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Plate Compression Analysis of Woven Spacer Fabrics ⋆

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Abstract

Diameter of spacer filament, thickness of spacer fabric, and warp threads per centimeter and weft threads per centimeter on plate compression of woven spacer fabric was studied by finite element method. Compression force and strain curves were acquired by ABAQUS software and compression indices were featured, including compression work, maximum compression force and compression index. Small relative errors of compression indices between experimental and theoretical results demonstrated that it was feasible to use finite element method to predict plate compression performance of spacer fabric. Woven spacer fabrics with different structure were designed and theoretical results showed that the thicker the spacer filament, the greater the three compression indices. Moreover, compression stress distribution of spacer fabrics indicated that stress of spacer filament was much larger than that of warp threads and weft threads of surface fabrics.

Keywords: Spacer Fabric; Plate Compression; Finite Element Analysis; Spacer Filament

1 Introduction

Woven spacer fabric is a kind of special sandwich structure, consisting of both two separate woven fabrics as an upper layer and a bottom layer and an inner layer linking the two layers. Spacer fabric is developed into a variety of special textile products, such as the preform of composite for light-weight and high strength by choosing carbon fiber, glass fiber and basalt fiber [1, 2]. Researchers established different structure of spacer filament to investigate mechanical properties of composite, which strongly influenced the mechanical properties of composites [3–7]. However, woven spacer fabric composites are stiff and unsuitable for comfortable cushion materials.

So, woven spacer fabric might also choose general synthetic fibers to make soft spacer fabrics. Currently, there are some work on spherical compression and relations between structure and compression property of knitted spacer fabrics [8–10]. Few investigation was focused on the compression performance of woven spacer fabrics. Actually, it depends on the specifications and

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performance of spacer filaments, including fabric density, thickness and fabric structure [11, 12]. Generally, compression force of woven spacer fabrics is very small, so woven spacer fabric that is lonely applied is rare. However, it could improve compression property by increasing density.

Therefore, the paper aims to discuss influence of structure of woven spacer fabric on plate compression property by finite element method. Plate compression force and strain curves were acquired by ABAQUS software and compression indices were featured so as to analyze effect of structure of spacer fabric on compression indices. Moreover, compression stress distribution of spacer fabrics were analyzed for spacer filament and warp threads and weft threads of surface fabrics. It is helpful to simulate plate compression performance of spacer fabrics and efficient to design structure models to simulate interaction between human body and spacer fabric in application.

2 Experimental Samples and Theoretical Design

Plate compression behaviour of woven spacer fabrics (A1, A2 and A3) with different thickness was analyzed. In order to have a comparative analysis, woven spacer fabrics (B, C, D, E and F) by varying structures, including thickness, filament diameters, and warp threads and weft threads per centimeter, were designed. Specifications of the spacer fabrics are listed in Table 1. Wherein, ratio of warp threads per centimeter refers to the ratio of the number of threads amongst warp threads of upper layer, warp threads of bottom layer and spacer filaments interweaving with weft threads in one unit length along weft direction, and ratio of weft threads per centimeter refers to the ratio of the number of weft threads interweaving with spacer filaments to that interweaving with warp threads of upper layer in one unit length along warp direction. For plate compression, a pair of circular plate with diameter 15 cm was used, and the compression speed was 12 mm/min. Samples were cut into circular shapes with diameter 10 cm. All compression tests were conducted within compression strain 0.6.

Table 1: Specifications of woven spacer fabrics

Samples	Indices			
	Ratio of warp threads per centimeter	Ratio of weft threads per centimeter	Thickness/mm	Diameter/mm
A1	7:7:2	3:8	5	0.2
A2	7:7:2	3:8	8	0.2
A3	7:7:2	3:8	10	0.2
B	7:7:2	3:8	10	0.4
C	3:3:2	3:8	5	0.2
D	5:5:2	3:8	5	0.2
E	7:7:2	5:11	5	0.2
F	2:2:1	3:8	5	0.2