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Application News

Dynamic and Fatigue Testing Machine Servopulser EHF-LV020k1A

Fatigue Testing of Artificial Joint Materials with Working Waves

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User Benefits

- Servo Controller 4830 enables high-precision dynamic control.
- Fatigue strength evaluation of artificial joint materials is possible using the Servopulser series.
- Force can be applied to specimens based on the force waveform data recorded in a CSV file.

■ Introduction

Artificial joints have been evaluated by fatigue tests because they are required to be durable against repeated load in daily life. In fatigue testing, it is common to apply a sine wave force or displacement to the specimen. However, the ankle has complex compressive loads that occur during walking. Therefore, by applying this force during walking to the specimen, it is possible to evaluate the fatigue strength in accordance with the actual application.

In this article, a case is presented in which the force applied to an ankle joint during walking was actually applied to a specimen. First, the TM5135, a compact telemetry system manufactured by Toyota Technical Development Corporation shown in Fig. 1, was used to measure strain data during walking and to generate force waveforms. Next, the generated force waveforms were loaded into a fatigue testing machine, and the force was applied to a square polyethylene material (23.5 × 23.5 × 12 mm) used as an artificial ankle joint material.

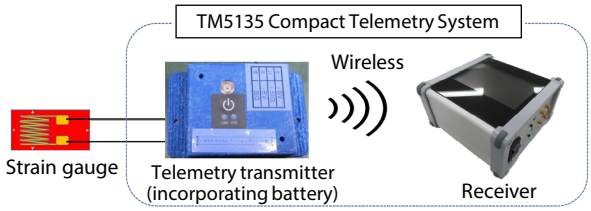

Fig. 1 TM5135 Compact Telemetry System

■ Acquisition of Force Waveform during Walking

A telemetry system is a device that emits sensor output from a lightweight transmitter that can be received wirelessly and output be a nearby receiver.

To generate the force waveforms, strain data during walking was first acquired. First, a resin test piece with a strain gauge was attached to the sole of a shoe. Next, the strain gauge was connected to the transmitter of the telemetry system through a simple prototype sensor to transmit strain waveforms. A device capable of digital storage was connected to the receiver to obtain digital strain waveforms during walking. This is an effective way to obtain actual waveforms without having to carry around a data storage device such as a personal computer or wiring.

The strain waveforms acquired this time are data obtained by walking on a flat floor and climbing stairs for about 30 seconds each. The maximum point of the obtained data was converted to force so that it was 1000 N, and the waveform of the load during walking equivalent to a person weighing 100 kg was used.

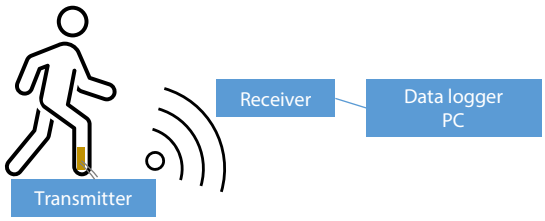

Fig. 2 Acquisition of Strain Data by Telemetry System

■ Measurement System

The Servopulser EHF-L dynamic and fatigue testing machine, shown in Fig. 3, was used for the measurements. Fig. 4 shows the test and Table 1 shows the test equipment used.

The software used program tests of Windows® Software for 4830 software for the Servopulser. Program tests can read waveforms from csv files in addition to ramp waves and hold waves. This allows control to be performed according to a pre-stored load pattern. It can output waveforms of any shape, making it a suitable function for simple control of complex real waveforms such as this one.

