

Application News

Fatigue/Endurance Testing Machine Servopulser EMT Series

Bench Durability Test of Shock Absorber Using the Intermittent Operation Function within the Specified Temperature Range of the Specimen [JASO C602]

Motofumi Kimura

User Benefits

- ◆ Bench durability tests of shock absorbers based on JASO C602 standard can be performed.
- ◆ The intermittent operation function enables testing while keeping the temperature of the specimen within the specified temperature range.
- ◆ The high responsiveness of the EMT series enables testing under high-speed excitation.

■ Introduction

Various parts play an important role in achieving a comfortable automobile ride. Among them, the shock absorber used in the suspension system is an important part that mitigates the shock caused by the uneven surface of the road and stabilizes the vehicle body.

JASO C602 Automotive parts - Telescopic shock absorbers for suspension systems¹⁾ specifies the definition, quality, and test method of shock absorbers. In the previous report (Application News No. 01-01017), Shimadzu's EMT series electromagnetic fatigue testing machine was used to test the damping force characteristics of the suspension strut, which mitigates shock similar to shock absorbers, as specified in JASO C611.

JASO C611 is derived from JASO C602 and has similar contents. For the shock absorber, we performed the "Durability test on bench" specified in JASO C602 using the function of Shimadzu's products so that the temperature of the specimen remained within a certain range.

■ Specimen Information

Fig. 1 and Table 1 show the specimen. The specimen is a commercially available four-wheel rear shock absorber.



Fig. 1 Specimen Shock Absorber

Table 1 Specimen Information

Compatible Site:	Rear
Compatible Type of Car:	Four-wheel vehicle
Dust Cover:	None
Outer Diameter:	45 mm

■ Testing Equipment

The EMT-1kNV-50 electromagnetic dynamic and fatigue testing machine was used in this test. Fig. 2 shows a photograph of the testing machine, and Table 2 shows equipment information. The electromagnetic actuator with extremely high frequency response enables highly accurate dynamic testing. In this test, the maximum test speed was 0.45 m/s. The EMT series is ideal for testing at such high speeds.



Fig. 2 Electromagnetic Fatigue Testing Machine EMT-1kNV-50

Table 2 Equipment Information

Testing Equipment:	EMT-1kNV-50
Grips:	Shock absorber fixture
Load Cell:	1kN
Stroke:	±50mm
Controller:	4830 controller
Software:	Windows software for 4830

Fig. 3 shows the jigs and shock absorber fixtures used. Since the pin fixing part of the shock absorber is sandwiched between tapered parts from both sides, it is possible to fix the shock absorber without rattling even when tensile and compressive loads are applied.



Fig. 3 Shock Absorber Fixtures

Fig. 4 shows the specimen attached in the testing machine. In order to measure the temperature of the specimen, a thermocouple was attached to the outer cylinder surface, and compressed air was sprayed on the outer cylinder for forced cooling from the outside.

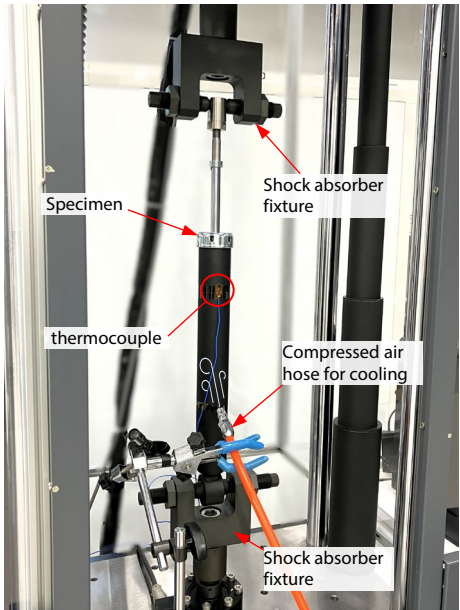


Fig. 4 Specimen Attached to the Testing Machine

■ Test Condition

A damping force characteristic test was conducted before and after the bench durability test. As for the damping force characteristic test, as in the previous report, the combination test software of Windows Software for 4830 was set up so that test conditions with different excitation speeds could be continuously and automatically executed. Similar to JASO C611, JASO C602 has prescribed excitation speeds of 0.05 m/s, 0.1 m/s, 0.3 m/s, 0.6 m/s, and 1.0 m/s. However, for this specimen, 0.6 m/s and 1.0 m/s were not tested because the damping force at 0.45 m/s or higher exceeded the testing capacity of the testing machine. Note that in JASO C602, excitation speeds other than 0.3 m/s are treated as reference values, and the final decision is made by the parties involved in the delivery.

