Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 117 (2015) 1028 – 1035

Procedia Engineering

www.elsevier.com/locate/procedia

International Scientific Conference Urban Civil Engineering and Municipal Facilities, SPbUCEMF-2015

Refinement of Wind Loads on Lattice Support Structures of the Intersystem Overhead Power Transmission Lines 750 kV

Yevgeny Shevchenko, Yaroslav Nazim*, Anton Tanasoglo, Igor Garanzha

Donbas National Academy of Civil Engineering and Architecture, Derzhavina, 2, Makeyevka, Donetsk region, 86123, Ukraine

Abstract

In this paper attention is paid to the intersystem overhead power transmission line (OPTL) 750 kV, which is being operated on the territory of Ukraine. Subjects of research are the intermediate supports of PS750-3i type with 5 m and 10 m stand or without it. Special attention is paid to the formation of climatic zone maps along the route of the OPTL under consideration. It's given a description of the wind load gathering algorithm, which consists of separate units each of which produces the calculation of loading on a predetermined structural element of lattice support. Calculated wind load is defined here as the sum of the static and dynamic of the components. Here are also represented the calculation data of a rod of equivalent stiffness by an engineering practice. Here are provided the numerical values of loadings from current carrying wires and lightning-protective ropes in normal and emergency operation modes of work for the most weighted OPTL supports of the given ground surface profile. On the base of design and extension of the obtained results it was compared the maximum longitudinal forces in support belts from the action of wind loading with the values represented at calculated worksheet (project institute "Ukrenergosetproekt", Kharkiv).

Peer-review under responsibility of the organizing committee of SPbUCEMF-2015

Keywords: wind load, overhead power transmission line, lattice support, longitudinal force, climatic zoning maps, characteristic value of load.

1. Introduction

Power transmission networks are one of the main components of the country's energy system, which counts 227000 km and more than 150 substations with a voltage between 220 – 750 кV [1].

Basically, during the building of the intersystem OPTL in Ukraine the unified structures of supports and foundations are traditionally used, which had been developed more than forty years ago according to the USSR standards and methodologies [2, 3, 4]. Considering the existing unification from a perspective of today's market

* Corresponding author. Tel.: +380-63-333-77-97. +380 (0626) 41-73-99
E-mail address: yaroslav.nazim@gmail.com

Peer-review under responsibility of the organizing committee of SPbUCEMF-2015
doi:10.1016/j.proeng.2015.08.225

relations, we can see that such overhead lines supports can not compete with similar foreign ones. That is why, in this situation the necessity arose to develop more effective and modern forms of steel supports on the ground of the development and refinement of loads collecting methods and improvement of calculation methods aimed without reserves in consumption of materials to ensure the reliable operation of OPTL [5].

Last years in Ukraine they began the construction of overhead transmission lines with the development of individual support structure under the specific weather conditions with conduction of the appropriate certification tests. Customers' requirements are focused mainly on the creating of modern line facilities, which fully correspond to the conditions of OPTL passage routes [6, 7, 8]. Whereas, it forces designers to make individual calculation and design of supports structures for each particular overhead line taking into account the terrain and climatic loads. And considering the fact that the wind load for lattice supports of power transmission networks (taking into account wind load on the conductors and ground wires) is one of the defining [9–13], the question of wind loads refinement to the 750 kV supports is very relevant, because the data overstating loads lead to the weighting of components [19].

2. Technological part

The subjects of research reviewed in this paper are intermediate lattice towers of PS750-3i type, installed on foundations F5-4 and F6-4 with anchor bolts M36 at the OPTL 750 kV "Rivne NPP – Kyiv Substation 750 kV", put into operation in 2012. The OPTL route passes through the territory of Zhytomyr and Kyiv regions (number of supports from 234 till 876).

The purpose of the wind impact calculating is to determine the maximum longitudinal forces in belts of support and to compare the obtained results with the typical calculations performed by the project institute "Ukrenergosetproekt" (Kharkiv).

Based on electrical calculations on 750 kV OPTL "Rivne NPP – Kyiv Substation 750 kV" it was adopted the phase construction with five Aluminum Conductor Steel Reinforced (ACSR), type AC-400/51 (by GOST 839-80E). The phase step of splitting wires is 400 mm, the horizontal distance between phases is 18 m. According to the permissible mechanical stresses in the conductors and by conditions of a normal distance ensuring between the conductors and ground wires [14, 15], in the function of the ground wires steel aluminum conductors of AC-95/141 type are used.

For the load calculation to the supports from the action of the conductors and ground wires the maximal stresses had been taken, which are given in Table 1.

Table 1. The maximal stresses in conductors and ground wires.

Type of the conductor or ground wire	Measurement units	AC-400/51	AC-95/141
With a maximal load and a minimal temperature	[MPa]	126	300
With an average annual temperature	[MPa]	84	225

The intermediate support type PS750-3i of OPTL 750 kV is a space-rod metal gantry rack height H=42.5 m. The width of traverse is 36 m, the height of a pole under the wire is 6.0 m. Belts, struts, strut bearings and diaphragms of the support sections are made of single angles. The elements joint in the nodes with the help of bolting. The spatial finite element model of support PS750-3i for the calculation is performed in software package "Structural CAD".

3. Climatic loads and impacts

For the climatic loads calculation data of the wind speed are used, which were received as a result of long-term observations of meteorological stations in Ukraine [17]. According to the results of data processing maps of climatic zoning along the route 750 kV "Rivne NPP – Kyiv Substation 750 kV" (Fig. 1, 2) have been built.