

Quantitative Method for Evaluating Dynamic Seat Support Performance During Driving

Hideaki Shibue ¹⁾ Yutaro Kobayashi ¹⁾ Hideyuki Muramatsu ¹⁾

1) S&VL Inc.

880 Uekino-cho, Ota-shi, Gunma, 373-0014, Japan

KEY WORDS: Human engineering, Bioinstrumentation/driving, Driver condition, Driving simulator, Sense of force, Dynamic seat support, Steering wheel force [C2]

Automotive seats are required not only to maintain the seated posture but also to support the driver's body against inertial forces generated by vehicle motion. During cornering, lateral acceleration acts on the driver's body. Therefore, the body support characteristics of the seat are considered to be an important factor related to stable driving operation. Yamaguchi et al. measured seatback support force, steering wheel force, and human body motion, and showed that shoulder support by the seatback affects ease of steering. However, direct measurement of seat support force or human body motion is not always easy when evaluating body support performance during vehicle motion, especially for comparative evaluation of passenger car seats.

Based on this issue, the present study focuses on the possibility that differences in seat body support characteristics appear in driver behavior. During vehicle motion, drivers may unconsciously perform compensatory behavior to stabilize the body, and part of this behavior may appear as force applied to the steering wheel. The authors have developed a steering operation and grip force measurement system capable of measuring forces applied to the steering wheel. In this study, this measurement system was applied to the evaluation of dynamic seat support performance. Experiments were conducted using a driving simulator equipped with a nine-axis motion system. The driving simulator was used because it can present highly repeatable vehicle motion under the same conditions. Two passenger car seats with different lateral support characteristics, Seat A and Seat B, were compared. Seat B featured stronger lateral support from the lumbar region to the shoulder region than Seat A.

The driver was instructed to drive on a closed course regulated by pylons and to trace the course centerline. Vehicle states, driver operation quantities, and steering wheel forces were measured under each seat condition. The analysis focused on the lateral force component F_y detected as a force acting in the radial direction of the steering wheel. The relationship between vehicle lateral acceleration and F_y was analyzed separately for the left and right hands. For comparison, the sign of lateral acceleration was defined as positive during right turns, while the positive direction of F_y was defined toward the left side for both hands. A linear regression line was calculated for each hand, and its intercept was evaluated as an offset component. In addition, the value obtained by subtracting the left-hand F_y intercept from the right-hand F_y intercept was defined as Clamping Force. This value represents the force acting in the direction in which both hands clamp the steering wheel.

The results showed that, for both seat conditions, F_y changed almost linearly with lateral acceleration (Fig.1). In addition, the distributions did not pass through the origin, indicating the existence of a steady force component independent of lateral acceleration. The signs of the left-hand and right-hand offsets were opposite, indicating that forces acted in the direction of clamping the steering wheel with both hands. The offset components and the resulting Clamping Force differed between the two seat conditions. Seat A showed a larger Clamping Force than Seat B.

The Clamping Force acts in the radial direction of the steering wheel and therefore does not directly contribute to rotating the wheel for steering input. Thus, this force is difficult to explain solely as steering operation and is considered to be a force generated by the driver for a purpose other than steering. In this study, the force was interpreted as driver behavior for compensating body support during vehicle motion. The stronger lateral support featured in Seat B may have reduced the need for such compensatory behavior, resulting in a smaller Clamping Force. These results indicate that Clamping Force calculated from offset components of steering wheel lateral force may serve as a quantitative index for evaluating differences in dynamic body support characteristics between seats.

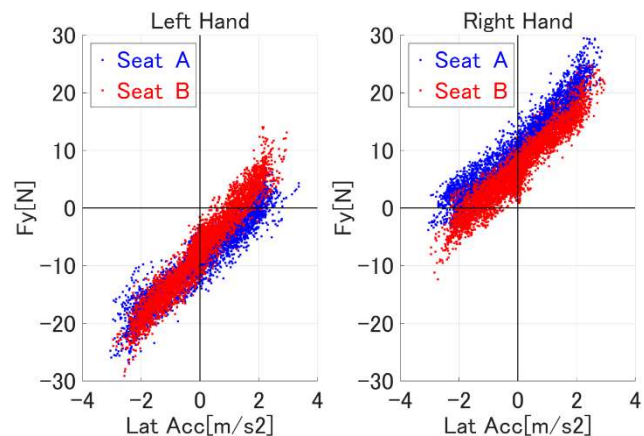


Fig. 1 Lateral Acceleration vs F_y