Special Feature: Dynamics Modeling Supporting Vehicle Performance

Overview

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Initially, the fundamental performance features of automobiles were the ability to “move”, “turn”, and “stop” as directed by the driver. However, automobiles have evolved over the last hundred years and designers must now provide increasingly higher levels of “strength and reliability”, “ride comfort", and “fuel economy” to achieve superior performance levels. Therefore, appropriate analyses using effective dynamics models are increasingly necessary to gauge these performance factors.

In this feature, we propose a number of analysis methods using different scale dynamics models that can be used to estimate various performance types. Our first report, which is entitled “Novel Scheme for Implementation of Nonlinear Constitutive Equations into General-purpose Finite Element Software”, is expected to help designers develop multiscale material models. The second report, which is entitled “Elastic Buckling Analysis for Compression and Torsion in Thin-walled Box Beams”, discusses an approximation equation model based on these precise analytical equations that would be useful in conceptual design stages. These models, which are mainly applied to "strength and reliability" estimations, are constructed based on mechanical structure and material properties.

The third report is entitled “Effects of Unsteady Aerodynamic Loads on Vehicle Motion Performance”. In this study, an aerodynamic load model is derived by dynamic wind-tunnel tests and large-eddy simulations. The fourth is “Experimental Analysis of Driver Motion and Applied Forces Using the Instantaneous Screw Axis and the Line of Action of the Applied Forces”. In this study, in which the inverse dynamics model is used, the ability of a human driver to apply force and torque in various ways is estimated from his or her motions. These studies show that the “ride comfort” performance could be clarified using not only dynamics models but also experimental results.

In order to estimate “fuel economy”, a dynamics model that considers the entire vehicle – from engine to tires – as a single system, is needed. The fifth study, “Study on Direct Yaw Moment Consumption and Power Consumption of an In-wheel Motor Vehicle”, explores simplification of an in-wheel motor system using the dynamics model.