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Tabletop Dynamic and Fatigue Testing System Servopulser™ EHF-L Series

Application News

Fatigue Testing of Rigid Plastics (JIS K 7118)

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User Benefits

- It is possible to test in accordance with JIS K 7118 “General rules for testing fatigue of rigid plastics” by using the dynamic and fatigue testing system Servopulser, EHF-L Series.
- High-accuracy dynamic control can be achieved with Servo Controller 4830.
- The surface temperature of the test specimen can be measured in real time, and the collected data can be incorporated into the control system.

■ Introduction

Plastic materials are widely used in daily necessities such as PET bottles due to their light weight, low cost, superior moldability, and colorability. In recent years, in addition to general-purpose plastics such as polyvinyl chloride (PVC) and polyethylene (PE), engineering plastics with improved heat resistance and mechanical strength such as polycarbonate (PC) and polyamide (PA) have attracted attention. These materials are used as structural materials and mechanical components in automobiles, aircraft, and piping, and are increasingly used in applications that require performance in particularly harsh environments.

In the process leading to the failure of a material, even a small load such as vibration that does not break a material with a single load can cause failure due to repeated action. This phenomenon is called “fatigue.” Because plastic materials used as structural materials are expected to be subjected to repeated loads over a long period of time, evaluation of fatigue characteristics is essential for product safety.

This article introduces an example of fatigue testing of plastics in accordance with JIS K 7118.

Fig. 1 Dynamic and Fatigue Testing System Servopulser EHF-L

■ Measurement System

Table 1 shows the instrument configuration. A tabletop dynamic and fatigue testing system, Servopulser EHF-L, was used in this test (Fig. 1). Table 2 shows the test specimen information. Rigid PVC and PC were used in this test.

The test setup is shown in Fig. 2. It is widely known that the mechanical properties of plastic materials are temperature-dependent.[1)] In addition, during a fatigue test, the temperature may rise due to the heat generated by the specimen. This phenomenon depends on the material properties, and tends to become more pronounced as the frequency and applied stress increase. Therefore, in this test, the surface temperature of the specimen was measured using a radiation thermometer, and the frequency of the fatigue test was set so that the specimen temperature would be 30 °C or less. For the temperature measurement, blackbody paint was applied to the center of the specimen.

Additionally, a prototype jig with improved operability was used for this measurement.

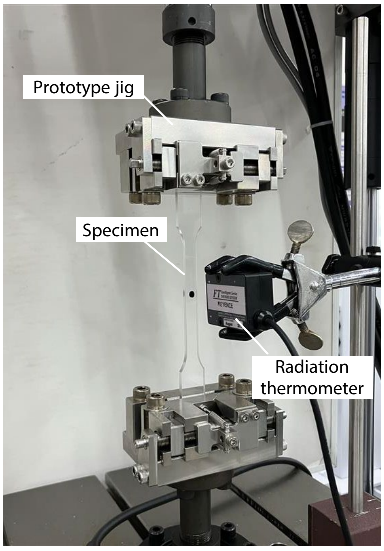

Fig. 2 View of the Test

Table 1 Instrument Configuration

Testing Machine:	Servopulser EHF-LV20k1A
Load Cell:	5 kN
Actuator Stroke:	±25 mm
Control Unit:	Servo Controller 4830
Software:	Windows Software for 4830
Test Jig:	Non-shift screw-type grips (prototype)
Thermometer:	Radiation Thermometer FT-H10 (KEYENCE)

Table 2 Test Specimen

Material Properties:	Rigid polyvinyl chloride (PVC) Polycarbonate (PC)
Shape:	ISO527-2-1A (JIS K 7161-2-1A)
Dimensions of the Parallel Section:	W10 × t4 × L80 mm

■ Static Test Results

Static tensile tests were performed to set the fatigue test conditions. Table 3 shows the test conditions for the static tensile tests. Fig. 3 shows the stress-strain diagram for each specimen. Table 4 shows the ultimate tensile strength of each specimen from the static test results.

Table 3 Static Test Conditions

Test Speed:	50 mm/min
Number of Specimens:	n = 3

Table 4 Static Test Results

Specimen	Static Ultimate Tensile Strength [MPa]	Standard Deviation	Coefficient of Variation (CV)
Rigid PVC	74.70	0.059	0.001
PC	64.05	0.118	0.002

