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A comprehensive methodology for characterization of dry fabrics

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Abstract

The development of a robust and reliable material model for dry fabrics is the main subject of this paper. Dry fabrics are used in a number of applications such as propulsion engines fan-containment systems, and soft body armor. A mechanistic-based material behavior model capturing the behavior of fabrics when subjected to impacts from high velocity projectiles would make a powerful predictive tool. In this paper, the constitutive model for Kevlar 49 is developed. Experimental static and high strain rate tensile tests have been conducted at Arizona State University (ASU) to obtain the material properties of Kevlar fabric. Results from laboratory tests such as Tension Tests including high strain rate tests, Picture Frame Shear Tests, and Friction Tests yield most of the material properties needed to define a constitutive model. The material model is incorporated in the LS-DYNA commercial program as a user-defined subroutine. The validation of the model is carried out by numerically simulating actual ballistic tests conducted at NASA-GRC and fan blade out tests conducted at Honeywell Aerospace (Propulsion Engines).

Key words: *Dry fabric, Kevlar fabric, Honeywell aerospace, Propulsion engines fan*

1. Introduction

High strength woven fabrics are ideal candidate materials for use in structural systems where high energy absorption is required. Their high strength to weight ratio and the ability to resist high speed fragment impacts enable them to be very efficient compared to metals. One of the more widely used applications for woven fabrics is in propulsion engine containment systems. The engine containment system is typically constructed by wrapping multiple layers of Kevlar®49 around a thin aluminum encasement (Figure 1). The fabric is then covered with a protective layer.

Designing the containment system consists of determining the type of fabric, the number of fabric layers and fabric width required. Currently the FAA's certification standards require that a full-scale test be completed to qualify an engine. Because of the extensive pre and post-test analysis, and the fact that equipment is unusable

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