P·A·Hilton Ltd

HI-TECH EDUCATION

STRUCTURES

STATICS

HI-TECH Education is a market leader in the manufacture and provision of teaching equipment for Universities and Technical Colleges worldwide for both degree and vocational level.

It has been designing and manufacturing "hands-on" Engineering Teaching Equipment for almost 50 years and has a wealth of knowledge and experience within the education and training industry. Its worldwide network of agents guarantees a fast and professional response to all enquiries.

The STRUCTURES range of HI-TECH Education equipment enables clear and comprehensive learning of structural **STATICS** covering a variety of theories and topics within Architectural, Mechanical, Civil and Structural Engineering. These include FORCE, BENDING, SHEAR, ELASTICITY, BEAMS, ARCHED BRIDGES, SUSPENSION BRIDGES, TRUSSES, FRAMEWORKS and PORTALS.

The STRUCTURES hardware can be connected to the HI-TECH Education Interface creating a stand alone solution within the laboratory. Alternatively the STRUCTURES hardware can be fully Data Acquisitioned in conjunction with the experiment software. With the software the students can benefit from a wider learning experience.

2 Two Year Warranty

HST1 UNIVERSAL FRAME AND STAND

Floor or bench mounted frame for use with all HI-TECH Education STRUCTURES hardware. Although the HST1 is designed for mounting on a floor, it can be modified for mounting on a table or bench top with the conversion kit provided as standard. The aluminium frame has an internal working area of 1.2 x 0.76 metres.
The frame facilitates quick and easy attachment of all experiments and is backward compatible with all previous versions of HI-TECH Education experiments. A full set of assembly instructions and tools are supplied.

Bench Top HST1 Frame

HST2 SIMPLE SUSPENSION BRIDGE

A visually realistic suspension bridge with deck and vertical hangers allows students to compare theoretical and experimental cable tensions and to study the performance of the bridge under varying load conditions. Twin suspension cables connect each hanger pair into a parabolic suspension. The cables pass over pulleys at "side towers" simulated by the HST1 frame. The bridge is loaded with point or uniformly distributed loads. The tensile force in the cables is distributed to load cells. Students read the cable tension through the HDA200. This arrangement provides stable yet sensitive experimental conditions. Supplied with instruction manual, load cells, hangers, weights and tools. **Essential accessories: HST1, HDA200.**

HST3 PLASTIC BENDING OF BEAMS

Demonstration of the theory of plastic bending of a beam section and increase in bending moment due to redundancy. The collapse load for the beam is also measured. The apparatus provides two end supports, which allow for rigid clamping or simple support (knife edge) of the test beams. One also allows horizontal travel whilst restricting rotation. A screw jack mechanism with integral load cell applies load to the test beam, while a dial gauge measures the deflection. The load cell connects to the HDA200 for the display of the force. A set of extra beam specimens is available as an optional extra (HST3a). Supplied with instruction manual, load cell and tools. **Essential accessories: HST1, HDA200.**

HST4 THREE HINGED ARCH

A model three hinged arch to investigate the horizontal thrust of its springing and calculation of its influence line. A 1 metre span flat deck, with spandrels and arch rib has bearings at the springings and crown. One springing is fixed while the other runs on a track plate against a load cell which measures the horizontal thrust. In addition to the symmetrical arch an interchangeable "unsymmetrical" arch, 0.75 metre span, is supplied. The arch is loaded using a point load, uniformly distributed load and a tandem load which simulates a vehicle. Supplied with instruction manual, load cell and tools. **Essential accessories: HST1, HDA200.**

HST5 TWO HINGED ARCH

A parabolic arch is used to compare horizontal reaction forces with simplified theory and create influence lines. One end is pinned in bearings while the other end runs on a track plate against a load cell to measure the horizontal reaction. Load is applied to the arch via seven equi-spaced load hangers and weights. For model analysis measurements, pins are set on the arch at each load hanger and a moveable dial gauge is provided for this work. A semi-circular arch is available as an optional extra (HST5a). Supplied with instruction manual, load cell, weights and tools. **Essential accessories: HST1, HDA200.**

