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.

Designation: D7248/D7248M − 21

Standard Test Method for High Bearing - Low Bypass Interaction Response of Polymer Matrix Composite Laminates Using 2-Fastener Specimens[1]

This standard is issued under the fixed designation D7248/D7248M; 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 test method determines the uniaxial bearing/bypass interaction response of multi-directional polymer matrix composite laminates reinforced by high-modulus fibers by either double-shear tensile loading (Procedure A) or single-shear tensile or compressive loading (Procedure B) of a two-fastener specimen. The scope of this test method is limited to net section (bypass) failure modes. Standard specimen configurations using fixed values of test parameters are described for each procedure. A number of test parameters may be varied within the scope of the standard, provided that the parameters are fully documented in the test report. The composite material forms are limited to continuous-fiber or discontinuous-fiber (tape or fabric, or both) reinforced composites for which the laminate is balanced and symmetric with respect to the test direction. The range of acceptable test laminates and thicknesses are described in 8.2.1. Test methods for high bypass - low bearing response of polymer matrix composite materials, previously published under Procedure C of this test method, are now published in Test Method D8387/D8387M.

1.2 This test method is consistent with the recommendations of Composite Materials Handbook, CMH-17, which describes the desirable attributes of a bearing/bypass interaction response test method.

1.3 The two-fastener test configurations described in this test method are similar to those in Test Method D5961/D5961M as well as those used by industry to investigate the bearing portion of the bearing/bypass interaction response for bolted joints, where the specimen may produce either a bearing failure mode or a bypass failure mode. Should the test specimen fail in a bearing failure mode rather than the desired bypass mode, then the test should be considered to be a bearing dominated bearing/bypass test, and the data reduction and reporting procedures of Test Method D5961/D5961M should be used instead of those given in this test method.

1.4 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.4.1 Within the text, the inch-pound units are shown in brackets.

1.5 *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.*

1.6 *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.*

iTeh Standards (https://standards.iteh.ai) Document Preview
ASTM D7248/D7248M-21
https://standards.iteh.ai/catalog/standards/sist/532659ba-6e17-4da8-92f6-5146f5...0d/astm-d7248-d7248m-21

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
D883 Terminology Relating to Plastics
D2584 Test Method for Ignition Loss of Cured Reinforced Resins
D2734 Test Methods for Void Content of Reinforced Plastics
D3171 Test Methods for Constituent Content of Composite Materials
D3878 Terminology for Composite Materials
D5229/D5229M Test Method for Moisture Absorption Properties and Equilibrium Conditioning of Polymer Matrix Composite Materials

[1] This test method is under the jurisdiction of ASTM Committee D30 on Composite Materials and is the direct responsibility of Subcommittee D30.05 on Structural Test Methods.

Current edition approved May 15, 2021. Published June 2021. Originally approved in 2007. Last previous edition approved in 2017 as D7248/D7248M – 12(2017). DOI: 10.1520/D7248_D7248M-21.

[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

D5687/D5687M Guide for Preparation of Flat Composite Panels with Processing Guidelines for Specimen Preparation

D5766/D5766M Test Method for Open-Hole Tensile Strength of Polymer Matrix Composite Laminates

D5961/D5961M Test Method for Bearing Response of Polymer Matrix Composite Laminates

D6484/D6484M Test Method for Open-Hole Compressive Strength of Polymer Matrix Composite Laminates

D6742/D6742M Practice for Filled-Hole Tension and Compression Testing of Polymer Matrix Composite Laminates

D8387/D8387M Test Method for High Bypass – Low Bearing Interaction Response of Polymer Matrix Composite Laminates

E4 Practices for Force Verification of Testing Machines

E6 Terminology Relating to Methods of Mechanical Testing

E83 Practice for Verification and Classification of Extensometer Systems

E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E251 Test Methods for Performance Characteristics of Metallic Bonded Resistance Strain Gages

E456 Terminology Relating to Quality and Statistics

E1237 Guide for Installing Bonded Resistance Strain Gages

2.2 *Other Document:*[3]

Composite Materials Handbook, CMH-17 Polymer Matrix Composites, Volume 1, Chapter 7

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 E6 defines terms relating to mechanical testing. Terminology E456 and Practice E177 define terms relating to statistics. In the event of a conflict between terms, Terminology D3878 shall have precedence over the other documents.

NOTE 1—If the term represents a physical quantity, its analytical dimensions are stated immediately following the term (or letter symbol) in fundamental dimension form, using the following ASTM standard symbology for fundamental dimensions, shown within square brackets: [*M*] for mass, [*L*] for length, [*T*] for time, [θ] for thermodynamic temperature, and [*nd*] for non-dimensional quantities. Use of these symbols is restricted to analytical dimensions when used with square brackets, as the symbols may have other definitions when used without the brackets.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *bearing area,* $[L^2]$, *n*—the area of that portion of a specimen used to normalize applied loading into an effective bearing stress; equal to the diameter of the fastener multiplied by the thickness of the specimen.

3.2.2 *bearing chord stiffness,* E^{br} $[ML^{-1}T^{-2}]$, *n*—the chord stiffness between two specific bearing stress or bearing strain points in the linear portion of the bearing stress/bearing strain curve.

3.2.3 *bearing force, P* $[MLT^{-2}]$, *n*—the in-plane force transmitted by a fastener to a specimen at the fastener hole.

3.2.4 *bearing strain,* ε^{br} [*nd*], *n*—the normalized hole deformation in a specimen, equal to the deformation of the bearing hole in the direction of the bearing force, divided by the diameter of the hole.

3.2.5 *bearing strength,* $F_x^{br\_byp}$ $[ML^{-1}T^{-2}]$, *n*—the value of bearing stress occurring at the point of bypass (net section) failure.

3.2.6 *bearing stress,* σ^{br} $[ML^{-1}T^{-2}]$, *n*—the bearing force divided by the bearing area.

3.2.7 *diameter to thickness ratio, D/h* [*nd*], *n—in a bearing specimen*, the ratio of the hole diameter to the specimen thickness.

3.2.7.1 *Discussion*—The diameter to thickness ratio may be either a nominal value determined from nominal dimensions or an actual value determined from measured dimensions.

3.2.8 *edge distance ratio, e/D* [*nd*], *n—in a bearing specimen*, the ratio of the distance between the center of the hole and the specimen end to the hole diameter.

3.2.8.1 *Discussion*—The edge distance ratio may be either a nominal value determined from nominal dimensions or an actual value determined from measured dimensions.

3.2.9 *gross bypass stress,* f^{gr_byp} $[ML^{-1}T^{-2}]$, *n*—the gross bypass stress for tensile loadings is calculated from the total force bypassing the fastener hole.

3.2.10 *net bypass stress,* f^{net_byp} $[ML^{-1}T^{-2}]$, *n*—the net bypass stress for tensile loading is calculated from the force bypassing the fastener hole minus the force reacted in bearing at the fastener.

NOTE 2—For compressive loadings, the gross and net bypass stresses are equal and are calculated using the force that bypasses the fastener hole (since for the compressive loading case, the bearing stress reaction is on the same side of the fastener as the applied force, the force reacted in bearing does not bypass the fastener hole).

NOTE 3—Several alternate definitions for gross and net bypass stress have been used historically in the aerospace industry. Comparison of data from tests conforming to this test method with historical data may need to account for differences in the bypass definitions.

