SOUTH AFRICAN NATIONAL INSTITUTE OF ROCK MECHANICS

CHAMBER OF MINES OF SOUTH AFRICA
CERTIFICATE IN ROCK MECHANICS

PART 2

BASIC ROCK MECHANICS PRACTICE

SYLLABUS

CONTENTS

PREAMBLE

TOPIC COVERED

This is a general paper covering basic rock mechanics practice applicable in all types of mining environment.
The rock engineering knowledge required here is thus of a fundamental nature, and is not specific to any particular type of mining.

CRITICAL OUTCOMES

The examination is aimed at testing the candidate's abilities in the six cognitive levels: knowledge, comprehension, application, analysis, synthesis and evaluation. Thus, when being examined on the topics detailed in this syllabus candidates must demonstrate their capacity for :

- Comprehending and understanding the general rock engineering principles covered in this syllabus and applying these to solve real world mining problems
- Applying fundamental scientific knowledge, comprehension and understanding to predict the behaviour of rock materials in real world mining environments
- Performing creative procedural design and synthesis of mine layouts and support systems to control and influence rock behaviour and rock failure processes
- Using engineering methods and understanding of the uses of computer packages for the computation, modelling, simulation, and evaluation of mining layouts
- Communicating, explaining and discussing the reasoning, methodology, results and ramifications of all the above aspects in a professional manner at all levels.

PRIOR LEARNING

This portion of the syllabus assumes that candidates have prior learning and good understanding of :

- The field of fundamental mechanics appropriate to this part of the syllabus
- The application and manipulation of formulae appropriate to this part of the syllabus as outlined in the relevant sections of this document
- The terms, definitions and conventions appropriate to this part of the syllabus as outlined in the relevant sections of this document.

STUDY MATERIAL

This portion of the syllabus assumes that candidates have studied widely and have good knowledge and understanding of :

- The reference material appropriate to this part of the syllabus as outlined in the relevant sections of this document
- Other texts that are appropriate to this part of the syllabus but that may not be specifically referenced in this document
- Information appropriate to this part of the syllabus published in journals, proceedings and documents of local mining, technical and research organisations.

SYLLABUS

2 GEOTECHNICAL CHARACTERISTICS

2.1 GEOLOGY

2.1.1 ROCK TYPES

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Identify, describe and differentiate between the fundamental classes of rock :

  Igneous rocks
  Sedimentary rocks
  Metamorphic rocks

- Identify, describe and differentiate between fundamental types of rock :

  Igneous rock types commonly occurring in South African mining operations, eg. dolerite, kimberlite, pyroxenite, granite, etc
  Sedimentary rock types commonly occurring in South African mining operations, eg. coal, sandstone, shale, dolomite, etc
  Metamorphic rock types commonly occurring in South African mining operations, eg. quartzite, conglomerate, schist, gneiss, mylonite, etc

- State the origins of the rock types above
- State the strengths of the rock types above.

2.1.2 GEOLOGICAL SEQUENCES

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Describe the general geological sequences and principal rock types associated with :

  The Karoo sedimentary period
  The Witwatersrand Supergroup
  The Ventersdorp Supergroup
  The Transvaal Sequence
  The Bushveld Igneous Complex

- Describe in particular the rock types associated with relevant ore horizons
- Describe and explain the geotechnical significance of the rock types associated with the relevant horizons.

2.1.3 STRUCTURAL GEOLOGY

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Construct and apply geological sections and projections from borehole information
- Construct and apply geological sections and projections from plans
- Define, describe and explain the significance of the following terms in terms of mining operations :

  Bedding, Cleavage
  Slips, Joints
  Faults

- Describe and explain normal faulting and the stress environments in which they are formed
- Describe and explain reverse faulting and the stress environment in which they are formed
- Describe and explain the following geological features and terms :

  Dykes, Sills,
  Folding
  Dip, Strike,
  Striation, Slicken side, Comminution, Mylonite,
  Erosion channels, Depositional channels, Wash-outs, Replacement zones

Potholes, Domes
Devolatisation, Calorific value, Ash content, Yield, Select height.