Table 3 Damping Force Characteristic Test Conditions

Test Mode:	Fatigue and endurance test
Control Signal:	Displacement
Waveform:	Sine wave
Excitation Speed:	0.05 m/s, 0.1 m/s, 0.3 m/s, 0.45 m/s
Amplitude:	±50 mm
Mean:	0 mm
Repetitions:	10, 20, 60, 90
Ambient Temperature:	Room temperature (24 °C)

The damping force characteristic test was performed before and after the bench durability test. “Windows Software for 4830” for fatigue and endurance systems was used for the bench durability tests. The excitation kinetic energy is converted into thermal energy by the oil within the shock absorber, so the temperature rises with continuous excitation. In the bench durability test in accordance with JASO C602, the cooling system is adjusted so that the temperature of the specimen falls within the specified temperature range, and the test is performed within the specified temperature range for the specified number of cycles. Ideally, the temperature should always be within the specified temperature range, but this may require extensive cooling system equipment.

Therefore, the “intermittent operation setting” function of Windows Software for 4830 was used to perform intermittent operation, which stops the test temporarily when the specified temperature is exceeded and restarts it after the temperature drops. The “intermittent operation setting” function has been implemented since version 4.15 (February 2023 onward). Even older versions can be upgraded (for a fee) to add this function.

Fig. 5 shows the intermittent operation setting wizard of the software. The Monitor TD (signal) was set to the outer cylinder surface temperature measured by the thermocouple, and the temperature range was set to 90 °C for pause and 70 °C for test restart in accordance with the standard (80 ± 10 °C).

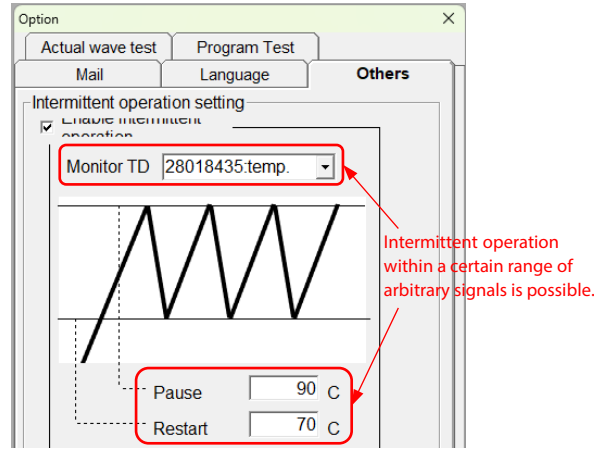


Fig. 5 Intermittent Operation Setting Wizard

Table 4 shows the test conditions for the bench durability test. Compressed air from the laboratory equipment was used as a cooling device. The temperature signal of the thermocouple attached to the outer cylinder surface was converted to analog and connected to the analog input terminal of the 4830 controller.

Table 4 Bench Durability Test Conditions

Test Mode:	Fatigue and endurance test
Control Signal:	Displacement
Waveform:	Sine wave
Excitation Speed:	0.45 m/s
Amplitude:	±25 mm
Mean:	0 mm
Excitation Direction:	Vertically erect
Repetitions:	1 x 10 ⁶
Ambient Temperature:	Room temperature (24 °C)
External Input Signal	Outer cylinder surface (analog input)
Specimen Temperature:	80 ± 10 °C
Cooling Device	Compressed air (laboratory equipment)
Temperature Sensor:	Type K thermocouple

■ Test Results

Fig. 6 shows the graph of the number of cycles of the bench durability test. It can be confirmed that the temperature remained within the range of 90 to 70 °C up to 1 million cycles. In addition, there was no significant change in the upper and lower peak values of the damping force. Therefore, it is considered that the damping force was not affected by the temperature change during the test.

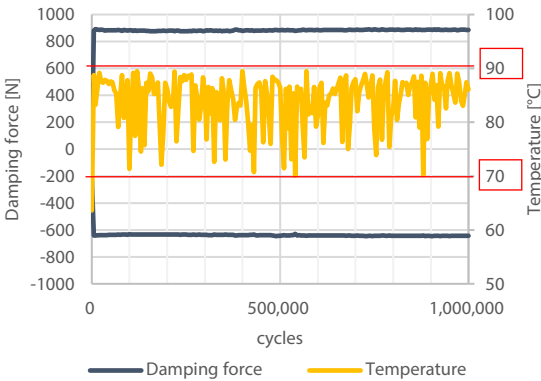


Fig. 6 Bench Durability Test Cycles Graph

■ Comparison of Damping Force Characteristics Before and After Durability Test

Fig. 7 shows a comparison of the damping force-stroke Lissajous figure before and after the bench durability test, and Fig. 8 shows a comparison of damping force-speed characteristics. There was no significant difference in performance.

