

JIS

JAPANESE INDUSTRIAL STANDARD

Testing Method of Loaders

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1. Scope

This Japanese Industrial Standard specifies the testing method of wheel and crawler tractor shovel, hereinafter referred to as the "tractor shovel".

Remark: The units and numerical values given in { } in this standard are in accordance with the International System of Units (SI) (and units which may be used together), and are appended for reference. Further, the load of freight and the load loading on the tyre of vehicle (for example: tipping load and front wheel load) shall mean the mass.

2. Definitions

The definitions of main terms used in this standard shall be as follows:

- (1) condition in working order The condition in working order herein means the condition where the fuel is not less than two-thirds of tank capacity, cooling water and lubricating oil respectively being an amount specified for each tractor shovel, and one operator member is on it.
- (2) tipping load The tipping load herein shall be the minimum load when the rear wheel separates from the road surface for wheeled tractor shovel, and the minimum load when the most front roller separates from the crawler for crawler tractor shovel under a condition where the bucket at the most front position is most backward tilted and loaded at the specified position of centre of gravity of bucket on good flat road.

The specified position of centre of gravity shall be the position of the centre of gravity of heaped solid shape in calculating the capacity of bucket.

Applicable Standards: See page 37.

- (3) ordinary load The ordinary load herein shall be the value of not more than 50 % of the tipping load for wheel tractor shovel and that of not more than 35 % of the tipping load for crawler tractor shovel.
- (4) working load condition The working load condition herein means the condition where the engine is adjusted in the condition of working load test in accordance with JIS D 1005, and the lever of fuel is at the highest position.
- (5) travel posture The travel posture herein means the condition where the lowest part of bucket is raised to the minimum ground clearance of vehicle when the bucket is most backward tilted.

3. Classification of Tests and Testing Items

The tests shall be classified into type test ⁽¹⁾ and acceptance test ⁽²⁾, and carried out as to the testing items with round mark given in Table.

Further, a part of testing items or measuring items may be omitted according to the type, construction, etc. of the vehicle.

Notes ⁽¹⁾ The type test herein means the test for confirming the designs and specifications.

⁽²⁾ The acceptance test herein means the test carried out in delivery.

Table

Test item	Test contents or measuring items	Type test (1)	Acceptance test (2)
Engine performance test	Working load test	○	—
	No load minimum rotary speed test	○	—
Practical performance test of torque converter	General performance test	○	—
	Stall performance test	○	—
Stationary test	Measurement of main dimensions	○	○
	Measurement of mass and position of centre of gravity	○	—
	Measurement of capacity of bucket	○	—
	Measurement of tipping load	○	—
	Measurement of operating force of operating device and measurement of operation range	○	○
	Measurement of ground pressure	○	—
	Measurement of operator cab's visibility	○	—
Travel test	Travel speed test	○	○
	Travel resistance test	○	—
	Climbing hill test	○	—
	Braking test	○	○
	Turning test	○	○
	Operating test	○	—
Maximum tractive force test		○	—
Loading capacity test		○	—
Test of working equipment	Test of operating speed of bucket	○	○
	Measurement of operating force of bucket	○	—
Test of noise and vibration	Measurement of noise	○	○
	Measurement of vibration	○	—

4. Test Preparation

The preparation of test shall be carried out as follows:

- (1) Elements and History Record the elements of testing tractor shovel in accordance with JIS D 0005, and record the history from its manufacture to this test in the history table of Attached Table 1.
- (2) Maintenance Sufficiently carry out the breaking-in operation of testing tractor shovel before the start of test, and make the tractor shovel under the condition in working order. The engine shall be put in the working load condition unless otherwise specified.
Further, make the inflation pressure of tyre (in the case of wheel tractor shovel) and the set pressure of relief valve be the pressure designated by manufacturers.
- (3) Fuel and Lubricating Oil For the fuel and lubricating oil herein, use those designated by manufacturers and record their name and standard.
- (4) Measuring Instruments Inspect the measuring instruments before test and correct them, if necessary.

