

STRUCTURAL MECHANICS SERIES

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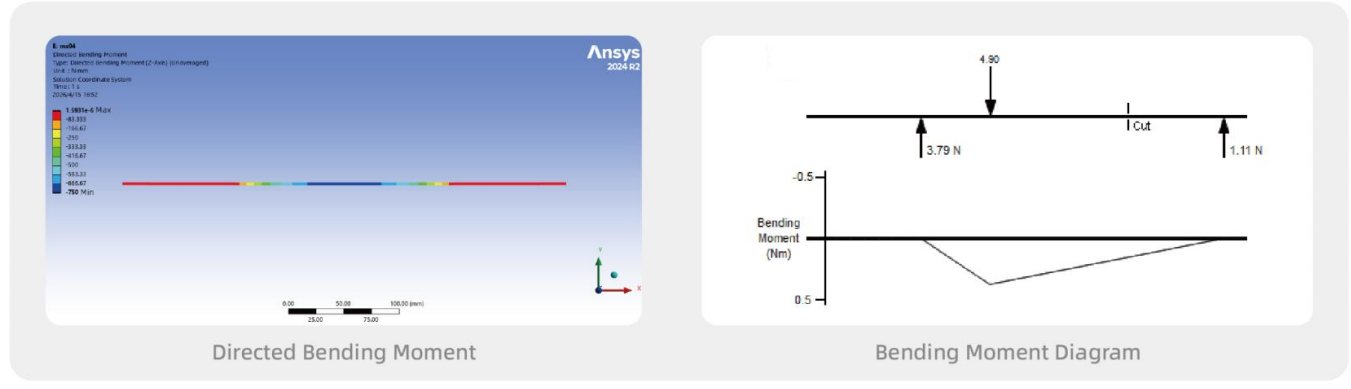
- Influence Line
 - Beam
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 - Truss
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- Plastic Limit Load
 - MST15 Beam Ultimate Load Machine
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- Suspension Bridge
 - MST19 Cable Tension Apparatus



► MST01 Simply Supported Beam Apparatus

- A precision teaching system for structural mechanics, comprising independent shear force and bending moment testing modules.
- Each module includes a cut-section beam, dual supports, and a base frame, with the beam disconnected at a predetermined section to simulate internal force testing.
- Using a force-arm bridge connection for stability and accuracy, integrated force sensors acquire real-time shear force and bending moment data, enabling intuitive verification of internal force distribution in statically determinate beams for teaching and research.

| FINITE ELEMENT SIMULATION ANALYSIS

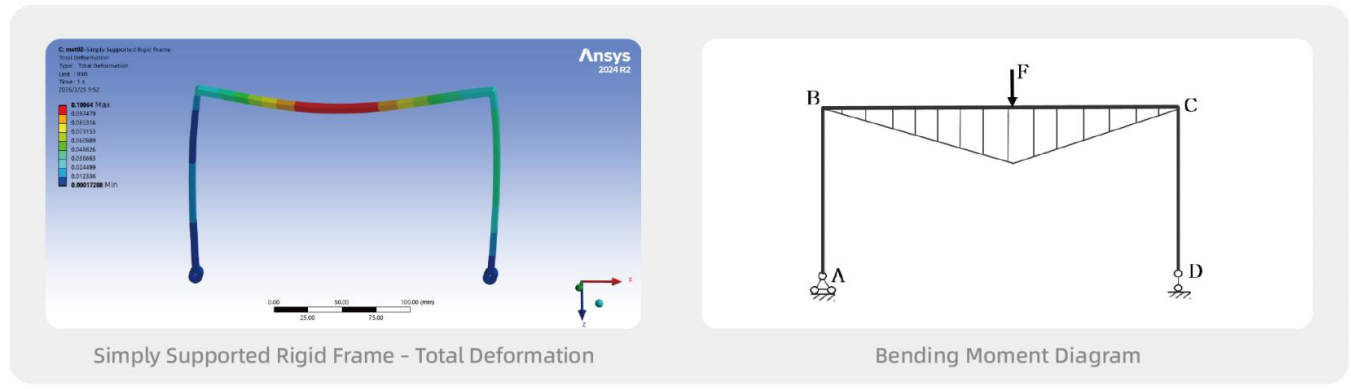


► MST02 Rigid Frame Apparatus

- An experimental module for structural mechanics teaching, integrating cantilever, simply supported, and three-hinged rigid frame configurations for civil and mechanical engineering applications.
- It precisely measures support reactions, member bending moments, and bending deformation under load, enabling intuitive comparison between theoretical calculations and measured data, helping students understand the load-bearing characteristics and deformation laws of rigid frame structures.



| FINITE ELEMENT SIMULATION ANALYSIS



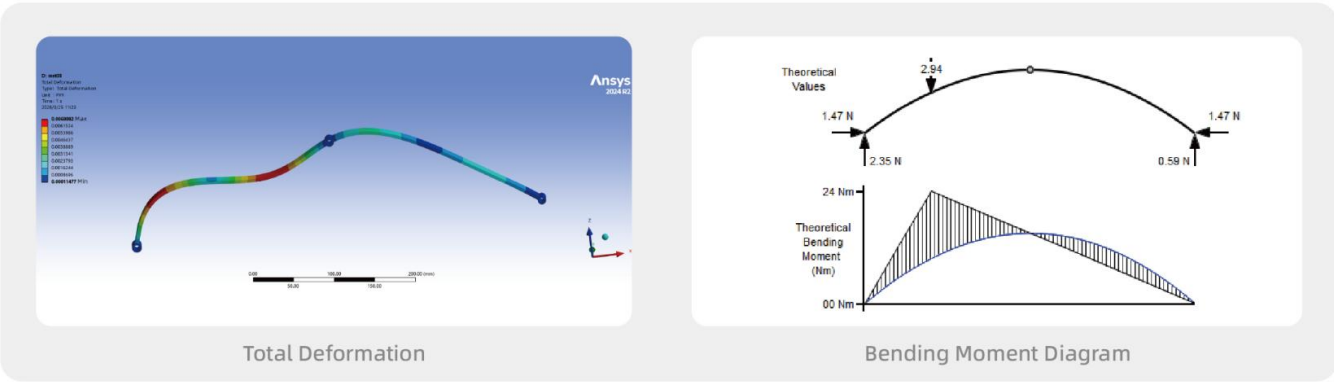


► MST03 Three-Hinged Arch Apparatus

- An experimental module specifically designed for structural mechanics teaching. Optimized to meet the application needs of civil and mechanical engineering disciplines, the apparatus consists of two supports and a symmetrical arch structure connected by a pin joint.
- It accurately simulates three-hinged arch loading under vertical forces, measures horizontal thrust in real time, and intuitively verifies force distribution differences between arches and equivalent simply supported beams—an ideal tool for understanding thrust structure mechanics.

