

# Development of Reinforcement Structure for Hat Shape Component under Eccentric Loads

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With the widespread adoption of battery electric vehicles (BEVs), the increase in vehicle mass has led to higher crash energy during collisions, which has become a critical challenge. In particular, during offset crash, eccentric loading occurs in the front side members, where axial compression and bending act simultaneously. In this study, we investigated a reinforced cross-sectional design of a hat-section member aimed at improving energy absorption under eccentric loading using LS-DYNA. The evaluation component included a hat-shaped member, a flat plate member, and a reinforcement member. We defined four models with different cross-sectional configurations by changing the reinforcement shape (Fig.1). We then examined how cross-sectional geometry affected deformation behavior and energy absorption. To simulate the deformation of a vehicle front side member in an offset crash, we applied eccentric loading through an L-shaped beam (Fig.2). This setup reproduced the constraints from the bumper reinforcement and the opposite-side front side member. The results showed that Model 4, which forms a closed cross section on the top side of the hat-shaped member, maintained a high load after the peak load (Fig.3). Model 4 exhibited the highest energy absorption among the four models. It also showed the highest energy absorption per unit mass, defined as energy absorption divided by component weight. These results suggest that a closed top cross section in a hat-shaped member is an effective reinforcement structure. This design improves energy absorption under eccentric loading while reducing weight.

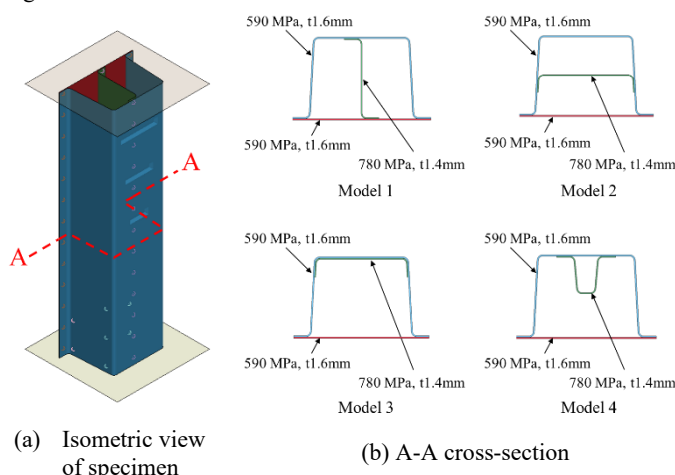


Fig.1 Evaluated specimen.

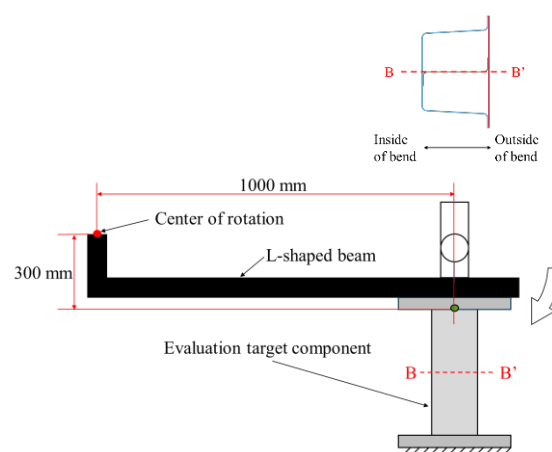


Fig.2 Schematic diagram of eccentric loading condition.

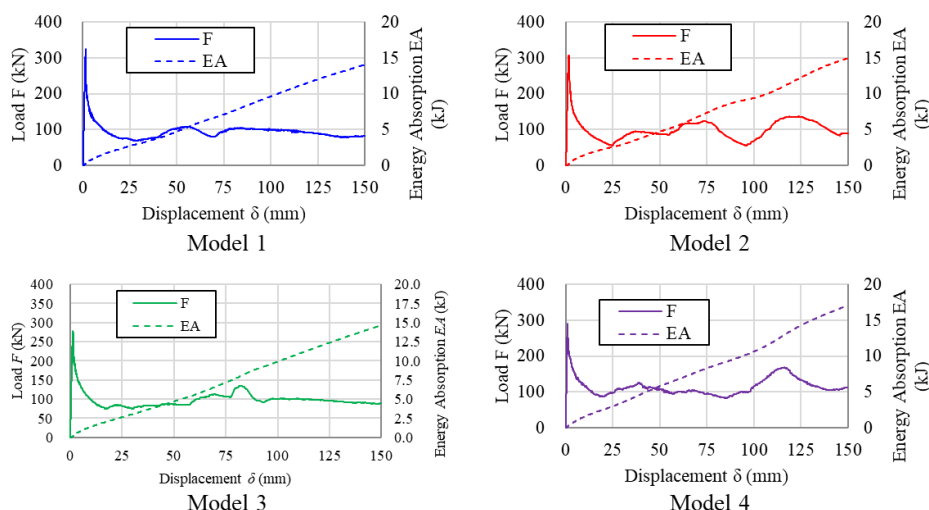


Fig.3 Comparison of the relationship between load F, EA and displacement  $\delta$  between each model.