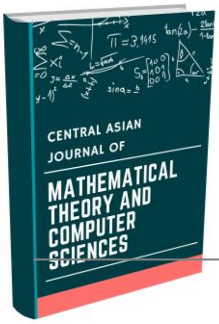


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# ON THE LINES CONNECTING THE RAILWAY TO THE CONTACT NETWORK, THE INDUCED VOLTAGE CAN BE OBTAINED USING A COMPUTER PROGRAM

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***Abstract***

*The article investigated the processes of calculating the induced voltages caused by the impact of the Torsion system on the lines on which the Torsion system is being repaired with the side and off. According to the results of the study, it was determined that the induced voltage in the maximum current mode of the traction system in the repair part of the line, which is switched off and the two ends are melted, will be significantly higher than the permissible value and on the basis of the fact that in order to ensure the safety of employees working on the switched off railway contact network, it is necessary to insulate the beginning and end of the repair line, as well as to land the repair site.*

**A R T I C L E I N F O**

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The occurrence of electromagnetic exposure from the railway contact network to adjacent energy objects and electrical energy transmission lines placed along the railway is one of the main disadvantages of an industrial frequency single-phase alternating current winding system.

The loads of traction substations are a non-constant quantity, which varies depending on the number of electric locomotives, their location among substations, and the current they consume. In addition, equalizing currents may occur in the winding system. Therefore, in practice, it is required to follow the established rules when measuring the induced voltage that occurs in the closed adjacent lines due to the voltage and current of the contact network in the maximum operating mode.

When evaluating the level of induced voltage generated in switched off lines, the calculation results should be as close as possible to real conditions. For this purpose, we consider the process of calculation of the induced voltages generated by the 1-PL and 2-PL power lines, which are switched off as a result of the electromagnetic influence of the contact network of the alternating current single-track railway section under investigation, using a computer program. The 110 kV 1-PL and 2-PL transmission lines are adjacent along the entire length to the industrial frequency alternating current 25 kV electrified single-track railway section.

The electricity supply of the railway section under consideration is carried out through the two-way Oqoltin and Chukursoy traction substations. The length of the affected Tashkent-Syrdarya railway section is 81.8 km.

The length of the 1-PL line (st. Uzbekiston-st. Pakhta) is 20.7 km, width of approach: 0.89 km in the section from st. Uzbekistan to base №53, 0.46 km in the section from base №53 to st. Pakhta.

The length of the 2-PL line (st. Pakhta – st. Chinoz) is 20 km, width of approach: 0.95 km in the section from Chinoz to base №29, 1.6 km in the section from base №29 to Pakhta.

The following parameters on the line were taken into account when drawing up approximation schemes:

- the width of the approach of the affected contact network cable between the rails and the line being repaired;
- mutual arrangement of phase wires on the supports of the line being repaired (transpositions, resetting two phases at once);
- the construction type of contact network and line supports under repair;
- availability of connection points on the line being repaired.

The shortest distances between the wires of the selected line and the rails and all the wires of the contact network were determined for the construction of the computational model of the section under consideration. In this case, the average hanging height of the wires, the cases of horizontal displacement of each wire from the road axis were taken into account.

The method of equivalent parallel approach is used when the railway track system and the line under repair cross each other or there is an approach on a curve. The equivalent parallel approach distance is determined using the following expression.

$$b_{12} \approx \frac{b_{max} + 2b_{min}}{3},$$

where $b_{max}, b_{min}$ – are the maximum and minimum distance between the wires of the circuit system (contact wire, supply wire and rails) and the line under repair, respectively.

Calculation of the induced voltage in the 1-PL and 2-PL line wires was performed using the Mathlab program. This complex allows modeling of railway traction networks and power transmission lines based on their physical parameters, taking into account the change in the geometry of their mutual location, as well as making calculations using the maximum current values of the affected line in different modes of grounding of the line under repair.

In the computer model of the researched alternating current railway contact network and the switched-off 1-PL power transmission line, the grounding condition is presented at the ends of the line (st. Uzbekiston, st. Pakhta) and the repair site (base № 53). We assume that the resistance of the station grounding devices is 0.5 Ohm, the resistance of the grounder at the repair site is 30 Ohm, and the specific resistance of the ground is 10000 Ohm·m.

Electric rolling stock moving on the site is supplied with electricity through two traction substations. In this case, the sum of the currents consumed by the electric locomotive from each traction station is taken as the total current consumption.

In the created model, the distribution of the current in the contact network is determined by the alternating current source, and the part of the return traction current leaking to the ground is determined by the ground-rail transition resistance $Z_n$.

