This document is not an ASTM standard and is intended only to provide the user of an ASTM standard an indication of what changes have been made to the previous version. Because it may not be technically possible to adequately depict all changes accurately, ASTM recommends that users consult prior editions as appropriate. In all cases only the current version of the standard as published by ASTM is to be considered the official document.

Designation: ~~D5687/D5687M – 95 (Reapproved 2007)~~ D5687/D5687M – 95 (Reapproved 2015)

Standard Guide for Preparation of Flat Composite Panels with Processing Guidelines for Specimen Preparation[1]

This standard is issued under the fixed designation D5687/D5687M; 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 guide provides guidelines to facilitate the proper preparation of laminates and test specimens from fiber-reinforced organic matrix composite prepregs. The scope is limited to organic matrices and fiber reinforcement in unidirectional (tape) or orthagonal weave patterns. Other forms may require deviations from these general guidelines. Other processing techniques for test coupon preparation, for example, pultrusion, filament winding and resin-transfer molding, are not addressed.

1.2 Specimen preparation is modeled as an 8-step process that is presented in Fig. 1 and Section 8. Laminate consolidation techniques are assumed to be by press or autoclave. This practice assumes that the materials are properly handled by the test facility to meet the requirements specified by the material supplier(s) or specification, or both. Identification and information gathering guidelines are modeled after Guide E1309. Test specimens shall be directly traceable to material used as designated in Guide E1434. Proper test specimen identification also includes designation of process equipment, process steps, and any irregularities identified during processing.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. Within the text the inch-pound units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

1.4 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C297/C297M Test Method for Flatwise Tensile Strength of Sandwich Constructions
D123 Terminology Relating to Textiles
D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
D883 Terminology Relating to Plastics
D2734 Test Methods for Void Content of Reinforced Plastics
D3163 Test Method for Determining Strength of Adhesively Bonded Rigid Plastic Lap-Shear Joints in Shear by Tension Loading
D3171 Test Methods for Constituent Content of Composite Materials
D3531 Test Method for Resin Flow of Carbon Fiber-Epoxy Prepreg
D3878 Terminology for Composite Materials
D3990 Terminology Relating to Fabric Defects
D4850 Terminology Relating to Fabrics and Fabric Test Methods
D5229/D5229M Test Method for Moisture Absorption Properties and Equilibrium Conditioning of Polymer Matrix Composite Materials
E1237 Guide for Installing Bonded Resistance Strain Gages

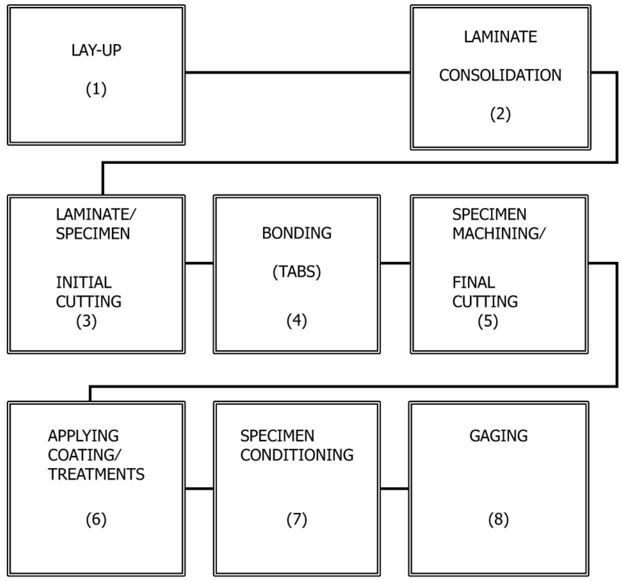
iTeh Standards (https://standards.iteh.ai) Document Preview
ASTM D5687/D5687M-95(2015)
https://standards.iteh.ai/catalog/standards/...8bd3f64/astm-d5687-d5687m-952015

[1] This guide is under the jurisdiction of ASTM Committee D30 on Composite Materials and is the direct responsibility of Subcommittee D30.04 on Lamina and Laminate Test Methods.

Current edition approved ~~May 1, 2007~~Nov. 1, 2015. Published ~~June 2007~~December 2015. Originally approved in 1995. Last previous edition approved in ~~2002~~2007 as D5687/D5687M - 95~~(2002).~~(2007). DOI: ~~10.1520/D5687_D5687M-95R07.~~10.1520/D5687_D5687M-95R15.

