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Fatigue/Endurance Testing Machine Servopulser EMT Series

Application News

Damping Force Characteristic Test of Suspension Struts [JASO C611]

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User Benefits

- Damping force characteristic tests on suspension struts can be performed based on the JASO C611 standard.
- Combination test enables automatic speed change and measurement.
- High responsiveness of the EMT series enables testing at high excitation speed.

■ Introduction

Various components play an important role in achieving a comfortable ride in vehicles. Among them, the suspension strut used in the suspension system is an important component that stabilizes the vehicle body by mitigating the impact caused by uneven road surfaces.

"JASO C611 Suspension Struts for Automobiles"[1], a standard of JASO (Japanese Automotive Standards Organization), established by JSAE, specifies the definition, quality, and test method for suspension struts. There is no international standard that is equivalent to JASO C611.

In order to improve the performance of suspension struts, it is necessary to measure the damping force against speed by changing the excitation speed. The performance of suspension struts can be confirmed by measuring the response, such as the relationship between speed and damping force and the Lissajous waveform.

This article introduces an example of the test method "Damping Force Characteristic Test" specified in JASO C611, which was conducted on a Shimadzu EMT series electromagnetic fatigue testing machine.

■ Testing Equipment

The EMT-1kNV-50 electromagnetic dynamic and fatigue testing machine was used in this test. Fig. 1 shows a photograph of the testing machine. The electromagnetic actuator with extremely high frequency response enables highly accurate dynamic testing. In this test, the maximum test speed was 0.6 m/s. The EMT series is most suitable for testing at such high frequencies.

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

Table 1 Equipment Information

Testing Equipment:	EMT-1kNV-50
Grips:	Dedicated grip for suspension strut
Load Cell:	1kN
Stroke:	±50mm
Controller:	4830 controller
Software:	Windows software for 4830

Table 1 shows the equipment information and Fig. 2 shows how the specimens were mounted on the test machine. The jigs used were suspension strut grippers. The specimen was a commercially available four-wheel front suspension strut.

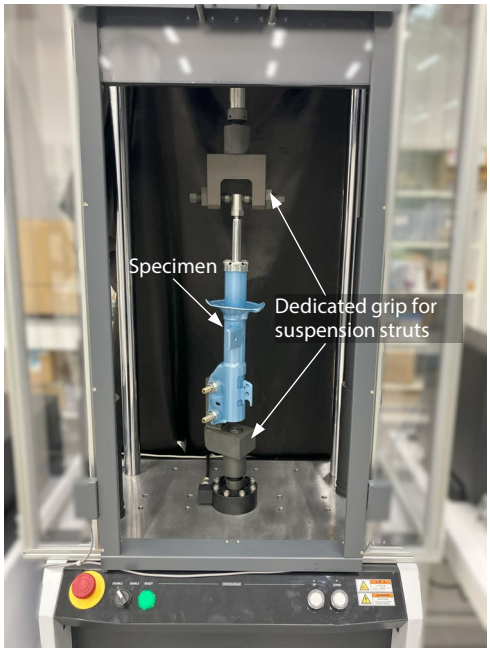

Fig. 2 Specimen Attached to Testing Machine

■ Testing Method

The tests were conducted by combining several fatigue and endurance tests at different excitation speeds. Each test was executed using separate test condition files, which were automated using the combination test software. All tests were at room temperature (24 °C).

The test conditions are shown in Table 2. JASO C611 specifies excitation speeds of 0.05 m/s, 0.1 m/s, 0.3 m/s, 0.6 m/s, and 1.0 m/s. EMT-1kNV has a speed capability of 1.0 m/s, but this test was not performed because the damping force at 1.0 m/s exceeded the test force capacity of the testing machine. The other condition parameters were set according to the standard. The test time was set to approximately 1 minute because the number of repetitions is specified as several times in the standard.

In Windows Software for 4830, it is possible to set test conditions using the excitation speed in addition to the excitation frequency. This function eliminates the trouble of setting the excitation frequency by calculating it from the excitation speed. Fig. 3 shows the test condition setting screen of Windows Software for 4830.