Specimen Material	Acquisition Channels	Error Range	Loading range
Aluminum alloy	5 channels	±5%	0-8N
Display	Product Dimensions(mm)	Product Weight	Input Power Supply
10.1-inch	950 × 300 × 950	Approx. 30 kg	Single-phase three-wire, 220 V

FINITE ELEMENT SIMULATION ANALYSIS



EXPERIMENTAL FUNCTIONS

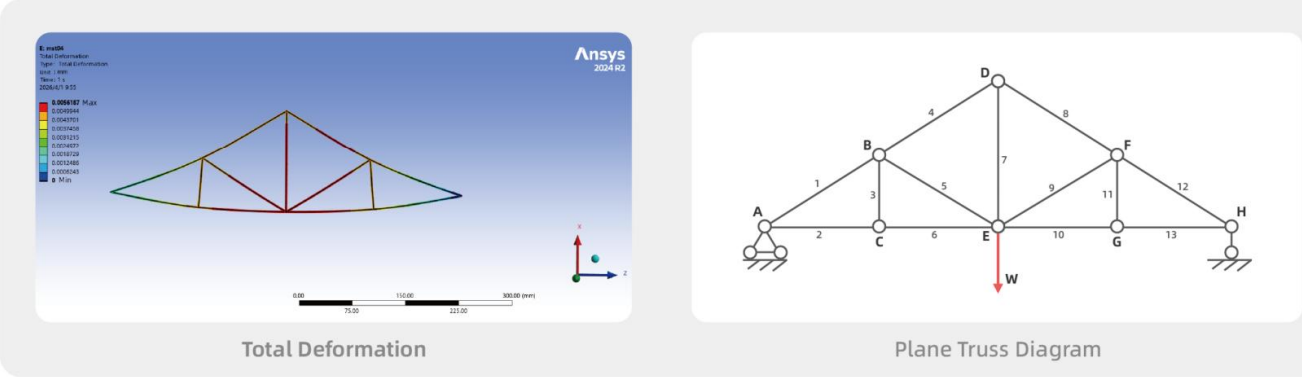
1. **Horizontal Thrust Test:** Measures horizontal reaction, verifying thrust is inversely proportional to arch rise.
2. **Moving Load Analysis:** Varies load position to plot horizontal reaction curves and analyze sectional internal force distribution.
3. **Uniform Load Simulation:** Long/short distributed load bars simulate real-world uniform loading (e.g., bridges), comparing measured and theoretical thrust values.
4. **Visualized Teaching:** Touchscreen displays real-time data and dynamic curves, enabling intuitive theoretical vs. measured comparison and understanding of concepts like the rational arch axis.



► MST04 Planar Truss Apparatus

- A precision experimental module for structural mechanics teaching, featuring a statically determinate plane truss with stainless steel members and pinned joints.
- Equipped with a screw loading mechanism, force sensors, displacement sensors, and half-bridge strain gauges, it precisely applies loads and simultaneously measures tensile/compressive strain in each member and structural deformation.
- Supporting intuitive theoretical vs. measured comparison, it is an ideal platform for truss internal force analysis and verification of the method of joints and method of sections.

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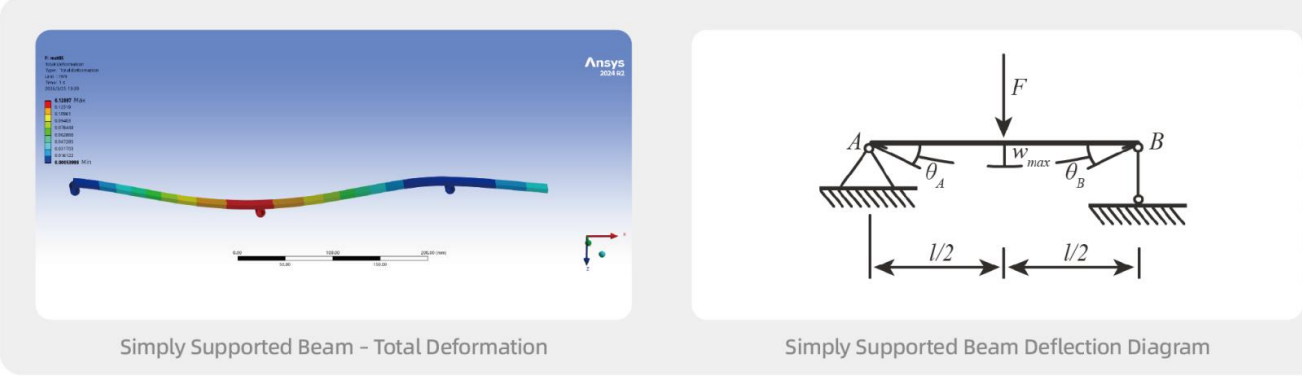


► MST05 Beam Deflection Apparatus

- An experimental module for structural mechanics teaching, consisting of a backboard, sliding displacement sensor, knife-edge supports, and base frame.
- It supports rapid setup of simply supported, cantilever, and overhanging beam configurations, with aluminum, copper, and steel beam specimens.
- Using a high-precision displacement sensor to measure deflection, it visually demonstrates the influence of load, span, and material on bending deformation—an ideal platform for verifying beam deflection theory and teaching the superposition method.