2.1.4 HYDRO-GEOLOGY

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Define, describe and explain the significance of the following terms in terms of mining operations :

  Aquifer, Aquifuge, Water table
  Porosity, Permeability

- Describe and explain the effect of pore water pressure on rock mass strength
- Describe and explain the effect of pore water pressure on the frictional strength of joints.

3 ROCK AND ROCKMASS BEHAVIOUR

3.1 ROCKMASS CLASSIFICATION

3.1.1 DATA COLLECTION

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Define and describe the standard terminology for core logging
- Describe, explain and evaluate the problems associated with characterising weathered rock
- Describe, explain and evaluate the implications and impact of the orientation of the survey line on the interpretation of recorded data
- Describe, explain and interpret data presented in the form of stereo nets
- Identify joint trends, failure mechanisms, and other features presented in the form of stereo nets
- Describe, explain and apply core logging techniques
- Describe, explain and apply scan line mapping techniques
- Describe, explain and apply stereo net analyses
- Describe, explain and apply stereo pair analyses.

3.1.2 ROCKMASS CLASSIFICATION

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Describe and explain how rock quality designation (RQD) may be determined from borehole core
- Describe and explain how rock quality designation (RQD) may be determined from the in-situ rockmass
- Describe and explain the formulation and components of Barton's Q system of rockmass classifcation
- Describe and explain the formulation and components of Bieniawski's RMR system of rockmass classifcation
- Describe and explain the formulation and components of Laubscher's MRMR system of rockmass classifcation
- Compare and contrast these three rockmass classification systems and their respective applications
- Describe and explain what modifications are necessary to apply rockmass classification systems to local conditions
- Apply Barton's Q system to classify a rockmass
- Apply Bieniawski's RMR system to classify a rockmass
- Apply Laubscher's MRMR system to classify a rockmass
- Describe, discuss and apply rockmass classification techniques for the selection of mining methods
- Apply rockmass classification results to determine the stability of unsupported spans
- Apply rockmass classification results to determine the stability of unsupported rockslopes
- Apply rockmass classification results to determine support requirements for various situations
- Determine rockmass 'm' and 's' parameters for the Hoek and Brown criterion based upon rockmass classification results
- Determine rockmass deformability from joint stiffness and rockmass classification results.

3.2 MINE SEISMICITY

3.2.1 PRINCIPLES OF SEISMICITY

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Identify, describe and explain the conditions required for a rockburst to occur
- Identify, describe and explain the processes that give rise to rupture in rock

- Identify, describe and explain the rupture processes in solid rock
- Identify, describe and explain the rupture processes along a pre-existing fault plane
- Describe and explain the phenomenon of foreshocks and aftershocks
- Describe and explain the phenomenon of seismic body waves
- Describe, explain and distinguish between different types of seismic body waves
- Describe and explain the phenomenon of seismic surface waves
- Describe and explain how seismic surface waves are generated
- Describe and explain how seismic surface waves are related to seismic body waves
- Describe and explain the differences between seismic body waves and seismic surface waves
- Identify and describe the factors affecting the velocity of propagation of seismic waves
- Describe and explain how the rockmass environment affects the velocity of P-waves and S-waves
- State typical velocities of P-waves and S-waves in hard rock and soft rock environments
- Describe and explain how this information may be used in locating the sources of seismic events
- Describe and explain how the energy of a seismic body wave is attenuated as it propagates through elastic rock
- Describe and explain how the energy of a seismic body wave is attenuated as it propagates through non-elastic rock
- Describe and explain how seismic waves and the energy of seismic waves causes damage in excavations
- Describe and explain the phenomena of reflection and refraction of seismic body waves
- Describe and explain how seismic wave reflection and refraction causes damage in excavations
- Distinguish between seismic source mechanism and seismic damage mechanism
- Identify, describe and explain the common methods used to locate seismic events
- Describe the simplifying assumptions commonly used in determining seismic event location
- Explain the difference between the terms hypo-centre and epi-centre used in describing the location of seismic events
- Describe, explain and contrast the following primary source parameters in terms of their physical meaning and the data required to determine them :

  Seismic energy, Seismic moment, Richter magnitude, Local magnitude, Source dimension, Corner frequency, Energy index

- Identify, describe and explain the basic steps that are involved in carrying out a rockburst site investigation.

