Development of Deformation and Failure Model (MAT 224) in the LS-DYNA Finite Element Program

Amos Gilat
Department of Mechanical and Aerospace Engineering
The Ohio State University, Columbus, OH, USA

The presentation will review the development of the material model MAT 224 in the LS-DYNA finite element code which is a model for plastic deformation and failure of metals. The deformation part of the model is a tabulated version of the Johnson-Cook model and the failure is modeled by a fracture locus of equivalent strain at failure as a function of stress triaxiality and the Lode angle. The failure locus is determined by numerically simulating experiments with specimens loaded with different states of stress and comparing the calculated and measured loads and deformations. The model is used in the automobile and aerospace industries in simulations of crush and impact events. The parameters of the model have been determined for 2024-T351 aluminium by carrying out a large testing program. Over 300 tests have been conducted with specimens machined from a single 12.7 mm thick plate. The testing program includes uniaxial tension and pure shear tests at strain rates ranging from 10^{-4} to 3,000 s^{-1}. Compression tests at strain rates ranging from 10^{-4} to 11,000 s^{-1}. Uniaxial tension, compression, and pure shear tests at strain rate of 1 s^{-1} and various temperatures ranging from -50^{o}C to 450^{o}C. Uniaxial tension and compression tests with specimens machined in different orientations in the plate. Combined loading experiments in which fracture occurs under a combined state of stress. These tests include tension of notched flat and notched round specimens with different notch sizes. Plane strain experiments with smooth and notched specimens with different notch sizes. Biaxial tension-torsion and compression-torsion tests and static and dynamic punch tests. Digital Image Correlation (DIC) is used in all the tests for a direct measurement of the strain (full field) on the surface of the specimens. The model is performing well in modeling projectile impact experiments.