Table 2 Test Conditions

Test Type:	Fatigue/endurance test
Control Mode:	Displacement
Waveform:	Sign wave
Test Speed:	0.05 m/s, 0.1 m/s, 0.3 m/s, 0.6 m/s
Amplitude:	±50 mm
Mean:	0mm
Number of Repeats:	10, 20, 60, 100
Temperature:	Room temperature (24 °C)

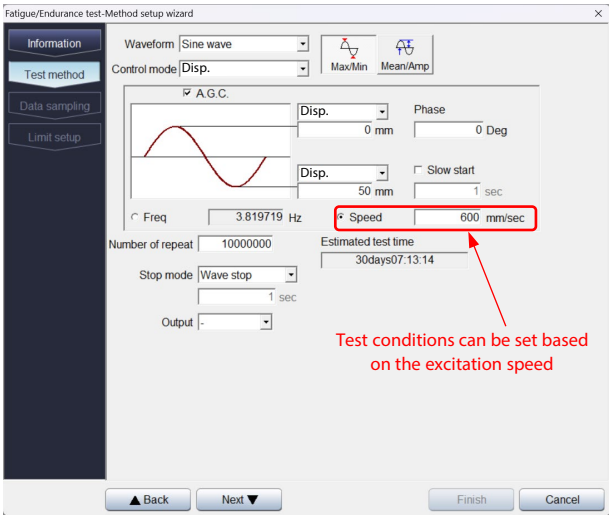

Fig. 3 Fatigue/Endurance Test Conditions Setup Wizard

Test condition files were created for different excitation speeds and set to be executed sequentially by the combination test software. Fig. 4 shows the condition setting screen of the combination test software.

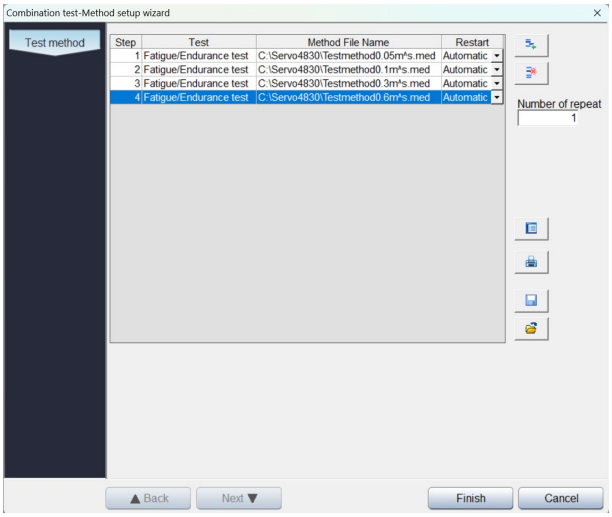

Fig. 4 Combination Test Conditions Setup Wizard

■ Test Results

Figs. 5 through 8 show time waveform graphs and cycle peak value graphs under each test condition. Blue indicates test force, and light blue indicates piston displacement. Test force corresponds to damping force, and piston displacement corresponds to stroke.

There is no rattling in the waveform at zero test force in any of the time waveform graphs, so there seems to be no problem with the method of fixing the specimen with the grips. In addition, there is no extreme change in test force in the cycle peak value graph, so there seems to be no effect of heat generation in the specimens.

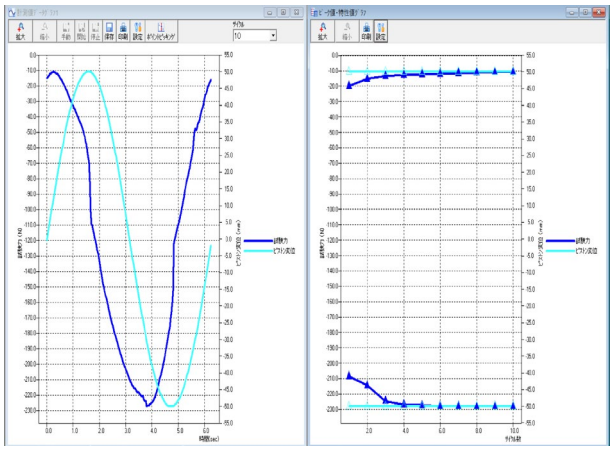

Fig. 5 0.05 m/s Test Result (at 10 Cycles)

