講演番号	358

Consideration of General Waveform Creation Method for Road Simulator Durability Test

- Development of Numerical Simulation Modeling Based on a Comparison of Real Vehicle Vibration Testing Accounting for Four Wheels Phase Differences and Numerical Simulations -

Tomoyuki Kita[1)] Atsuhito Nakamura[2)] Mitsuo Harino[3)] Tetsu Oami[4)] Atsushi Yagi[5)] Yuki Ogi[5)]
Ryo Okabe[6)] Masahiro Kajihara[7)] Hisami Oishi[8)] Kousei Fukatsu[8)] Yusuke Kasai[8)]

1) Press Kogyo Co., Ltd. 2003-1, Endo, Fujisawa-shi, Kanagawa 252-0816, Japan 2) Mitsubishi Fuso Truck and Bus Corporation 4300, Washijuku, Sakura-shi, Tochigi 329-1411, Japan 3) Suzuki Motor Corporation 300, Takatsuka-cho, Chuo-ku, Hamamatsu-shi, Shizuoka 432-8611, Japan 4) Toyota Motor Corporation 1, Toyota-cho, Toyota-shi, Aichi 471-8572, Japan 5) Toyota Auto Body Co.,Ltd. 100, Kanayama, Ichiriyama-cho, Kariya-shi, Aichi 448-8666, Japan 6) Mitsubishi Motors Corporation 1, Nakashinkiri, Hashime-cho, Okazaki-shi, Aichi 444-8501, Japan 7) Honda R&D Co., Ltd. 4630, Shimotakanezawa, Hagagun Haga-machi, Tochigi 321-3393, Japan 8) Kogakuin University 1-24-2, Nishi-shinjuku, Shinjuku-ku, Tokyo 163-8677, Japan

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This paper investigates a generalized waveform creation method for road simulator durability testing, aiming to accurately reproduce real vehicle responses under four-wheel excitation conditions. The study builds on long-term research by the Society of Automotive Engineers of Japan focused on reflecting real road loads in laboratory testing and enabling fair comparison among vehicles with different suspension characteristics.

Full-vehicle vibration experiments were conducted using a mid-size passenger car mounted on a four-poster test rig. Sinusoidal displacement inputs with constant amplitude were applied under four vehicle body modes—Bounce, Pitch, Roll, and Twist—across a frequency range of 0.5 to 5 Hz. Responses such as sprung and unsprung mass accelerations, suspension forces, and wheel forces were measured at all four wheels. In parallel, a numerical simulation model was developed using MATLAB/Simulink, extending earlier single-wheel models to a four-wheel, seven-degree-of-freedom system that includes vertical motions of each wheel, body heave, pitch, roll, and torsion (Figure 1). Nonlinear characteristics of shock absorbers and bump stoppers were included.

Initial comparisons revealed discrepancies between experimental and simulated resonance frequencies, particularly in Roll mode, due to simplified modeling of factors such as hysteresis, body torsional stiffness, and suspension bush characteristics (Figure 2). To improve accuracy, model tuning was performed by adjusting wheel rates, stabilizer stiffness, and body inertia moments referenced to the roll center. After tuning, the simulation successfully reproduced resonance frequencies for all four body modes, with good agreement in Bounce, Pitch, and Roll (Figure 3). Twist mode resonance frequency was also captured, although differences in response amplitude remained.

The results demonstrate that a four-wheel, seven-degree-of-freedom model can effectively reproduce vehicle body modes and resonance behavior observed in real vehicle tests. However, remaining amplitude discrepancies indicate the need for further refinement.

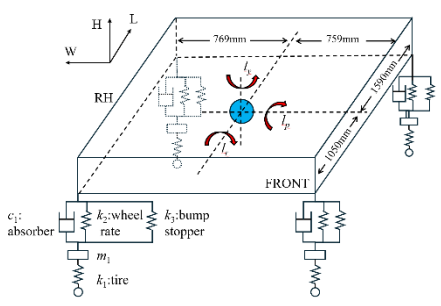

Fig. 1 4-wheels 7degrees freedom model

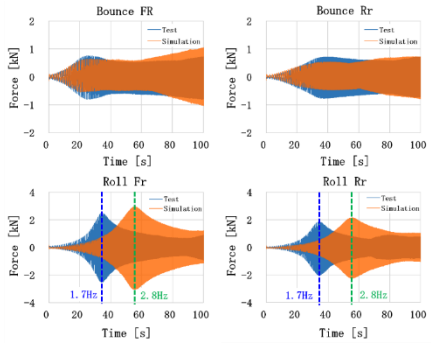

Fig. 2 Fr/Rr WFT Fz before tuning (Bounce/Roll sine sweep wave)

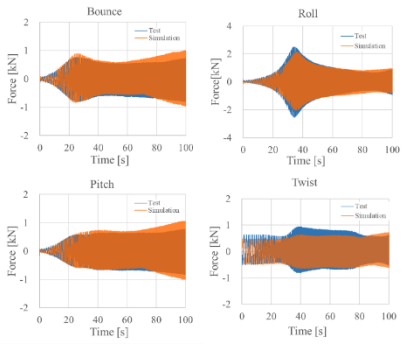

Fig. 3 WFT Fz after tuning (4mode sine sweep wave)