

**VALIDATION OF THE
ROCK QUALITY TUNNELING
INDEX, Q-SYSTEM,
IN UNDERGROUND MINE TUNNELING
ON A SOUTH AFRICAN PLATINUM MINE**

by

WOUTER HARTMAN

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DECLARATION

All the information gathered including the literature survey and underground q-observations done in this thesis were compiled by myself. The fall of ground statistics were obtained when completing the mines code of practice and was further modified into a presentable format. All the interpretation and concluding remarks were completed by myself to substantiate the work. I thus declare that this thesis which I am submitting to the University of Pretoria for the Master's degree, represents my own work and has never been submitted by me to any other tertiary institution for any degree.

ABSTRACT

The South African mining industry has been dominated by experts on stope and tunnel support design for gold mines in the last 50 years. Little work to date has been done on the Bushveld Complex Platinum and Chrome Mines. Many questions still remain to date how to properly design support in a quasi-static environment using geological characteristics as an indicator and design tool. Many believe empirical means are best to establish design criteria for the Platinum and Chrome Mines. The question remains how to go about establishing a sound empirical approach to generate reliable design criteria.

In the platinum-mining environment poor rockmass support interaction has been associated with highly jointed and low friction rockmass structures, as well as the fall out of blocks between support units, where highly persistent vertical jointing is present.

This thesis will provide a simple approach in analysing existing critical rockmass parameters and provide information with an empirical validation method based on Barton's Rock Tunneling Quality Index, Q , for rockmass conditions found on a typical South African Platinum mine.

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CONTENTS

| | |
|---|------------|
| Declaration | I |
| Abstract | II |
| Acknowledgments | III |
| | |
| CHAPTER I - INTRODUCTION | 1 |
| | |
| CHAPTER II - GEOLOGICAL SETTING AT IMPALA MINE | 6 |
| 2.1 Rock Types | 7 |
| 2.2 Geological Succession | 7 |
| 2.3 Geological Structures | 12 |
| 2.4 Water | 15 |
| 2.5 Rock Strength | 15 |
| | |
| CHAPTER III - FALL OF GROUND STATISTICS IN TUNNELS AT IMPALA PLATINUM MINE | 19 |
| 3.1 Results of the analysis of reportable and fatal fall of ground accidents from 1992 to 1996 | 22 |
| | |
| CHAPTER IV - ROCKMASS CLASSIFICATION SCHEMES AND GEOMETRY | 32 |
| 4.1 Identification of keyblocks shapes and sizes | 33 |
| 4.2 Terzaghi's Rockmass Classification | 36 |
| 4.3 Rock Quality Designation Index (RQD) | 37 |
| 4.4 Rock structure Rating (RSR) | 38 |
| 4.5 Geomechanics Classification | 43 |
| 4.6 Modifications to RMR for mining | 46 |
| 4.7 Classifications Involving Stand-up Time | 50 |
| 4.8 Checklist Methodology | 52 |
| 4.9 Rockwall Condition Factor | 53 |
| 4.10 Rock Tunneling Quality Index, Q | 54 |

| | |
|---|------------|
| CHAPTER V - CASE STUDIES | 63 |
| 5.1 Methodology | 63 |
| 5.2 10 Level Crosscut, No. 9-Shaft, Impala Platinum | 71 |
| 5.3 23 Level Conveyor Decline, No. 14-shaft, Impala Platinum | 76 |
| 5.4 Q-Rating information analysis of 10 level crosscut and 23 level conveyor decline | 77 |
| | |
| CHAPTER VI - CONCLUSIONS | 96 |
| | |
| BIBLIOGRAPHY | 98 |
| | |
| Appendix A. Classification of individual parameters used in the Tunnel Quality Index & Suggested support measures for the 38 categories, Table A.1 - A.5 | 104 |
| Appendix B. Table B.1 - B.9 (Data Sheets) | 111 |
| Appendix C. Plate 1 - 20 : 10 Level Crosscut, No. 9-Shaft | 117 |
| Appendix D. Plate 21 - 28 : 23 Level Conveyor Decline, No. 14-Shaft | 128 |
| Appendix E. Plan 1 - 10 Level Crosscut, No. 9-Shaft | 132 |
| Plan 2 - 23 Level Conveyor Decline, No. 14-Shaft | |

