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Finite Element Stress Response Analysis and Strength Estimation of Butt Adhesive Joints of Hollow Cylinders Subjected to Impact Torsional Loadings

Toshiyuki SAWA
Interdisciplinary Graduate School of Medicine and Engineering
University of Yamanashi

Yoshihito SUZUKI
University of Yamanashi

Shoichi KIDO
Seimens Automotive K.K.

The stress variations in butt adhesive joints of similar hollow cylinders subjected to impact torsional loadings are analyzed in elastic and elasto-plastic deformation ranges using a finite-element method. The stress distributions in the joints under static torsional loadings are also analyzed by FEM. The characteristics of the stress variations in the joints under impact loadings are compared with those in the joints under static loadings. Thus, the design method for the joints under both impact and static torsional loadings is clarified. The FEM code names employed are DYNA3D for impact loadings and MARC for static loadings. The effects of Young's modulus ratio between the adhesive and the adherends, the adhesive thickness and the inner radius on the stress variations and stress distributions at the adhesive interfaces are examined in elastic deformation range. In addition, a process of rupture at the adhesive interface of the joint is simulated. The joint strengths under impact loadings are estimated by an elasto-plastic FEM calculations. As the results, it is found that the maximum value of the maximum principal stress σ_1 occurs at the outside edge of the lower adhesive interface. It is also found that the maximum principal stress σ_1 at the lower interface decreases as the adhesive thickness increases. The characteristics of the joints under impact loadings are found to be opposite as those under static loadings. For verification of the FEM calculations, experiments were carried out to measure the strain responses and the strains of the butt adhesive joints under both impact and static tortional loadings using strain gauges. Furthermore, the joint strengths under both impact and static loadings were measured. Fairly good agreements are observed between the numerical and the measured results.