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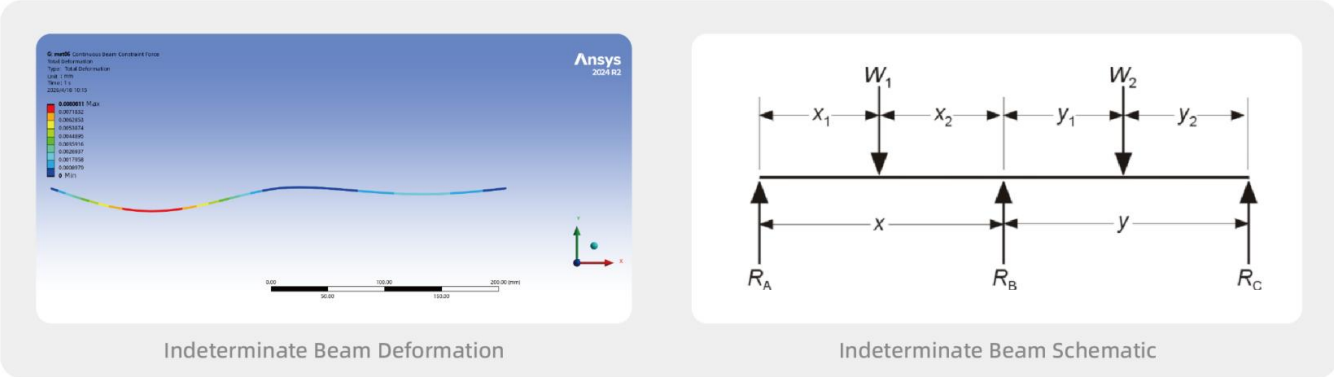




► MST06 Multi-Load Beam Apparatus

- Designed for comprehensive beam mechanical property testing, supporting statically determinate, indeterminate, and continuous beam experiments.
- Equipped with three vertical force-measuring supports and a fixed-end moment measurement structure for accurate reaction and internal force data, plus two high-precision displacement sensors for deflection monitoring and moving load influence line testing.
- Robust and easy to operate, it suits both university teaching and research, enabling comprehensive analysis of beam mechanical response.

I FINITE ELEMENT SIMULATION ANALYSIS



I EXPERIMENTAL FUNCTIONS

1. Constraint Force Testing of Statically Indeterminate & Continuous Beams:

- ① Redundant force differences under same load with different materials/elastic moduli.
- ② Reaction and redundant force differences for same material with varying load positions.
- ③ Mastering solution methods (additional constraint method, primary system selection).
- ④ Understanding theoretical assumption limitations via error analysis (material nonlinearity, sensor accuracy).

2. Beam Influence Line Testing:

- ① Plotting bending moment, shear force, and reaction influence lines at specified sections.
- ② Precisely measuring target quantities under unit load at specific positions.
- ③ Verifying theoretical values at key points.
- ④ Demonstrating multi-load arrangement for maximum effect using influence lines.
- ⑤ Verifying the Müller-Breslau principle (kinematic method).

3. Continuous Beam Internal Force Influence Line Testing:

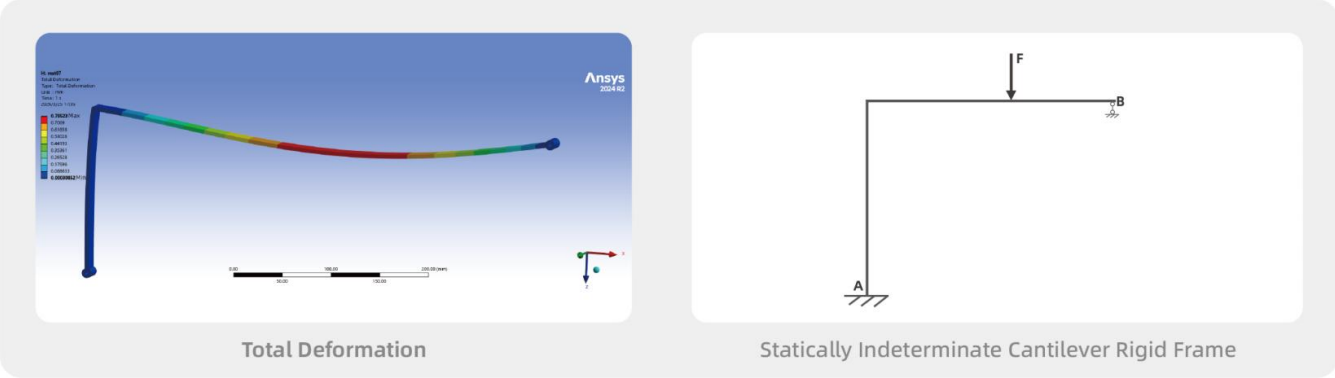
- ① Plotting influence line curves for statically indeterminate structures.
- ② Demonstrating positive and negative effect zones.
- ③ Verifying Müller-Breslau principle application in indeterminate structures.
- ④ Determining most unfavorable load positions.
- ⑤ Studying span ratio effects on influence lines.



► MST07 Indeterminate Frame Apparatus

- An experimental module for structural mechanics teaching, consisting of a mounting plate, cantilever rigid frame internal force measurement module, and force sensors.
- It simulates loading of a once statically indeterminate cantilever rigid frame, measuring horizontal/vertical displacements, support reactions, and member internal forces in real time via high-precision displacement sensors and strain gauges.
- Supporting intuitive comparison between measured data and force method theoretical values, it is ideal for studying indeterminate structure characteristics and verifying force method principles.