LIST OF TABLES

| | |
|---|-----|
| TABLE 2.1 - The Uniaxial Compressive Strength on the Rock Strata Horizons directly above and below reef | 16 |
| TABLE 2.2 - Approximate strength criteria for intact rock and jointed rockmasses (After Hoek & Brown, 1980) | 18 |
| TABLE 3.1 - Statistical Analysis of Falls of Ground accidents at Impala (1992-1996) | 21 |
| TABLE 4.1 - Rock Structure Rating - Parameter A - General Area Geology | 39 |
| TABLE 4.2 - Rock Structure Rating - Parameter B - Joint pattern, direction of drive | 40 |
| TABLE 4.3 - Rock Structure Rating - Parameter C - Ground Water, Joint Condition | 41 |
| TABLE 4.4 - Rockmass Classification Parameters for the Rock Mass Rating (RMR) system | 43 |
| TABLE 4.5 - Rock Mass Rating (After Bieniawski, 1989) | 44 |
| TABLE 4.6 - Guidelines for excavating and support of 10m span tunnels in accordance with RMR system (After Bieniawski, 1989) | 45 |
| TABLE 4.7 - Modified geomechanics classification scheme (After Laubscher, 1977) | 48 |
| TABLE 4.8 - Assessment of joint condition - adjustments as combined percentages of total possible rating of 30 (After Laubscher, 1977) | 49 |
| TABLE 4.9 - Classification of individual parameters used in the Tunneling Quality Index Q (After Barton et al 1974) | 56 |
| TABLE 4.10 - Equivalent Support Ratio (ESR) values to excavation category | 61 |
| TABLE 5.1 - Backfill "SOUP" Parameters - Stress/strain relationship of the 3m x 6m in stope yielding pillars (After T.J. Kotze, 1997) | 73 |
| TABLE 5.2 - Mining steps modeled using MINSIM W | 73 |
| TABLE A.1 - Suggested support measures for the 38 categories (After Barton et al, 1977). Support measures for Rock Masses of 'Exceptional', 'Extremely Good', 'Very Good' and 'Good Quality (Q range : 1000 – 10) | 104 |
| TABLE A.2 - Suggested support measures for the 38 categories (After | |

| | |
|--|-----|
| TABLE A.1 - Barton et al, 1977). Support measures for Rock Masses of 'Fair' and 'Poor' Quality (Q range : 10 – 1) | 105 |
| TABLE A.3 - Suggested support measures for the 38 categories (After Barton et al, 1977). Support measures for Rock Masses of 'Very Poor' Quality (Q range : 1 – 0.1) | 106 |
| TABLE A.4 - Suggested support measures for the 38 categories (After Barton et al, 1977). Support measures for Rock Masses of 'Extremely Poor' and 'Exceptionally Poor' Quality (Q range : 0.1 – 0.001) | 107 |
| TABLE A.5 - Supplementary notes by Barton, Lien and Lunde (After Barton et al, 1977) | 108 |
| TABLE B.1 - Case study 1 - 10 Level crosscut, No. 9-Shaft, Impala Platinum Limited - 640m Below Surface | 111 |
| TABLE B.2 - Case Study 2 – 23 Level Conveyor Decline – N0. 14-Shaft Impala Platinum – 1058m Below Surface – Q-ratings | 112 |
| TABLE B.3 - Q-value Categories Distribution – 10 Level Crosscut and 23 Level Conveyor Decline | 113 |
| TABLE B.4 - Joint Number Critical Parameters Distribution – 10 Level Crosscut and 23 Level Conveyor Decline | 113 |
| TABLE B.5 - Joint Roughness Critical Parameters Distribution – 10 Level Crosscut and 23 Level Conveyor Decline | 113 |
| TABLE B.6 - Joint Alteration Critical Parameters Distribution – 10 Level Crosscut and 23 Level Conveyor Decline | 113 |
| TABLE B.7 - Stress Reduction Factor Critical Parameters Distribution – 10 Level Crosscut and 23 Level Conveyor Decline | 113 |
| TABLE B.8 - Barton comparison - Scatter plot Equivalent Dimension vs Q-values Data Base | 114 |
| TABLE B.9 - Case study 2 – 23 Level Conveyor Decline No. 14-Shaft Calculated Conditional Factors | 115 |

