Analysis of Contact Loss Characteristics according to Amplitude of Rigid Catenary

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ABSTRACT: *In this paper, Amplitude of excitation frequency operated by contact loss was analyzed using a contact loss simulator for a rigid catenary system.A contact loss simulator for a rigid catenary system was designed using real rigid catenary(R-bar) system. And this simulated excitation frequency of R-bar according to movement of the railway vehicle. And the characteristic of contact loss was analyzed in accordance with the magnitude of amplitude.This study is helpful in analyzing the characteristics of contact loss in the interface between a real railway system.*

KEYWORDS *-Contact Loss, Amplitude, Rigid Catenary, Arc, Railway*

I. INTRODUCTION

Railway systems use electric cables to provide power. The railroad vehicle is fed by sliding the catenary through the pantograph, which is a power collecting device. The types of catenary are different between ground and underground sections. The rigid catenary is applied at the tunnel and underground. There is a difficulty to accelerate speed of the railway vehicle because sections applied a rigid catenary don't change the height compared with general catenary system and the arc occur between the catenary and pantogragh of railway vehicle. So a simulator is necessary to analyze its characteristics for this. In this study, A contact loss simulator for a rigid catenary system was designed using real R-bar system was recently used. And this simulated excitation frequency of R-bar according to movement of the railway vehicle. And the characteristic of contact loss was analyzed in accordance with the Magnitude of amplitude. This study is helpful in analyzing the characteristics of contact loss in the interface between real railway systems.

II. DEFINITION OF CONTACT LOSS

The contact loss can result in abnormal wear and damages by causing arc due to electrically incomplete contact. Therefore, the contact loss occurred on a move is inevitably one of the key factors to determine the speed of a train. The rate of loss of contact is defined as 'Percentage loss of contact'.

$$percantage\ loss\ of\ contact == \frac{The\ sum\ of\ contact\ loss\ time\ when\ driving\ apredetermined\ period}{Driving\ a\ predetermined\ period\ time} \times 100[\%]$$
$$= \frac{The\ sum\ of\ driving\ distance\ with\ contact\ loss\ when\ driving\ a\ predetermined\ period}{Driving\ a\ predetermined\ period\ of\ distance} \times 100[\%]$$

III. CHARACTERISTIC OF CONTACT LOSS SIMULATOR FOR RIGID CATENARY SYSTEM

In this study, the contact loss simulator for a rigid catenary system to generate contact loss was designed and its operational characteristics were analyzed. The pantograph slides on the catenary in an electric railway vehicle, and vibration occurs according to the excitation frequency in the catenary. The simulator in this study is a prototype model. Because generating the vibration is difficult according to the running of the railway vehicle, in order to generate the contact loss, a motor were installed at the left end of the rigid catenary and the system was installed to generate vibrations through vertical movement according to the frequency. Vibration is designed to be 0~10[Hz] in the frequency effect characteristics of the current collection of the pantograph, and the experiment was performed by varying the conditions. For the study of the interface of the rigid catenary system in order to simulate the contact loss in the rigid catenary system. And the parameters shown in Table 1 were applied.

Table 1. Parameters of contact loss simulator for the rigid catenary system

Content	High-speed railway	Contact loss simulator
Input voltage	25,000[V]	220[V]
MCB breaking current	2,000[A]	20[A]
Maximum capacity of power conversion system	2,600[kW]	2.0[kW]

Figure1 shows configuration of contact loss simulator to analyze the contact loss ofa rigid catenary system. This simulator consists of ①R-bar, ②pantogragh, ③control unit. The R-bar was installed on top and pantogragh on bottom for simulating contact loss of real R-bar system. And the pantogragh is available to move. It is designed in a similar configuration to the actual system through this. And the R-bar vibrates according to the excitation frequency. The amplitude of the R-bar changes depending on the fixed point. A fixed point is the point of support in the rigid catenary. For this purpose, the R-bar in the simulator is designed to be able to move up and down.

