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

Application News

Shear Fatigue Testing of Adhesives

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User Benefits

- Shear fatigue testing of adhesives can be performed in accordance with JIS K 6864 using the EHF-L series.
- High-accuracy dynamic control can be achieved with Servo Controller 4830.

■ Introduction

Adhesives are often used to join objects. Since they can be used on almost any material, they can join dissimilar materials. They also have the advantage of not changing the properties or shape of the materials they adhere to. This is why they are used in a wide range of industries, such as transport machinery including the automobile and aerospace field, electrical and electronic equipment, and civil engineering. For transport vehicles in particular, applications such as strengthening or replacing spot welding (weld bonds) are increasing, so the ability to evaluate these things is necessary to ensure their long-term reliability. This article describes shear fatigue testing performed on four types of adhesive in accordance with JIS K 6864 (ISO 9664). The Servopulser EHF-L tabletop dynamic and fatigue testing system was used in the tests.

■ Test Specimen Information and Measurement System

In these tests, four types of adhesive from the company ThreeBond (hereafter referred to as TB) were used. The test specimen is shown in Fig. 1. Test specimen information is shown in Table 1, and the curing conditions of each adhesive are shown in Table 2. SUS 304 stainless steel was used as the material to be joined. The tests were performed using the Servopulser EHF-L tabletop dynamic and fatigue testing system. The test equipment configuration is shown in Table 3, and the test setup is shown in Fig. 2.

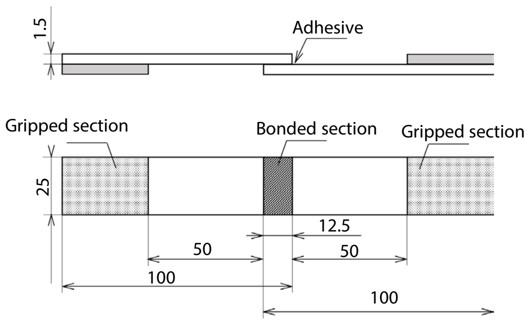

Fig. 1 Test Specimen Shape

Table 1 Test Specimen Information

Adhesive Type:	TB1160 (one-component room temperature curing non-silicone sealant)
	TB2049/2149 (two-component room temperature curing epoxy compound resin)
	TB2237J (one-component heat curing type epoxy compound resin)
	TB3953 (two-component room temperature curing elastic adhesive)
Bonded Material:	SUS304
Bonded Area:	25 × 12.5
Specimen Dimensions:	W25 × t6 × L187.5 mm (for TB1160 only, t7 mm)

Table 2 Curing Conditions

TB 1160:	(23 °C, 50 %RH) × 168 h
TB 2049/2149:	25 °C × 24 h
TB 2237J:	120 °C × 60 min
TB 3953:	(23 °C, 50 % RH) × 168 h

Table 3 Equipment Configuration

Fatigue Testing Machine:	EHF-L
Load Cell:	10 kN
Test Jig:	Non-shift screw-type grips
Control Device:	Servo Controller 4830
Software:	Windows software for Servo Controller 4830

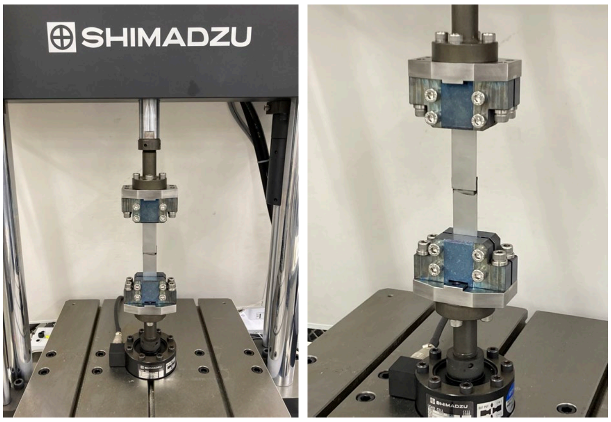

Fig. 2 Test Setup

■ Static Shear Test Results

To set the conditions in the fatigue tests, static shear tests were performed. The static shear test conditions are shown in Table 4. The shear stress - displacement curves for each test specimen are shown in Fig. 3, and the shear strength obtained from the shear strength tests on each test specimen are summarized in Table 5.

