Hub Fatigue Test Procedures — SAE J1095 JUN82

SAE Recommended Practice
Approved June 1982

THIS IS A PREPRINT WHICH IS SUBJECT TO REVISIONS AND CORRECTIONS. THE FINAL VERSION WILL APPEAR IN THE 1983 EDITION OF THE SAE HANDBOOK.

SAE The Engineering Resource For Advancing Mobility

PREPRINT

Report of the Truck Wheel Subcommittee, approved by the Wheel Committee June 1982. Rationale statement available.

1. Scope—This recommended practice provides uniform laboratory procedures for fatigue testing of hubs intended for highway use on trucks, buses, truck-trailers, and multi-purpose passenger vehicles having bolt circles from 6.5–13$\frac{3}{16}$ in (165.1–335 mm) diameters. The tests described in this recommended practice are not to be construed as the only tests required or permitted to assure that a hub will perform satisfactorily for its intended use.

2. Definitions—A detailed listing of basic nomenclature is contained in SAE J393 (June 1969).

3. Test Procedures

3.1 Hubs for Test—Use only fully processed hubs which are representative of production parts intended for vehicle installation. New hubs and related parts shall be used for each test. If the hub application is always used with a brake drum or rotor, the hub may be tested with a brake drum or rotor attached. If the hub application is ever to be used without a brake drum or rotor, the hub must be tested without a brake drum or rotor attached.

3.2 Hub Dynamic Fatigue Test—The dynamic fatigue test may be conducted by one of the following methods:

3.2.1 CORNERING FATIGUE, 90 DEG LOADING METHOD (METHOD #1)

3.2.1.1 *Equipment*—The test machine shall be one with a means to impart a constant rotating bending moment and radial load to the hub (see Fig. 1).

3.2.1.2 *Procedure*—Mount the hub assembly to a test fixture adaptor using wheel nuts representative of those required by the application, and torqued to the limits specified in Appendix I for the appropriate application. Bearings and test speed may be adjusted so as to maximize bearing life. The mating surfaces of the test adaptor and hub shall be free of paint, dirt, or foreign matter. The final clamped position of the hub without load must not exceed an eccentricity of 0.010 in (0.254 mm) total