5. Measuring Items and Measuring Methods

The measuring items and measuring methods on each test shall be as follows:

- (1) Performance of Engine The performance of engine shall be in accordance with JIS D 1005.
- (2) Performance of Torque Converter The performance of torque converter shall be in accordance with JIS D 1007.
- (3) Dimensions Measure the dimensions by the use of the tape or rule specified in JIS B 7512 or JIS B 7516. Allow the measuring accuracy to be within 0.2 % of measuring object or within 1 mm, whichever is greater.
- (4) Mass Measure the mass by the use of platform weighing machine or suspension balance. Allow the measuring accuracy to be within 1 % of measuring object or within 10 kg, whichever is greater.
- (5) Operating Force Measure the operating force by the use of spring type suspension indicating dynamometer or resistance wire strain gauge type dynamometer. Allow the measuring accuracy to be within 5 % of measuring object or within 0.5 kgf{4.9 N}, whichever is greater.
- (6) Angle Measure the angle by the use of the angle gauge with level, the level specified in JIS B 7511 or the rule specified in JIS B 7516. Allow the measuring accuracy to be within 3 % of measuring object or within 1°, whichever is greater.
- (7) Time Measure the time by the use of stopwatch or electronic type counter. Allow the measuring accuracy to be within 0.2 s.

- (8) Speed of Rotation Measure the speed of rotation by the use of the tachometer specified in JIS B 7521 or electronic type counter. Allow the measuring accuracy to be within 1 % of measuring object.
- (9) Pressure of Air Measure the pressure of air by the use of the tire gauge or pressure gauge specified in JIS D 8201 or JIS B 7505.
- (10) Temperature Measure the temperature in accordance with JIS Z 8704 or JIS Z 8705. Allow the measuring accuracy to be within 1°C.
- (11) Fuel Consumption Measure the volume (ml) or mass (g) of consumed fuel and the time (s). Allow the measuring accuracy to be within 2 % of measuring object.
- (12) Tractive Force, Tipping Load and Operating Force Measure the tractive force, tipping load and operating force by the use of electrical tensile force transducer and recorder. Allow the measuring accuracy to be within 2 % of measuring object or within 50 kgf{490 N}, whichever is greater.
Further, allow the capacity of used transducer to be within 3 times the measuring object.
- (13) Noise Measure the noise by the use of sound level meter specified in JIS C 1502.
- (14) Vibration Measure the vibration by the use of resistance wire strain gauge type or piezo-electric vibration accelerometer.

6. Test Place

The test place shall be as follows:

- (1) Stationary Test Place and Working Equipment Test Place Allow the stationary test place and working equipment test place to be the place where the wheel or the boss of crawler shoe does not sink or a flat cement concrete paved road and the like.
- (2) Travelling Test Place Allow the travelling test place to be flat cement concrete paved road surface for wheel tractor shovel and flat straight soil road for crawler one. Further, allow the turning test place to be a flat broad space having sufficient area. Allow the climbing hill test place to be the uniform artificial sloping road of sliding-proof construction or natural sloping road of hard soil of 20° in uniform gradient.
- (3) Maximum Tractive Force Test Place Allow the maximum tractive force test place to be the flat cement concrete paved road surface (for wheeled tractor shovel) or flat soil road (for crawler tractor shovel) having the average gradient not exceeding 1 % and the traverse gradient of not more than 1.5 %. Maintain the condition of test road so as to meet the purpose of test during test.
- (4) Working Test Place Allow the working test place to be the flat place having the area and hardness enough for loading operation.

7. Engine Performance Test

For the engine equipped with the testing tractor, carry out the working load test (100 %) and no load minimum rotary speed test given in JIS D 1005 before each test, and record the test results according to the form given in JIS D 1005.

8. Practical Performance Test of Torque Converter

For the torque converter equipped with the testing tractor shovel, carry out the general performance test and stall performance test in the practical performance test specified in JIS D 1007, and record the test results in accordance with the form given in JIS D 1007.

In that case, combine the engine carried out with the test of 7. with the driving side of torque converter.

9. Stationary Test

Carry out this test, excepting (7), under a condition where the engine stops.