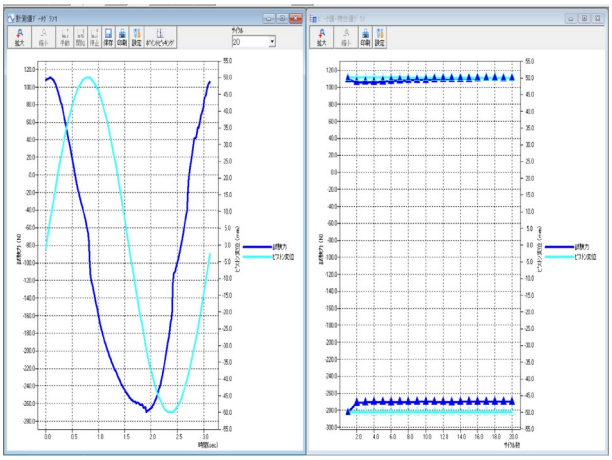

Fig. 6 0.1 m/s Test Result (at 20 Cycles)

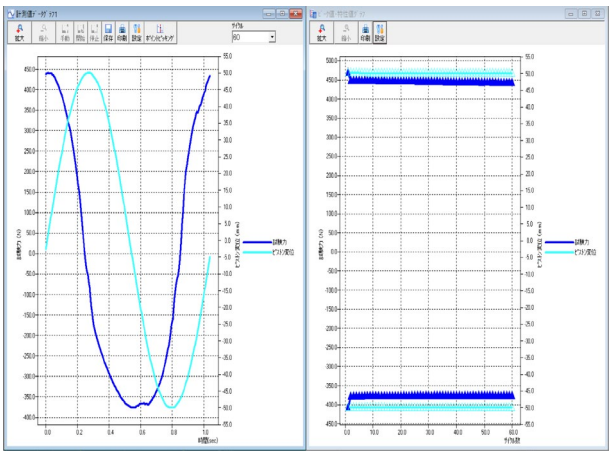

Fig. 7 0.3 m/s Test Result (at 60 Cycles)

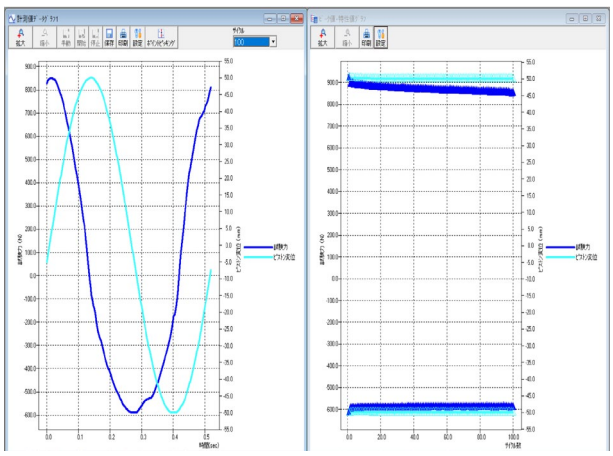

Fig. 8 0.6 m/s Test Result (at 100 Cycles)

■ Damping Force Characteristics

The test results were converted to a text file and the damping force characteristics were analyzed.

Fig. 9 shows the results of the damping force and stroke at each excitation speed. It can be seen that the damping force increases as the excitation speed increases.

Fig. 10 shows the results of the damping force and speed at each excitation speed. The speed is obtained by differentiating the stroke with time. By paying attention to the left and right edges of the graph at each excitation speed, it can be seen that the excitation speed has reached the set value and that the control is performed with high accuracy.

