WANCE Testing Machine

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WANCE Testing Machine

Fatigue Testing System

WANCE®

Fatigue Testing System

Contents

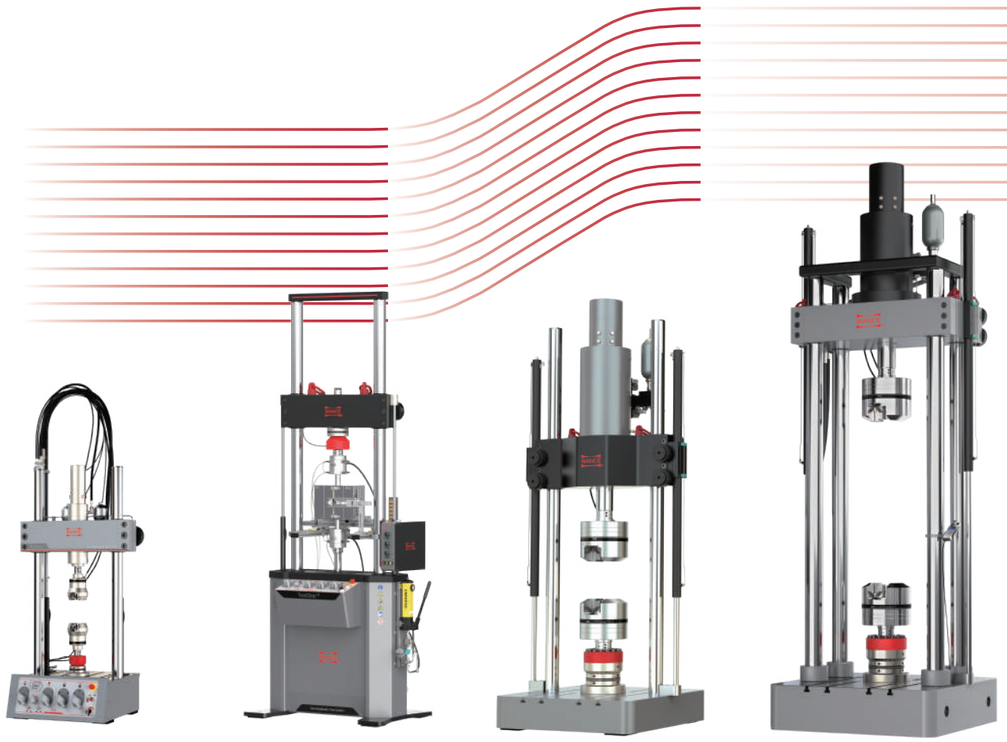
Company Profile

Founded in 2011 and headquartered in Shenzhen, WANCE is a provider of mechanical property testing machines and solutions that integrates R&D, manufacturing, sales, and service. Driven by market demands and committed to technological innovation, the company operates two major R&D and manufacturing bases in Shenzhen and Wuhan. Among them, its self-owned Wuhan R&D and manufacturing base covers an area of 23,333 square meters with a construction area of nearly 30,000 square meters.

From compact melt flow indexers to 100,000J drop weight impact testing machines, WANCE leverages years of industrial expertise and a creative technical team to provide robust testing support and confidence to clients across fields. To date, over 16,000 sets of material testing systems have successfully contributed to the development of industries worldwide, including aerospace, national defense and military, research institutes, institutions of higher education, engineering quality inspection, automotive and shipbuilding, bridge and civil engineering, new energy, and new materials.

With a dedication to delivering comprehensive, in-depth products and solutions, WANCE strives to be your primary and reliable partner in advancing testing excellence.

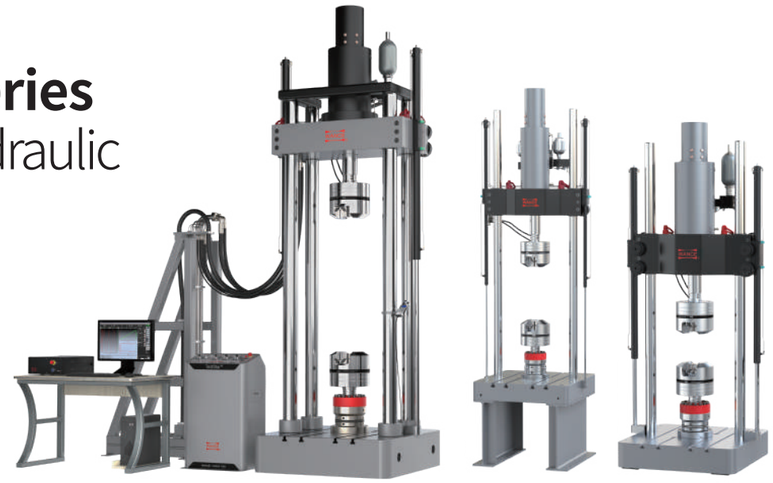
Dynamic and Fatigue Testing Systems



Servo-hydraulic fatigue testing systems

High frequency resonant testing systems

HDT-A series
Servo-hydraulic



Functions
It is mainly used to test the static and dynamic mechanical properties of metal and non-metal materials, components, elastomers and shock absorbers. It can perform mechanical tests such as tension, compression, bending, tension-tension, compression-compression and tension-compression, as well as tests like high-cycle fatigue, low-cycle fatigue, crack propagation and fracture mechanics. It can output various waveforms including sine wave, triangular wave and square wave. Equipped with a high-temperature furnace, a high-low temperature chamber and a corrosion chamber, it can conduct mechanical tests under different environments.

Features
▶ The actuator is placed on top, and the T-slot table is placed at the bottom, forming a closed frame structure with high frame rigidity, backlash free, and good stability;
▶ The actuator adopts a double-acting oil cylinder design, and the T-shaped table can be equipped with hydraulic fixtures, as well as various parts and structural components;
▶ The lifting, locking of the moving crossbeam and the clamping of the sample are all operated by buttons, which is flexible and convenient.

Parameters

Name	Model	HDT254A	HDT504A	HDT105A	HDT255A	HDT505A	HDT106A	HDT206A
	Guidance columns	2	2	2	2	2	4	4
Capacity	Dynamic (kN)	25	50	100	250	500	1000	2000
	Static (kN)	25	50	100	250	500	1000	2000
Accuracy	Load	Better than ±0.5% of reading (static), ±1% of reading (dynamic)						
	Extension	Better than ±0.5% of reading						
	Displacement	Better than 0.5%F.S						
Dynamic	Frequency (Hz)	60				50	30	20
	Amplitude (mm)	Determine the amplitude based on the HPU flow rate						
	Waveform	Sine wave, square wave, triangular wave, trapezoidal wave, ramp wave, custom waveform, etc.						
	Piston travel (mm)	150 (±75)						
	Control	Force, displacement, and extension, three-closed-loop control						

HDT-B series
Servo-hydraulic

Functions
It is mainly used to test the static and dynamic mechanical properties of metal and non-metal materials. It can perform mechanical tests such as tension, compression, tension-tension, compression-compression and tension-compression, as well as tests like high-cycle fatigue, low-cycle fatigue, crack propagation and fracture toughness. It can output various waveforms including sine wave, triangular wave and square wave. Equipped with a high-temperature furnace, a high-low temperature chamber and a corrosion chamber, it can conduct mechanical tests under different environments.

Features
▶ The crosshead is positioned on the upper part while the actuator is located below, forming a closed-frame structure with high rigidity, backlash free, and excellent stability.
▶ The actuator is designed with a double-acting hydraulic cylinder, featuring a rational spatial layout for convenient operation.
▶ The lifting, locking of the movable crosshead and the clamping of specimens are all controlled by buttons, enabling flexible and user-friendly operation.

Parameters

Name	Model	HDT254B	HDT504B	HDT105B	HDT255B	HDT505B
Capacity	Dynamic (kN)	25	50	100	250	500
	Static (kN)	25	50	100	250	500
Accuracy	Load	Better than ±0.5% of reading (static), ±1% of reading (dynamic)				
	Extension	Better than ±0.5% of reading				
	Displacement	Better than 0.5%F.S				
Dynamic	Frequency (Hz)	60				50
	Amplitude (mm)	Determine the amplitude based on the HPU flow rate				
	Waveform	Sine wave, square wave, triangular wave, trapezoidal wave, ramp wave, custom waveform, etc.				
	Piston travel (mm)	150 (±75)				
	Control	Force, displacement, and extension, three-closed-loop control				

HDT-B series
Table-top servo-hydraulic

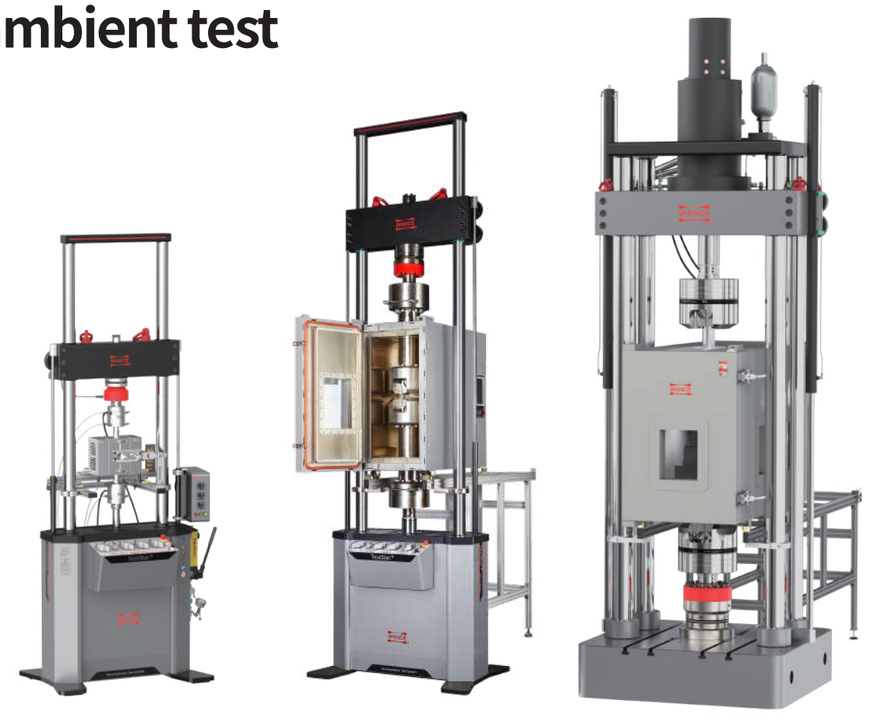
Functions
It is primarily used for fatigue mechanical property testing of metallic materials, composite materials and their components, biological bones, and elastomers. It can perform tension, compression, bending, and tension-compression loading tests. It is capable of conducting high-cycle fatigue, low-cycle fatigue, fracture mechanics, and other types of tests. The control methods include load control, strain control, and displacement control, with various waveform outputs such as sine wave, triangular wave, and trapezoidal wave.

Features
▶ Compact structure, small footprint, can be placed on the desktop;
▶ Can be equipped with manual wedge clamps, hydraulic clamps, compression clamps, bending clamps, fracture mechanics clamps, biological bone clamps, etc.;
▶ Can be equipped with a corrosion tank to allow samples to undergo fatigue tests in environments such as water, NaCl solution, acid, and alkali solutions;
▶ The height of the crossbeam is easy to adjust, with hydraulic lifting and hydraulic locking;
▶ The base is equipped with air spring vibration reduction, preventing fatigue vibration from being transmitted to the surroundings;
▶ Equipped with a servo oil source, featuring low noise, low energy consumption, and adjustable output flow;
▶ Elegant appearance.

Parameters

Name	Model	HDT503A	HDT104A	HDT254A
Capacity	Dynamic (kN)	5	10	25
	Static (kN)	5	10	25
Accuracy	Force	Better than ±0.5% of reading (static), ±1% of reading (dynamic)		
	Extension	Better than ±0.5% of reading		
	Displacement	Better than 0.5%F.S		
Dynamic	Frequency (Hz)	60		
	Amplitude (mm)	Determine the amplitude based on the HPU flow rate		
	Waveform	Sine wave, square wave, triangular wave, trapezoidal wave, ramp wave, custom waveform, etc.		
Piston travel (mm)		100 (±50)		
Control		Force, displacement, and extension, three-closed-loop control		

Non-ambient test



▲Furnace ▲Environmental chamber

Functions
Equipped with furnace or chamber to simulate mechanical tests at different temperatures.