Table 4 Test Conditions

Test Speed:	1.2 mm/min
Number of Tests:	n = 3

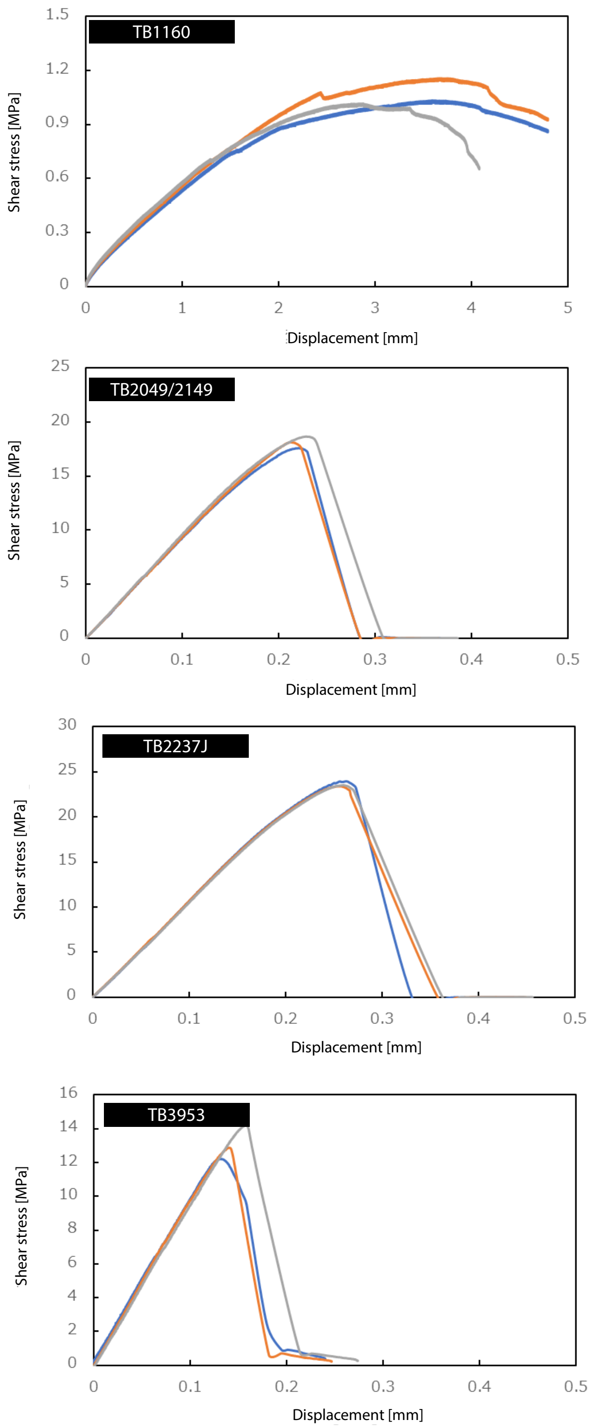

Fig. 3 Shear Stress - Displacement Curves

Table 5 Static Shear Test Results (Shear Strength)

Specimen	Shear Strength (Mean) [MPa]	Standard Deviation	Coefficient of Variation
TB1160	1.070	0.077	7.17
TB 2049/2149:	18.14	0.537	2.96
TB 2237J:	23.64	0.286	1.21
TB 3953:	13.11	1.019	7.78

■ Shear Fatigue Test Results

Normally, the mean stress in a fatigue test is set to $0.35\tau_R$, where τ_R is the static shear strength in accordance with JIS K 6864. The stress amplitude with respect to this mean stress value is set as the fatigue test condition. In this case, shear stress of 5 to 30 % of the static shear strength was set as the stress amplitude. It is a requirement that tests are performed at the test frequency of 30 Hz unless prescribed otherwise. The fatigue test conditions are summarized in Table 6.