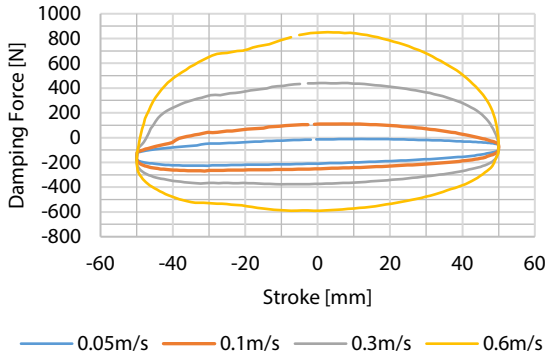

Fig. 9 Damping Force and Stroke Chart

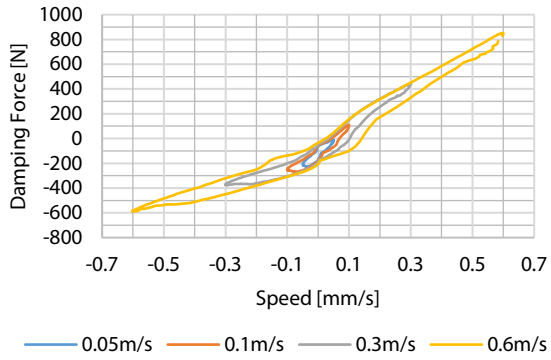

Fig. 10 Damping Force and Speed Chart

The damping force-speed characteristic chart shows the vertical damping force peak values at each excitation speed plotted on the damping force-speed graph. The blue color indicates the extension side, and the orange color indicates the contraction side. Fig. 11 shows the damping force-speed characteristic chart. The damping force characteristics of the suspension strut are evaluated using this damping force-speed characteristic chart.

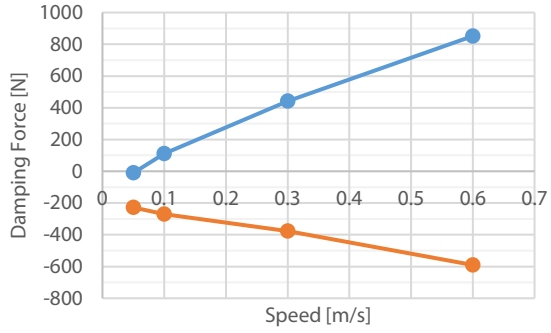

Fig. 11 Damping Force-Speed Characteristic Chart

■ Conclusion

A damping force characteristic test on a suspension strut based on JASO C611 was conducted using an EMT series electromagnetic fatigue testing machine and Windows software for 4830. The test conditions were set using the excitation speed, and it was confirmed that the test was accurately controlled as set. The standard "JASO C611 Suspension Struts for Automobiles" referred to this time is derived from "JASO C602 Automotive Parts - Telescopic Shock Absorbers for Suspension Systems"[2]. Although C602 also prescribes a damping force characteristic test, it is almost equivalent to the C611, and the test machine configuration can be used by replacing the jig.

■ Other Testing Machine Lineup

Because the EMT-1kNV-50 was used in this test, the test force capacity was exceeded at the excitation speed of 1 m/s, and that test could not be conducted. However, an EMT-5kNV with a capacity of 5 kN is also available in Shimadzu's product lineup (Fig. 12). The EMT-5kNV can handle a wider variety of test specimens.

We also have a dedicated testing machine for shock absorber performance evaluation, which is a customized version of the standard product (Fig. 13). In the dedicated testing machine, up to 10 levels of excitation speed test conditions can be set in one condition file, and the damping force-speed characteristic chart can be output from the software. When equipped with a lateral load loading mechanism, it is possible to perform "sliding resistance tests" in accordance with JASO C602 and C611.

Fig. 12 EMT-5kNV Fatigue Testing Machine

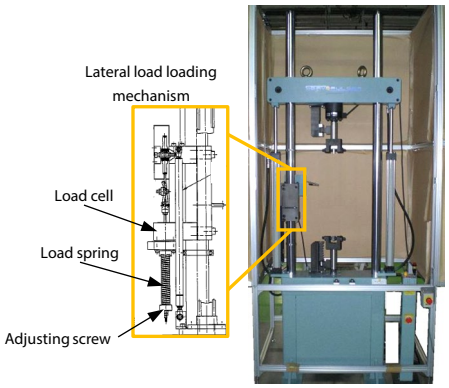

Fig. 13 Dedicated Testing Machine
for Shock Absorber Performance Evaluation

<References>

1) JASO C611:93 Suspension Struts
2) JASO C602:2001 Cylindrical Shock Absorbers for Automotive Parts and Suspensions

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