Optional configurations:
▶ **Furnace:** The temperature range is +100°C~+1000°C. It is a small square high-temperature furnace. Equipped with a high-temperature extensometer, it is suitable for metal low-cycle fatigue tests.
▶ **Chamber:** The temperature range includes various specifications from -70°C to +350°C for selection, and there are two cooling methods: liquid nitrogen cooling and compressor cooling. It can also be equipped with a full-temperature hydraulic fixture. The chuck extends directly into the chamber, and the clamping and installation of the sample do not require other transitional links, which is very stable and reliable. It is suitable for fatigue tests of composite materials, adhesives, rubber, etc.
▶ **Salt spray chamber:** The space size and salt spray sedimentation amount can be customized according to user needs. It is suitable for fatigue tests, fracture mechanics tests, etc. of corrosion-resistant materials.

EDT series
Electrodynamic

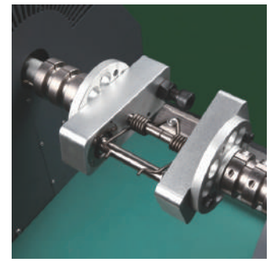
Functions
It is mainly used to test the static and dynamic mechanical properties of micro-material samples, components, and elastomers. It can perform mechanical tests such as tension, compression, bending, tension-tension, compression-compression, and tension-compression, as well as tests like high-cycle fatigue, low-cycle fatigue, crack propagation, and fracture toughness. It can output various waveforms including sine waves, triangular waves, and square waves. Equipped with a high-temperature furnace, a high-low temperature chamber, and a corrosion chamber, it can conduct mechanical tests under different environments.

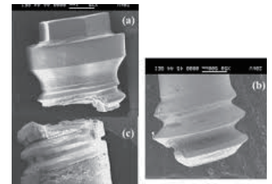
Features
▶ The crosshead is placed on top and the actuator is placed at the bottom, forming a closed frame structure with high frame rigidity, no backlash, and good stability;
▶ The spatial design is reasonable and the operation is convenient;
▶ An integrated linear servo electric cylinder is adopted, ensuring stable and reliable loading;
▶ The lifting, locking of the moving crossbeam and the clamping of the sample are all operated by buttons, which is flexible and convenient.

Parameters

Name	Model	EDT203B	EDT503B	EDT104B	EDT204B
Capacity	Dynamic (kN)	2	5	10	20
	Static (kN)	2	5	10	20
Accuracy	Force	Better than ±0.5% of reading (static), ±1% of reading (dynamic)			
	Extension	Better than ±0.5% of reading			
	Displacement	Better than 0.5%F.S			
Dynamic	Frequency (Hz)	0.01~10			
	Amplitude (mm)	±50/±100			
	Waveform	Sine wave, square wave, triangular wave, trapezoidal wave, ramp wave, custom waveform, etc.			
	Control	Force, displacement, and extension, three-closed-loop control			

HDT-S series
EDT-S series
Torsion fatigue





Functions
It is mainly used for static torsion and dynamic torsion fatigue durability tests of metals, non-metals and other materials. Equipped with corresponding fixtures, it can also realize torsion performance testing of various components such as springs, drive shafts, clutches and shock absorbers. With environmental chambers such as high-temperature furnaces, high-low temperature chambers and corrosion chambers, it can also conduct torsion performance tests of materials under different environments.

Features
▶ Adopting a horizontal floor-mounted structure, it allows for convenient loading and unloading of samples, with good overall dynamic stability, safety and reliability;
▶ Through computer settings, automatic measurement and control of torque, frequency and torsion angle can be realized;
▶ The test process can be queried and called up at any time.

Parameters

Name	Model	EDT102S	EDT202S	HDT302S	HDT502S	HDT103S	HDT503S	HDT104S
Capacity	Dynamic (N.m)	100	200	300	500	1000	5000	10000
	Static (N.m)	100	200	300	500	1000	5000	10000
Accuracy	Torque	Better than ±0.5% of reading (static), ±1% of reading (dynamic)						
	Angle	Better than 0.5%F.S						
	Angle resolution (°)	0.03						
Dynamic	Frequency (Hz)	0.01-20		0.01-50				
	Waveform	Sine wave/square wave/triangular wave/trapezoidal wave/ramp wave/random waveform, etc.						
	Max. Swing angle (°)	Unlimited		100 (±50)				
	Control	Torque and angle closed-loop control						

Hydraulic power unit

HPU 1-2 pumps

Features

▶ Noise reduction design: An oil-immersed motor is adopted, with the oil pump and motor completely immersed in hydraulic oil to prevent noise from the motor-pump unit from spreading outward; through vibration reduction design, special vibration-damping rubber is attached when installing the motor and oil tank to block mutual transmission of vibrations and reduce noise; the fully enclosed oil source structure further blocks noise from spreading outward.
▶ Energy-saving design: A variable displacement piston pump is used, which can automatically adjust the flow output according to the actual oil demand of the servo actuator, achieving an energy-saving effect.

Parameters

Model	HPU201	HPU401	HPU631	HPU102	HPU202
Rated flow rate (L/min)	20	40	63	100	200
Rated pressure (MPa)	21	21	21	21	21
Rated power (kW)	11	18.5	30	45	90
Oil tank (L)	200	200	400	400	600
Filter (μm)	3	3	3	3	3
Noise (dB)	58	62	65	68	73
Weight (kg)	340	350	480	500	1100
Length (mm)	1370	1370	1670	1670	1900
Width (mm)	780	780	780	780	1080
Height (mm)	1155	1155	1305	1305	1305

HPU 3-6 pumps

Features

▶ Noise reduction design: An oil-immersed motor is adopted, with the oil pump and motor completely immersed in hydraulic oil, allowing the hydraulic oil to block the noise from the motor-pump unit from spreading outward; through shock absorption design, special shock-absorbing rubber is attached during the installation of the motor and oil tank to prevent mutual transmission of vibrations and reduce noise; the fully enclosed oil source structure blocks the noise from spreading outward again.
▶ Energy-saving design: A variable displacement piston pump is adopted, which can automatically adjust the flow output according to the actual oil demand of the servo actuator, thus achieving an energy-saving effect.

▶3-6 pump units, which can be combined arbitrarily as required.

Parameters

Model	HPU302	HPU402	HPU502	HPU602
Rated flow rate (L/min)	300	400	500	600
Pump quantity	3	4	5	6
Rated pressure (MPa)	21	21	21	21
Rated power (kW)	135	180	225	270
Oil tank (L)	1200	2200	2200	2200
Filter accuracy (μm)	3	3	3	3
Noise (dB)	74	75	76	77
Weight (kg)	2200	3100	3400	3700
Length (mm)	2900	4370	4700	4700
Depth (mm)	1080	1080	1080	1080
Height (mm)	2180	2180	2180	2180

★Pump quantity can be made to order

Servo motor HPU

Features

▶Compact in shape;
▶Driven by a servo motor, with adjustable flow output;
▶The oil source cabinet adopts an assembled cabinet structure, facilitating disassembly and maintenance;
▶Air-cooled, no need to connect cooling water.

Parameters

Model	HPU101
Rated flow rate (L/min)	10
Rated pressure (MPa)	16
Rated power (kW)	4
Oil tank (L)	25
Filter accuracy (μm)	3
Noise (dB)	60
Length (mm)	580
Width (mm)	580
Height (mm)	930

HFT series
High frequency resonant testing machine

Functions

This type of machine mainly used in the fields of quality inspection (QC), quality analysis (QA) and research and development (R&D). They are used to test various technical parameters of the fatigue fracture resistance of various metal materials, composite materials, etc. Equipped with corresponding fixtures and accessories, they can test S-N curves, K_{1c}, J_{1c}, CTOD, etc. They are especially suitable for testing the fatigue characteristics or fatigue life of various parts (such as plates, gears, crankshafts, threads, bolts, screws, studs, chains, connecting rods, compact tension, valves, etc.) and components (such as operating joints, connectors, spiral motion pairs, etc.) under alternating forces, as well as conducting prefabricated crack and crack propagation tests. They can complete various types of fatigue tests such as symmetric fatigue tests, asymmetric fatigue tests, unidirectional tension or compression fatigue tests, program-controlled (block spectrum) fatigue tests, waveform composite (modulation) controlled fatigue tests, three-point bending, four-point bending, etc. They can also complete fatigue tests under complex environments such as high and low temperatures, corrosion, high and low pressures after being equipped with specific environments.

Features

▶ Static load is applied by a motor-driven ball screw, and dynamic load is applied by electromagnetic resonance, eliminating mutual interference between dynamic and static loads. The combination of dynamic and static test functions enables dual use for both dynamic and static tests.
▶ High test frequency and short testing time.
▶ Low energy consumption of electromagnetic resonance (about 3% of that of electro-hydraulic servo fatigue testing machines).
▶ Pulse width modulation to improve control stability.
▶ Protection functions: overload protection, mechanical limit protection, exciter overcurrent protection, fracture protection, frequency drop protection, upper and lower load limit protection, etc.
▶ The coaxiality adjustment device ensures a high level of coaxiality.
▶ Dual modes of hydraulic clamping and manual thread clamping, enabling fast clamping, reliability and durability.
▶ The test frequency can be changed through multi-level adjustment of the counterweight mass.

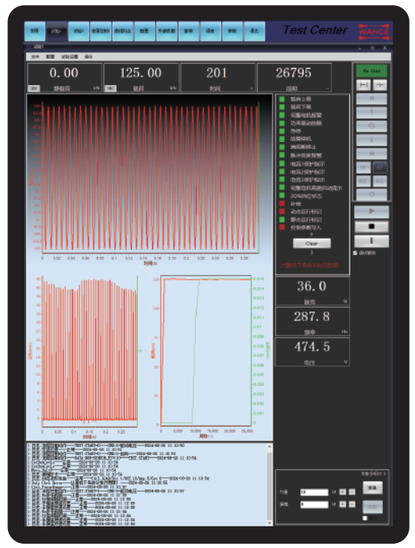
Parameters

Capacity	50kN	100kN	250kN	1000kN
Maximum mean force	±50kN	±100kN	±250kN	±1000kN
Maximum cyclic force	±25kN	±50kN	±125kN	±500kN
Frequency range	50～320Hz	50～320Hz	50～300Hz	50～300Hz
No. of frequency steps	6	6	8	8
No. of guide columns	4	4	4	4
No. of lead screw	2	2	2	2
Loading rate (mm/min)	0-550	0-450	0-550	0-250
Max. displacement rate without loading (mm/min)	800	700	880	500
Noise (dB)	⩽90	⩽100	⩽110	⩽115
Weigt (kg)	1800	4200	4500	20000
[Depth x Width x Height](mm)	660x915x2500	685x1130x2820	820x1150x3130	1550x1700x4200

Controller

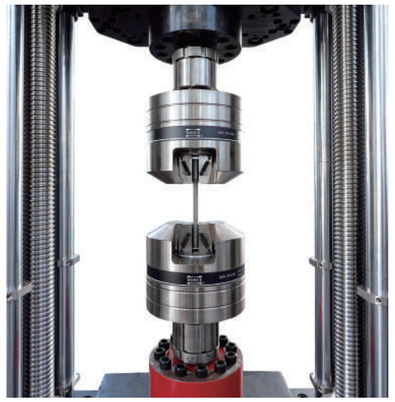
▶DSP fully digital closed-loop control, with functions such as multi-channel acquisition and high-speed data transmission.
▶ Accurately analyze and capture the resonant frequency of the system through FFT transformation to ensure smooth vibration initiation of the testing machine.
▶10kHz sampling frequency and control frequency ensure accurate and reliable data.
▶Adopt PID control algorithm, and utilize the hardware PWM characteristics of DSP itself to precisely control the excitation power of the drive output, ensuring the stability of dynamic load.
▶Phase detection and frequency locking functions: Utilize the high-speed capture function of DSP itself to accurately lock the phase of the feedback load, ensuring phase synchronization of resonance.
▶ Can collect various test data: quickly collect data such as frequency, average value, cycle data, power supply voltage, working current, working voltage, etc.
▶According to the width of the working pulse, the controller automatically adjusts the voltage output to make its output pulse width within an appropriate range, ensuring high-precision control requirements.

