

Experimental Evaluation of Semiactive Magnetorheological Primary Suspensions for Heavy Truck Applications

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This study evaluates the performance of a semiactive magnetorheological primary suspension on a heavy truck application. A set of magnetorheological dampers is designed, fabricated, and characterized. The set of magnetorheological test dampers are implemented on a Volvo VN heavy truck. An embedded controller determines the level of damping to be supplied by the test dampers. The level of damping in each of the controllable magnetorheological dampers is determined according to a skyhook control scheme. Eleven PCB Piezotronics accelerometers are used to measure the acceleration at various points on the truck. The measurement positions include four measurements on the axles of the truck, and four measurements on the frame of the truck. This data is both recorded for post-test analysis and determining the damping level during testing. Additionally, three accelerometers measure the roll, heave, and pitch of the truck cab.

The performance of the truck equipped with the semiactive magnetorheological suspension is primarily compared to the performance of the truck with the original (stock) passive system. Results from operation with the adjustable dampers fixed in both their on and off states are also given. The performance comparison between the semiactive and the original passive system is performed for two different driving situations. The first comparison between the two suspension types is for a test case where the truck is driven over a speed bump at approximately 6-7 mph. The second comparison is for the test case where the truck is driven at a constant speed along a stretch of straight and level highway at a constant speed of 55 mph. Acceleration data for both of these test cases is analyzed in the time domain (RMS and peak values of acceleration), and in the frequency domain (average peak intensity in different frequency bands).

The findings presented here are confined to the specific magnetorheological dampers that were tested on the truck. Little effort was spent on tuning the high and low states of the adjustable dampers. In addition, the controller used was relatively crude, in the sense that it only implemented the on-off skyhook policy. The findings are meant to highlight some of the potential benefits, as well as shortcomings, of the magnetorheological dampers for heavy truck applications.

The data for driving the truck over speed bumps indicate that the magnetorheological dampers used in this study with the skyhook control policy have only a small effect on the vehicle body and wheel dynamics, as compared to the passive stock dampers. The highway data shows that magnetorheological dampers and skyhook control policy are effective at reducing the RMS value of the measured acceleration at most measurement points, as compared to the stock dampers.