OPGW strain monitoring

Luna distributed strain sensing measured 32 km of a 500 kV overhead line in China and detected the local events that put lines and towers at risk.

CASE STUDY **Client location: Guangdong, China**

Challenge

Optical ground wire (OPGW) on high-voltage towers is exposed to icing, lightning strikes, wind load and tower collapse. Theoretical models predict large strain changes in the OPGW before these failures occur, but they needed to be proven in the field.

Solution

Luna installed an EN.SURE distributed strain sensing controller in a substation of a 500 kV overhead line. Connected to a single-mode fiber in the OPGW, it turned the existing communications fiber into a 32 km strain sensor.

Results

The system measured strain along the full 32 km every 15 minutes, with a resolution of about 2 με. The line was stable overall, and the system detected a few local strain events, most likely caused by wind at the tower connections.

The study shows that strain monitoring can become a valuable tool for preventing damage to overhead lines and high-voltage towers.

Background information

OPGW lines are mounted on high-voltage towers. They carry optical fibers for data communication and conductive wires that connect the towers to ground.

Nature puts a strain on overhead lines

Being out in the open makes the lines vulnerable. Common failures include icing, lightning strikes, tower collapse and wind load.

To understand this strain, Luna continuously measured a 500 kV OPGW line in Guangdong, China, using a single-mode fiber in the OPGW as the sensor. Figure 1 shows the set-up.

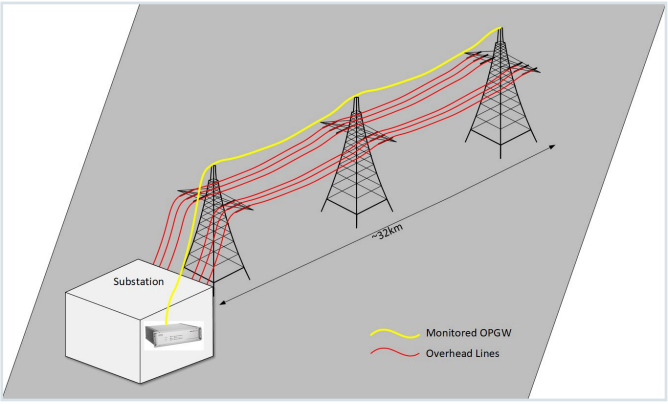


Figure 1: Overhead line test set-up. The Luna controller in the substation monitors about 32 km of OPGW.

Precise strain information

One optical channel of the Luna controller was connected to a single-mode fiber in the OPGW, measuring strain over a length of 32 km.

Each measurement took about 15 minutes, with a minimum strain resolution (repeatability) of about 2 με. Because 1 με is a strain or compression of 0.0001%, the controller detects strain changes as small as 0.0002%.

Local events detected

Figure 2 shows the change in strain between two consecutive measurements over the whole OPGW, excluding 250 m of feed cable. The line is very stable, with changes below ±50 με.

The system also detected a few local events that indicate an impact on the OPGW (Figure 3). These were most likely caused by wind, for example where the OPGW connects to the towers.

The study shows that strain monitoring on OPGW reveals how strain is distributed along a line and pinpoints local events. A longer measurement campaign is planned to track strain over time.

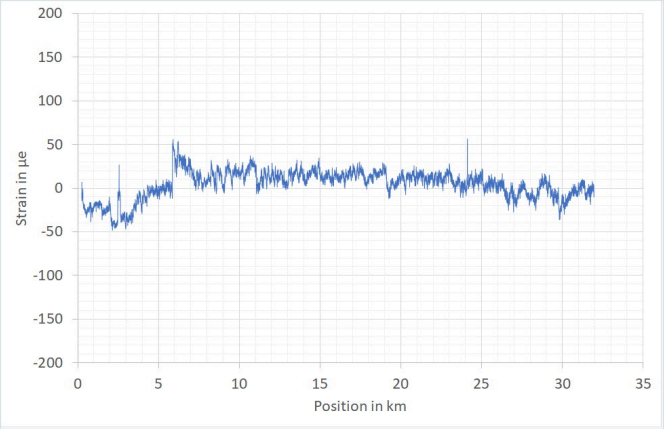


Figure 2: Measured strain changes along the OPGW.

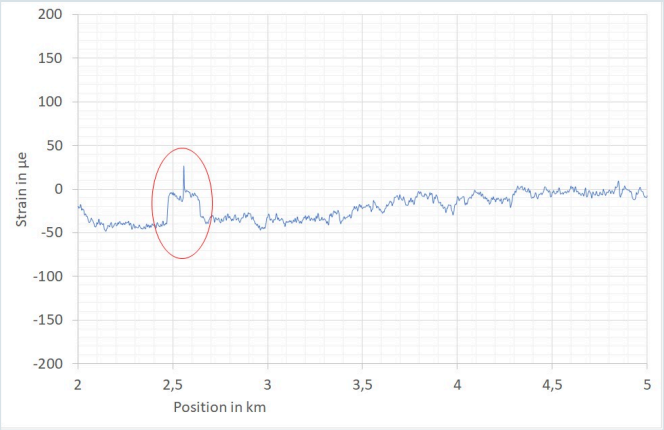


Figure 3: A single strain event on the OPGW (circled).

Why Luna Strain Monitoring?

Highly sensitive

Proprietary Brillouin technology resolves strain changes down to 2 με, so even small local events on the line are detected.

Uses the fiber already there

A standard single-mode fiber in the OPGW becomes a continuous sensor, with no extra sensors on the line or towers.

Long reach from one substation

One controller in a substation covered 32 km of line in this study, and every point along the fiber is measured.

Made for high voltage

Fiber-optic sensing is immune to electromagnetic interference, and the passively cooled controllers are maintenance-free.



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