[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.

Copyright © ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959. United States



NOTE 1—Material identification is mandatory. Continuous traceability of specimens is required throughout the process.

Process checks (Appendix X4) may be done at the end of each step to verify that the step was performed to give a laminate or specimen of satisfactory quality.

Steps 4 and 5 may be interchanged. For aramid fibers, step 5 routinely precedes step 4.

Steps 6, 7 and 8 may be interchanged.

FIG. 1 8 Step Mechanical Test Data Model

iTeh Standards

E1309 Guide for Identification of Fiber-Reinforced Polymer-Matrix Composite Materials in Databases (Withdrawn 2015)[3]
E1434 Guide for Recording Mechanical Test Data of Fiber-Reinforced Composite Materials in Databases (Withdrawn 2015)[3]

Document Preview

3. Terminology

3.1 *Definitions*—Terminology D3878 defines terms relating to high-modulus fibers and their composites. Terminology D883 defines terms relating to plastics. Terminology D123 defines textile related terms. Terminology D4850 defines terms relating to fabric. In the event of a conflict between terms, Terminology D3878 shall have precedence over the other standards.

3.2 *Description of Trems Used in This Standard*—The terms used in this guide may conflict with general usage. There is not yet an established consensus concerning the use of these terms. The following descriptions are intended only for use in this guide.

3.2.1 *bag, v*—the process of enclosing the ply layers within a flexible container. See *lay-up.*

3.2.2 *base plate, n*—a flat plate on which a laminate is laid up [usually made of aluminum and 6 mm [0.25 in.] or thicker with a flatness requirement of 0.05 mm [0.002 in.] or less].

3.2.3 *breather string, n*—a glass string connected from the laminate to a breather in the autoclave bag. It is used as a degassing aid; providing a path for gasses to be transferred from the laminate.

3.2.4 *caul plate, n*—a flat plate used to provide a flat surface to the top of the laminate during laminate consolidation [usually made of aluminum and 3 mm [0.125 in.] thick or thicker with a flatness requirement of 0.05 mm [0.002 in.] or less].

3.2.5 *cloth, n*—a piece of textile fabric containing woven reinforcement without a load transferring matrix.

3.2.6 *dam, n*—a solid material (such as silicone rubber, steel or aluminum) used in the autoclave bag to contain the matrix material within defined boundaries during laminate consolidation.

3.2.7 *debulk, v*—process of decreasing voids between lamina before laminate consolidation through use of vacuum or by mechanical means. Laminae can be debulked at ambient or elevated temperatures.

3.2.8 *doubler, n*—an unbonded tab used to hold the laminate specimen in a grip or fixture. See *tab*.

3.2.9 *fiber washing, n*—the tendency of fibers to change orientation due to resin flow from the original lay-up direction. Fiber washing may occur during the laminate consolidation process mainly at the sides of a laminate.

3.2.10 *fill, n*—(*1*) Fiber inserted by the shuttle during weaving also designated as filling. See Terminology D123. (*2*) The direction of fiber running perpendicular to the warp fibers.

[3] The last approved version of this historical standard is referenced on www.astm.org.

3.2.11 *flip/flop, v*—the process of alternating plies through an angle orientation of 180° during laminate lay-up. This practice is commonly used if material of the same width as the laminate has a reoccurring flaw. The process changes the location of the flaw so that it does not unduly affect the laminate structure.

3.2.12 *flaw, n*—a material defect, typically occurring in the discrete fiber reinforcement, but possible in the matrix.

3.2.13 *flow, n*—the movement of uncured matrix under pressure during laminate consolidation.

3.2.14 *harness, n*—a weaving designation of how many fill fibers a warp float crosses in a satin weave. Typical weaves are 5-Harness and 8-Harness.

3.2.15 *joint, n*—a location where two edges of prepreg meet. Two common types of joints used in lay-up are a butt joint (where 2 plies are aligned edge to edge) and an overlap joint (where the edge of each ply is overlapped some specified width with another ply).

3.2.16 *lay-up, n*—the finished product of ply stacking and bagging operations.

3.2.17 *matrix, n*—the continuous constituent of a composite material.

3.2.18 *mold, n*—the support structure that holds the laminate or lay-up during the laminate consolidation process.

3.2.19 *non-perforated TFE, n*—a non-porous tetrafluoroethylene film.

3.2.20 *panel, n*—a uniformly contoured composite laminate, typically flat.