For the 2-PL power transmission line, we create a calculation model similar to the 1-PL line model, taking into account its initial data.

We calculate the induced voltage values in switched-off 1-PL and 2-PL power transmission lines with the help of a computer program for different grounding conditions of the adjacent line in the contact network maximum current mode.

In Fig. 1, we present the calculated values of the induced voltage on the switched-off 1-PL and 2-PL lines with the help of a computer program in a graphic form. Each curve in this graph shows the level of induced voltage at the time when the structure of electric current in the studied section is moving opposite to the points where the induced voltage is calculated at the beginning, middle and end of the line, respectively.

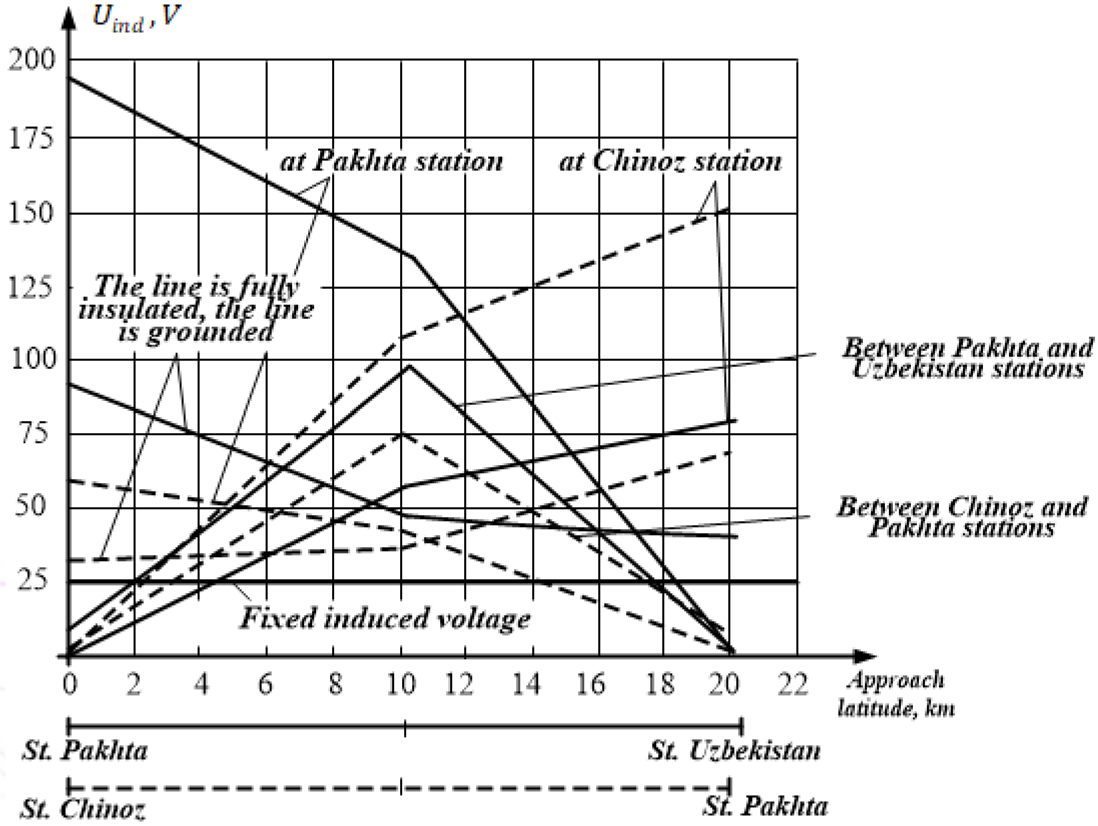


Figure 1. Calculated curves of induced voltage in 1-PL (not a broken line) and 2-PL (broken line)

It can be seen from the generated curves that in all cases under investigation, the value of the induced voltage significantly exceeded the safe voltage of 25 V for repair workers, except for the case where the place of repair was at the end of the switched-off line (Fig. 1).

The calculation of the induced voltage in 1-PL and 2-PL switched-off power transmission lines at the place of repair was also carried out for the cases where the line head and end were grounded by a grounder with a resistance of 30 Ohm and the line was isolated from the head and end of the line.

The middle part of the line under investigation was chosen as the place of repair. Figure 2 shows the results of the induced voltage distribution on the investigated switched-off lines while the electric rolling stock is moving opposite to the repair site on the railway section, calculated using the computer program. From the curves created as a result of research, we can see that the level of induced voltages in the repair place of each line does not differ from each other, and the value of the induced voltage in the repair places of two lines does not exceed 1 V for the case of isolation from the beginning and end of the overhead line.