4 FUNDAMENTAL PRINCIPLES OF MINING LAYOUTS AND MINING LAYOUT DESIGN

4.1 SURVEY AND ECONOMICS

4.1.1 MINE PLANS

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Describe and explain the meanings of the following terms :

  Reef width, Internal waste, Channel width, Stope width
  Mine call factor, Block factor

- Interpret and apply information contained in survey plans
- Construct sections from survey plans
- Interpret and apply information contained in sections drawn from survey plans.

4.1.2 MINING ECONOMICS

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Describe and explain the reasons for attempting to mine an ore reserve at a constant grade
- Identify, describe and evaluate the implications of mining unpayable ore against leaving ore pillars in mining situations.

4.2 MINE DESIGN

4.2.1 MINING LAYOUTS

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Describe and explain for underground mining operations :

  How materials (support units, explosives, etc.) are transported into a section
  What services (electricity, water, etc.) are required in a section

How services (electricity, water, etc.) are provided in a section
How broken ore is removed from a stope.

4.2.2 SHAFT LAYOUTS

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Describe and explain the layout associated with a vertical shaft, showing the method of handling the broken ore
- Describe and explain the layout associated with an inclined shaft, showing the method of handling the broken ore
- Describe and explain how vertical shafts are protected from the effects of mining induced stresses and displacements
- Describe and explain how inclined shafts are protected from the effects of mining induced stresses and displacements
- Describe and explain how the ore around a vertical shaft may be mined early to avoid the necessity of leaving a shaft pillar
- Describe and explain methods of avoiding shaft pillars
- Describe and explain the implications of the above methods on mine layouts
- Describe, explain and design shaft layouts for the extraction of particular blocks of ground.

4.3 MINE VENTILATION

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Describe and explain the purpose of ventilating a mine
- List, describe and explain the main sources of heat in a mine
- List and describe the most common gasses found in a mine and their associated hazards
- Describe and explain in principle how ventilation is brought into and exhausted from a mine
- Describe and explain how the flow of ventilation is controlled on the different mining levels
- Describe and explain how the flow of ventilation is controlled in development ends
- Describe and explain how the flow of ventilation is controlled in stopes
- Describe and explain in principle how refrigeration is provided in mine workings using

:

Cooled air, Chilled water, Ice plants.

4.4 AUDITING FOR BEST PRACTICE

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Describe and explain geotechnical investigation/design/monitoring/evaluation loop processes
- Describe and explain process of geotechnical hazard and risk evaluation and assessment.

5 MINING SUPPORT AND MINING SUPPORT DESIGN

5.1 SUPPORT TYPES AND SPECIFICATIONS

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Describe and explain the concept of active support
- Describe and explain the concept of passive support
- Describe and explain the differences between active and passive support
- Describe and explain the functions of skin support
- Describe and explain the functions of areal support
- Describe and explain the principles of rock reinforcement
- Describe, characterise and discuss the following tunnel support types :

  Mechanically anchored bolts, Cable bolts, Friction bolts (split sets, hyro-bolts)
  Cement grouted bolts, Resin bonded bolts
  Full-column grouted/bonded bolts
  Yielding bolts (cone bolts)
  Multiple rod bolts, Multiple strand cable anchors
  Prestressed tendons
  Steel arches, Massive concrete linings
  Shotcrete, Gunite, Thin sprayed linings
  Wire mesh, Rope lacing, Tendon straps

- Characterise the following aspects of these support types :

  Their principles of operation
  Their technical specifications
  Their load-deformation characteristics
  The methods of ensuring support unit quality
  Their installation/application procedures
  The methods of ensuring their installed quality

- Determine appropriate support types, support sizes and support patterns given tunnel layouts, rockmass conditions and stress regimes
- Describe, characterise and discuss specifications for the variety of support types
- Describe, characterise and discuss specifications for the variety of support sizes
- Describe, characterise and discuss specifications for the variety of support patterns
- Describe, characterise and discuss quality control requirements for support units from fabrication to installation.

