BUSITEMA UNIVERSITY

www.busitema.ac.ug

FACULTY OF ENGINEERING

DEPARTMENT WATER RESOURCE AND MINING ENGINEERING

REDESIGNING THE SUPPORT SYSTEM FOR GREENSTONE RESOURCES LIMITED TO IMPROVE MINERS' SAFETY

BY

MUKYALA LILLIAN BRENDA

BU/UG/20012/105

+256750606841

mukyalaswt1@gmail.com

MAIN SUPERVISOR: Mr. NASASIRA HILLARY

A final year project report submitted to the Department of Water Resources and Mining Engineering as a partial fulfilment for the award of a Bachelor of Science in Mining Engineering of Busitema University

May 2016

ABSTRACT

The mining industry is currently facing rock related accidents accounting for in excess of 50% of all fatalities occurring in the underground mines (Daehnke et al., 2001). Falls of ground still account for around 35% of all fatalities in underground South African mines as shown below (Ferreira, 2012).

In Uganda, most of the gold mines are at small scale mining level and they are still using timber for supporting which is external and passive. At Greenstone Resources Limited, the main tunnel is divided into drives which tend to the north and south direction measured from the main tunnel point as 28 m North, 28 m South, 45 m North and 45 m South of the shaft. The southern drives have minimal and randomly placed supports inform of timber but the northern drives have not been supported because the rock is a bit strong for working.

During my Industrial training at Greenstone Resources in June 2014, I observed a variety of accidents in underground workings in relation to rock falls which were normally caused by the instability of the rocks and the poor timber supports. The existing randomly placed timber supports are weak and others have rotted away because of the percolating water since the mine is located at 54m and the water table is approximately at 36m.

From the Cost point of view, Bolts and Timber have the cheapest cost so they were chosen for further analysis

From the Results of RMR and Guidelines for excavation and support of 10 m span rock tunnels (After Bieniawski 1989), it shows that it is a fair Rock which requires Systematic bolts 4 m long, spaced 1.5 - 2 m in crown and walls with wire mesh in crown. However RMR is used for design of supports in development galleries so due to limitations of its application, other approaches were considered.

After analysis of factor of safety, Rock Bolts are considered because their factor of Safety is approximately equal to 1.2 while that of Timber is less than 1.2.

DECLARATION

I do hereby declare that this industrial training report has been originally compiled by me at greenstone resources ltd and has not been presented by any student to any University or other institution of higher learning for any academic award.

Signature..

Date.....30TH MAY 2016

MUKYALA LILLIAN BRENDA

ACKNOWLEDGEMENT

First I thank the Almighty God for the gift of life, His gracefulness and provision of life to me that has enabled me make it all this far.

I thank the management of Greenstone Resources Limited for arranging and taking the decision to accept me conduct a Research in the Underground mine which has enabled me understand the Geology of the mine and various support methods required.

I appreciate the contributions made by all technicians, instructors, engineers and managers of Greenstone Resources Limited for working tirelessly to see that my Research Project became a success.

Great gratitude goes to the following persons for contributing directly to my Research and provision of technical information; **MR. EARNEST** (Underground Mine Supervisor), **MR. DESIRE** (Mine Geologist), **MR. HILLARY NASASIRA** (Main supervisor), **MR. TUGUME WYCLIFF** (Supervisor) and **MISS MARION ENGOLA** (Acting head of department of water resources and mining department)

As well, I would like to thank the rest of the Lectures and Staffs in the Mining and water Resources Department of Busitema University for easing my transition into a new field and discipline through giving me the basic theories required in mining careers. In addition, the financial support provided by the Government of Uganda and my parents.

Finally, I would like to thank my family and friends for their continuous encouragement, support and love throughout the development of this Research project. They have been there for me through good and bad times, and I hope they know how much I appreciate it.

APPROVAL

This is to confirm that this report has been written and presented by **MUKYALA LILLIAN BRENDA**, registration number **BU/UG/2012/105** of Busitema University for a Research Project conducted at Greenstone Resources Limited from December 2015 to May 2016.

The following Approvals confirm me conducting the Research Project;

1. Main supervisor

   MR HILLARY NASASIRA Signature...............

2. Head of Department Mining and Water resources engineering Busitema University

   MS. MARION ENGOLA Signature................

DEDICATION

I dedicate this report to my parents; **MR. MWIGO PATRICK SIMON** and **MS. KWAGALA ESTHER** who have raised me up, given me financial assistance, parental guidance and counseling plus encouragement in all my academic endeavors, my supervisors of greenstone resources ltd, lectures for the skills impacted in me and my fellow students.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

RMR-Rock Mass Rating

Q-Rock Tunneling Index

RQD- Rock Quality Designation

BIF-Banded Iron Formations

ML-Mining Lease

Jn-Joint Set Number

Jr-Joint Roughness Number

Jw-Joint Water Reduction Number

SRF-Stress Reduction Factor

De-Equivalent Diameter

f- Correction Factor

UCS-Uniaxial Compressive Strength

Is-Point Load Index

CHAPTER ONE

1.0: INTRODUCTION

1.1: BACK GROUND

The mining industry is currently facing rock related accidents accounting for in excess of 50% of all fatalities occurring in the underground mines (Daehnke et al., 2001).

Falls of ground still account for around 35% of all fatalities in underground South African mines as shown below (Ferreira, 2012).

In response to the rock-related hazard, a significant research thrust was, and continues to be directed at stope support, to combat the hazards of rock falls and rock bursts. In spite of a considerable amount of research effort focused in the area of improved stope support, the trend in fatality rates over the past ten years has shown only a marginal improvement. New, alternative support systems and technologies are required to significantly reduce the rock-related hazards associated with underground mining operations (Daehnke et al., 2000).