I FINITE ELEMENT SIMULATION ANALYSIS

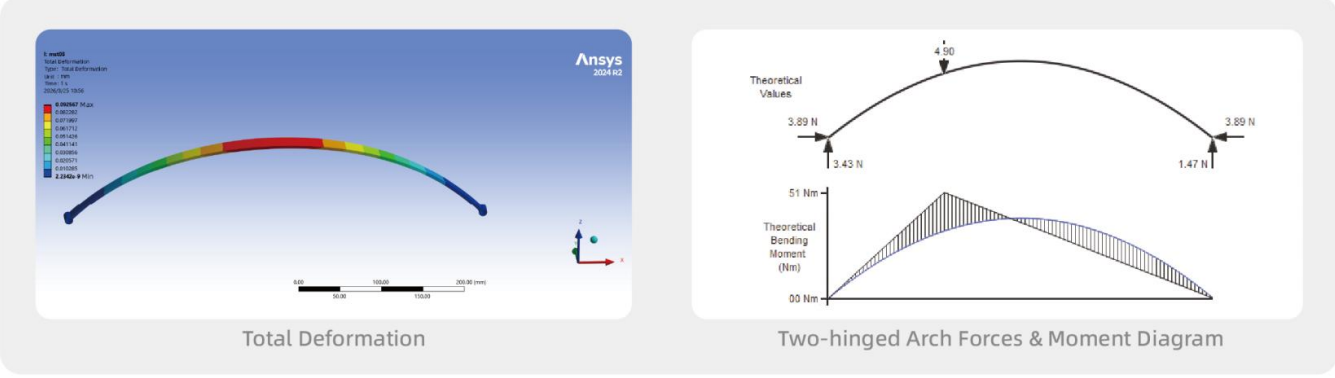


► MST08 Two-Hinged Arch Apparatus

- An experimental module for structural mechanics teaching, consisting of two supports and a symmetrical rigid-connected arch structure.
- It accurately simulates two-hinged arch loading under vertical forces, measures horizontal thrust and support reactions in real time, and intuitively verifies force distribution differences between arches and equivalent simply supported beams—an ideal tool for understanding statically indeterminate thrust structure mechanics.



I FINITE ELEMENT SIMULATION ANALYSIS

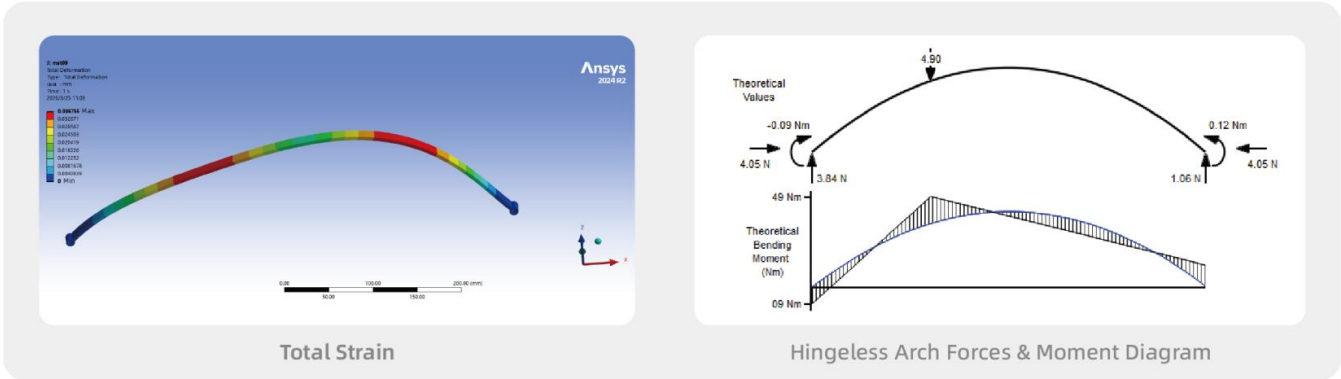




► MST09 Hingeless Arch Apparatus

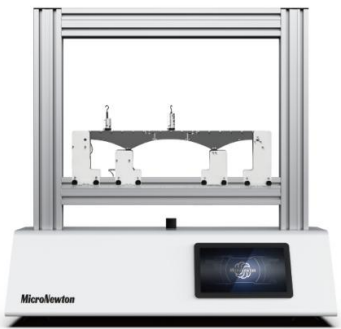
- An experimental module for structural mechanics teaching, consisting of two fixed-end supports and a symmetrical rigid-connected arch structure.
- It accurately simulates fixed arch loading under vertical forces, measures horizontal thrust, vertical reactions, and support moments in real time, and intuitively verifies force distribution differences between arches and equivalent simply supported beams—an ideal tool for understanding highly statically indeterminate thrust structure mechanics.

I FINITE ELEMENT SIMULATION ANALYSIS

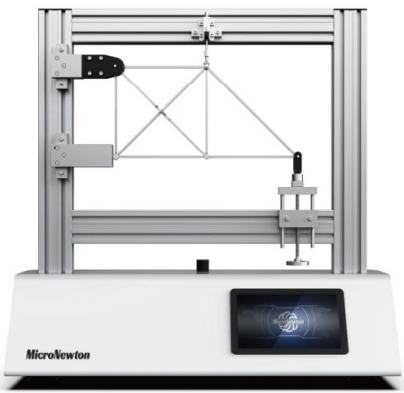
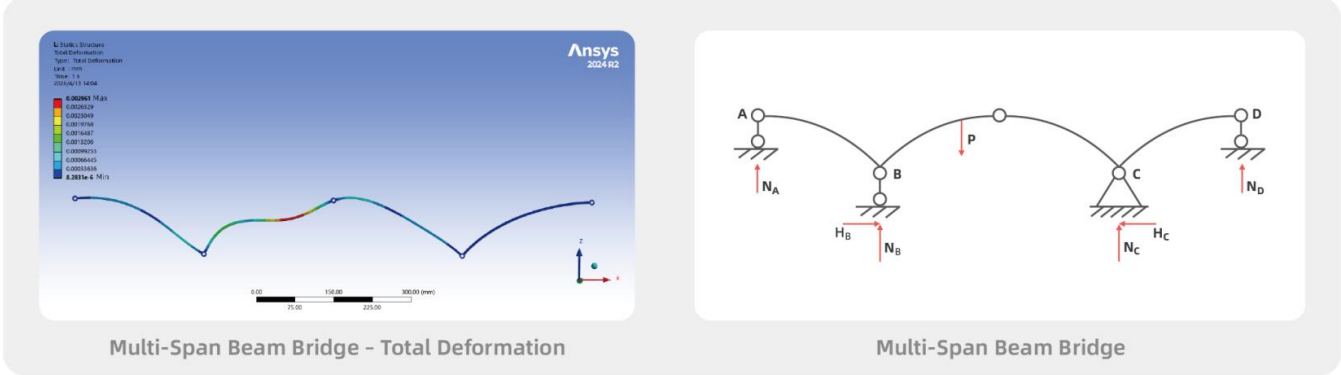


► MST10 Multi-Span Bridge Beam Apparatus

- Designed for structural mechanics teaching, this apparatus analyzes the force mechanism of statically determinate multi-span beams (Gerber beams).
- Using a precision articulated beam structure and high-sensitivity force-measuring supports, it captures real-time support reaction variations under moving loads.
- Students can plot reaction influence lines by hand, intuitively understand the force transfer between "primary" and "secondary" parts, and master most unfavorable load position determination—bridging mechanics theory and bridge engineering practice.



