Awardee: **S. Kyriakides, Professor, ASE/EM**

Research Award Title: Propagating Instabilities in Structures and Materials

Research Summary

The award freed the PI from teaching and most administrative duties for a semester and allowed him to concentrate on the investigation of three problems outlined below, each with a strong numerical component. The PI acknowledges this award with thanks.

(a) Dynamic Buckle Propagation in Pipelines

The dynamic buckle propagation in offshore pipelines is a fundamental problem in which driven by the external pressure, the collapse of the pipe is influenced by inertia and by its interaction with the receding fluid. The structure develops self-contact, and large plastic deformations that are influenced by the rate-dependent properties of the solid. The physics of the problem is presently in good standing, but numerical simulations of the prevalent events has long been a challenge. In the course of this award, the PI has been able to pull together both experimental and numerical results that represent the state of the art in two chapters in a book on Buckle Propagation and Arrest [1]. Included are new numerical simulations of dynamic propagation, performed in the course of this award, that reproduce the flipping mode of buckle propagation illustrated in Fig. 1. These ground-breaking results will soon also appear in the archival literature.

(b) Multiaxial Crushing of Foams

The PI and his group have used experiment and modeling to demonstrate that under compression, deformation in low-density foams localizes into narrow bands of crushed cells. Crushing spreads at nearly constant stress with crushed and relatively undeformed foam coexisting. This behavior bestows to foams their unique energy absorption and impact mitigation characteristics. Using micromechanically accurate models of foams, and a custom true triaxial numerical crushing apparatus, they recently demonstrated that this partially unstable behavior occurs also under multiaxial loadings [2]. These unique results were used in the course of this award to develop a constitutive model for highly compressible materials with partially unstable regimes. The constitutive model has been used in large-scale finite element calculations to simulate the localization and propagation instabilities exhibited by foams under multiaxial crushing. Results from an example of such a simulation appear in Figs. 2 and 3.