Committee D30 on Composite Materials

Current Work in Standard Test Methods Development

Carl Rousseau, D30 Chairman (LM Aero)

Adam Sawicki, D30 Vice-Chairman (Boeing)

Jen Rodgers, D30 Staff Mgr (ASTM)

Outline

- ASTM D30 Overview and Overall Objective
- Recent History
- ASTM Process Description
- D30 Organization and Breakdown
- D30 Standards Use
- New Standards – 2006/2007
- Focus on D30.09 Sandwich Test Methods
- New Work Items
- Technical Rigor/Publications
- Future Objectives
- Relationships

ASTM International Fast Facts

- **Formed in 1898**
- **World-Wide Development of Voluntary, Full-Consensus Standards for Materials, Products, Systems & Services**
- **12,000 Standards Developed by 138 Technical Committees are Administered, Published, and Distributed by ASTM International**
- **Over 32,500 Members from 125 Countries Participate on ASTM Committees**
- **ASTM Standards are Living Documents, Continually Revised to Meet Stakeholder Needs, Reflecting Current Technology**

Committee D30 on Composite Materials

Committee D30 formed in 1964 (with heritage to the early '50s) out of Committee D20 on Plastics

Current (2008) D30 Scope

"The Committee will develop standard test methods, practices, terminology, and guides; sponsor symposia; stimulate research; and exchange technical information pertaining to composite materials (primarily those with fibrous reinforcement), as well as to reinforcing fibers with a Young's modulus greater than 20 GPa (3 Msi).

This Committee will not develop standard specifications."

D30 Objective

A complete, effective, and coordinated suite of testing standards for composites

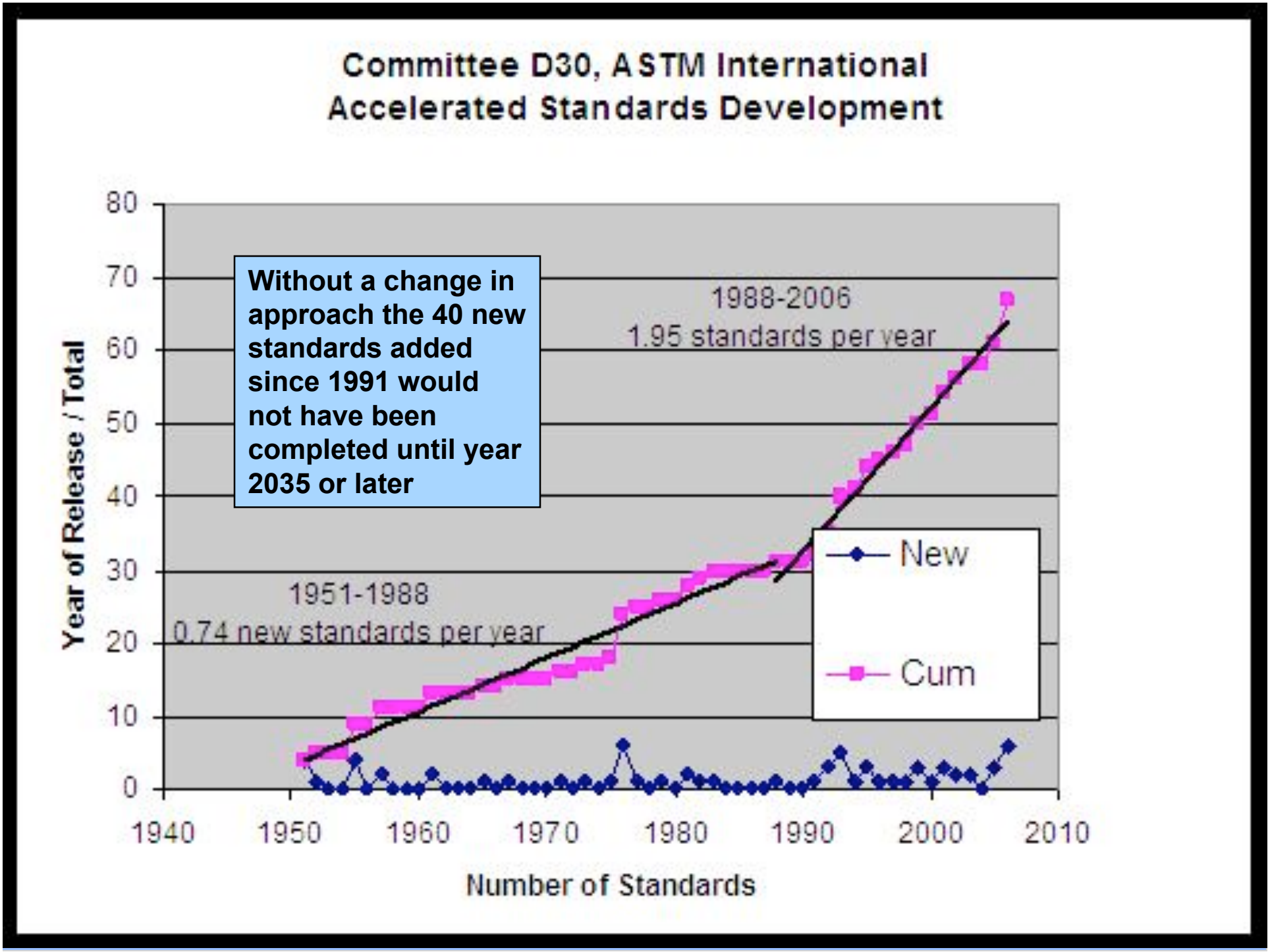
State of Composites Testing in mid-1980's

