# CHAPTER VI

# CONCLUSIONS

In a mining environment such as Impala Platinum where stress changes on tunnel elevations are small, rockfalls from the hangingwall will in most cases be controlled by the strength of the rockmass, joints and the dimensions of tunnels. In certain instances the presence of unfavourably orientated structures could result in large block fall outs. The Barton Rock Tunneling Quality Index does not include a parameter for describing such a phenomenon, which is insignificant in relation to the other categories i.e. rock quality designation, joint number, joint roughness, joint alteration, joint water and stress reduction factor.

The fall of ground analysis in Chapter 3 was done to ensure that the fall of ground problem on Impala was structurally controlled by jointing and supported by various joint characteristics and rock strength variations. However the choice to validate the Q-system for Impala was substantiated by the fact that the main parameters of the system are involved with block size (RQD/Jn), inter-block shear strength (Jr/Ja) and active stress (Jw/SRF). The Q-system in its entirety was scrutinized and modifications were made to suit the Impala ground conditions.

A conclusion concerning rock mass rating systems in general are that they are still qualitative, site specific, and therefore must be modified to suit the particular situation. Generalisation of a single RMR system to all conditions may not always be possible, if the chosen system is sometimes inapplicable, then the engineer should turn to basic engineering design principles (SIMRAC, 1998).

The empirical approach in validating the Q-system for Impala lead to the following changes in the formula (5.4),

$$Span = 1{,}56 * ESR * Q^{0{,}3442}$$

where ESR is equivalent to 1,6 for a permanent mine opening. This was however necessary for a conservative approach on the mine where man-made and natural unsupported excavations are described in Figure 5.4 and Figure 5.5.

Barton (1976) created another equation, following numerous case studies in unsupported man-made excavations and natural openings in limestone at Carlsbad, New Mexico. This is shown below as the altered version

$$Span = 2 * Q^{0,3441921}$$

The conservative approach is mainly due to the limited amount of information presented in this thesis and that these excavations are mainly supported by shepherd crooks and will not be secondary supported by a cast concrete lining. Thus concluding the use of the Q-value Rock Quality Tunnel Index at Impala Platinum as a typical rock classification indicator with some modifications that must be taken into consideration when conducting a typical rockmass classification on Impala.

The geological structure orientation to excavation orientation however still dictates the scale of excavation instability. It was further noted that using the rockmass classification system in itself is not a goal but rather a foundation from which to determine if and what support systems are required. It is thus essential that the rock mass classification process followed a systematic approach to convert observations into workable results.

It was felt at a certain stage that the fall of ground analysis with the length (3,5m), width (2,5m), weight (13 000 kg), volume ($9m^3$), areal ($9m^2$) and height (0,9m) for which a 95 cumulative percentage limit has been determined, should be combined with the Q-system whereby the bolt lengths, spacing and ultimate strength are altered or substituted.

This would have altered the support design rock height, spacing and strength of the bolt or tendon to such an extent that it would assist in reducing overall cost to the mine. However it was decided not to combine the two fields of information, due to the limited amount of fall of ground information and the lack of information regarding typical excavation widths with fall out heights.

The joint roughness category graph produced in Figure 5.12 and the average Q-value plotted against joint roughness in Figure 5.13 provided some concern about the weighting of the joint roughness category. The system may not adequately warn the rock engineer of an impending rockfall hazard.

Therefore once support is opted for, irrespective of the rockmass strength, the question of support resistance and length of anchor become highly contentious bearing in mind the unknowns and the lack of rigid guidelines.