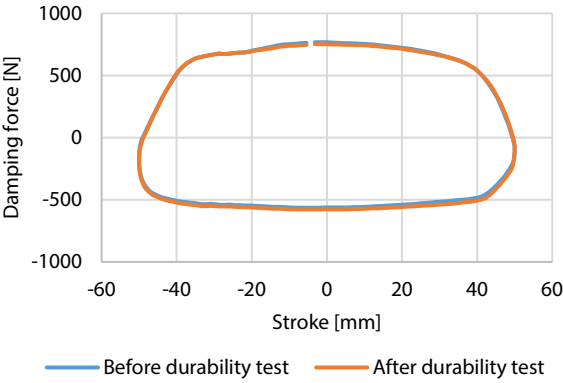


Fig. 7 Damping Force-Stroke Lissajous Figure

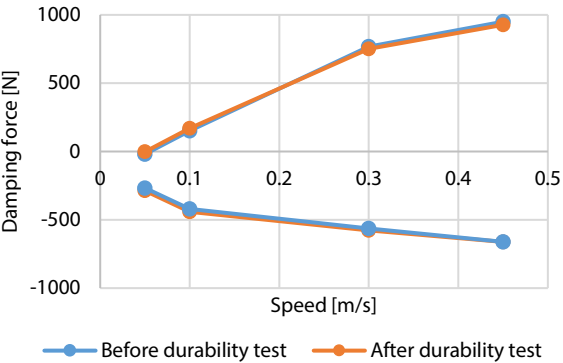


Fig. 8 Damping Force-Speed Characteristics

JASO C602 specifies the tolerance of damping force at an excitation speed of 0.3 m/s as a definition of quality. Other speeds are treated as reference values. For this specimen, the tolerance is $\pm (13 \% + 20 \text{ N})$ on the extension side and $\pm (16 \% + 20 \text{ N})$ on the contraction side. Table 5 shows the damping force at 0.3 m/s. The damping force after endurance was within the tolerance before endurance, and it was confirmed that there was no problem with the quality.

Table 5 Damping Force of 0.3 m/s

	Extension side	Contraction side
Before Durability Test	768.6 N	563.8 N
Upper Tolerance Limit before Durability Test	888.5 N	674.0 N
Lower Tolerance Limit before Durability Test	648.7 N	453.6 N
After Durability Test	752.0 N	578.0 N

■ Conclusion

Bench durability tests and damping force characteristics tests were conducted on a shock absorber based on JASO C602 using an EMT series electromagnetic fatigue testing machine and Windows Software for 4830. In the bench durability test, it was possible to perform the tests within the specified temperature range using the intermittent operation function.

References

- 1) JASO C602: 2001 Telescopic Shock Absorbers for Suspension Systems

Related Applications

1. Damping Force Characteristic Test of Suspension Struts [JASO C611] Application News No. 01-01017-EN

Servopulser is a trademark of Shimadzu Corporation or its affiliated companies in Japan and/or other countries.



Shimadzu Corporation

www.shimadzu.com/an/

For Research Use Only. Not for use in diagnostic procedures.

This publication may contain references to products that are not available in your country. Please contact us to check the availability of these products in your country.

The content of this publication shall not be reproduced, altered or sold for any commercial purpose without the written approval of Shimadzu. See <https://www.shimadzu.com/about/trademarks/index.html> for details.

Third party trademarks and trade names may be used in this publication to refer to either the entities or their products/services, whether or not they are used with trademark symbol "TM" or "®".

Shimadzu disclaims any proprietary interest in trademarks and trade names other than its own.

The information contained herein is provided to you "as is" without warranty of any kind including without limitation warranties as to its accuracy or completeness. Shimadzu does not assume any responsibility or liability for any damage, whether direct or indirect, relating to the use of this publication. This publication is based upon the information available to Shimadzu on or before the date of publication, and subject to change without notice.

➤ Please fill out the survey

Related Products

Some products may be updated to newer models.



➤ EMT Series

Electromagnetic Force Fatigue and
Endurance Testin...



➤ 4830 Controller

Servo Controller for Fatigue and
Endurance System

Related Solutions

➤ Automotive

➤ Price Inquiry

➤ Product Inquiry

➤ Technical Service /
Support Inquiry

➤ Other Inquiry