I FINITE ELEMENT SIMULATION ANALYSIS

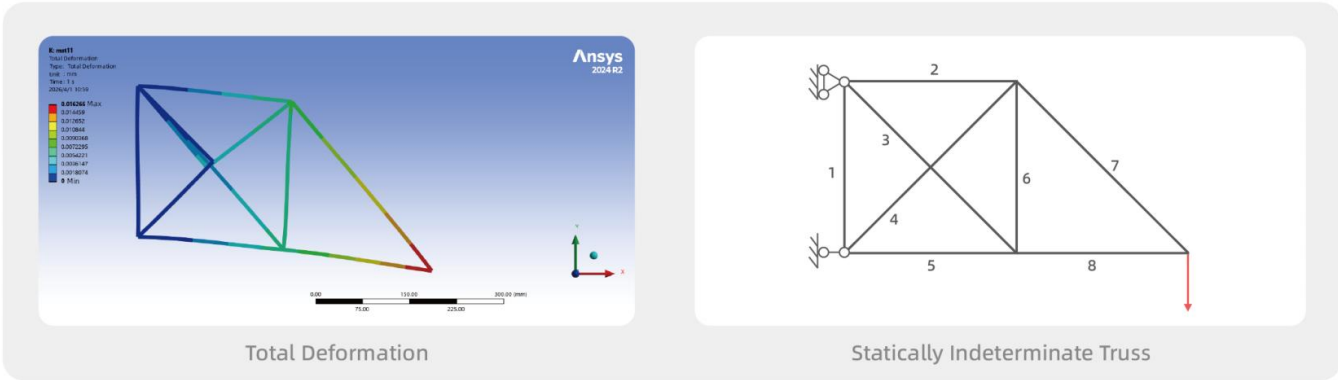


► MST11 Indeterminate Truss Apparatus

- An experimental apparatus for structural mechanics teaching, measuring key mechanical responses of statically indeterminate plane trusses under vertical loads, including member internal force distribution and overall truss displacement.
- Students systematically compare measured internal force data against force method theoretical values, gaining intuitive understanding of the principles and calculation process for solving indeterminate structures.
- It provides solid experimental evidence for abstract theory while enhancing students' ability to analyze complex structures and solve practical engineering problems.

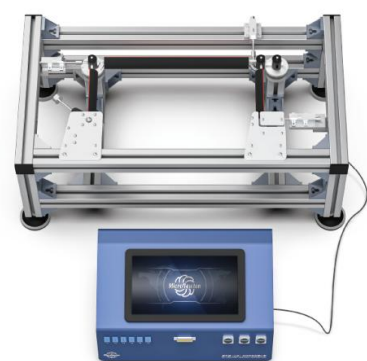
Specimen Material	Acquisition Channels	Error Range	Loading range
Stainless steel	10 channels	±5%	0-600N
Display	Product Dimensions(mm)	Product Weight	Input Power Supply
10.1-inch	950 × 300 × 950	Approx. 30 kg	Single-phase three-wire, 220 V

I FINITE ELEMENT SIMULATION ANALYSIS



I EXPERIMENTAL FUNCTIONS

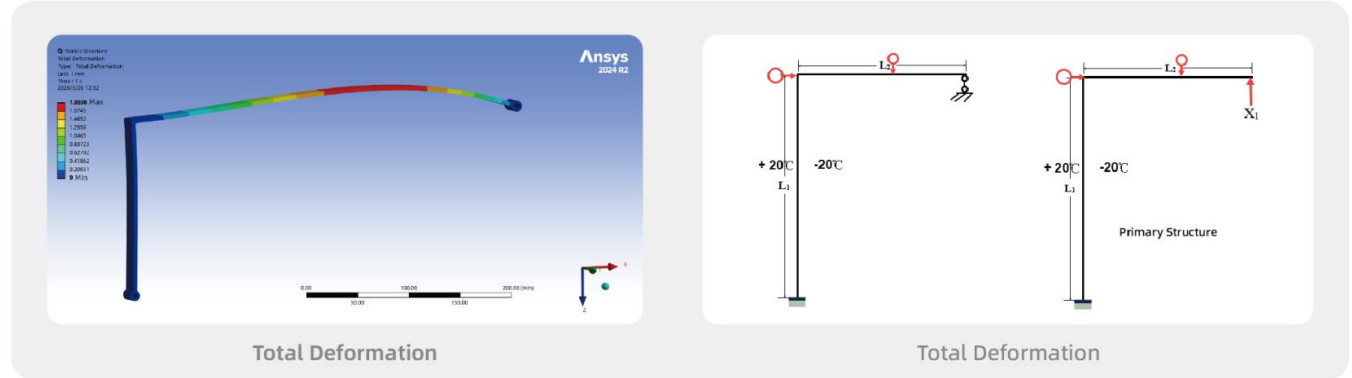
1. Apply varying loads/positions to identical geometry trusses; record member internal forces and overall displacement.
2. Perform force method calculations using experimental data (axial forces, reactions, joint displacements); verify agreement with theoretical values.
3. Review method of joints and method of sections for determinate trusses; strengthen ability to select advantageous redundant constraints for simplifying indeterminate truss calculations via the force method.
4. Understand ideal truss assumption limitations through error analysis (joint friction, material nonlinearity), supporting subsequent learning of approximate methods (force method, displacement method) for indeterminate structures like continuous beams and arches.