3.2.21 *peel ply, n*—a cloth with release capabilities. Usually used in conjunction with laminates requiring secondary bonding.

3.2.22 *perforated TFE, n*—a porous tetrafluoroethylene film used in the bagging process that allows gasses or excess matrix materials to escape from a laminate during laminate consolidation, while protecting the laminate from physical bonding to other items such as base plates or caul plates.

3.2.23 *ply, n*—a single layer of prepreg used in lay-up.

3.2.24 *press, n*—equipment consisting of heated, flat [usually within a tolerance of 0.3 mm [0.01 in.] or less] platens that supply pressure against a surface.

iTeh Standards
(https://standards.iteh.ai)
Document Preview

3.2.25 *satin, adj*—a weave pattern in which warp floats pass over several yarns before crossing under a single yarn. It is characterized by parallel fibers and no diagonal pattern.

3.2.26 *sealant, n*—a high temperature material used to seal the edges of a vacuum bag to the base plate during a consolidation or debulking cycle.

3.2.27 *staggered, adj*—the description of ply placement where the joints are not positioned in the same inplane location through some specified thickness of the laminate.

ASTM D5687/D5687M-95(2015)

3.2.28 *tab, n*—a piece of material used to hold the laminate specimen in a grip or fixture for testing so that the laminate is not damaged, and is adequately supported. It is bonded to the specimen. An unbonded tab is termed a doubler.

3.2.29 *TFE coated cloth, n*—a cloth coated with a tetrafluoroethylene coating. This is used in the bagging process to allow gases or excess matrix material to escape during the laminate consolidation. It differs from perforated TFE in that it gives a textured surface to the laminate.

3.2.30 *traveler, n*—a coupon with the same nominal thickness and width as the test specimen, made of the same material and processed similarly to the specimen except usually without tabs or gages. The traveler is used to measure mass changes during environmental conditioning when it is impractical to measure these changes on the actual specimen.

3.2.31 *vacuum bag, n*—a low gas permeable material used to enclose and seal the laminate during a consolidation or debulking cycle.

3.2.32 *vacuum couple, n*—the mechanical connection that seals the vacuum source to the lay-up during a consolidation or debulking cycle.

3.2.33 *warp surface, n*—the ply surface which shows the larger area of warp tows with respect to filling tows. Fabrics where both surfaces show an equal area of warp tows with respect to filling tows do not have a warp surface.

3.2.34 *warp nested, n*—warp plies alternated in the pattern warp surface up, warp surface down.

4. Summary of Guide

4.1 This guide describes the general process flow for preparation of flat composite panels and provides specific recommended techniques that are generally suitable to laminated fibrous organic polymer matrix composites for each of the process steps to test specimen fabrication.

4.2 The specific techniques included in this guide are the minimum recommended for common composite material systems as represented in the scope of this guide. For a given application other techniques may need to be added or substituted for those described by this guide.

5. Significance and Use

5.1 The techniques described in this guide, if properly used in conjunction with a knowledge of behavior of particular material systems, will aid in the proper preparation of consolidated laminates for mechanical property testing.

5.2 The techniques described are recommended to facilitate the consistent production of satisfactory test specimens by minimizing uncontrolled processing variance during specimen fabrication.

5.3 Steps 3 through 8 of the 8-step process may not be required for particular specimen or test types. If the specimen or test does not require a given step in the process of specimen fabrication, that particular step may be skipped.

5.4 A test specimen represents a simplification of the structural part. The test specimen's value lies in the ability of several sites to be able to test the specimen using standard techniques. Test data may not show identical properties to those obtained in a large structure, but a correlation can be made between test results and part performance. This may be due, in part, to the difficulty of creating a processing environment for test specimens that identically duplicates that of larger scale processes.

5.5 Tolerances are guidelines based on current lab practices. This guide does not attempt to give detailed instructions due to the variety of possible panels and specimens that could be made. The tolerances should be used as a starting reference from which refinements can be made.

6. Interferences

6.1 Specimen preparation practices should reflect those used on an applicable part, to the greatest extent practical. However, due to scaling effects, processing requirements for test laminates may not exactly duplicate the processes used in larger scale components. The user should attempt to understand and control those critical process parameters that may produce a difference in material response between the test coupon and the structure. Critical process parameters are material, application, and process dependent and are beyond the scope of this guide.