LIST OF FIGURES

| | | |
|----------|---|----|
| FIG. 2.1 | Locality plan – Geology of the Western Lobe of the Bushveld Complex showing the position of the Impala Lease Area | 6 |
| FIG. 2.2 | Impala Platinum Limited - Generalised Geological succession | 8 |
| FIG. 2.3 | Section showing thinning of the footwall units at Impala | 10 |
| FIG. 3.1 | Maximum fall out thickness in mine development | 23 |
| FIG. 3.2 | Areal extent of Falls of Ground in mine development | 24 |
| FIG. 3.3 | Weight of falls of ground in mine development | 25 |
| FIG. 3.4 | Volume of falls of ground in mine development | 26 |
| FIG. 3.5 | Width of falls of ground in mine development | 27 |
| FIG. 3.6 | Length of falls of ground in mine development | 28 |
| FIG. 3.7 | Shape of falls of ground in mine development | 29 |
| FIG. 3.8 | Rock type falls of ground in mine development | 30 |
| FIG. 3.9 | Boundaries of falls of ground in mine development | 31 |
| FIG. 4.1 | Potential unstable hangingwall block (SIMRAC, 1994) | 35 |
| FIG. 4.2 | Procedure for measurement and calculation of RQD (After Deere, 1968) | 37 |
| FIG. 4.3 | RSR Support estimates for 24ft (7.3m) Diameter circular tunnel | 42 |
| FIG. 4.4 | Joint spacing ratings for multi-joint systems (after Laubscher 1977) | 50 |
| FIG. 4.5 | Stand-up time vs roof span compared to rock quality, RMR & Q-value | 51 |
| FIG. 4.6 | Stand-up time vs roof span compared to rock quality, TBM classes | 51 |
| FIG. 4.7 | Estimated support categories based on the Tunneling Quality Index - Q - (After Grimstad and Barton, 1993) | 56 |
| FIG. 5.1 | Different scale of roughness, small scale of laboratory shear test, medium scale of an in-situ shear test and the large scale waviness of the joint | 66 |
| FIG. 5.2 | Profiles of different classes of joint roughness (After Barton et al, 1974) | 67 |

| | | |
|-----------|--|----|
| FIG. 5.3 | Man made and natural unsupported excavations in different quality rock masses (After Barton, 1976) | 69 |
| FIG. 5.4 | Recommended maximum unsupported excavation spans for different rock mass quality (Q) and ESR values (After Barton, 1976) | 70 |
| FIG. 5.5 | Recommended support for different rock mass quality (Q) and ESR values (After Barton et al, 1977) | 71 |
| FIG. 5.6 | MINSIM W, Plan view for stress analysis - UG2 | 74 |
| FIG. 5.7 | MINSIM W, Window placing for stress analysis | 75 |
| FIG. 5.8 | Section of crosscut showing stress state prior to and after mining of the two reefs | 75 |
| FIG. 5.9 | 10 Level Crosscut and 23 Level Conveyor Decline Q-Value Distribution | 78 |
| FIG. 5.10 | Joint Number Categories analysis | 79 |
| FIG. 5.11 | Joint Number Categories vs Ave. Q-Values | 80 |
| FIG. 5.12 | Joint Roughness Categories | 81 |
| FIG. 5.13 | Joint Roughness Categories vs Ave. Q-Values | 81 |
| FIG. 5.14 | Joint Alteration Categories | 82 |
| FIG. 5.15 | Joint Alteration Categories vs Ave. Q-value | 83 |
| FIG. 5.16 | Stress Reduction Factor Categories | 84 |
| FIG. 5.17 | Stress Reduction Factor vs Ave. Q-Values | 84 |
| FIG. 5.18 | Scatter plot Equivalent Dimension vs Rock Mass Quality Q-Value Excavation Support Ratio of 1,6 (i.e. Permanent Mine Openings) Unsupported tunnel | 85 |
| FIG. 5.19 | Scatter plot Unsupported Span vs Rock Mass Quality : Q-Value – Excavation Support Ratio of 1.6 (Permanent Mine Opening) Unsupported tunnel | 90 |
| FIG. 5.20 | Scatter plot equivalent dimension vs Rock Mass Quality : Q-Value – Excavation Support Ratio of 1.6 (Permanent Mine Opening) Supported tunnel | 91 |

FIG. 5.21 Scatter plot Unsupported Span vs Rock Mass Quality Q-Value –
Excavation Support Ratio of 1,6 (i.e. Permanent Mine Opening)
Supported tunnel

PLATE DESCRIPTION

I. 10 Level Crosscut No. 9-Shaft – Impala Platinum – 640m below surface

- PLATE 1 Photo showing typical joint spacing, infilling, joint roughness (i.e. undulating)
- PLATE 2 Pegmatite vein with sympathetic jointing
- PLATE 3 Photo showing typical joint spacing, infilling, joint roughness (i.e. Undulating, planar)
- PLATE 4 Photo showing tunnel profile with no support installed
- PLATE 5 Dyke intruded with altered infilling, joint roughness (undulated)
- PLATE 6 Hangingwall at wide section, keyblock fallout's, joint angle at 70 degrees from the horizontal. Hangingwall supported with 12mm diameter shepherd crooks, 1,8m long, typical spaced 1m apart
- PLATE 7 Section with relative low angle (i.e. 50 degrees) sympathetic jointing with Cross-jointing intersection close to a fault plane Perpendicular discontinuous jointing between main joint system – Could be related to inherent stresses from fault planes
- PLATE 8 Section with relative low angle (i.e. 50 degrees) sympathetic jointing with Cross-jointing intersection close to a fault plane Perpendicular discontinuous jointing between main joint system – Could be related to inherent stresses from fault planes
- PLATE 9 Tunnel 4,8m wide at this section
- PLATE 10 1,8m long, 12mm diameter, shepherd crooks installed at the normal 1m spacing. Little jointing is found at this wide section
- PLATE 11 Tunnel profile, with only eyebolts installed. Again limited amount of jointing found
- PLATE 12 Tunnel profile, with only eyebolts installed. Limited amount of jointing found
- PLATE 13 Joint spacing, infilling and joint roughness (undulating)

