Hydraulic Master Cylinders for Motor Vehicle Brakes—Test Procedure—SAE J1153

SAE Recommended Practice
Approved July 1976

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HYDRAULIC MASTER CYLINDERS FOR MOTOR VEHICLE BRAKES—TEST PROCEDURE—SAE J1153

SAE Recommended Practice

Report of Hydraulic Brake Systems Actuating Committee approved July 1976.

1. Type—This recommended practice applies to both single and dual output master cylinder assemblies used in hydraulically operated brake systems of highway vehicles. It covers such cylinders where they are employed in passenger car, truck, bus, and like brake systems utilizing motor vehicle brake fluids which conform to SAE J1702 or J1703.

2. Scope—The recommended practice specifies the test procedure to determine minimum performance and durability characteristics for master cylinder assemblies of current established designs, components of which conform to SAE Standards. It is applicable to new assemblies from commercial production and remanufacture (factory rebuild).

The minimum performance and durability requirements are specified in SAE J1154, Hydraulic Master Cylinders for Motor Vehicle Brakes—Performance Requirements.

3. Test Apparatus—The basic apparatus shall be that shown and as arranged in Fig. 1 or equivalent. All hydraulic lines and fittings shall be of sufficient size as to permit unrestricted flow to and from test master cylinder(s). The apparatus shall operate per the following description and as called for in Section 5. It is desirable to have the test apparatus portable to facilitate cold, hot, and room temperature bench testing.

3.1 Displacement Mechanism—The displacement mechanism(s) connected to the master cylinder outlet(s) shall restrict the master cylinder(s) output performance to the shaded area of Fig. 2. In addition, the heel of the pressure cup(s) on the piston(s) shall be past the compensating port(s) before a pressure of 345 kPa (50.0 psi) is attained. The master cylinder outlet pressure(s) shall rise smoothly to a maximum of 6900 ± 690 kPa (1000 ± 100 psi) within 60-80% of total piston travel.

3.2 Stroking Mechanism—The stroking mechanism shall contain a mounting plate to which the master cylinder can be attached. The actuating push rod shall be compatible with the master cylinder piston socket and shall operate coaxially within 2 deg of the master cylinder bore longitudinal axis. The fixture shall be constructed such that full release of the master cylinder piston is obtained. The stroking mechanism may accommodate multiple master cylinders, if desired.

Means must be provided for the stroking mechanism to stroke the master cylinder both singly and cyclically. For single stroke operation the means must be capable of generating pressures in the master cylinder up to the following limits:

Diameter	Pressure
Thru 31.8 mm (1.25 in)	20 680 kPa (3000 psi)
Over 31.8 mm (1.25 in)	10 340 kPa (1500 psi)

The means shall also be capable of applying the push rod to generate pressure that will provide for full master cylinder stroke and allow holding of a fixed stroke position. For cyclic operation the stroking mechanism shall be capable of applying the push rod to generate 10 340 ± 690 kPa (1500 ± 100 psi), at a rate that can be adjustable from 250 to 1000 cycles/h. The push rod shall be stroked forward at a smooth rate and allow the piston(s) to return rapidly to the retracted position(s). The time cycle shall be adjusted to allow maximum time for forward stroking while insuring that the piston(s) return to the fully retracted position before the start of the next forward stroke.

Means must also be provided for a 207 ± 7 kPa (30 ± 1 psi) air pressure source to be applied to the outlet port(s).

3.3 Instrumentation

3.3.1 Two hydraulic pressure gages shall be employed for each outlet port. One shall have a range of 0-207 kPa (0-30.0 psi) and the other shall have a range of 0-20 680 kPa (0-3000 psi). Both shall be of a type which require small hydraulic displacement and are equipped with a bleeder and a shut-off valve. Gage accuracy shall be ±0.5% or better. Suitable pressure transducer systems may be used in place of gages.

3.3.2 Suitable displacement measuring equipment shall be provided, accurate to 0.1 cm^3 or better.

3.3.3 Short lengths of tubing with suitable connections shall be provided in order to bleed flow fluid from outlet(s) into reservoir(s).