- Through the mid-1980's the ability to correctly test advanced composites was considered a proprietary advantage in the aerospace industry. Databases were closely held, testing standards were few, and approaches varied widely.
- The few standards that existed were "artsy", with good results often dependent on undocumented "tribal" knowledge that was not widely available.
- There was even active resistance to the creation of new and better standards, for fear of loss of competitive edge; however, this attitude started to change by the mid-1980s.
- By the late 1980s, with a shift in competitive emphasis from the material level up to the product level, the composites industry was in dire need for a complete, effective, and coordinated suite of testing standards for composites.
- Internal project and corporate standards, and products from industry organizations (such as SACMA and CMC), filled the gap in the interim.
- D30 radically changed organization in 1990 to meet the demand.
- **By working at an increased pace, D30 has since caught-up with demand.**

1988 D30 Standards Shortfall

(focus on constituent and lamina properties)

Constituent	Lamina(te)	Structure	Other
Fiber Tension	Tension	Open-Hole Tension	Terminology
Fiber Density	Compression	Open-Hole Compression	Fabrication Practice
Tow Density	Shear	Filled-Hole Tension	Orientation Code
Fiber Content	Unnotched Fatigue	Filled-Hole Compression	General Test Guide
Resin Content	Short-Beam Strength	Bearing	Textile Test Guide
Volatiles Content	Flexure Response	Bearing Interaction	Database Records
Fiber Areal Weight	Fiber Volume	Bearing Fatigue	
Core Density	Mode I Fracture	Damage Impact Resistance	
Core Thickness	Mixed-Mode Fracture	Residual Strength After Damage	
Core Shear	Mode I Fracture Fatigue	Sandwich Beam Flexure	
Core Compression	Ply Thickness	Sandwich Panel Flexure	
Core Shear Fatigue	Moisture Absorption	Sandwich Flexure/Creep	
Core Water Absorption	Glass Transition	Fastener Pull-Through	
(more)	(more)	(more)	


Committee D30, ASTM International
Accelerated Standards Development
Without a change in approach the 40 new standards added since 1991 would not have been completed until year 2035 or later
1988-2006
1.95 standards per year
1951-1988
0.74 new standards per year
New
Cum
Year of Release / Total
0
10
20
30
40
50
60
70
80
1940
1950
1960
1970
1980
1990
2000
2010
Number of Standards

2007 D30 Standards Summary

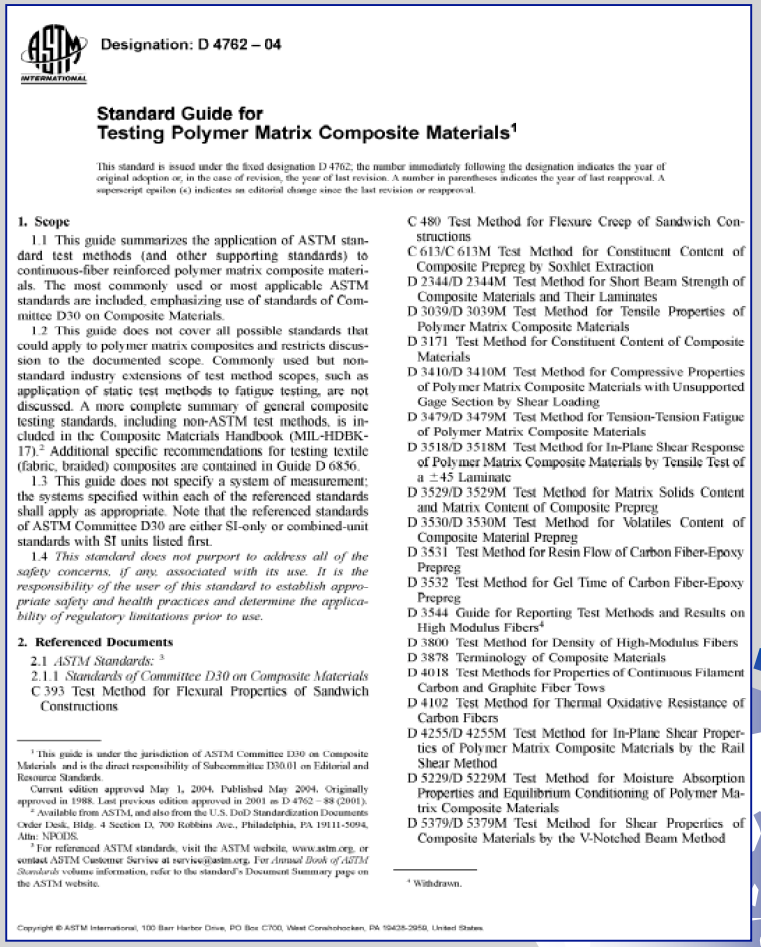
(with most pre-existing standards updated)