6.2 Laminate quality is directly related to the prevention of contamination during lay-up and processing.

iTeh Standards
(https://standards.iteh.ai)
Document Preview
ASTM D5687/D5687M-95(2015)

7. Apparatus and Materials

NOTE 1—This section provides a listing of apparatus and material items that have been shown to be acceptable. The list is not meant to be all inclusive, but may be helpful to novice users.

7.1 *Equipment:*

7.1.1 *Lay-up Environment/Tools:*

7.1.1.1 *Tables*—Tables should be 1 m [3 ft] in height (or adjustable tables) with ample area for lay-up. The table should be accessible from all sides. The table surface should have a fully supported metal or wood undersurface. The table surface should be of (*1*) safety glass with edges protected by aluminum angle plate or (*2*) A toughened transparent plastic sheet.

7.1.1.2 *Convenient accessibility of lay-up materials*—Wall racks hold bulk cloth, TFE, and other expendable bagging materials. These racks typically consist of a steel rod which can hold a roll of material. The rods should be able to accommodate material rolls up to 1.5 m [60 in.] wide. The spacing between racks should be a minimum of 0.4 m [15 in.] spacing between rods with the bottom rod being no closer than 0.6 m [25 in.] to the floor and the top rod being no higher than 2.2 m [85 in.] from the floor. Cabinets and drawers hold other lay-up materials such as sealants, spare tape, vacuum couples, hoses, caul plates, thermocouple wire, and so forth. These should be compartmentalized for easy access.

7.1.1.3 *Vacuum Supply*—Overhead piping for vacuum with a flexible hose reel over the table has been found to be satisfactory. The vacuum pump should be located within 45 m [150 ft] of the lay-up site.

7.1.1.4 *Cleanliness and Airborne particulates*—Controlling dust in air, on surfaces and other contamination (such as from skin or material contact) should be a priority. Adequate particulate air filters, gloves, floor sweeping compound, and wiping cloths should be present to help minimize contamination.

7.1.2 *Tool Plate*—Plates of aluminum or steel have been found to be satisfactory. The plate should have a minimum thickness of 6 mm [0.25 in.] [base plate] or 3 mm [0.125 in.] thick [caul plate] with a flatness tolerance of 0.05 mm [0.002 in.]. The surface should be coated with a mold release, except around the edges where sealant is to be applied.

7.1.3 *Cutting Apparatus*—A cutting apparatus may range from a simple retractable knife blade to die or ultrasonic or laser devices. Whenever there is a cutting surface, this must be evaluated for wear. If the blade cuts without pulling the material the blade is adequately sharp and need not be changed.

7.1.4 *Vacuum Source*—The vacuum capacity at the lay-up site shall be at least 75 kPa [22 in. Hg] with a drop of no more than 3.5 kPa [1 in. Hg] in 5 min. Pump requirements are dependent on autoclave size and distance of pump from the lay-up. Standard oil type pumps have proven satisfactory.

7.1.5 *Debulking:*

7.1.5.1 *Bag*—Two types have been shown to be satisfactory: (*1*) commercially available rubber bag with a vacuum source or (*2*) an internally built bag made from a tool plate, vacuum coupling and vacuum bag materials.

7.1.5.2 A wooden or hard plastic roller or spatula may be used for mechanical debulking.

7.1.6 *Vacuum Ports*—Hose couplings that provide a flat surface against the breather material are preferred. The port is connected to the hose through quick connect couplings. The hose is a braid reinforced hose. Both hose and coupling must be able to withstand consolidation temperature and pressure.

7.2 *Lay-up Expendables:*

7.2.1 Bagging films are placed over the lay-up and sealed to the base plate with sealant.

7.2.1.1 For cures up to 200°C [400°F], use a 0.06 mm [0.002 in.] thick Nylon 6 film sold for vacuum applications.

7.2.1.2 For cures up to 230°C [450°F], use a 0.06 mm [0.002 in.] thick high temperature Nylon 66 film sold for vacuum applications.

7.2.1.3 For cures from 230°C to 425°C [450°F–800°F], specific bagging materials are temperature and application dependent.

NOTE 2—Most other lay-up materials (specifically sealant, bleeders, peel ply, vacuum couplings, hoses, thermocouples) may also need modification at higher temperatures. Some other items such as bleeders and breathers have no high temperature equivalent. Suppliers should be consulted for specific applications above 230°C [450°F].