Software



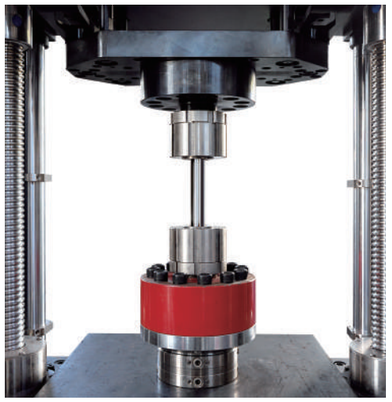
▶Programmed in C# language, which is efficient and fast.
▶Dynamic and static loads can be set separately or simultaneously during the test.
▶It can display data such as static force, cyclic force, displacement, voltage, frequency, period, pulse width, and deformation in real time.
▶Detect and display fault code information to keep abreast of the test status.
▶Real-time monitoring, real-time waveform display, processing and saving of data graphics, storage and printing of test reports, etc.
▶ Equipped with intelligent online diagnosis function, which monitors the entire test process and alarms in time to ensure the smooth progress of the test.
▶Supports test scheme editing function, facilitating timely adaptation to new test methods.
▶Provides test schemes in line with conventional test method standards, making it easy to master the usage methods.
▶Automatically store the test process and original data.
▶For continuous test data interrupted by factors such as power failure, data docking can be realized to ensure the integrity of test data without loss.
▶ Test data can be imported into various office software, such as Microsoft Office and WPS Office.
▶Monitor the status of frequency, force value, limit, displacement, etc. online, and emergency shutdown in case of abnormalities to ensure equipment safety.
▶Various types of curves can be switched at any time.
▶Supports operations such as arbitrary zooming, panning, and traversal of test curves. During the test, the coordinate system is automatically switched according to the change of range, so that the test curve is always kept in the optimal coordinate system.
▶Supports real-time printing of test reports and test curves.
▶Supports remote computer control.

Accessories



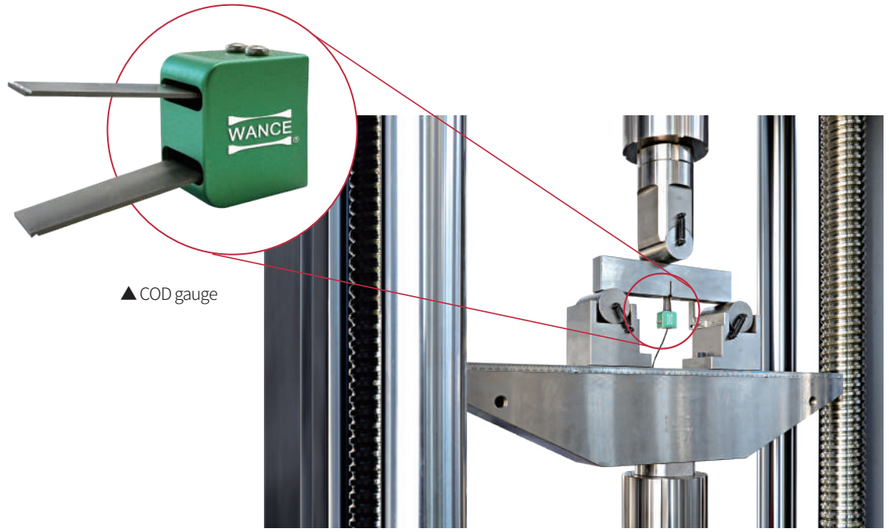
▲Hydraulic grips

Hydraulic gripping



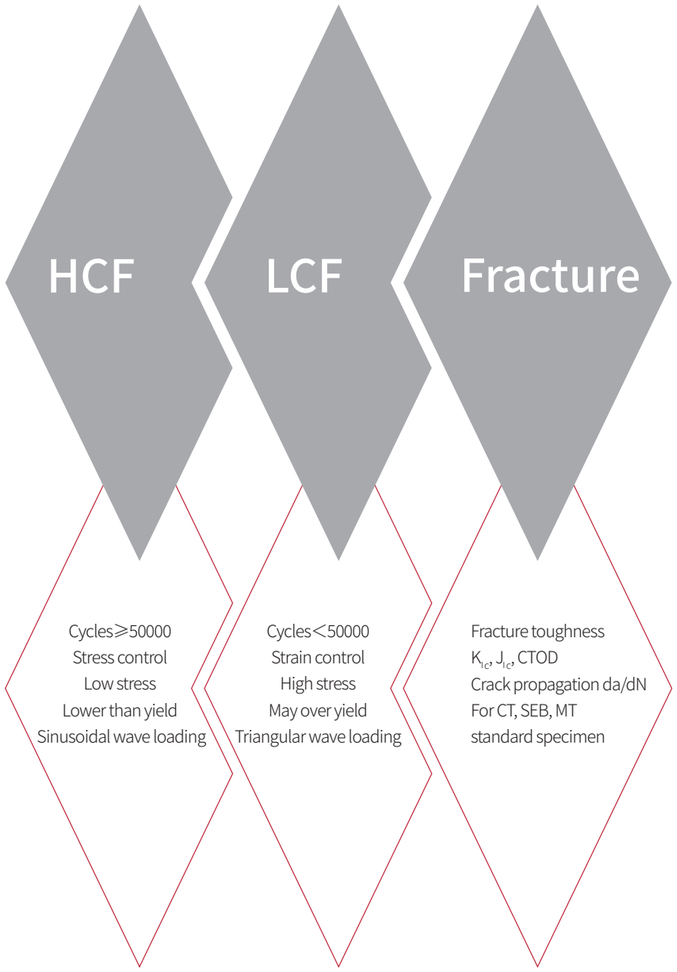
▲Manual grip

Manual screw gripping



▲COD gauge

Fatigue and fracture testing Test solution



Fatigue and Fracture Testing Solutions

HCF test solution

High-cycle fatigue refers to the situation where the number of load cycles in the fatigue life is relatively high, generally more than 50,000 cycles. The cyclic stress level applied to parts or components is relatively low, and the maximum cyclic stress is generally less than the yield stress of the material, so the material is always in the elastic stage. Stress is generally used as the control parameter, so high-cycle fatigue is also called stress fatigue. After undergoing a sufficient number of cyclic loads, cracks first form from local areas with high stress inside the material, which is called crack initiation. After that, under the continuous action of cyclic loads, the cracks further propagate until complete fracture occurs. The three stages of crack initiation, propagation, and fracture are a characteristic of the fatigue failure process, and the number of cyclic loads borne in these three stages is called the fatigue life.

▲ HDT_A (actuator upper-seated)

▲ HDT_B (actuator lower-seated)

WANCE has developed fatigue testing machines specifically designed for high-cycle fatigue testing, consisting of two series: HDT_A (with an upper-mounted actuator) and HDT_B (with a lower-mounted actuator). Both series are driven by electro-hydraulic servo systems and feature a closed-loop servo control system composed of an electrical controller, servo valve, load sensor, displacement sensor and computer. This system enables PID control of force, deformation, and displacement while automatically measuring test parameters such as test force, displacement and deformation.

Both HDT_A and HDT_B series can be used to test the dynamic fatigue properties of metallic materials, non-metallic materials, composite materials, elastomers and structural components. Fatigue tests can be performed using loading waveforms such as sine waves, triangular waves, trapezoidal waves, and user-defined waveforms. By configuring different fixtures, various loading methods such as tension-tension, compression-compression, and tension-compression can be achieved. Additionally, environmental test devices can be configured to conduct simulated environmental tests under conditions such as high temperature, low temperature, salt spray and corrosion. These testing machines are ideal fatigue test systems for industries including scientific research institutions, material manufacturing, civil engineering, national defense and military, higher education, machinery manufacturing and transportation.

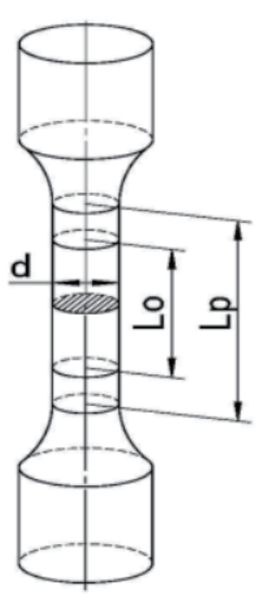
Standards

- ▶ GB/T 3075, GB/T15248
- ▶ ISO 1099
- ▶ ASTM E466

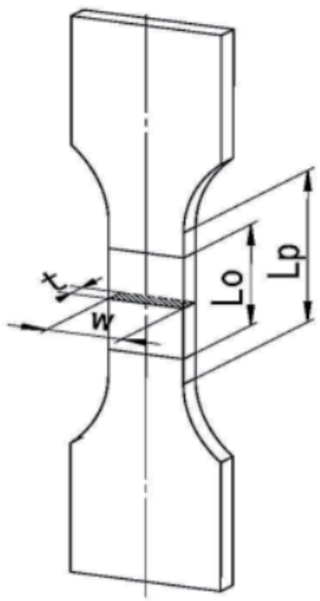
In addition to the above standards for high-cycle fatigue testing of metallic materials, it can also meet many fatigue testing standards for non-metallic materials, parts and components. Moreover, relevant standards can be added to the software and customized fixtures can be designed according to customer requirements. Low-cycle fatigue testing at room temperature (strain fatigue) can also be realized in this solution by adding a deformation measurement device.

Round / Flat specimen

The basic S-N curves that generally describe the fatigue properties of materials are all obtained using small-sized specimens under cyclic loading. To ensure that the test data reflect the true properties of the materials and reduce their discreteness, relevant standards have clear requirements for the processing dimensions, precision and surface roughness of the specimens. The specimens of general metal materials are in the shape of bars or plates, and some non-metallic materials are in similar shapes. The figure below shows the types of specimens supported by the high-cycle fatigue test module of our test software. You can input the specimen dimensions into the software one by one corresponding to the dimension codes to establish the specimen parameters.



▲Round specimen



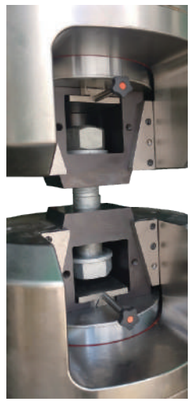
▲Flat specimen

Hydraulic grip

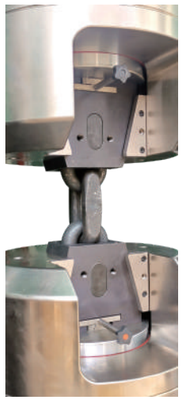
25kN 100kN 250kN 500kN 1000kN 2500kN

Model	25kN	100kN	250kN	500kN	1000kN	2500kN
V jaws (mm)	Φ5~Φ10 Φ10~Φ15	Φ5~Φ10 Φ10~Φ15 Φ15~Φ20	Φ10~Φ20 Φ20~Φ30	Φ10~Φ20 Φ20~Φ30 Φ30~Φ40	Φ20~Φ30 Φ30~Φ40 Φ40~Φ50	Φ30~Φ40 Φ40~Φ50 Φ50~Φ60
Flat jaws (mm)	0~8	0~8 8~15	0~10	0~10	0~15	0~20
Flat jaw (WxH) (mm)	30×38	50×65	50×90	80×90	130×130	160×150
Outside diameter (mm)	Φ126	Φ210	Φ270	Φ340	Φ444	Φ580
Height (mm) (without rod)	163	175	232	287	414	514
Single weight (kg)	9	39	85	162	410	900
Pressure (MPa)	21	21	21	21	21	42

