A New Semi-active Control Method of Yaw Damper inHigh-speed Railway Vehicle and its Experiment in Hardware-in-the-loop System

Yongqiang Liu[1,2], Shaopu Yang[1*] ,Yiwei Zhao[3], Ya Li[2]

1 State Key Laboratory of Mechanical Behavior in Traffic Engineering Structure and System Safety, Shijiazhuang, Hebei, P.R.China

2 School of Mechanical Engineering, Shijiazhuang Tiedao University, Shijiazhuang, Hebei, P.R.China

3 School of Traffic and Transportation, Shijiazhuang Tiedao University, Shijiazhuang, Hebei, P.R.China

Abstract. For the yaw dampers of a railway vehicle, it's a contradiction of lateral stability on tangent railway and safety while passing a curve track. A new semi-active control method of yaw damper is proposed to overcome this problem. The new method adjust the damping coefficient according to track condition, namely tangent track and curve track. A simplified two freedom dynamics model of single wheelset with two yaw dampers is built to test the proposed control strategy. Then, a whole railway vehicle model is used to simulated, and the comprehensive dynamic performance is analyzed when the proposed control method is carried out. At last, a hardware-in-the-loop (HIL) experimental system with two magneto-rheological (MR) dampers is used to verified the simulation results. According the simulation and experimental results, the new semi-active control of yaw dampers proposed in the paper can ensure the safety ability and lateral stability of the high-speed railway vehicle at a time.

Keywords: High-Speed Railway Vehicle, Yaw Damper, Semi-active Control, MR Damper, Hardware-in-the-Loop

Introduction

In order to avoid hunting instability when the train is running at high speed on a straight line, the greater longitudinal damping between the body and the frame is required in most cases, while the longitudinal damping should not be too large when the train passes through the curve to ensure the safety performance of the train.Therefore, the contradiction between lateral stability and curving performance has always been difficult to solve in the process of train speed increasing. Engineers constantly optimize the suspension parameters and bogie structure to coordinate the relationship between them, and finally achieve the overall balance. However, the effect of parameter and structure optimization is not endless. When the optimization reaches a certain degree, the contradiction between lateral stability and curving performance will become the main bottleneck of further improving train speed[1-2]. This paper presents a control system of anti hunting shock absorber, which can change the damping coefficient between straight track and curve track so as to solve the contradiction between lateral stability and curving performance of train.

Results and discussion

Aiming at the contradiction between lateral stability and curving performance of high-speed EMUs, the control problem of anti hunting shock absorber is studied by using single wheelset and joint simulation methods. At the same time, the experimental verification is carried out by using the HIL test. As shown in Figure 1~3. The simulation results show that, without affecting the lateral stability, the anti hunting damper control system greatly reduces the safety index(derailment coefficient, wheel load reduction rate and so on) of EMUs when passing the curve track.The control method improves the curving performance of high-speed EMUs.

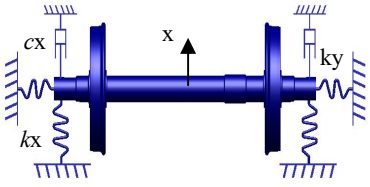

Fig.1 Two freedom dynamics model of single wheelset

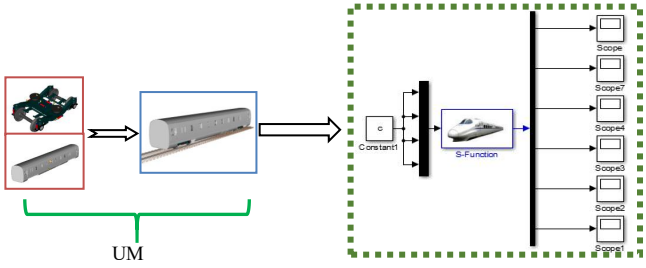

Fig.2 High speed train integration model

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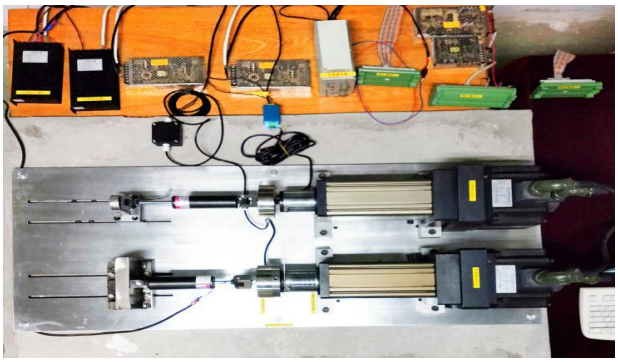

Fig.3 Hardware in the loop test of MR dampers

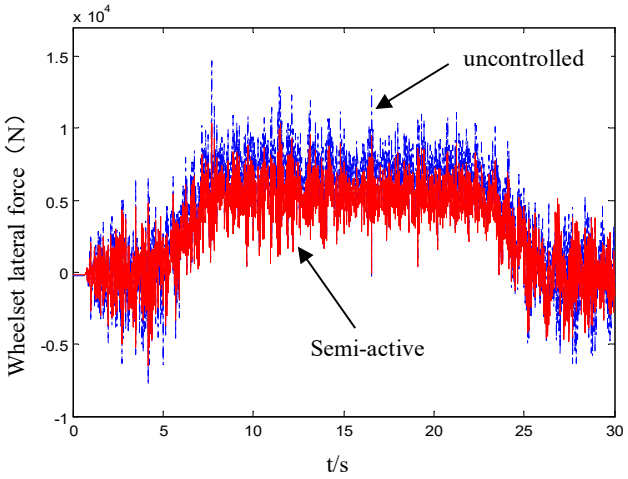

Fig.4 Comparison of wheelset lateral force

Corresponding author: Shaopu Yang, Yangsp@stdu.edu.cn