3.3.4 Proper air fittings with gages and shut-off valves shall be provided.

3.3.5 Suitable graduated cylinder shall be provided capable of measuring fluid volumes, accurate to 1 cm^3 or better.

3.4 Environmental Equipment

3.4.1 HEATED AIR BATH CABINET—An insulated oven or cabinet shall be provided having sufficient capacity to house test apparatus fixtures. A suitable thermostatically controlled heating system is required to maintain a temperature of 120 ± 3°C (248 ± 5°F). Heaters shall be shielded to prevent direct radiation to master cylinder.

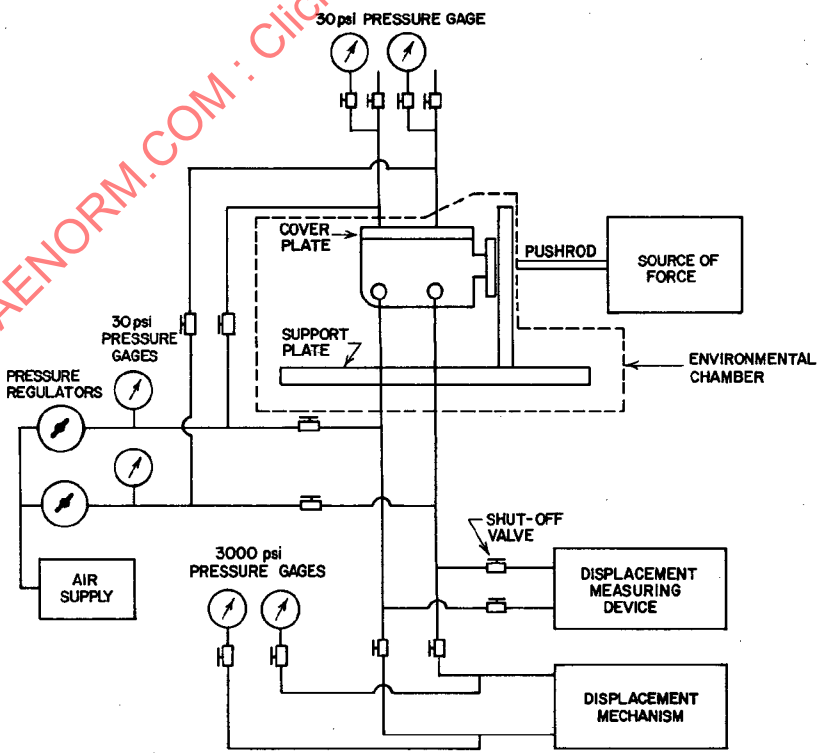

FIG. 1—TEST APPARATUS

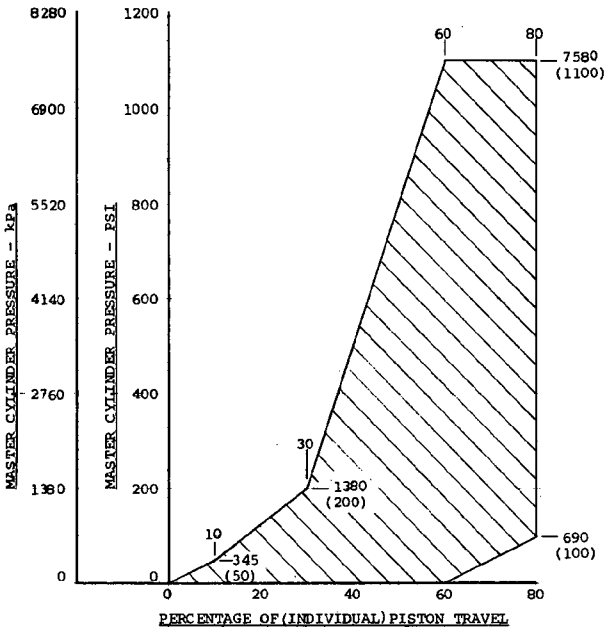

FIG. 2—RECOMMENDED STROKING PERFORMANCE CURVES

3.4.2 COLD CHAMBER—A cold chamber shall be provided having sufficient capacity to house test apparatus fixtures. It shall be capable of maintaining a uniform atmosphere of cold dry air at −40 to −42.8°C (−40 to −45°F).