▲Thin plate anti-buckling fixture



▲Bolt tension fixture



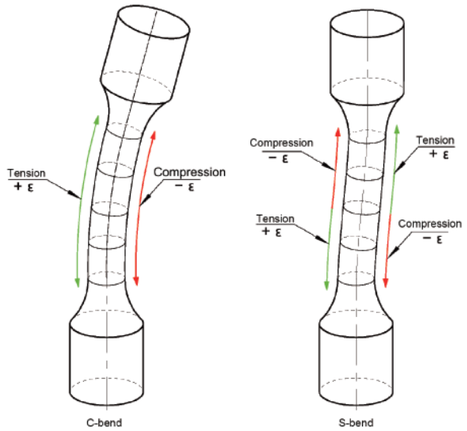
▲Anchor chain tension fixture

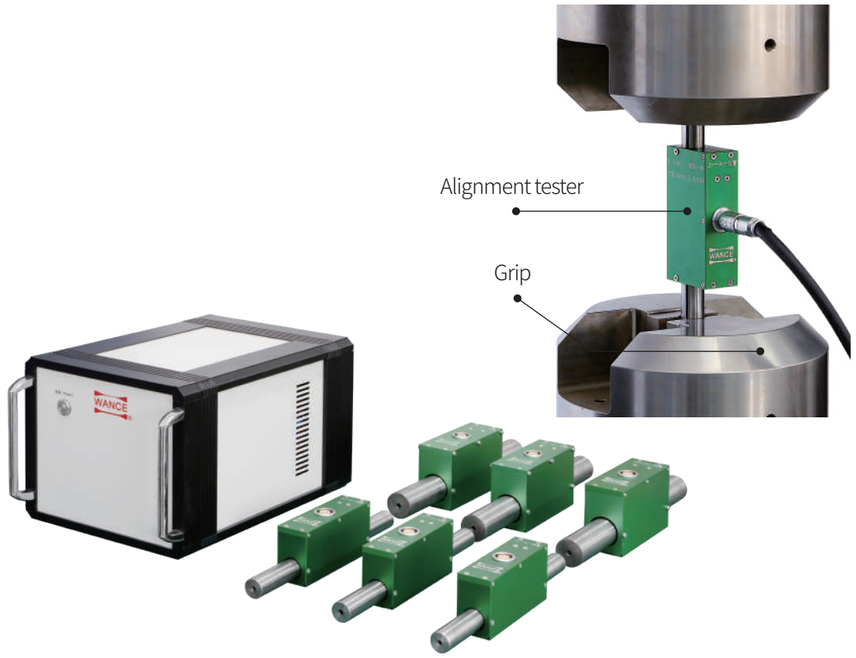
In addition to directly clamping bars and plates, hydraulic fixtures can also be extended to bolt tension fixtures and anchor chain tension fixtures.

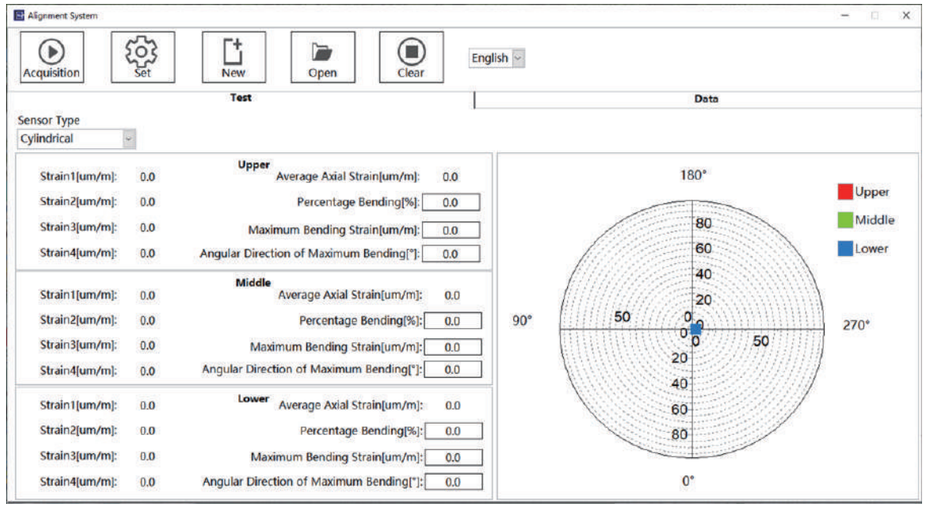
Alignment verification

Inevitable errors in mechanical structures can lead to misalignment between the upper and lower fixtures, causing the specimen to undergo C-shaped deformation, S-shaped deformation, or a combination of both. As a result, the local stress/strain of the specimen will be much greater than the set value, and ultimately, the fatigue test life of the specimen will be severely reduced.

Relevant test standards require that the bending rate of the specimen be ⩽ 5%. However, relying solely on machining accuracy and assembly precision is far from meeting the requirement of a bending rate ⩽ 5%. Therefore, adding an alignment ring to the main machine allows for precise adjustment of the hydraulic fixture through this ring, ultimately making it easy to achieve a bending rate ⩽ 5%.

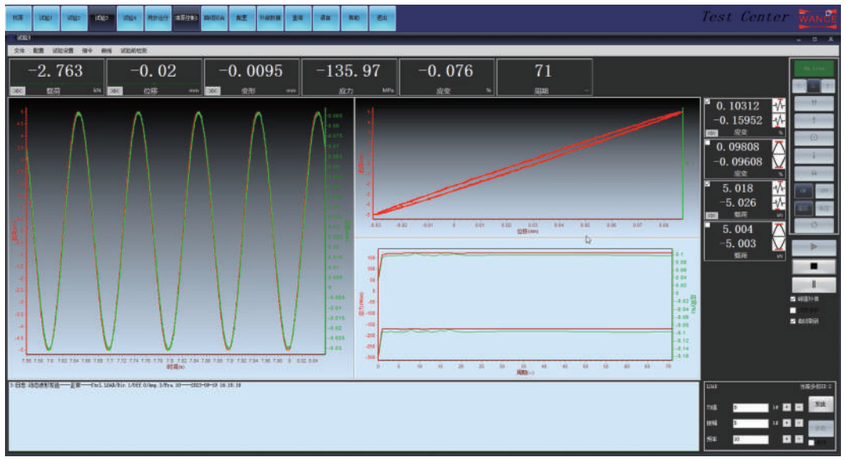






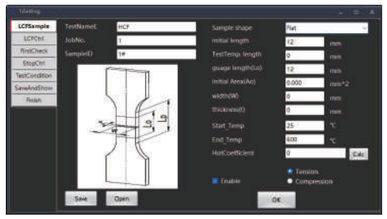
▲Alignment verification software

HCF test software



Main interface

▶ Multiple curve windows can be displayed on the main interface and arranged arbitrarily.
▶ The display content of the X/Y axes in the curve windows can be switched freely, such as Time-Displacement, Time-Cycle, Time-Command, Time-Output, Displacement-Load, etc.
▶ Multi-curve display in a single window, for example, Time-Displacement and Time-Command can be shown simultaneously in one window.
▶ The maximum peak/valley values of fluctuations during the entire test process can be displayed, such as those of displacement, load and deformation.
▶ During the test, the mean value, amplitude, and frequency can be adjusted on the main interface without pausing the test.
▶ Log recording function tracks every user operation and system-generated command for easy traceability of issues.
▶ Quick actuator operations include rapid up/down movement and slow up/down movement.



▲ Graphical parameter setting for standard specimens of flat and round specimens

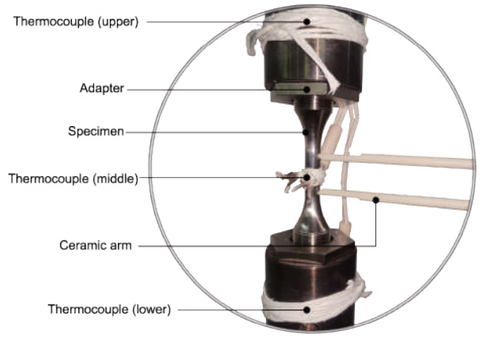
▲ Control parameters setup

LCF test solution

Fatigue failure caused by the cyclic action of plastic strain in metallic materials under cyclic loading is called low-cycle fatigue. In low-cycle fatigue, the cyclic stress applied to the material is close to or even exceeds its yield strength. At this point, even a slight change in stress will lead to a significant change in the corresponding strain value. The loading frequency of low-cycle fatigue is very low, resulting in a certain amount of plastic deformation in each cycle.

For ductile materials, once yielding occurs, even a very small change in stress will cause a relatively large change in strain, and the relationship between stress and strain is no longer one-to-one. Strain becomes a more sensitive parameter than stress, so it is obviously better to use strain as the control parameter for low-cycle fatigue.

The stress-strain trajectory obtained from the plastic strain generated in materials under cyclic loading close to or exceeding the yield strength is called a hysteresis loop. Low-cycle fatigue tests simulate real working conditions by loading materials to plastic strain. When studying the influence of plastic strain, the strain rate is a key consideration. Throughout the test process, the strain amplitude and average level remain unchanged, and a triangular wave is used to maintain a constant strain rate instead of the traditional sine wave loading under load control. The total strain range in low-cycle fatigue tests is generally less than 2% engineering strain. This means that high-quality, reliable extensometers must be used, along with smaller specimens and shorter parallel lengths. Additionally, the coaxiality of the fixtures and the elimination of gaps are particularly critical.

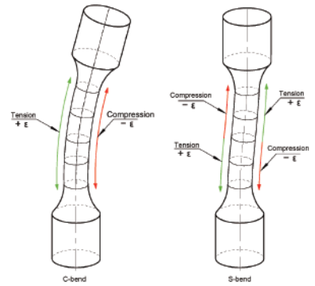


The low-cycle fatigue test system developed by WANCE is based on the HDT_B series fatigue test system platform and is configured with accessories such as a high-temperature furnace, temperature control system, high-temperature extensometer and hydraulic ejector rod fixture. It can overcome the difficulties of low-cycle fatigue, enabling users to easily conduct high-temperature low-cycle fatigue tests and efficiently and accurately obtain test data.

Standards

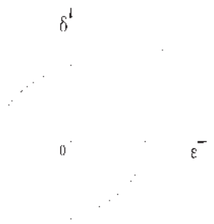
▶ GB/T 26077, ISO 12106, ASTM E606

LCF test key points



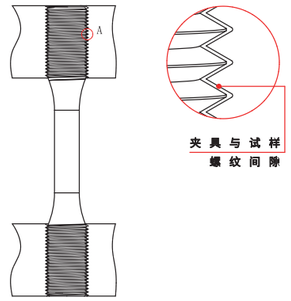
▲Alignment≤5%

Inevitable errors in mechanical structures can lead to misalignment between the upper and lower fixtures, causing the specimen to undergo C-shaped deformation, S-shaped deformation, or a combination of both. Consequently, the local stress/strain of the specimen will be much greater than the set value, and ultimately, the fatigue test life of the specimen will be severely reduced.



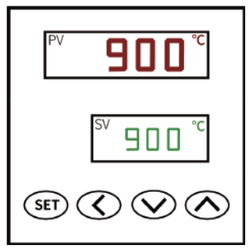
▲ Strain control

After temperature rise and elastic modulus check, switch from force control to strain control with a smooth transition free of overshoot. At the start of the test, the difference between the actual strain half-amplitude and the controlled strain half-amplitude shall not exceed 5% of the controlled strain half-amplitude. To ensure that the strain peak does not exceed ±1% of the set value, adjustments to the strain shall be made, and the entire adjustment process shall be completed within the first 10 cycles or ±1% of the failure cycle count, whichever is smaller. Loading shall be performed at a constant strain rate, i.e., triangular wave loading.



▲ No clearance in the connections between fixtures/specimens, as well as in all other connections.

