

Life Prediction Based on Transient Dynamics Analysis of Van Semi-trailer with Air Suspension System

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Abstract: The early fatigue damage in the van-body of the semi-trailer is often caused by the unique mechanical characteristics and the dynamic impact of the loads. The traditional finite element method with static strength analysis cannot support the fatigue design of van-body; thus, the dynamics analysis should be adopted for the endurance performance. The accurate dynamics model to describe the transient impacts of all kinds of uneven road and the proper system transfer functions to calculate the load transfer effects from tire to van-body are two critical factors for transient dynamics analysis. In order to evaluate the dynamic performance, the dynamics model of the trailer with the air suspension is brought forward. Then the analysis method of the power spectral density (PSD) is set up to study the transient responses of the road dynamic impacts. The transient responses transferred from axles to van-body are calculated, such as dynamic stress, dynamic RMS acceleration, and dynamic load factors. Based on the above dynamic responses, the fatigue life of van-body is predicted with the finite element analysis (FEA) method. Applying the test parameters of the trailer with air suspension, the simulation system with Matlab/Simulink is constructed to describe the dynamic responses of the impacts of the tested PSD of the vehicle axles, and then the fatigue life is predicted with FEA method. The simulated results show that the vibration level of the van-body with air suspension is reduced and the fatigue life is improved. The real vehicle tests on different roads are carried out, and the test results validate the accuracy of the simulation system. The proposed fatigue life prediction method is effective for the virtual design of auto-body.

Key words: van-body, air suspension system, transient dynamics, power spectral density (PSD), life prediction

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