk is based on surface observations of a pit wall and does not necessarily include structures and features that are back in the pit wall.

Anglo Coal Australia Highwall Inspection Sheet				Inspection Ref No.:
Location:				Date:
RISK ASSESSMENT CHECK LIST	LOW	MODERATE	HIGH	CONTROLS & COMMENTS
Local movement detected by local (over 8 hour interval)	None	0-10mm	> 10mm	
Highwall Geometry				
Overall batter angle (degrees)	< 75	< 75	Unstable	
Highwall Integrity				
Free face bands	Clearly defined	Partially defined	Faintly defined	
Crack development	None observed	Minor or Long narrow cracks	Development under opening or cracks	
Spall (inclined or horizontal frequency)	< 1 per 5m	1-2 per 5m	> 2 per 5m	
Bluffs & Riprap (height/frequency/width)	None	None	None	
Potential erosion rate (classified in 10% bins)	None	1% - 5%	5% - 20%	
Under rubble	None observed	Present in lower 10%	Present in upper 10%	
Moisture/Matrix (contaminating)	None	< 5%	> 5%	
Highwall Crest				
Undermining	Present in lower 10%	Present but not in 10%	Not present	
Open face (height/width over 24 hours)	< 20mm	< 20mm	> 20mm	
Highwall Face				
Face shape	None		None	
Undermining (height/width)				
OH clearance from face	None	< 200mm	> 200mm	
OH clearance from coal reserve	None or 10mm	< 200mm	> 200mm	
Face in process 24 hours	None	Minor	Highly visible	
Drilling/Loading activity				
Construction mining activity likely to impact OH integrity	None	Yes		
Construction mining activity likely to impact OH integrity	None	Yes		
Vegetation				
Revegetation likely to prevent OH	None	Yes	Yes (potential of large trees)	
Face in process	None	Minor	Yes	
Face in process 24 hours	None	Minor	Yes	
Maintenance to address design or mining error	Yes	Minor design modification	Major design modification	
TOTAL RISK	LOW	MED	HIGH	
Number of medium or high risk ratings above last inspection	Decreased		Increased	

Figure 1 - Check sheet used prior to introduction of Open Risk

ACTUAL USE AND RESULTS

The Open Risk program is currently being used by geotechnical engineers, geotechnical technicians and geologists at the Anglo American Australian coal mines. The program is used whenever a high wall is inspected. It is being monitored or will be monitored and as part of the production of hazard plans produced at all of the mines. The normal method is to take a hard copy of the components in the field and check off the appropriate box, as shown in Figures 2 and 3. The data is then transferred to the computer program to obtain the output of the categories (Figures 4, 5 and 6). The chart, shown in Figure 7, is used to show trends so that observations obtained over time can be plotted, possibly indicating deterioration of the high wall.

For this study, a random sample of results from the different mines has been plotted. The output of the program consists of three parts: the geotechnical rating, the mining rating and the rating of the combination of the two categories. The results of the geotechnical ratings are shown in Figure 8 and the results of the mining ratings are shown in Figure 9. In the Geotechnical rating there are seven high walls in the high risk category and nine in the medium risk category. The risk rating for the same high walls in the mining rating show three high walls in the high risk and two high walls in the low risk categories. This indicates that the physical conditions of some of the pits are adverse and that these adverse conditions are being managed by good mining practices. The overall ratings shown in Figure 10 also indicate that the adverse conditions are being managed. The two high walls in the high ratings in the geotechnical and mining consequences were evaluated. The “highest” rated high wall is the same in both categories. The “second” highest rated system in the geotechnical category is not the same high wall as the “second” highest rated high wall in the mining system. The adverse conditions of this high wall were well managed. Inspection of the mining rating categories indicates that most of the high walls are being managed by the design and mining methods used.

CONCLUSIONS

The use of the program has allowed site personnel to evaluate the potential for failure quickly and to prioritise high walls that may require additional monitoring controls. These controls may also include design revisions or revisions of mining methods. The program also highlights high walls with adverse geological or geotechnical conditions that require additional attention.