3.2.11 *nominal value, n*—a value, existing in name only, assigned to a measurable quantity for the purpose of convenient designation. Tolerances may be applied to a nominal value to define an acceptable range for the quantity.

3.2.12 *offset bearing strength,* F_x^{bro} $[ML^{-1}T^{-2}]$, *n*—the value of bearing stress, in the direction specified by the subscript, at the point where a bearing chord stiffness line, offset along the bearing strain axis by a specified bearing strain value, intersects the bearing stress/bearing strain curve.

3.2.12.1 *Discussion*—Unless otherwise specified, an offset bearing strain of 2 % is to be used in this test method.

3.2.13 *ultimate bearing strength,* F_x^{bru} $[ML^{-1}T^{-2}]$, *n*—the value of bearing stress, in the direction specified by the subscript, at the maximum force capability of a bearing specimen.

iTeh Standards
(https://standards.iteh.ai)
Document Preview
ASTM D7248/D7248M-21
https://standards.iteh.ai/catalog/standards/sist/

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

3.2.14 *ultimate gross bypass strength,* $F_x^{gr\_byp}$ [$ML^{-1}T^{-2}$], *n*—the value of gross bypass stress, in the direction specified by the subscript, at the maximum force capability of the specimen.

3.2.15 *ultimate net bypass strength,* $F_x^{net\_byp}$ [$ML^{-1}T^{-2}$], *n*—the value of net bypass stress, in the direction specified by the subscript, at the maximum force capability of the specimen.

3.2.16 *width to diameter ratio, w/D* [*nd*], *n—in a bearing specimen*, the ratio of specimen width to hole diameter.

3.2.16.1 *Discussion*—The width to diameter ratio may be either a nominal value determined from nominal dimensions or an actual value, determined as the ratio of the actual specimen width to the actual hole diameter.

3.3 *Symbols:*

A = cross-sectional area of a specimen

CV = coefficient of variation statistic of a sample population for a given property (in percent)

d = fastener or pin diameter

D = specimen hole diameter

d_{csk} = countersink depth

d_{fl} = countersink flushness (depth or protrusion of the fastener in a countersunk hole)

e = distance, parallel to applied force, from hole center to end of specimen; the edge distance

E_x^{br} = bearing chord stiffness in the test direction specified by the subscript

$F_x^{br\_byp}$ = bearing stress at the ultimate bypass strength in the test direction specified by the subscript

$F_x^{gr\_byp\_c}$ = ultimate compressive gross bypass strength in the test direction specified by the subscript

$F_x^{gr\_byp\_t}$ = ultimate tensile gross bypass strength in the test direction specified by the subscript

$F_x^{net\_byp\_c}$ = ultimate compressive net bypass strength in the test direction specified by the subscript

$F_x^{net\_byp\_t}$ = ultimate tensile net bypass strength in the test direction specified by the subscript

g = distance, parallel to applied force, from hole edge to end of specimen

h = specimen thickness

k = calculation factor used in net bypass strength calculations to determine net force portion

L_g = extensometer gage length

n = number of specimens per sample population

P = force carried by test specimen

P^f = force carried by test specimen at failure

P^{max} = maximum force carried by test specimen prior to failure

s_{n-1} = standard deviation statistic of a sample population for a given property

w = specimen width

x_i = test result for an individual specimen from the sample population for a given property

iTeh Standards
(https://standards.iteh.ai)
Document Preview
ASTM D7248/D7248M-21
https://standards.iteh.ai/catalog/standards/sist/532659ba-6e17-4daf-92fa-61655aad9e9d/astm-d7248-d7248m-21

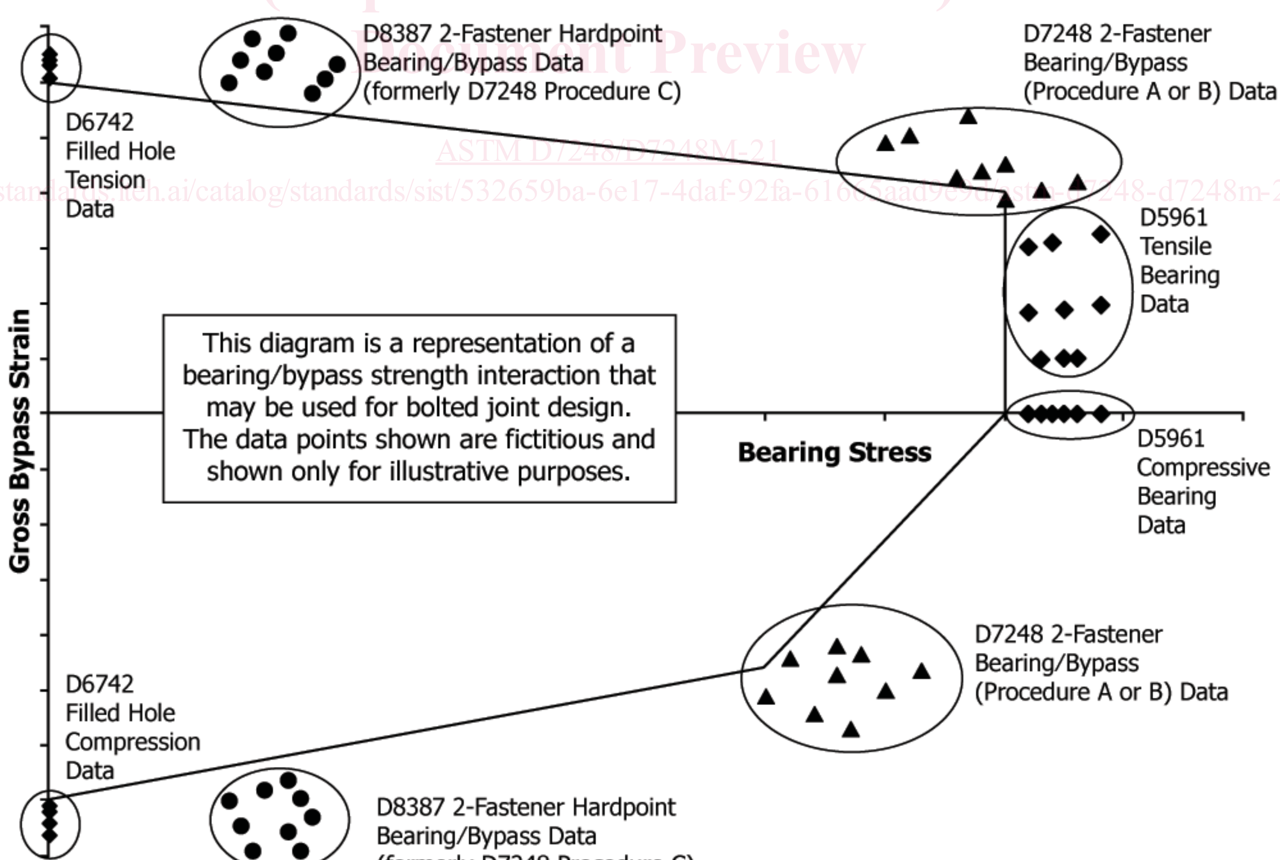


FIG. 1 Illustration of FHT, FHC, Bearing and Bearing/Bypass Bolted Joints Data and Bearing/Bypass Interaction Diagram (Refs 1-3)

