New Concept Mining

Dynamic Drop Testing of the M Props Camlok Canopy Design

Confidential to New Concept Mining & M Props

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Executive Summary

Falls of ground still remain the highest risk that causes injuries / fatalities to personnel and damage to property in the South African mining industry. Research has always been employed in developing products aimed at minimizing the effect of eliminate falls of ground were practically possible.

M Props in collaboration with New Concept Mining (NCM) have designed the Camlok Canopy, that employs the NCM net design with the M Props Camlok Prop design.

Dynamic drop testing of the M Props Camlok Canopy design was conducted at NCM's Netting facility on 18 February 2019. All Camlok Canopy samples tested were able to sustain an impulse 0.4 kJ, with a minimum survival height of 0.89 m.

TABLE OF CONTENTS

List of Tables

List of Figures

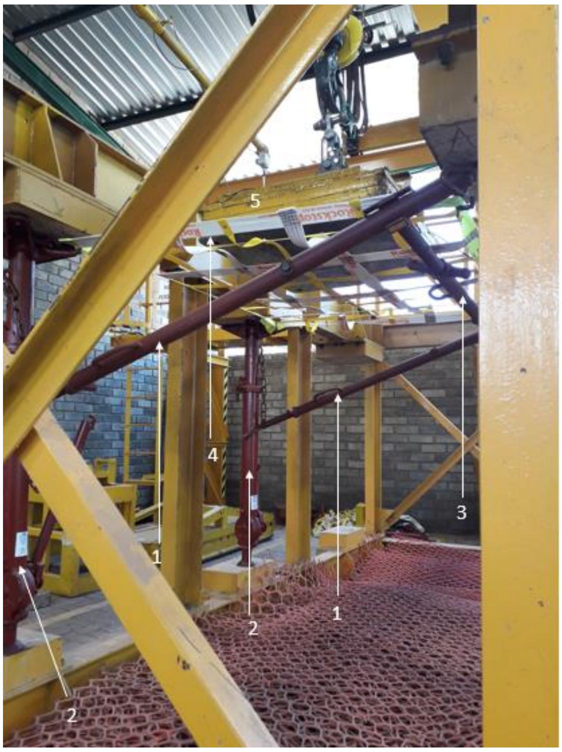
1. INTRODUCTION

A collaboration between New Concept Mining (NCM) and M Props resulted in the development of the Camlok Canopy system. The aim of the development was to limit the exposure of personal at the face, by providing a system to enable areal support to be installed from the safety of a supported area.

In order to quantify the dynamic performance of the system a 0.4 kJ impulse was imparted into the sample at the NCM Net testing facility.

2. CAMLOK CANOPY SYSTEM

The Camlok Canopy system is installed as seen in Figure 1, a pair of Camlok Props (2) are installed in the supported area. The Canopy arms (1) extend in to the unsupported area. The RockStop net (4) is attached to the props and arms via S-Hooks. The nets used in this application were a 150 mm aperture with external dimensions of 1.6 m x 1.2 m.

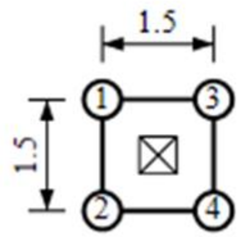


1. **Canopy Arm**
2. **Camlok Prop**
3. **Canopy Brace**
4. **RockStop Net**
5. **Mass (450 kg)**

Figure 1: Camlok Canopy system installed in the test frame

3. METHOD

Figure 2 is a schematic illustration of the test setup and a table of the input parameters for the three tests conducted. The illustration is a plan view of the setup with the dynamic test frame configured to simulate the Camlok Canopy spacing. Positions 1 and 2 represent the positions where the Camlok Props are installed, with positions 3 and 4 representing the end position of the of the extended Canopy Arms. Position 3 and 4 is connected together by the Canopy Brace, with the RockStop Net connected at the four attachment points.



Test Conditions

Support Spacing:	0 x 1.5m
Stope Height:	1.2 m
FOG Mass:	450 kg
FOG Height:	0.10 m
Number of Attachments:	4
Number of Load Cells:	0

Figure 2: Test input parameters

During the dynamic test the forces applied to the mass by the net and the deflection of the net is recorded using a string potentiometer and an accelerometer.

