Characterization of a Bouc-Wen model-based damper model for automobile comfort simulation

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***Abstract*—**Ride comfort is considered as one critical focus for a chassis system. To ensure a satisfying comfort performance of a vehicle in development, a detailed damper characterization needs to be pre-defined in the early phase of project with the help of simulation results in virtual proving ground. However, the current damper model integrated in whole vehicle simulations is sometimes difficult to fit to test results due to its over-simplifications especially in low speed excitation regimes. Thus this article proposes an enhanced shock absorber model to improve simulation predictions without increasing substantially calculation costs. The parameterized model is mainly based on a Bouc-Wen model considering its capability of reproducing highly nonlinear hysteretic phenomenon. Other components such as a velocity-dependent switch have been included to reproduce the asymmetrical curve in compression and rebound phases. In order to identify the parameters, firstly a multi-objective optimization using NSGA-II algorithm has been applied based on the measurements under sinus signals. The excitations on test bench have been separated into several groups according to the forms of their force-velocity curves. The objectives are to achieve the minimum error corrections for each group. As a result, an optimum set which represents the best trade-off between the objectives is obtained and form a Pareto front. By analyzing the solutions included in this front, the best-fit intervals of parameters can be revealed. Secondly weighting factors can be decided for each objective in order to choose proper optimums from the front according to different frequency regime orientations of simulation conditions. Finally comparative examples in virtual proving ground show that the correction quality is well improved for chassis' comfort prediction using the proposed model. This example demonstrates the effectiveness of the modeling and its potential in comfort improvement with the help of design of experiments.

***Keywords*—** Bouc-Wen hysteresis model, damper modeling, ride comfort, system identification, virtual proving ground

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