► MST12 Thermal Structural Loading Apparatus

- A specialized apparatus for studying temperature effects on statically indeterminate structures.
- Temperature changes cause only deformation in determinate structures, but generate significant self-stress and additional internal forces in indeterminate structures due to redundant constraints restricting free expansion/contraction.
- By simulating a temperature field, it measures internal forces and displacements of both determinate and indeterminate structures via sensors, involving strain and displacement testing of bar systems under varying temperature differences.

I FINITE ELEMENT SIMULATION ANALYSIS



► MST13 Indeterminate Beam Apparatus

- A core apparatus for studying load-bearing characteristics of continuous beams or fixed-end beams with multiple degrees of static indeterminacy.
- Its main feature is direct measurement of bending moments and shear forces at supports under load, verifying force method, displacement method, and moment distribution calculations.
- A key teaching aid for understanding internal force redistribution in indeterminate structures and the effects of support settlement/rotation.



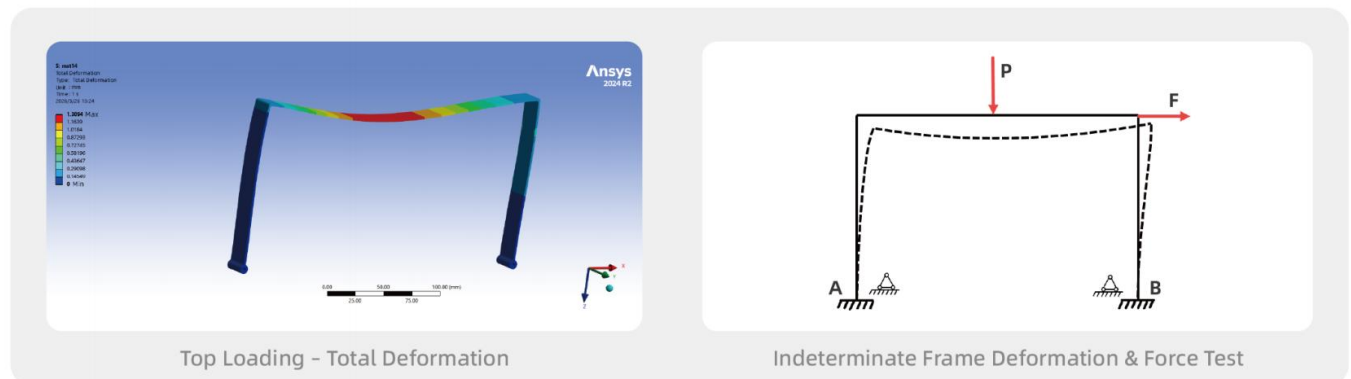
I FINITE ELEMENT SIMULATION ANALYSIS



► MST14 Indeterminate Frame Apparatus

- A specialized apparatus for studying deformation and internal force distribution of plane rigid frames under load.
- It features an aluminum portal frame on a backboard, with eight strain measurement points (four on the beam, four on columns) and four displacement sensors measuring joint lateral displacement and rotation.
- Equipped with a static strain acquisition unit, its core lies in accurately measuring rigid joint rotation and horizontal sidesway, verifying displacement method and moment distribution method calculations.

I FINITE ELEMENT SIMULATION ANALYSIS



I EXPERIMENTAL FUNCTIONS

1. Determination of Rigid Joint Displacements:

- ① Horizontal Sidesway : Measure sidesway under horizontal loads, asymmetric vertical loads, or couples; the key feature differentiating rigid frames from continuous beams.
- ② Joint Rotation : Measure rotation at beam-column intersections; at rigid joints, beam-end and column-end rotations are equal—a fundamental displacement method assumption.

2. Member End Force Determination:

- ① Measure bending moments, shear forces, and axial forces at column bases, tops, and beam ends via strain gauges or force transducers
- ② plot moment, shear, and axial force diagrams

3.Verification of Displacement Method Canonical Equations :

- ① Verify relationships between basic unknowns (joint rotations, linear displacements) and external loads
- ② verify physical meaning of stiffness coefficient kij (reaction from unit displacement)

4. Sidesway Effect on Internal Forces:

Compare internal force distribution with and without sidesway (e.g., bracing added), demonstrating that sidesway generates significant additional bending moments (basis of second-order effects)

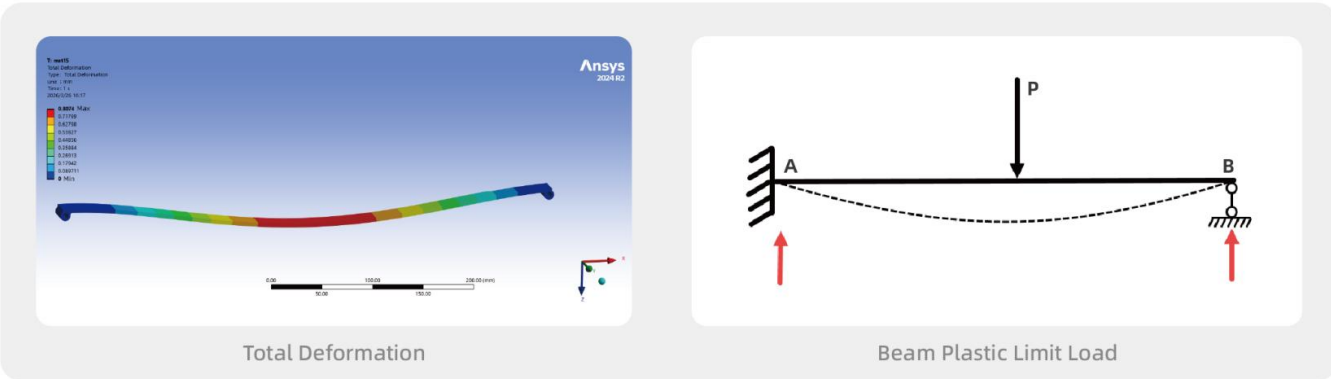


► MST15 Beam Ultimate Load Machine

- A core apparatus for studying material nonlinear behavior, plastic hinge formation and development, and beam load-carrying capacity at the ultimate limit state.
- Through precise loading, it visually demonstrates plastic hinge location and rotational characteristics after yielding, and verifies theoretically derived ultimate load values.
- Students master ultimate load determination via the static equilibrium method, gain in-depth understanding of plastic hinge unidirectional rotation and residual deformation after unloading—providing a practical foundation for plastic design of steel structures.

