Designation: D6507 – 19

Standard Practice for Fiber Reinforcement Orientation Codes for Composite Materials[1]

This standard is issued under the fixed designation D6507; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice establishes orientation codes for continuous-fiber-reinforced composite materials. Orientation codes are explicitly provided for two-dimensional laminates and braids. The laminate code may also be used for filament-wound materials. A method is included for presenting subscript information in computerized formats that do not permit subscript notation.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D3518/D3518M Test Method for In-Plane Shear Response of Polymer Matrix Composite Materials by Tensile Test of a ±45° Laminate

D3878 Terminology for Composite Materials

2.2 *Other Documents:*

CMH-17-2G, *Polymer Matrix Composites*, Volume 2 Materials Properties, Section 1.6.1[3]

ISO 1268-1 *Fibre-reinforced Plastics—Methods of Producing Test Plates—Part 1: General Conditions*, Annex Stacking Designation Systems[4]

3. Terminology

3.1 *Definitions*—Definitions in accordance with Terminology D3878 shall be used where applicable.

4. Significance and Use

4.1 The purpose of a laminate orientation code is to provide a simple, easily understood method of describing the lay-up of a laminate. The laminate orientation code is based largely on a combination of industry practice and the codes used in the *NASA/DOD Advanced Composites Design Guide*,[5] CMH-17-2G, and ISO 1268-1.

4.2 The braiding orientation code provides similar information for a two-dimensional braid, based largely on *Standard Test Methods for Textile Composites*.[6]

5. Reference Systems

5.1 A set of reference coordinate axes and associated reference plane and direction are selected before writing the orientation code.

5.1.1 The reference plane is selected as the bottom or top layer for the laminate orientation code. The orientation code is then determined by progressing through the laminate thickness. For a laminate symmetric about its midplane, the orientation code using the top layer as the reference plane is identical to the orientation code using the bottom layer as the reference plane.

5.1.2 The reference direction, from which ply orientation is measured, is somewhat arbitrarily selected for convenience and relevance to the application. Often, a dominant fiber direction, such as that aligned with the laminate principal axis, is defined to be 0°. An example in which relevance to testing determines the reference direction is the Test Method D3518/D3518M

[1] This practice is under the jurisdiction of ASTM Committee D30 on Composite Materials and is the direct responsibility of Subcommittee D30.01 on Editorial and Resource Standards.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, http://www.sae.org.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[5] NASA/DOD Advanced Composites Design Guide, Vol. 4, Section 4.0.5, Air Force Wright Aeronautical Laboratories, Day, OH, prepared by Rockwell International Corp., 1983 (distribution limited).

[6] Masters, J. E., and Portanova, M. A., *Standard Test Methods for Textile Composites*, NASA CR-4751, NASA Langley Research Center, 1996.

in-plane shear specimen configuration for which the loading direction is selected as 0°.

5.2 This set of reference coordinate axes and associated reference plane and direction can be defined locally for a general three-dimensional part. These can change location and overall orientation in three-dimensional space, with the origin of the reference coordinate axes moving along the part being described based on the three-dimensional geometry of that part.

5.2.1 In such cases, local in-plane reference axes are often defined based on tangents to the local part, and are thereby dependent upon the varying curvature of the part. Thus, the reference direction (0°) is defined locally and changes along the part. The local third reference axis generally runs through the local thickness of the part, with its direction defined by orthogonality to the two local in-plane references axes, in order to complete the local set of right-handed Cartesian coordinate axes. This results in the local third reference axis being normal to the part when the local in-plane reference axes are based on the tangents to the local part.

5.2.2 Similarly, a set of global reference axes are usually defined, and the local location and orientation of the part and the associated local reference coordinate axes are defined via a transformation between the global and local sets of axes.

5.2.3 An example of such local and global reference axes for a three-dimensional part is shown in Fig. 1. The local in-plane reference axes, x and y, are defined at each local location of the origin, with three shown at points A, B, and C, based on tangents to the surface of the part at the location. These two local in-plane axes are orthogonal. The third local axis, z, generally runs locally through the thickness with its direction defined by orthogonality to the local in-plane axes. In this case, the local reference direction (0°) is defined relative to the local x-axis.

