MEASURING STRAIN OF THE LATTICE TOWERS

The paper deals with strain measuring of bolted steel lattice high voltage tower structure on the test field. This measurement was associated to the test according to international standard IEC 60652, Ed. 2.0. If the tower is simulated as a truss structure and we expect the linear behavior of this object then the test data and calculation may show variations. The displacements of screw joint were detected as a source of this variation or non linear properties of structure. The key to this conclusion was detection of peak in measurement data.

Keywords: strain gauge, bolted lattice tower, non linearity, screw, peak detection
also installed on the test element in the laboratory of the Faculty of Mechanical Engineering and the installation with the whole measuring string was verified on a test stand too. The properties installed sensors and the measuring system was also tested at ambient temperature below $-10^\circ C$. It should be noted that the bridge does not eliminate the potential bending in members.

The strain (deformation) $e_{\mu\nu} [\mu \nu]$ for different load stage is generally defined:

$$ e = \frac{\Delta L}{L}, \quad 1\mu = 10^{-6}, \quad e = 10^{-6} e_{\mu\nu} \quad (1) $$

$e [1]$ is the measured strain, $[1]$, $L [1]$ is the active grid length of strain gauge, $[m]$ $\Delta L [1]$ is the change of active grid length of strain gauge, $[m]$.

For full-bridge type III, [6]:

$$ e = \frac{-2V_e}{GF(\nu + 1) - V_e(\nu - 1)} \quad (2) $$

$V_{CH}$ is the measured signal’s voltage, $[V]$, $V_{EX}$ is the excitation voltage, $[V]$, $\nu$ is the Poisson’s ratio, defined as the negative ratio of transverse strain to the axial strain (longitudinal) strain, $[1]$, $GF$ is gauge factor, $[1]$.

The tensile – compressional force $F [kN]$:

$$ F = EA(10^{-6} e_{\mu\nu})/1000, \quad (3) $$

$E$ is Young’s modulus of elasticity, $[N/mm]$, $A$ is area of cross section, $[mm]$.

The measured data are below the yield stress value, therefore the linear model is sufficient. In the case of the nonlinear region,
we have to use the tensile curve. Based on the shape of the tensile curve then we would determine the bilinear or multilinear model according to which the Young’s modulus $E$ would be changed in the formula (3).

3. Results

The results of measurement are depicted in Figs. 4-6. In Fig. 4 is depicted strain – deformation of chosen parts versus number of samples. It presented step by step increasing of strain (in absolute value) according to the increase of horizontal load. Rapid decrease of compressive strain (divergence of curves) in bottom of Fig. 4 is important. If the top curves (tensile strain) presented linear increase of strain, then the bottom curves (compressive strain) presented non linear decrease.

In Fig. 5 is depicted zoom of Fig. 4. Inside the ellipse are recognized peaks of strain. This phenomenon is explained as a displacement of parts of truss structure on the base tolerances in the holes of bolts.

In Fig. 6 is depicted zoom of Fig. 4 too. After this displacement are recognized next displacements in the bolt’s holes, Fig. 4. This moment was recognized as a start of non linear properties of strain on the tested object.

In Fig. 7 is depicted zoom of Fig. 4 for $T_1$, average values and original data stored with sampling frequency of 1 kHz. The displacement is recognized, it is marked with ellipse.
4. Conclusion

The objective of the paper was to present the experiences with strain measurements of bolted steel lattice high voltage tower structure and interpret non linear properties of measured strain. The displacements of members truss structure in screw bolts is presented in measurement data as a start of this non linear relation. The displacement of elements can cause a violation of the construction and the location of loading forces can be changed too. The peaks are presented in the strain measured data. These changes are not implemented in usual computers models. The plastic deformation of truss is not source the peaks identified in the measured data in this paper. The next step will be formulation of this problem as a task with uncertainty parameters, [7].

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References