DISTRIBUTION OF AC CONTACT NETWORK ELECTRIC FIELD STRENGTH

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Summary To provide the stock electromagnetic compatibility is a serious problem with the contemporary development of the railway transport and implementation of lines for connection.The AS contact system is one of the main equipment of the electrify railway transport that implements the electrical connection between the traction substations and the roiling stock.But it is also one of the main sources of interference due to the presence of its strong electromagnetic field. The paper presents an distribution of electric intensity by contact system.

1. INTRODUCTION

The AC contact network creates strong electromagnetic fields, which effect all the electrical equipment in it. From the viewpoint of electromagnetic compatibility and the safety of the serving staff, it is of certain interest to determine the potential and strength of a random point of the AC contact network electric field.

The parameters of the electric field can be determined using the system of Maxwell's linear equations [1]. The system has the following matrix form:

(1) $\varphi = q\alpha$

$\varphi=[\varphi_i]$-matrix of the wire system potentials;i=1-n

$q=[q_i]$- matrix of the linear densities of charges;

$\alpha=[\alpha_{ij}]$- matrix of the wire system potential coefficients.

2. DETERMINING THE ELECTRIC FIELD STRENGTH

Let examine the case of the electric field caused by contact wire *k* of potential φ_K, radius r_K and charge q_K per a unit of length. The field effects neighboring wire *m* of potential φ_m (Fig.1).

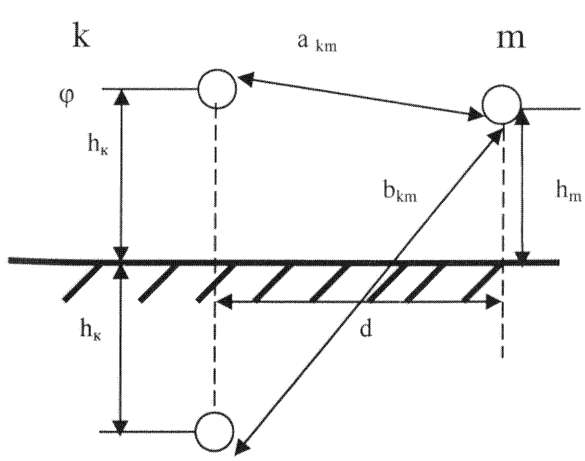

Fig.1. The heights of wires towards the ground are relatively h_K and h_m and the distance between their horizontal projections is d.

On the base of the mirror images [1], according to equation (1) it can be written:

$$(2)\qquad \begin{aligned}\varphi_k &= \alpha_{kk} q_k + \alpha_{km} q_m \\ \varphi_m &= \alpha_{mk} q_k + \alpha_{mm} q_m\end{aligned},$$

where :

$$\alpha_{kk} = \frac{1}{2\pi\varepsilon_0}\ln\frac{2h_k}{r_k}$$ - natural potential coefficient;

$$(3)\qquad \alpha_{km} = \alpha_{mk} = \frac{1}{2\pi\varepsilon_0}\ln\frac{b_{km}}{a_{km}}$$ - mutual potential coefficient.

Since a wire of connection or an isolated and unsupplied wire have been examined in the part of a neighboring wire, it can be assumed that its charge is q_m=0. From (2) and (3) it is obtained that:

$$(4)\qquad \varphi_m = \varphi_k \frac{\ln\frac{b_{km}}{a_{km}}}{\ln\frac{2h_k}{r_k}},$$

where $b_{km} = \sqrt{(h_k + h_m)^2 + d^2}$ is the distance between the second wire and the mirror image of the contact wire;

$a_{km} = \sqrt{(h_k - h_m)^2 + d^2}$ is the distance between the two wires.

Since $\varphi_k = U_k$, it follows that:

$$(5)\qquad \varphi_m = \frac{U_k}{\ln\frac{2h_k}{r_k}}\ln\frac{\sqrt{(h_k + h_m)^2 + d^2}}{\sqrt{(h_k - h_m)^2 + d^2}}.$$

Hence for random point M of the electric field with coordinates *x*, *y* the potential in the common case is:

$$(6)\qquad \varphi_M = \frac{U_k}{\ln\frac{2h_k}{r_k}}\ln\frac{\sqrt{(h_k + y)^2 + x^2}}{\sqrt{(h_k - y)^2 + x^2}}.$$

Then for the vertical component of the electric field strength at that point it can be written that:

$$(7)\qquad E_y = \frac{d\varphi_M}{dy} = \frac{U_k}{\ln\frac{2h_k}{r_k}}\left[\frac{h_k + y}{(h_k + y)^2 + x^2} + \frac{h_k - y}{(h_k - y)^2 + x^2}\right].$$

3. CALCULATION RESULTS AND GRAPHIC DEPENDENCIES

The numerical results in Table 1 have been found on the base of analytical dependency (7) for two typical values of y (y_1=1,8m – curve 1 and y_2=6,24m – curve 2) and the graphic dependencies of $E_y=f(x)$ have been built in Fig. 2.

Tab. 1.

Ey kV/m	*Distance x, [m]*								
	0	1	2	2,5	3	4	5	6	8
y= 1,8m	1,7	1,6	1,5	1,4	1,3	1,1	1	0,8	0,6
y= 6,24m	7,2	3,1	1,3	1	0,8	0,6	0,5	0,4	0,3

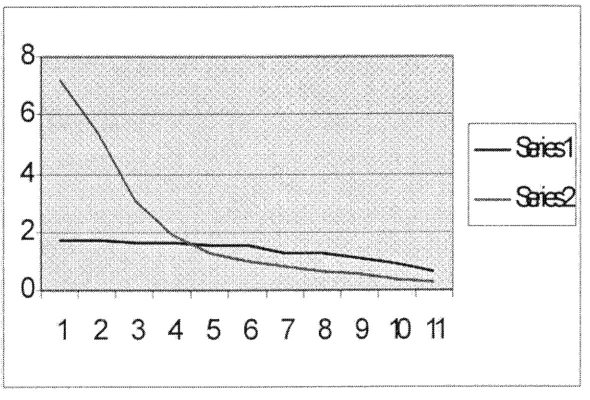

Fig. 2.

4. CONCLUSIONS

The analytical dependencies worked out for contact network electric field potential and strength as well as the numerical results obtained give a possibility to look for providing the admissible effect of these interference. This effect should be in compliance with the existing standards in this field [4].

The problems of increasing the stability of radio and electronic equipment used in railway transport against the effect of electric and magnetic fields are part of the general theory of providing electromagnetic compatibility. In certain important aspects, which determine the operation of radio equipment under the conditions of railway transport [3], the distribution of contact network electric field strength has a specific character. In that sense, the obtained graphic dependencies and analytical expressions of assessment give a possibility to determine the distribution of the electric field as an essential component of electromagnetic compatibility. This distribution determines the quality and reliability of radio electronic equipment.

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