5.2 SUPPORT INSTALLATION METHODS AND PROCEDURES

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Sketch, describe and explain the methods and procedures for installing common excavation support units
- Determine appropriate support installation methods and procedures for given tunnel layouts, rockmass conditions and stress regimes
- Describe, characterise and discuss specifications for the variety of support installation procedures
- Describe, characterise and discuss quality control requirements for support installation methods and procedures.

5.3 BACKFILL SYSTEMS

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Describe and explain the functions of backfill as local support
- Describe and explain the functions of backfill as regional support
- Sketch, describe and explain the different backfill preparation methods and preparation systems for :

    Full plant tailings fill
    Classified tailings fill
    Paste fill

- Describe and explain the uses of cementitious binders in backfill
- Sketch, describe and explain in principle how backfill is transported from preparation plant to underground stope
- Sketch and describe the methods of containing backfill in stopes
- Describe and explain the methods of controlling the quality of backfill

- Sketch, describe and explain the features of backfill systems to fill particular blocks of ground.

6 INVESTIGATION AND EVALUATION

6.1 ROCKMASS CHARACTERISATION

6.1.1 FUNDAMENTALS OF ROCK PROPERTY DETERMINATION

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Sketch, describe and explain how uniaxial compressive strength tests are carried out
- Sketch, describe and explain the test equipment required for uniaxial compressive strength tests
- Describe and explain the test procedure for uniaxial compressive strength tests
- Sketch, describe and explain how triaxial compressive strength tests are carried out
- Sketch, describe and explain the test equipment required for triaxial compressive strength tests
- Describe and explain the test procedure for triaxial compressive strength tests
- Describe and explain how samples may be collected for compressive strength tests
- Describe and explain how samples are prepared for compressive strength tests
- Describe and explain how load measurements are made during compressive strength tests
- Describe and explain how strain measurements are made during compressive strength tests
- Sketch, describe and explain how discontinuity shear strength tests are carried out
- Sketch, describe and explain the test equipment required for discontinuity shear strength tests
- Describe and explain the test procedure for discontinuity shear strength tests
- Describe and explain how samples may be collected for shear strength determinations
- Describe and explain how samples are prepared for shear strength determinations
- Sketch, describe and explain how Brazilian indirect tensile strength tests are carried out
- Sketch, describe and explain the test equipment required for Brazilian indirect tensile strength tests
- Describe and explain the test procedure for Brazilian indirect shear strength tests

- Describe and explain how samples may be collected for Brazilian indirect shear strength determinations
- Describe and explain how samples are prepared for Brazilian indirect shear strength determinations
- Describe the method of calculating strength for Brazilian indirect tensile strength tests
- Sketch, describe and explain how point load index tests are carried out
- Sketch, describe and explain the test equipment required for point load index tests
- Describe and explain the test procedure for point load index tests
- Describe and explain how samples may be collected for point load index determinations
- Describe and explain how samples are prepared for point load index determinations
- Describe the method of calculating strength for point load index tests
- Evaluate the shortcomings of each of the above tests as indicators of the large scale strength of rock
- Describe and explain how the following variables may affect the indicated strength of rock samples tested in uniaxial compression :

    Specimen end-effects
    Volume of rock tested
    Test machine stiffness
    Loading rate

- Sketch and describe the complete stress-strain graph for rock in uniaxial compression, indicating :

    Hysteresis in the post peak portion of the curve
    The associated radial strain
    The associated volumetric strain
    The brittle-ductile transition
    The residual strength

- Sketch and describe the complete stress-strain graph for rock in triaxial compression, indicating :

    Hysteresis in the post peak portion of the curve
    The associated radial strain
    The associated volumetric strain
    The brittle-ductile transition
    The residual strength.

