POLYMER COMPOSITE BASED OF TEXTILES IN VARIOUS GEOMETRY

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Abstract

The development of textile composite materials and their design and manufacturing technologies is one of the most important advances in the materials engineering. Textile reinforced composites proved to be competitive materials due to certain advantages, in addition to their strength (given by the fiber/yarn structure) and unity and ability to transmit strains (ensured by the polymeric matrix). Wide choice of matrices and fibers give good opportunities to choose an appropriate combination for the given application. Since the composite material properties are anisotropic and inhomogeneous in nature, parameters that are controlling mechanical properties depend of the fiber reinforcement, generally of the fiber architecture, fiber properties, etc. In this paper a types of textile structure used as reinforcement in composite industry is presented. The main three fibers used in textile composite: glass, aramids and carbon are discussed. These fibers are usually used to weave 3D orthogonal woven composites' preforms.

Classifications of textile preforms

Textile preforms can be classified according to different criteria, such as the macro, method of production of the textiles, and the resulting structural micro geometry. The micro geometry should include directions of reinforcement, linearity of reinforcement in each direction, continuity of reinforcement, fiber packing density, fiber bundle size in each direction etc.

Various level of fiber structure for composite [Scardino]

Level	Reinforcement system	Textile construction	Fiber length	Fiber orientation	Fiber entanglement
I	**Discrete**	Chopped fiber	Discontinuous	Uncontrolled	None
II	**Linear**	Filament yarn	Continuous	Linear	None
III	**Laminar**	Simple fabric	Continuous	Planar	Planar
IV	**Integrated**	Advanced fabric	Continuous	3-D	3-D

Classification system by Khokar

	Loom	Fabric dimension	Architectural structure
1	**Conventional 2D loom**	2D fabrication	Orthogonal
2	**Conventional 2D loom**	2.5D fabrication	Conventionally woven
3	**Conventional 2D loom**	3D fabrication	Orthogonal with through the thickness, (multilayer)
4	**Conventional 2D loom**	3D fabrication	Non-woven
5	**Specialized 3D loom**	3D fabrication	Orthogonal
6	**Non -woven**	Non-interlaced 3D fabrication	Orthogonal

Types of textile reinforcements [Fukuta and al.]

Dimension	Axis				
	0 Non-axial	**1 Monoaxial**	**2 Biaxial**	**3 Triaxial**	**4 Multiaxial**
Unidimensional		Roving yarns			
Bidimensional	Chopped strand mats	Pre - impregnation sheet	Plain weave	Triaxial weave	Multiaxial weave, knit
Tridimensional (linear element		3D braiding	Multiple weave	Triaxial 3D weave	Multiaxial 3D weave
Tridimensional (plane element,		Laminates	H or I Beams	Honeycombs	

3D textile structures and weave architectures [Chen]

Structure	Architecture	Shape
Solid	Multilayer Orthogonal Angle Interlock	Compound structure, with regular or tapered geometry
Hollow	Multilayer	Uneven surfaces, even surfaces, and tunnels on different level in multi-directions
Shell	Single layer Multilayer	Multilayer Spherical shells and open box shells
Nodal	Multilayer Orthogonal Angle Interlock	Tubular nodes and solid nodes

A comparison among different production techniques of textile material

Parameter	Direction of yarn introduction	Fabric formation principle
Weaving	Two (0°/90°) (warp and weft)	Interlacing
Knitting	One (0°/90°) (warp or weft)	Interloping
Braiding	One (machine direction)	Intertwining (position displacement)
Nonwoven	Three or more (orthogonal)	Mutual fiber placement

Examples of hollow, shell and nodal structures

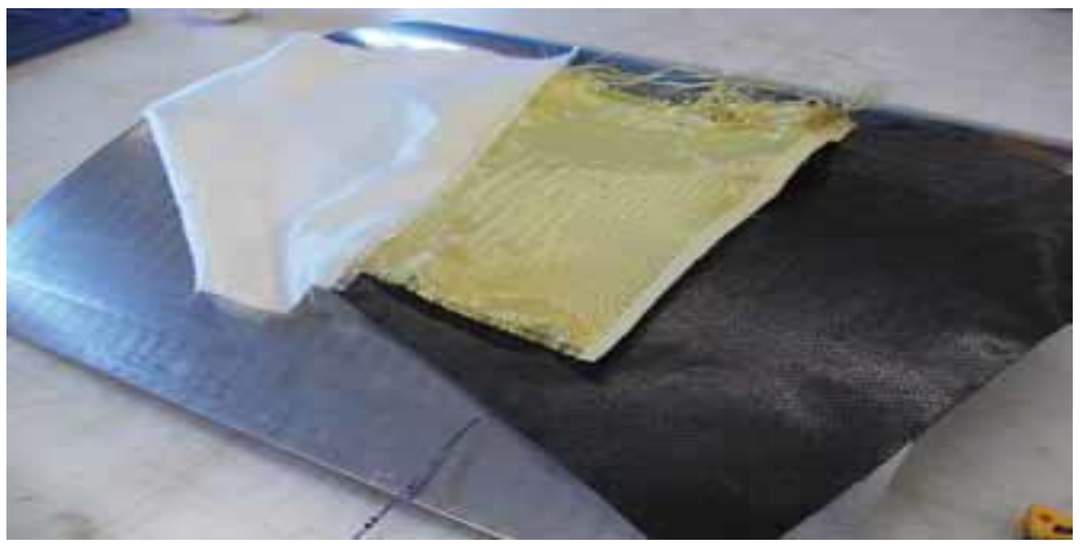
Fibers used for complex textile structures

Fibers to be utilized in composites should have specific properties:

- high modulus of elasticity,
- high ultimate strength,
- uniform cross section,
- low variation of properties between individual fibers, and
- the ability to withstand fabrication without significant property loss.

Main characteristics of fibers used in textile reinforcements

Fiber	Relative density (g/cm^3)	Young`s modulus (GPa)	Tensile strength (GPa)
Carbon	2.0	400	2.0-2.5
E-glass	2.5	70	1.5-2.0
S-glass	2.6	84	4.6
Kevlar 29	1.44	60	2.7
Kevlar 49	1.45	60	2.7



Fiberglass (left), Kevlar® (middle), and carbon fiber material (right)