$\bar{x}$ = mean or average (estimate of mean) of a sample population for a given property

δ = extensional displacement

ε = general symbol for strain, whether normal strain or shear strain

ε^{br} = bearing strain

σ^{br} = bearing stress

4. Summary of Test Method

4.1 *Bearing/Bypass Procedures*—Definition of the uniaxial bearing/bypass interaction response requires data for varying amounts of bearing and bypass forces at a fastener hole. Fig. 1 shows a typical composite laminate bearing/bypass interaction diagram (Refs **1-3**),[4] along with illustrative data from various test types. Data from Practice D6742/D6742M and Test Method D5961/D5961M define the 100 % bypass and bearing ends of the interaction diagram. Rationale for the baseline bearing/bypass specimen geometry and fastener torques are given in 6.7 and 6.8. Procedures A and B of this test method provide data in the bypass/high bearing region, while tests per Test Method D8387/D8387M provide data in the bypass/low bearing region. More complicated test setups have been used to develop data across the full range of bearing/bypass interaction. This test method is limited to cases where the bearing and bypass loads are aligned in the same direction. It is also limited to uniaxial tensile or compressive bypass loads. Test procedures for cases where the bearing and bypass loads act at different directions, or cases with biaxial or shear bypass loads are outside the scope of this test method.

4.1.1 Ultimate strength for all procedures is calculated based on the specimen gross cross-sectional area, disregarding the presence of the hole. While the hole causes a stress concentration and reduced net section, it is common industry practice to develop notched design allowable strengths based on gross section stress to account for various stress concentrations (fastener holes, free edges, flaws, damage, and so forth) not explicitly modeled in the stress analysis. This is consistent with the ASTM D30 test methods for open and filled hole tension and compression strength (Test Methods D5766/D5766M, D6484/D6484M, and Practice D6742/D6742M).

4.2 *Procedure A, Bypass/High Bearing Double Shear:*

4.2.1 A flat, constant rectangular cross-section test specimen with two centerline holes located near the end of the specimen, as shown in the test specimen drawings of Figs. 2 and 3, is loaded at the hole in bearing. The bearing force is normally applied through a close-tolerance, lightly torqued fastener (or pin) that is reacted in double shear by a fixture similar to that shown in Figs. 4 and 5. The bearing force is created by pulling the assembly in tension in a testing machine. The difference from a standard "bearing" test is that the expected primary failure mode is net section tension, rather than a bearing mode.

4.2.2 Both the applied force and the associated deformation of the hole are monitored. The applied force is normalized by the projected hole area to create an effective bearing stress. The specimen is loaded until a two part failure is achieved.

NOTE 4—Should the test specimen fail in a bearing failure mode rather than the desired bypass (net tension or compression) mode, then the test should be considered to be a bearing dominated bearing/bypass test, and the data reduction and reporting procedures of Test Method D5961/D5961M should be used instead of those given in this test method.

4.2.3 The standard test configuration for this procedure has defined values for the major test parameters. However, the following variations in configuration are allowed and can be considered as being in accordance with this test method as long as the values of all variant test parameters are prominently documented with the results.

Parameter	Standard	Variation
Loading condition	double-shear	none
Loading type	tensile	none
Mating material	steel fixture	any, if documented
Number of holes	2	3
Countersink	none	none
Hole fit	tight	any, if documented
Fastener torque	9.0-10.7 N·m [90-95 lbf-in.]	any, if documented
Laminate	quasi-isotropic	any, if documented
Fastener diameter	6 mm [0.250 in.]	any, if documented
Edge distance ratio	3	any, if documented
w/D ratio	5	any, if documented
D/h ratio	1.2-2	any, if documented

4.3 *Procedure B, Bypass/High Bearing Single Shear:*

4.3.1 The flat, constant rectangular cross-section test specimen is composed of two like halves fastened together through two centerline holes located near one end of each half, as shown in the test specimen drawings of Figs. 6 and 7. The eccentricity in applied force that would otherwise result is minimized by a doubler bonded to each grip end of the specimen, resulting in a force line-of-action along the interface between the specimen halves, through the centerline of the hole(s).

4.3.1.1 *Unstabilized Configuration (No Support Fixture)*—The ends of the test specimen are gripped in the jaws of a test machine and loaded in tension.

4.3.1.2 *Stabilized Configuration (Using Support Fixture)*—The test specimen is face-supported in a multi-piece bolted support fixture, as shown in Fig. 8. The test specimen/fixture assembly is clamped in hydraulic wedge grips and the force is sheared into the support fixture and then sheared into the specimen. Either tensile or compressive force may be applied. The stabilization fixture is required for compressive loading. For tensile loading, the fixture is optional, but is often used to simulate actual stabilized joint configurations.

4.3.2 Both the applied force and the associated deformation of the hole(s) are monitored. The applied force is normalized by the projected hole area to yield an effective bearing stress. The specimen is loaded until a two part failure is achieved.

NOTE 5—Should the test specimen fail in a bearing failure mode rather than the desired net tension or compression, then the test should be considered to be a bearing dominated bearing/bypass test, and the data reduction and reporting procedures of Test Method D5961/D5961M should be used instead of those given in this test method.

4.3.3 The standard test configuration for this procedure has defined values for the major test parameters. However, the following variations in configuration are allowed and can be considered as being in accordance with this test method as long as the values of all variant test parameters are prominently documented with the results.

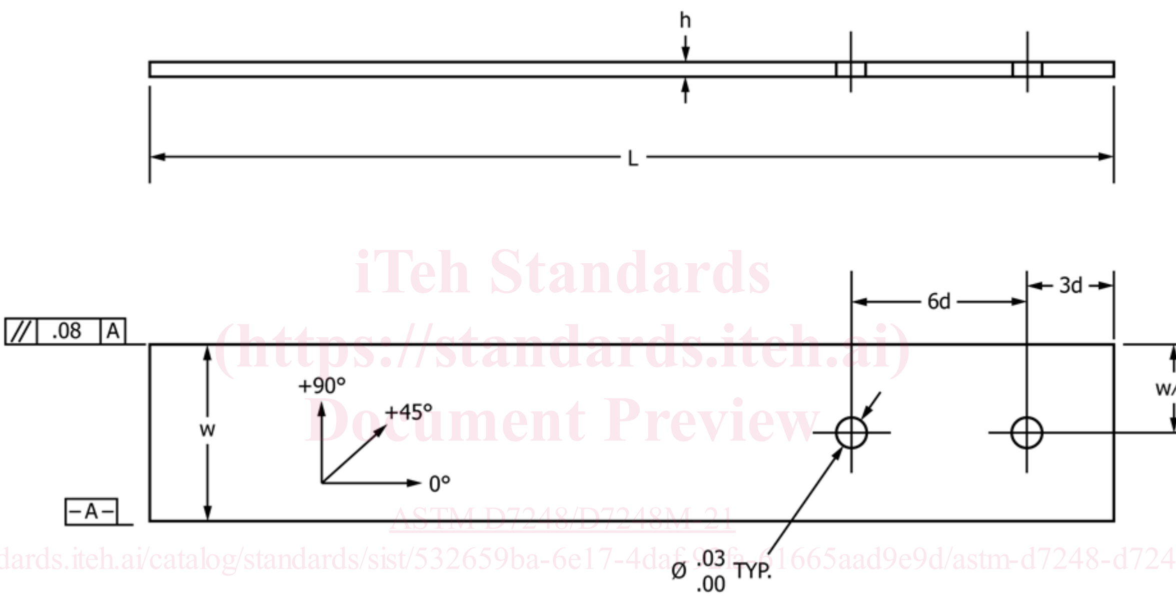
[4] The boldface numbers in parentheses refer to the list of references at the end of this standard.

iTeh Standards
https://standards.iteh.ai
Document Preview
ASTM D7248/D7248M-21
https://standards.iteh.ai/catalog/standards/sist/...

