GUIDELINES AND BEST PRACTISES FOR THE UTILIZATION OF TENDON MONITORING TECHNOLOGY IN HARD ROCK MINES

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WE CAN ALL AGREE!

Doyle (1892) in the book “A Scandal in Bohemia”, the fictional detective Sherlock Holmes advises Dr Watson that:

“It is a capital mistake to theorize before one has data. Insensibility one begins to twist facts to suit theories, instead of theories to suit facts.”
An Inconvenient Observation

In a rock mechanics context the need for geotechnical data was articulated by Hoek (1994). In a letter to the International Society of Rock Mechanics (ISRM) News Journal he provided a sobering commentary:

“I see almost no research effort being devoted to the generation of the basic input data which we need for our faster and better models and our improved design techniques. These tools are rapidly reaching the point of being severely data limited.”
In region 1 there are good data but little understanding; this is where statistics is the appropriate modelling tool.

In region 3 one has both the data and the understanding; models can be built, validated and used with conviction.

Regions 2 and 4
- data-limited problems
- relevant data are unavailable or cannot easily be obtained.
Bieniawski (1988) suggested that: “…..geological and rock mechanics data must be collected in sufficient quantity and of high quality; data interpretation should be performed specifically for purposes of engineering design; and innovative design approaches should be used to bring about improvements in productivity and safety”.

Bolt rupture occurs at the end of a very complex and involved geotechnical process. Is a design approach based on bolt rupture realistic? **More importantly, from a liability standpoint is it prudent????** For ethical/legal reasons YieldPoint Inc. would never want to market a product that provided a BOOLEAN output related to rockbolt rupture.

The loading behavior of the rock bolt is intrinsically driven by the rock mass. Once the rock mass begins to fail the effectiveness/accuracy of existing design tools begins to degrade. Therefore it is extraordinarily difficult to interpret why a sub-population of bolts might fail, whether that represents a hazard, and what action should be taken. This lack of understanding could make MIGS II the most expensive project that RTC has ever proposed for its partners.
MONITORING PHILOSOPHY 2

At YP the focus is completely on improving Rock Bolt Design.

RULE #1. Must have numerical models and associated understanding in place before even considering instrumentation. START THE FEEDBACK ENGINE (NB. it’s a rotary engine)

RULE #2 Data limited approach: Generate “rich” data that can provide feedback for computational design tools. Analyze patterns in space and time, focus on comparative studies (data limited approach)

• Relate mining events to increases in rock bolt load.
• Relate different bolt types to different rates of load increase
• Promote understanding that critical design parameter for rock bolts is stiffness.

From an operational perspective the objective is to assess the reserve capacity of the rock bolt system and hence whether there is requirement for proactive rehabilitation. HOW MUCH GAS IS LEFT IN THE TANK?
Freeman (1978) to explain data obtained from the Kielder experiment (UK)
These bolt may have completely different strain profiles
In reality it is found that loads quickly transfer onto the rebar’s bolt plate depending upon the proximity of the deformation to the collar.
2. How about Bending??

![Graph showing strain distribution with different weights applied](chart.png)
Mode 3: Shear

[Graph showing strain vs. distance along the fiber for different series (Series 1, Series 2, Series 3, Series 4).]
Shear Plane
$d$-REBAR Design

Provisional patent obtained September 2011
$d^6$REBAR Case Study - Mine A
$d^6$REBAR Case Study - Strain Distribution

$153 \mu \varepsilon = 10kN$

First Reading: 08/29/2010

07/02/2011
$d^6$REBAR Case Study - Displacement Distribution

First Reading: 08/29/2010

AIMS 2012 Rock Bolting and Rock Mechanics in Mining

02/07/2011
d\textsuperscript{6}REBAR Case Study - Mine B
FGP $d^6$REBAR Results - Intersection
153\(\mu\varepsilon\)=10kN

Heading #7 Intersection

08/06/2010 (Initial readings) - 3 days after installation
153\mu \varepsilon = 10kN

09/07/2010 11:00
$153 \mu \varepsilon = 10 \text{kN}$

Node location

1
2
3
4
5
6
7

Heading #7 Intersection

09/07/2010 13:00

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153 \mu \varepsilon = 10 \text{kN}

09/07/2010 17:00
Bolt elongation ($\mu m$)

14/07/2010 00:00
The intersection did not require rehabilitation.
Independently conducted FLAC modeling [17]. The model uses strain softening behavior of failed rock to simulate “shear bands” similar to those hypothesized by the instrumentation results.
MCB - Resin Rebar Comparison

Approx Yield Point of Steel
WIRELESS DATA TRANSMISSION

ROCK TENDON MONITORING

Keyword; Monitoring

Today monitoring implies bring data to the desktop.

Leaky feeder WIRELESS NODES: $2000ea

For this price we need to transmit “RICH” data
CONCLUSIONS

Personally the response to our Proposal has provided a philosophical crisis.

We have presented our position and we obviously realize that we have not been able to address the specific demands of the RFP.

We have made some preliminary investigations of suitable technology but we do not have a “silver bullet” costing $3.

YieldPoint is not a single “widget company”. We want to bring technologies that can demonstrably provide insight into rock bolt design.