F2010-C-031

Methodology of Service life Estimation for Automotive Rubber Component

[1]Chang Su Woo[*], [1]Wan Doo Kim, [1]Hyun Sung Park, [2]Young Gil Kim, [3]Seong Hoon Lee
[1]Korea Institute of Machinery & Materials, Korea, [2]Daeheung R&T, Korea, [3]Hyundai-Kia Motor, Korea

KEYWORDS – rubber component, hyper-elastic, fatigue test, life prediction, reliability

ABSTRACT – Useful lifetime prediction on the rubber components was increasing according to the extension of warranty period of the automotive components. A design of rubber components against fatigue failure is one of the critical issues to prevent the failures during the operation. Therefore, fatigue lifetime prediction and evaluation are the key technologies to assure the safety and reliability of automotive rubber components. In this paper, Fatigue lifetime prediction methodology of vulcanized natural rubber was proposed by incorporating the finite element analysis and fatigue damage parameter of maximum Green-Lagrange strains appearing at the critical location determined from fatigue test. In order to develop an appropriate fatigue damage parameter of the rubber material, a series of displacement controlled fatigue tests was conducted using 3 dimensional dumbbell specimens with different levels of mean displacement. It was shown that the maximum Green-Lagrange strain was a proper damage parameter, taking the mean displacement effects into account. Nonlinear finite element analyses of engine mount insulator and 3dimensional dumbbell specimens were performed based on a hyper-elastic material model determined from the simple tension, equi-biaxial tension and planar test. Fatigue lifetime prediction of engine mount insulator was made by incorporating the maximum Green-Lagrange strain values, which was evaluated from the finite element analysis and fatigue tests, respectively. Predicted fatigue lives of the rubber component showed a fairly good agreement with the experimental fatigue lives. Fatigue analysis procedure employed in this study could be used approximately for the fatigue design.