Abstract

Elastomer matrix based composites are widely used in the automobile industry as tires, seals, and hoses. Elastomers undergo considerably larger amount of deformations under applied stress than other materials. Due to this phenomenon, cracks can propagate through them very quickly and cause catastrophic failures. This is why the assessment of fracture properties of such materials is critical. The strength of elastomeric products is improved majorly through the action of fillers. Considering the rising demand for eco-friendly green tires, the elastomer matrix composites used in this thesis comprise silica filler. The quantity of silica is optimized in CB-filled SSBR composites using several chemical and mechanical characterizations in which ODR, SEM, FTIR, RPA, and UTM were utilized. The silica is also varied in natural rubber composites for potential heavy-duty applications. The deformation of crack tip for rubber composites is considered to be adamanteus using experimentation; thus, FEA is utilized to evaluate fracture properties (J-integral, CTOD, geometry factor, and crack advancement). The constitutive material modeling revealed that it strongly depends on the type of elastomer matrix used. In the present study, Ogden, N=4 and Ogden, N=2 were found to be the best material models for SSBR and natural rubber composites, respectively. The maximum principal strain based damage model is developed for Mode-I loading and clubbed with ABAQUS using 'VUSDFLD' subroutine to evaluate the failure of rubber composites which is verified experimentally with an error of 2%. This study examines the effect of the varied geometric configuration on fracture characteristics of rubber composites in which different combinations of height to width ratio (*HWR*) and notch to width ratio (*NWR*) were considered. The fracture assessment of SENT, DENT, and V-Notched specimens is carried out using FEA and verified experimentally. It is observed that for a fixed HWR when NWR is increased, J-integral increases, whereas the geometry factor strongly depends on the type of geometric configuration. The J-integral is seen to be decreasing with increasing crack opening angle for V-Notched rubber composites. An empirical relationship between CTOD and crack advancement depending on *HWR* and *NWR* has been proposed, and it was observed that this relationship had a correlation coefficient of more than 0.9. The stress and strain fields across the crack tip are evaluated, and depending on that critical assessment in terms of factor of safety and fracture propagation resistance is carried out for different geometric configurations. It is envisaged that this thesis has potential application in damage modeling and failure assessment of various elastomer matrix composite based products, especially silica filled green products.

Keywords: Elastomer matrix, Fracture, J-integral, CTOD, Geometry factor, FEA, HWR, NWR.