SURFACE VEHICLE RECOMMENDED PRACTICE

SAE

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Fatigue Test Procedures: Hubs and Wheels for Demountable Rims

RATIONALE

During the 5-year review we added the test fixture adapter dimensions for metric mounting systems XVII and XVIII along with the mounting nut torque values for the M14X2, 2-piece flange nut which makes this document consistent with SAE J694. We also upgraded Table 2 "Mounting Nut Torques for Laboratory Wheel/Rim Tests", and Table 3 "Static Loaded Radii for Bending Moment Calculation" to be consistent with the tables in SAE J267. Also, the nomenclature for the spoke wheel was changed to wheel for demountable rims. The angular cornering fatigue test (40 degree) method and the dynamic radial fatigue test method were removed from this document as they are no longer being used.

1. SCOPE

This SAE Recommended Practice provides uniform laboratory procedures for fatigue testing of wheels for demountable rims and hubs intended for normal highway use on trucks, buses, truck trailers, and multipurpose passenger vehicles. The hubs included have bolt circle diameters from 165.1 to 335.0 mm (6.50 to 13.19 in). It is up to each hub and/or wheel for demountable rims developer to determine what test method, accelerated load factor and cycle life requirements are applicable to obtain satisfactory service life in a given application. When deviations from the procedures recommended herein are made, it is the responsibility of the hub and/or wheel for demountable rims developer to modify other parameters to obtain satisfactory service life.

2. REFERENCES

2.1 Applicable Publications

The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated, the latest revision of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE J393   Nomenclature—Wheels, Hubs, and Rims for Commercial Vehicles

SAE J694   Disc Wheel/Hub or Drum Interface Dimensions—Truck and Bus

SAE J851   Dimensions—Wheels for Demountable Rims, Demountable Rims, and Spacer Bands—Truck and Bus

SAE J1835   Fastener Hardware for Wheels for Demountable Rims

3.   TEST PROCEDURES

3.1   Wheels for Demountable Rims and Hubs for Test

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

3.2   Hub Dynamic Cornering Fatigue Test

3.2.1 Equipment

The test machine shall be one with a means to impart a constant rotating bending moment and radial load to the hub (see Figure 1). Test fixture adaptor dimensions are described in Table 1.

TEST
LOAD

MOMENT ARM =
[.7(slr) + d] MINIMUM

$\mathbb{C}$ RIM

d

X

Y

TEST FIXTURE
ADAPTOR

slr
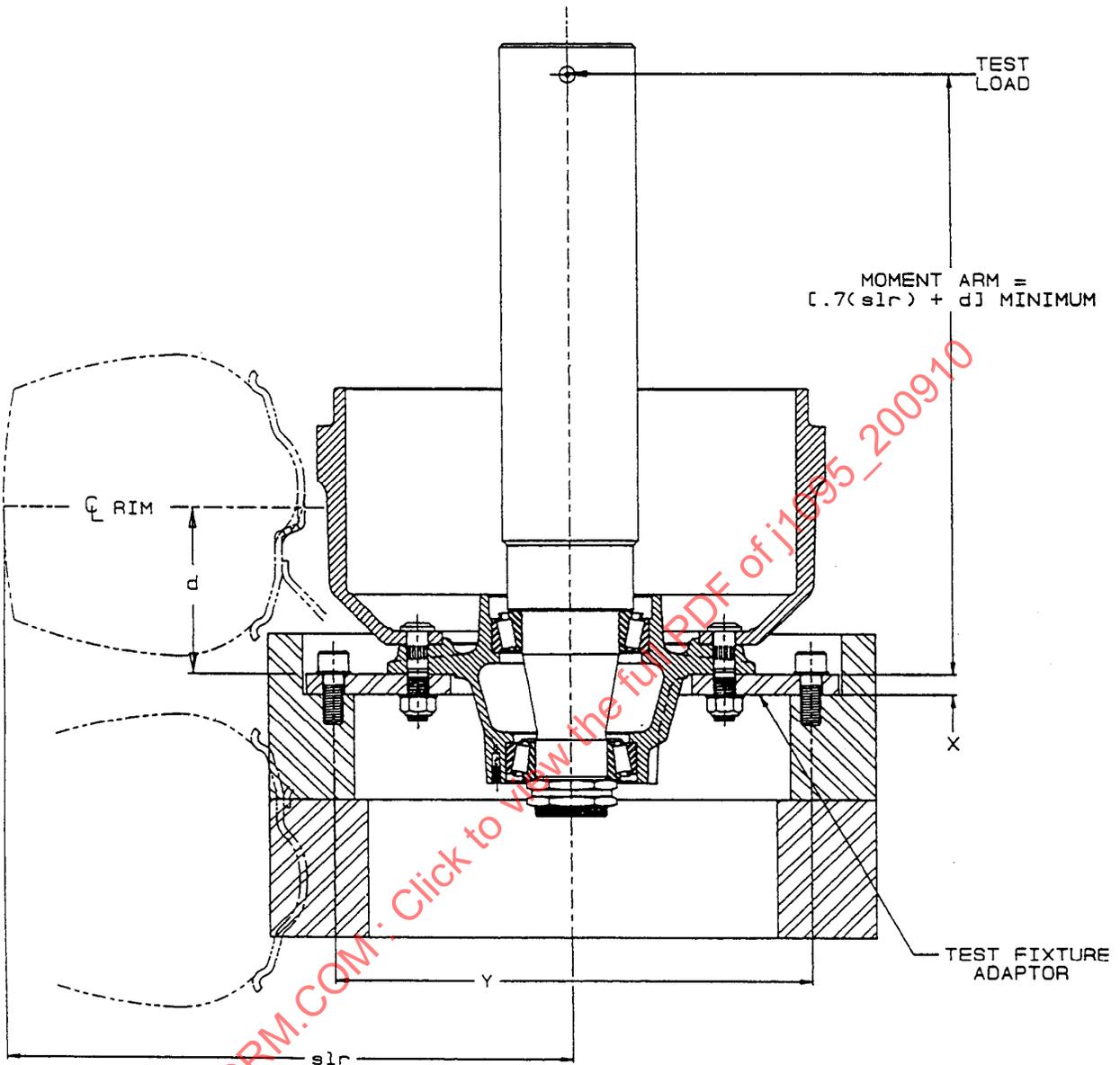
d = INSET OF WHEEL
X = ADAPTOR PLATE THICKNESS
Y = ADAPTOR PLATE BOLT CIRCLE (B.C.)
slr = STATIC LOADED RADIUS OF TIRE