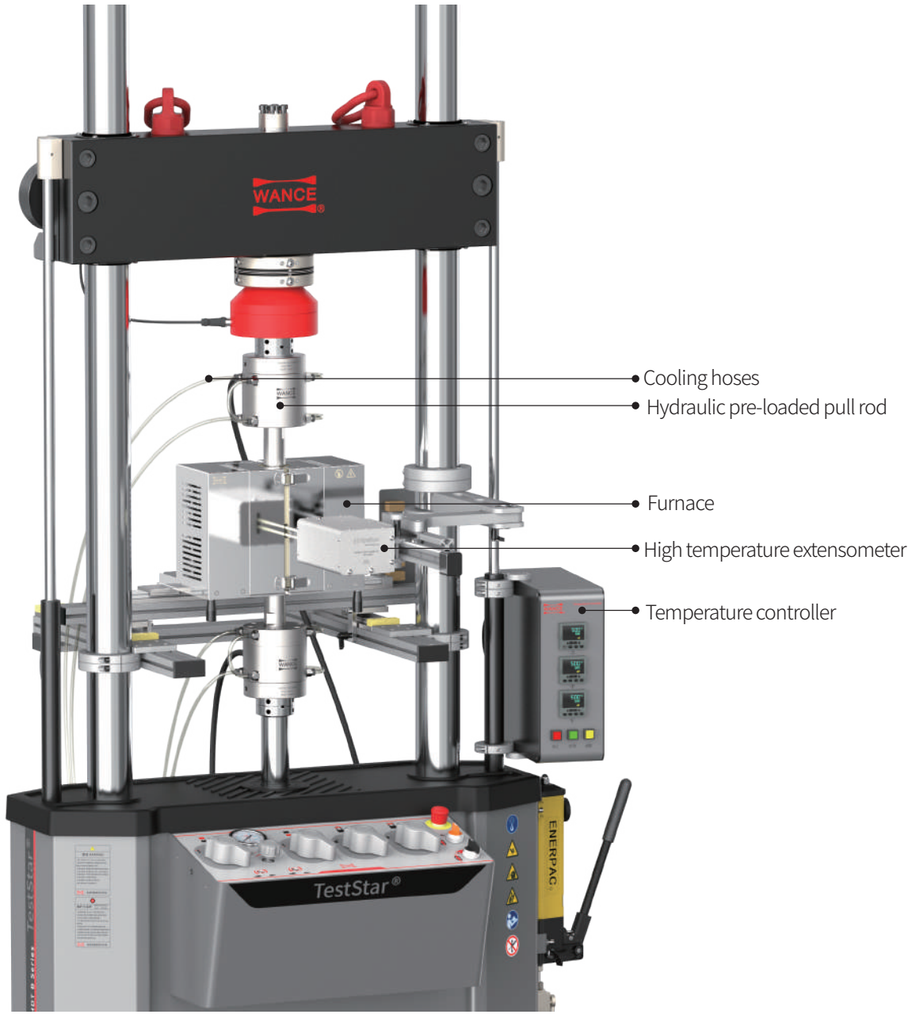
Connections between the specimen and fixtures, as well as all other force-bearing connections in the equipment, must avoid connection gaps. When the test strain ratio is negative (i.e., during tension-compression zero crossing), the stress-strain test curve will be severely distorted. The fixtures should ensure the repeatability of specimen installation and allow for convenient and quick clamping of the specimen.



▲ Temperature control

The accuracy of temperature control can be affected by factors such as the structure of the furnace body, the installation of temperature sensors, the configuration of temperature control hardware, and the setting of empirical parameters for temperature control.

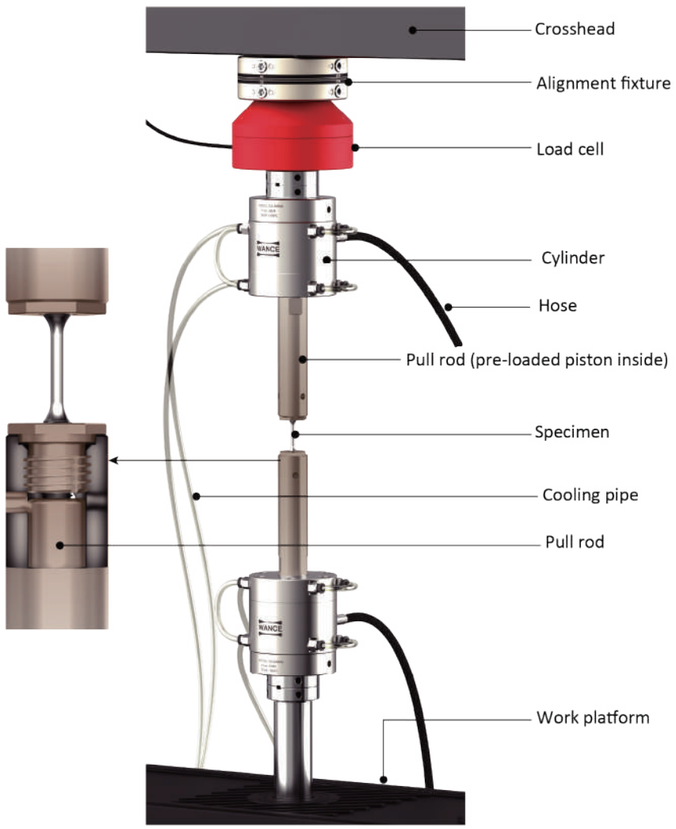
LCF test accessories



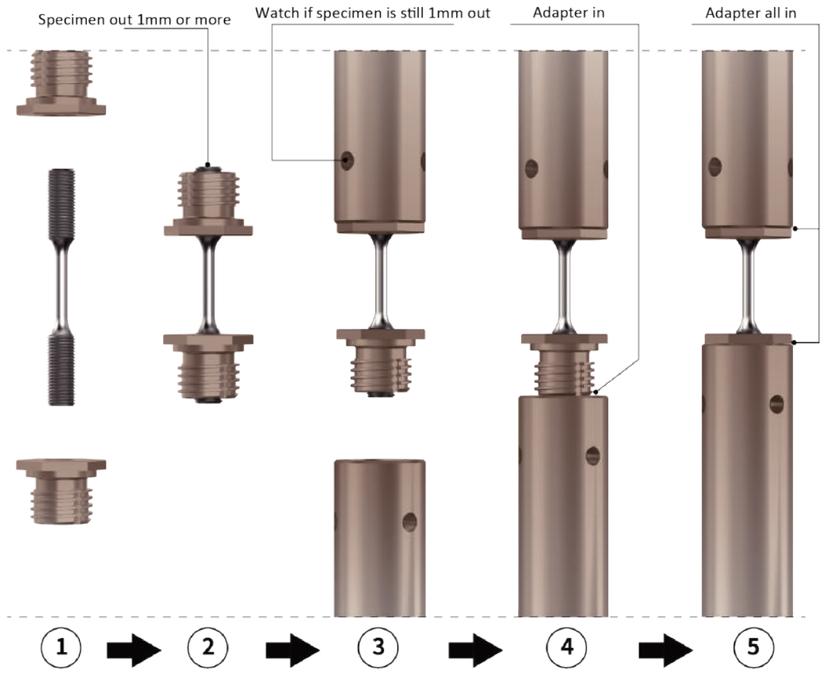
Hydraulic Pre-loaded Pull Rod

Features

▶ All connection processes of the fixture are simple.
▶ Through the adjustment of the alignment fixture, the alignment within 5% can be achieved.
▶ It is connected with the specimen through threads, and the specimen is pushed by a hydraulic pull rod, which can eliminate all gaps. The entire test process will not loosen, and even for tests with strain crossing zero, the test curve can be guaranteed to be perfect.
▶ The test installation is extremely convenient.
▶ Applicable temperature range: room temperature ~ +1150°C; high-temperature material: DZ22.



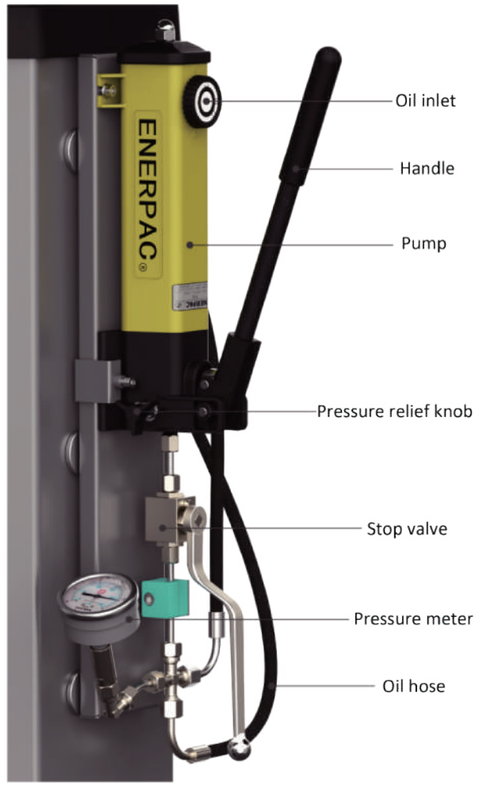
Mount specimen



▶ Easy specimen mount without high skills.
▶ Pull rod can rotate freely.
▶ When the software is in a force-holding state, the actuator can automatically follow under the action of the screwing force when the specimen is screwed in until the specimen is completely screwed in. A displacement protection is set during the process to ensure safety.
▶ After the specimen is installed, if it is found that the center of the specimen is not aligned with the center of the high-temperature furnace, the crosshead can be raised or lowered to directly move the specimen to the center of the high-temperature furnace. During this process, the actuator remains in a follow-up state with minimal force holding, requiring no manual control.

Hydraulic manual pump

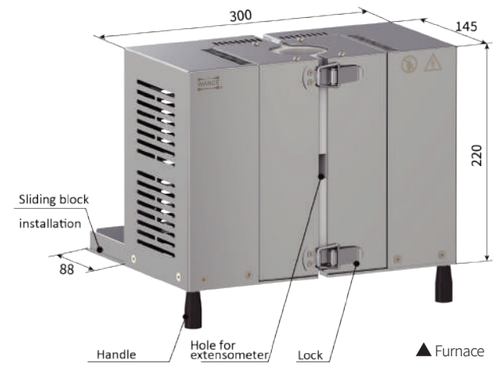
▶ The hydraulic pump provides stable hydraulic pressure to the pull rod.
▶ During the slow pressurization process of the hydraulic pump, the pressure of the pull rod can be observed through the pressure gauge, ensuring that the pressure required by the pull rod is reached and reducing the axial impact on the specimen.
▶ After pressurization, the shut-off valve cuts off the channel between the pump and the pull rod, allowing the pull rod to maintain stable pressure for a long time without the need for pressure replenishment during the test.
▶ One pump pressurizes two hydraulic ejector rod fixtures simultaneously, and both fixtures can reach the required pressure at the same time.



Temperature control

Features

▶ The GW1000 high-temperature furnace is suitable for various types of high-temperature material mechanical property tests, including tensile, compressive, and fatigue tests of metal materials, as well as mechanical tests of composite materials and ceramic materials.
▶ The high-temperature furnace features three-zone heating, adopting composite silicon carbide heaters, and each heating zone can be controlled independently.
▶ The thermal insulation layer made of alumina fiber reduces heat loss and prolongs the service life of the high-temperature furnace.
▶ The split-type high-temperature furnace simplifies the installation process of samples and fixtures, and the furnace bracket uses precision linear guides to ensure smooth opening and closing.
▶ The temperature control system is equipped with an imported Eurotherm 0.1-class PID temperature controller, ensuring rapid temperature rise, accurate temperature control without overshoot.



▲ Furnace

▲ Temperature controller

Parameters

Structure	3-section heating, seperate control		
Temperature range	100°C~1000°C		
Uniform temperature zone	60mm		
Heating zone size (LxWxH)	62.5*62.5*180mm		
Outside dimension (LxWxH)	300*233*220mm		
Heating element	Silicon carbide		
Power supply	220V±10%		
Furnace movement	Precision guide rail		
Heating power	1.3kW		
Thermal insulation material	Alumina fiber		
Accuracy (°C)	Temperature	Temperature fluctuation	Uniformity
	100～1000	±2	2
Heating time	⩽20min		

Strain measurement

Epsilon 7650A high temperature extensometer

▶ It features a unique design and low strain range, thus achieving high precision. It meets the accuracy requirements of ASTM B1 class and can provide ISO 9513 standard 0.5 accuracy test certificates upon request.
It can realize strain control and high-frequency fatigue tests, with a frequency up to 10Hz.

▶ It allows hot clamping, with flexible expansion and contraction. The sliding clamping system enables convenient and quick clamping onto hot samples. There is no need to remove the extensometer when the sample breaks.