With the test specimens TB1160 and TB3953, large variations in fatigue were produced under the stress amplitude conditions. Fig. 4 shows the fatigue test results for TB1160 and TB3953 under stress amplitudes of 22.5 and 25 %, respectively. Photos of the failure surfaces for the corresponding test results are also shown. For TB1160, when the number of cycles to failure was low, interfacial failure and cohesive failure occurred, as shown in photos [1] and [2]. However, when the number of cycles to failure was high, only cohesive failure occurred, as shown in photo [3]. Generally, when interfacial failure occurs, fatigue failure occurs earlier than the actual fatigue life of the adhesive. Therefore, to evaluate the pure fatigue life of an adhesive, achieving cohesive failure is desirable. However, the occurrence of interfacial failure depends on the surface condition of the object on which the adhesive is adhering to, so that object was included in this evaluation. In these test results, there were many cases of interfacial failure and cohesive failure, so the test results are summarized according to the failure mode. With TB3953, the failures were all interfacial failures and cohesive failures. But the higher the number of cycles to failure were, the more the adhesive was thinly spread over the entire failure surface. With TB3953, the central three points were summarized as the test results. The S-N curves for each test specimen are shown in Fig. 5.

Table 6 Fatigue Test Conditions

Mean Stress:	35 % of τ_R	
Stress Amplitude:	The percentages of τ_R were as follows	
	TB1160	20, 22.5, 25, 27.5, 30 %
	TB2049/2149	2.5, 5, 10, 15, 20, 25, 30 %
	TB2237J	5, 10, 15, 20, 25, 30 %
	TB3953	20, 25, 30 %
Frequency:	30 Hz	
Number of Tests:	n = about 3	