Constituent	Lamina(te)	Structure	Other
Fiber Tension	Tension	Open-Hole Tension	Terminology
Fiber Density	Compression	Open-Hole Compression	Fabrication Practice
Tow Density	Shear	Filled-Hole Tension	Orientation Code
Fiber Content	Unnotched Fatigue	Filled-Hole Compression	General Test Guide
Resin Content	Short-Beam Strength	Bearing	Textile Test Guide
Volatiles Content	Flexure Response	Bearing Interaction	Database Records
Fiber Areal Weight	Fiber Volume	Bearing Fatigue	
Core Density	Mode I Fracture	Damage Impact Resistance	
Core Thickness	Mixed-Mode Fracture	Residual Strength After Damage	
Core Shear	Mode I Fracture Fatigue	Sandwich Beam Flexure	
Core Compression	Ply Thickness	Sandwich Panel Flexure	
Core Shear Fatigue	Moisture Absorption	Sandwich Flexure/Creep	
Core Water Absorption	Glass Transition	Fastener Pull-Through	
(and more)	(and more)	(and more)	

D4762 – A New Gateway to D30 Standards

Standard Guide to Testing Polymer Matrix Composite Materials

- Re-released May 2004
- The major 2004 revision now briefly summarizes the scope, advantages, and disadvantages of every related D30 standard (as of release date), as well as other commonly referenced related standards of other ASTM committees.
- An aid in education and selection of appropriate standards for use with advanced composite materials
- **2007-08 update just approved, includes information on standards published 2004-07**



Designation: D 4762 – 04

Standard Guide for Testing Polymer Matrix Composite Materials[1]

This standard is issued under the fixed designation D 4762; 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 summarizes the application of ASTM standard test methods (and other supporting standards) to continuous-fiber reinforced polymer matrix composite materials. The most commonly used or most applicable ASTM standards are included, emphasizing use of standards of Committee D30 on Composite Materials.

1.2 This guide does not cover all possible standards that could apply to polymer matrix composites and restricts discussion to the documented scope. Commonly used but non-standard industry extensions of test method scopes, such as application of static test methods to fatigue testing, are not discussed. A more complete summary of general composite testing standards, including non-ASTM test methods, is included in the Composite Materials Handbook (MIL-HDBK-17).[2] Additional specific recommendations for testing textile (fabric, braided) composites are contained in Guide D 6856.

1.3 This guide does not specify a system of measurement; the systems specified within each of the referenced standards shall apply as appropriate. Note that the referenced standards of ASTM Committee D30 are either SI-only or combined-unit standards with SI units listed first.

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:* [3]

2.1.1 *Standards of Committee D30 on Composite Materials*

C 393 Test Method for Flexural Properties of Sandwich Constructions

C 480 Test Method for Flexure Creep of Sandwich Constructions

C 613/C 613M Test Method for Constituent Content of Composite Prepreg by Soxhlet Extraction

D 2344/D 2344M Test Method for Short Beam Strength of Composite Materials and Their Laminates

D 3039/D 3039M Test Method for Tensile Properties of Polymer Matrix Composite Materials

D 3171 Test Method for Constituent Content of Composite Materials

D 3410/D 3410M Test Method for Compressive Properties of Polymer Matrix Composite Materials with Unsupported Gage Section by Shear Loading

D 3479/D 3479M Test Method for Tension-Tension Fatigue of Polymer Matrix Composite Materials

D 3518/D 3518M Test Method for In-Plane Shear Response of Polymer Matrix Composite Materials by Tensile Test of a ±45 Laminate

D 3529/D 3529M Test Method for Matrix Solids Content and Matrix Content of Composite Prepreg

D 3530/D 3530M Test Method for Volatiles Content of Composite Material Prepreg

D 3531 Test Method for Resin Flow of Carbon Fiber-Epoxy Prepreg

D 3532 Test Method for Gel Time of Carbon Fiber-Epoxy Prepreg

D 3544 Guide for Reporting Test Methods and Results on High Modulus Fibers[4]

D 3800 Test Method for Density of High-Modulus Fibers

D 3878 Terminology of Composite Materials

D 4018 Test Methods for Properties of Continuous Filament Carbon and Graphite Fiber Tows

D 4102 Test Method for Thermal Oxidative Resistance of Carbon Fibers

D 4255/D 4255M Test Method for In-Plane Shear Properties of Polymer Matrix Composite Materials by the Rail Shear Method

D 5229/D 5229M Test Method for Moisture Absorption Properties and Equilibrium Conditioning of Polymer Matrix Composite Materials

D 5379/D 5379M Test Method for Shear Properties of Composite Materials by the V-Notched Beam Method

[1] This guide 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.

Current edition approved May 1, 2004. Published May 2004. Originally approved in 1988. Last previous edition approved in 2001 as D 4762 – 88 (2001).

[2] Available from ASTM, and also from the U.S. DoD Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

[3] 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.

[4] Withdrawn.