7.2.2 Release cloths allow the laminate to be separated from other cloth materials.

7.2.2.1 *Peel Plies*—Several types of peel ply are commercially available. Release properties and shrinkage vary with both fiber and style. Nylon and polycarbonate are two common fibers used. Aramid may be used for higher temperature applications above 230°C [450°F]. Peel plies are generally used when secondary bonding is required.

7.2.2.2 *TFE coated release cloth*—Generally weaves that have significant air spacing are preferred. These are used to separate the laminate from bleeders.

7.2.3 *Non-porous TFE Film*—used as a release to separate ply stack from tool or caul plate.

7.2.4 *Breather*—Cloth which allows even gas flow over the lay-up surface. The breather also helps minimize bag puncture by metal plates. Use (*1*) batted material type 10 or (*2*) 1581 style glass cloth.

7.2.5 *Bleeder*—Cloth that allows matrix to flow into it. Use (*1*) 120 style glass cloth with finish or (*2*) CW1850 style mat.

7.2.6 *Thermocouples* allow for temperature monitoring:

7.2.6.1 Use type J, 24 gage thermocouple wire to 370°C [700°F]. Lower gage wire or same gage type K can be used for higher temperatures.

7.2.6.2 Use gold plated thermocouple 2 pole connectors.

7.2.7 *Dams*—May be silicone rubber or cork. These can be different thicknesses depending on the panel thickness [3 mm [0.125 in.], 4.5 mm [0.188 in.], or 6 mm [0.25 in.] thick]. The dam thickness should slightly exceed panel thickness. The dams are typically 25 mm [1 in.] wide with adhesive on one side.

iTeh Standards (https://standards.iteh.ai) Document Preview

NOTE 3—Dams and peel plies may have chemicals that could influence secondary bonding operations. There are various materials. Find a material that is suitable for the particular operation.

ASTM D5687/D5687M-95(2015)

NOTE 4—Silicone rubber dams may be used to 280°C [545°F] due to limitations of adhesive backing. Moldable sealants may be used at higher temperatures.

https://standards.iteh.ai/catalog/standards/sist/df34c44e-925a-4665-b0ab-d043a8bd3f64/astm-d5687-d5687m-952015

7.2.8 *Moldable sealant,* capable of providing an adequate vacuum seal when placed between the base plate and the vacuum film. Several types are available for different temperature applications.

7.2.9 *Tape:*

7.2.9.1 For use in lay-up, tape with adhesive on one side. The tape remains in surface contact with a plate or dam under temperature and pressure, typically 25 or 50 mm [1 or 2 in.] wide. The tape must be able to withstand heat generated in consolidation.

7.2.9.2 Used as an aid during ply stacking, adhesive on both sides, typically 25 mm [1 in.] wide.

7.3 *Test Material*—The test material (prepreg) should be free of contaminants. It may be unrolled from a rack. Under no conditions should it be folded on itself. Taped ends should be removed before the material is plied.

7.4 *Consolidation Equipment:*

7.4.1 *Press*—A variety of hydraulic and air driven presses are available. Generally a hydraulic press with platen support posts is preferred. Cooling water is generally a requirement. A press that can ramp through a programmed cycle for both temperature and pressure control/monitoring is recommended. The press must be large enough to hold the lay-up and provide satisfactory pressure to the lay-up area. Press platens should have a flatness of 0.3 mm [0.01 in.]. A facility may determine press flatness with the press platens open or at minimal contact.

7.4.2 *Autoclave*—Capable of holding lay-up. Provides adequate control and monitoring of consolidation cycle including pressure application and temperature and vacuum if required.

7.4.3 *Oven*—Capable of holding lay-up and providing adequate vacuum and temperature control and monitoring.

7.5 *Machining Equipment*—Machining equipment is described in Table X3.1.

7.6 *Secondary Bonding:*

7.6.1 *Release Cloth*—Peel plies (Section 7.2.2) are recommended.

7.6.2 *Adhesives*—Obtain an adhesive suitable for the particular test requirements (for example do not use an adhesive with low shear strength if significant shear loads will be placed on the bond) and temperature and humidity conditions. Follow manufacturer's recommended use and cure conditions.

7.6.3 *Tooling*—Tools set gage length and tab position. Tools are typically steel or aluminum and coated with a mold release. Usually tab and gage distance are set either by spring loading the fixture or by set pins or spacers.

7.7 *Strain Gaging:*

7.7.1 *Soldering iron,* capable of heating solder to its melting point.