DRAWING NOTES:
1. INTERPRET DRAWING IN ACCORDANCE WITH ANSI Y14.5M–1982, SUBJECT TO THE FOLLOWING:
2. ALL DIMENSIONS IN MM WITH DECIMAL TOLERANCES AS FOLLOWS:

NO DECIMAL	.X	.XX X
+/–3	+/–1	+/–.3

3. ALL ANGLES HAVE TOLERANCE OF +/– .5°
4. PLY ORIENTATION DIRECTION TOLERANCE RELATIVE TO –A– WITHIN +/– .5°.
5. FINISH ON MACHINED EDGES NOT TO EXCEED 1.6 √ SYMBOLOGY IN ACCORDANCE WITH ASA B46.1, WITH ROUGHNESS HEIGHT IN MICROMETRES.)
6. VALUES TO BE PROVIDED FOR THE FOLLOWING, SUBJECT TO ANY RANGES SHOWN ON THE FIELD OF DRAWING; MATERIAL, LAY–UP, PLY ORIENTATION REFERENCE RELATIVE TO –A–, OVERALL LENGTH, HOLE DIAMETER, COUNTERSINK DETAILS, COUPON THICKNESS.



iTeh Standards
(https://standards.iteh.ai)
Document Preview
ASTM D7248/D7248M-21
https://standards.iteh.ai/catalog/standards/sist/532659ba-6e17-4daf-9?f?-61665aad9e9d/astm-d7248-d7248m-21

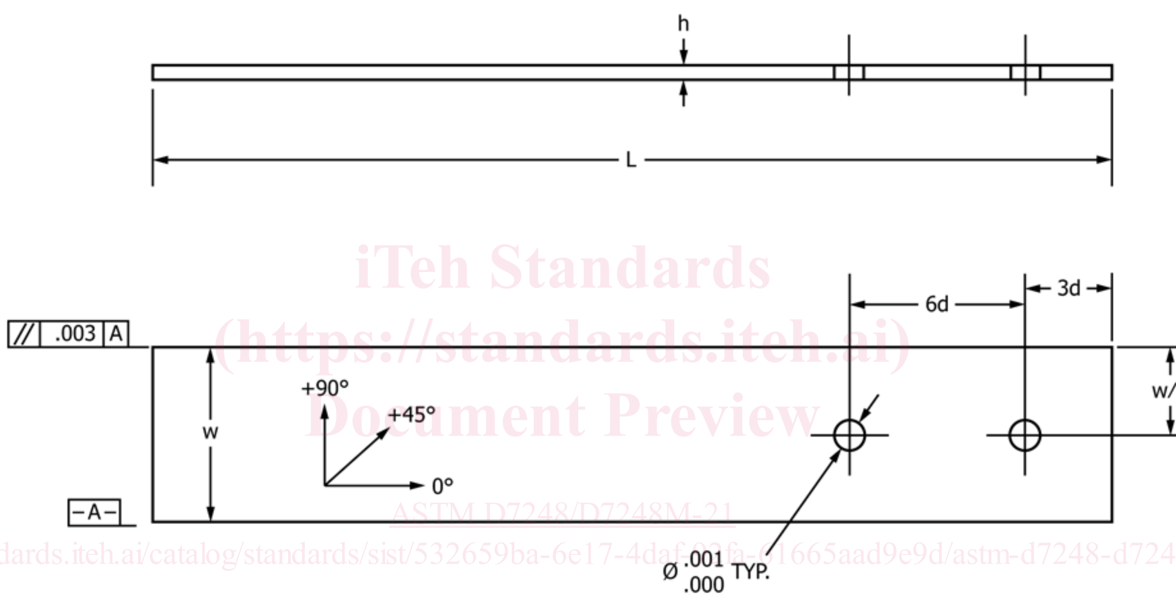
Parameters	Standard Dimensions (mm)
fastener diameter, d	6+0.00/–0.03
hole diameter, Ø	6+0.03/–0.00
thickness range, h	2–5
length, L	200
width, w	30+/–1
edge distance, e	18+/–1
countersink	none

FIG. 2 Double-Shear, Two-Fastener Test Specimen Drawing (SI)

DRAWING NOTES:
1. INTERPRET DRAWING IN ACCORDANCE WITH ANSI Y14.5M−1982, SUBJECT TO THE FOLLOWING:
2. ALL DIMENSIONS IN INCHES WITH DECIMAL TOLERANCES AS FOLLOWS:

.X	.XX	.XXX
+/−.1	+/−.03	+/−.003

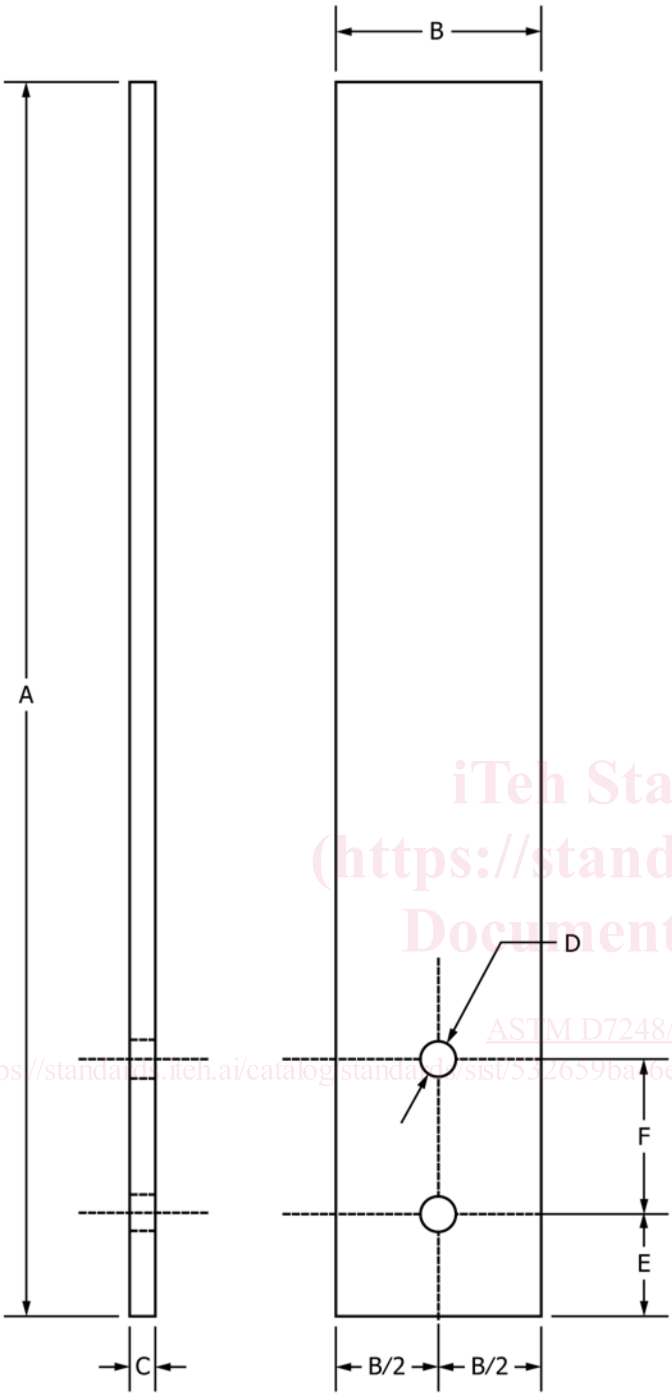
3. ALL ANGLES HAVE TOLERANCE OF +/− .5°.
4. PLY ORIENTATION DIRECTION TOLERANCE RELATIVE TO −A− WITHIN +/− .5°.
5. FINISH ON MACHINED EDGES NOT TO EXCEED 64√ SYMBOLOGY IN ACCORDANCE WITH ASA B46.1, WITH ROUGHNESS HEIGHT IN MICROINCHES.)
6. VALUES TO BE PROVIDED FOR THE FOLLOWING, SUBJECT TO ANY RANGES SHOWN ON THE FIELD OF DRAWING; MATERIAL, LAY−UP, PLY ORIENTATION REFERENCE RELATIVE TO −A− , OVERALL LENGTH, HOLE DIAMETER, COUNTERSINK DETAILS, COUPON THICKNESS.