ASTM Standards Development Process

- **Develops Voluntary, Full-Consensus Standards for Materials, Products, Systems & Services World-Wide.**
- **12,000+ ASTM Standards Used Internationally.**
- **ASTM Standards Reflect Current Technology, Being Living Documents that are Continually Revised.**
- **31,000+ Members from Around the Globe Participate on ASTM Committees.**

ASTM Staff Support Structure

ASTM Headquarters

A 180 person ASTM staff manages & supports the standard development activities of the Technical Committees.

Staff Managers

Each Committee has an Staff Manager & Editor to ensure efficient committee operation & provide guidance & support in developing documents.

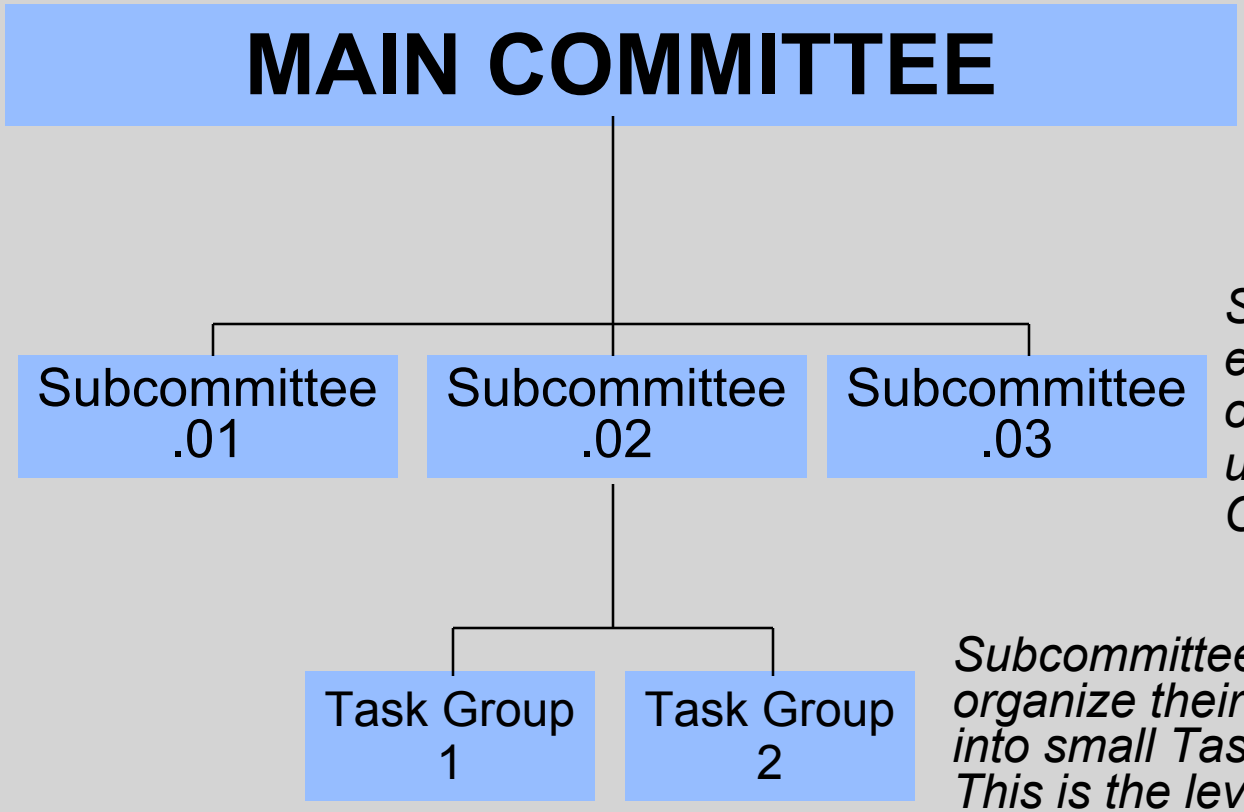
~138 Technical Committees
~32,500 Members

Managers & Editors help Technical Committees maintain fair, open, transparent development of standards, and assure that the documents are well structured.