▶ The gauge length of the extensometer can be automatically set before contacting the sample, which allows the extensometer to contact the sample after the test temperature is reached.

▶ It is equipped with an alumina rod for tests at 1200°C, and a silicon carbide rod can be optionally configured for high-temperature tests at 1600°C.

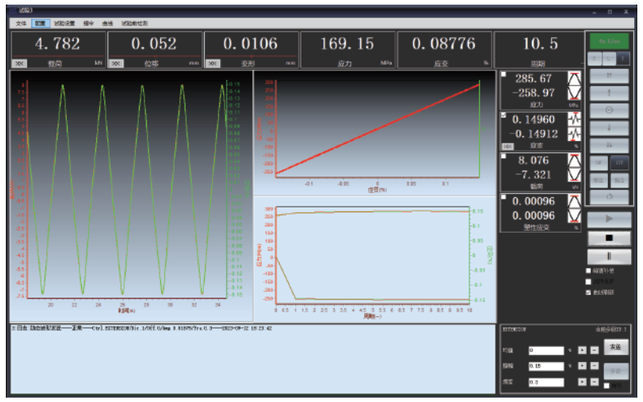
Model: 7650A – Gauge length – Range – Temperature

-0125M	12.5mm
-025M	25mm

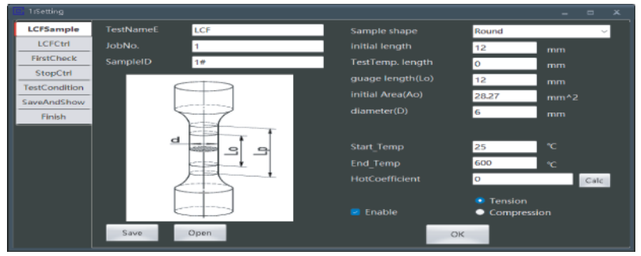
-015M	+1.5/-1.5mm
-020M	+2.0/-1.0mm
-025M	+2.5/-0.5mm

-ST	Ambient~1200℃
-HT	Ambient~1600℃

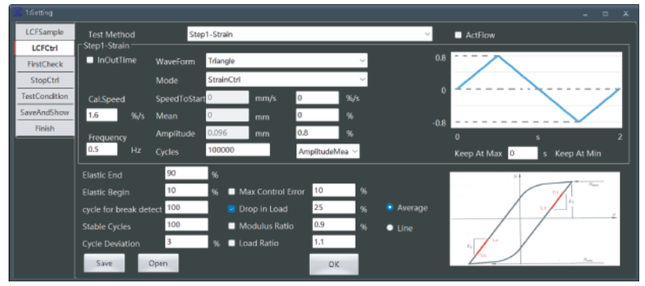
LCF test software



▲ LCF test software



▲ Graphic specimen size



▲ Strain control

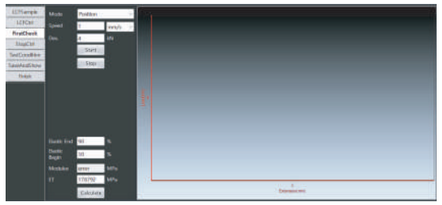
LCF test software

▶ Strain+Stress control

The program first executes strain control. When the stress stabilizes or meets the set stabilization cycle, the software automatically switches to high-frequency stress control to reduce the test time.

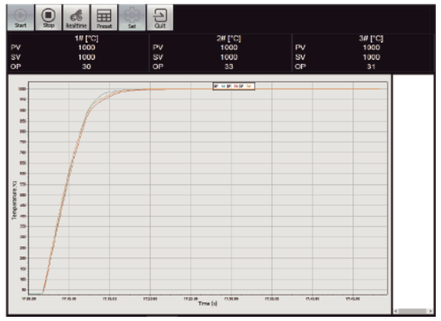
▶ First check

After the specimen is clamped, the software can automatically measure the elastic modulus of the material and verify the correctness of the operation of the measurement system (force and strain). Relevant standards require that the deviation between the measured elastic modulus and the expected value should not exceed ±5%.



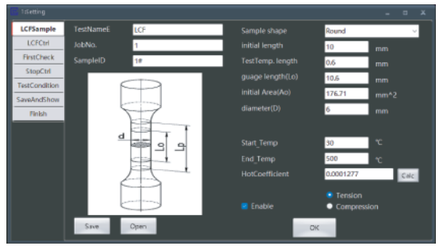
▶ Temperature monitor

The temperature monitoring software communicates with the temperature control meter, enabling the setting of temperature control parameters on the software and real-time collection of temperature data.
It can communicate with the test software, so that the fatigue loading test can be automatically carried out after the set temperature is reached.



▶ Parameters correction after heating

After the temperature is raised from room temperature to the test temperature, modify the deformation after temperature rise and the test gauge length (initial gauge length + increment after temperature rise) in the specimen parameters.



Fracture test solution

The occurrence of defects (or cracks) in materials or structures is inevitable. Fracture caused by defects is the most important and common failure mode in engineering. When people could not profoundly understand the mechanism and laws of fracture failure, if cracks were found in parts or components, they could generally only be disposed of as unqualified products and scrapped, which often resulted in huge waste. Therefore, it is necessary to use fracture mechanics knowledge to study the crack propagation characteristics, ensure that parts and components with cracks will not fracture due to crack propagation, and thus study the fatigue crack propagation laws of these materials. Therefore, studying the laws of fatigue crack propagation is necessary in practical engineering.

Study how cracks propagate in materials under the action of stress. Materials are divided into the following categories:
Brittle material: Cracks typically cause rapid failure of the specimen. Brittle fracture testing defines the critical stress intensity level, K_{Ic}, which represents the maximum stress at which a crack in the specimen remains stable. Stresses exceeding this level lead to rapid crack growth, often resulting in catastrophic failure of the test piece.
Ductile material: Cracks do not cause immediate failure of the test piece; instead, as the applied stress increases, the test piece continues to resist crack propagation. Ductile fracture testing describes J_{Ic}, which is a measure of the energy required to cause crack extension.

Test_Center test software

The fracture mechanics test system developed by WANCE has added a fracture mechanics module to the Test_Center fatigue test software. For the hardware, the HDT_A or HDT_B series fatigue testing machines can be selected.

Features

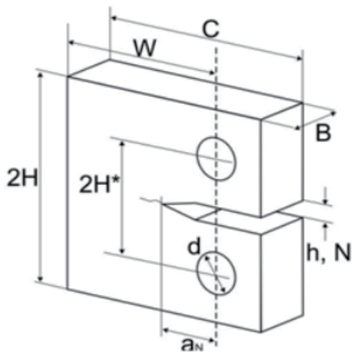
▶ It can set independent test schemes to improve customer operability;
▶ It can automatically prefabricate cracks;
▶ It meets K_{Ic}, J_{Ic}, CTOD, and da/dN tests;
▶ It is applicable to specimen shapes such as CT, SEB and MT;
▶ The data result statistics module can generate R resistance curves;
▶ CTOD and J_{Ic} tests support multi-specimen and single-specimen methods;
▶ Crack propagation tests support K-increasing, K-decreasing, and K-constant modes.
▶ It can be equipped with environmental equipment such as high-low temperature chambers, high-temperature furnaces, and salt spray chambers, allowing fracture mechanics tests to be closer to real working conditions.

Standards

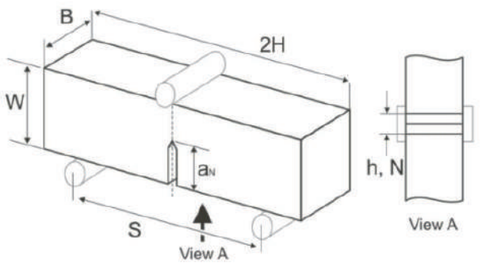
▶ GB/T 6398, GB/T 21143;
▶ ISO 12135; ISO 12108
▶ ASTM E1820, ASTM E399, ASTM E647

Test specimen

Most crack tests require specimens of specific shapes, which are described in a series of standards. When setting parameters, you can select different specimen shapes. The commonly used specimen shapes on the market include CT (Compact Tension) and SEN(B) (Single-Edge Notched Bending, three-point bending) specimens. The shape and size information of the specimen directly affect the results, so the dimensions should be measured accurately during measurement.

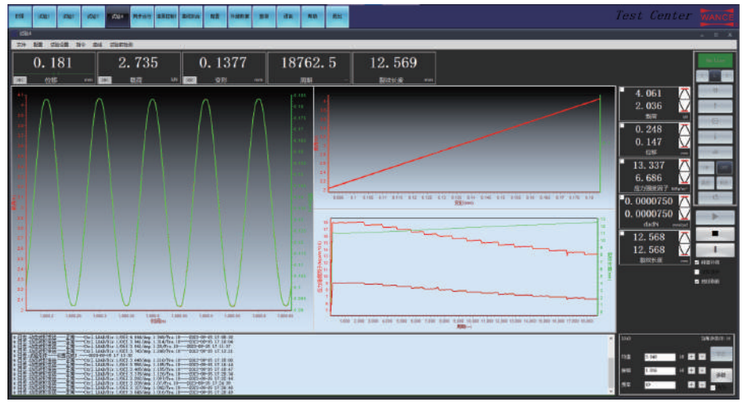


W	Distance from loading line to specimen rear side, 30mm-150mm
C	Width
B	Thickness, 15mm-75mm
2H	Height
d	Pin diameter
2H*	Pin distance
a_N	Notch length from loading line
h,N	Notch width



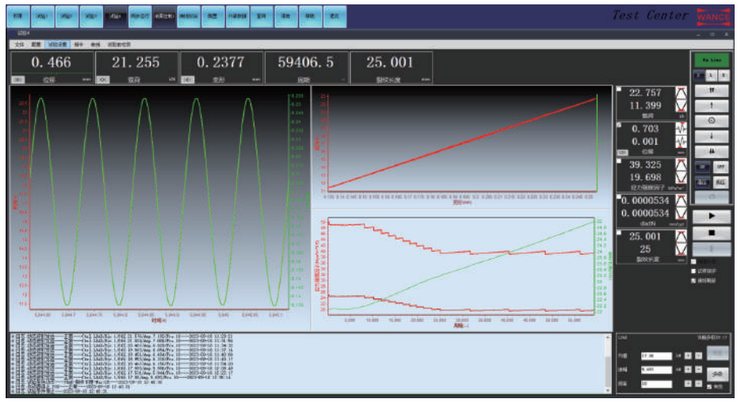
W	Distance from loading line to specimen rear side
B	Thickness
2H	Height
a_N	Notch length
h,N	Notch width
S	Span, 100mm-200mm

Precracking



▲ Descending K pre-crack

1. The software automatically adjusts the control force value according to the parameter settings, and a test log is generated every time the force value is adjusted.
2. The initial K value of the test is generally less than 80%.
3. The test ends when the set K or crack length is reached.



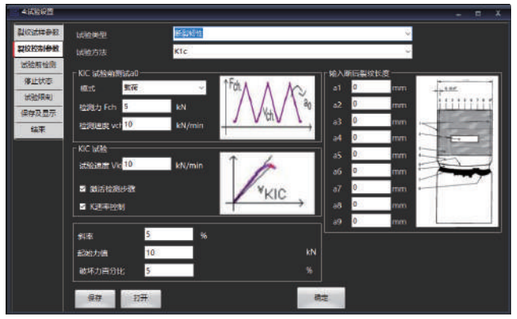
▲ Constant K pre-crack

1. The program first executes the K descending process.
2. After reaching the set K value, it remains around the set K to allow continuous crack propagation.
3. The test ends when the crack length reaches the set target. This method can directly lock the K value at the rear end of the prefabricated crack.

Fracture toughness

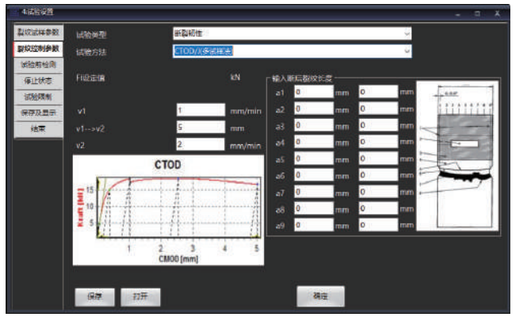
▶ Fracture toughness-K_{Ic}

1. Cycle 3 times within the set force value range to eliminate the gaps between the fixture, sample, and extensometer.
2. Apply the load according to the set test speed. The test ends when the test force drops to a percentage of the peak force (60% is recommended).



