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Topology optimization based on the higher-order beam theory for automobile body frame design

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A beam-based topology optimization method can be very useful for the layout design of automotive body structures at an early design stage. However, analyses of even T-joint thin-walled structures by the Euler or Timoshenko theory estimate their structural behavior too stiff. This is because these theories cannot properly capture the joint flexibility that comes from cross-sectional deformation such as warping and distortion. To estimate the flexibility correctly, a higher-order beam theory developed in our group is employed to formulate thin-walled beam topology optimization. In addition to conventional beam deformations, the theory includes kinematic variables representing warping and distortion. Because special joint modeling and connectivity interpolating techniques consistent with the higher-order beam theory are needed, ideas and issues related to the techniques are explained in some details. Finally, several case design studies, including those simulating automobile body structures, will be presented.

Keywords: Beam based topology optimization, Higher-order beam theory, Thin-walled structures, Joint connectivity