Fig. 3 Servopulser EHF-L Dynamic and Fatigue Testing Machine

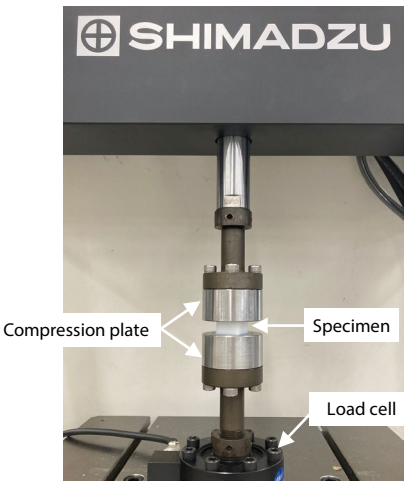

Fig. 4 View of the Test

Table 1 Test Equipment

Dynamic and Fatigue Testing Machine:	Servopulser EHF-LV020k1A
Load Cell:	20 kN
Compression Plate:	Φ 60 mm
Actuator Stroke:	±25 mm
Software:	Windows® software for 4830 Program test

■ Measurement Conditions

The conditions of this measurement are shown in Table 2. The strain data during walking was converted to a maximum test force of 1000 N, and the measurement was performed by force control. In terms of the number of repetitions, the test was repeated for five cycles of one-minute walking data for walking on a flat floor and walking up and down a stairs.

Table 2 Measurement Condition

Dynamic and Fatigue Testing Machine:	Servopulser EHF-LV020k1A
Load Cell:	20 kN
Compression Plate:	Φ 60 mm
Actuator Stroke:	±25 mm
Software:	Windows software for 4830 Program test

■ Measurement Results

Fig. 5 shows the set signal and the force waveform versus time (first cycle). The force waveform follows the set signal waveform well, indicating that it is possible to apply force to the specimen in accordance with the set signal taken into the testing machine. It was shown that the program test of Windows® Software for 4830 can be used to conduct dynamic control tests with the force signals of complex waveforms, as in this test.

■ Conclusion

In this article, a case was introduced in which the force waveform generated from the data acquired by the telemetry system was taken into a fatigue testing machine and the force was applied to a polyethylene square test piece used in the artificial joint.

By using the telemetry system, complex waveforms such as a strain data during walking could be easily obtained without having to carry storage equipment or wiring. The force applied to the specimen was compared with the set force taken into the testing machine. From the results, it was confirmed that the force applied to the sole of the shoe during walking can be roughly reproduced.

Thus, by using the measurement system introduced in this article, it is possible to perform a fatigue test in which a complex force is applied to a specimen.

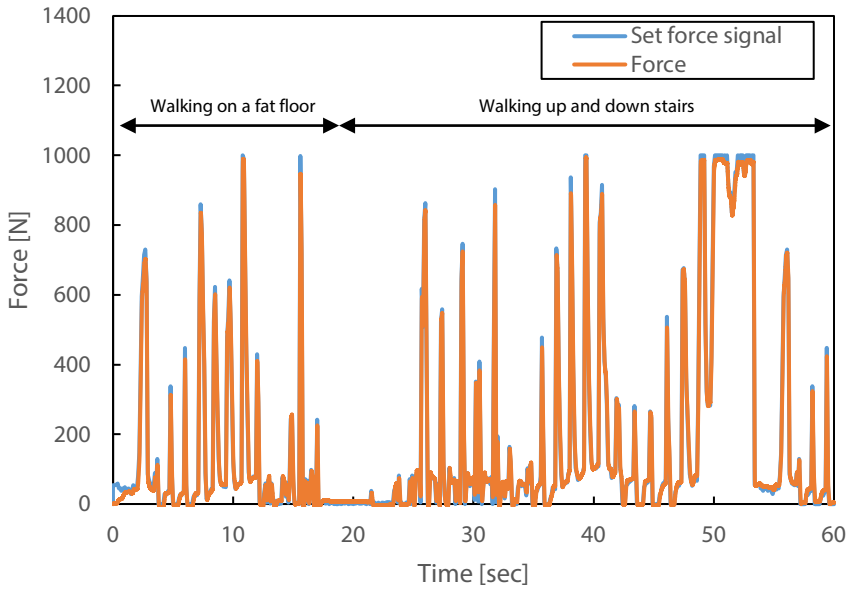

Fig. 5 Set Signal and Force Waveform for Time

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