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Structural upgrading of steel columns for overhead power lines

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Abstract

The article presents a study on the design and expertise of steel columns for overhead power lines for high voltage transportation. In our days is a matter of safety to verify and maybe redesign some component elements. The collapse of the columns in actual changing climate conditions can be eliminated by developing methods of structural upgrading, which has to be efficient from the implementation technology point of view, as well as costs.

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1. Introduction

The electro-energetic system includes the electrical part of the energetic system, starting with the electrical generators up to the electrical receptors. The producing installations, transport, distribution and utilization of the electrical energy are interconnected and have common and continuous conditions of employment for producing and consuming the electrical energy. Electrical overhead lines are an important part of this system, the main disadvantage being the fact that offers a lower safety in utilization, due to the direct meteorological factors on a long surface/distance.

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2. Specific issues on design of electrical overhead columns

The design or verification of these types of columns needs knowledge both from the electrical and civil engineering expertise fields, as the loads that had to be taken into account are part of both fields.

On the design of the overhead columns, in whole and in its components, the next hypotesis of combined loads must be taken into consideration:

- minimum temperature (no wind or frost);
- medium temperature (no wind or frost);
- medium temperature, wind speed of 10 m/s (no frost);
- medium temperature, maximum wind speed (no frost););
- maximum temperature (no wind or frost);
- frost temeperature and frost deposits on the lines (no wind);
- frost temeperature (wind with frost and frost deposit on the lines

On the columns, the loads have different values and angles, depending also on the position of the electrical lines. Establishing the geometrical equation of an active conductor (active line), uniformly loaded, can be done by neglecting the rigidity of the material, assuming that the line is equivalent with a flexible and inextensible thread.

For a tensioned line into an opening, at a certain state of external medium, predetermination is required for the efforts and the deformations that appear when the external medium changes its state (growing of the frost layer, wind pressure, temperature as the lines are considered fixed in their suspension points, in the moment of these changing, variations of their lengths are produced, so, by consequence, variations of the internal efforts. The equation that establishes the characteristic values of an opening between two columns (temperature, loads, length, specific deformations) is called state equation of the conductor and for a line with the suspensions points at the same level it can be brought to the following for:

$$u \cdot p_{0,n} - \frac{a_{med}^2 \cdot \gamma_{(n)n}^2}{24 \cdot p^2{}_{0,n}} \cdot E_c = u \cdot p_{0,m} - \frac{a_{med}^2 \cdot \gamma_{(m)c}^2}{24 \cdot p^2{}_{0,m}} \cdot E_c - \alpha_c \cdot E_c \cdot (T_n - T_m) \quad (1)$$

3. Structural upgrading

In the past years, upgrading of the services offered by the electrical energy providers took place, by changing some of the components into the electrical line, introducing bigger conductors, thus resulting in bigger efforts on the columns. Also, the climate changing by meteorological extreme conditions on global level can have a negative influence on column behaviour. The cyclic loading and the vibrations induced by the wind can degrade some of the diagonals, usually very slender elements, and in time cracks may appear. The collapse can rapidly propagate along the lines (“the domino effect”) and cause serious injuries to the whole system of electric transportation. The estimate costs for repair and/or replacement for an alignment in double circuit of 40 km may cost 30 million dollars [3]. The collapse of the columns can be eliminated by developing methods of structural upgrading, efficient from the point of view of technology of implementation as well as costs.