

Issued 1969-01
Reaffirmed 2009-08

Superseding J379 AUG2004

(R) Gogan Hardness of Brake Lining**1. Scope**

Hardness measurements are used as a quality control check of the consistency of formulation and processing of brake linings. Gogan hardness is nondestructive (the penetrator causes shallow surface deformation.). Gogan hardness method alone does not show anything about a lining's ability to develop friction or to resist fade when used as a friction element in brakes.

The hardness and the range of hardness are peculiar to each formulation, thickness, and contour; therefore, the acceptable values and ranges must be established for each formulation and part configuration by the manufacturer.

1.1 The hardness of sintered powder metal lining is usually determined with Rockwell Superficial hardness equipment. See ASTM B 347.

1.2 Purpose

To measure the Gogan Hardness of Brake Linings

There are two accepted methods to measure hardness of brake linings:

Gogan hardness measurements measure the compression of the materials under load while, Rockwell hardness measurements measure the depth of penetration after the application of a load (See SAE J2654).

Selection between the two methods depends on the specific properties desired.

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2. *References*

2.1 **Applicable Publications**

2.1.1 ASTM INTERNATIONAL PUBLICATIONS

Available from ASTM International, 100 Barr Harbor Dr., West Conshohocken, PA 19428 (www.astm.org)

ASTM B 347—Standard Method of Test for Hardness of Sintered Metal Friction Materials.

2.1.2 SAE INTERNATIONAL PUBLICATIONS

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001 (www.sae.org)

SAE J2654—Hardness of Brake Lining.

3. *Equipment*

A commercially available Gogan Model 911 (or equivalent) direct reading hardness testing machine is required. In this machine, the flat end of a cylindrical penetrator is forced against the lining supported by a matching anvil. The Gogan hardness number is the distance, in units of 0.0064 mm (0.00025 in) the penetrator advances into the lining, while the force on the penetrator increases from the initial or minor load to the final or major load. Two load ranges are used: 14.71 or 29.42 kN (1500 or 3000 kg) major loads with nominal 4.90 and 14.71 kN (500 and 1500 kg) minor loads, respectively.

3.1 The test cycle is initiated by closing an electric switch, causing the penetrator to approach and contact the lining sample and start to apply the test load. When the minor load is reached, the hardness indicator is engaged to the penetrator and the two timers that control the actual test cycle are activated. At 0.75 seconds (ET1), the hardness indicator is disengaged and arrested. The major load is reached prior to the ET1 setting, the time depending upon the hardness of the lining penetrator travel, and the force buildup in the hydraulic system. At 1.75 seconds (ET2), the cycle is terminated and the machine returns to its idle position and is reset for the next test. The one second interval between ET1 and ET2 provides sufficient dwell for the operator to read the Gogan hardness dial indicator. Four test combinations are possible utilizing 25.40 or 19.05 mm (1 or 0.75 in.) diameter penetrators with either 14.71 or 29.43 kN (1500 or 3000 kg) major loads. This requires that Gogan hardness numbers be prefixed with a scale symbol representing the load and penetrator as listed in Table 1. The combination of the load and penetrator is selected to provide the greatest sensitivity with the least damage to the lining. Usually, this is accomplished when the Gogan readings fall within the ranges shown, although the desirable range will differ with formulation and the configuration of the lining, particularly its thickness and curvature.

TABLE 1—GOGAN HARDNESS SCALES

Scale Symbol	Major Load		Nominal Minor Load		Penetrator Diameter		Recommended Range of Gogan (G) Numbers
	kN	kg	kN	kg	mm	in	
A	14.71	1500	4.90	500	25.39	1	GA10-GA80
B	29.42	3000	14.71	1500	25.39	1	GB10-GB80
C	14.71	1500	4.90	500	19.05	$\frac{3}{4}$	GC10-GC80
D	29.42	3000	14.71	1500	19.05	$\frac{3}{4}$	GD10-GD80

4. Test Machine Specifications

4.1 Minor Load

Nominal 4.90 or 14.71 kN (500 or 1500 kg)

4.2 Major Load

14.71 or 29.42 kN (1500 or 3000 kg)

4.3 Penetrator Diameter

25.4 or 19.05 mm (1 or $\frac{3}{4}$ in)

4.4 Split Penetrator

For grooved lining, it has a flat end face consisting of two semicircles, either 25.4 or 19.05mm (1 or $\frac{3}{4}$ in) in diameter, spaced apart a minimum of the groove width plus 6.4 mm ($\frac{1}{4}$ in) as shown in Figure 1.

