Study Committee B2

Overhead Lines

10624-2022

Correlation between tensile force in conductors and stress loading of tensile towers

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Motivation

- How correlate the sag and the tensile forces in the conductors with a continuous measurements of strain in all legs of the transmission line tensile tower?
- The purpose of these measurements is to evaluate the stress response in the legs of the tower to the mechanical loads of conductors with respect to the temperature condition of the conductors.

Method/Approach

- ELES, Slovenian TSO, we are establishing system on tower No 13 at OHL 110 kV Cerkno - Idrija at Bevkov vrh for on-line monitoring of conductors and tower's leg.
- As well as whether conditions were monitoring, it can be possible to find the influence of temperature and season's changes on the tower and their influence on stress on the tower legs.
- The initial state at the point of placement of the dipstick, the actual stress state in the legs of the tower is determined by residual stress measurements adding continuously measured deformations, which is a prerequisite for assessing the degree of utilization of the material of the tower and thus its useful life.
- OTLM (Overhead-Temperature Line Monitoring) device has been used for on-line measurements of conductor's temperature, sag and tensile forces.

On-line measurements in legs

The measured data is stored in a buffer of the DynaStat measuring system on the No 13 tower. From the temporary memory of the system, they are transmitted via the communication platform to the FME server for combining measurements in legs and conductors.

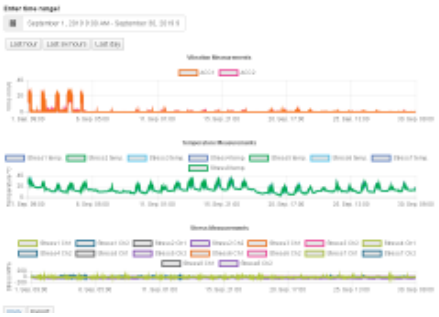

Fig. 2. Panel with results of measurements by DynaStat systems during one month

Objects of investigation

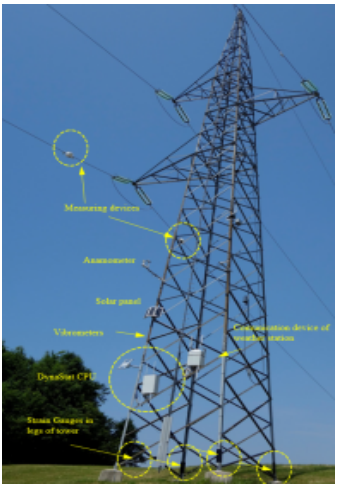

Fig. 1 Establishing of a measuring system with a unit for capturing and processing signals and sending data

Conclusion

- Measured stresses in each of tower leg vary with temperature and with wind influence as well as the mechanical behaviour of the tower.
- Results of measurement in period of one month show that results of stresses can be used for span distances for both sides of tower. Each span distance had different tensile load.
- It was found correlation between stresses in the legs and sag for both span distances.
- This approach can be extended to observing stress behaviour during icing, since the stress conditions is going to be changed by icing of conductors and/or towers substructure.
- In the case of ice accumulation, under extraordinary but realistic loading conditions, the stress values will strongly be deviated from ordinary operating conditions, what can be sign that mechanical loading increasing as consequence of snow or ice loading.
- The study shows essentially an alternative measurement of the sag and tensile forces in the conductor in an indirect way. The presented method, in addition to the mentioned correlations, also gives data on the condition of the conductor and on the condition of the steel part of the tower.

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Residual stress measurements in legs

Fig.3 Measurement of initial stress in legs of towers

Fig.4 Strain gauges at the location of the measured residual stresses on the L profile

Experimental setup & test results

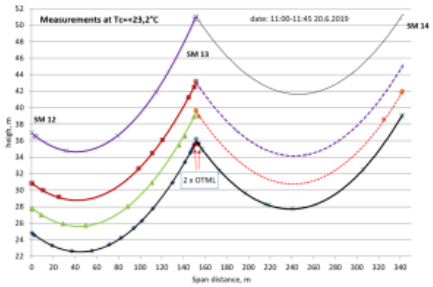

Fig. 5 Results of catenary measurements of all conductors with both OTLM devices in both spans of tower No.13

On-line measurements with OTLM

OTLM device measured angle of catenary vs. vs. temperatury at mounting point.

