Simulation of Dynamic Current Collection between Pantograph and Catenary of Elastic Catenary Suspension System

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Abstract. Stable operation of the high speed train requires reliable contact between pantograph and catenary in order to offer stable electricity. But as the train speed increases, the vibration between pantograph and catenary intensifies, so the current collection between pantograph and catenary of high speed train gets more attention. A simulation model of the dynamic current collection between pantograph and catenary is established by MSC. Marc simulation software based on FEM. According to elastic catenary suspension system, the simulation is carried out under different working conditions. In this paper, with the standard deviation of contact pressure and the rate of current collection bad points as the evaluation standard of the current collection, the effect of the design parameters (contact wire tension) of catenary to the current collection quality is discussed. By analyzing the results of simulation data, this paper obtains the general law of the effect of the contact wire tension to the current collection quality.

Keywords: Elastic catenary suspension system, design parameters, simulation.

1 Introduction

Stable operation of the train requires reliable contact between pantograph and catenary in order to offer stable electricity. Unfortunately, as the train speed increases, the vibration of contact wire intensifies, and the vibration in contact force between pantograph and catenary also intensifies, which can lead to a loss of contact, arcing and wear [1]. So the current collection between pantograph and catenary of high speed train gets more attention. To study the problem of current collection, in addition to theoretical analysis, there are three main methods of field tests, establishment of laboratories and computer simulation. Due to the restrictions of physical testing and commissioning, computer simulation is a shortcut to simulate the interaction between pantograph and catenary. The computer simulation method is intuitive and easy to change the conditions and data. Although some approximate properties, it’s a main method to study the dynamic current collection of the electrical railway.
In this paper, a simulation model of the dynamic current collection between pantograph and catenary is modelled by MSC.Marc simulation software based on FEM, through which study the problem of the current collection. In the mode of single pantograph, this paper studies the effect of the design parameters of catenary to the current collection quality by changing the design parameter (contact wire tension).

2 Dynamic Model and Calculation Conditions of Pantograph-Catenary System

The overhead line systems consist of catenaries connected by some droppers which are fitted to minimise the droop of the contact wire. To the catenary-pantograph system, the displacement of the pantograph head and the contact force are both the bond of the interaction between pantograph and catenary. With the interaction force between pantograph and catenary as the study object, catenary model and pantograph model are modelled respectively in this paper, and then the model of catenary-pantograph system is coupled.

2.1 Modelling of the Catenary

In this paper, catenary model is elastic catenary suspension, and the catenary model of six span lengths and seven poles is modelled with Marc software. This model is composed of contact wires, carrying cables, stitch wires, droppers, poles and support equipments. Ignore the pre-sag of the contact wire and only consider the catenary sag. In the catenary model, apply the weight of the contact wire, carrying cable, stitch wire and dropper to the divided finite element.

2.2 Modelling of the Pantograph

In this paper, the pantograph model is nonlinear so that it’s more visually. The pantograph model consists of three main parts; lower frame and pushrod, main frame, pantograph head and pantograph pan, and the three parts are linked by hinges and nonlinear springs. Add the boundary conditions to the static lift force of the spring of the pantograph and limit the motion displacement of the pantograph pan by the boundary conditions too. After the establishment of the model, give the initial speed to the pantograph.

Figure 1 gives the dynamic model of Pantograph-catenary system, which shows the velocity distribution of the contact line.

2.3 Pantograph / Catenary Calculation Conditions

The system model consists of catenary system and pantograph system, and the various parameters of the two systems can be modified. In this paper, different simulation data are gained by changing the contact wire tension, system height and span lengths on the basis of the basic parameters of the catenary. Table 1 show the basic parameters of the catenary.