Specimen Material	Acquisition Channels	Error Range	Loading range
Aluminum alloy	5 channels	±5%	0-600N
Display	Product Dimensions(mm)	Product Weight	Input Power Supply
10.1-inch	950 × 300 × 950	Approx. 30 kg	Single-phase three-wire, 220 V

I FINITE ELEMENT SIMULATION ANALYSIS



I EXPERIMENTAL FUNCTIONS

1. Plastic Limit Load Determination:

- ① Measure the complete load-displacement curve from elastic through elastic-plastic to fully plastic failure
- ② determine ultimate load at loss of capacity and compare with theoretical value from plastic section modulus

2. Plastic Hinge Formation & Development:

- ① Visually demonstrate how the maximum moment section progresses from edge yielding to full-section yielding, forming a freely rotating "plastic hinge"
- ② verify its difference from a mechanical hinge (sustains ultimate moment, directional rotation)

3. P-Δ Full-Range Curve Plotting:

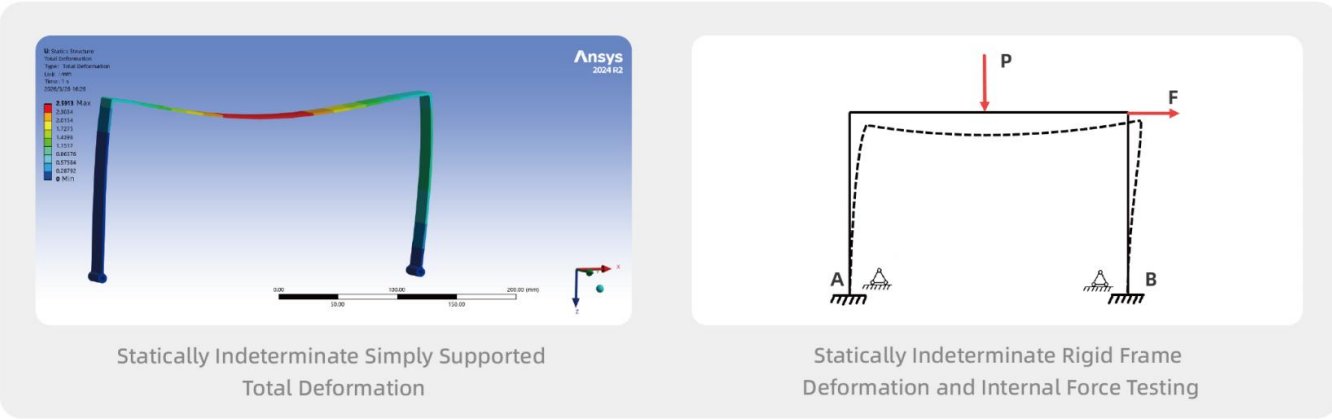
Record load vs. mid-span deflection, clearly distinguishing elastic, elastic-plastic transition, and plastic flow (plateau) segments



► MST16 Frame Ultimate Load Machine

- An apparatus for testing nonlinear behavior, failure mechanism formation, and ultimate load-carrying capacity of plane rigid frames under extreme loads.
- Rigid frame failure modes are complex, involving competition among sidesway, beam, and combined mechanisms.
- It demonstrates the entire process from elastic to plastic state, internal force redistribution through sequential plastic hinge formation, and ultimate collapse upon becoming a geometrically unstable system.

I FINITE ELEMENT SIMULATION ANALYSIS

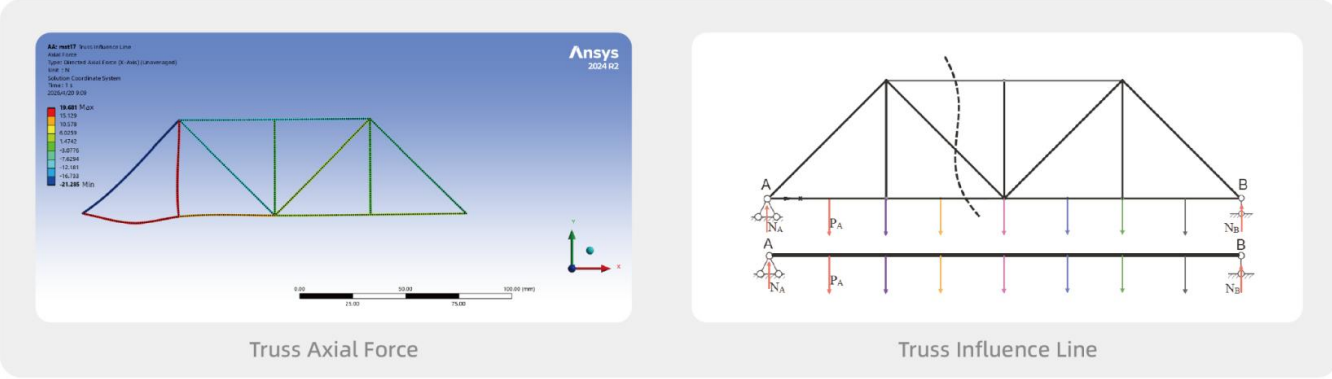


► MST17 Truss Influence Line Apparatus

- A testing apparatus for studying axial force variation in plane truss members under moving loads.
- A moving load system simulates a unit load traveling along the truss span, supporting concentrated, uniformly distributed, and multi-point loading adaptable to different truss topologies. Electrical measurement captures real-time stress data at each joint, generating influence line curves for comparison with theoretical values.