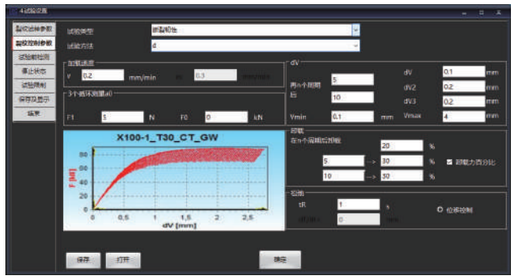
▶ Fracture toughness-CTOD (multiple specimen)

1. Switch the test speed to apply the load. The test ends when the test force drops or the set crack opening (COD gauge) is reached.
2. Each test needs to end at a different opening position to meet the positions of valid data points in the final R resistance curve.



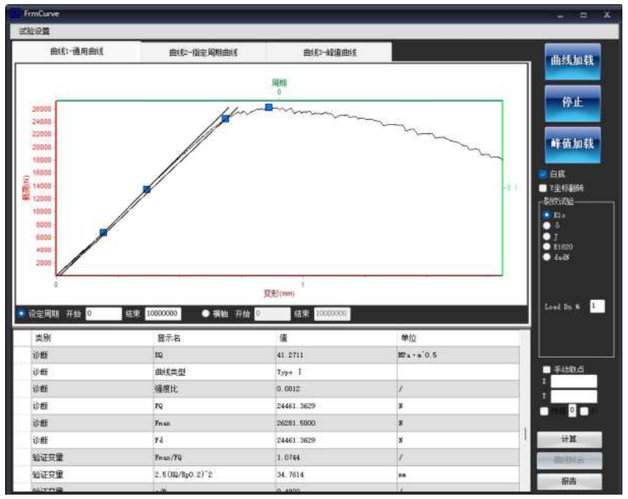
▶ Fracture toughness-J_{Ic} (Single specimen)

1. Cycle 3 times within the set force range to eliminate the gaps between the fixture, sample and extensometer; detect a0.
2. Apply load to the set extensometer opening amount according to the set test speed, keep relaxation, and unload the set force value (10%-20% is recommended); repeat this step, with the extensometer target increasing each time of loading, and the test stops when the extensometer reaches the set target.
3. The J value calculated from the loading and unloading points should be at the position of valid data points in the R resistance curve.



K_{Ic} Data analysis

1. Functional K: Obtain K curve analysis and data analysis.
2. Curve loading: Load test data according to conditions.
3. Curve: Display the load-crack opening displacement curve in accordance with the K_{Ic} curve standard.
4. Calculation: The software automatically obtains the elastic segment of loading , draws a 5% offset line based on the elastic segment, and calculates Kq and characteristic points.
5. Display of calculation results.



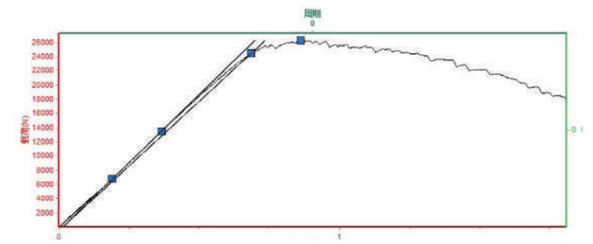
1. Header: Test information, sample dimensions, crack length, etc. can be selected for output.
2. Data: Actual calculated data.
3. Judgment: Make judgments according to the content of the standard.
4. Curve: K_{Ic} analysis curve.

KⅠc报告

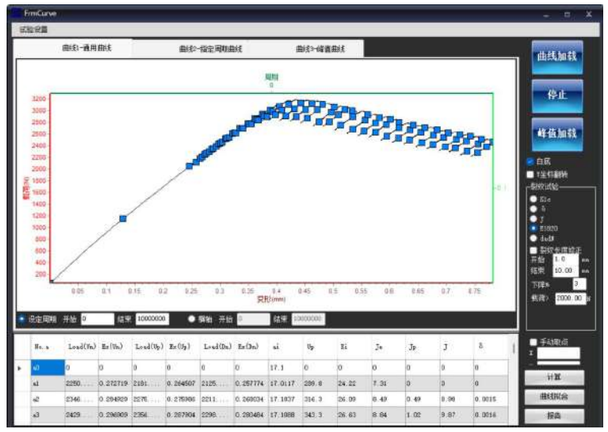
试验开始时间	2022/7/4 10:40:09	Bn(mm)	25	a0(mm)	22
试验名称		B(mm)	25		
委托编号	01号	W(mm)	50		
试样编号	zyx	S(mm)	0		
		E(--)	72000		
		v(--)	0.3		
		Rm(MPa)	400		
		Rp0.2(Mpa)	350		
		z(mm)	0		
		X/W(--)	0.25		

编号	FQ N	Fmax N	Fd N	KQ Mpa*√m	a mm
	24461.363	26281.500	24461.363	41.271	24.610

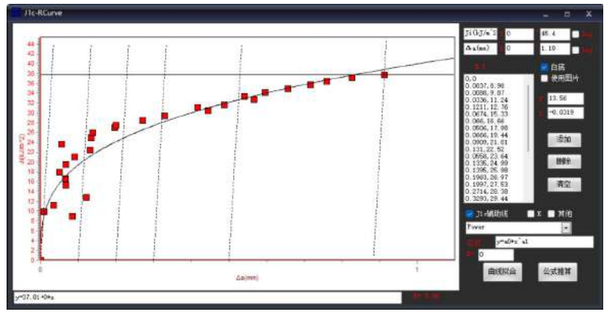
0.45<a0/W<0.7	True	Fmax/Fq≤1.1	True		
a2-a8与平均值的差<0.1a0	True	2.5(KQ/Rp0.2)^2≤a0	True		
预制裂纹长度大于1.3mm或者2.5%W	True	2.5(KQ/Rp0.2)^2≤B	True		
预制裂纹在包络线内	True	2.5(KQ/Rp0.2)^2≤(W-a0)	True		



J_{Ic}Data analysis

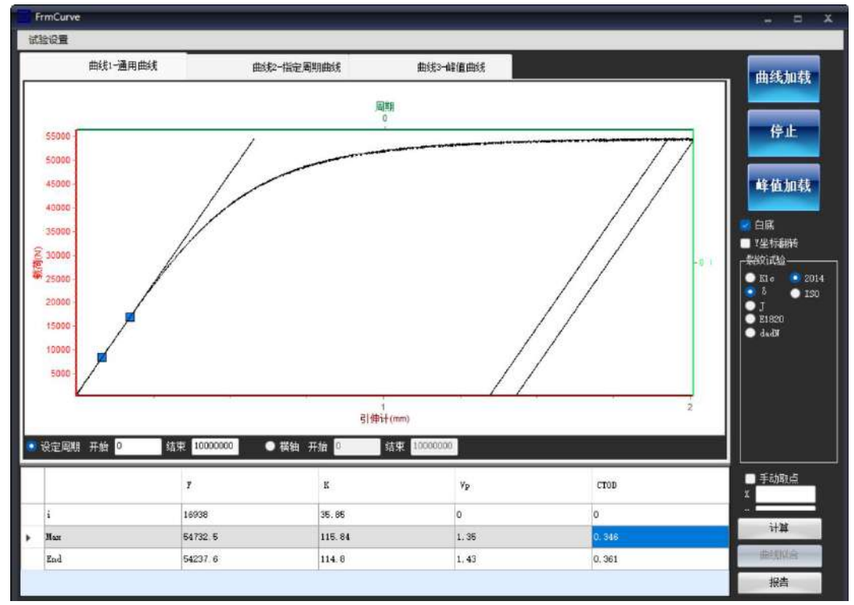


1. Set filtering criteria based on test data to obtain data characteristic points (unloading points, loading points, force-relieving points).
2. Calculate the test data andJ_{Ic}integral calculation data for each unloading process.
3. Plot the R-curve (resistance curve).
4. Export the J_{Ic} integral report.



1.Automatically draw a fitted curve based on the data points; draw the blunting line, 0.1,0.2,0.3,0.5 offset line, J_{max}, Δa_{max}.
2. Obtain the corresponding function equations.
3. Obtain the R-curve (resistance curve).

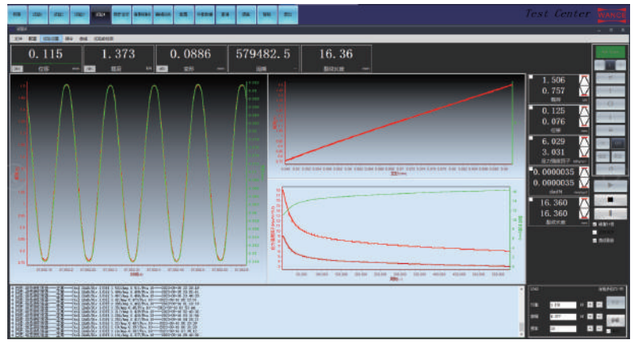
CTOD Data analysis



	T	K	Vp	CTOD
i	16938	96.86	0	0
Max	54732.5	115.84	1.36	0.346
End	54237.6	114.8	1.43	0.361

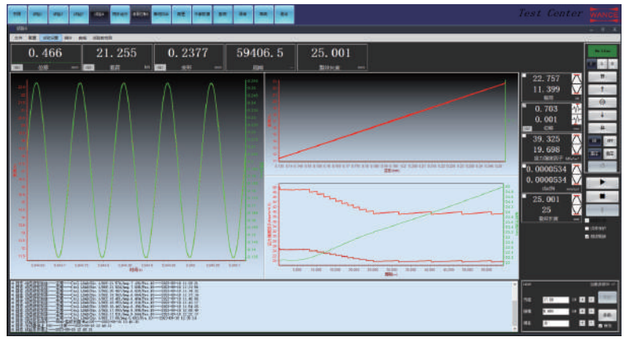
1. Obtain the notch opening displacement (loading point displacement) and load curve.
2. Check whether pop-in occurs in the curve, and calculate δ or J.
3. Conduct tests on multiple samples to obtain corresponding δ or J, and generate the R-curve (resistance curve).

Crack Propagation (da/dN)



Crack Propagation (da/dN)
K-decreasing test

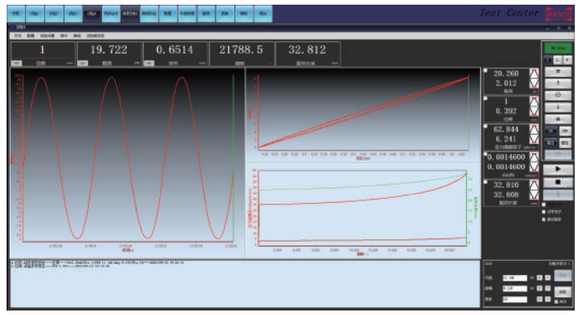
1. The software automatically reduces the force continuously according to the set gradient C
2. The stress intensity factor K decreases continuously.
3. The crack growth rate decreases gradually.
4. The K-decreasing test is suitable for determining the threshold value ΔK_{th}



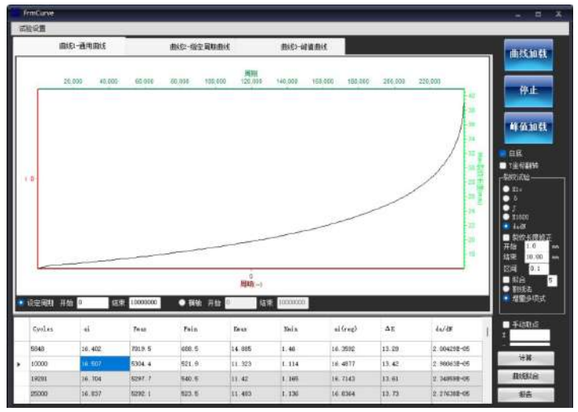
Crack Propagation (da/dN)
constant K test

1. As the specimen begins to fatigue and the crack grows, the stress intensity factor gradually increases. The software maintains Kmax within a certain range by adjusting the control force value.
2. During the test, the stress intensity factor K decreases gradually and remains stable once it reaches the set value.
3. After K_{max} remains stable, the crack growth rate maintains a constant slope.