HST6 PARABOLIC ARCH WITH FIXED ENDS

A visual experiment that allows students to evaluate the influence lines of horizontal thrust and end fixing moments (solution of three redundancies) of a parabolic arch with fixed ends, by direct measurement and advanced model analysis. It pivots at one end on a load cell for measuring moments. The other end of the arch rests against a load cell for horizontal thrust measurement. Seven equi-spaced load hangers with deflection measuring points are fitted on the arch. Two dial gauges are provided for measuring displacements and rotations. Supplied with instruction manual, load cells, weights and tools. **Essential accessories: HST1, HDA200.**

HST7 DEFLECTION OF FRAMES

Through horizontal and vertical loading, the deflections of simply supported frames can be compared against theory using **Castigliano's theorem** and **Simpson's rule**. Horizontal reactions, fixing moments and sway can also be measured. Three portal frames are supplied with fixed, pinned or simple supports. Load cells monitor the moment at one end and horizontal reaction at the other. A dial gauge measures frame deflection. Load is applied using hangers and weights. A further set of portal frames is available as an optional extra (HST7a). Supplied with instruction manual, load cells, weights and tools. **Essential accessories: HST1, HDA200.**

HST8 PLASTIC DEFORMATION OF PORTALS

Studies the collapse mechanism of a portal frame when subjected to simultaneous horizontal and vertical loading. Students can calculate and verify the position of greatest bending moment where plastic hinging is likely to form.
Two "ground" supports, pinned or fixed, are used as the feet of the portal frames. Load cells measure and apply force and deformation to the portals. Two moveable dial gauges are used to monitor the deflections into the plastic range of deformation of the portal. Rectangular and pitched portals are supplied as standard. Additional portal sets are available as an optional extra (HST8a). Supplied with instruction manual, load cells, weights and tools.
Essential accessories: HST1, HDA200.

HST9 SHEAR FORCE IN A BEAM

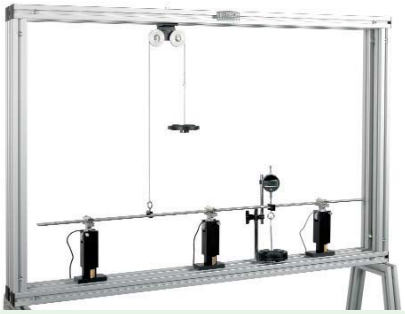
This visually realistic experiment teaches students about the action of shear at a "cut" section in a beam and allows comparison of the measured values with theory. The apparatus emphasises both negative and positive shear. The "cut" beam is simply supported over varying spans. The hinge mechanism at the "cut" limits vertical travel, while an underslung spring resists bending. The shear force is measured with a load cell which connects directly to the HDA200. Load hangers and weights apply load to the beams. Supplied with instruction manual, hangers, load cell, weights and tools.
Essential accessories: HST1, HDA200.

HST10 BENDING MOMENT IN A BEAM

Similar to the HST9, students can observe the action of bending moment at a "cut" section in a beam and compare the measured and theoretical values. The beam is in two halves and joined at the "cut" using a "hinge" mechanism. As the beam is loaded using the hangers and weights provided, the bending moment force is measured using the load cell attached to the underslung moment arms. A variety of beam spans and hanger positions are achievable. Supplied with instruction manual, hangers, load cell, weights and tools.
Essential accessories: HST1, HDA200.

HST11 CONTINUOUS AND INDETERMINATE BEAMS

Enables a wide range of beam experiments to measure support reactions, fixing moments, deflections and rotations of simply supported, fixed, two span continuous beams and propped cantilevers. Sinking supports can also be studied. Three piers measure vertical reaction forces with their integral load cells. Dial gauges on each pier measure support deflections while moveable dial gauges measure the beam deflection. A fourth pier clamps a cantilever or the fixed end of a beam, allowing fixing moments to be measured. A double pulley assembly provides vertical loading of the beam. Point loads and uniformly distributed loads can be applied to the beams. A variety of beams of different section and material are included. Supplied with instruction manual, hangers, load cell, weights and tools. **Essential accessories: HST1, HDA200.**



