

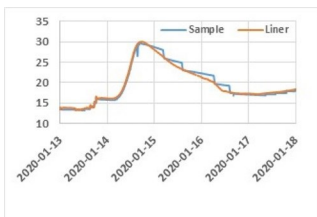
Jansen | Shaft Liner Concrete Curing



LS-Series node located 900 m underground



LoRa enclosure that collects data from every individual node



Example graph comparing remotely collected temperature measurements and actual temperature measurements of concrete cylinders



View of the warehouse where the C3 Match are located

Following up on the success of the in-shaft geotechnical instrumentation program at the Jansen mine in Canada, GKM Consultants was mandated by TRL (Thyssen-Redpath-Ledcor) and BHP to design, deploy and commission a large-scale concrete cure match system for the construction of the shaft liner. The challenge that GKM Consultants attacked head-on was that the concrete cylinders produced for quality control had to be cured at the surface at temperatures matching exactly, in real-time, temperatures measured 900 meters underground. GKM Consultants developed and introduced an innovative solution that would allow TRL to go ahead with the construction of the shafts.

In this project, the design called for building the liner of the shafts from the bottom up. Major constraints on concrete volume, work schedule, and underground conditions required accurate knowledge of the actual properties of each concrete pour. The compression strength of the concrete is critical before removing the forms. Every hour that can be shaved off removing the forms to move on to the next section translates into large savings for the contractor.

The system uses a custom-made thermistor array (Geokon model 3800) connected to a vibrating wire node (GKM Consultants' LS-Series). Measurements are taken automatically from the start of the pour and transmitted wirelessly to the platform for several months. These measurements are then relayed back to the surface, where

a control system takes individual thermistor readings and redirects them as set-points for the curing boxes (GKM Consultants model C3-Match). It has proven possible to maintain the temperature of the concrete cylinders within 2 °C of the in-shaft forms at all times.

The in-shaft nodes are low-power long-range LoRa nodes that can read the thermistors continuously for months and transmit the data wirelessly back to the platform no matter at what depth it is located. Additionally, this wireless infrastructure will be able to be upgraded to integrate structural health monitoring instruments such as strain gauges or extensometers.

The keystone of the system is the remote data visualization platform. It provides real-time alarms if any of the temperatures are out of range, if temperature gradients are too large or if communications are lost with any of the instruments. It also provides real-time plotting capabilities of the in-shaft concrete forms and concrete cylinder temperatures. A custom tool was developed to calculate and plot maturity curves for each pour in real-time, giving valuable insights to the engineers and project managers.

GKM Consultants' innovative solution saves time and money to the mine owner and contractors by aiding the production of highly-accurate concrete samples and real-time actionable data.