Evaluation of Handling Characteristics of an Intercity Bus by Multi-Body Dynamic Simulations

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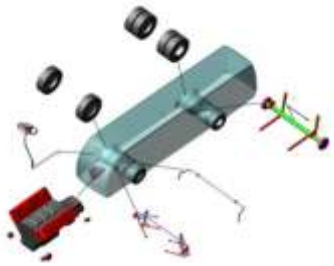
Abstract:

Vehicle dynamics is the study of response of the vehicle to driver's input. Various parameters like location of center of gravity (CG), suspension spring stiffness, wheel alignment parameters determine the handling behavior of the vehicle. Vehicle dynamic tests can be simulated virtually to assess the handling behavior. This is a study to investigate the effects of aforesaid parameters on handling characteristics of an intercity bus using MSC ADAMS software tool.

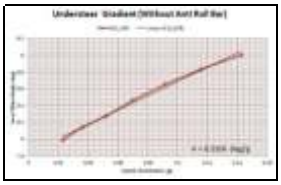
Handling performance was determined by evaluating various parameters such as understeer gradient and roll gradient. Understeer gradient is influenced by various parameters like location of CG, tire cornering stiffness etc. Roll gradient of a vehicle depend on various parameters like vertical stiffness of tires, anti-roll bars (ARB) diameter, location of CG, etc. As a part of this study, four different configurations of MBD models were built as per the exterior dimensions and specifications of the selected baseline bus in order to investigate the effect of location of ARB on handling behavior of bus. Several vehicle dynamic tests were virtually conducted on the MBD model of the bus. Sensitivity analysis was done to determine the sensitivity of understeer gradient and roll gradient with respect to above mentioned parameters.

It was observed that the magnitude of understeer gradient was more in case of bus with front ARB and less in case of bus with rear ARB compared to the bus without ARB. The roll gradient was observed to be minimum for the bus with both front and rear ARB and maximum for the bus without ARB and it was most sensitive to height of CG. The sensitivity analysis revealed that the bus tends to exhibit increased understeer characteristics with the increase in caster, camber, cornering stiffness of rear tires and weight distribution on front axle. However, the understeer gradient was observed to be most sensitive to weight distribution compared to other parameters. At higher speeds, there was considerable reduction in roll angle when ARB was attached at front and rear separately, and for the bus with both front and rear ARB, the roll angle was minimum. For Single Lane Change (SLC) maneuver, lateral displacement was least for the bus with front ARB and maximum for bus without ARB.

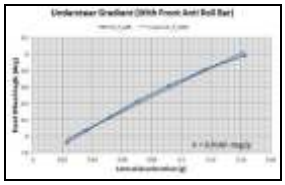


Full vehicle assembly

Results – Constant radius cornering



Understeer gradient (without ARB)

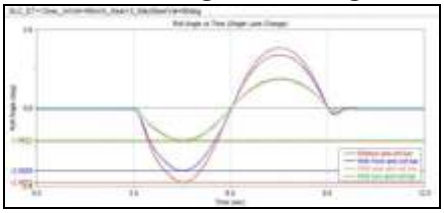


Understeer gradient (front ARB)

Constant radius cornering maneuver

Single lane change maneuver

Results – Single lane change



Time history plot of roll angle (SLC at 40 km/h)