3.4.3 HUMIDITY CABINET—A humidity cabinet shall be provided having sufficient capacity to house test apparatus fixtures. It shall be capable of maintaining a relative humidity between 80 and 90% at 21 ± 3°C (70 ± 5°F) and 46.1 ± 3°C (115 ± 5°F).

3.5 Test Fittings and Material—Test hydraulic fluid shall conform to SAE J1702 or J1703. The compatibility fluid of SAE J1703 is recommended.[1] The hydraulic connector to the master cylinder shall be of the type used by the vehicle manufacturer.

4. Test Sample—The master cylinder shall come from one of the sources described in Section 2. It shall not have been used after manufacture or rebuild, and it shall not be disassembled prior to testing.

5. Test Setup and Procedure—Tests shall be conducted in the sequence shown and at room temperature except where otherwise specified. The master cylinder shall not be disassembled until after all tests are completed or unless testing is discontinued.

NOTE:

1. When outlet ports are pressurized on dual master cylinders, both ports must be pressurized simultaneously.

2. When fully stroking master cylinders which do not incorporate internal stroke limiting means, care shall be exercised to avoid damage to spring(s), retainer(s), cup(s), etc.

5.1 Unrestricted Apply and Release—Remove shipping plug(s) from master cylinder outlet port(s) and stroke the piston through full design stroke 5 times and allow it to return by the return spring load.

5.2 Venting—Install the master cylinder on the mounting plate and tighten mounting bolts. Make certain that the push rod is properly aligned with the cylinder bore longitudinal axis within 2 deg. Adjust push rod to allow piston(s) to return to normal release position.

5.2.1 Connect a 207 ± 7 kPa (30.0 ± 1 psi) air supply to the outlet port(s). Bore venting will be indicated by air flow from the vent port(s).

5.2.2 Without changing the setup in procedure 5.2.1, stroke the input push rod a minimum of 5.1 mm (0.200 in). Apply 207 ± 7 kPa (30.0 ± 1 psi) air pressure to the outlet port(s) and observe that no air is flowing from the vent port(s).

5.3 Residual Pressure Valve—For master cylinders with residual check valve(s) only. Release the push rod to allow piston(s) to return to the normal release position.

5.3.1 Cap (both) reservoir(s), apply 207 ± 7 kPa (30.0 ± 1 psi) maximum air through cap with outlet port(s) open.

5.3.2 Open (both) reservoir(s) and apply air pressure to outlet port(s) as specified in manufacturer's data for residual valve operation check.

[1]Compatibility fluid may be obtained from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, Pennsylvania 15096.

5.4 Applied Leakage—Stroke piston(s) a minimum of 5.1 mm (0.200 in) such that the vent port(s) is (are) closed and mechanically restrain piston(s) from releasing. Apply 207 ± 7 kPa (30.0 ± 1 psi) constant air pressure to the outlet port(s). Cap reservoir(s) with pressure gage(s) mounted through cap.

5.4.1 Stroke the pistons once to full design stroke at no more than 6.35 mm/s (0.250 in/s) and allow to return to starting restrained position. Record reservoir gage pressure after 30 ± 1 s stabilization period.

5.4.2 Remove piston restraint and disconnect air pressure source from outlet port(s). Connect low pressure hydraulic gage(s). Fill the test setup with new clean brake fluid to the manufacturer's recommended level and bleed air from master cylinder and gage(s) by stroking until the exiting fluid stream is free of bubbles. If bleed screws are present, open for required bleeding then tighten to nominal torque specified by the manufacturer.