6.2 FUNDAMENTALS OF MONITORING ROCKMASS BEHAVIOUR

6.2.1 OBJECTIVES OF MONITORING

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Describe the general objectives of a monitoring system
- Describe and explain the observational method of design in rock engineering
- Describe and explain what may be learned from monitoring
- Describe and explain how the results learned from monitoring may be used in design
- Describe the rock parameters which may be measured in a monitoring program
- Describe the rock response which may be measured in a monitoring program.

6.2.2 PRINCIPLES OF MONITORING

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Describe and explain the general features of a monitoring system
- Describe and explain measuring instruments in terms of :

  Accuracy
  Error
  Sensitivity
  Precision

- Describe and explain how one would measure :

  The stress tensor in a rock mass
  The depth of fracturing in tunnel walls
  Convergence
  Tunnel wall dilation
  Stress changes in rock
  Pressure changes in backfill
  Height of caving of hangingwall.

6.2.3 MONITORING INSTRUMENTS

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Describe the following instruments and explain their purpose, installation and operation :

  Hydraulic pressure cells

Tapes and tape extensometers
Doorstopper stress cell
Triaxial stress cell
Closure meter
Peizometer
Inclinometer
Multiple Point Borehole Extensometers
Hydraulic Pressure Cells
Vibrating Wire extensometers and stressmeters
Petroscopes
Brunton Compass

- Interpret results from the above instruments
- Interpret rockmass response indicated by results from the above instruments
- Describe and explain the principles of operation of strain gauges.

6.3 FUNDAMENTALS OF SEISMIC MONITORING SYSTEMS

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Identify, describe and explain the objectives of seismic monitoring in mines
- Identify, describe and explain the features of a seismic event that are used to locate the source of the event
- Describe and explain the differences between geophones and accelerometers
- Identify, describe and discuss typical applications of geophones
- Identify, describe and discuss typical applications of accelerometers
- Describe, explain and discuss the functions and physical attributes of the following components of a seismic system :

  Seismometer, Amplifier
  Analogue to Digital Converter
  Trigger Unit, Storage Unit
  Data transmission to surface
  Data processing, Data base

- Describe and explain the factors that need to be considered in the placement of seismometers
- Describe and explain how placement could affect event location accuracy
- Describe and explain how placement could affect the sensitivity of a seismic system
- Describe and explain possible reasons for differences between ideal seismic network layouts and actual installed seismic network layouts
- Describe and explain the physical limitations of seismic network performance in terms of the accuracy of source parameters
- Identify, describe and explain the various factors that may influence the quality of seismic data

- Describe the factors affecting hardware performance
- Describe the factors affecting the quality of seismic data processing
- Describe the factors affecting data storage and data analysis
- Describe the controls that may be instituted to minimise the above effects
- Estimate approximate installation and operating costs associated with various size seismic networks.

6.4 FUNDAMENTALS OF NUMERICAL MODELLING

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Describe and explain the principles of the following numerical modelling techniques :

  Finite Element Methods
  Finite Difference Methods
  Boundary Element Methods
  Distinct Element Methods
  Keyblock Methods

- Describe and explain for which rock engineering applications the above numerical modelling techniques are suitable
- Describe and explain what the limitations of the above numerical modelling techniques are in terms of the following aspects :

  When that method should be used
  Why that particular method should be used
  How the results should be interpreted
  How the results should be correlated with actual conditions.

7 DRILLING AND BLASTING

7.1 EXPLOSIVES

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Describe and explain the main types of explosives used in mining
- Describe the ingredients of the main types of explosives used in mining
- Describe and explain the types of initiating explosives used in mining
- Describe and explain the mechanism of rock breaking by blasting
- Describe and explain the effect of shock energy on rock fragmentation

- Describe and explain the effect of gas pressure on rock fragmentation
- Describe and explain the function of stemming
- Apply knowledge of explosives and their characteristics to select appropriate explosives for a given task.

