Ultrasonic Fatigue Testing System

USF-2000A

20 kHz Fatigue Testing
Ultra Efficient for Gigacycle Testing
Also for Analyzing Inclusions in Metals

This ultrasonic fatigue testing system achieves a vibration rate of 20 kHz by applying a vibration generated by a Piezoelectric element and amplified by a horn. This not only significantly reduces cycle times, it also helps discover microscopic defects and inclusions in high-strength steel materials, which can cause fatigue fractures at the megacycle level.

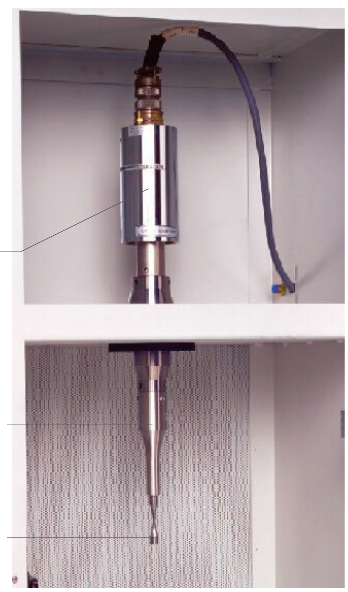
Capable of Testing 1000 MPa Class Steel Material

High stresses can be generated by performing tests at resonance frequencies. With a 20 kHz cycle capacity, this system is able to accelerate fatigue life evaluations of metals and other materials. It is perfect for long service life evaluation of materials or high-speed vibration testing.

Extremely Economical with Power Consumption of Only 100 W

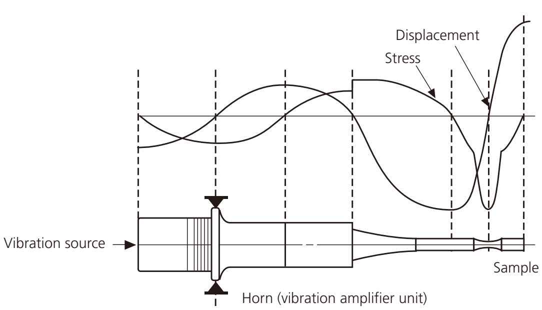
Use of resonance requires only minimal power consumption.

Ultrasonic Vibration Generator Unit

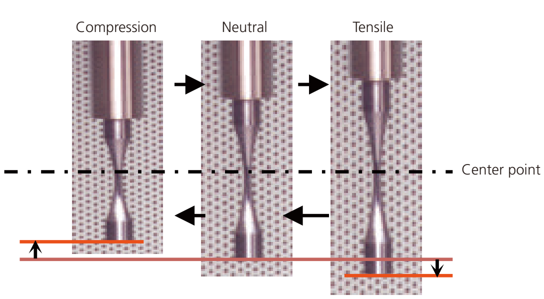


20 kHz Vibration Uses Resonance

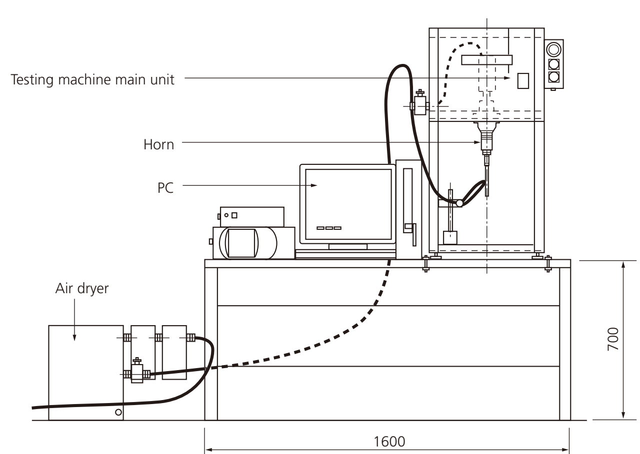
The load applied to samples is a 20 kHz longitudinal wave vibration generated by an actuator (Piezoelectric element) and amplified by a booster and horn. Longitudinal waves travel through metals as the metal stretches and compresses in the longitudinal direction. Therefore, a cyclic stress is applied to the metal. The stress is calculated from the displacement of the front edge of the sample, rather than directly measuring the test force using a load cell.



Operating Principle of the Ultrasonic Fatigue Testing System



Testing at Resonance Frequency



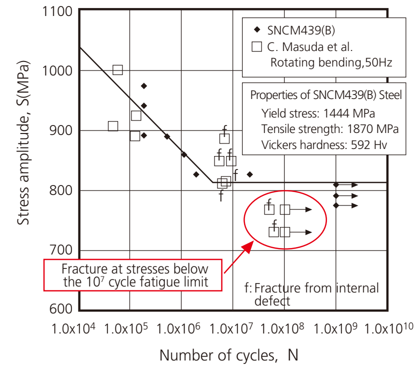
Standard Layout

For Evaluating Fatigue Strength at Cycle Level of 10^8 or Higher

Conventionally, it was assumed that fatigue strength of steel was constant beyond 10^7 cycles. In other words, it was assumed that fatigue failure would not occur at stresses below the fatigue limit for 10^7 cycles. However, we are now learning that in the case of materials strengthened by quenching or surface treatment, internal inclusions can cause fatigue fractures between 10^8 and 10^9 cycles even for stress levels below the 10^7 fatigue limit.
Therefore, now that products are being used for longer periods at higher speeds, fatigue fractures between 10^8 and 10^9 cycles have become an extremely important issue.