iTeh Standards
(https://standards.iteh.ai)
Document Preview
ASTM D7248/D7248M-21
https://standards.iteh.ai/catalog/standards/sist/532659ba-6e17-4daf-92fb-01665aad9e9d/astm-d7248-d7248m-21

Parameters	Standard Dimensions (inches)
fastener diameter, d	0.250+0.000/−0.001
hole diameter, Ø	0.250+0.001/−0.000
thickness range, h	0.080−0.208
length, L	8.00
width, w	1.25+/−0.03
edge distance, e	0.75+/−0.03
countersink	none

FIG. 3 Double-Shear, Two-Fastener Test Specimen Drawing (Inch-Pound)



Recommended Material: 17-4PH Stainless Steel 1 GPa [145 ksi] yield stress						
	A	B	C	D	E	F
mm	200	30	3	6	18	36
inch	8.00	1.25	0.12	0.25	0.75	1.50

FIG. 4 Fixture Loading Plate for Procedure A (2 Required)

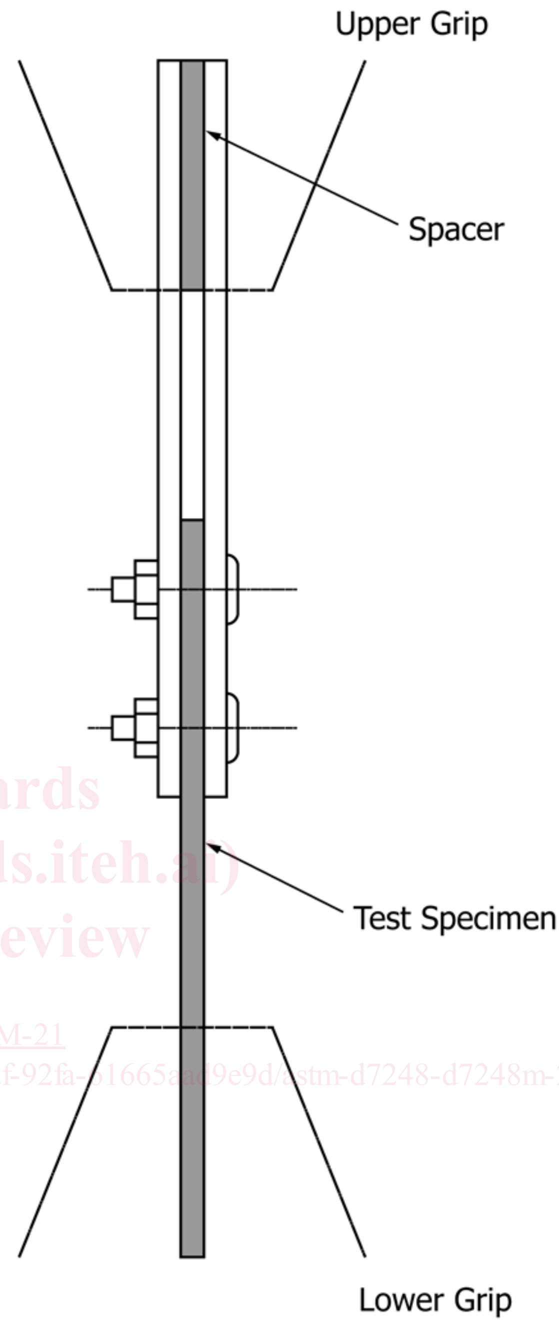


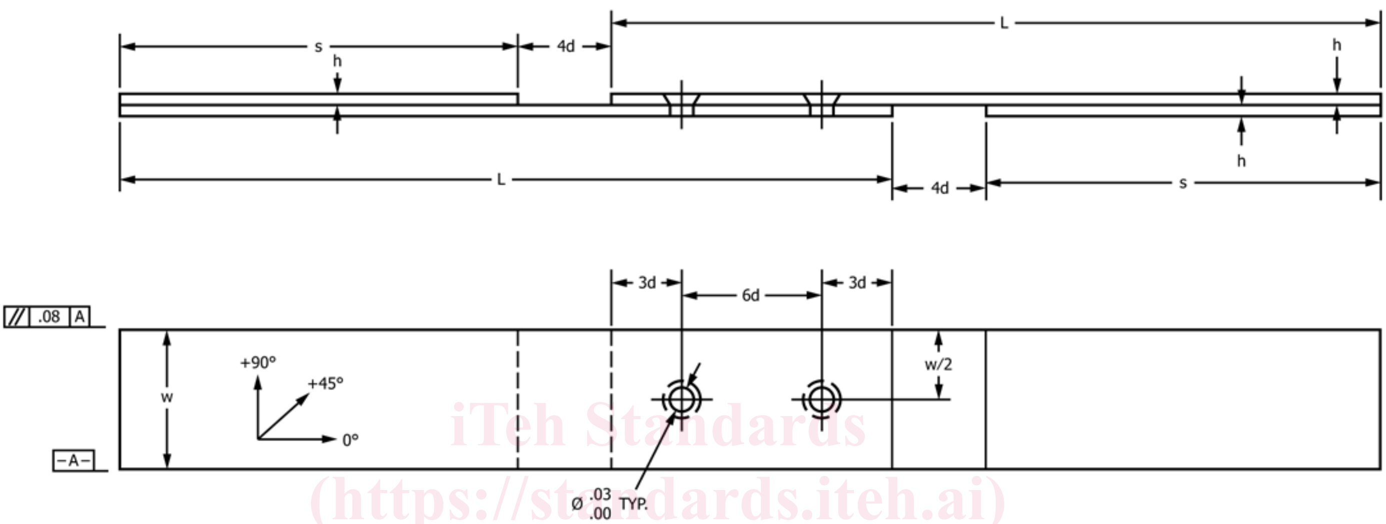
FIG. 5 Fixture Assembly for Procedure A

iTeh Standards
(https://standards.iteh.ai)
Document Preview
ASTM D7248/D7248M-21
https://standards.iteh.ai/catalog/standards/sist/532659ba-5e17-4daf-92fa-b1665aad9e9d/astm-d7248-d7248m-21

