

Vehicle vibration analysis



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It is known that vibration levels depend on various parameters, such as type of vehicle suspension, inflation pressure and condition of the tires, the speed of vehicle, road condition, vehicle load, etc. As this simulation is held on a 4-post shaker and tested vehicle is given, some of the factors should be ignored. Hence two factors are selected, tire inflation pressure and vehicle load, as test variables.

1. Effect of tire inflation pressure:

This project will detect the dynamic performance of pickup truck with tire pressure at 50%, 100% and 150% of rated inflation. This variable is considered base on the principle of how the road excitation is damped all the way from tire-ground interfaces to the chassis. Tires are the most important parts of a car. The damping occurs at two points: the car suspension, which consists of a combination of bushes and the shock absorber with its different types depending on the car model, and the tires. This shock absorber is connected in parallel with a helical spring coil. In addition to shock absorbers and springs, the tires damp the road excitations. Although the damping effect of tires is small when compared to that of that of the shock absorbers and springs, this damping effect cannot be ignored. Under rough road excitation, tire sidewall and tire stiffness affect the dampening. Varying tire pressure will have a great impact on the damping coefficient of the tires. At overinflation condition, tires tend to be stiff and transmit vibrations directly to the shock absorbers and other suspension components, and for tires themselves, the tread wear is severe along the center due to bulging of the tire structure at a high pressure. Since decreasing the pressure will decrease the stiffness of the tires, the effect will be greater damping before

transmitting the excitation to the suspension components. But reducing it after a certain threshold will reduce the driver's car control and pose a danger to him and his surroundings. Driving with underinflated tires will cause uneven tread wear either, potentially lead to fatigue breakdown of the tire's internal structure resulting in tread separation or other structural failure and also conversely degrade the car performance by increasing vibrations. Hence different tire inflation rate should be applied during testing and observe the difference of the performance of the unsprung system.

2. Effect of Vehicle Load

It has been shown that the dynamics of a lightweight vehicle are more sensitive to payload parametric variations, i. e., passengers or freight loads, than a conventional vehicle. For example, a harsh turning may lead to rollover much more easily, or the maximal acceleration/deceleration is significantly reduced, when a large amount of payloads is placed on a lightweight vehicle. All these deviations in lightweight vehicle dynamic responses, even if sometimes trivial, can mean life or death, particularly under some critical maneuvers and challenging driving conditions.

Fortunately, the existing numerous advanced “parameter-adaptive” vehicle control systems, such as adaptive traction/braking control, adaptive steering control and adaptive roll/lateral stability control, can partly relieve the aforementioned problems. However, these controllers originally were not targeted for lightweight vehicles and did not explicitly consider the vehicle payload variations, and more importantly, they seldom generated the information on the unknown parameters. Since payload may count for a considerable part for a lightweight vehicle, the knowledge of the actual

payload parameter values can greatly benefit the ride dynamics analyzation in lightweight vehicles.

It is concluded by previous research that, for active suspensions, both ride and handling can be improved by reducing the vehicle load. In particular, when the total vehicle mass is kept constant, every 10% reduction in vehicle load contributes to a circa 6% reduction in r. m. s. sprung mass acceleration for the same level of wheel-hop. For active suspension vehicles, this provides a clearer picture of the unsprung load effect on vehicle ride dynamics.