FED. SUPPLY CLASS
53GP

FOREWORD

This standard sets forth a standard test method to determine the tensile strength of externally and internally threaded fasteners.

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AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC
1000 WILSON BLVD.
ARLINGTON, VA 22209

THIS DRAWING SUPERSEDES ALL ANTECEDENT STANDARD DRAWINGS FOR THE SAME PRODUCT AND SHALL BECOME EFFECTIVE NO LATER THAN SIX MONTHS FROM THE LAST REVISION DATE.

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THIRD ANGLE PROJECTION	CUSTODIAN	REVISION
	NATIONAL AEROSPACE STANDARDS COMMITTEE	2
PROCUREMENT SPECIFICATION	TITLE	CLASSIFICATION
NONE	**FASTENER TEST METHODS, METHOD 8, TENSILE STRENGTH**	STANDARD PRACTICE
		NASM1312-8
		SHEET 1 OF 14

FORM 09-01

FIGURES

TABLES

(2) COMPLETELY REVISED

1. SCOPE

1.1 Applicability. This method covers a procedure for testing all types of structural fasteners in axial tension at room temperature. This procedure is intended to define the test required to determine the tensile strength of the fastener itself, not the strength of the fastener in any combination of sheet materials, sheet heat treat levels, or sheet thicknesses.

2. REFERENCED DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards and handbooks. Unless otherwise specified, the following specifications, standards and handbooks of the issue listed in the current Department of Defense Index of Specifications and Standards (DoDISS) and the supplement thereto (if applicable), form a part of this standard to the extent specified herein.

MILITARY STANDARDS

~~MIL-STD-45662 Calibration System Requirements~~

(Copies of specifications, standards, handbooks, drawings and publications required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Other publications. The following document(s) forms a part of this specification to the extent specified herein. The issues of the documents which are indicated as DOD adopted shall be the issue in the current DoDISS and the supplement thereto, if applicable.

ASTM INTERNATIONAL

ASTM E4 Standard Methods of Force Verification of Testing Machines
ASTM E83 Tentative Method of Verification and Classification of Extensometers Systems

(Copies can be obtained from ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA, 19428-2959 USA www.astm.org)

AEROSPACE INDUSTRIES ASSOCIATION (AIA)

NAS1069 Tension Fatigue Test Procedure for Aeronautical Fasteners

(Copies can be obtained from the Aerospace Industries Association, 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209 www.aia-aerospace.org)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 10012 Measurement Management Systems - Requirements for Measurement Processes and Measuring Equipment

(Copies can be obtained from the American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036-8002 USA www.ansi.org)

NCSL International (National Conference of Standards Laboratories)

NCSL Z540.3 Calibration Laboratories and Measuring and Test Equipment

(Copies can be obtained from NCSL International, 2995 Wilderness Place, Suite 107, Boulder, CO 80301. www.ncsli.org)

3. DEFINITIONS

Not applicable.

4. GENERAL REQUIREMENTS

4.1 Test apparatus.

4.1.1 Testing machine. The testing machine shall be capable of applying a tensile load at a controllable rate. The calibration system for the machine shall conform to the requirements of ~~MIL-STD-45662~~ISO 10012 or NCSL Z540.3. Its accuracy shall be verified every 12 months by a method complying with ASTM E4, using a calibration device that shall have been calibrated by the National Institute of Standards and Technology not more than 2 years prior to its use. The yield loads, ultimate loads, and structural failure loads of the fasteners tested (5.4 and 5.5) shall be within the loading range of the testing machine as defined in ASTM E4.

4.1.2 Extension measuring device. The extension measuring device shall be an averaging, differential-transformer extensometer, or equivalent, preferably of the separable type. It shall conform to the requirements of ASTM E83, Class B-1 when used in conjunction with an autographic recorder. The extensometer shall be capable of installation so as to measure either the relative movement between the movable and stationary crossheads of the testing machine or the extension of the fastener only, preferably the latter. Load and extension ranges shall be used to give the initial portion of the load-extension curve a slope between 45 and 60 degrees.