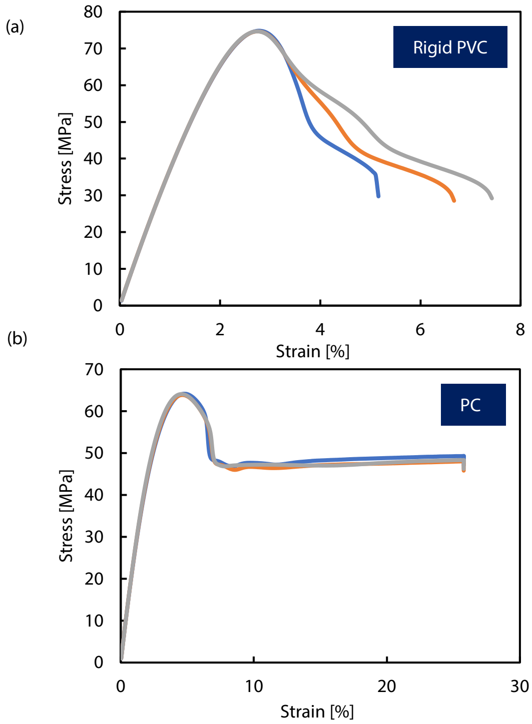

Fig. 3 Stress-Strain Curves (a) Rigid PVC, (b) PC

■ Fatigue Test Results

Table 5 shows the fatigue test conditions. Six conditions were set for the maximum loading stress in the fatigue tests: from 20 to 70 % of the ultimate tensile strength in the static test results.

Fig. 4 shows the relationship between the maximum loading stress and the specimen temperature. This time, the test was conducted with the frequency determined so that the surface temperature was 30 °C or less. Although the surface temperature of the specimen increased as the maximum loading stress increased, it can be confirmed from Fig. 4 that the tests were conducted at 30 °C or less. Fig. 5 shows the relationship between the maximum loading stress and the number of cycles to failure (S-N diagram). In this article, S-N diagrams were obtained for two types of materials and it was possible to evaluate their fatigue properties.

Table 2 Fatigue Test Conditions

Maximum Loading Stress:	The percentages of static ultimate tensile strength were as follows PVC 20, 30, 40, 50, 60 % PC 20, 30, 40, 50, 60, 70 %
Stress Ratio:	0.1
Maximum Cycles:	1.0×10^6 Cycles
Frequency:	5 Hz
Number of Specimens:	n = 2
Test Temperature:	23 °C

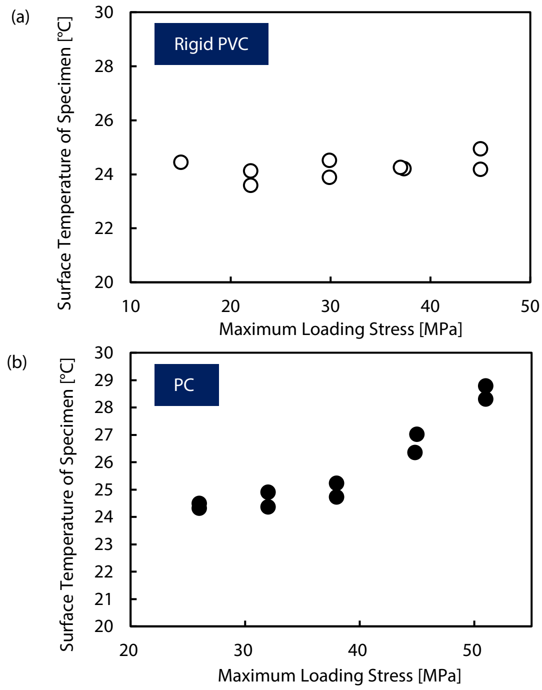

Fig. 4 Surface Temperature of Specimen-Maximum Load Stress Curves
(a) Rigid PVC, (b) PC

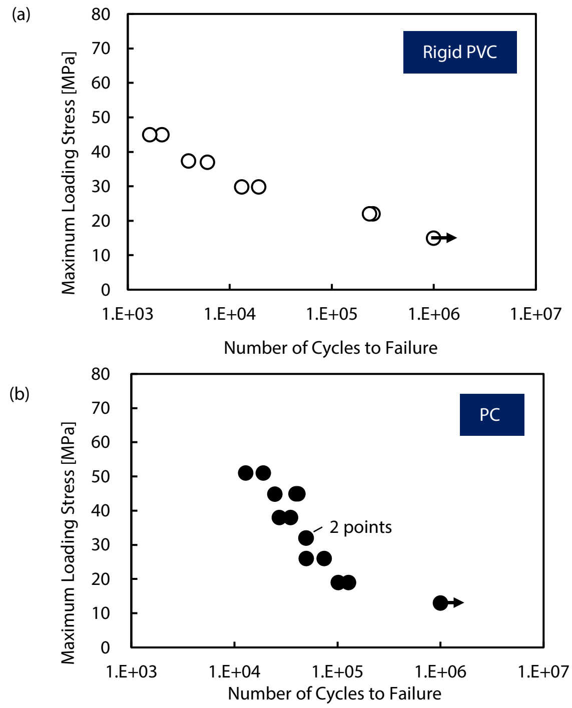

Fig. 5 S-N Diagram (a) Rigid PVC, (b) PC

■ Conclusion

In these tests, rigid PVC and PC were subjected to fatigue tests in accordance with JIS K 7118 using the dynamic fatigue testing machine Servopulser EHF-L. The surface temperature of the specimens was measured using a radiation thermometer.

As described above, this instrument configuration can be used for fatigue characterization of plastic materials.

<References>

1) Takeshi Kunio: Materials System, 6 (1987), 7-19

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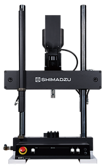

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