

A Human Body Model Based Sensitivity Analysis of Belt Routing Conditions in Frontal Impact Simulation

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Seat belt routing conditions may affect thoracic and abdominal responses in frontal impact simulations. This study compared occupant responses under multiple belt routing conditions using a human body finite element model.

A finite element sled model was constructed based on the publicly available 2014 Honda Accord finite element vehicle model provided by NHTSA. THUMS AM50 v7.1 was used as the human body model, and the input pulse was based on vehicle longitudinal acceleration from a 56 km/h full-frontal crash test. Five belt routing conditions were evaluated: Base, Clip, Lap only, Sho only, and Under arm. These alternative conditions represented changes in the shoulder and/or lap belt path relative to the Base condition. Thoracic response was evaluated using rib-wise peak MPS95 and Global peak MPS95. Abdominal organ responses were evaluated using liver MPS95, spleen MPS95, and small intestine Press95. All values were normalized by the corresponding Base condition values.

The normalized Global peak MPS95 exceeded the Base condition in all alternative belt routing conditions. However, the ribs showing increased response differed depending on the belt routing condition. In the Under arm condition, increased normalized peak MPS95 was observed around Rib_L5 to Rib_L7. Fig. 1 shows the positional relationship among the belt path, ribs, and abdominal organs in the Under arm condition, and Fig. 2 shows the rib-wise normalized peak MPS95 distribution among belt routing conditions.

The abdominal organ responses did not necessarily show the same trend as the thoracic response. Although the thoracic Global peak MPS95 increased in all alternative belt routing conditions, abdominal organ responses showed values above, close to, or below the Base condition depending on the belt routing condition and organ. The normalized responses also differed among the liver, small intestine, and spleen. These results indicate that belt routing conditions affect not only the magnitude of the local thoracic response but also the rib region where the response increases. Therefore, rib-wise thoracic response and organ-specific abdominal responses should be evaluated together when comparing occupant responses under different belt routing conditions.

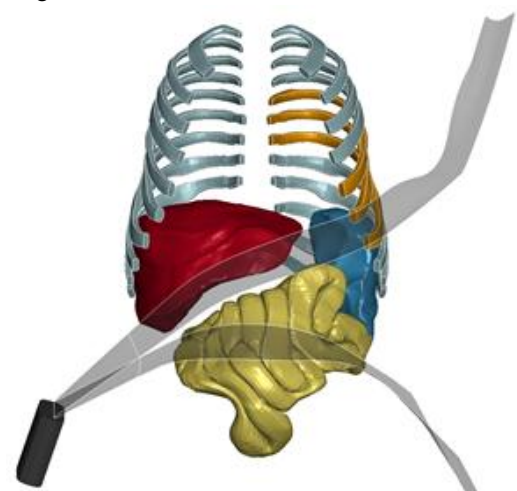


Fig. 1 Positional relationship among ribs showing increased response, abdominal organs, and belt path in the Under arm condition.

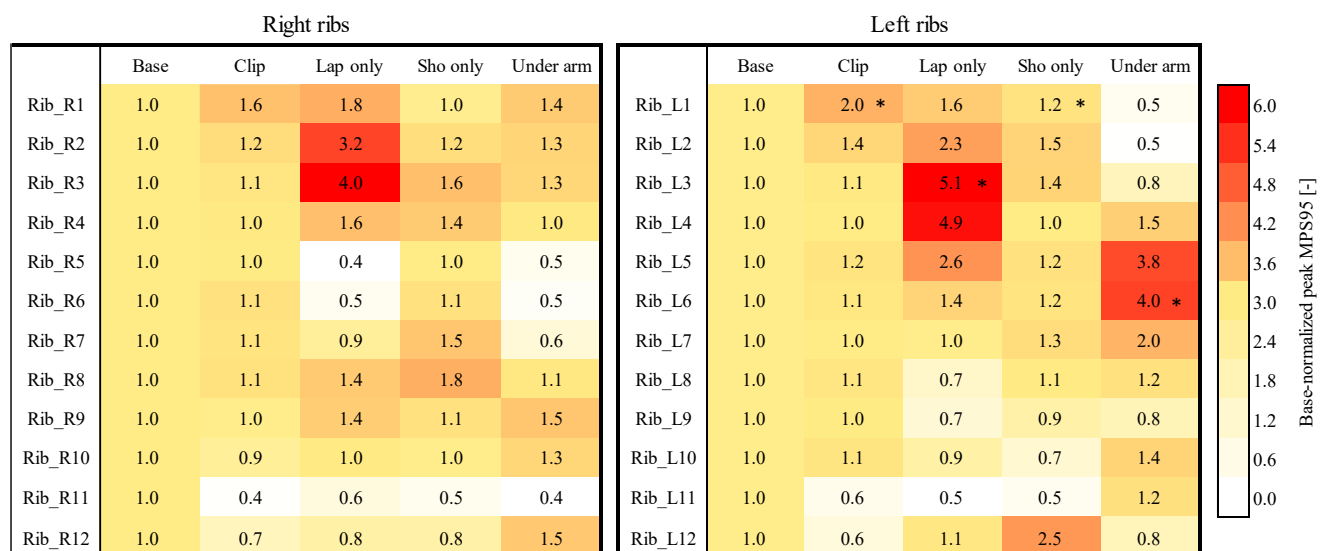


Fig. 2 Rib-wise distribution of normalized peak MPS95 showing condition-dependent differences in ribs with increased response.