The coal mining industry has adopted leading support technologies over the years. This includes use of full-column resin capsule steel bolting with fast and slow setting resin in the hole, which allows for an immediately tensioned bolt. Stope support systems, typically consisting of props and packs, are used extensively in the gold mining industry to stabilize the rock mass in the excavation vicinity and to reduce the hazard associated with rock falls and rock bursts. The design of stope support systems was historically based predominantly on past experience and practices, and cost considerations (Daehnke et al., 2001).

Gold mines are generally lagging in the adaptation of leading and appropriate support technologies, especially for in-stope support. In fact, very limited in-stope bolting is practiced in gold mines, more than likely due to friable hanging wall conditions, hanging wall closure rates and perhaps the higher rock stresses due to depth. Development ends are generally not supported by resin bolts, which suggests an opportunity for improvement in the application of full-column, fast setting resin bolting (Ferreira, 2012)

In Uganda, most of the gold mines are at small scale mining level and lack technology and equipment to control and monitor rock falls and rock bursts.

REFERENCES

Daehnke et al., 2000. *The design and development of an effective support system for tubular stopes in gold and platinum mines,* pretoria: Safety in Mines Research Advisory Committee.

Kushwaha et.al, 2006. Development of support guidelines for depillaring panels in coal mines. *CIMFR Report, October 2001 to December 2006 Central Institute of Mining and Fuel Research,* pp. 45-48.

Norwegian Geotechnical Institute, 2013. *Using the Q System.* Norway: Allkopi As.

Anon., n.d. In-situ characterization of rocks. In: *i.* s.l.:s.n.

Archibald et al,, n.d. *Economic and Productivity comparison of Bolt and screen, Shortcrete and Polymer Rock Support Methods,* canada: Department of Mining Engineering, Queens University.

Archibald et al., 1999. *Economic and Productivity Comparison of Bolts and Screen, Shortcrete and Polymer Rock Support Methods,* Canada: s.n.

Avinash Paul et al, 2014. Rock load Estimation in Development Gallaries and Junctions for underground coal mines. *Journal of Mining,* p. 9.

Barton et al, 1974. *Engineering classification of rock masses for the design of tunnel support,* s.l.: s.n.

Barton et al, 1974. *Engineering classification of rock masses for the design of tunnel support,* s.l.: s.n.

Bieniawski, Z., 1976. *Rock mass classification in rock engineering,* Cape Town: s.n.

Bieniawski, Z., 1976. *Rock mass classification in rock engineering,* Cape Town: s.n.

Bieniawski, Z., 1989. *Engineering rock mass classification,* New York: Wiley.

Daehnke et al., 2001. Review and application of stope support design criteria. *The Journal of The South African Institute of Mining and Metallurgy,* pp. 135-164.

Daehnke et al., 2001. Review and application of stope support design criteria. *The South African Institute of Mining and Metallurgy.*

Deere, D., 1963. *Technical description of rock cores for engineering purposes,* s.l.: s.n.

Deere, D., 1963. *Technical description of rock cores for engineering purposes,* s.l.: s.n.

Einstein et al., 1982. Probabilistic and statistical methods in engineering geology. In: *Rock mechanics.* s.l.:s.n.

Ferreira, 2012. A Perspective on Underground Support Technologies in South African Platinum Mines to Reduce Safety Risks and enhance Productivity. *The South African Institute of Mining and Mettallurgy.*

Ferreira, 2012. A Perspective on Underground Support Technologies in South African Platinum Mines to Reduce Safety Risks and enhance Productivity. *The South Afican Institute of Mining and Metallurgy.*

H.Madencilik, 1995. *Rock mass characterisation at the corrxgbxhalt mzme,* Norther Ireland: s.n.

Hester, 2009. *Gold Exploration Projects of Grey Crown Resources Limited, Busia District, Uganda.*, s.l.: s.n.

Kaiser et al., 2012. Design of rock support system under rock burst condition. *Journal of Rock Mechanics and Geotechnical Engineering,* pp. 215-227.

Kumar, 2010. *Design of Support System for Board and Pillar workings,* s.l.: s.n.

Larbi et al, 2012. Study of fractured rock masses deformation in Boukhadra(Tebessa) underground mine empirical and numerical approach. *Journal of Geology and Mining,* Volume 4(2), pp. 23-34.

Mosenthal, 1990. Presidential Address: Stoping in Witwatersrand gold mines during the past forty years. *J. S. Atra. Inst. Mining. Metall,* 90(9), pp. 234-255.

Mostafa et al, 2013. Correlation of sandstone rock properties obtained from field and laboratory tests. *INTERNATIONAL JOURNAL OF CIVIL AND STRUCTURAL ENGINEERING.*

Palmstrom, A., 2001. Measurement and characterisation of rock mass jointing. In: *In-situ characterizationof rocks.* Norway: s.n., pp. 8-12.

Palmstrom, A., 2005. Measurement of and Correlation between Block size and Rock Quality Designation(RQD).

Robert, 1970. *Mine Timber Market,* s.l.: s.n.

Sabatini et al., 2002. *Evaluating of Soil and Rock properties,* s.l.: s.n.

Sabatini et al., 2002. Evaluation of soil and rock properties. *GEOTECHNICAL ENGINEERING CIRCULAR NO 5,* pp. 102-107.

Sharma et al., 2013. Statistical Analysis of CMRI-RMR and Q-System for Implementation in depillaring Panels of Indian coal mines. *International Journal of Scientific Enginnering and Technology,* 2(10), pp. 947-952.

SINGH, V. D., 2013. *DESIGN OF SYSTEMATIC SUPPORT SYSTEM FOR DEVELOPMENT AND DIPILLARING IN UNDERGROUND COAL MINES,* s.l.: s.n.