HST12 DEFLECTIONS OF CURVED BARS

Students can compare the deflections of one end of a curved bar, with theoretical deflections derived from **Castigliano's theorem**, mathematical integration or **Simpson's rule**. Six cantilever brackets, of varying geometry, attach to the HST1 frame and have two pins for a special load hanger at the free end. The load hanger, with weights, applies a vertical load and presents faces for two moveable dial gauges to measure the vertical and horizontal deflections simultaneously. Supplied with instruction manual, hangers, load cell, six cantilever brackets, weights and tools.
Essential accessories: HST1; Optional extra: HDA200.

HST13 BEAM AND CANTILEVER DEFLECTIONS

Allows students to analyse the deflections experienced by beams and cantilevers under load and to verify the differential equation of a beam in the calculation of slopes and deflections. Two beams of different thickness can rest on moveable beam supports fitted with knife edges. Cantilevers can be created using a support fitted with a clamp. Three moveable dial gauges measure deflections and hence slope. Point and uniformly distributed loads are applied to the beam using hangers and weights. Supplied with instruction manual, hangers, weights and tools.
Essential accessories: HST1; Optional extra: HDA200.

HST14 SHEAR FORCE INFLUENCE LINES

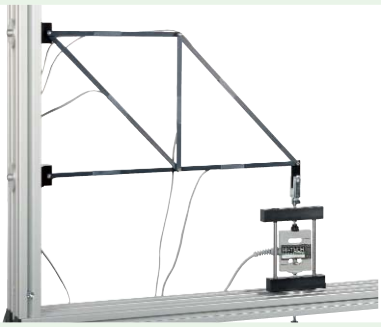
Students derive the shear force influence line for a point on a beam and study the difference between a unit load crossing a beam together with the action of shear at a "cut" section. The "cut" beam is simply supported over varying spans. The mechanism at the "cut" limits vertical travel, while an underslung spring resists bending. The shear force is measured with a load cell, which connects directly to the HDA200. Load hangers and weights apply load to the beams. A hinged loading device that transmits the load only at the hinges is used to simulate the load on a truss. Supplied with instruction manual, hangers, load cell, weights and tools.
Essential accessories: HST1, HDA200.

HST15 BENDING MOMENT INFLUENCE LINES

Students derive the bending moment influence line for a point on a beam, study the difference between a unit load crossing a beam and observe the action of the bending moment at a "cut" section. The beam is in two halves and joined at the "cut" using a "hinge" mechanism. As the beam is loaded using the hangers and weights provided, the bending moment force is measured using the load cell attached to the underslung moment arms. A hinged loading device that transmits the load only at the hinges is used to simulate the load on a truss. A variety of beam spans and hanger positions are achievable. Supplied with instruction manual, hangers, load cell, weights and tools. **Essential accessories: HST1, HDA200.**

HST16 REDUNDANT TRUSS

A two bay cantilevered truss is supported inside the HST1 frame via upper and lower springings, which allow pivoting and rolling. The redundant truss member can have its length adjusted to vary its fit within the truss. Member strains (hence forces) and joint deflections are measured when the redundant member is adjusted. Enables comparison of experimental strains with theoretical values. Each truss member has a strain bridge attached, which connect directly to the HDA200. A screw jack mechanism with integral load cell applies loading, while a moveable dial gauge records joint deflections. Supplied with instruction manual, load cell and tools. **Essential accessories: HST1, HDA200.**



HST17 FORCES IN A TRUSS

Students measure the axial strain and hence force in this realistic cantilevered truss with true pin joints. Allows comparison of experimental results with the member forces calculated by resolution at a joint. An HST1 frame mounted truss comprises of six truly pin jointed members with two bays and a screw jack loading mechanism with integral load cell. Strain bridges attached to each member record the axial strain and connect directly to the HDA200 together with the load cell. Supplied with instruction manual, load cell and tools.
Essential accessories: HST1, HDA200.