DRAWING NOTES:
1. INTERPRET DRAWING IN ACCORDANCE WITH ANSI Y14.5M–1982, SUBJECT TO THE FOLLOWING:
2. ALL DIMENSIONS IN MM WITH DECIMAL TOLERANCES AS FOLLOWS:

NO DECIMAL	.X	.XX X
+/−3	+/−1	+/−.3

3. ALL ANGLES HAVE TOLERANCE OF +/− .5°.
4. PLY ORIENTATION DIRECTION TOLERANCE RELATIVE TO −A− WITHIN +/− .5°.
5. FINISH ON MACHINED EDGES NOT TO EXCEED 1.6√ (SYMBOLOGY IN ACCORDANCE WITH ASA B46.1, WITH ROUGHNESS HEIGHT IN MICROMETRES.)
6. VALUES TO BE PROVIDED FOR THE FOLLOWING, SUBJECT TO ANY RANGES SHOWN ON THE FIELD OF DRAWING; MATERIAL, LAY–UP, PLY ORIENTATION REFERENCE RELATIVE TO −A−, OVERALL LENGTH, HOLE DIAMETER, COUNTERSINK DETAILS, COUPON THICKNESS, DOUBLER MATERIAL, DOUBLER ADHESIVE.



iTeh Standards
(https://standards.iteh.ai)
Document Preview
ASTM D7248/D7248M-21
https://standards.iteh.ai/catalog/standards/sist/...-6e17-4daf-...5aad9e9d/astm-d7248-d7248m-21

Parameters	Standard Dimensions of Specimen (mm)	
	without support fixture	with support fixture
fastener diameter, d	6 + 0.00/−0.03	6 + 0.00/−0.03
hole diameter, Ø	6 + 0.03/−0.00	6 + 0.03/−0.00
thickness range, h	2–5	2–5
length, L	210	210
width, w	30 +/− 1	30 +/− 1
edge distance, e	18 +/− 1	18 +/− 1
countersink	none (optional)	none (optional)
doubler length, s	108	108

FIG. 6 Single-Shear, Two-Fastener Test Specimen Drawing (SI)

Parameter	Standard	Variation
Loading condition	single-shear	none
Loading type	tensile	compressive
Support fixture	no for tensile load yes for compressive load	yes, if documented
Number of holes	2	3
Countersunk holes	no	yes, if documented
Grommets	no	yes, if documented
Mating material	same laminate	any, if documented
Hole fit	tight	any, if documented
Fastener torque	9.0-10.7 N·m [80-95 lbf-in.] for tensile load 2.2-3.4 N·m [20-30 lbf-in.] for compressive load	any, if documented
Laminate	quasi-isotropic	any, if documented
Fastener diameter	6 mm [0.250 in.]	any, if documented
Edge distance ratio	3	any, if documented
w/D ratio	5	any, if documented
D/h ratio	1.2-2	any, if documented

5. Significance and Use

5.1 This test method is designed to produce bearing/bypass interaction response data for research and development, and for structural design and analysis. The standard configuration for each procedure is very specific and is intended as a baseline configuration for developing structural design data.

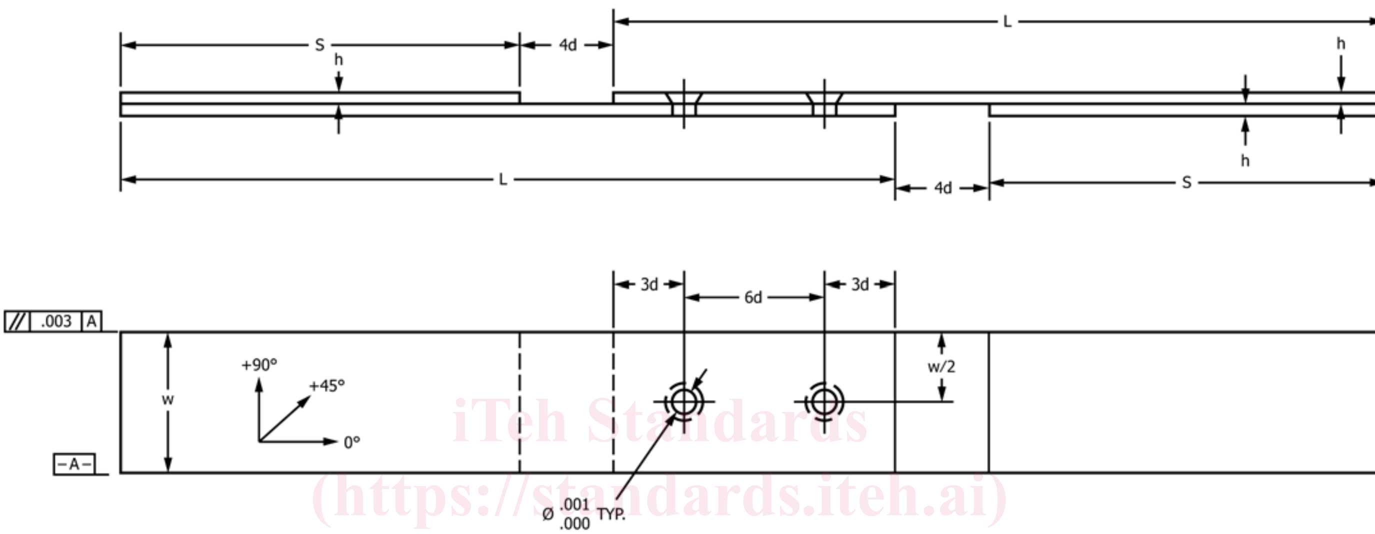
5.1.1 *Procedure A,* the bypass/high bearing double-shear configuration is recommended for developing data for specific applications which involve double shear joints.