NOTE: During the following tests 5.4.3 and 5.4.4, allow 15-20 s such that the pressure shall stabilize and then record pressure at the beginning and end of a 30 ± 1 s interval. If the specified pressure cannot be obtained simultaneously in both pressure chambers on any one application of a dual master cylinder, repeat the procedure to obtain the specified pressure for each individual chamber.

5.4.3 Apply master cylinder to build up 138 ± 14 kPa (20.0 ± 2 psi) pressure. Hold push rod in applied position(s) and observe gage(s) for pressure drop.

5.4.4 Replace low pressure hydraulic gage(s) with high pressure hydraulic gage(s) and bleed gage(s). With gage bleeder screw(s) open, stroke piston(s) sufficiently for seal(s) to pass vent hole(s), restrain piston(s) and close bleeder screw(s). Repeat 5.4.3 for high pressure test of 6900 ± 690 kPa (1000 ± 100 psi).

5.5 Fluid Displacement—Suitable fluid displacement measuring equipment shall be connected to cylinder outlet port(s) with shut-off valve(s) between measuring equipment and outlet(s). The cylinder and equipment shall be bled of air before starting test measurements. The cylinder shall be stroked to its full design stroke for five full applications at 2.5 mm/s (0.1 in/s) maximum velocity with a minimum of 5 s interval between strokes. Close shut-off valve(s) at end of each application and while cylinder is being returned to release position. Make-up fluid may be added to the reservoir(s). The fluid volume discharge from the outlet(s) at the end of each stroke shall be recorded. Calculate and record the average of all trials.

5.6 Replenishing—From the results obtained in Procedure 5.5, calculate the variation between each application and the average obtained in 5.5 and determine percentage.

5.7 Physical Strength—Connect high pressure gage(s) to outlet port(s) and apply push rod force to develop pressure as follows for 15 ± 5 s.

Nominal Diameter	Pressure
Thru 31.8 mm (1.25 in)	20 680 ± 1 030 kPa (3000 ± 150 psi)
Over 31.8 mm (1.25 in)	10 340 ± 690 kPa (1500 ± 100 psi)

Observe gage(s) for an abrupt decline in pressure and master cylinder for fluid leakage.

5.8 Humidity Operation—Place stroking mechanism with master cylinder mounted and filled with brake fluid to the manufacturer's recommended level into the temperature-humidity cabinet. Connect the displacement mechanism(s) to the outlet port(s) of the cylinder. The system shall be bled and carefully dried of fluid. Set the stroking mechanism to cycle at 1000 ± 100 apply/release cycles/h (3.27-4.00 s/cycle). Adjust the input force to the master cylinder and/or adjust the displacement mechanism(s) to stroke (each) master cylinder piston 60-80% of its full stroke at output pressures of 6900 ± 690 kPa (1000 ± 100 psi). The rate of pressure rise versus travel shall fall within the shaded limits of Fig. 2. Stroke 8 h at 46.1 ± 3°C (115 ± 5°F) temperature and 80-90% relative humidity. Cease stroking for 16 h while at room temperature and resultant relative humidity. Repeat this sequence.

5.8.1 Periodically observe master cylinder for fluid disturbance in the reservoir(s) as an indication of venting. NOTE: On dual output cylinders often only one chamber will give fluid disturbance during venting.

5.8.2 Remove master cylinder from humidity cabinet at the end of the second day (16,000 apply/release cycles and 32 h static).

5.8.3 Remove the pressure line(s) from the cylinder outlet port(s) to the displacement mechanism(s), and attach bleeder loop(s) from the cylinder outlet port(s) into the reservoir(s). Stroke piston(s) 5 times to full design stroke and allow to return, observing smoothness of stroke and returnability.

5.8.4 Remove bleeder loop(s) and reinstall pressure line(s) from the cylinder outlet port(s) to the displacement mechanism(s). Repeat Procedure 5.4.3.

5.8.5 Repeat Procedure 5.4.4.

5.9 High Temperature Durability—Place stroking mechanism with master cylinder mounted and filled with brake fluid to the manufacturer's recommended level into the heated air bath cabinet. Connect the displacement mechanism(s) to the outlet port(s) of the cylinder.