The following process was followed for each of the three tests:

- Install the two Camlok Props securely onto the stope-mock “footwall”.
- The mock-up employed a 1.2 m “stope height”.
- Connect both Canopy Arms to the Camlok Props and secure them tightly.
- Connect the Canopy Brace to the Canopy Arms.
- Hook the first two net corners at the Camlok Prop hooks (one on each Camlok), then connect the remaining two corners to the hooks on the Canopy Arms.

- Extend the Canopy Arms (connected with the Canopy Brace and RockStop Net) to the mock-up “face” position, which is 1.5 m from the Camlok Props.
- Measure the drop height to be 0.1 m from the RockStop Net.
- Drop the suspended weight unto the net using a sling connected to the mobile crane.
- Remove the dropped mass with the crane for visual observation of the post drop deformation endured by the Camlok Canopy System (Canopy Arms, Canopy Brace, RockStop Net, net attachment points).
- Connect new Canopy Arms, Brace and RockStop Net post each dynamic test.
- The Camlok Props remained unchanged for the duration of the three tests.

4. RESULTS

In every test, the mass was successfully arrested by the Camlok Canopy system. The effect of the test can be noted in Figure 3, the RockStop net was able to arrest the mass with minor damage, only a single failure of the secondary webbing was noted.

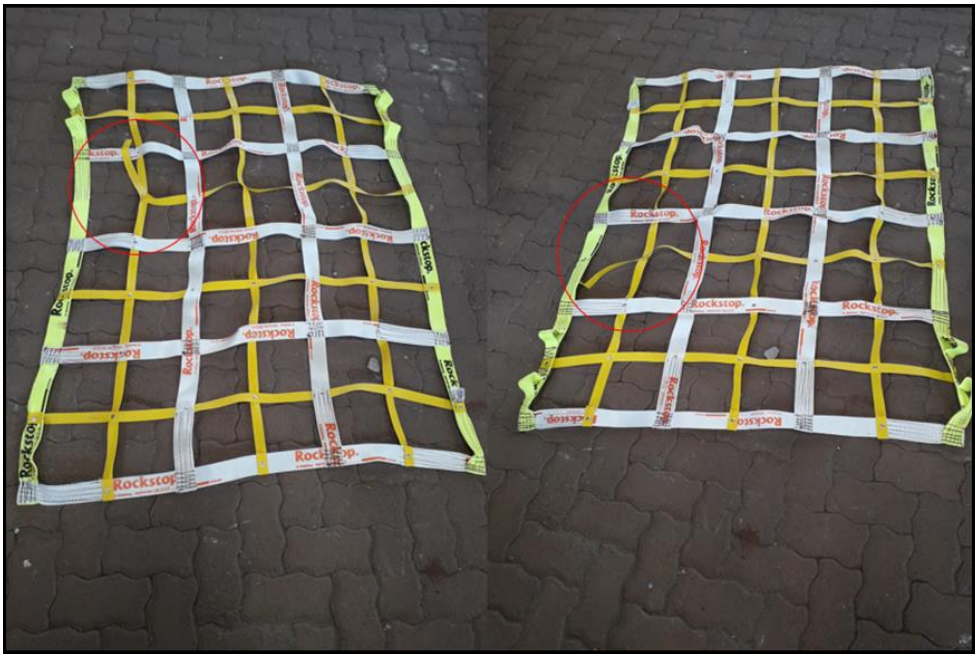


Figure 3: Post drop deformation of RockStop Net

A Table 1 provides a summary of the test results. The complete result for each test can be found in Appendix A.

Table 1: Drop testing results

Variable	T1	T2	T3
Impact Velocity (m/s)	1.4	1.4	1.4
Kinetic Energy (kJ)	0.4	0.4	0.5
Absorbed Energy (kJ)	1.8	1.8	1.8
Final Deformation (m)	0.27	0.26	0.28
Maximum Deflection (m)	0.30	0.30	0.31
Maximum Force (kN)	21.6	18.9	20.9
Survival Height (m)(1)	0.90	0.90	0.89
Observation	Mass arrested. One failure position observed on the net	Mass arrested. One failure position observed on the net	Mass arrested. One failure position observed on the net

1. *Survival height is based on a 1.2 m stoping height (Survival height = 1.2 – Max. Deflection)*

5. DISCUSSION

What is of critical importance for the Camlok Canopy system is the Maximum Deflection, Final Deformation and resultant Survival Height. Those values can directly be correlated to the net deflection should a fall of ground of the same 0.4 kJ magnitude occur. The survival height gives an indication of how much of the original (assumed 1.2 m) stoping height remains after a fall of ground.

