Analysis of the effect of road surface conditions and rutting on vehicle dynamics using CARSIM

Dang Quoc Thuyet[1], Masakazu Jomoto[2], Thit Oo Kyaw[3],
Yin Lei Lei Swe[4], and Shuichi Kameyama[5]

[1] Institute of Research and Development, Taisei Rotec Corporation,
1456, Kamiya Kounosu City, Saitama 365-0027, Japan. dangquoc_thuyet@taiseirotec.co.jp
[2] Institute of Research and Development, Taisei Rotec Corporation,
1456, Kamiya Kounosu City, Saitama 365-0027, Japan. masakazu_jomoto@taiseirotec.co.jp
[3] Institute of Research and Development, Taisei Rotec Corporation,
1456, Kamiya Kounosu City, Saitama 365-0027, Japan. thit_ookyaw@taiseirotec.co.jp
[4] Institute of Research and Development, Taisei Rotec Corporation,
1456, Kamiya Kounosu City, Saitama 365-0027, Japan. yin_lei_lei_swe@taiseirotec.co.jp
[5] Department of Civil and Environmental Engineering, Faculty of Engineering, Hokkaido University of Science, 7-Jo 15-4-1 Maeda, Teine, Sapporo, Hokkaido 006-8585, Japan.
kameyama@hus.ac.jp

ABSTRACT

Lane change maneuver for obstacle avoidance in unfavorable road surface conditions such as rutting coupled with wet, snow or icy road surfaces is one of the riskiest driving tasks. Vehicle spinning and uncontrollable driving path in these conditions may cause serious accidents. Understanding vehicle dynamic behaviors in such conditions are importance to provide proper road design, maintenance and repair to ensure safety driving. This study used CARSIM, a vehicle dynamic simulation software, to model the lateral motion, yaw motion of a normal car and a light truck in a double-lane-change (DLC) maneuver. Simulated road surface conditions were designed with a rut depth (RD) ranging from 0.5 to 10 cm in both single and dual rutting cases. Road surface friction coefficient (Mu) varied from 0.01 to 1 to simulate icy, snow, wet and normal road conditions. Considered vehicle dynamic behaviors were spinning, moving out of the road, wrong path, stuck in the rut and normal driving. Results show that wrong path driving mainly occurred at Mu < 0.4, which was likely in icy, snow or wet road surface condition. Driving in dual rut roads was more dangerous than that in single rut roads. The light truck had a higher risk of spinning in icy road surfaces than the normal car. Spinning mainly occurred in the turning points for the normal car while it could happen at any positions in a driving path during DLC maneuvers. The higher RF caused a higher risk of spinning and required a higher Mu to ensure safety driving. In a typical icy road condition Mu= 0.1, RD < 1 cm is recommended for safety driving.

Keywords: Carsim, rutting, spinning, double lane change