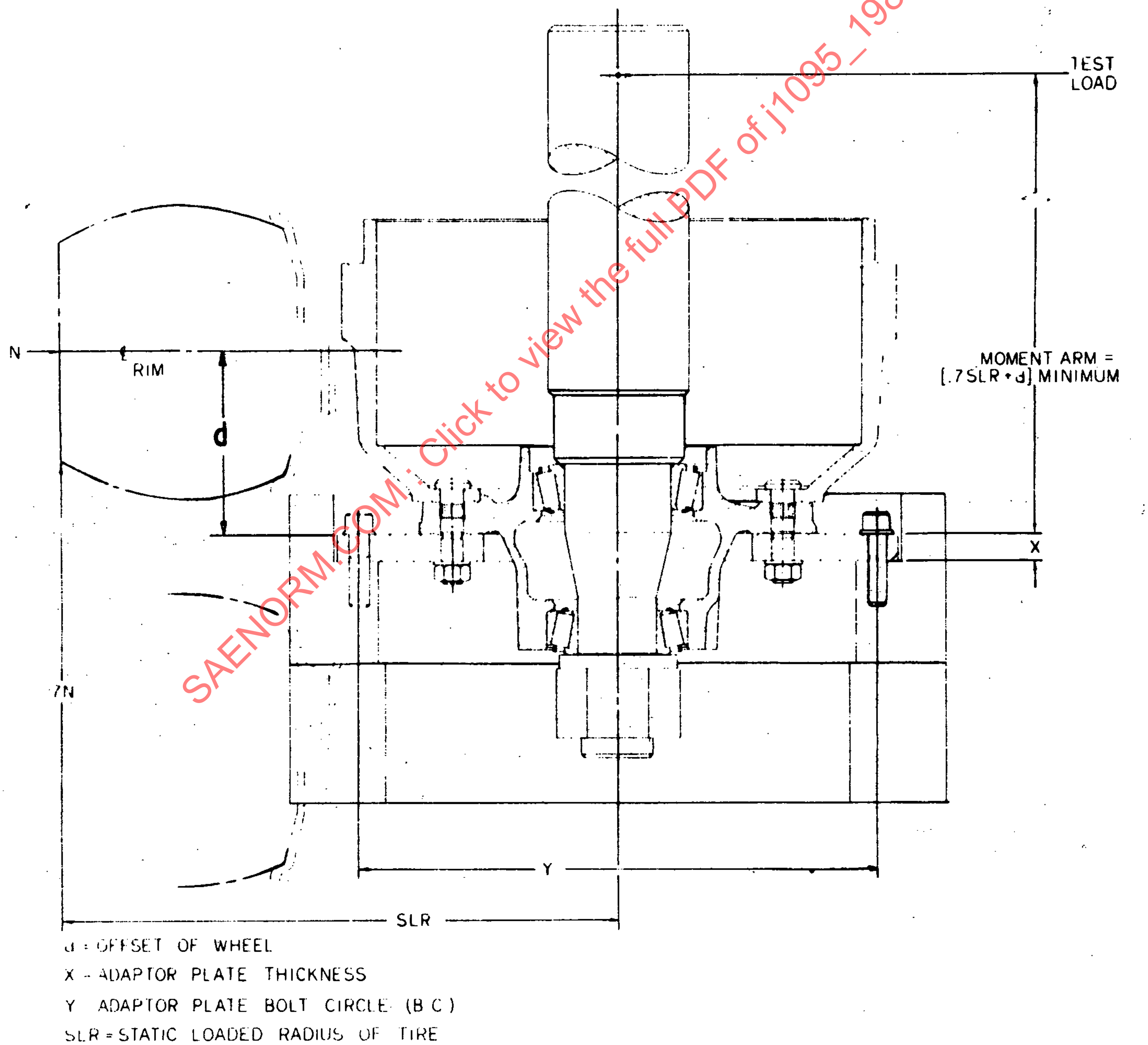

FIG. 1—90 DEG CORNERING FATIGUE TEST

indicator reading normal to the shaft axis at the point of loading. The load system shall maintain the specified load within ±3%. The application of the test load shall be parallel to the plane of the wheel mounting surface of the hub assembly at a specified distance (moment arm) as shown in Fig. 1.

3.2.1.3. *Test Load and Bending Moment Determination*—The test load is determined by:

$$\text{Test load} = \frac{M}{\text{Moment Arm (See Fig. 1)}}$$

M is determined by the formula:

$$M = \left[\frac{\mu\,(slr) + d}{12}\right](S)\quad L$$

where, M = Bending moment, lb force-ft (Nm)

L = Load rating of the hub as specified by the hub manufacturer, lb force (N)

slr = Static loaded radius of the largest tire to be used with the hub as specified by the vehicle manufacturer, inches, (mm × 39.37 × 10^{-3}). Refer to Appendix II for static loaded radius.

μ = Coefficient of friction developed between tire and road (0.7).

S = Accelerated test load factor.

d = Offset of wheel; inches (mm × 39.37 × 10^{-3}) as measured from the centerline of the rim to the wheel mounting surface of the hub assembly. For hubs used with symmetrical dual wheels only, d is zero. For hubs used with both dual wheels and singles with d values other than zero, use the largest absolute value for the offset. See Fig. 3 in SAE J393 to determine if d is positive or negative. If wheel may be used as both a positive or negative offset, use positive offset.