6. CONCULSION

- In all three tests, the RockStop Net was able to arrest the dropped weight of 4.5 kN (450 kg) dropped from a height of 0.1 m.
- There was no observable damage to the Canopy Arms, Braces or the Camlok Props during the tests.
- The survival heights calculated were no less than 0.89 m from an original height of 1.2 m.

Appendix A Test Certificates

Gravity Induced FOG Test

Customer Details

Name:	NCM
Sector:	Internal
Representative:	Billy

New Concept Mining

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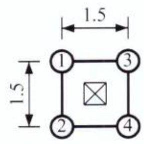
Date:	2019-02-18
Test No.	1902038
Result	Passed

Product Info

Net Stock Code:	WB-1.2X1.6X150
S-Hook Stock Code:	Nil
Face PlateS tock Code:	Nil
Hydra Bolt Stock Code:	Nil



Test Conditions

Support Spacing:	0 x 1.5m
Stope Height:	1.2 m
FOG Mass:	450 kg
FOG Height:	0.10 m
Number of Attachments:	4
Number of Load Cells:	0

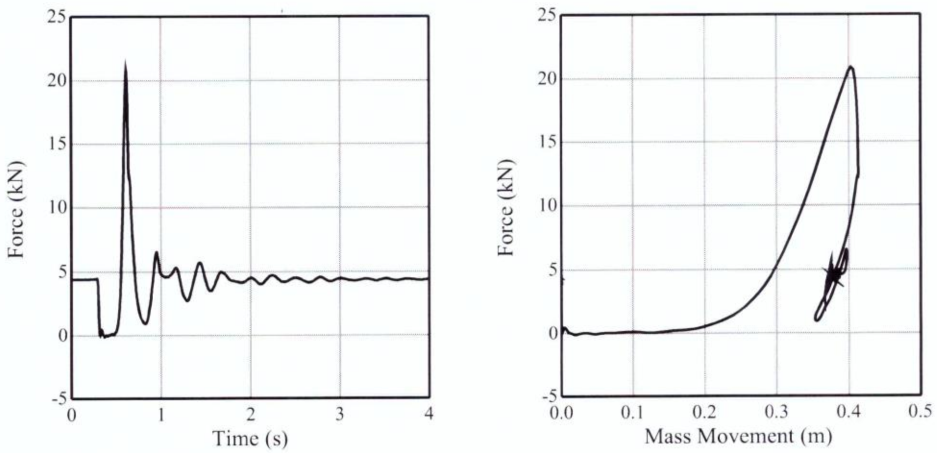
Results

Impact Velocity:	1.4 m/s
Kinetic Energy:	0.5 kJ
Total Energy:	1.8 kJ
Final Deformation:	0.28 m
Maximum Deflection:	0.31 m
Maximum Force:	20.9 kN
Survival Height	0.89 m

Maximum Forces

Comments:

ROCKSTOP CANOPY SAFETY NET



Methodology: A mass of known weight is positioned over the net at a specific height above the net. The Weight is then dropped onto the net to evaluate the total energy that is absorbed and the total displacement of the net without failure.

v1.6 Customer: ____________ Test Technician ____________

Gravity Induced FOG Test

Customer Details

Name:	NCM
Sector:	Internal
Representative:	Billy

New Concept Mining

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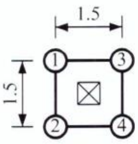
Date:	2019-02-18
Test No.	1902036
Result	Passed

Product Info

Net Stock Code:	WB-1.2X1.6X150
S-Hook Stock Code:	Nil
Face PlateS tock Code:	Nil
Hydra Bolt Stock Code:	Nil



Test Conditions

Support Spacing:	0 x 1.5m
Stope Height:	1.2 m
FOG Mass:	450 kg
FOG Height:	0.10 m
Number of Attachments:	4
Number of Load Cells:	0