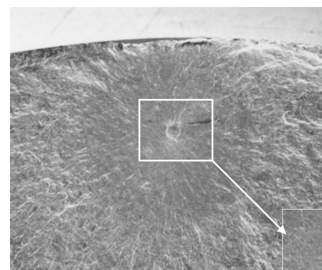
Allows tests of 10^{10} cycles to be completed in only six days, which would normally take 3.2 years at 100 Hz.

Fatigue Strength of SNCM439(B) Steel

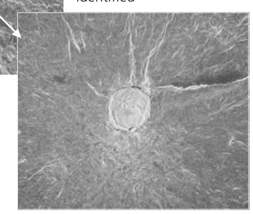


For Analyzing Inclusions in Test Materials

In high-strength steels and other materials, fatigue can propagate from micro defects and inclusions inside the material, which are known to result in fatigue fractures at the gigacycle level. Therefore, identifying and analyzing defects and inclusions in test materials are useful for developing materials with high fatigue strength.
Due to the extremely small size of such defects and inclusions, they are very difficult to identify using non-destructive methods. Typically, materials were sliced and the section surface visually inspected.
However, the efficiency of identifying and analyzing inclusions can be increased dramatically by using an ultrasonic fatigue testing machine to the point of fatigue fracture, which ensures a defect or inclusion will be discovered on the fracture surface.



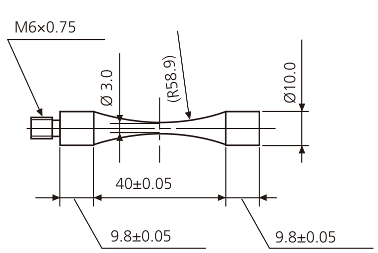
Example of the fatigue fracture surface of high-strength steel fractured by the Shimadzu USF-2000 Ultrasonic Fatigue Testing System



Inclusion where the fatigue fracture originated can be identified

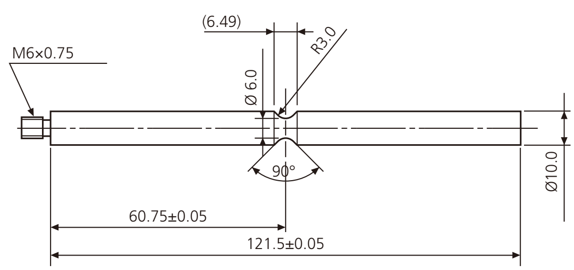
Example of Sample Dimensions (given Young's modulus of 206,000 MPa and density of 7.85 g/cm³)

Circular Tapered Sample



Test stress range: About 200 to 1000 MPa nominal

Notched Sample



Test stress range: About 140 to 700 MPa nominal
Stress concentration factor: About 1.56

Units: mm

Specifications

Test frequency	20 kHz ±500 Hz (recommended test range: 20 kHz ±30 Hz) Note: The test frequency is determined from the resonance frequency of the sample.
Vibration at horn tip	±10 to ±50 μm
Test stress range	Stress given ±10 to ±50 μm displacement of sample Note: Stress values depend on sample shape and physical property values.
Stress ratio	-1
Testable materials	Materials that can be resonated at 20 kHz and generate minimal heat during resonance Example: High-strength steel, duralumin, titanium alloy, aluminum, etc.
Not-testable materials	●Materials that cannot resonate at 20 kHz ●Materials for which samples are difficult to attach ●Materials that generate significant heat during resonance at 20 kHz, due to friction Examples: Resins, ceramics, etc.
Power requirements	3-phase 200 V: 2 kVA (air compressor), 1-phase 200V: 3.5 kVA (ultrasonic fatigue testing system), 1-phase 100V: 1 kVA (computer, displacement logger, air dryer, etc.)
Standard contents	USF-2000A Ultrasonic Fatigue Testing System main unit (including table), ultrasonic resonance system, control computer, ultrasonic testing control and measurement software, and cooling unit (air dryer and compressed air lines) Note: Air compressor for cooling is not included.
Required optional products	Air compressor (for regions with 50 Hz or 60 Hz power) 3-phase 200 V: 2 kVA
	Displacement measuring system (eddy current displacement gauge with 0.5 μm resolution) Note: A high-speed data logger or digital oscilloscope is required separately for reading voltages output from the displacement gauge.
	Displacement gauge calibrator (CDE-25 C1 high-performance micrometer)

Note: Systems can be selected without an air compressor in cases where the customer will supply the compressed air. A 150 L/m flow rate of compressed air at a minimum 0.2 MPa is required.