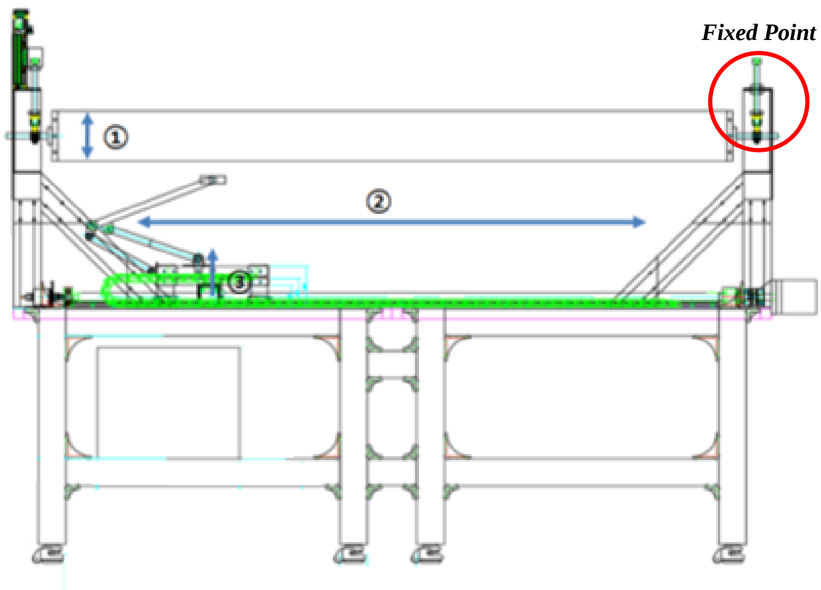


Fig. 1. Configurationof contact loss simulator for a rigid catenary system

Figure 2 shows experiment block diagram of the contact loss simulator. Input of the simulator is speed, up and down of the pantogragh and excitation frequency, amplitude of the R-bar. Speed of the pantogragh is

0.6[km/h], 0.8[km/h], 1[km/h] because too high speed gives the equipment a load. Depending on user input, various condition such as frequency, amplitude, and speed can be simulated. In this study, the characteristics according to amplitude was analyzed. The amplitude was varied with fixed frequency and the system was simulated with the moving and stopped pantograph.

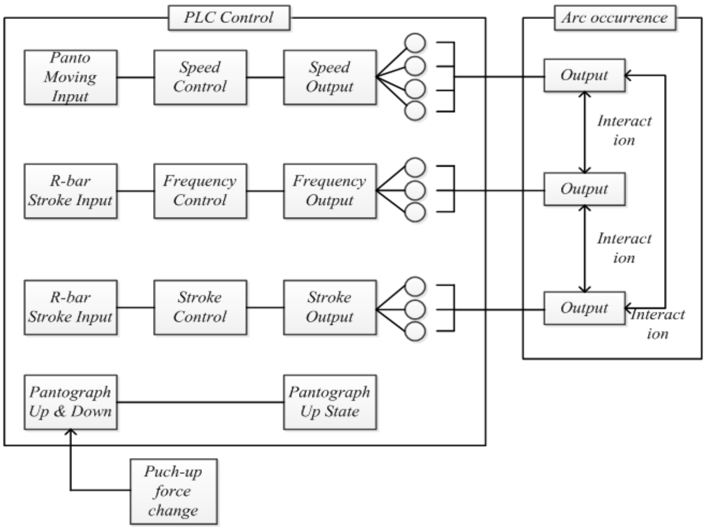
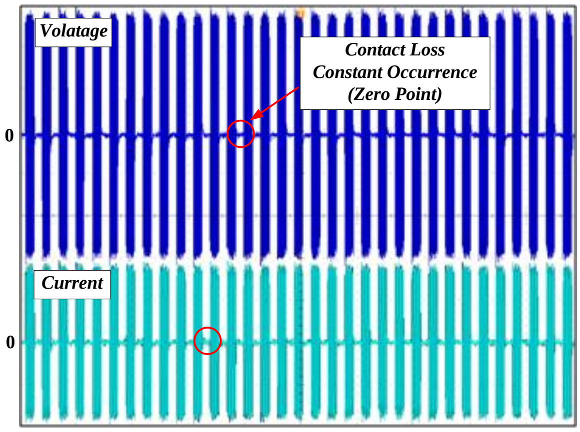


Fig. 2. Experiment block diagram of contact loss simulator for a rigid catenary system

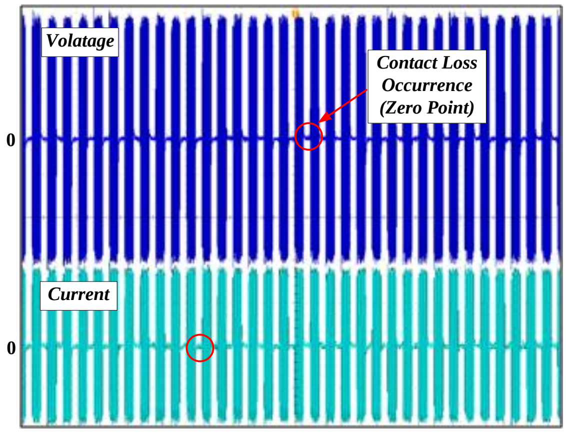
IV. RESULT OF EXPERIMENT

The waveform was analyzed in the condition of R-L load, constant frequency, and the pantograph in the stop and moving state for the contact loss phenomenon analysis according to amplitude variation. Figure 3 shows the voltage and current waveforms of 5[mm]amplitude in the state condition with 2[Hz] frequency and R-L load. Figure 4 shows the voltage and current waveforms of 15[mm]amplitude in the same condition with others. Although the amplitudes of the two waveforms were different, it was confirmed that the waveforms in the stationary state were almost the same. It has been confirmed that the amplitude in the stationary state had no significant relation with the generation of contact loss.