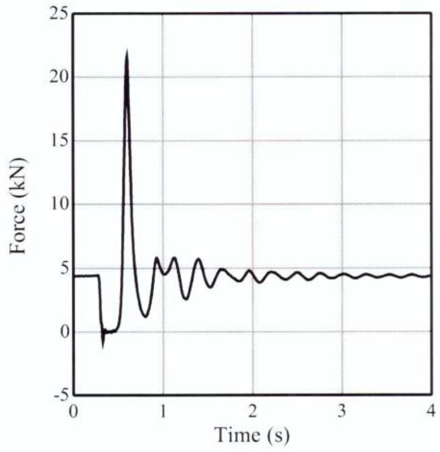
Results

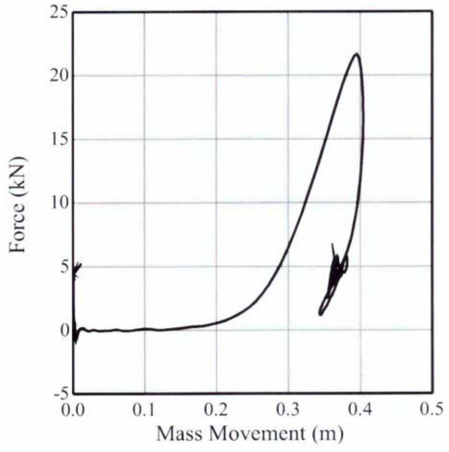
Impact Velocity:	1.4 m/s
Kinetic Energy:	0.4 kJ
Total Energy:	1.8 kJ
Final Deformation:	0.27 m
Maximum Deflection:	0.30 m
Maximum Force:	21.6 kN
Survival Height	0.90 m

Maximum Forces

Comments:

ROCKSTOP CANOPY SAFETY NET





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v1.6 Customer: ____________ Test Technician ____________

Gravity Induced FOG Test

Customer Details

Name:	NCM
Sector:	Internal
Representative:	Billy

New Concept Mining

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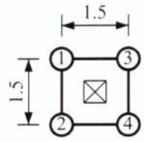
Date:	2019-02-18
Test No.	1902037
Result	Passed

Product Info

Net Stock Code:	WB-1.2X1.6X150
S-Hook Stock Code:	Nil
Face PlateS tock Code:	Nil
Hydra Bolt Stock Code:	Nil



Test Conditions

Support Spacing:	0 x 1.5m
Stope Height:	1.2 m
FOG Mass:	450 kg
FOG Height:	0.10 m
Number of Attachments:	4
Number of Load Cells:	0

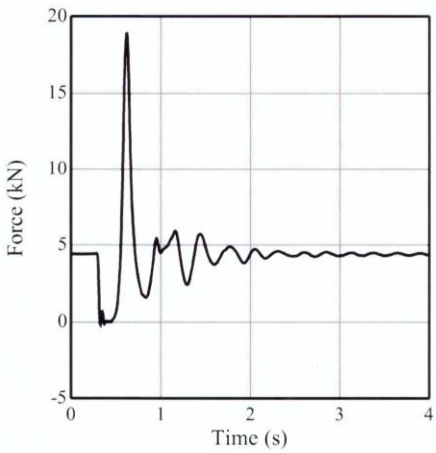
Results

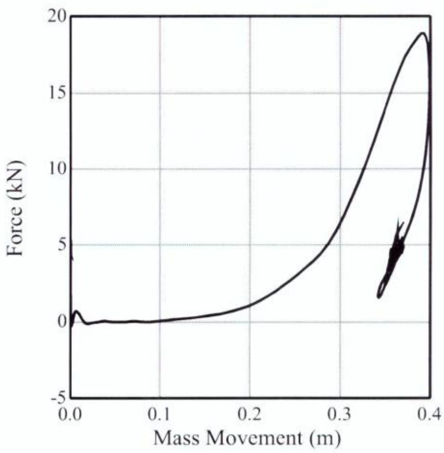
Impact Velocity:	1.4 m/s
Kinetic Energy:	0.4 kJ
Total Energy:	1.8 kJ
Final Deformation:	0.26 m
Maximum Deflection:	0.30 m
Maximum Force:	18.9 kN
Survival Height	0.90 m

Maximum Forces

Comments:

ROCKSTOP CANOPY SAFETY NET





Methodology: A mass of known weight is positioned over the net at a specific height above the net. The Weight is then dropped onto the net to evaluate the total energy that is absorbed and the total displacement of the net without failure.

v1.6 Customer: ____________ Test Technician ____________

Appendix B Disclaimer

While every detail of the testing and the resultant contents of this report have been meticulously examined and checked, it must be noted that the contents of this report are only based on what could be observed during the testing and the feedback provided by the relevant officials and experts interviewed. Accordingly, New Concept Mining, its associates and employees make no claims or guarantees about the accuracy, completeness, or adequacy of the contents of this report, takes no responsibility for errors and omissions contained therein, and will in no event be liable to any "Company" for any decisions made or actions taken in reliance on the contents of this report or for any consequential, special or similar damages, even if advised of the possibility of such damages.