4.1.3 Test fixtures. Test fixtures specified in 4.1.3.1 and 4.1.3.2 are permissible. Other types of fixtures may be used provided all of the following requirements are met:

a. Hole size for any fastener shall be the maximum shank diameter of the fastener to be tested plus 0.001 inch with a tolerance of +0.004, –0.000 inch. Alternatively, the hole shall conform to the diameter and limits specified by the fastener manufacturer or by the applicable procurement specification.

b. The hole shall be perpendicular to the fixture surfaces within ±1 degree.

c. Where applicable, the hole shall be chamfered to provide clearance for the head-to-shank fillet radius of the fastener. The diameter of the chamfer shall not exceed the maximum diameter of the shank of the fastener being tested, plus two times the maximum fillet radius of the fastener being tested, plus .010 inch. When a chamfer at the entrance of the hole is used, the diameter of the chamfer shall be recorded in the Test Report. See 6.1.

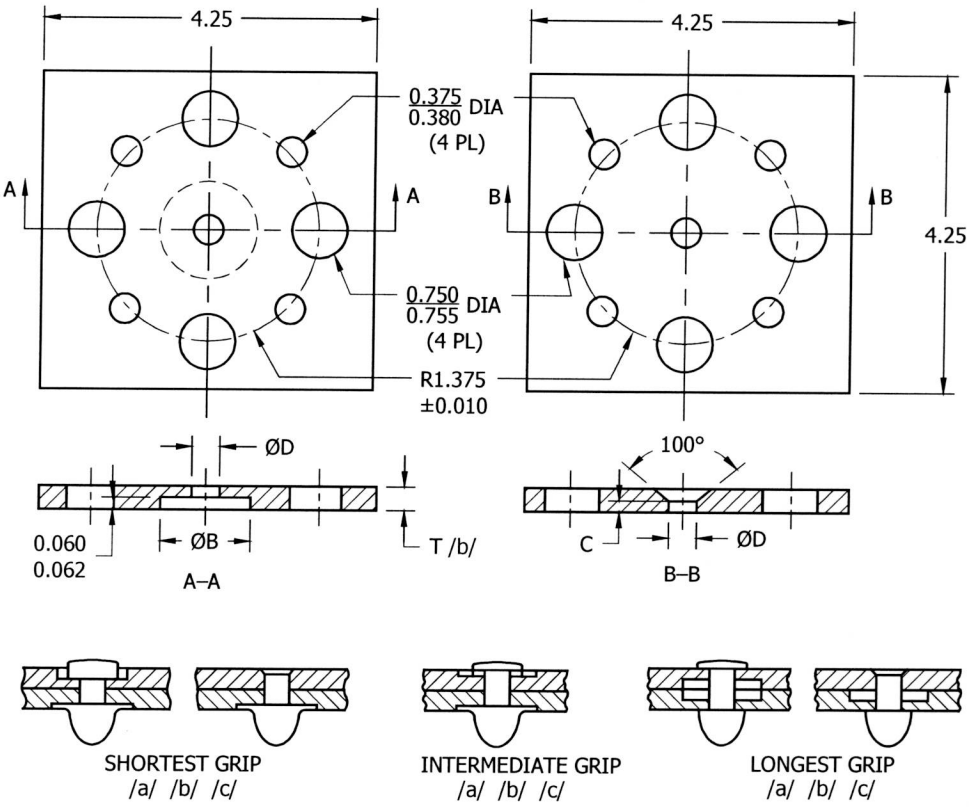
d. The fixture shall be capable of applying an axial tensile load through the center line of the fastener by means of suitable supporting fixtures.

