CLIMATIC LOADS ASSESSMENT FOR OHL DESIGN USING ICE-LOAD MAPS.

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Abstract: Climatic (ice-load and wind-ice load) maps are widely used in Russia for the pur poses of designing, construction and exploitation of o verhead transmission lines (OHL). This article provid es with an overall review of techniques used from in itial meteorological data collection, through climatic maps creation till design climatic loads definition and its practical engineer usage. Moreover we have done a comparison of Russian practices with similar inter national ones.

1. Introduction

The main problem for the researcher of ice loads for the purposes of overhead transmission line (OHL) design is to interpolate observation data in descrete points into continious picture as far as OHL is an object extensive in space. In Russian practice this problem is solved by using ice-load maps.

2. Results

Creation of ice-load maps are based on meteorological information collected on the meteorological stations network that covers all the territory of the country.

Ice observations on meteorological stations are performed using a special designed device (icing device). This icing device consists of four cables of 5 mm in diameter, fixed in pair towards meridional and latitudinal directions and suspended at the two different heights of 1,9 and 2,2 m above the ground for each pair. For every icing event are measured size of ice accretion, its weight and type (glaze ice, hard rime, etc.). During every icing event are also measured other meteorological parameters, such as air temperature, wind speed and direction.

The meteorological stations network in the territory of the Russian Federation has carried on mass observations of icing events since 1951. Today’s observations of icing events are performed by 1254 meteorological stations all over the territory of Russia. The period of instrumental observations reaches today 58 years, and for some stations even beyond.

Long-period observations data collected on every meteorological station is used to create statistical arrays on the base of yearly maximums.

In order to automate work of climatic data processing, we have created a specialised information system for climate conditions.

The information system consists of a database of climate conditions (DB) and of a specific program.

The DB contains the following information about icing events: date of observation, icing type, its size and weight, speed and direction of the wind at the beginning of the icing event, maximum wind speed during the icing event.

For every meteorological station the DB stores the following information: its name, administrative belonging, height above the sea level, meteostation's vicinity description and technical characteristics such as height of weather-vane and height of wind meter.

The program allows performing automatic data update in the DB in an electronic format, their handling, their processing in order to get uniform data, statistical arrays and statistical parameters. The program also allows describing the arrays with different statistical distributions, obtaining climatic characteristics having different return period.

For types and subtypes of large-scale relief we build a graph of functional dependence of climatic characteristic (wind speed, equivalent radial ice-thickness, ice-wind load, maximum wind speed for icing event) from the height above sea level. The dependence is $x=f(H)$ (where x – value of climatic characteristic, H - height above sea level) and is built considering local small-scale relief. In Russia for climatic characteristics we use a return period of 25 years.

For the break down of the territory into icing regions we distinguish 8 regions with equivalent radial ice thickness from 10 to 40 mm and above. Gradation range of the region is 5 mm.

For the break down of the territory into ice-wind load regions we distinguish 9 regions with the value of ice-wind load from 3 to 28 N/m and above. For every ice-wind load region it is specified the wind speed having a return period of 25 years and a conventional equivalent radial ice-thickness.

In order to create regional maps of the territory of the Russian Federation we use a geo-information system. This Geographical Information System (GIS) is a system for the management of geographical information, their analysis and representation. Geographical information is given as a series of selected geographical data, which model the geographical environment with simple, summarised and structured data. GIS includes a set of modern and powerful instrumental means to work with geographical data.

The usage of GIS allows the making of regional maps with an elevate degree of detailed elaboration of the icing regions that takes into account local relief. Furthermore, the use of GIS improves significantly the effectiveness and quality of executed work.

We selected the GIS system of the company ESRI - ArcGIS 9.2. This system possesses a powerful set of instruments that allows processing all the range of cartographic work, the analysis of the data, mapping and final preparation of ready regional maps for printing.

