YieldPoint *Sensing the future*

d-Cable

YieldPoint's ***d*-Cable** technology allows engineers, technicians, consultants and contractors to monitor how the load develops along 7-wire stand cable bolts over time, and hence to assess the Factor of Safety against cable rupture. The instrument is applicable to cable bolts, ground anchors, tendons, and tie-backs used in all types of mining and civil projects. It has the potential to predict the risk of catastrophic structural failure: in fact ***d*-Cable** data can enhance many aspects of *engineering design*, *installation quality control*, *long-term operation assessment*, and *rehabilitation*.

The ***d*-Cable** is indistinguishable from a regular cable and deployment simply involves replacing a regular cable with its instrumented equivalent. During cementing/grouting no special procedures need to be followed. The readout head of the ***d*-Cable** has a diameter of 25mm. If no face-plate is required the instrument can be installed "head-at-collar(HAC)" with the readout head simply recessed into the collar of the hole. This provides protection from mining activities. When the cable is to be plated then the instrument is installed "Head-at-Toe (HaT)".

The lead-wire can be supplied in a durable polyethylene tube to allow shot-creting. Alternatively lead-wires can be eliminated altogether using BluLink.

Features:

- *Digital (d-Tech) instrumented cable with RS485 signal out.*
- *Instrumented 7-wire strand cable applicable to plain strand, Bulb cables.*
- *Available with 1(d^1Cable) to 6 (d^6Cable) node points*
- *25mm Readout head.*
- *HaT configuration for plated cables*
- *Microcontroller provides output directly in load (tons).*
- *Individually calibrated.*
- *Immunity to hostile environment*
- *High survivability to shock and vibration.*
- *Easy to install and maintain.*
- *Low cost peripheral devices for datalogging (d-Logger and BluLogger) and Ethernet/WiFi or LTE-M upload*
- *Competitively priced.*

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d-Cable

Technology

How Does it work?

The ***d*-Cable** is based on a miniature borehole extensometer manufactured into a surrogate tubular king-wire. A total of up to six wires are fixed to the king-wire at nodal locations $x_1, x_2 \ldots\ldots x_6$. Node 1 is always closest to the head. The translation of the six wires is measured by 6 displacement sensors at the head of the device. As the cable stretches each displacement sensor measures the relative displacement between the head and the nodal point (u_1, u_2 $\ldots u_6$). The difference between adjacent nodal points can be used to calculate the strain of the cable,

$$\varepsilon_{12}(\%) = \frac{u2-u1\ (mm)}{x2-x1(mm)} \times 100$$

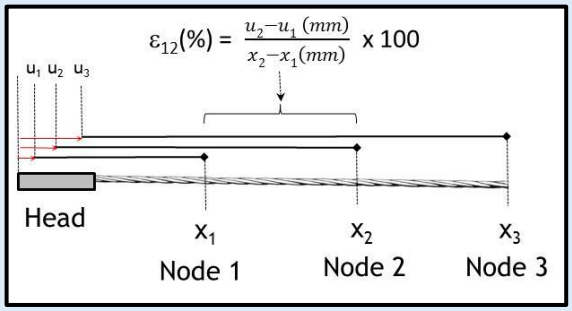
or

$$\varepsilon_{12\ (\mu\varepsilon)} = \frac{u2-u1\ (mm)}{x2-x1(mm)} \times 10^6$$

Where ε_{12} is the average strain between nodes 1 and 2. The corresponding load can be calculated by multiplying the strain ($\varepsilon_{12(\mu\varepsilon)}$) by the stiffness of the cable (30N/με or 300kN/%).

The nodal points can be concentrated at locations where it is predicted that the cable may intersect a known geological feature. Locations of the nodal points is specified by the customer.

$$F(kN) = \varepsilon_{12} \times 30{,}000$$



Telemetry

Measurements are output from the instrument directly in mm according to the YieldPoint's d-Tech format. The RS485 output signal can be transmitted over 500m without amplification. These values represent the stretch of the steel cable. As a rule of thumb conversion between stretch and load: 8mm of differential stretch between adjacent nodes results in 240kN of load for a 1m node spacing.

