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Specific Issues on the Design and Expertise of Steel Columns for Overhead 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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Keywords: steel columns for energy transportation; civil engineering; electrical engineering; optimization; specific loadings in design.

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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Nomenclature

m	reference state (started state)
n	corresponding state to a temperature value for which a traction p_{0m} is calculated
m	reference state (started state)
p_{0m}	horizontal component of the specific traction for the “m” state
p_{0n}	horizontal component of the specific traction for the”n” state
$\gamma_{(m)c}$	specific design loading for the reference state
$\gamma_{(n)n}$	specific norm loading , corresponding to the ”n” state
T_n	the temperature state for which the horizontal component of the traction is calculated
T_m	the reference temperature state
U	the medium bump factor
α_c	linear dilatation coefficient

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 temperature and frost deposits on the lines (no wind);
- frost temperature (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:

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

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