**A NEW NUMERICAL APPROACH TO PREDICT ENERGY ABSORPTION OF COMPOSITE STRUCTURES UNDER CRUSH**

Mehmet Engul1, Nuri Ersoy1-2

1Department of Mechanical Engineering, Bogazici University, Bebek, 34342, Istanbul, TURKEY

2Department of Engineering, Design, and Mathematics, University of West England, BS16 1QY, Bristol, UNITED KINGDOM

Emails: mehmet.engul@boun.edu.tr, nuri.ersoy@boun.edu.tr

**ABSTRACT**

Composites are being increasingly used in the industry because of their benefits over traditional metallic materials including their strength, weight, and reduction in manufacturing time. Along with these benefits, composites also have excellent performance related to energy absorption during impact and crash events. The fracture process in composite structures is quite complex which involves not only intralaminar failure modes, but also interlaminar failure. For crashworthiness simulation of large scale composite structures compromise modelling methods are needed that can balance accuracy and modelling efforts with acceptable computational (CPU) costs. Although advances in commercial Finite Element Analysis (FEA) software have enabled engineers to realistically simulate the performance of composite components, computational cost is still a significant issue for numeric studies.

This study proposes a new modelling approach to predict the energy absorption capability of composite structures under axial crush numerically with reasonable run times in commercial finite element analysis software, ABAQUS/Explicit. For effective predictions, in addition to intralaminar failure modes, Finite Element Model should also take interlaminar failure mechanisms into account. In this paper, Cohesive Zone Modelling (CZM) is adopted for delamination initiation and propagation. However, instead of applying interlaminar failure between all plies separately, delamination behaviour is adopted only to middle interface by formulation of new set of cohesive parameters.

For this purpose, in this study, AS4/8852 carbon epoxy flat and semicircle specimens are manufactured and tested under axial compression for validation of numerical results. To obtain interlaminar properties, Double Cantilever Beam (DCB) and End-Notched Flexure (ENF) tests are conducted. Starting from these parameters, new fracture toughness, interfacial strength and interface stiffness values are formulated depending on the number of plies (thickness). A methodology has been developed which requires reasonable run times with accurate energy absorption prediction.