I FINITE ELEMENT SIMULATION ANALYSIS



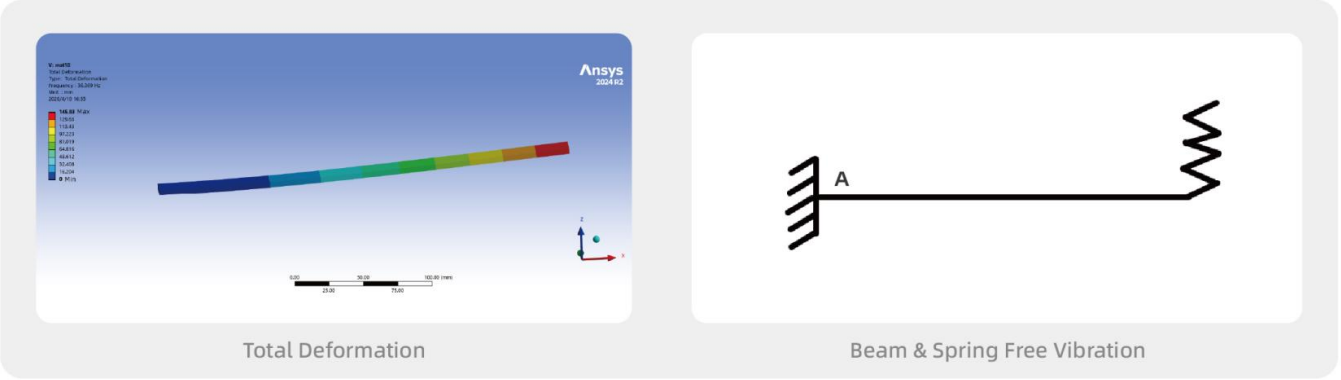


► MST18 Free Vibration Apparatus

- A comprehensive experimental platform for structural mechanics and mechanical vibration teaching.
- Its modular design integrates simple pendulum, compound pendulum, string pendulum, center of percussion, mass-spring system, torsional vibration, and cantilever beam modules.
- Serving civil and mechanical engineering teaching, practical training, and research, it helps students master simple harmonic motion, moment of inertia, and natural frequency through intuitive physical experiments.

Specimen Material	Acquisition Channels	Error Range	Input Power Supply
Carbon steel, Stainless steel, Spring steel	5 channels	±5%	Single-phase three-wire, 220 V
Display	Product Dimensions(mm)	Product Weight	Frequency Range
10.1-inch	950 × 300 × 950	Approx. 30 kg	0-200 Hz

I FINITE ELEMENT SIMULATION ANALYSIS



I EXPERIMENTAL FUNCTIONS

1. **Simple & Compound Pendulum:** Determine gravitational acceleration *g*; verify period relationships with length, mass, and amplitude; explore Kater's pendulum principle
2. **Moment of Inertia & String Pendulum:** Study mass distribution effects on period using bifilar/trifilar pendulums; verify the parallel axis theorem
3. **Center of Percussion:** Identify this special rigid-body point; analyze impact force vs. pivot reaction force relationship
4. **Vibration System Analysis:** Cover free vibration of mass-spring systems, free torsional vibration, and cantilever beam vibration; determine natural frequency, stiffness, and damping characteristics

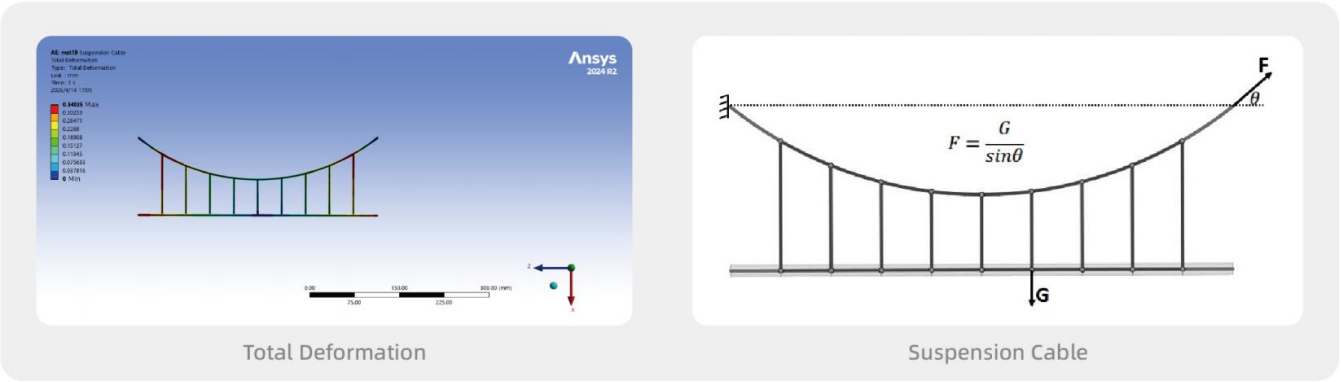


► MST19 Cable Tension Apparatus

- A specialized platform for teaching and research on flexible cable structure force mechanisms and cable force measurement techniques.
- Simulating a real suspension system, it accurately measures cable force variation under vertical loads, visually demonstrating flexible structure deformation compatibility.
- It investigates how load magnitude, position, and type influence cable forces, verifying the nonlinear relationship between cable force and load application points—providing theoretical and practical support for cable force monitoring in bridges and large-span spatial structures.

Specimen Material	Acquisition Channels	Error Range	Input Power Supply
Aluminum alloy, Stainless steel	5 channels	±5%	Single-phase three-wire, 220 V
Display	Product Dimensions(mm)	Product Weight	Loading Range
10.1-inch	950 × 300 × 950	Approx. 30 kg	0-20N

I FINITE ELEMENT SIMULATION ANALYSIS



I EXPERIMENTAL FUNCTIONS

1. Apply varying load magnitudes and positions to identical geometry suspension cables; observe and record cable force variation
2. Apply different load types (concentrated, uniformly distributed) to identical geometry cables; observe and record cable force variation
3. conduct comparative analysis between concentrated load-cable force and distributed load-cable force relationships
4. Systematically study geometric parameter effects on cable force by adjusting support spacing, initial sag, or cable cross-sectional properties; establish a quantitative "geometric parameters-cable force response" model and verify correction coefficients in the theoretical cable force formula