4.1.3.1 NAS1069 fixture. This recommended test fixture is either the cup or insert type as defined in NAS1069, figures 8-13. Hole size for any unspecified fastener shall be the maximum shank diameter of the fastener to be tested plus 0.001 inch with a +0.004, –0.000 inch tolerance. In any case, the hole in the fixture shall not reduce the bearing area of the fastener head by more than 10 percent. The bearing area shall be considered as the area between the minimum bearing face outer diameter and the maximum diameter at the point of tangency of the head-to-shank fillet radius. The fixture design shall provide clearance for the head to shank fillet radius.

4.1.3.2 Tension plate fixture. The tension plate type fixture may be used for short grip length fasteners. The fixture configuration shall be as shown in Figures 1 and 2 or Figures 3 and 4. The upper and lower plates shall be parallel within 0.25 degree.

4.1.3.3 Angularity evaluation. When tests are intended to evaluate the effect of angularity under the head or nut (collar) end of the fastener, the angularity shall be applied by the use of tapered spacers with the required angularity. The spacers shall be made of material harder than that of the fastener and shall have flat ground surfaces. The area of the spacer shall be greater than the bearing area of the fastener head or the nut being tested. The hole shall be the maximum shank diameter plus 0.005 inch with a tolerance of +0.003, –0.000 inch. Alternatively, the hole size shall conform to the diameter and limits specified by the fastener manufacturer or applicable specification.

4.2 Test specimens.



/a/ ~~Omit counterbore and use 2024-T3 or 2024-T4 aluminum sheet when testing DEUTSCH blind rivets, unless otherwise specified.~~

/b/ Counterbore optional, if short and intermediate grips are not required.

/c/ Surface Roughness 32 to 63 microinches Ra per ASME B46.1.

(d) Material: ~~4140~~ Alloy steel heat treated to 200/220 KSI ~~200,000 psi, or equal /1/~~.

(e) Tolerances unless otherwise specified: decimals ±0.010, angels ±1 degree.

(f) Chamfer all hole edges to provide head fillet clearance.

(g) Dimensions in inches.

FIGURE 1 – TENSION FIXTURES FOR SHORT GRIP FASTENERS

TABLE I – DIMENSIONS

Nom Fstnr Size	T +0.001 −0.000	ØB ±0.01	ØD, +0.004, −0.000						C dimension, +0.000, −0.002						
			/a/ /b/ /c/ /d/	/e/	~~/f/~~	~~/g/~~	/h/	~~/j/~~	/a/	/b/ /h/	/c/ ~~/j/~~	/d/	/e/	~~/f/~~	~~/g/~~
0.093	0.125	0.75	0.094				0.097			0.036					
0.125	0.125	0.75	0.125			~~0.136~~	0.129			0.042		0.030			~~0.039~~
0.156	0.188	0.88	0.156	0.164	~~0.170~~	~~0.173~~	0.160			0.055		0.038	0.072	~~0.070~~	~~0.049~~
0.164	0.188	0.88	0.165						0.072						
0.190	0.250	1.00	0.190	0.199	~~0.197~~	~~0.204~~	0.192	~~0.190~~	0.084	0.070	0.048	0.046	0.084	~~0.080~~	~~0.064~~
0.190	0.250	1.00	0.190	0.199	~~0.197~~				0.084	0.070	0.048		0.084	~~0.080~~	
0.250	0.250	1.00	0.250	0.261	~~0.258~~		0.256	~~0.260~~	0.110	0.095	0.063	0.061	0.111	~~0.108~~	
0.313	0.250	1.12	0.312	0.313	~~0.339~~				0.138	0.106	0.070		0.139	~~0.128~~	
0.375	0.250	1.12	0.375	0.375	~~0.391~~				0.159	0.134	0.081		0.167	~~0.160~~	

/a/ Protruding and flush tension head solid shank fasteners.

/b/ Flush (MS20426) head solid shank fasteners.

/c/ Flush head solid shank fasteners.

/d/ Flush shear head driven rivets.

/e/ ~~JO bolts~~ NAS1675 Blind Fasteners and NASM81177 Blind bolts.