1) GEOLOGY			2) WATER			
1.1	Depth of weathering		2.1	Water coming out of face bedding or structure		
	0 - 5 m	1		NO	1	
	5 - 10 m	5		YES	10	
	10 - 20 m	10		2.2 Is there water accumulation at toe of slope		
	> 20 m	20	NO	1		
			YES	10		
1.2	Discontinuities		2.3 Water on top of highwall/benches within 30m of crest			
	None		NO	1		
	1 (simple)	10	YES	10		
	2 (complex)	10	2.4 Rain			
	>3 (complex)	20	No rain in past 5 days			
1.3	Direction of discontinuities		No rain in past 5 days		1	
	Not applicable		Rained in the past 5 days		5	
	Same direction (<30 deg.)		Has been raining for the past 5 days		10	
	Different direction (>30 deg.)	20	2.5 Head of water			
1.4	Dipping structure / bedding		No water		1	
	Flat/dipping into the face		Stable, no increase		5	
	Dipping into the cut		Increase in water head		10	
1.5	Clay material in bedding		3) SPONTANEOUS COMBUSTION			
	NO	1	3.1 Is the toe of highwall burning			
	YES	10	NO			
1.6	Length of structure		YES			10
	0 - 1 m		3.2 Is the toe of lowwall/spoil or any layer burning			
	1 - 5 m		NO			1
	> 5 m	20	YES			10
1.7	Presence of floor rolls and dipping seam		3) DRAGLINE			
	NO	1	4.1 Dragline bench built on			
	YES	10	Not applicable (truck and shovel operation)			0
1.8	Major dykes/faults/burnt coal		Unweathered material			1
	NO		Weathered material			5
	YES		Weathered material and water			10
1.9	Cracks on highwall/benches within 10 m of crest					
	NO	1				
	YES	20				
1.10	Highwall condition					
	Stable					
	Loose/rock/blocks					
	Wedges/overhangs					
	Zone of weakness	20				

Figure 2 - Input sheet for the geotechnical risk section of open risk

1) GEOMETRY			1.9 Loose blocks at crest		
1.1	Batter back soft material		NO		
	Not Applicable		YES		
	Yes / minimum 50 deg.		10		
	No / more than 50 deg.	20	2) MINING		
1.2	Height of highwall		2.1 Undercutting spoils		
	0 - 35 m		NO		
	35 - 50 m		YES		
	50 - 70 m		20		
	> 70 m	20	2.2 Undercutting highwall		
1.3	Angle of highwall		NO		
	< 65 deg.		YES		
	65 - 75 deg.		20		
	> 75 deg.	10	2.3 Spoils in water		
1.4	Top bench width		NO		
	> 10 m		YES		
	0 - 10 m		2.4 Spoiling of weathered material at toe of spoils		
	No bench	10	NO		
1.5	Spoils on the highwall		YES		
	Not applicable		3) BLASTING		
	< 15 m high/>10 m from crest		3.1 Blasting method of highwall		
	<15 m high/<10 m from crest		Pre-split		
	>15 m high/>10 m from crest		No pre-split		
	>15 m high/<10 m from crest	10	Highwall condition due to blasting		
1.6	Height of spoils on lowwall		Straight H/W no loose material		
	Not applicable		Straight highwall, some loose material		
	0 - 40 m		Frozen coal, overhangs, loose material		
	40 - 95 m		3.3 Pre-split barrels		
	> 95 m	10	Not applicable		
1.7	Cut width (deviation from standard)		Visible		
	Standard within 5 m		Not visible		
	Not standard (> 5 m deviation)		10		
1.8	Noses present		3.4 Blast holes		
	NO		Visible		
	YES		Not Visible		
		20			