Manual Readout

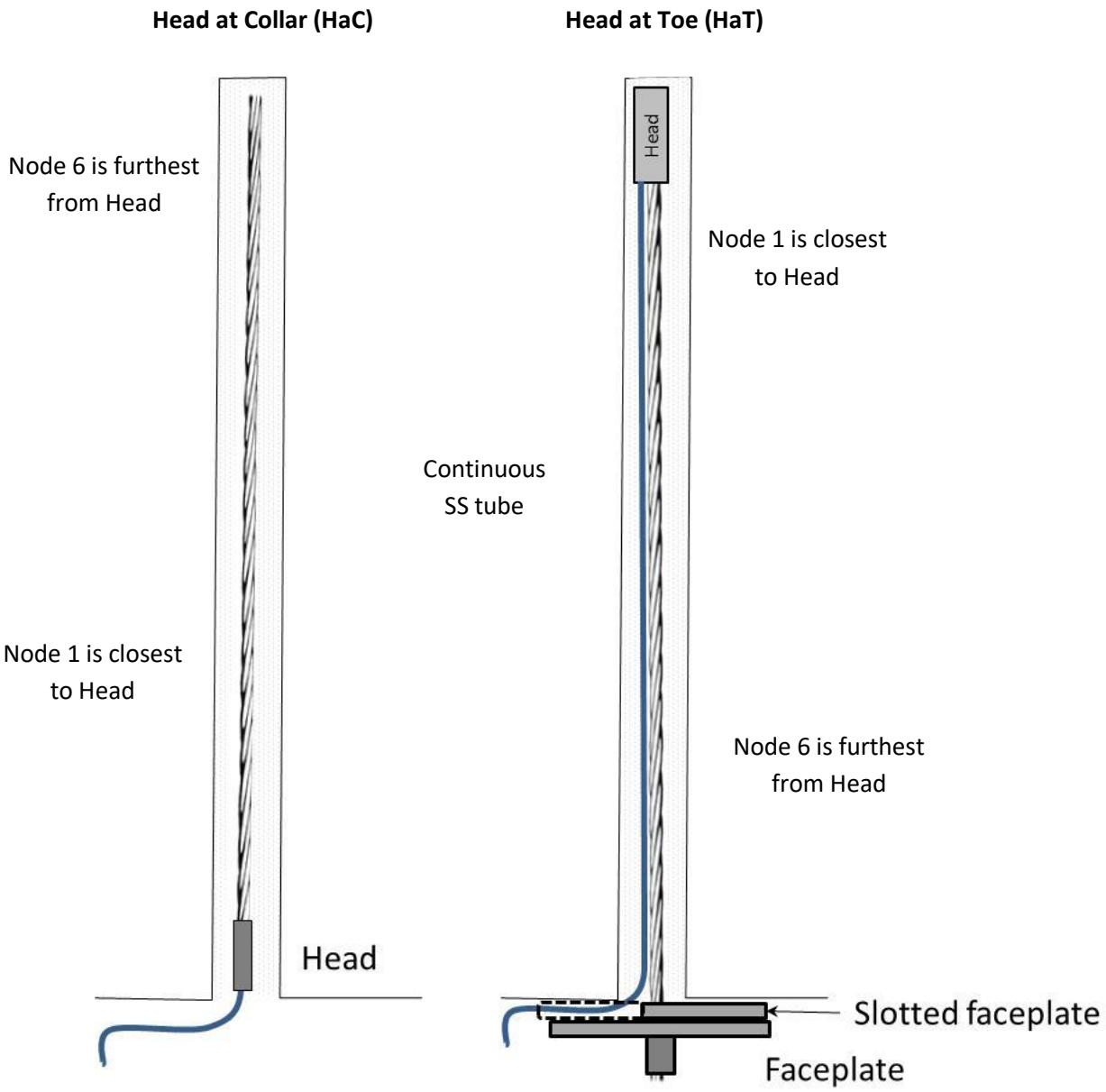
YieldPoint's low cost ***d*-Reader** readout unit provides the temperature and load data directly in °C and mm.

Datalogging

Data from the ***d*-Cable** can be collected using YieldPoint's **BluLink** or **d4BluLOGGER** data-loggers. The data-loggers require no configuration and are fully interchangeable with any other type of YieldPoint instrument (***d*-Exto** borehole extensometers, ***d*-GMM**, and ***d*-MPBX** etc). Thus arrays of instruments to monitor cable load and ground movement can easily be combined.

Post-Tensioning

Face-plating the **d-Cable** is possible by specifying the HaT configuration. The lead-wire is retrieved inside a continuous stainless steel tube. At the collar of the borehole this is routed through a slotted faceplate.



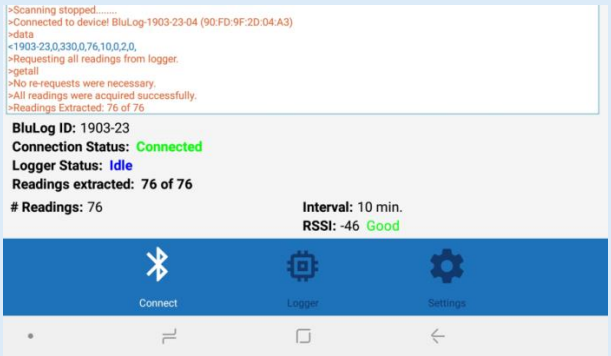
For customers using HaT configured cables, contact YieldPoint for information concerning the slotted faceplate.

