21st International Conference **ENGINEERING MECHANICS 2015**
Svratka, Czech Republic, May 11 –14, 2015
Paper **#068, pp. 366–367**

Numerical Simulation of Aerodynamic Forces Which Have an Impact on the Pantograph

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Keywords: pantograph, numerical simulation, aerodynamics, fluid mechanics, ANSYS CFX

Abstract: The paper presents the process of creation of a numerical model, designed for determination of the aerodynamic forces which have an impact on the pantograph. Numerical analyses were carried out in ANSYS CFX environment. The object of the study was the author's original concept model of pantograph. The values of aerodynamic forces have been computed for different velocities and heights of pantograph elevation. Furthermore, the model allowed to specify percentage of the individual elements of the pantograph on the total drag force. The values were determined by a special algorithm, which was implemented in a dynamic model of the pantograph.

Introduction

Nowadays, the development of high-speed rail causes the maximum speed increase. At the moment, the speed record of conventional high-speed train is 574.8 km/h. The record was established by the French train TGV. This is an impressive result, but the majority of high-speed railways in Europe is designed for speeds between 200-300 km/h. The railway which can reach the speed above 300 km/h appears only in Spain and France.

Developing such a high speed by trains, which receive electricity from overhead catenary traction causes a number of problems associated with the current reception. The aerodynamic force has strong impact on the proper work of pantograph and disturb the flow current. Definition of the aerodynamic force is necessary when the interaction between pantograph and catenary is modeled.

Research facility

The pantograph is a multibody construction, which changes height of elevation depending on working conditions. Changing the elevation of the pantograph also affects the change of the cross section and the drag coefficient in the pantograph.

This behaviour requires the calculation of the aerodynamic force for different elevations of the pantograph and to determine the coefficient of drag for these values. Numerical analyses were carried on the author's original concept model of pantograph. (Fig. 1.).

Fig. 1: The author's original concept model of pantograph

Results

Numerical analyses were carried out in ANSYS CFX environment for three heights of elevation: 1000 mm, 2000 mm, and 3000 mm. The results are presented in Fig. 2.

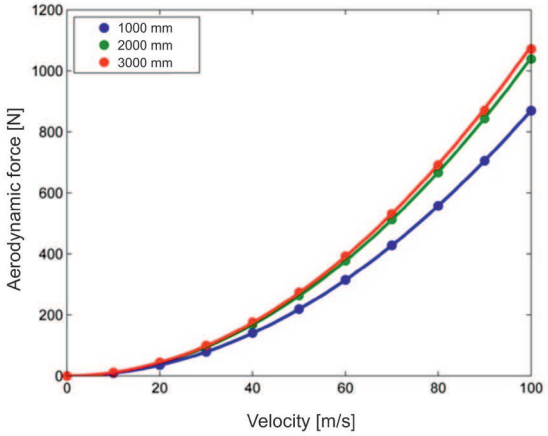

Fig. 2: Values of the aerodynamic force acting on pantograph

The aerodynamic force which acts on pantograph depends on heights of elevation of the pantograph. This dependence is non-linear and it is associated with the change of the surface which the force acts.

In addition to the determination of total aerodynamic force, the influence of the air flow on the individual components of the pantograph is summarized in Table 1 as percentage of the total force.

Tab. 1: Percentage of the total aerodynamic force for selected items

Heights of elevation pantograph [mm]	Pantograph Head	Lower Arm	Upper Arm
	Percentage of total aerodynamic force		
1000	83%	19%	6%
2000	62%	24%	4%
3000	57%	32%	10%

Summary

- The study showed that the increased height of elevation of pantograph increases the value of the aerodynamic force acting on pantograph. This change is non-linear.
- The percentage of total aerodynamic force depend on height of elevation of pantograph.
- The drag coefficient at height of elevation 3000mm is about 118% greater than that corresponding to the height of elevation 1000 mm.

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