IMPACT OF ELECTROHYDRAULIC PROCESSES UPON LIGHTNING PROTECTION OF THE BUILDINGS CONSTRUCTED ON HIGH WATER GROUNDS AND ONSHORE FACILITIES

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Abstract. Many international lightning protection standards allow and even require to connect electrical circuitry of grounding circuits/contours with grounding of lightning conductors ([5], [6], [7], [8]). Appropriate grounding and connection are based on the system, which contains grounding (dispersing electricity in the soil) and connecting network (minimizing the difference of electrical potentials and decreasing magnetic field).
The novelty of the research described in the paper is presented by study related with correlation between a famous physical phenomenon the Yutkin (EHB) effect and lightning protection, which may take place in case of lightning at the construction sites, equipped with the outer lightning protection and being constructed on high water grounds or along the shores.

1. Introduction

The contents and moisture of the Earth are not homogeneous. The electrical resistivity of the Earth changes horizontally and in depth.

Depending on the importance of the site, existence and classes of explosion and fire sensitive zones in the industrial buildings, and also taking into consideration possibility of lightning, one of three existed categories of lightning protection is applied ([2], [3], [4]).

The categories of lightning protection standards do not foresee the peculiarities of the buildings constructed on high water grounds or along the shores. Concrete in dry ground is a good insulator. However, concrete buried in the ground has a resistivity that does not exceed several hundred Ohm.m.

Between the grounded pedestal (being in water or in liquid bog soil) and soil basement lighting may through water (bog soil liquid) cause high-voltage discharge provoking electro hydraulic blow (EHB) [1]. Pressure of tens and hundred thousand atmosphere is immediately created at the place of discharge [9]. The foundations of the buildings constructed on high water grounds or along the shores are badly damaged due to electro hydraulic blow.

When fulfilling the requirements for lightning protection, without the recognition of specific (local) climatic conditions and physical processes / phenomena when lightning strikes, the installed lightning rod can cause unexpected destruction of the protected object.

2. Experimental procedure

For the experiment, the foundation models were prepared: Model N1 - 400x400x230 mm^3; Model N2 - 500x490x190 mm^3; Model N3 - 290x290x180 mm^3; The model is -210x190x190 mm^3. As shown experiment in dry ground with a multiple high-voltage discharge (10kV) in the basement of the foundation, no special damage was detected.

A similar experiment was carried out in a wet environment - the foundation model was immersed in fresh and salty (0.6%) water and a high-voltage electric discharge was applied to it. If the foundation is wet and a few millimeter water medium forms between the reinforcement bars and the concrete, there is a danger of formation of an EHB. The same effect is obtained if the lightning is discharged in the water near the basement. The water surrounding the spark spreads with great rapidity to the sides, creating the first hydraulic impact. A void is formed - a cavity that is immediately filled with water; another powerful hydraulic shock is produced - cavitation. The electric discharge of a lightning, thus, can provoke an explosion capable of destroying the foundation.

3. Results of experiments

The results show that the closer the high-voltage wire / electrode to the foundation the damage is larger: rod of armature received strong oxidation; damage to the surface of the concrete model increases; the foundation reinforcement fixed washer broke away from the foundation (fig.1).

(a) (b) (c)

Fig.1.Foundation model befor (a) and after (b,c) high voltage discharge

Conclusions

The experiments were carried out at a voltage of 10 kV. With a real thunderstorm lightning, we have a voltage of several million volts, and accordingly the discharge power is much higher than in the cases considered.

Based on the results of the experiment, one can draw conclusions:

1) In the instructions / rules for the device of lightning protection of buildings and structures, it is necessary to separate the category for shore structures or for buildings in high-water grounds;

2) For shore structures or for buildings in high-water soils, it is necessary:

- apply a separately standing lightning conductor - a lightning conductor, lightning receivers and current collectors are located in such a way that the lightning current path does not have contact with the protected object;

- Observe the safe distance between the foundation and the metal objects around the foundation, which can provoke the EHB.

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