/f/ ~~Blind bolts.~~

/g/ ~~Explosive Rivets.~~

/h/ Blind rivets ~~except DEUTSCH.~~

/j/ ~~DEUTSCH blind rivets. /1/~~

(k) Dimensions in inches.

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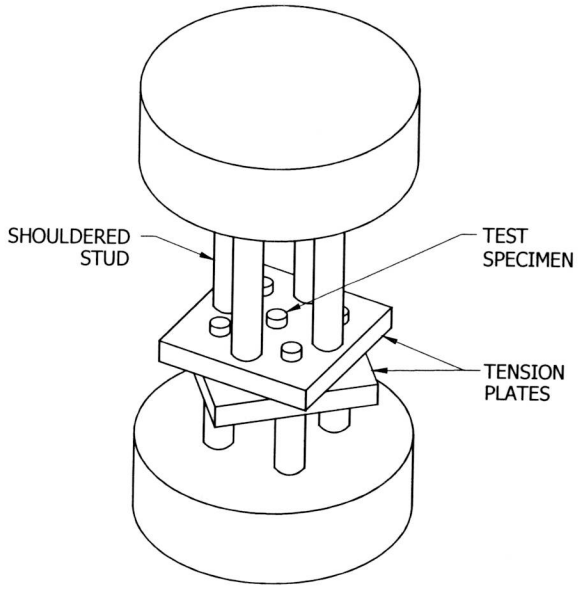


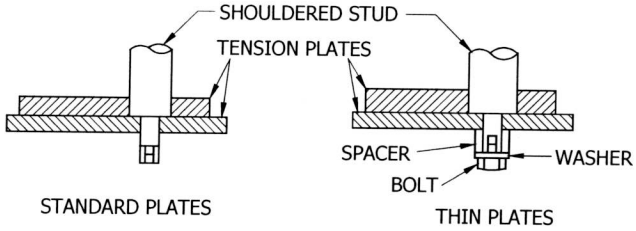
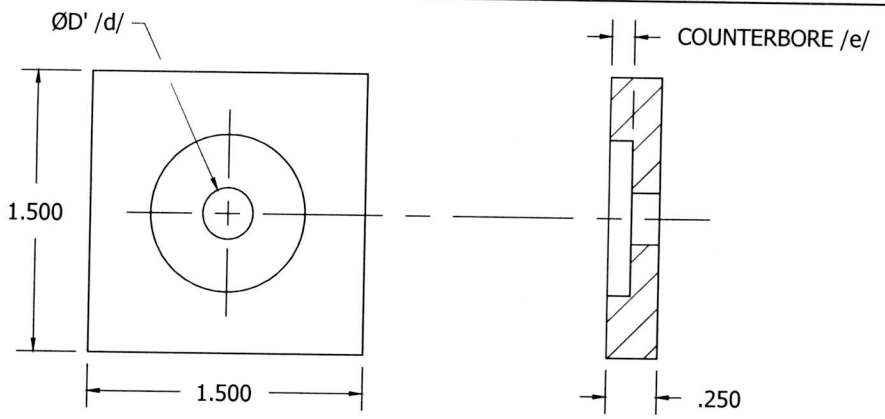
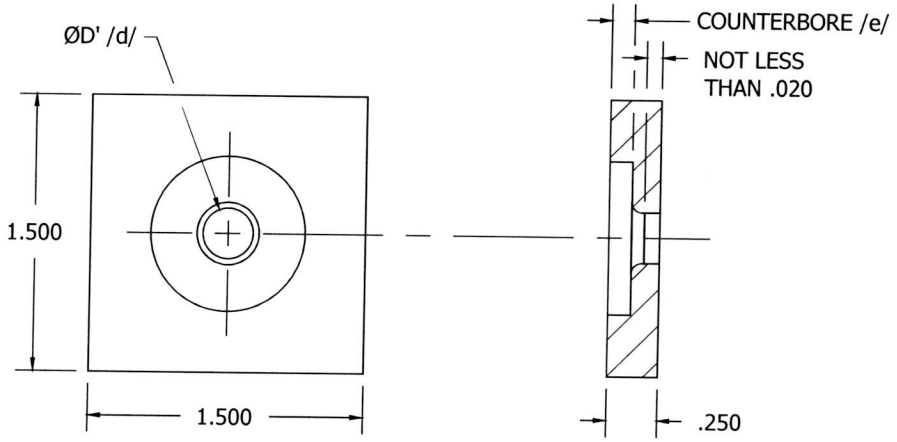