On Figure 1 is presented a fragment of regional map created for the Kursk region. It can be seen from the picture that on the territory are distinguished five icing region (from 1st to 5th). Along with this regions with smallest radial ice thickness are located in river valleys or on leeward hill sides and on the contrary regions with highest ice thickness are located on the hill tops or wind ward hillsides.

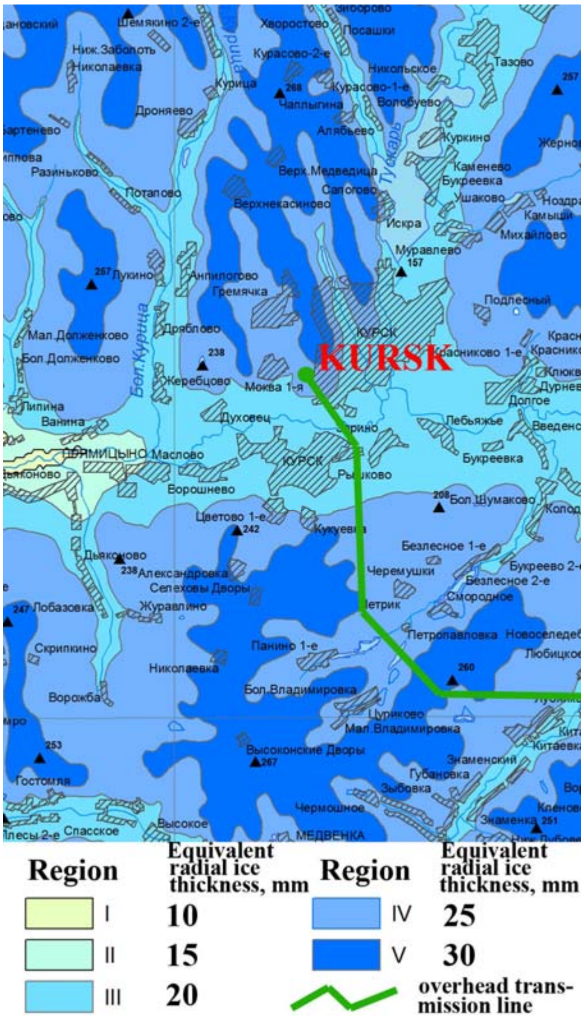

Figure 1: Frament of a regional map for the Kursk region

According to current Russian standard, design loads are obtained on the base of normative climatic conditions. Normative climatic conditions are calculated using regional climatic maps on wind pressure, equivalent radial ice thickness and ice-wind load or calculated by using measurements for a long period made on meteorological stations [3].

To obtain normative ice load it is used a normative ice thickness b_e, mm, with density of 0.9 g/cm^3 on a conductor with a diameter of 10 mm that is suspended 10 m above the ground.

Normative ice thickness be vary from 10 mm in the I° normative region to 40 mm in the VII° normative region. And it is called “special region” if ice thickness exceeds 40 mm. In this case the value is used as it is.

To obtain normative ice-wind load it is used the value of the wind load on the iced conductor with a diameter of 10 mm that is suspended 10 m above the ground.

Normative ice-wind load Pw vary from 3 N/m in the I° normative region to 28 N/m in the VIII° normative region. It is called “special region” if ice-wind load exceeds 28 N/m. In this case, the normative ice-wind load that is used is rounded to the value divisible by 5 N/m.

For example on Figure 1 in green is shown overhead transmission line passing near Kursk. According to the map the line is located in the following regions, shown in the table 1

Table 1: Ice regions for the OHL starting in Kursk.

OHL run, kilometers	Ice region	Equivalent radial ice thickness, mm
0 (Kursk) - 3,0	IV	25
3,0 – 11,5	III	20
11,5 - 22,0	IV	25
22,0 - 26,0	V	30
26,0 - 32,5	IV	25
32,5 - 34,5	III	20

In this mode is obtained normative ice thickness for the certain transmission line based on regional map.