5.1.2 *Procedure B,* the bypass/high bearing single-shear configuration is more useful in the evaluation of typical joint configurations. The specimen may be tested in either an unstabilized (no support fixture) or stabilized configuration. The unstabilized configuration is intended for tensile loading

DRAWING NOTES:
1. INTERPRET DRAWING IN ACCORDANCE WITH ANSI Y14.5M–1982, SUBJECT TO THE FOLLOWING:
2. ALL DIMENSIONS IN INCHES WITH DECIMAL TOLERANCES AS FOLLOWS:

.X	.XX	.XXX
+/–.1	+/–.03	+/–.003

3. ALL ANGLES HAVE TOLERANCE OF +/– .5°.
4. PLY ORIENTATION DIRECTION TOLERANCE RELATIVE TO –A– WITHIN +/– .5°.
5. FINISH ON MACHINED EDGES NOT TO EXCEED 64√ SYMBOLOGY IN ACCORDANCE WITH ASA B46.1, WITH ROUGHNESS HEIGHT IN MICROINCHES.)
6. VALUES TO BE PROVIDED FOR THE FOLLOWING, SUBJECT TO ANY RANGES SHOWN ON THE FIELD OF DRAWING; MATERIAL, LAY–UP, PLY ORIENTATION REFERENCE RELATIVE TO –A–, OVERALL LENGTH, HOLE DIAMETER, COUNTERSINK DETAILS, COUPON THICKNESS, DOUBLER MATERIAL, DOUBLER ADHESIVE.



iTeh Standards
(https://standards.iteh.ai)
Document Preview
ASTM D7248/D7248M-21
https://standards.iteh.ai/catalog/standards/sist/...-4daf-...d9e9d/astm-d7248-d7248m-21

Parameters	Standard Dimensions of Specimen (inches)	
	without support fixture	with support fixture
fastener diameter, d	0.250+0.000/–0.001	0.250+0.000/–0.001
hole diameter, Ø	0.250+0.001/–0.000	0.250+0.001/–0.000
thickness range, h	0.080–0.208	0.080–0.208
length, L	8.25	8.25
width, w	1.25+/–0.03	1.25+/–0.03
edge distance, e	0.75+/–0.03	0.75+/–0.03
countersink	none (optional)	none (optional)
doubler length, s	4.25	4.25

FIG. 7 Single-Shear, Two-Fastener Test Specimen Drawing (Inch-Pound)

and the stabilized configuration is intended for compressive loading. These configurations, particularly the stabilized configuration, have been extensively used in the development of design allowables data. The variants of either procedure provide flexibility in the conduct of the test, allowing adaptation of the test setup to a specific application. However, the flexibility of test parameters allowed by the variants makes meaningful comparison between datasets difficult if the datasets were not tested using identical test parameters.

5.2 General factors that influence the mechanical response of composite laminates and should therefore be reported include the following: material, methods of material preparation and lay-up, specimen stacking sequence, specimen preparation, specimen conditioning, environment of testing, specimen alignment and gripping, speed of testing, time held at test temperature, void content, and volume percent reinforcement.

5.3 Specific factors that influence the bearing/bypass interaction response of composite laminates and should therefore be reported include not only the loading method (either Procedure A or B) and loading type (tension or compression) but the following (for both procedures): edge distance ratio, width to diameter ratio, diameter to thickness ratio, fastener torque, fastener or pin material, fastener or pin clearance; and (for Procedure B only) countersink angle and depth of countersink, type of grommet (if used), type of mating material, and type of support fixture (if used). Properties, in the test direction, which may be obtained from this test method include the following:

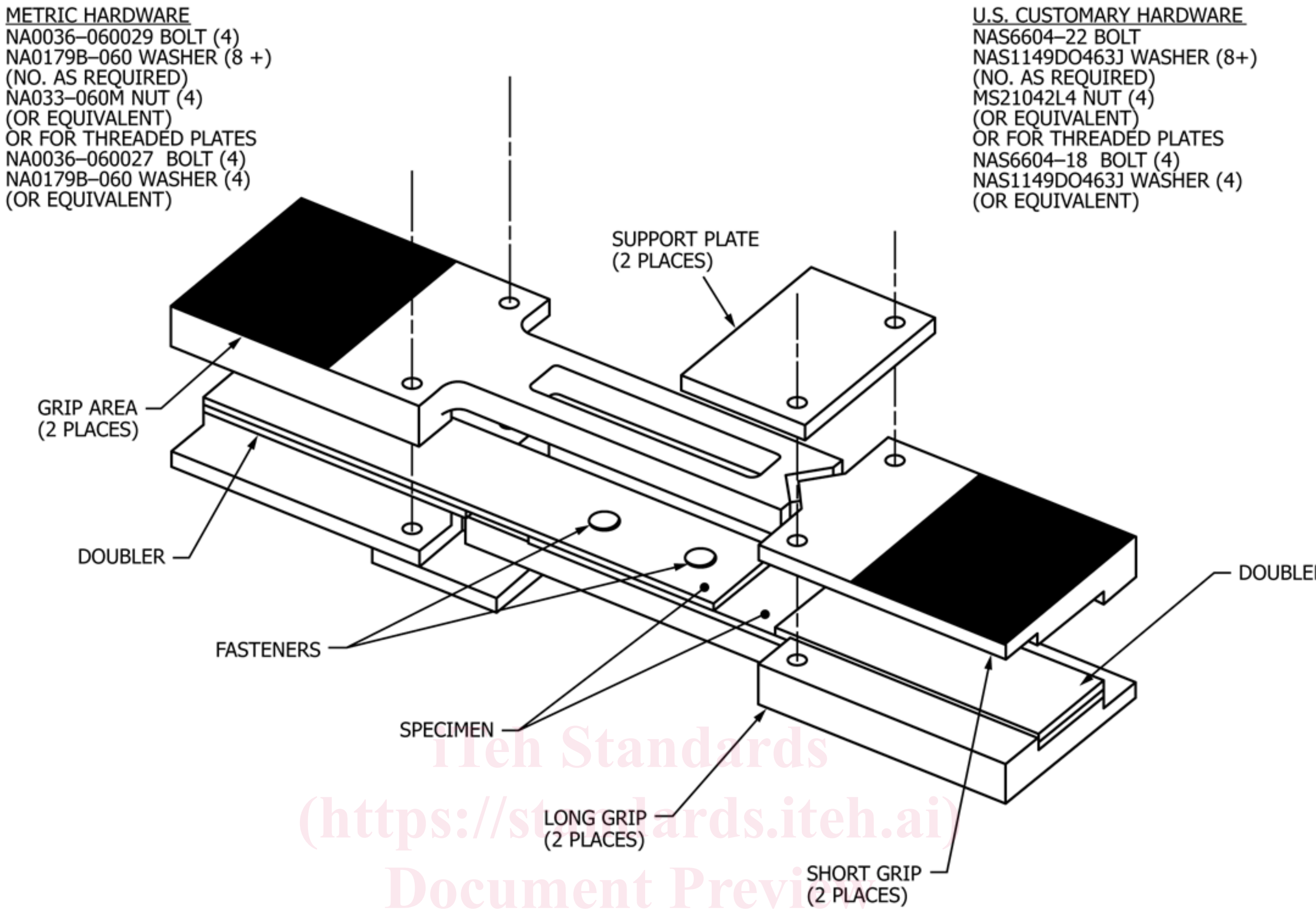


FIG. 8 Support Fixture Assembly for Procedure B (for details of the Support Fixture, see Test Method D5961/D5961M)

iTeh Standards (https://standards.iteh.ai) Document Preview
ASTM D7248/D7248M-21
https://standards.iteh.ai/catalog/standards/sist/5526f9ba-6e17-4daf-921a-0160faad9e9d/astm-d7248-d7248m-21

5.3.1 Filled hole tensile bearing/bypass strength.

5.3.2 Filled hole compressive bearing/bypass strength.

5.3.3 Bearing stress/bypass strain curve.

6. Interferences

6.1 *Material and Specimen Preparation*—Bearing/bypass response is sensitive to poor material fabrication practices (including lack of control of fiber alignment), damage induced by improper specimen machining (hole preparation is especially critical), and torqued fastener installation. Fiber alignment relative to the specimen coordinate axis should be maintained as carefully as possible, although there is currently no standard procedure to ensure or determine this alignment. A practice that has been found satisfactory for many materials is the addition of small amounts of tracer yarn to the prepreg parallel to the 0° direction, added either as part of the prepreg production or as part of panel fabrication. See Guide D5687/D5687M for further information on recommended specimen preparation practices.