FIGURE 2 – TENSION SETUP

(2) COMPLETELY REVISED



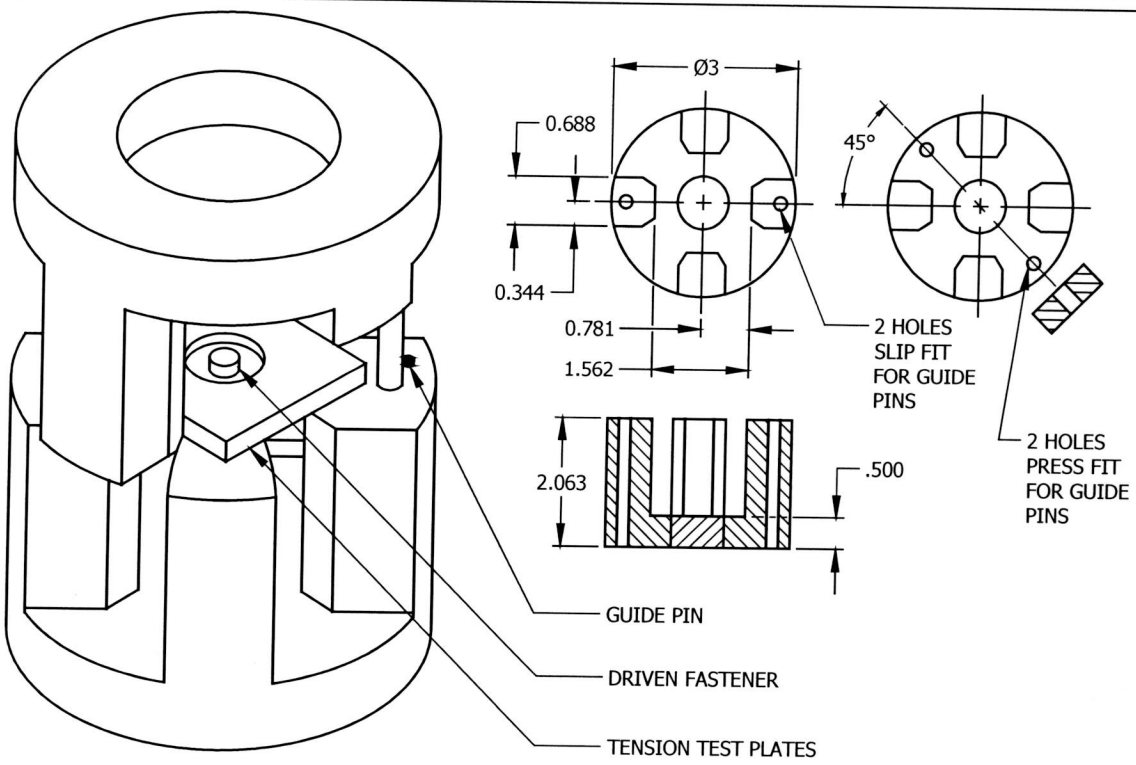
PROTRUDING HEAD TEST PLATE



FLUSH HEAD TEST PLATE

(a) Material: Alloy steel.
(b) Heat treat: 48-50 HRC.
(c) Machine or grind edges square with face.
/d/ ØD' = (ØD + 0.001), +0.002, –0.000, where "ØD" equals the fastener maximum shank diameter.
/e/ Counterbore as required for grip.
(f) Dimensions in inches.
(g) Tolerances: ±0.010 unless otherwise noted.