(X axis: 2[s]; Y axis: 100[V/div.], 10[A/div.])

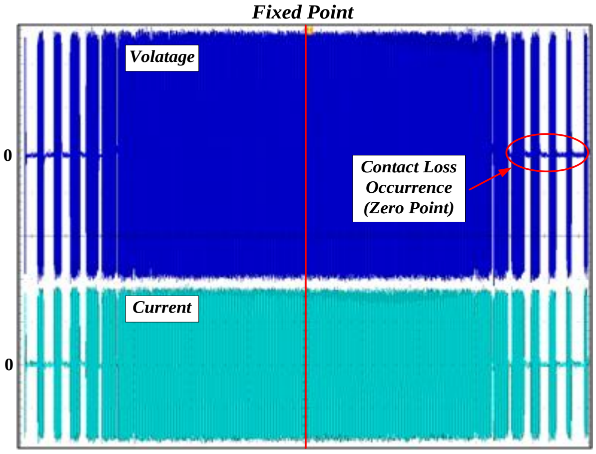
Fig. 3. Voltage and current waveforms for 5[mm]amplitudes in the stopped state



(X axis: 2[s]; Y axis: 100[V/div.], 10[A/div.])

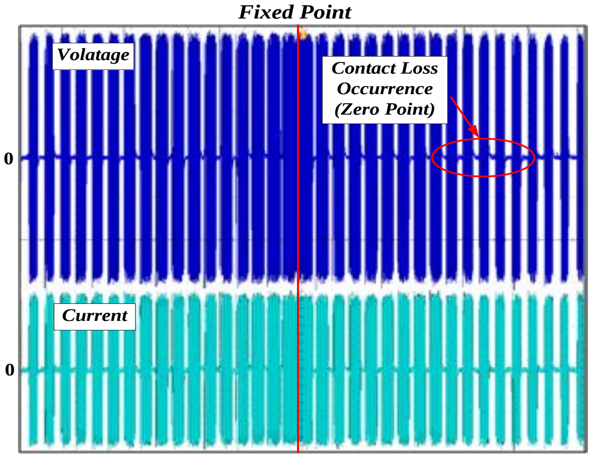
Fig. 4. Voltage and current waveforms for 15[mm]amplitudes in the stopped state

The waveform was analyzed in the condition of R-L load, constant frequency, and the pantograph in the moving state for the contact loss phenomenon analysis according to amplitude variation. Figure 5,6 show the voltage and current waveforms according to amplitude in the 0.6[km/h] moving condition with 2[Hz] frequency and R-L load. The voltage and current waveform sin the moving condition had no contact loss during the 6.4[s]based fixed point (total time of the waveform is 12.8[s]), but contact loss occurred after this time shown as figure 5 in 5[mm] amplitude condition. And the voltage and current waveform sin the moving condition had no contact loss during the 0.6[s] based fixed point (total time of the waveform is 1.2[s]), but contact loss occurred after this time shown as figure 6 in 15[mm] amplitude condition.



(X axis: 2s; Y axis: 100V/div., 10A/div.)

Fig. 5. Voltage and current waveformsin5[mm] amplitudes in the moving state



(X axis: 2s; Y axis: 100V/div., 10A/div.)

Fig. 6. Voltage and current waveformsin15[mm] amplitudes in the moving state

V. CONCLUSION

In this paper, the contact loss characteristics according to the amplitude was analyzed using the contact loss simulator. For this purpose, the R-bar in the simulator was designed to be able to move up and down. And the amplitude was varied with fixed frequency and the system was simulated with the moving and stopped pantograph. The results are as follows.

1. Although the amplitudes of the two waveforms were different, it was confirmed that the waveforms in the stationary state were almost the same. It has been confirmed that the amplitude in the stationary state had no significant relation with the generation of contact loss.

2. The results were different according to amplitude due to the deflection of the rigid catenary even if the frequency is fixed in the moving state.

This study is helpful in analyzing the characteristics of contact loss in the interface between real railway systems.

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