



# Thermo-mechanical properties of polymer matrix woven composites

Ö. Soykasap , Ş. Karakaya and M. Çolakoğlu

*Afyon Kocatepe University, Faculty of Technical Education, Department of Mechanics,  
Gazlıgöl Yolu, 03200, Afyonkarahisar, Turkey.*

## Abstract

This paper studies the thermo-mechanical properties of polymer matrix woven composites by numerical analytical and experimental techniques. E-glass/epoxy and carbon/epoxy plain weave composites with different lay-up are considered. In-plane and bending properties are obtained by finite element analysis and experimental techniques. Thermo-mechanical behavior of the plain woven laminates is investigated by tension, bending, and thermal expansion coefficient tests. It is found that the mechanical behavior of the woven composites is different from that of unidirectional laminates and the properties depend on the number of layers and ply lay-up.

**Key words:** *Textile composites, Mechanical properties, Finite element analysis*

## 1. Introduction

Polymer matrix woven composites are of current interest for mainly aerospace, automotive and marine structures due to several advantages such as symmetrical and balanced properties along with good ballistic properties over unidirectional composites. Although woven composites have been used and studied for decades, there are still some present works to better understand thermo-mechanical behavior and correct the previously estimated properties.

There have been many analytical and numerical approaches to estimate thermo-mechanical behavior based on micromechanics. On the one hand analytical approaches were used first simplistic and then more elaborate techniques to estimate the properties (Naik,

1994; Johnson *et al.*, 2002; Soykasap, 2008). On the other hand finite element approaches were used to estimate the properties more accurately (Page *et al.*, 2004; Kueh *et al.*, 2005; Soykasap, 2006; Soykasap, 2007). The studies aim at the estimation of homogenized properties and yield effective orthotropic properties so that already available theories like the classical lamination theory or some other formulas developed for unidirectional composites. In this way a structural response problem decouples into two problems: first determining the homogenized orthotropic properties of the woven material and then analyzing the composite structure for macro response.

Thermo-mechanical properties can also be obtained using standard and nonstandard coupon tests. Standard tests like tension, compression, shear, and bending are usually conducted to the woven materials with several layers, whereas some new test methods are developed for