7.2 DRILLING

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Describe and explain the mechanism of rock breakage by chisel bit
- Describe and explain the mechanism of rock breakage by button bit
- Describe the types of equipment used by the following drilling methods :
- Describe, explain and discuss the use of the following drilling methods :

    Percussion drilling
    Rotary drilling
    Diamond drilling
    Raise / Tunnel boring

- Describe and explain how cuttings are removed from the hole for each of the above drilling methods.

7.3 BLASTING

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Describe, explain and discuss the effect of the following parameters on blast damage :

    Explosive type
    Initiation method
    Initiation sequence
    Hole orientation

- Describe, explain and discuss the following cushion blasting techniques :

    Smooth blasting
    Post-splitting
    Pre-splitting

- Describe typical applications of each
- Describe, explain and discuss the objectives of de-coupling explosives
- Describe, explain and discuss the effects of de-coupling explosives

- Describe, explain and discuss the methods by which de-coupling of explosives is achieved.

8 LEGAL COMPLIANCE AND GENERAL MANAGEMENT

8.1 MINE HEALTH AND SAFETY ACT AND REGULATIONS

8.1.1 THE MINE HEALTH AND SAFETY ACT, ACT 29 of 1996

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to describe and explain the requirements of the Act in terms of :

- Owner's responsibilities and duties
- Manager's responsibilities and duties
- Employee's rights and duties
- Suspension of working due to inadequate safety
- Manufacturer's and Supplier's duties
- Manager's duty to consult a Rock Engineer
- Rock Engineer's responsibilities and duties
- Rock-related codes of practice requirements
- Hazard identification and risk assessment
- Negotiation and consultation forum's function, duties and powers
- Tripartite institution's functions and duties
- Inspector' functions and powers
- Requirements for enquiries into accidents
- Minister's abilities and powers
- Scope of safety-related regulations.

8.1.2 REGULATIONS

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to describe and explain the requirements of regulations formulated in terms of the Act under the following headings :

- Appointments and Administration
- Duties and Responsibilities
- Health and Safety Representatives and Committees
- Inspectorate of Mine Health and Safety
- Miscellaneous and General Provisions

- Outlets, Ladderways and Travellingways
- Protection of the Surface and in the Workings
- Qualifications and Certificates of Competency
- Surveying and Mine Plans
- Tripartite Institutions
- Definitions.

8.2 CODES OF PRACTICE

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to describe and explain the fundamental requirements of codes of practice to combat rock-related accidents as contemplated in terms of the Act and the DME Guideline for the Compilation of a Mandatory Code of Practice for :

- Tabular Metalliferous Mines
- Underground Coal Mines
- Massive Mining Operations
- Surface Mines.

8.3 BASIC RISK ASSESSMENT

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Describe and explain the process and procedure of geotechnical hazard and risk evaluation and assessment.

8.4 GENERAL MANAGEMENT

8.4.1 REPORTING

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Describe the requirements and format of a formal technical report
- Compile clear technical reports to senior mine officials on subjects covered in this syllabus
- Compile clear technical reports to head office personnel on subjects covered in this syllabus.

8.4.2 MINE ACCIDENTS

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- State, describe and explain the requirements of investigations into rockfall and rockburst accidents
- State, describe and explain the main causes of rock-related accidents in various mining operations in various mining districts.

8.4.3 ROCK ENGINEERING FUNCTIONS

The candidate must be able to demonstrate knowledge and understanding of the above subject area by being able to :

- Describe, explain and discuss the functions of the rock engineering discipline on various types of mines
- Describe, explain and discuss the functions of various staff categories encountered in a rock mechanics department.