ASTM Committee Regulations

Form & Style Manual

ASTM Technical Committee Organization



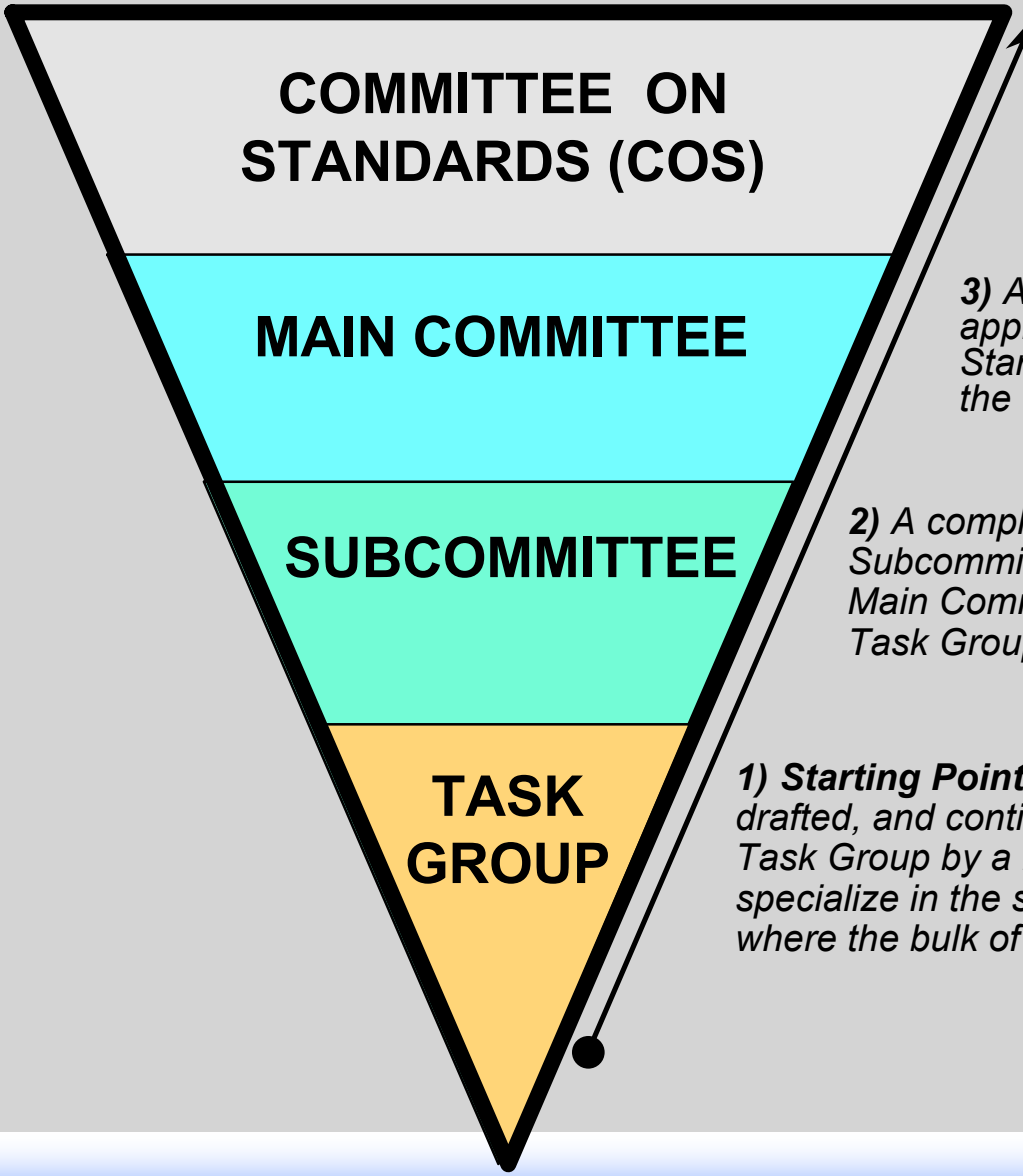
Technical Committees form to address specific industry issues. They develop scopes to define their jurisdiction.

Subcommittees are established to address subsets of specialized subject matter under the scope of the Main Committee.

Subcommittees further organize their expertise into small Task Groups. This is the level at which documents are first developed and are subsequently revised.

The 138 Technical Committees, 2,000+ Subcommittees, & thousands more Task Groups produce 1,200 drafts, or revisions to drafts, annually.

ASTM International Balloting Process



4) *As a final check, a standing committee (COS) of the ASTM Board of Directors reviews the process by which each standard is developed or revised, to ensure compliance with ASTM regulations.*

3) *After S/C approval the Main Committee votes. If approved it is presented to the Committee on Standards for final review. Otherwise it returns to the Task Group for re-work & balloting is repeated.*

2) *A completed draft is voted on by the Subcommittee. If approved, it moves to a Main Committee vote. If not, it returns to the Task Group for re-drafting.*

1) Starting Point. *Documents are drafted, and continually revised, in the Task Group by a few members who specialize in the subject matter. This is where the bulk of the activity occurs.*

D30 Committee Organization

- D30.01 Editorial and Resource Standards
- D30.02 Research and Mechanics
- D30.03 Constituent/Precursor Properties
- D30.04 Lamina and Laminate Test Methods
- D30.05 Structural Test Methods
  - D30.05.01 Civil and Marine
- D30.06 Interlaminar Properties
- D30.09 Sandwich Construction
- D30.90 Executive
  - D30.91 Planning
  - D30.92 Awards
  - D30.93 Standards Coordination and Globalization Initiative
  - D30.94 Technical Specialists

D30 Committee Leadership

D30 Officers (2006-2007, 2008-2009)

Chairman, Rich Fields (LM MFC)
Vice-Chair, Carl Rousseau (LM Aero) (Chairman-Elect)
Recording Secretary, Adam Sawicki (Boeing) (Vice-Chair-Elect)
Membership Secretary, James Ratcliffe (NASA) (Recording Sec-Elect)
Past Chairman, Gene Camponeschi (US Navy)
Membership Secretary Elect, Mark Chris (Textron Bell)

