



Torque, Tension, Angle Evaluation of U-bolted Joints

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. To determine dynamic torque, tension, and angle characteristics of a U-bolted joint.

1.2 Applicability. Unless otherwise specified, this procedure applies to initial tightening event of joints using threaded fasteners with new thread and bearing surfaces and new clamped members.

1.3 Remarks.

1.3.1 Limitation. This procedure does not apply to Pulse tools.

1.3.2 Unless otherwise specified, any requirements or direction provided in Test Request documentation will supercede this test procedure.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW15569 GMW16820

2.3 Additional References. None.

3 Resources

3.1 Facilities. GM approved laboratory or location for this test procedure.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment.

3.2.1 Torque/angle transducers (two (2) per U-bolt).

3.2.2 Data acquisition system capable of collecting data at a sampling rate of at least 1000 Hz, plotting data at user specified scales, and identifying data at all points on curve.

3.2.3 Strain gaged U-bolts.

3.2.4 Tightening tools (two (2) per U-bolt).

3.2.5 Load frame.

3.2.6 Strain indicator.

3.2.7 Appropriate fixturing, bedplate, or slotted table.

3.3 Test Vehicle/Test Piece.

3.3.1 A complete bill of materials of required test pieces will be specified in Test Request documentation.

3.3.2 Unless otherwise specified, a minimum of four (4) joints are to be used for this test.

3.3.3 Typical component quantities (see Table 1).

Table 1: Typical Component Quantities

Component	Quantity
Anchor Plate	4
Spacer	4
U-Bolt	14
Axle with Spring Seat	4
Leaf Spring	1
Nut and Washer	20

3.4 Test Time.

Calendar time: 4 d

Test time: 120 h

Coordination time: 40 h

3.5 Test Required Information. Test Request documentation shall outline specific information and test parameters (reference Appendix B, Data Sheet B1, or use similar format).

3.6 Personnel/Skills. Test Technician shall be qualified on basis of appropriate education, training, experience, and/or demonstrated skills.

4 Procedure

Note: Any deviations to this procedure are to be entered in Test Notes or Log Sheets.

4.1 Preparation.

4.1.1 U-bolt Load Deflection Test.

4.1.1.1 In order to establish a calibration value for strain gaged U-bolts, randomly select two (2) U-bolts.

4.1.1.1.1 Perform U-bolt Saddle Tensile Test in accordance with GMW16820 while recording load and deflection.

4.1.1.1.2 Supply load vs. deflection curve.

4.1.1.1.3 Core hardness check (optional) can be also performed.

4.1.1.2 Select Calibration Load from saddle tensile plot.

Note: Plot depicts total load. Divide by two (2) to obtain tensile load per U-bolt leg.

Curve should be linear up to desired calibration load per U-bolt leg.

4.1.2 U-bolt Strain Gaging and Calibration.

4.1.2.1 Randomly select eight (8) U-bolts and attach required strain gages, full bridge wired for axial loading with bending compensation. Reference U-bolt schematic for location of strain gages (see Appendix A, Figure A1).

4.1.2.2 Install a U-bolt into load frame using load frame fixturing.

4.1.2.3 To ensure U-bolt is centered on fixture, run two (2) threaded adapters down evenly until adequate engagement (minimum one (1) U-bolt diameter from first full thread) is achieved.

4.1.2.3.1 If possible, adapters should not be placed in area where nuts will reside upon final assembly.

4.1.2.3.2 Threads used to achieve correct clamp should remain virgin. This is desirable because any change in surface finish of thread could affect coefficient of friction.

4.1.2.4 Exercise U-bolt by loading it to maximum calibration value and returning to zero load a minimum of three (3) times.

4.1.2.5 Remove zero offset from strain gage if necessary.

4.1.2.6 Measure strain gage output and calibration load cell values in at least five (5) equally spread increments, from zero load to maximum calibration value, and from maximum value back to zero.

4.1.2.7 Repeat 4.1.2.6 two (2) more times and average data.

4.1.2.8 If calibration error is $\leq 2.5\%$ full scale, document sensitivity, shunt **calibration** resistance, shunt calibration load values, excitation voltage and zero output voltage.