4.5 Timers

Reference, Gogan Machine Co., Wiring Diagram XE-1473. ET1: 0.75 s., ET2: 1.75 s.

4.6 Anvil for Curved Lining

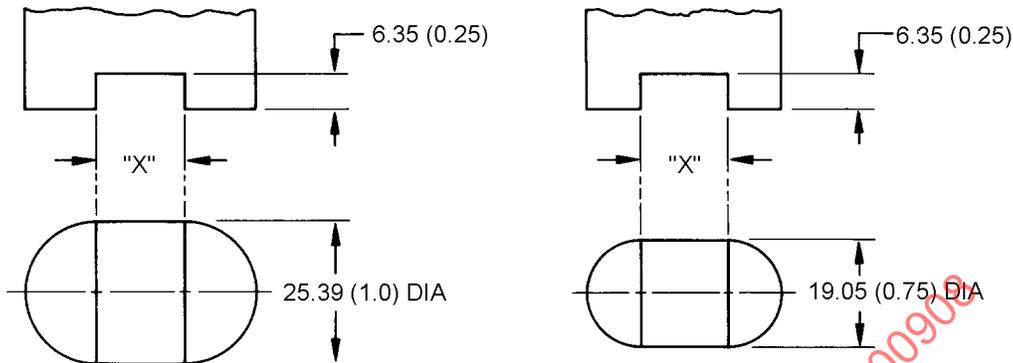
Curved to minimum inside radius specified for lining. Chord length: 50.8 mm (2 in); minimum width: 50mm (2 in).

4.7 Anvil for Flat Lining

Minimum 44.4mm (1 $\frac{3}{4}$ in) diameter flat.

4.8 Penetrator Travel to Upper Surface of Lining

13 \pm 3 mm ($\frac{1}{2}$ \pm 1/8).



"X" = (LINING GROOVE WIDTH PLUS
6.35 (0.25) MINIMUM)

DIMENSIONS ARE mm (in)

FIGURE 1—SPLIT PENETRATOR END

5. Operating Procedure

- 5.1 Position anvil in socket of anvil, adjusting screw after making sure seating surfaces are clean.
- 5.2 Position brake lining on anvil. Adjust backstop so that penetrator is no closer than 3 mm (1/8 in) to edge of lining.

NOTE—The penetrator must be completely supported by brake lining with a minimum of 3mm (1/8 in) to any edge of the lining or groove for a valid Gogan hardness test.

A split penetrator will be used when the dimensions of the lining grooves on either side of the braking or shoe surface make it impossible to provide 3mm (1/8 in) clearance between toe OD of the penetrator and the edge of the lining or groove.

In positioning grooved brake lining on the anvil, adjust the back stop so the groove in the lining is centered with the penetrator and rotate the anvil so the groove in the lining and the groove in the penetrator are parallel. Gogan hardness numbers taken on grooved lining with a split penetrator are prefixed with an additional symbol, "S," as in Table 1; thus GAS, GBS, GCS, and GDS.

- 5.3 With square bar gage, adjust space between penetrator and top of lining to 13 ± 3 mm ($1/2 \pm 1/8$ in). Tighten adjusting screw clamping nut.
- 5.4 Start machine pump. Allow 2 min minimum warm-up. Operate machine a few times to seat anvil and eliminate backlash of anvil screw.
- 5.5 Test the lining at the desired locations and note the Gogan hardness from the dial indicator.