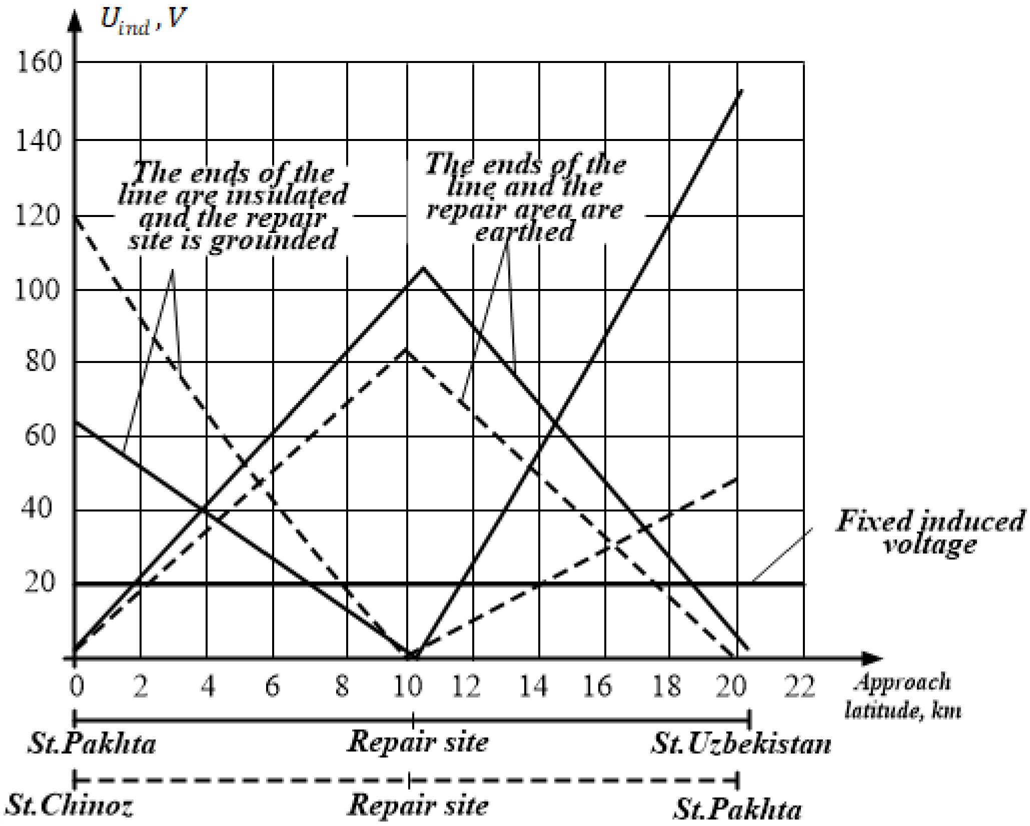


Figure 2. Distribution of the induced voltage in the 1-PL (not a broken line) and 2-PL (broken line) being repaired when the EMS passes by the repair site

It can be seen from the generated curves that the level of induced voltage is symmetrically distributed in the sections from the repair place to the traction substations in each investigated line in these grounding cases. Symmetrical distribution of the induced voltage occurs due to the fact that the currents consumed by the electric power structure from the supply traction stations are different from each other. When calculating the induced voltage in the 1-PL power transmission line, the largest part of the current (67% of the full current) is consumed from the Chukursoy substation, while in the calculation of the induced voltage in the 2-PL power transmission line, on the contrary, the largest current (69% of the full current) is consumed by Oqoltin it is consumed from substation. Also, the width of the approach of the second part of the 1-PL electric power transmission line (from the place under repair to St. Pakhta) is about two times smaller than the first part (from St. Uzbekistan to the place under repair), and we can observe a high level of induced voltage (151 V) on the side of the st. Pakhta in this part possible.

As a result of the research, it became clear that using Mathlab is convenient and easy enough to solve the problem. With the help of computer programs, the models consisting of the alternating current circuit system and switching circuits of the switched-off power transmission line were built, taking into account the geometry of the location of the objects. To carry out these studies, there are several computer programs, from which it is advisable to select programs that allow you to enter torsion currents and easily distribute them between the rail chain and the ground, replace the electric rolling stock location on the plot and simply change the line landing mode, conveniently and quickly, accurately and efficiently obtain the result.

The induced voltages in the wires of the switched 1-PL and 2-PL power transmission line were determined for different melting States of the lines, and according to the results of the study, the maximum current-mode induced voltage of the winding system in the repair section of the switched and two ends is significantly higher than the permissible value, and the addition of additional resistance at it was determined that it was advisable to insulate the beginning and end of the repair line, as well as to land the repair site.

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