Crack propagation (da/dN) data analysis

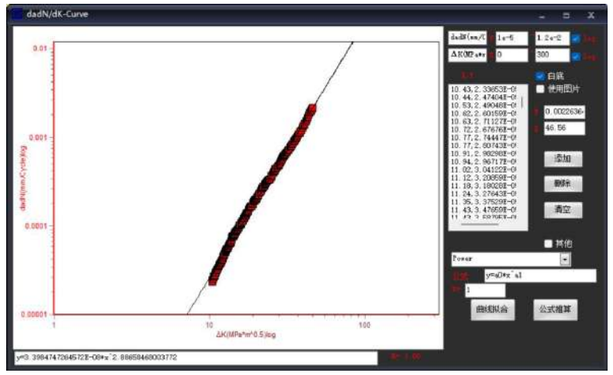


Crack propagation (da/dN) k-increasing test
1. As the crack in the specimen grows larger, the stress intensity factor K gradually increases.
2. As the fatigue time increases, the crack growth rate gradually accelerates.
3. The K-increasing method is applicable when the crack growth rate is >1×10.
4. The test stops when the crack length or K is reached.



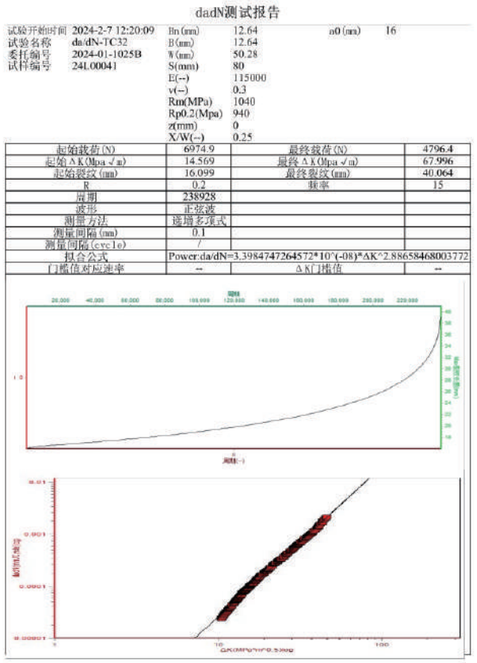
Crack propagation (da/dN) k-increasing test data analysis
Trend curve of crack length versus cycle number during the loading test.
Crack correction: Amend the entire crack propagation process based on the initial and final crack lengths.
Set a crack length interval to screen the required data from the original dataset.
Secant method, polynomial: Calculation methods for obtaining the crack growth rate.
Calculate crack growth-related data such as ΔK and da/dN, and plot the ΔK-da/dN rate curve.
Export the report.

Crack propagation (da/dN) data analysis



ΔK-da/dN rate curve

1. Calculate the equation formula based on the test data and draw the fitting curve.
2. Obtain the ΔK-da/dN rate curve displayed in logarithmic coordinates.



dadN测试报告

试验开始时间	2024-2-7 12:20:09	Bn (mm)	12.64	n0 (mm)	16
试验名称	da/dN-TC32	B (mm)	12.64		
委托编号	2024-01-1025B	W (mm)	50.28		
试样编号	241.00041	S(mm)	80		
		E(--)	115000		
		v(--)	0.3		
		Rm(MPa)	1040		
		Rp0.2(Mpa)	940		
		z(mm)	0		
		X/W(--)	0.25		

起始载荷 (N)	6974.9	最终载荷 (N)	4796.4
起始 ΔK (Mpa √m)	14.569	最终 ΔK (Mpa √m)	67.996
起始裂纹 (mm)	16.099	最终裂纹 (mm)	40.064
R	0.2	频率	15
周期	238928		
波形	正弦波		
测量方法	逐增多项式		
测量间隔 (mm)	0.1		
测量间隔 (cycle)	/		
拟合公式	Power:da/dN=3.39847472645721*10^(-08)*ΔK^2.8865846800377 2		
门槛值对应速率	--	ΔK门槛值	--

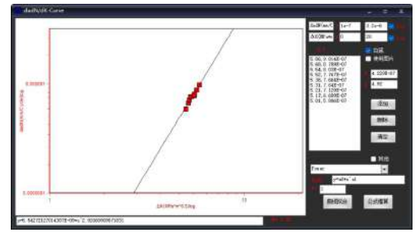
Crack Propagation (da/dN) Incremental Polynomial Test Report

1. Report header: It is possible to select and output test information, specimen dimensions, crack length, etc.
2. Data: Data related to da/dN.
3. Curves: Output the crack length-cycle trend line and the da/dN-ΔK rate curve.

Crack propagation (da/dN) data analysis

K-decreasing threshold

1. Obtain valid data points within the range of 10^{-6}~ 10^{-7} through condition settings.
2. Select the secant method or polynomial method to obtain the calculation method for crack growth rate.
3. Calculate ΔK, da/dN (crack growth rate) and other related data, and plot the ΔK-da/dN rate curve.
4. Export the report.



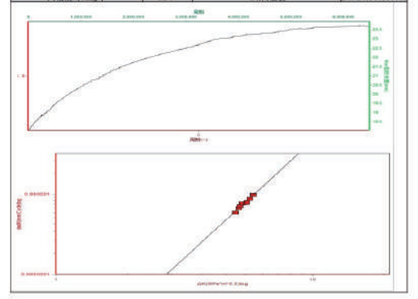
ΔK-da/dN rate curve

1. Calculate the equation formula based on the test data and draw the fitting curve.
2. Obtain the ΔK-da/dN rate curve displayed in logarithmic coordinates.

dadN测试报告

试验开始时间	2022/8/25 14:26:23	Bn (mm)	10.02	n0 (mm)	13.95
试验名称	试验机k-2	B (mm)	10.02		
委托编号	测试1	W (mm)	29.9		
试样编号	zyx	S(mm)	0		
		E(--)	177000		
		v(--)	0.3		
		Rm(MPa)	345		
		Rp0.2(Mpa)	410		
		z(mm)	0		
		X/W(--)	0.25		

起始载荷 (N)	3996.9	最终载荷 (N)	1268.6
起始 ΔK (Mpa √m)	16.754	最终 ΔK (Mpa √m)	8.391
起始裂纹 (mm)	18.048	最终裂纹 (mm)	23.654
R	0.5	频率	15
周期	6490099.5		
波形	正弦波		
测量方法	割线法		
测量间隔 (mm)	0.15		
测量间隔 (cycle)			
拟合公式	Power:da/dN=5.54272172014307*10^(-09)*ΔK^2.9206690982183 1		
门槛值对应速率	1E-07	ΔK门槛值	2.6924156755683



Crack Propagation (da/dN) Secant Method Test Report

1. Report header: Optional output of test information, specimen dimensions, crack length, etc.
2. Data: da/dN-related data.
3. Curves: Output of crack length-cycle trend line and da/dN-ΔK rate curve (with the rate ranging between 10^{-6} and 10^{-7}).

Fracture toughness test accessories

SEB fixture

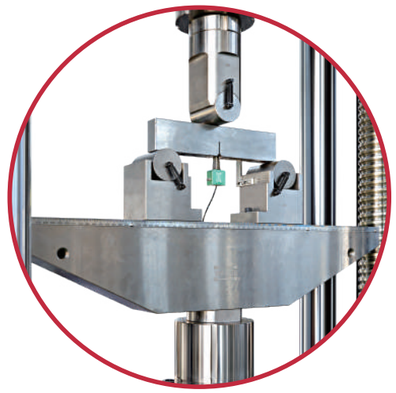
Model	Type 1	Type 2
Span (mm)	38~305	80~610
Roller diameter (mm) (made to order)	Φ5, Φ10, Φ15, Φ20, Φ25	Φ20, Φ30, Φ40, Φ50
Roller length (mm)	46	75
Maximum force (kN)	100	250

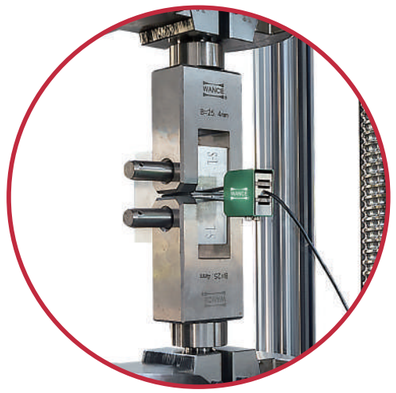
Other types can be customized.

CT fixture

Model	Type 1	Type 2	Type 3
Thickness B (mm)	6.35	12.7	25.4
Pin diameter (mm)	Φ6	Φ12.2	Φ12.2
Max. force (kN)	15	60	60

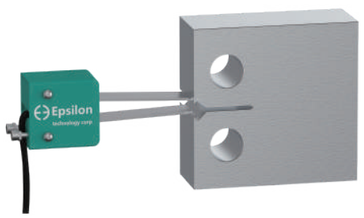
Other types can be customized.





COD gauge

Model: 3541 – Gauge length – Range – Temperature



Gauge length	
-003M	3.0mm
-005M	5.0mm
-008M	8.0mm
-010M	10.0mm
-012M	12.0mm
-020M	20.0mm

Range	
-025M	+2.5/-1.0mm
-040M	+4.0/-1.0mm
-070M	+7.0/-1mm
-100M	+10.0/-1mm
-120M	+12.0/-2mm

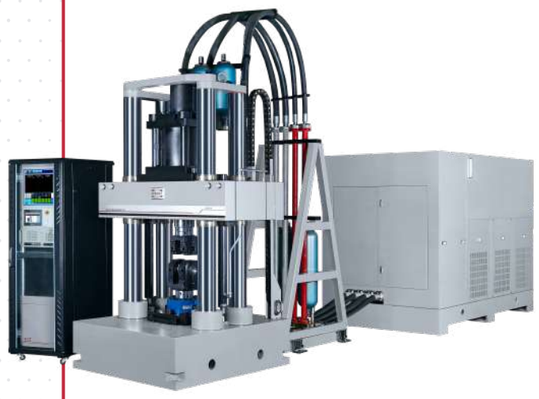
Temperature	
-LT	-270°C~100°C
-ST	-40°C~100°C
-HT1	-40°C~150°C
-HT2	-40°C~200°C
-LTT	-270°C~200°C

Fatigue and fracture test

Servo-hydraulic fatigue testing machine

High frequency resonant testing machine

Other machines



▲ Engine connecting rod fatigue test (800kN)

▲ Stranded wire testing (1000kN)

▲ EDT Series K-type Anti-seismic Bracing Fatigue Testing Machine

▲ Shock absorber dual-excitation fatigue testing machine

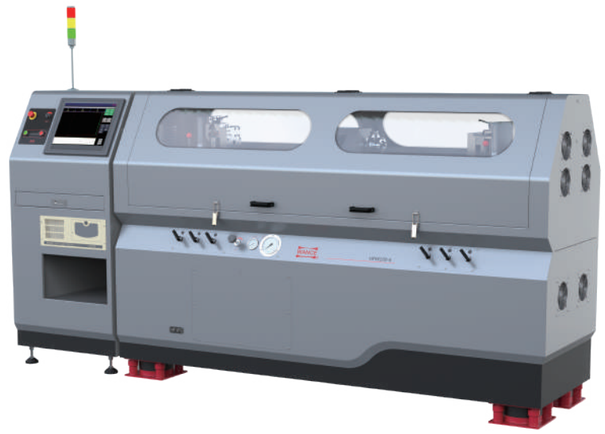
▲ 2500kN servo-hydraulic fatigue testing machine

▲ 5-station fatigue testing machine

▲Anti-glare board fatigue testing machine

▲Automobile stabilizer bar fatigue testing machine

▲Multi-channel coordinated loading test system



▲Hydraulic pipeline component rotating bending fatigue test bench