D30 Members-At-Large

Bill Bertelsen (Gougeon Brothers)
Paul Lagace (MIT)
Jian Li (Boeing)
Steve Ward (Consultant)

ASTM Staff

Jim Olshefsky, D30 Staff Mgr
Jill DiCicco, D30 Admin Asst
Karen Wilson, D30 Secretary
Jessica Rosiak, D30 Editor

D30 Subcommittee Chairs

.01, Editorial/Resource, Paul Lagace (MIT)
.02, Research & Mechanics, Gene Camponeschi (US Navy)
.03, Constituent/Precursor, Jim Ferrel (Hexcel)
.04, Lamina/Laminate, Mark Kistner (USAF)
.05, Structural, Mark Chris (Textron Bell)
.06, Interlaminar, James Reeder (NASA)
.09, Sandwich, Steve Ward (consultant)

ASTM D30 Membership by Group

- **OEMs**
- **Testing Laboratories**
- **Material Suppliers**
- **Component Fabricators**
- **Academic & Research Institutions**
- **Government and Certification Agencies**
  - US Army, Air Force, Navy, NASA
  - FAA, CAA
  - NIST, non-US standards groups

~245 Individual Members of ASTM D30

Category	Approximate Numbers as of Oct 2006	
	United States	International non-US
Industry	125	21
Academia/ Research	50	17
Government	27	5
Totals:	202	43

Committee D30 participation comes from 22 countries

D30 Standards Breakdown, late 2007

Subcommittee		Standards	
No.	Name	Published	Draft
D30.01	Resource Standards	6	0
D30.02	Research and Mechanics	NA	NA
D30.03	Constituent/Precursor Properties	8	0
D30.04	Lamina/Laminate Test Methods	20	3
D30.05	Structural Test Methods	13	5
D30.06	Interlaminar Properties	5	1
D30.09	Sandwich Construction	20	4
Total		72	13

Specifying D30 Standards

- **Warning -** Correct use of D30 standards currently often requires considerable interaction with the standards by the user.
- Therefore, the quality of test results can be a function of, and may interact with, the maturity and the method of reference.
- *Detailed "how-to" best practices for use and reference are left to a separate presentation.*
- D30 considers its standards educational as well as restrictive.
- It is impossible to write a document that can foresee all possible abuse by the user, but most current D30 standards have attempted to anticipate abuse or ignorance by including substantial (critics might say excessive) detailed explanatory guidance, in addition to the requirements.
- The next generation of D30 standards revisions will seek to reduce the burden on the user without also losing the valuable guidance.

New D30 Standards Since 2000

2000-2001: New D30 Standards

D 6507: Practice for Fiber Reinforcement Orientation Codes for Composite Materials

D 6641/D 6641M: Test Method for Determining the Compressive Properties of Polymer Matrix Composite Laminates Using a Combined Loading Compression (CLC) Test Fixture

D 6671/D 6671M: Test Method for Mixed Mode I-Mode II Interlaminar Fracture Toughness of Unidirectional Fiber Reinforced Polymer Matrix Composites

D 6742/D 6641M: Practice for Filled-Hole Tension and Compression Testing of Polymer Matrix Composite Laminates

2002: New D30 Standards

D 6772: Test Method for Dimensional Stability of Sandwich Core Materials

D 6790/D 6790M: Test Method for Determining Poisson's Ratio of Honeycomb Cores

2003: New D30 Standards

D 6856: Guide to Testing Fabric-Reinforced “Textile” Composites

D 6873/D 6873M: Test Method for Bearing Fatigue Testing of Polymer Matrix Composite Laminates

2004: New D30 Standards

D 4762: Guide for Testing Polymer Matrix Composite Materials

(the 1988 standard with this same designation was completely re-written in 2004 to summarize the scope and applicability of all D30 PMC standards as well as some key related standards of other ASTM Committees, and is in revision again in 2007 to capture the recent progress)

2005: New D30 Standards

D 7078/D 7078M: Test Method for Shear Properties of Composite Materials by the V-Notched Rail Shear Method

D 7136/D 7136M: Test Method for Measuring the Damage Resistance of a Fiber-Reinforced Polymer Matrix Composite to a Drop-Weight Impact Event

D 7137/D 7137M: Test Method for Compression Residual Strength Properties of Damaged Polymer Matrix Composite Plates

CAI = Dynamic Impact Resistance + Residual Compressive Strength

Designation: D 7741Z

DUAL

Standard Test Method for

Measuring the Damage Resistance of a Fiber-Reinforced Polymer Matrix Composite to a Dynamic Impact Event [1]