Figure 3 - Input sheet for the mining risk section of open risk

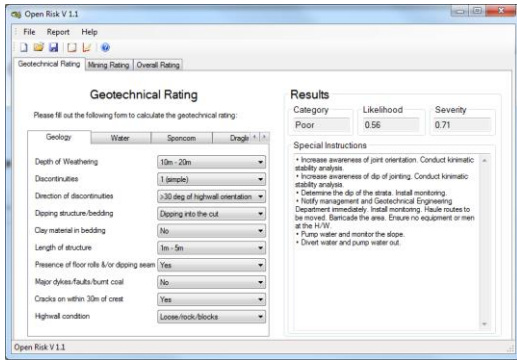


Figure 4 - Output of the geotechnical rating

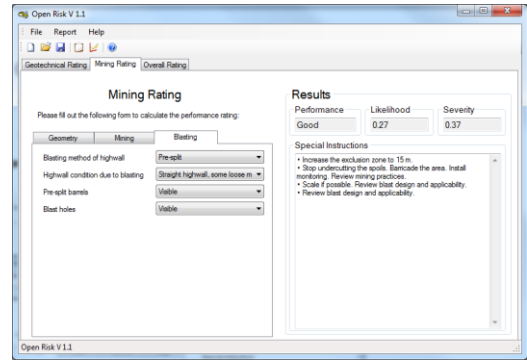


Figure 5 - Output of the mining rating

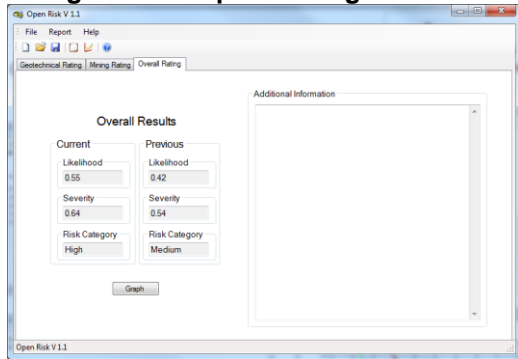


Figure 6 - Output of the overall results

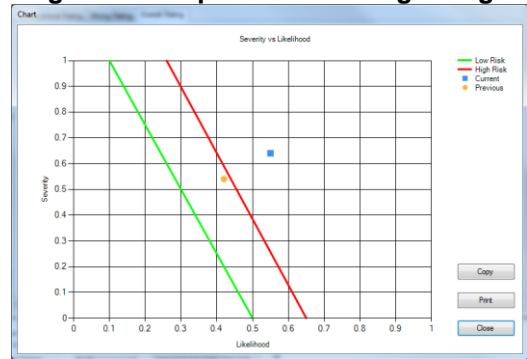


Figure 7 - Chart with the results of the initial and up-dated ratings

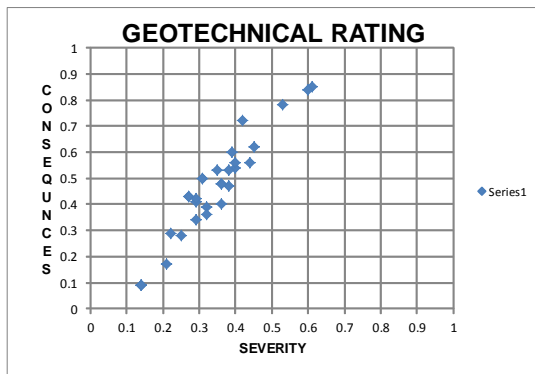


Figure 8 - The results of the geotechnical ratings from several high walls at the Anglo American mines

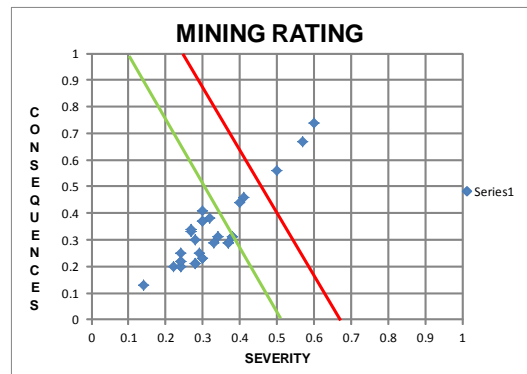


Figure 9 - The results of the mining ratings from several high walls at the Anglo American mines

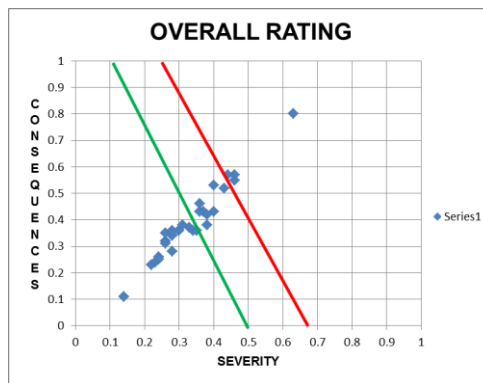


Figure 10 - The overall results from the high walls shown in Figures 8 and 9

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