7.7.2 *Solder/Flux,* as recommended by the strain gage manufacturer based on gage and wire.

7.7.3 *Wire,* as recommended by strain gage or test machine manufacturer.

7.7.4 *Surface preparation:*

7.7.4.1 220 grit sandpaper is used to lightly abrade the surface.

7.7.4.2 The surface is cleaned with isopropanol or other chemical that does not attack the laminate and leaves a minimum of residue.

7.7.5 Strain gage selection is dependent on the material type, lay-up, specimen and test constraints. Section II of the *Manual on Experimental Methods for Mechanical Testing of Composites*[4] gives additional information for the strain gage selection.

7.7.6 Strain gage adhesive can be recommended by the gage manufacturer based on the specific environmental/test conditions.

7.7.7 Strain gage coatings may be recommended by the gage manufacturer based on the specific environmental conditions.

7.8 *Conditioning:*

7.8.1 A chamber contains humidity and temperature control and monitoring capability. The chamber must be capable of holding specimens and monitoring environment within the chamber.

7.8.2 Coatings for specimen protection depend on specific environmental or test condition.

8. Procedure

8.1 *Laminate Lay-up:*

8.1.1 Terminology and designation systems found in Terminologies D3878, D123, D883, D4850, D3990 and Guide E1309 are used in this document so that terminology and designation systems will be the same between test facilities. Ply orientation designations that determine laminate stacking are described in Appendix X1.

8.1.2 The area in which the lay-up is to be performed should be a clean area. Clean room definitions allow no more than a concentration of 35 000 particles greater than 5 µm in diameter per cubic meter (1000 particles greater than 200 µin. diameter per cubic foot). Clean room definitions may be too restrictive for some working environments. However, care should be taken that the area approaches clean room conditions, being visually free of dust. Work surfaces must be likewise free of residue dust or debris. Any agglomeration of contaminant on the panel during lay-up should be avoided. These conditions should be verified before commencing work. Care should be taken to minimize contamination while handling plies (hand oils, lotions, talc in gloves, fabric softener are some materials that have been shown to contaminate material).

iTeh Standards (https://standards.iteh.ai) Document Preview
https://standards.iteh.ai/catalog/standards/sist/...-d043a8bd3f64/astm-d5687-d5687m-952015

8.1.3 *Laminate Dimensional Considerations*—More than one laminate will at times need to be made for the desired number of specimens. Since lay-up does play a role in specimen quality, the ideal situation is to make all specimens from the same laminate. Randomize specimens within the laminate if possible. If more than one laminate is used, randomize specimens between laminates.

8.1.3.1 The size of the laminate should be determined based on the size and number of specimens required. Additional area should be provided to make up for discarded or destroyed material. It is recommended that at least 15 mm [0.5 in.] from the laminate edges be discarded due to nonrepresentative matrix/fiber ratio or thickness taper. Typically, cutting destroys some material [1–2 mm [.03–.08 in.] or more] with each pass. This discarded or destroyed material should be considered when determining panel surface area.

8.1.3.2 The limitations of the lay-up tooling (base plates, caul plates) or consolidation apparatus (autoclave, oven, press) should be considered when determining laminate size.

8.1.4 *Lay-up materials and tooling:*

8.1.4.1 *Plate or mold flatness/surface preparation*—The mold or base plate should be flat [no more than 0.05 mm [0.002 in.] deviation in any square meter (in.^{2})]. Caul plates should show similar flatness. Interior of molds and the bottom surface of the caul plate shall be coated with a mold release or lined with nonperforated TFE film. Base plates shall be coated with a mold release or lined with a nonperforated TFE film except where sealant is to be applied. The surfaces in contact with the laminate should have a minimum average surface roughness of 0.8 µm [32 µin.] and preferably 0.4 µm [16 µin.]. Cutting operations shall not be performed on mold or base plates.

8.1.4.2 *Tool size*—The base plate should be large enough to encompass the laminates, and any other material to be placed on the baseplate such as dams, sealant and vacuum ports (ideally vacuum ports should not be placed over the laminate).

8.1.5 *The ply layer (1st ply and single ply considerations):*

8.1.5.1 Check the material consistency. Inclusion of material flaws such as fiber breaks, drags or pulls will affect specimen properties.

[4] *Manual on Experimental Methods for Mechanical Testing of Composites*, Edited by Richard L. Pendleton, Mark E. Tuttle, Society of Experimental Mechanics.