FIGURE 3 – TEST PLATE



(a) Dimensions in inches.

(b) Tolerances: ±0.010 and ±1.0 degrees unless otherwise noted.

FIGURE 4 – TENSION FIXTURE ASSEMBLY

4.2.1 General. When specific bolt-nut combinations, pin and collar fasteners, or integral fasteners supplied complete in one assembly, are being evaluated, the tests must be performed on the entire assembly. Tests resulting in failure of any component of the assembly shall be considered a malfunction for the entire fastener; i.e. the failure of any component shall be cause to terminate the test.

4.2.2 Externally threaded fasteners. Unless otherwise specified, the nut or internally threaded component used for testing of the externally threaded fastener alone shall be of sufficient strength to ensure bolt failure. For guidance purposes, the internally threaded component should, as a minimum, have a strength rating equal to the externally threaded fastener being tested. The internally threaded component can be an integral part of the test fixture. Tests resulting in failure of the internally threaded component shall not be considered a satisfactory test of the ultimate strength of the externally threaded fastener. However, this data may be acceptable to establish conformance to minimum tensile strength requirements.

4.2.3 Internally threaded fasteners. Unless otherwise specified, the externally threaded fastener or fixture used for testing of the internally threaded fastener specifically shall be of sufficient strength to ensure failure of the internally threaded component. As a minimum, the bolt should have a higher strength rating than the internally threaded fastener being tested. Tests resulting in failure of the externally threaded fastener shall not be considered a satisfactory test of the ultimate strength of the internally threaded component. However, this data may be acceptable to establish conformance to minimum tensile strength requirements. When it is desired to verify the strength of the test bolt, a separate test of the bolt may be performed using either the companion nut specified on the bolt standard or the nut defined in Figure 2 of NASM1312-11.

4.2.4 Grip length.

4.2.4.1 Specified grip range. Fasteners having a specific grip range (such as lockbolts, HI-LOKS, blind rivets, and blind bolts) shall be tested in such grip conditions as required by applicable specifications or procurement documents.

4.2.4.2 Unspecified grip range. Threaded fasteners having no specified grip range, such as those threaded to the head, shall be tested at the grip length where, as a minimum, the chamfer at the end of the bolt threads must project beyond the end of the nut.

4.2.4.3 Grip length adjustment. The grip length for fasteners which must be installed with installation preload shall be adjusted with washers or shims located between the test fixtures, not under nuts, collars or heads.

4.2.5 Washers or spacers. The use of washers or spacers under fastener heads, nuts or collars is specifically prohibited unless the use of such washers or spacers is specifically required in the product application. Where spacers are required to evaluate the effect of angularity or to provide clearance for the head to shank fillet radius, they shall be hardened and ground as specified in 4.1.3.3.

5. DETAIL REQUIREMENTS

5.1 Test procedures.

5.1.1 Test Setup.

5.1.1.1 ~~NAS1069~~ Test fixture. The specimen shall be installed in the holding fixture at the proper grip using normal installation procedures. Preload shall not be used except for those fasteners where preload is a normal result of the installation. The assembly of specimen and fixtures shall be placed between the machine tension heads. The difference between the maximum and the average stress caused by misalignment or eccentric loading shall not exceed 3 percent average stress.

5.1.1.2 Tension plate fixture. The specimens shall be installed in the fixture at the proper grip using normal installation procedures. Preload shall not be used except for those fasteners where preload is a normal result of the installation. The assembly of specimen and plates shall be installed in a suitable test jig as shown in Figures 2 or 4 and placed between the compression heads of the testing machine. Care shall be exercised to locate the jig at the center of the piston when hydraulic testing machines are used.