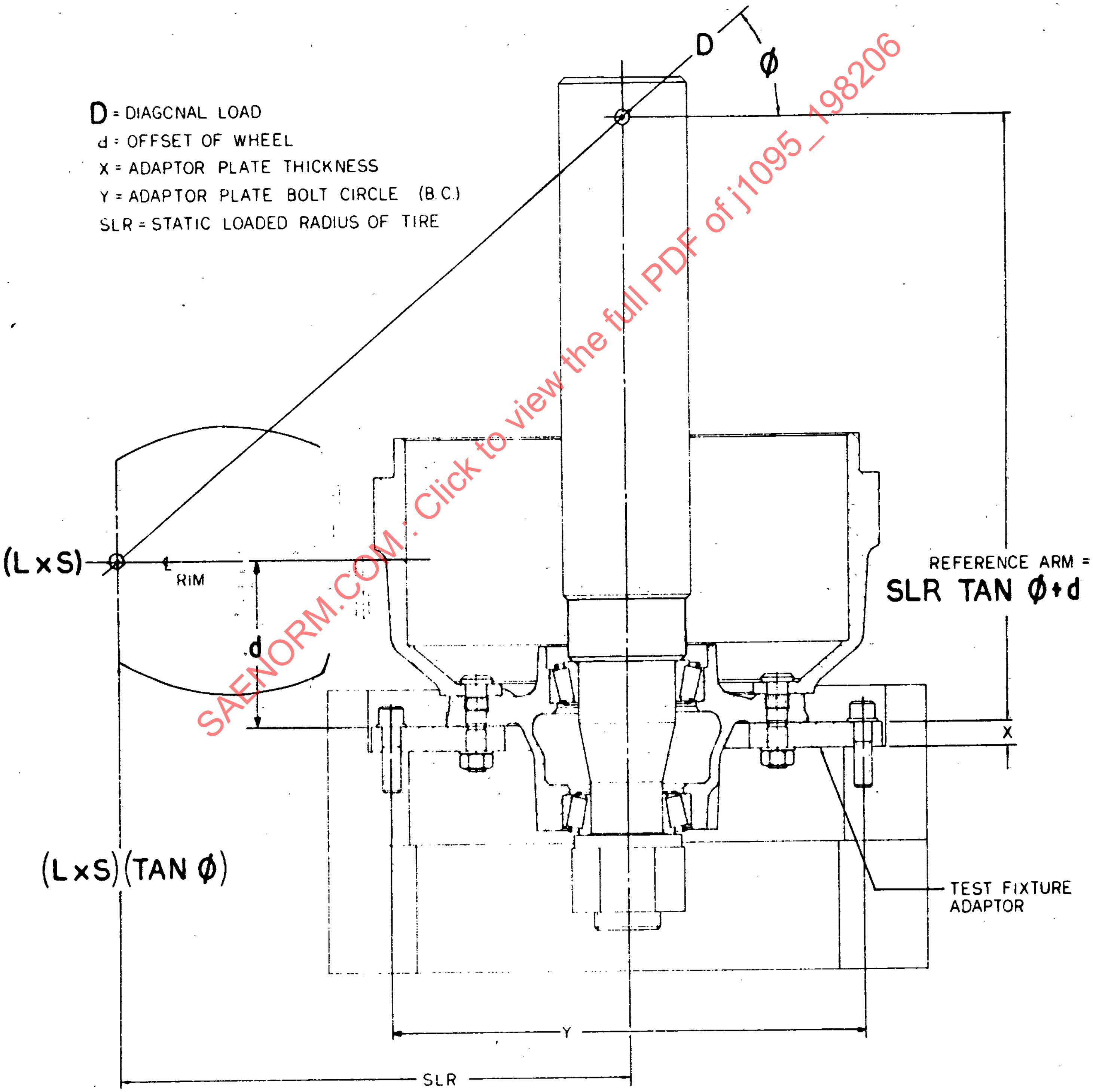

FIG.2—ANGULAR CORNERING FATIGUE TEST

3.2.1.4 *Test Load Factors*—See Appendix III.

3.2.2 CORNERING FATIGUE, ANGULAR LOADING METHOD (METHOD #2)

3.2.2.1 *Equipment*—The test machine shall be one with a means to impart constant rotating bending moment and axial and radial load to the hub (see Fig. 2).

3.2.2.2 *Procedure*—Mount the hub assembly to a test fixture adaptor using wheel nuts representative of those required by the application, and torqued to the limits specified in Appendix I for the appropriate application. Bearings and test speed may be adjusted so as to maximize bearing life; however, bearing adjustments may not necessarily be those recommended for commercial practice. Excessively loose bearings may change the failure mode of the hub structure. The mating surfaces of the test adaptor and hub shall be free of paint, dirt or foreign matter. The final clamped position of the hub without load must not exceed an eccentricity of 0.010 in (0.254 mm) total indicator reading normal to the shaft axis at the point of loading. The load system shall maintain the specified load within ±3%. The application of the test load shall be at an angle from a plane through the *load centerline* of the rim as shown in Fig. 2.

3.2.2.3 *Test Load and Reference Arm Determination*—The test load and reference arm are determined as follows:

$$D = \frac{(L) \times (S)}{\cos \theta}$$

where, D = Diagonal test load resultant; lb force (N)
L = Load rating of the hub as specified by the hub manufacturer; lb force (N)
S = Accelerated test load factor
θ = Test load angle

$$\text{Reference Arm} = \text{slr} \tan \theta + d$$

where, slr = Static loaded radius of the largest tire to be used with the hub as specified by the vehicle manufacturers, inches (mm). Refer to Appendix II for static loaded radius.
d = Offset of wheel; inches (mm) as measured from the centerline of the rim to the wheel mounting surface of the hub and drum/rotor assembly. For hubs used with symmetric dual wheels only, d is zero. For hubs used with both dual wheels and singles with d values other than zero, use the largest absolute value for the offset. See Fig. 3 in SAE J393 to determine if d is positive or negative. If wheel may be used as both a positive or negative offset, use positive offset.