HST18 SUSPENDED CENTRE SPAN BRIDGE

This experiment models a suspended centre span bridge. Students analyse the reaction influence lines for the bridge as a tandem rolling load (vehicle simulation) crosses it. The model bridge has a flat deck and solid spandrels to the three spans. The bridge is supported on the two inner piers and is anchored to the two outer piers to provide a pair of cantilevers on which the suspended centre span is carried. Six integral load cells connect directly to the HDA200 and record the bridge reactions when a tandem load or point load crosses the bridge deck. Supplied with instruction manual, load cells and tools. **Essential accessories: HST1, HDA200.**

HST19 PIN-JOINTED FRAMEWORKS

Apparatus enabling students to assemble a variety of pin-jointed frameworks using metal struts and ties to measure the stresses, strains and joint deflections. Each member can be easily interconnected. The assembled frameworks mount onto two end pillars. One pillar allows pivoting while the other allows pivoting and rolling. Fine and accurate loading is applied to the framework at known joints by a screw jack mechanism with integral load cell. Each framework member has a strain bridge attached. The load cell and strain bridges connect directly to the HDA200. Joint deflections are measured using a moveable dial gauge. An additional load cell is available as an optional extra (HST19a). Supplied with instruction manual, load cell and tools. **Essential accessories: HST1, HDA200.**

HST20 BENDING STRESS IN A BEAM

Experiment for determining the bending stresses and strains within a T-beam. Students learn about strain gauging, bending equation, neutral axis and second moment of area. An inverted T-beam is mounted onto simple supports. The load on the T-beam is applied using a screw jack mechanism with integral load cell. The load cell arrangement can be tilted to enable angled loads to be applied. A number of strain gauges are arranged on the T-beam specimen. A fully strain gauged rectangular beam is available as an optional extra (HST20a). The loads and strains are measured directly by the HDA200. Supplied with instruction manual, load cell and tools.
Essential accessories: HST1, HDA200.

HST21 UNSYMMETRICAL BENDING AND SHEAR

Apparatus allowing the relationship between vertical and horizontal deflections and the principle moments of area for a number of different sectioned specimens. The shear centre for each specimen can also be found. A "rectangular", "U" and "L" shaped specimen are each held vertically. The angular position of each specimen can be changed thus altering the angle of loading. Load is applied to the specimens using a hanger and weights. Dial gauges at one end of the specimen measure the deflections. Supplied with specimens, instruction manual, hanger, weights and tools. **Essential accessories: HST1; Optional extra: HDA200.**

HST22 TORSION OF RODS AND TUBES

Enables students to verify the torsion of a solid round bar and the equation of torsion. The theory also extends to non-circular specimens. Solid rod, tube, slotted tube and hollow square specimens are held horizontally between two chucks. One chuck is rotated against known angles, whilst the other chuck is retained by a load cell thus enabling the torque to be derived. A pointer on the specimen monitors the angle of twist against a stationary vernier scale. Supplied with specimens, instruction manual, load cell and tools.
Essential accessories: HST1, HDA200.

HST23 EQUILIBRIUM OF FORCES

A purely analogue experiment for the study of the equilibrium of forces acting in a single vertical plane. Students can study concurrent and non-concurrent forces in the vertical plane and also construct a polygon of forces. A force board mounts into the HST1 frame while a number of pulleys attach around the perimeter. Cords attach to load hangers on one end and terminate at a single (concurrent) or double (non-concurrent) ring assembly at the other. Paper maybe attached to the board for indicating the lines of action. Supplied with instruction manual, hangers, weights, cords and tools. **Essential accessories: HST1.**

HST24 EQUILIBRIUM OF PARALLEL FORCES

Excellent for studying the equilibrium of vertical forces and the special case of equal and opposite parallel forces in a single plane. A force board is clamped into the HST1 frame while two models simulating a "Warren" and "N" truss are used for the application of vertical loads and reactions. The forces are produced by weights on hangers. Double pulleys are used to invert the upward forces. A circular disc with twelve attachment points is used for the coupling. To simplify the results each model has a counterbalancing weight to render each one "weightless". Lines of action maybe indicated on paper attached to the force board. Supplied with instruction manual, hangers, weights, cords and tools. **Essential accessories: HST1.**