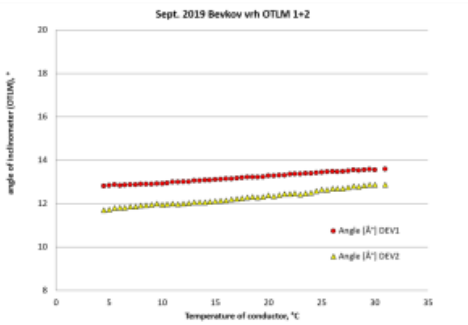

Fig. 6. Temperature of conductor 1 vs. angle of both inclinometers

Horzontal tension load vs. temp.

Tensile load measurements vs. sag shows decreasing of tensile load with increasing of sag

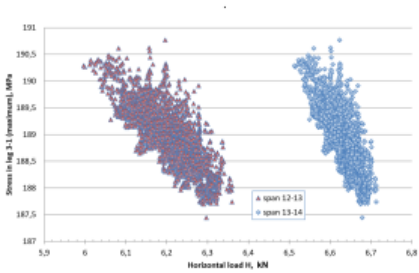

Fig. 7. Horizontal load in both conductor from both side of tower.

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Stress vs. Temperature of legs

Respect to scatter or measured results a statistical treatment of results is necessary in order to find correlation between temperatures of ambient and stresses in the legs.

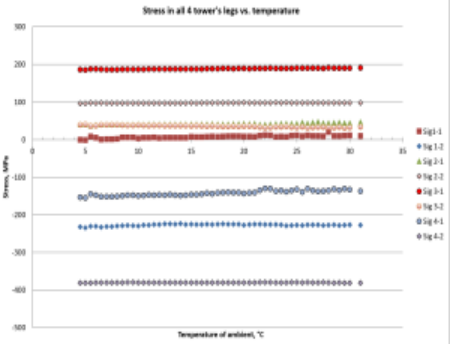

Fig. 8. An average measured stress vs. temperature at all 8 measured points

Stress in legs vs. horizontal forces

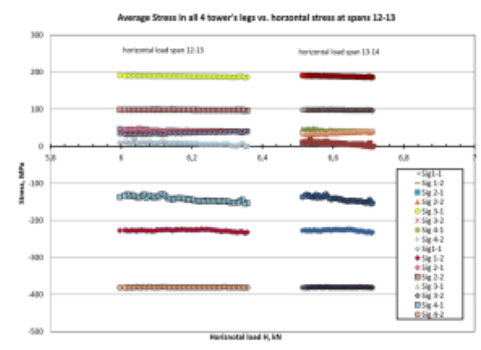

Fig. 9. Linear correlation between horizontal load and measured stresses in all 8 positions. It is obvious that the horizontal loads shifted for each span distance

Stress in leg vs. Sag of conductor

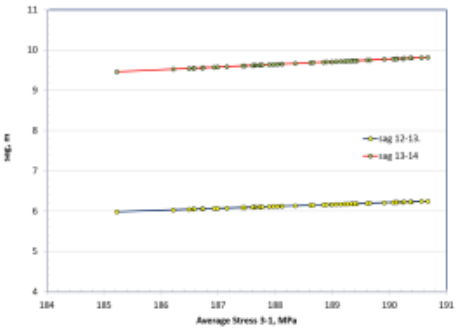

Fig. 10. Linear correlation between measured stresses in leg (position 3-1) and sag of both span distances

Communication sheme

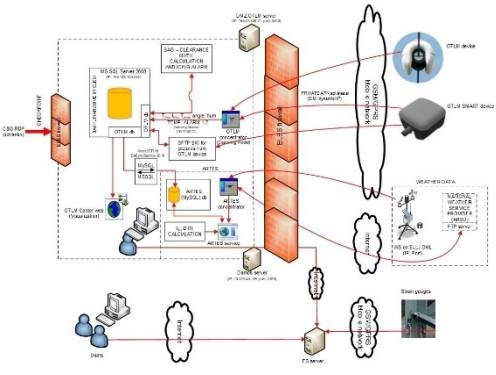

Fig. 11. Communication scheme of the entire measurement system in coordination with the temperature and angle on-line monitoring.