Telemetry

BT5 and BluPoint

Instruments can be wirelessly enabled using **BluLink** which provides a Bluetooth 5.0 connection which has a range of 100m LOS. BluLink can transmit data to BluGateways which are (i) Ethernet/WiFi or (ii) LTE-M enabled. These devices can upload data to VantagePoint, YieldPoint's data aggregation and visualization tool.

BluLink also functions as a local data-logger storing 30,000 readings. Wireless download can be by any Bluetooth enabled Android device using the BluPoint app.



BluLink and the BluPoint App.

Telemetry

LTE-M and 900MHz 1for1 mesh Telemetry

For longer range deployments the d-Cable operates with YieldPoint's 900MHz 1for1 mesh radio telemetry system. Individual radios have a LOS range of 300m.

: *An installed 1 for 1 radio*

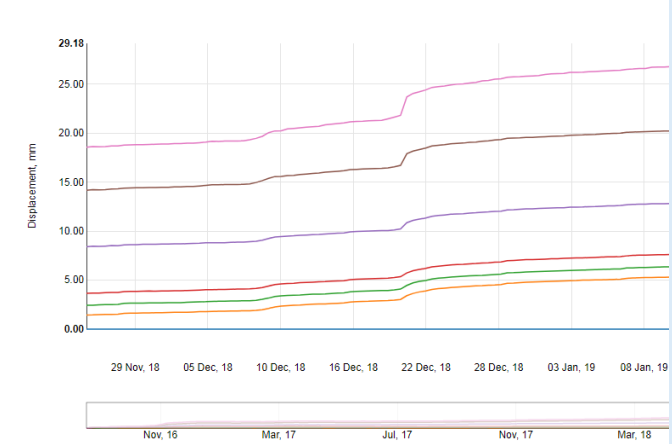
Alternatively if an LTE-network (e.g. AMBRA) is available the LTE-M gateway can be used to backhaul readings.

The d4BluGateway

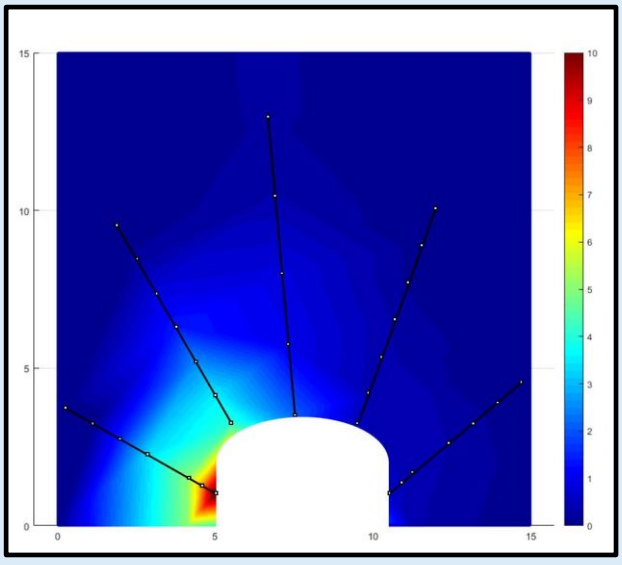
d-Cable

Applications

- Slope Monitoring
- Monitoring cable reinforcement in tunnels and drifts
- Monitoring cable reinforcement in stopes and other large openings
- Monitoring cables in fill mats
- Monitoring ground anchors
- Monitoring strand reinforced concrete
- Monitoring tie-backs



Detailed d-Cable data recorded using a d-Logger.



Contoured data for an array of d-Cables

Specification

- **Core Technology:** 6 point borehole extensometer integrated into 7-wire strand cable.
- **Output Signal** -RS485 with transmission up to 1000m over 2xtp.
- **Disp. Range (F.S.)** - 0-125mm(typ).
- **Disp. Resolution** -approx 0.01 mm.
- **Disp. Linearity** - typically 0.25% F.S(0-125mm)
- **Total Accuracy** - typically better than 0.5mm.
- **Temp. range**: Temp: -40 to 125°C
- **Temp Resolution**: 0.1°C
- **Temp Accuracy**: +/- 2°C Temp
- **Temp. sensitivity:**<+/- 0.02%/C

To Order Specify:

- Type of cable (plain versus Garford blub with bulb spacing).
- Plated / non-plated
- Number of nodes(1-6).
- Location of nodes.
- Leadwire length.
- Poly leadwire cover.

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