- (1) Measurement of Main Dimensions Measure the main dimensions under the condition of unladen bucket and record the measured results in Attached Table 2 or Attached Table 3. However, allow the names of items to be in accordance with JIS D 0005.
- (2) Mass of Tractor Shovel Measure the mass of tractor shovel and record the measured results in Attached Table 2 or Attached Table 3. In this measurement, allow the amount of fuel to be a specified one.
Further, add the mass (55 kg) of one operator to the mass of tractor shovel, and allow the sum to be the mass in working order.
- (3) Measurement of Position of Centre of Gravity Measure the centre of gravity in accordance with JIS A 8915 and record the results in Attached Table 4 or Attached Table 5.
- (4) Measurement of Position of Centre of Load (Only for Wheel Type) Lade the bucket with the homogeneous load such as sand in a specified shape, and respectively measure the mass of tractor shovel and the front and rear wheel loads in travel posture. Calculate the position of centre of load from the following formula and record the results in Attached Table 2. In that case, allow the specified shape to be a heaped shape in calculating the capacity of bucket, that is to say, the heaped shape wherein the inclination of load becomes 1 to 2 against the plane including the upper edge of spill guard and the front fringe of blade edge.

$$l' = \left(lG - \frac{L \cdot g'_r}{g'_f + g'_r} G' \right) / (G' - G)$$

where l' : horizontal distance from the centre of front axle to the centre of load (mm)

l : horizontal distance from the centre of front axle to the centre of gravity (mm)

L : wheel base (mm)

G : mass of tractor shovel

G' : mass of tractor shovel in loading (kg)

g'_f : load of front wheel in loading (kg)

g'_r : load of rear wheel in loading (kg)

- (5) Measurement of Capacity of Bucket Load homogeneous material such as sand to the bucket in a specified shape given in JIS D 0005, and measure the mass of tractor shovel and the average specific mass of material before and after loading. Calculate them from the following formula and record the results in Attached Table 6. However, allow the average specific mass to be the mass per unit volume.

$$V_r = \frac{G'_1 - G}{1000 \gamma_1}$$

$$V_s = \frac{G'_2 - G}{1000 \gamma_2}$$

where V_r : heaped mass (m³)

V_s : struck mass (m³)

G'_1 : mass of tractor shovel in heaped load (kg)

G'_2 : mass of tractor shovel in struck load (kg)

G : mass of tractor shovel (in no-load) (kg)

γ_1 : average specific mass in heaped load (g/cm³)

γ_2 : average specific mass in struck load (g/cm³)

- (6) Measurement of Tipping Load Position the bucket at the most front place, and add a load to the specified position of centre of gravity of bucket in the condition of the most backward inclination. Measure the minimum load when the vehicle becomes in tipping state, and record the results in Attached Table 7.

Further, measure the horizontal distance from the centre of front axle or front idle axle to the acting point of load and append it for informative reference. However, carry out the measurement at the maximum left and right steerings in the case of folding car body type tractor shovel.

- (7) Measurement of Operating Force of Operation Device and of Operation Range Measure the force operating a variety of operating levers and pedals such as main clutch, conduct clutch, brake, etc. and the total travelled distance, and record the measured results in Attached Table 8. In that case, measure the operating force at the position where an operator lays his hand and foot on lever and pedal, sitting in operating seat. Make the maximum value during the stroke of operation be the operating force. However, for the brake, make the minimum value capable of stopping tractor shovel on a sloping road of 20° in gradient, and record the angle of it in a remarks column.

Further, measure the relative position in horizontal and vertical directions between the operating seat and the variety of levers and pedals, and append them in the layout figure of operating device (plan and side view).

- (8) Measurement of Ground Pressure (Only for Wheel Type) Measure the apparent ground contact area of front and rear wheel tire and the true ground contact area only concerning to boss part in the travel posture of unladen bucket. Calculate the ground pressure from the following formulae and record the results in Attached Table 9.

$$P_A = \frac{g_n \cdot g}{A} \quad \left\{ P_A = 10 \frac{g_n \cdot g}{A} \right\}$$

$$P_B = \frac{g_n \cdot g}{B} \quad \left\{ P_B = 10 \frac{g_n \cdot g}{B} \right\}$$

where P_A : true ground pressure (kgf/cm²) {kPa}

P_B : apparent ground pressure (kgf/cm²) {kPa}

g : distributed mass of front or rear wheel (kg)

A : ground contact area of boss parts of front or rear wheel tire (cm²)

B : apparent ground contact area of front or rear wheel (cm²)

g_n : acceleration of standard free fall (1 kgf/kg)
{ 9.81 m/s²}

- (9) Measurement of Visibility of Operating Seat Measure the range of the area around the tractor where an operator of standard physique cannot see from the operating seat in operating posture. Prepare the figure of the range and record it in Attached Figure.

