# DECLARATION

I declare that this research report is my own unaided work. It is being submitted to the Degree of Master of Science to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other University.

……
(Signature of candidate)

…….. day of ……..... (year) …….....

at ……

# ABSTRACT

In underground and surface excavations, rock mass instability often occurs, and one method of remedying this is to spray support liners onto the unstable rock surfaces. Thin Spray-on Liners (TSLs) have been used in both the mining and civil engineering industries as sealants, and as surface support to maintain rock mass stability. As a replacement of shotcrete, the use of TSLs for rock support is gaining increasing acceptance in the mining industry due to experience with its exposure. The literature describing success stories of the application of the products have been emerging lately. A significant amount of testing has been carried out to determine the properties of TSLs and to investigate how the products provide support to the excavations.

The research described in this research report describes a laboratory investigation into the extent to which various spray-on liners, coated on unreinforced and reinforced shotcrete specimens, will enhance the tensile strength of the shotcrete. Physical properties and the mechanisms of behaviour of these sprayed liners on shotcrete under laboratory conditions are compared as well. Brazilian indirect tensile strength tests were performed on shotcrete specimens, both uncoated and hand-coated with TSL material for this research. Tests were carried out for a specified range of curing times, and thus the performance of the TSLs was established as a function of curing time. This is seen as a significant parameter to be checked for sensitivity.

The laboratory test results of a total of 96 unreinforced and reinforced shotcrete specimens, using three different TSL products as coatings, showed that the spray-on liners significantly enhanced the tensile strength of the shotcrete. Strength gains 2 hours after application were in the order of 20%, and this increased to approximately 40% after 28 days. Slightly higher strength gains were recorded for the fibre-reinforced shotcrete specimens. In summary, the tests showed that the performance of the TSLs coated on the shotcrete depends on the type and quality of the liner, the curing time and the added material in the shotcrete, eg fibre product. The Brazilian test provided a satisfactory method of evaluating and comparing the enhancement of shotcrete tensile strength provided by different TSL products.

# ACKNOWLEDGEMENTS

First and foremost, praise and thanks goes to my savior Jesus Christ for his favour and the many blessings undeservingly bestowed upon me.

My profound gratitude on the assistance and support for the success in completing this research work is extended to the following people and institutions:

Professor T. R. Stacey for his supervision, guidance, encouragement and motivation throughout this research report

Dr H. Yilmaz for his motivation and guidance.

University of the Witwatersrand for granting me the opportunity to do the research project.

GENMIN Laboratories for affording me the opportunity to carry out laboratory tests.

Minova RSA, SA Mining and Concrete Lining Products (CLP) for donating all the Shotcrete products, fibres and Thin spray-on liners used in the laboratory tests.

My family members, friends and colleagues for being around in times of need during the research work.

……To the three most important people in my life; my wife Portia, my son Tshenolo and daughter Omolemo ……

# TABLE OF CONTENTS

**CONTENTS** **PAGE**

# LIST OF FIGURES

# LIST OF TABLES



# LIST OF SYMBOLS AND ACRONYMS

| | |
|---|---|
| $\sigma t$ | Tensile strength (MPa) |
| MPa | Mega Pascal |
| Kg | Kilogram |
| P | Applied Load (kN) |
| D | Diameter of specimen core (mm) |
| A | Failure Area ($m^2$) |
| t | Thickness of the core (mm) |
| TSL | Thin Spray-on Liner |
| * | Typical values assumed |