REFERENCES

1 GEOTECHNICAL CHARACTERISTICS

8.5 GEOLOGY

8.5.1 ROCK TYPES

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Lexicon Publishers Jhb Chapters 3, 5, 7

8.5.2 GEOLOGICAL SEQUENCES

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8.5.3 STRUCTURAL GEOLOGY

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8.5.4 HYDRO-GEOLOGY

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IMM London Chapter 6
Fauconnier CJ & Kersten RWO (ed) 1982 Increased Underground Extraction of Coal SAIMM Jhb Chapter 3

9 ROCK AND ROCKMASS BEHAVIOUR

9.1 ROCKMASS CLASSIFICATION

9.1.1 DATA COLLECTION

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SIMRAC Jhb Chapter 2
Hoek E & Brown ET 1980 Underground Excavations in Rock
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9.1.2 ROCKMASS CLASSIFICATION

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Hoek E & Brown ET 1980 Underground Excavations in Rock
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9.2 MINE SEISMICITY

9.2.1 PRINCIPLES OF SEISMICITY

Ryder JA & Jager AJ 2002 Rock Mechanics for Tabular Hard Rock Mines
SIMRAC Jhb Chapter 5
Mendecki AJ (ed) 1997 Seismic Monitoring in Mines
Chapman & Hall London Chapters 1, 2, 5, 7, 8

10 FUNDAMENTAL PRINCIPLES OF MINING LAYOUTS AND MINING LAYOUT DESIGN

10.1 SURVEY AND ECONOMICS

Local knowledge

10.2 MINE PLANS

Local knowledge

10.3 MINING ECONOMICS

MINE DESIGN

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10.4.1 SHAFT LAYOUTS

10.5 MINE VENTILATION

10.6 AUDITING FOR BEST PRACTICE

Jager AJ & Ryder JA 1999 Rock Engineering Practice for Tabular Hard Rock Mines
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11 MINING SUPPORT AND MINING SUPPORT DESIGN

11.1 SUPPORT TYPES AND SPECIFICATIONS

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11.2 SUPPORT INSTALLATION METHODS AND PROCEDURES

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11.3 BACKFILL SYSTEMS

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SIMRAC Jhb Chapter 7
Brady BHG & Brown ET 1993 Rock Mechanics for Underground Mining
Chapman & Hall New York Chapter 14
Budavari S (ed) 1986 Rock Mechanics in Mining Practice
SAIMM Jhb Chapter 11
Stacey TR 2001 Best Practice Rock Engineering Handbook for 'Other' Mines
SIMRAC Jhb Chapter 4

12 INVESTIGATION AND EVALUATION

12.1 ROCKMASS CHARACTERISATION

12.1.1 FUNDAMENTALS OF ROCK PROPERTY DETERMINATION

Hoek E & Brown ET 1980 Underground Excavations in Rock IMM London
Chapters 2, 3, 4
Stacey TR 2001 Best Practice Rock Engineering Handbook for 'Other' Mines
SIMRAC Jhb Chapter 2

12.2 FUNDAMENTALS OF MONITORING ROCKMASS BEHAVIOUR

12.2.1 OBJECTIVES OF MONITORING

Ryder JA & Jager AJ 2002 Rock Mechanics for Tabular Hard Rock Mines

SIMRAC Jhb Chapter 9
Jager AJ & Ryder JA 1999 Rock Engineering Practice for Tabular Hard Rock Mines
SIMRAC Jhb Chapter 10
Brady BHG & Brown ET 1993 Rock Mechanics for Underground Mining
Chapman & Hall New York Chapter 18

12.2.2 PRINCIPLES OF MONITORING

Ryder JA & Jager AJ 2002 Rock Mechanics for Tabular Hard Rock Mines
SIMRAC Jhb Chapter 9
Jager AJ & Ryder JA 1999 Rock Engineering Practice for Tabular Hard Rock Mines
SIMRAC Jhb Chapter 10
Brady BHG & Brown ET 1993 Rock Mechanics for Underground Mining
Chapman & Hall New York Chapter 18