6.2 *Restraining Surfaces*—The degree to which out-of-plane hole deformation is possible, due to lack of restraint by the fixture or the fastener, has been shown to affect test results.

6.3 *Cleanliness*—The degree of cleanliness of the mating surfaces has been found to produce significant variations in test results.

6.4 *Eccentricity (Procedure B Only)*—A loading eccentricity is created in single-shear tests by the offset, in one plane, of the line of action of force between each half of the test specimen. This eccentricity creates a moment that, particularly in clearance hole tests, rotates the fastener, resulting in an uneven contact stress distribution through the thickness of the specimen. The effect of this eccentricity upon test results is strongly dependent upon the degree of clearance in the hole, the size of the fastener head, the mating area, the coefficient of friction between the specimen and the mating material, the thickness and stiffness of the specimen, the thickness and stiffness of the mating material, and the configuration of the support fixture. Consequently, results obtained from this procedure where the support fixture is used may not accurately replicate behavior in other structural configurations.

6.5 *Hole Preparation*—Due to the dominating presence of the filled hole(s), results from this test method are relatively insensitive to parameters that would be of concern in an unnotched tensile or compressive property test. However, since the filled hole(s) dominates the strength, consistent preparation of the hole(s) without damage to the laminate is important to meaningful results. Damage due to hole preparation will affect strength results. Some types of damage, such as delaminations, can blunt the stress concentration due to the hole, increasing the force carrying capacity of the coupon and the calculated strength. Other types of damage can reduce the calculated strength.

6.6 *Fastener-Hole Clearance*—Compressive bearing/bypass results are affected by the clearance arising from the difference between hole and fastener diameters. Clearance can change the observed specimen behavior by delaying the onset of bearing damage. Tensile bearing/bypass results are also affected by clearance, but to a lesser degree than under compressive loads. Hole clearance also effects the proportion of force transferred in each fastener, and the proportions can change as the force is increased during the test. Damage due to insufficient clearance during fastener installation will affect strength results. Countersink flushness (depth or protrusion of the fastener head in a countersunk hole) will affect strength results and may affect the observed failure mode. For these reasons, both the hole and fastener diameters must be accurately measured and recorded. A typical aerospace tolerance on fastener-hole clearance is +75/–0 µm [+0.003/–0.000 in.] for structural fastener holes.

6.7 *Fastener Torque/Pre-load*—Results are affected by the installed fastener pre-load (clamping pressure). Laminates can exhibit significant differences in both failure force and failure mode due to changes in fastener pre-load under both tensile and compressive loading. The critical pre-load condition (that is, either high or low clamping pressure) can vary depending upon the type of loading, the laminate stacking sequence, and the desired failure mode. For compressive loaded bearing/bypass, the nominal test configuration uses a relatively low level of fastener installation torque to give conservative results. For tensile loaded bearing/bypass, the nominal test configuration uses a high level of fastener installation torque (full fastener installation torque) since this usually gives conservative results. Fastener torque levels used for bearing/bypass test specimens should correspond to the torque levels that give the most conservative results for corresponding filled hole tension and filled hole compression tests of the same material and layup (see Practice D6742/D6742M).

6.8 *Specimen Geometry*—Results are affected by the ratio of specimen width to hole diameter (w/D); this ratio should be maintained at 5 to avoid bearing failure modes, unless the experiment is investigating the influence of this ratio, or invalid (bearing) failure modes occur. If bearing failures occur with w/D = 5 specimens, then the width should be reduced; with some layups having low bearing capabilities, w/D values as low as 3 may be required to obtain a bypass failure mode. Results may also be affected by the spacing distance between the two fasteners; the baseline distance is equal to 6D. Results may also be affected by the distance between the end hole and the end of the specimen, with small end distances potentially resulting in invalid shear-out failure modes; the baseline end distance to diameter ratio is 3D unless the experiment is investigating the influence of this ratio. Results may also be affected by the ratio of hole diameter to thickness; the preferred ratio is the range from 1.5-3.0 unless the experiment is investigating the influence of this ratio. Results may also be affected by the ratio of countersunk (flush) head depth to thickness; the preferred ratio is the range from 0.0-0.7 unless the experiment is investigating the influence of this ratio. Results may also be affected by the ratio of ungripped specimen length to specimen width; this ratio should be maintained as shown, unless the experiment is investigating the influence of this ratio.

6.9 *Material Orthotropy*—The degree of laminate orthotropy strongly affects the failure mode and measured bearing/bypass strengths. Bearing/bypass strength results should only be reported when appropriate and valid failure modes are observed, in accordance with 11.4.

6.10 *Thickness Scaling*—Thick composite structures do not necessarily fail at the same strengths as thin structures with the same laminate orientation (that is, strength does not always scale directly with thickness). Thus, data gathered using these procedures may not translate directly into equivalent thick-structure properties.

6.11 *Environment*—Results are affected by the environmental conditions under which the tests are conducted. Laminates tested in various environments can exhibit significant differences in both bearing/bypass strength and failure mode. Experience has demonstrated that elevated temperature, humid environments are generally critical for bearing failure modes, while bypass dominated failure modes can be critical at either cold or hot/wet conditions, depending on the material and layup. Therefore, critical environments must be assessed independently for each material system, stacking sequence, and torque condition tested.

6.12 *Fastener Force Ratios*—The ratio of force in each of the two fasteners (Procedures A and B) may vary with the applied force level during the test. This variation in load transfer can result from the onset of bearing damage, fastener bending, and frictional effects.

7. Apparatus

7.1 *Micrometers*—A micrometer with a 4 to 8 mm [0.16 to 0.32 in.] nominal diameter ball interface shall be used to measure the specimen thickness when at least one surface is irregular (such as the bag-side of a laminate). A micrometer with a 4 to 8 mm [0.16 to 0.32 in.] nominal diameter ball interface or with a flat anvil interface shall be used to measure the specimen thickness when both surfaces are smooth (such as tooled surfaces). A micrometer or caliper, with a flat anvil interface, shall be used to measure the width of the specimen. The accuracy of the instruments shall be suitable for reading to within 1 % of the sample dimensions. For typical specimen geometries, an instrument with an accuracy of ±0.0025 mm [±0.0001 in.] is adequate for the thickness measurement, while an instrument with an accuracy of ±0.025 mm [±0.001 in.] is adequate for the width measurement. Additionally, a micrometer or gage capable of determining the hole diameters to ±0.025 mm [±0.001 in.] shall be used.

NOTE 6—The accuracies given above are based on achieving measurements that are within 1 % of the sample width and thickness.

7.2 *Loading Fasteners or Pins*—The fastener (or pin) type shall be specified as an initial test parameter and reported. The assembly torque (if applicable) shall be specified as an initial test parameter and reported. This value may be a measured

iTeh Standards
(https://standards.iteh.ai)
Document Preview
ASTM D7248/D7248M-21
https://standards.iteh.ai/catalog/standards/sist/...1665aad9e9d/astm-d7248-d7248m-21