FIGURE 1 – HUBS: CORNERING FATIGUE TEST (TYPICAL SET-UP)

TABLE 1 - TEST FIXTURE ADAPTOR DIMENSIONS

Hub Bolt Circle Diameter mm	Hub Bolt Circle Diameter in	X Plate Thickness mm	X Plate Thickness in	Y Plate Outside Bolt Circle Diameter mm	Y Plate Outside Bolt Circle Diameter in
165.10	6.500	22.22	0.875	317.50	12.50
170.00	—	22.22	0.875	317.50	12.50
205.00	8.000	20.00	0.787	317.50	12.50
222.25	8.750	19.05	0.750	317.50	12.50
225.00	---	19.05	0.750	317.50	12.50
275.00	—	22.22	0.875	444.50	17.50
285.75	11.250	22.22	0.875	444.50	17.50
335.00	13.188	17.16	0.675	444.50	17.50

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

3.2.2   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 Table 2 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 0.25 mm (0.010 in) total indicator reading normal to the shaft axis at the point of loading. The 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 Figure 1.

3.2.3   Test Load and Bending Moment Determination

The test load is determined by Equation 1:

$$\text{Test Load} = \frac{M}{\text{Moment Arm}} \ (\text{See Figure 1}) \tag{Eq. 1}$$

M is determined by the formula:

$$M = (L)\left[\mu(slr) + d\right](S) \tag{Eq. 2}$$

where:

M = Bending moment, N-m (lbf-in)

μ = Coefficient of friction developed between tire and road, use 0.7 for μ.

slr = Largest static loaded radius of the tires to be used with the hub on the wheel as specified by the current Tire and Rim Association Yearbook or the vehicle/wheel manufacturer, mm x 10^{-3} (in). Use the values of slr found in Table 3.

d = Inset or outset (positive for inset, negative for outset) of the wheel, millimeters x 10^{-3} (in), as measured from the centerline of the rim to the wheel mounting surface of the hub assembly. For hubs used only with dual wheels, d is zero. For hubs used with single wheels and d values other than zero, use the largest absolute value.

S = Test factor. The following test factors are used: 1.0, 1.2, and 1.4.

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

TABLE 2 - MOUNTING NUT TORQUES FOR LABORATORY WHEEL/RIM TESTS

Application[1]	Thread Size	Dry Torque[2] +10%-0% N-m	Dry Torque[2] +10%-0% lbf-ft
Disc Wheels	M12 x 1.5	110	80
Light Truck	7/16 - 20	110	80
60 degrees Cone Nuts	1/2 -20	110	80
	9/16 - 18	170	125
	5/8 - 18	170	125
Hub Piloted Mounting	9/16 - 18	160	120
1-piece Nut	11/16 - 16	410	300
Hub Piloted Mounting	9/16 - 18	170	125
2-piece Nut	5/8 - 18	180	130
	3/4 - 16	410	300
	7/8 - 14[3]	480	350
	7/8 - 14	610	450
	M12 X 1.75	115	85
	M14 x 1.75	180	130
	M14 X 2.0	150	110
	M18 X 1.5	260	190
	M20 X 1.5	380	280
	M22 X 1.5	610	450
Hub Piloted Mounting	9/16 - 18	150	110
with Clamp Plate and	M14 x 1.5	150	110
90 degree Cone Nuts	5/8 - 18	180	130
Ball Seat Mounting	3/4 - 16	610	450
	1-1/8 - 16	610	450
Heavy-Duty Ball	15/16 - 12	1020	750
Seat Mounting	1-5/16 - 12	1020	750
Demountable Rims	3/4 - 10	270	200
Studs and Nuts			

1. For applications and sizes not shown, use torque recommendations prescribed by the wheel/rim or vehicle manufacturer.
2. Dry torque means no additional lubricants are applied.
3. Bus Front.