OTHER EXPERIMENTS AVAILABLE *(Refer to our Website for details)*

HST25 Equilibrium of a Rigid Body
HST26 Deflections of Beams
HST27 Three Dimensional Equilibrium
HST28 Area Moment Method
HST29 Shear Centre Apparatus
HST30 Modulus of Elasticity
HST31 Suspension Cable
HST32 Laminated Spring
HST33 Beam Stiffness and Carry Over Factors
HST34 Virtual Work
HST35 Strain Measurement for Structures
HST36 Column Buckling Failure
HST37 Beam Deflections
HST38 Deflections of Trusses
HST39 Suspension Bridge
HST40 Two Dimensional Bending
HST41 Equilibrium of a Beam
HST42 Forces in a Truss (Sections)
HST43 Welded Truss
HST44 Fixed End Beam Apparatus
HST45 Buckling of Struts

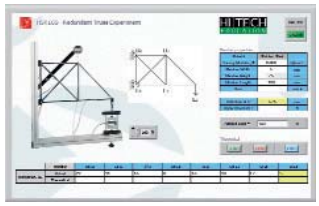
SOFTWARE AND INTERFACE

EXPERIMENT SOFTWARE

To accompany most of the STRUCTURES experiments, HI-TECH Education has developed experiment software to compliment the hardware and to give the operator a broader learning experience. The software can both simulate and capture (in real-time) experimental data. The software graphics include an image of the actual experiment, thereby giving consistency between hardware and software. A wide variety of experiment parameters can be altered on screen including; applied force, deflection position, load position, specimen geometry, type of loading (point or uniformly distributed load), material properties and many more.

On-line or off-line operation is screen selectable with the off-line option allowing the operator to be remote from the hardware while simulating experimental data. The on-line option requires the experiment hardware to be connected to the software via the HDA200 Interface. When the HDA200 Interface is connected real-time experimental data is fed to the graphical display allowing the operator to compare actual and theoretical results. The software includes a number of numerical and graphic display options and the data files are easily exported to Excel or another spreadsheet format for analysis and report writing.

For each individual experiment purchased with a dedicated HDA200 Interface as an essential accessory the software for that experiment is supplied as standard.



HDA200 INTERFACE

This unique and compact unit is essential for all HI-TECH STRUCTURES experiments requiring the parameters of Force, Strain and Deflection to be monitored. The on board Data Acquisition facility captures and stores data. Via its integral 4 line back-lit LCD display the operator can retrieve this data for reviewing at anytime. Further data manipulation can be undertaken when the HDA200 Interface runs in conjunction with the experiment software. In the event that more than four parameters are being captured simultaneously the operator can select between them using the front panel keypad. The interface allows for quick and easy connection to the experiment and can be bench or HST1 frame mounted. For computer connection a USB port is provided. The unit is supplied with an instruction manual and universal power supply.

HAC20 2-CHANNEL STRAIN METER

This unit is a versatile, portable and compact device which allows for the connection of quarter, half or full bridge configurations from any strain gauged member on HI-TECH Education or third party equipment. The two channels work independently and can have their gauge factor, bridge arrangement and tare values stored internally for safe retrieval when required. Strain readings up to ±2000 microstrain can be read via the back-lit LCD. An analogue output socket is available along with control buttons for entering the strain gauge parameters and for taring the display value. The unit has internal rechargeable batteries for remote operation. Expansion of this unit to an 18 channel device is accomplished by connecting to the optionally available 16 channel HAC20M. The unit is supplied with an instruction manual and universal power supply.

P·A·Hilton Ltd

Horsebridge Mill, King's Somborne, Stockbridge
Hampshire SO20 6PX, England
Tel: +44 (0)1794 388382
Fax: +44 (0)1794 388129
Email: sales@p-a-hilton.co.uk
Web: www.p-a-hilton.co.uk

Represented by:

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