- PLATE 14 Dyke intersection with sympathetic jointing – undulated / slickensided jointing
- PLATE 15 Dyke intersection with sympathetic jointing – undulated / slickensided jointing
- PLATE 16 Typical keyblock fall out in dyke from hangingwall with the tunnel profile adjacent to dyke intersection
- PLATE 17 Spotted Anorthosite – Signs of stress fracturing
- PLATE 18 Spotted Anorthosite – Signs of stress fracturing
- PLATE 19 Set Support – Signs of dripping water
- PLATE 20 Set Support – Signs of dripping water

II. 23 Level Incline No. 14-Shaft – Impala Platinum – 1054m below surface

- PLATE 21 Poor photo. However clear intense jointing providing a highly blocky texture. Typical three joint sets intersecting. Jointing are however rough undulating. Hangingwall view. Support installed are 3,0m long, 16mm diameter, shepherd crooks at a regular 1m spacing
- PLATE 22 Sidewall view. Joint frequency high resulting slabs. Rough planar jointing
- PLATE 23 Poor quality photo. However clearly showing joint angles at 90 – 70 degrees, rough undulating joint planes. Support installed are 3,0m long, 16mm diameter, shepherd crooks at a regular 1m spacing. Hangingwall view
- PLATE 24 Poor quality photo. However clearly showing joint angles at 90 – 70 degrees, rough undulating joint planes. Support installed are 3,0m long, 16mm diameter, shepherd crooks at a regular 1m spacing. Hangingwall view
- PLATE 25 Fault plane gouge infilling
- PLATE 26 Sidewall view. Joint frequency high resulting slabs. Rough undulating jointing. Blocks interlocking
- PLATE 27 Sidewall view. Joint frequency high resulting slabs. Rough undulating jointing. Blocks interlocking

PLATE 28 Internal angle of friction measured on site at 35 degrees

TERMINOLOGY

| | |
|----------------------|--|
| Aperture | The perpendicular distance between adjacent rock surfaces of a discontinuity |
| Block size | Rock block dimensions resulting from the intersection of joint sets and resulting from spacing and orientation of the individual sets |
| Critical Bond length | That minimum bonded length of a particular tendon and grout combination that develops a pull-out resistance equal to that of the tensile strength of the tendon |
| Filling | Material that separates the adjacent rock surfaces of a discontinuity and that is usually weaker than the parent rock. |
| Joint | A break in the rock of a geological origin, not man made, along which there has been no visible displacement or movement. |
| Joint Set | A group of joints, which run parallel to each other |
| Joint System | If joint sets intersect they form what is called a joint system. |
| Persistence | The discontinuity trace length observed in an exposure Termination in solid rock or at other discontinuities reduces persistence. Describing the areal extent or size of a discontinuity within a plane |
| Random Joints | Joints which do not have the same orientation as the joint sets observed. They are not visible for long distances, only a couple of centimeters or perhaps meters |
| Rockbolt | Generic term for all types of inflexible rock reinforcement units, as well as to the process of rock reinforcement (e.g. Roofbolting) |
| Rock mass | In-situ rock, composed of small or large pieces of solid rock limited by discontinuities |
| Rockfall | Loosening or failure of rock from the rock mass |

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| Rock reinforcement | The installation of rockbolts, cables or any other type of element in a rock mass to reinforce and mobilize the inherent strength of the rock, so that the rock becomes self-supporting. The rock reinforcement element is installed inside the rock mass, that is, it forms part of the rock mass |
| Roughness | The inherent surface roughness and waviness relative to the mean plane of the discontinuity |
| Seepage | Water flow and moisture visible in individual discontinuities or in the rock mass as a whole |
| Shotcrete | This is a mixture of cement, aggregate and water which is pumped pneumatically through a nozzle onto walls of an excavation to form a bonded coherent layer. It may contain admixtures, additives and fibres or a combination of these to improve tensile, flexural and shear strength, resistance to cracking |
| Tendon | Includes the generic “rockbolt”, plus flexible forms such as “cable anchor” |
| Wall strength | The equivalent compression strength of the rock adjacent to the surface of a discontinuity |