4.1.2.9 If calibration error is $> 2.5\%$, repeat 4.1.2.5 through 4.1.2.7 until error of $\leq 2.5\%$ is achieved.

4.1.2.10 If unable to satisfy calibration requirements within three (3) calibration cycles, contact requestor.

4.2 Conditions.

4.2.1 Environmental Conditions. Not applicable.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.3 Instructions.

4.3.1 Review part quantities and condition.

4.3.2 Secure test parts to T-slot table or fixture.

4.3.3 Select tightening tools and mount parts in tool holding fixture.

4.3.4 Synchronize all tools to tool speed requested and document free spinning speed.

4.3.5 Select strain gaged U-bolts and torque transducers with angle encoders.

4.3.6 Configure data acquisition system to collect torque, tension, and angle data for each spindle.

4.3.7 Obtain test parts and **loosely** assemble parts (i.e., no load on U-bolts until after calibration check).

4.3.8 Record calibration signal from instrumented U-bolts (no load applied).

4.3.9 (Optional). Apply minimum torque to all nuts in order to bring assembly together in a **uniform** manner and visually inspect to ensure that thread protrusion is approximately equal.

4.3.10 Unless otherwise specified, test requestor is to approve test setup.

4.3.11 Using multi-spindle setup, simultaneously torque nut on each U-bolt leg.

4.3.12 Joint shall be tightened to specifications outlined in Test Request documentation. Test shutoff parameters may include but are not limited to:

4.3.12.1 Maximum U-bolt calibrated load.

4.3.12.2 Maximum tightening specification target.

4.3.12.3 Joint failure.

4.3.13 Unless otherwise specified, run first sample recording torque, tension, angle, and failure mode, if any.

4.3.13.1 Visually inspect joint for deformation, fracture, etc.

4.3.13.2 Review findings with requestor and receive approval prior to proceeding.

4.3.14 If necessary, adjust test configuration to comply with instructions of requestor.

4.3.15 (Optional). After each test, conduct an audit torque (reference GMW15569).

4.3.15.1 For tightening sequence, refer to appropriate Master Process Document.

4.3.15.2 Record data on Appendix C, Data Sheet C1 or use similar format.

4.3.16 Complete test matrix on Appendix C, Data Sheet C1 or use similar format.

4.3.17 Summarize results according to requirements in Section 5 of this procedure.

4.3.18 Take photographs or digital images of test setup.

5 Data

5.1 Calculations. Not applicable.

5.2 Interpretation of Results.

5.2.1 Summary of Results (Required).

5.2.1.1 Provide detail of failure modes consisting of, but not limited to, fastener fracture, component fracture, component distortion or internal or external thread stripping (if applicable).

5.2.1.2 Test incidents to be recorded on Appendix C, Data Sheet C1 or use similar format.

5.2.1.3 Test data summarization to be recorded on Data Appendix D, Data Sheet D1 or use similar format.

5.2.1.4 Torque tension data summarization to be recorded on Appendix E, Data Sheet E1 or use similar format.

5.2.1.5 Required plots and tabular data tables include items shown in Table 2.

Table 2: Required Plots and Tabular Data Tables

Y-Axis	Torque	Tension	Angle	Compression	Load	Displacement	RPM	Time
Torque	.	T5	.	.	.	.	.	.
Tension	M	.	.	.	.	.	.	.
Angle	.	.	.	.	.	.	.	.
Compression	.	.	.	.	.	.	.	.
Load	.	.	.	.	.	.	.	.
Displacement	.	.	.	.	.	.	.	.
RPM	.	.	.	.	.	.	.	.

Legend:

- I** Individual sample plots (all spindles for each sample).
- L** Individual spindle (leg) plot.
- M** Multiple sample plot.
- S** Statistical plot.
- T** Tabular data table followed by incremental value.
- D** Dual Y Axis.

5.2.2 Summary of Results (Optional). After reviewing required data summarization, requestor may ask for additional items including, but not limited to, following:

5.2.2.1 Summary of results including, but not limited to, maximum torques, ultimate torques, and prevailing torques are recorded on Appendix F, Data Sheet F1 and/or Appendix G, Data Sheet G1 or use similar format.

5.2.2.2 Optional plots and tabular data tables include items shown in Table 3.