5.2 Loading rate. Tension load shall be applied to the fastener slowly and evenly. Unless otherwise specified by the fastener manufacturer, or by applicable detail specification or procurement document, the rate of loading shall be in accordance with Table II. Larger or smaller fasteners than those shown in Table II shall be tested at rates producing 100,000 pounds/minute (±10 percent) per square inch of nominal shank area.

TABLE II – TENSION LOAD RATES

Nominal fastener diameter	Load rate (lb./min ± 10%)	Nominal fastener diameter	Load rate (lb./min ± 10%)
0.125	1,240	0.563	24,800
0.156	1,920	0.625	30,600
0.164	2,100	0.750	44,000
0.190	2,800	0.875	60,000
0.250	5,000	1.000	78,000
0.313	7,700	1.125	100,000
0.375	11,000	1.250	122,000
0.438	15,000	1.375	148,000
0.500	19,600	1.500	176,000

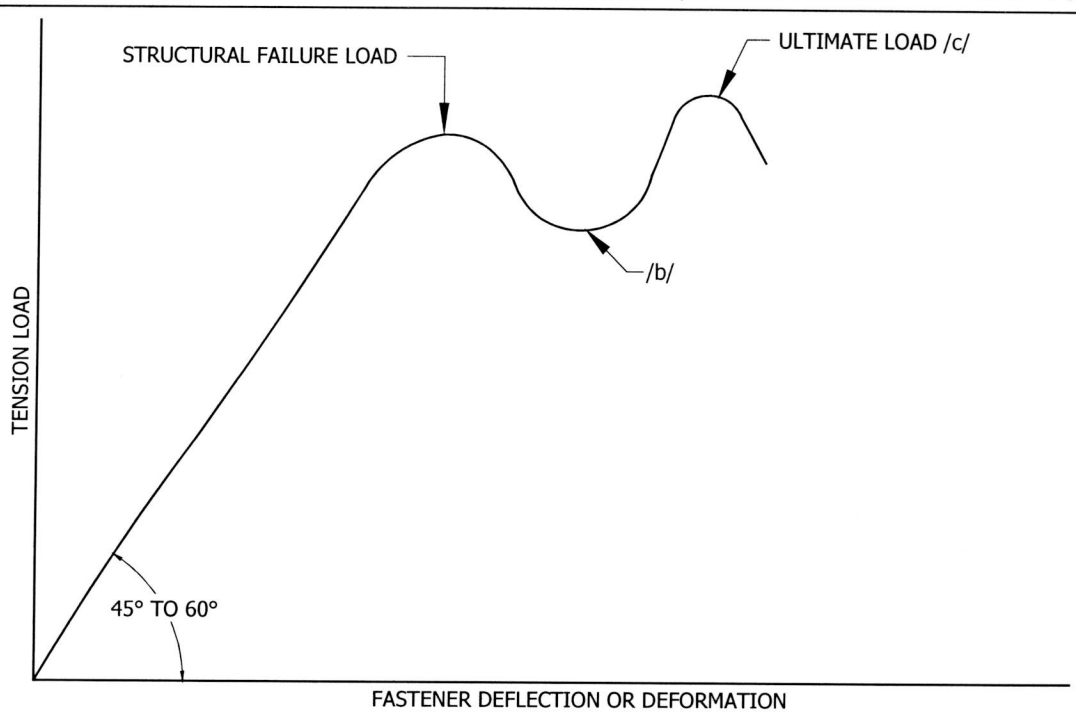
(a) As an alternative loading method, the rate of loading can be determined as a constant head travel that gives strain rates consistent with the above load rates in the elastic range.

5.3 Load-deflection curves. Load-deflection curves, when specified, shall be made by autographic recording. The movement sensing element shall be so installed as to either measure the relative movement between the movable cross-head and the stationary cross-head, or to measure the deflection of the fastener only, preferably the latter. The latter measurement shall be accomplished by placing the movement sensing elements adjacent to the fastener between the facing surfaces of the fastener holding fixtures for the NAS1069 fixture, or on the externally opposed surfaces of the tension plate, or over the ends of the fastener. The fixture shall have the capability of being non-yielding at ultimate load.