5.2.4 Specific examples of such are parts constructed via filament winding. For such cases, the 0° direction is usually the winding axis of symmetry and the in-plane axes of the local reference coordinate axes are usually based on the tool surface.

5.2.5 The global reference axes do not need to be Cartesian, but can be defined based on the needs for description of the structural configuration and associated details of the part. One example is the use of cylindrical axes. Generally, the global reference axes should be consistent for the design definition, overall analysis, and manufacturing/inspection.

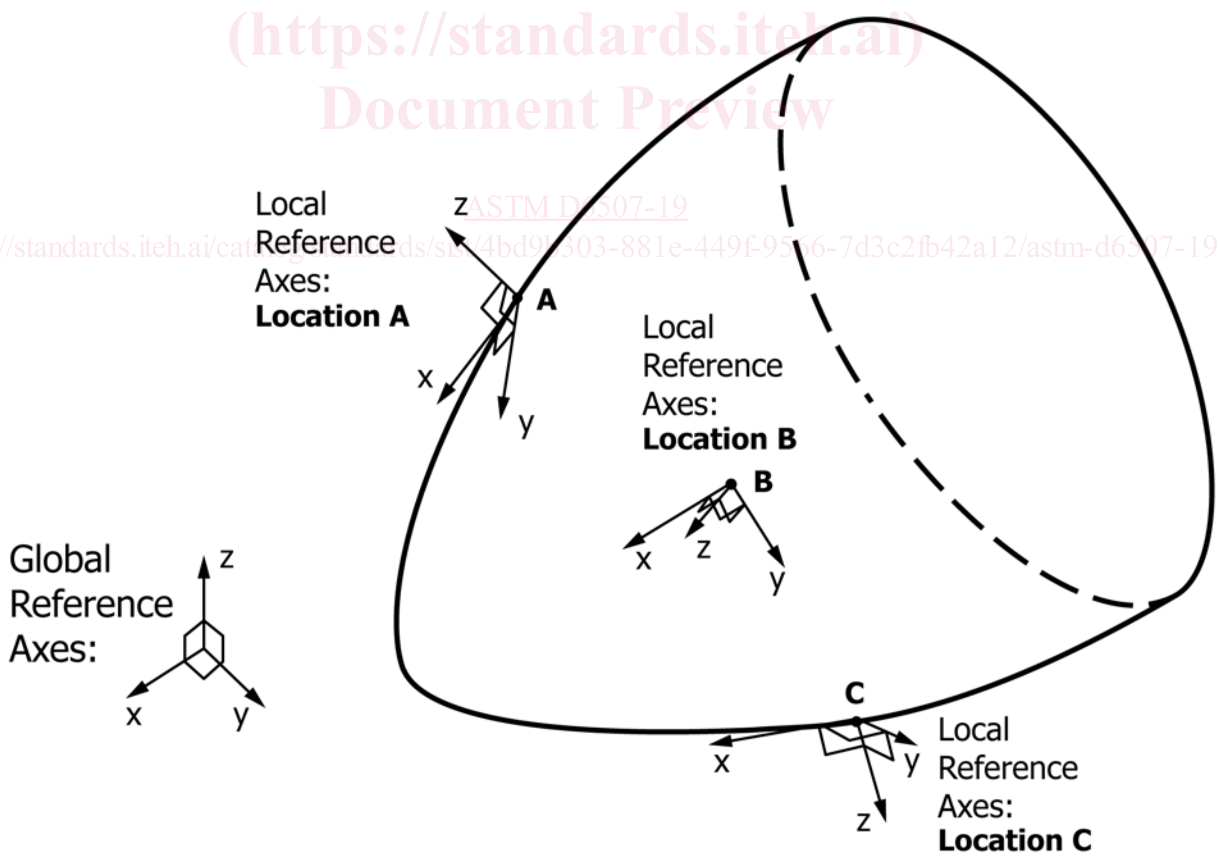

FIG. 1 Illustration of Possible Global and Local Reference Coordinate Axes for a Three-Dimensional Part