12.2.3 MONITORING INSTRUMENTS

Ryder JA & Jager AJ 2002 Rock Mechanics for Tabular Hard Rock Mines
SIMRAC Jhb Chapter 9
Jager AJ & Ryder JA 1999 Rock Engineering Practice for Tabular Hard Rock Mines
SIMRAC Jhb Chapter 10
Brady BHG & Brown ET 1993 Rock Mechanics for Underground Mining
Chapman & Hall New York Chapter 18
Obert L & Duvall WI 1967 Rock Mechanics and the Design of Structures in Rock
John Wiley & Sons New York Chapter 9

12.3 FUNDAMENTALS OF SEISMIC MONITORING SYSTEMS

Ryder JA & Jager AJ 2002 Rock Mechanics for Tabular Hard Rock Mines
SIMRAC Jhb Chapter 5
Jager AJ & Ryder JA 1999 Rock Engineering Practice for Tabular Hard Rock Mines
SIMRAC Jhb Chapter 9

12.4 FUNDAMENTALS OF NUMERICAL MODELLING

Ryder JA & Jager AJ 2002 Rock Mechanics for Tabular Hard Rock Mines
SIMRAC Jhb Chapter 8
Jager AJ & Ryder JA 1999 Rock Engineering Practice for Tabular Hard Rock Mines
SIMRAC Jhb Chapter 11
Lightfoot N & Maccelari MJ 1998 Numerical Modelling of Mine Workings

SIMRAC Jhb Chapters 1-11

13 DRILLING AND BLASTING

13.1 EXPLOSIVES

Brady BHG & Brown ET 1993 Rock Mechanics for Underground Mining Chapman & Hall New York Chapter 17

13.2 DRILLING

General knowledge of standards, practices and procedures concerning drilling on mines

13.3 BLASTING

Brady BHG & Brown ET 1993 Rock Mechanics for Underground Mining Chapman & Hall New York Chapter 17

14 LEGAL COMPLIANCE AND GENERAL MANAGEMENT

14.1 MINES HEALTH AND SAFETY ACT AND REGULATIONS

14.1.1 THE MINES HEALTH AND SAFETY ACT

Act of Parliament 1996 Mine Health and Safety Act - Act 29 of 1996 Kivell Law Publishing Homestead

14.1.2 REGULATIONS

Ministerial Act Latest Mine Health and Safety Act - Regulations Kivell Law Publishing Homestead

14.2 CODES OF PRACTICE

Chief Inspector of Mines Latest Guideline for the Compilation of a Madatory Code of Practice to Combat Rock Fall and Rock Burst Accidents in Tabular Metalliferous Mines - Ref.No. DME 16/3/2/1-A3 DME

Chief Inspector of Mines Latest Guideline for the Compilation of a Madatory Code of Practice to Combat Roof Fall Accidents in Underground Coal Mines - Ref.No. DME 16/3/2/1-A4 DME

Chief Inspector of Mines Latest Guideline for the Compilation of a Madatory Code of Practice to Combat Rock Fall Accidents in Massive Mining Operations - Ref.No. DME 16/3/2/1-A5 DME

Chief Inspector of Mines Latest Guideline for the Compilation of a Madatory Code of Practice to Combat Rock Fall and Slope Instability Related Accidents in Surface Mines - Ref.No. DME 7/4/118-AB4 DME

14.3 BASIC RISK ASSESSMENT

14.4 GENERAL MANAGEMENT

14.4.1 REPORTING

General knowledge of report writing practice

14.4.2 MINE ACCIDENTS

Act of Parliament 1996 Mine Health and Safety Act - Act 29 of 1996
Kivell Law Publishing Homestead

14.5 ROCK ENGINEERING FUNCTIONS (ROCK ENGINEERING AS PART OF A MINING OPERATION)

Jager AJ & Ryder JA 1999 Rock Engineering Practice for Tabular Hard Rock Mines
SIMRAC Jhb Chapter 12