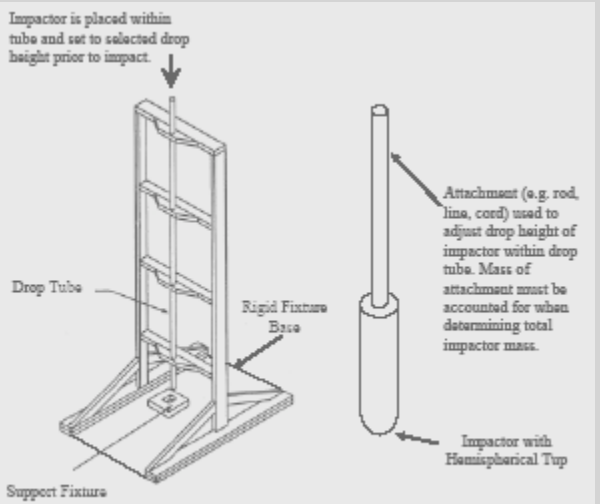


FIG. 5 Impact Device with Cylindrical Tube Impactor Guide Mechanism

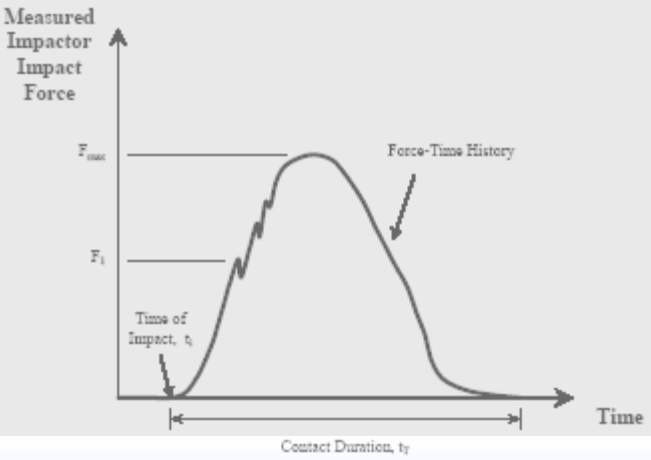
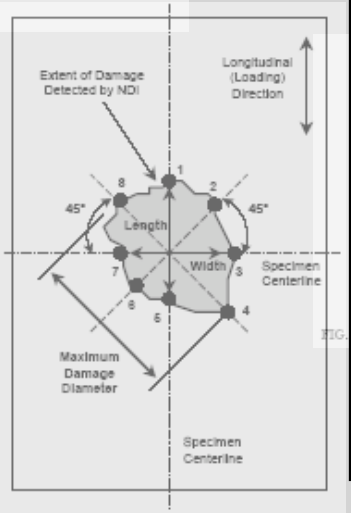


FIG. 7 Representative Impactor Force versus Time History



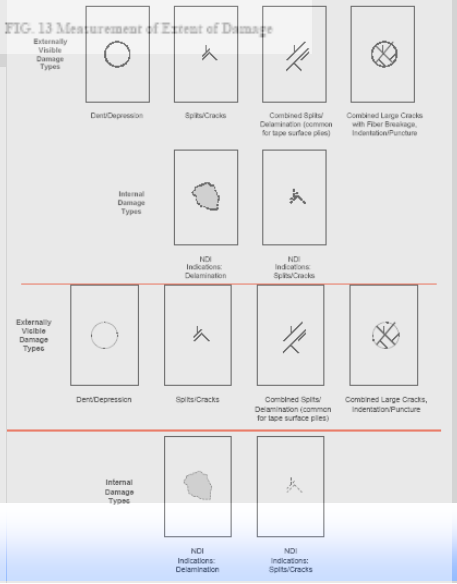


FIG. 13 Measurement of Extent of Damage

Designation: D 7043Z

DUAL

Standard Test Method for

Compression Residual Strength Properties of Damaged Polymer Matrix Composite Plates [1]

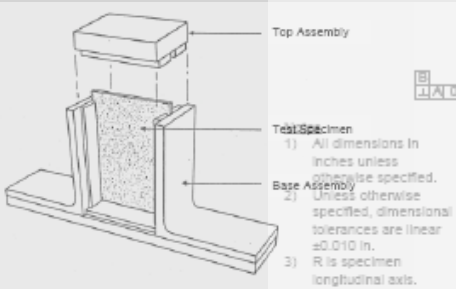


FIG. Schematic of Compression Residual Strength Support Fixture with Specimen in Place

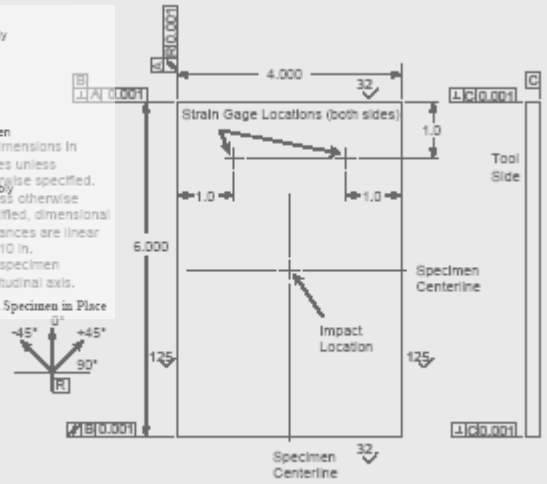


FIG. 11 Compression Residual Strength Test Specimen (Inch-Pound Version)