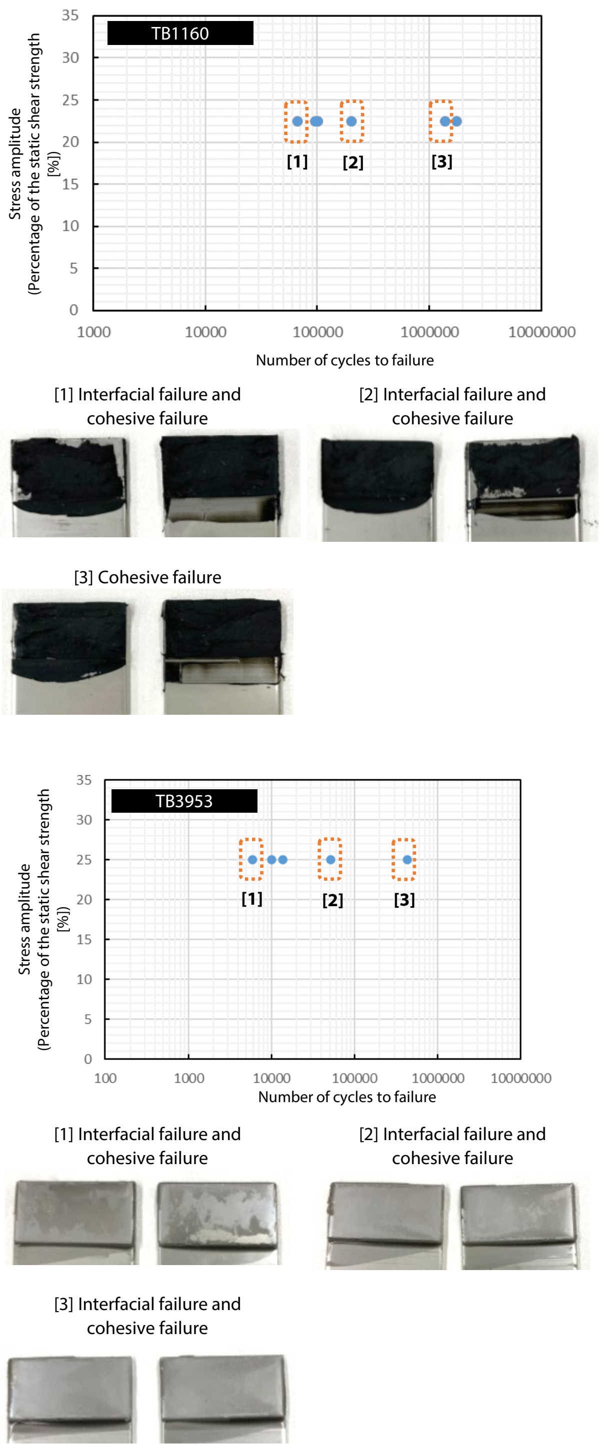

Fig. 4 Examples of Fatigue Test Results for TB1160 and TB3953

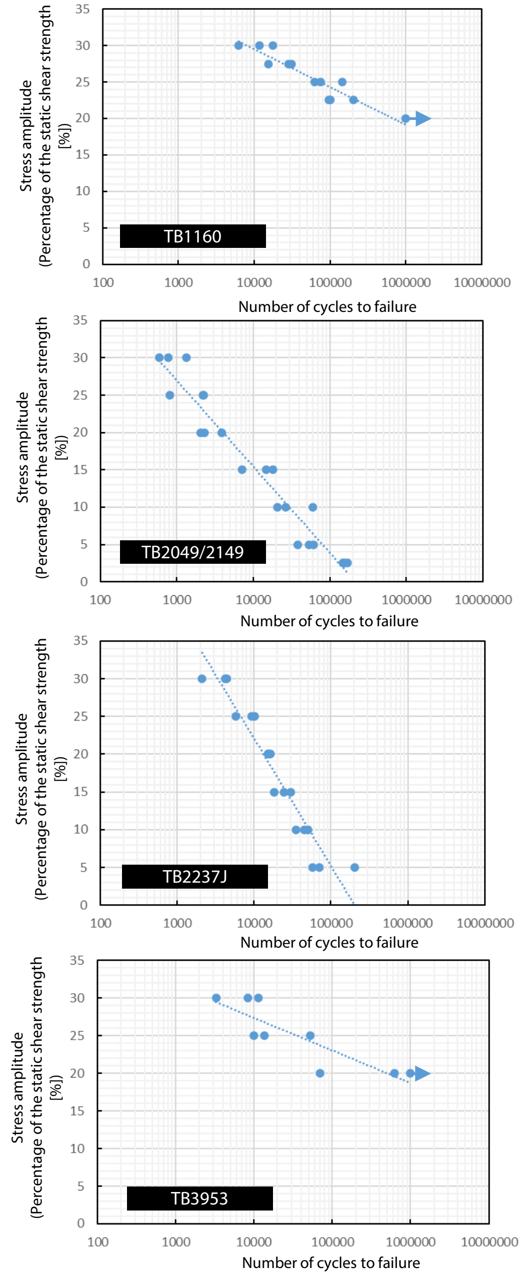

Fig. 5 S-N Curves

■ Conclusion

Shear fatigue tests were performed on four types of adhesive, by reference to JIS K 6864. It is possible to perform shear fatigue tests on adhesives in accordance with JIS K 6864 using the present equipment configuration.

Acknowledgments
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<Related Applications>

1. Temperature Dependence Evaluation of Tensile Shear Strength of Adhesive, Application News No.01-00799
2. Test Speed Dependence Evaluation of Shear Strength of Adhesive and Fracture Observation, Application News No.01-00743

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