A Combined Ride and Handling Model for Railway Vehicles

S. Vishnu[1], Subir K. Saha[2], S P. Singh[3]

[1] *Dept. of Mech. Engg., Indian Institute of Technology Delhi,vishnu1992@gmail.com*

[2] *Dept. of Mech. Engg., Indian Institute of Technology Delhi, saha@mech.iitd.ac.in*

[3] *Dept. of Mech. Engg., Indian Institute of Technology Delhi, singhsp@mech.iitd.ac.in*

Research and development in railway dynamics has gained significant momentum in past decades. One of the top priorities of engineers working in this domain is to increase the operating speeds of the railway vehicle without compromising the safety and comfort of the passengers. An outline regarding the modeling of railway vehicle was presented [1] and their ride characteristics were investigated using active secondary suspension [2]. An analytical method was proposed to study the vertical vibrations of railway vehicles [3] and results of the theoretical model have been validated with test results. Passive anti – roll bars are replaced with hydraulic actuators to control the tilt (roll) [4] to improve the handling performance of railway vehicles. An active H^{∞} control strategy is used [5] to reduce the roll, lateral motion and yaw in railway vehicles. Similarly, in vehicle dynamics, ride and handling behaviors have been investigated separately [6 – 8].

From the literature, it is clear that combined ride and handling model, needs to be developed for optimizing suspension parameters, Note that, a soft suspension provides a better ride comfort [9], and compromise in handling behavior. Hard suspensions, on the other hand, provide good stability during turning, but lack ride comfort. Research efforts are going on for the combined ride and handling model of a single unit heavy vehicle, in automotive sector [9]. These strategies need to be extended for railway vehicles.

In, this work, a detailed literature review is presented based on the work done in assessing ride and handling characteristics of railway vehicles. In order to investigate combined ride and handling behavior, railway vehicles can be modeled as lumped mass models connected with each other and supported by primary and secondary suspensions as shown in Fig 1. Track alignments in vertical and lateral direction can be used as inputs to study the combined ride and handling behavior.

System of equations can be written in state space form, where the system states correspond to position and velocity of generalized coordinates of carbody and bogies. System of equations will be in the form of eq. (1)

$$[\mathbf{M}][\ddot{\mathbf{x}}]+[\mathbf{K}][\mathbf{x}]=[\mathbf{B}] \tag{1}$$

Where, $[\mathbf{M}]$ is the mass matrix, $[\mathbf{x}]$ consists of system states (position and velocities of carbody and bogies), $[\mathbf{K}]$ is the stiffness and damping matrix, $[\ddot{\mathbf{x}}]$ is the derivative of system states and $[\mathbf{B}]$ is the input matrix which contains track irregularities.

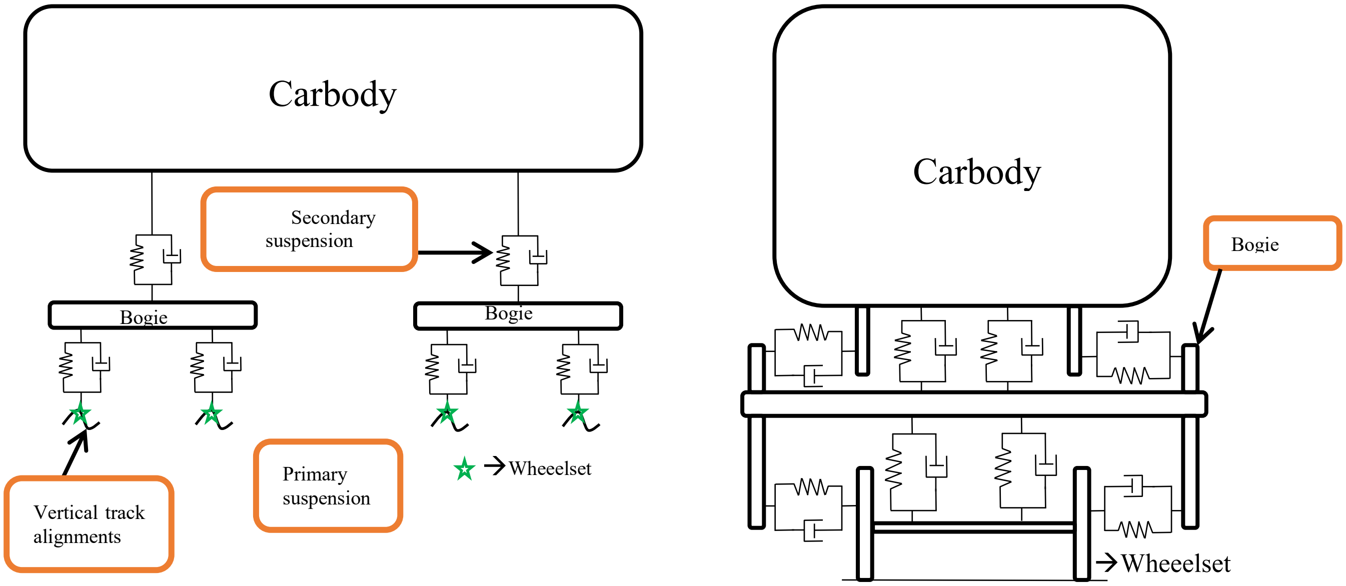

Fig. 1: Combined ride and handling model of a railway vehicle

The dynamic equations could be are solved to obtain the carbody motions such as pitch and bounce (for ride), roll and sway (for handling) for the given track data as a function of time and the train running parameters. Preliminary results of dynamic response of the railway vehicle will be also be reported.

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