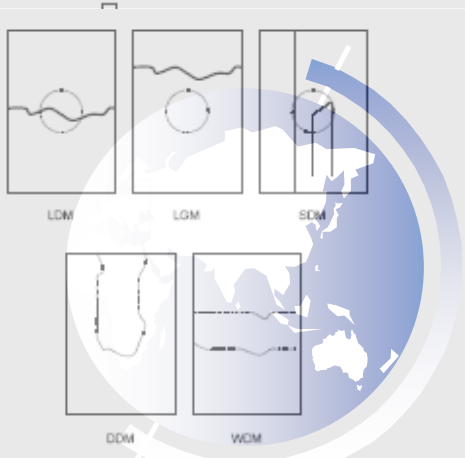


FIG. 15 Commonly Observed Acceptable Compressive Residual Strength Failure Modes

2006: New D30 Standards

D 7205/D7205M: Tensile Properties of Continuously-Reinforced Polymer Matrix Composite Bars

D 7248/D7248M: Test Method for Bearing/Bypass Interaction Response of Polymer Matrix Composite Laminates Using 2-Fastener Specimens

D 7249/D7249M: Test Method for Facing Properties of Sandwich Constructions by Long Beam Flexure

D 7250/D7250M: Practice for Determining Sandwich Beam Flexural and Shear Stiffness

D 7264/D7264M: Test Method for Flexural Properties of Polymer Matrix Composite Materials

D 7290: Practice for Evaluating Material Property Characteristic Values for Polymeric Composites for Civil Engineering Structural Applications

2007 to date: New D30 Standards

D7291/D7291M Test Method for Through-Thickness "Flatwise" Tensile Strength and Elastic Modulus of a Fiber-Reinforced Polymer Matrix Composite Material

D 7332/D7332M: Test Method for Measuring the Fastener Pull-Through Resistance of a Fiber-Reinforced Polymer Matrix Composite

D 7336/D7336M: Test Method for Static Energy Absorption Properties of Honeycomb Sandwich Core Materials

D 7337/D7337M: Tensile Creep Rupture of Fiber Reinforced Polymer Matrix Composite Bars

D 7028: Test Method for Glass Transition Temperature (DMA Tg) of Polymer Matrix Composites by Dynamic Mechanical Analysis (DMA)

New Standards Initiatives

- ***Civil Engineering infrastructure standards: test methods, practices, and guides:***
  - *In March 2005 the American Concrete Institute (ACI) Committee 440 on "Fiber Reinforced Polymer Reinforcements", joined D30.05.01 to transition 17 ACI 440 documents into D30 Standard Guides, Practices, and/or Test Methods.*
  - *The TG consists of about 13 D30 members from the Civil Engineering Structures community, with 8 non-ASTM subject matter experts from ACI.*
- ***Draft standard test methods are currently in-work for a number of other items, including:***
  - *Open-hole fatigue testing*
  - *Additional testing modes for interlaminar fracture*
  - *Sandwich cleavage fracture toughness*
  - *Non-ambient environmental testing*

Possible New Standards

Other technical areas for possible D30 standards development include:

- *HPLC and FTIR*
- *Large-scale CAI*
- *Creep*
- *Stress-rupture*
- *Notched laminate testing guide*

D30.02 Research and Mechanics

- Past Symposia and resulting (peer-reviewed) Special Technical Publications and Workshops:
  - March 2004, Salt Lake City: Workshop on Computational Fracture Mechanics
  - March 2003, Kansas City: *Joining and Repair of Composite Structures (STP 1455)*
  - March 2002, Pittsburgh: 14th *Composite Materials: Testing and Design* (STP 1436)
  - March 2001, Phoenix: *Composite Materials: Testing, Design, and Acceptance Criteria* (STP 1416)
  - March 2000, Seattle: *Composite Structures: Theory and Practice* (STP 1383)

Future D30 Objectives

- *Add more quantative precision statements based on accurate and effective round-robin test programs*
- *Improve balance between a concise lab procedure and detailed explanatory guidance or requirements*
- *Increase exposure and acceptance in non-aerospace and international markets*
- *Consider standardizing the experimental benchmarking of advanced numerical methods*
- *Expand into non-aerospace statistical assurance of measured properties*

Current and Future Relationships

- *Cooperation with CMH-17 (MIL-HDBK-17) on consensus test methods and testing guidance*
- *Cooperation with SAE Committee P on test methods for consensus standard composite material specifications*
- *Standards supporting marine and civil infrastructure product development*

D30 Standards Coordination and Globalization

- **Objective:** Provide timely, full-consensus solutions to the standards needs of the global composites industry
- **Approach:**
  - Expanded Affiliate membership.
  - Added participation via electronic communications, electronic standards development, and electronic balloting.
  - Special invitations to international stakeholders.
  - Increased partnering:
    MIL-HDBK-17, SAE, ASC, SAMPE, etc

ASTM International Campus

Learning Modules

- *Enhance students' skills and knowledge through standards education*

Meet the Standards Setters

- *Experts share how standards knowledge can benefit students' job placement and career success*

Standards on Campus

- *Easy and cost effective way to incorporate standards into teaching curriculum*

  - *create a package of up to 10 ASTM standards of your choice and make it available to students for just $10 per student.*

ASTM International

Committee D30 on Composite Materials

www.astm.org

www.astm.org/COMMIT/D30.htm