Further, record the height above ground of eyes, height and sitting height of the operator.

10. Travel Test

Carry out the travel test in the travel posture with unladen bucket and record the results in Attached Tables 10 to 15.

- (1) **Travel Speed Test** For the travel speed test, make 100 m for not less than 35 km/h of vehicle speed in test, 50 m for 10 km/h and over up to 35 km/h excluding and 20 m for under 10 km/h the measuring section, and provide suitable approach-run sections at their both ends. Reciprocatingly travel at each step of forward and backward speed and calculate the travel speed from the average value of their required times according to the following formula. Record the results in Attached Table 10.

$$v = \frac{L}{t}$$

$$V = 3.6v$$

where v : travel speed (m/s)

L : measuring section (m)

t : average necessary time (s)

V : travel speed (km/h)

- (2) **Travel Resistance Test** Provide the tractive force meter between the tractor and the testing tractor shovel and haul the testing tractor shovel with neutralizing the change speed lever. Measure the tractive force under a stable condition at 3 steps of speed of about 5 km/h, 10 km/h and 15 km/h for wheel type and of 3 km/h, 5 km/h and 7 km/h for crawler type, and record the results in Attached Table 11.

Further, allow the measured value to be under a condition stabilized for not less than 10 sec. and carry out the measurement by the same times in both directions of test road.

The change of speed during measurement shall be within 5 %.

- (3) **Climbing Hill Test** For the climbing hill test, install the measuring section of not less than 5 m in length and a suitable approach-run distance (however, the slope to be 1.5 times total vehicle length), and measure the time required for ascending the measuring section at the lowest speed step. Calculate the output required for ascending sloping hill from the following formula and record the results in Attached Table 12. Further, record the condition of slide in a remarks column.

Further, when there is allowance as to output and slide, carry out the test on the same sloping road at a speed step of higher speed, and determine the speed step capable of climbing hill.

$$Q = \frac{g_n \cdot M \cdot L \cdot \sin \alpha}{75 t} \quad \left\{ Q = \frac{g_n \cdot M \cdot L \cdot \sin \alpha}{t} \right\}$$

where Q : output necessary for climbing hill (PS) {W}

M : mass of tractor shovel (kg)

L : distance of climbing hill (m)

α : angle of gradient of sloping road (degree)

t : time necessary for climbing hill (s)

g_n : acceleration of standard free fall (1 kgf/kg)
{9.81 m/s²}

- (4) Brake Test (Only for Wheel Type) Carry out the test on reciprocation, and travel the section for measuring the initial speed at a fixed initial speed (designated initial speed) after a suitable approach-run. Stop it with quick braking by the signal at a fixed position. Measure the stopping distance from the position of tractor shovel at the stop signal to the stopped position, and observe the condition of wheel adhering to the road surface, together.

When the device marking the road surface by the operation of laying foot on brake pedal is used to apply brake, measure the distance (braking distance) from the marked point to the stopped position.

Further, allow the designated initial speed to be 35 km/h when the maximum speed of tractor shovel is not less than 35 km/h, 20 km/h for the range of 20 km/h and over to 35 km/h excluding, and the maximum speed for the maximum speed of tractor shovel of under 20 km/h. Only when the initial speed in test is within 10 % of designated initial speed, correct it from the following formula and obtain the average value. Further, allow the section for measuring initial speed to be 100 m for 35 km/h of designated initial speed, 50 m for 10 km/h and over up to 20 km/h excluding and 20 m for under 10 km/h.

$$L_s = L'_s \left(\frac{V}{V'} \right)^2$$

where L_s : corrected stopping distance or corrected braking distance (m)

L'_s : measured stopping distance or measured braking distance (m)

V : designated speed (km/h)

V' : measured initial speed (km/h)

Further, in the case of measuring the braking distance, calculate the reduction speed and the braking efficiency from the following formula:

$$b = \frac{V^2}{25.9 L_s}$$

$$e = \frac{b}{9.8}$$

where b : reduction speed (m/s²)

e : braking efficiency

Record the above-mentioned results in Attached Table 13.