Nut torque values shall be checked and reset periodically during the course of a test in order to compensate for "wearing in" of mating surfaces.

TABLE 3 - STATIC LOADED RADII FOR BENDING MOMENT CALCULATIONS

Size	slr mm	slr in	Size	slr mm	slr in
5 degree			**Tubeless - 15 degree (continued)**		
8.25R20	452	17.8	9R22.5	460	18.1
9.00R20	480	18.9	10R22.5	480	18.9
10.00R20	495	19.5	11R22.5	506	19.9
11.00R20	513	20.2	12R22.5	513	20.2
12.00R20	523	20.6	255/70R22.5	439	17.3
14.00R20	569	22.4	275/70R22.5	452	17.8
365/80R20	503	19.8	305/70R22.5	465	18.3
			365/70R22.5	498	19.6
11.00R22	539	21.2	245/75R22.5	447	17.6
			265/75R22.5	462	18.2
11.00R24	559	22.0	295/75R22.5	485	19.1
12.00R24	572	22.5	235/80R22.5	442	17.4
			255/80R22.5	455	17.9
			275/80R22.5	478	18.8
			295/80R22.5	493	19.4
			315/80R22.5	511	20.1
			11R24.5	531	20.9
Tubeless - 15 degree			12R24.5	539	21.2
9R17.5	391	15.4	285/75R24.5	500	19.7
10R17.5	399	15.7	305/75R24.5	508	20.0
10R17.5HC	409	16.1	275/80R24.5	490	19.3
215/75R17.5	363	14.3	**Wide Base - Tubeless - 15 degree**		
			445/65R19.5	495	19.5
8R19.5	406	16.0			
225/70R19.5	389	15.3	445/50R22.5	483	19.0
245/70R19.5	399	15.7	455/55R22.5	495	19.5
265/70R19.5	404	15.9	385/65R22.5	506	19.9
285/70R19.5	414	16.3	425/65R22.5	526	20.7
305/70R19.5	424	16.7	445/65R22.5	539	21.2

For tire sizes not shown, use the slr listed in the individual tire manufacturer's Tire Data Book

3.3   Wheels for Demountable Rims, Dynamic Cornering Fatigue Test

3.3.1   Equipment

The test machine shall be such that either the wheel for demountable rims rotates under the influence of a stationary bending moment, or the stationary wheel for demountable rims is subjected to a rotating bending moment (see Figure 2).

3.3.2   Procedure

The wheel for demountable rims shall be clamped securely to the test device using studs and nuts representative of those specified for the wheel assembly. The rim clamp nuts shall be tightened to the torque limits specified in Table 2 for the thread size listed for wheels for demountable rims. 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 wheel structure. The mating surface of the test adaptor and wheel for demountable rims shall be free of excessive buildup of paint, dirt, or foreign material. A rigid load arm shaft shall be attached to the hub of the wheel for demountable rims. The final clamped position of the wheel without load shall not exceed 0.25 mm (0.010 in) total indicator reading normal to the shaft axis at the point of loading. The load system must maintain the specified test load within ±3%.

3.3.3   Test Load and Bending Moment Determination

The test load is determined by:

$$\text{Test Load} = \frac{M}{\text{Moment Arm}} \; (\text{See Figure 3}) \qquad \text{(Eq. 6)}$$

M is determined by the formula:

$$M = (L)\mu(slr)(S) \qquad \text{(Eq. 7)}$$

where:

   M = Bending moment, N-m (lbf-in)
   μ = Coefficient of friction developed between tire and road, use 0.7 for μ .
   slr = Largest static loaded radius of the tires to be used on the wheel for demountable rims as specified by the current Tire and Rim Association Yearbook or the vehicle/wheel manufacturer, mm x 10^{-3} (in). Use the values of slr found in Table 3.
   S = Accelerated test factor. See Table 4.
   L = Load rating of the wheel for demountable rims as specified by the wheel manufacturer, N (lbf)

3.3.4   Accelerated Test Factor and Cycle Requirements

Refer to Table 5.

3.4   Test Termination Definitions

3.4.1   Inability to sustain load.

3.4.2   A visually detected fatigue crack penetrating through a section.

3.4.3   Loose bearing cup.

3.4.4   Broken studs before 20 000 cycles.

3.5   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 wheel for demountable rims or hub under test.

TABLE 4 - TYPICAL "S" FACTORS AND CYCLE LIFE FOR FERROUS WHEELS

SAE J1095 Paragraph	Load Angle	Moment Arm	Accelerated Test Factor	Minimum Cycle Life
3.3	90 Degrees	See Figure 2	1.9	35 000
			1.5	100 000