3.2.2.4 *Test Load Factors*—See Appendix III.

3.2.3 DYNAMIC RADIAL FATIGUE (METHOD #3—Reference SAE Recommended Practice J267a (Sept. 1973), Paragraph 3.3)

3.2.3.1 *Equipment*—The test machine shall be as specified in paragraph 3.3.1 of SAE J267a.

3.2.3.2 *Procedure*—The procedure shall follow paragraph 3.3.2 of SAE J267a, as described for disc wheels. The hub assembly shall be mounted to the test fixture spindle substantially as in service, and shall function as the "test adaptor" (as described in SAE J267a, paragraph 3.3.2.). Camber and/or steer angles may be incorporated in the test; however, these angles must be noted in the test results. Bearings may be adjusted to maximize bearing life.

3.2.3.3 *Radial Load Determination*—The radial load is determined as follows:

$$R = L \cdot S$$

where: R = radial load, lb force (N)
L = load rating at the hub as specified by the hub manufacturer, lb force (N)
S = accelerated test factor

3.2.3.4 *Test Load Factors*—See Appendix III.

3.3 Test Termination Definition (Applies to Methods #1, #2, and #3)

3.3.1 Inability to sustain load.

3.3.2 A visually detected fatigue crack penetrating through a section.

3.3.3 Loose bearing cup.

3.3.4 Broken studs before 20 000 cycles.

3.4 Test Disqualification—If any failure of the test fixture or associated parts (i.e. shaft, bearings, adaptor plate, etc.) occurs during test, the test may be disqualified if the failure is deemed to have affected the life characteristics of the hub under test.

3.5 Typical Test Fixture Adaptor Plate Dimensions—Test Procedures 3.2.1 and 3.2.2 Only

Hub Bolt Circle Diameter		X; Plate Thickness		Y; Plate Outside Bolt Circle Diameter	
in	mm	in	mm	in	mm
6.500	165.1	0.875	22.22	12.50	317.50
—	170.0	0.875	22.22	12.50	317.50
8.000	205.0	0.787	20.00	12.50	317.50
8.750	222.25	0.750	19.05	12.50	317.50
—	275.00	0.875	22.22	17.50	444.50
11.250	285.75	0.875	22.22	17.50	444.50
13.188	335.00	0.675	17.16	17.50	444.50

NOTE: These steel plate thickness selections give 19 000–21 000 psi (131–145 MPa) radial bending stress at the inner bolt circle of the adaptor plate when loaded with the typical test loading for each specified bolt circle.

APPENDIX I

Application[a]	Thread Size[a], in	Torque (dry)[b] lbf · ft	N · m
Disc Wheels			
Passenger and light truck type mounting	7/16–20	80–90	110–120
	1/2 –20	80–90	110–120
	9/16–18	110–120	150–165
	5/8 –18	125–135	170–185
In-out coined mounting cone seat nut	9/16–18	175–185	240–250
	5/8 –18	175–185	240–250
In-out coined mounting flange nut	5/8 –18	275–285	370–385
		1-pc. nut 2-pc. nut	1-pc. nut 2-pc. nut
Piloted mounting	9/16–18	120–250 —	165–340 —
	11/16–16	300–320 250–300	410–440 340–410
	3/4 –16	450–470 300–350	610–640 410–470
	7/8 –14	— 350–400	— 470–540
Ball seat mounting	3/4 –16	450–470	610–640
	1-1/8 –16	450–470	610–640
Heavy-duty ball seat mounting	15/16–12	750–770	1020–1040
	1-5/16–12	750–770	1020–1040
Spoke Wheels			
Studs and nuts	5/8 –11	150–175	200–240
	3/4 –10	175–225	240–300
Bolts and nuts	5/8 –11	180–200	240–270
	3/4 –10	270–295	370–400

[a] For applications and sizes not shown, use torque recommendations prescribed by the hub or vehicle manufacturer.

[b] Nut torque values shall be checked and reset periodically during the course of a hub test in order to compensate for the "wearing in" of mating surfaces of nuts and bolt-holes.