5.4 Failing load determination. When a structure failure occurs before the ultimate or fracture load has been recorded, it may be detected on the load-deflection curve as a peak load followed by severe permanent deformation without increase in load or with a decrease in load. A sample load-deflection curve illustrating a "structural failure" is shown on Figure 5. The first peak load shall be designated as the "structural failure load" and the second peak shall be the "ultimate load."

5.5 Yield load determination. The yield load shall be determined by the Johnson's two-thirds method of approximation, as shown on Figure 6. On the load-deflection plot described in 5.3, draw a line (line "A") with two-thirds the slope of the straight portion of the curve. Parallel to this line and tangent to the load-deflection curve, draw another line (line "B"). The point of tangency of line "B" with the curve represents the yield load.

5.6 Number of specimens. Unless otherwise specified in the detail specification or purchase order, a minimum of five (5) specimens shall be tested for each fastener diameter and test condition.

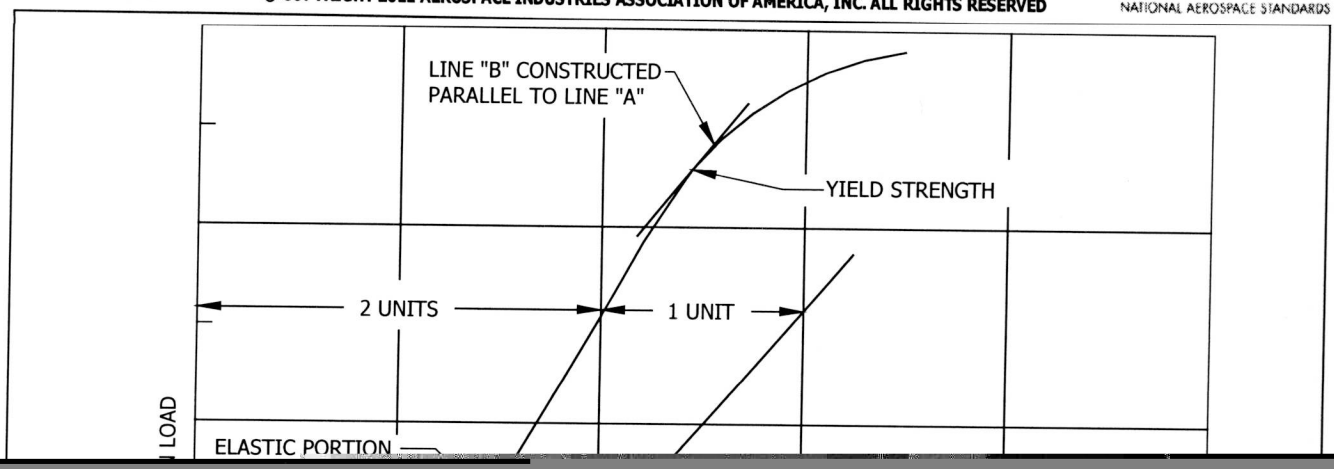


(a) The effect of a structural failure is more obvious when testing at constant head travel than when testing at constant load rate.

/b/ There may or may not be a severe reduction of load depending on the relation between load rate and deformation rate.

/c/ Ultimate if higher than structural failure load. Second peak may be lower than the first peak.

FIGURE 5 – SAMPLE LOAD-DEFLECTION CURVE



b. Test machine.
   1. Model and serial number.
   2. Calibration date.

c. Loading rate or strain rate.

d. Ultimate loads.

e. Yield loads.

f. Installation procedure.

g. Fixture used.
   1. Hole diameter.
   2. Chamfer dimensions (for fillet radius clearance).

h. Structural failure loads.

i. Mode of failure.

j. Load-deflection curve.

k. Strain magnification factor.

l. Method of deflection measurement.

m. Cause and duration of any interruptions during test.

n. Results of all inspections.