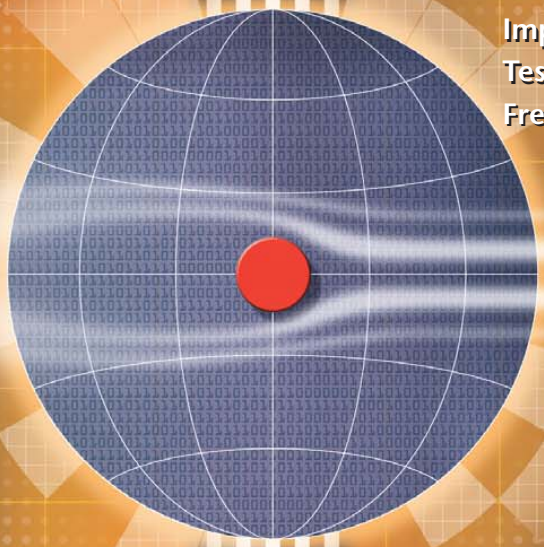
Materials Testing and Properties



“ The university community has been deriving optimal educational benefits from the use of TecQuipment teaching aids. Latest technology of high quality with robustness, durability, environment friendly and diverse experiment facilities, the TecQuipment products play a significant role in ensuring ‘ease of transfer of technology’. ”

Prof M Alimullah Miyan, International University of Business Agriculture and Technology, Bangladesh

Materials Testing and Properties

Experience

TecQuipment has decades of experience making products that test materials specimens, refining and developing them over time to match the needs of modern engineering courses. These high-quality robust products are made for the teaching laboratory, giving the long term performance and reliability needed for accurate and dependable results.

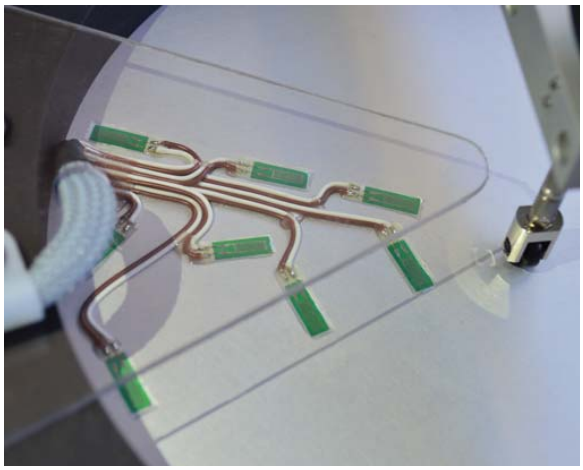
Broad and progressive range

The range includes products to show key materials principles, such as Hooke's Law and Young's Modulus.

It progresses to complex analysis of stress and strain and testing specimens to destruction.

KEY FEATURES AND BENEFITS:

- **Refined products: refined through experience to meet the needs of a modern materials course.**
- **Broad and progressive range of experiments: teaches the fundamental principles, progressing to complex stress and strain analysis.**
- **Automatic data acquisition: multiple and fast-changing measurements make data acquisition a valuable tool.**



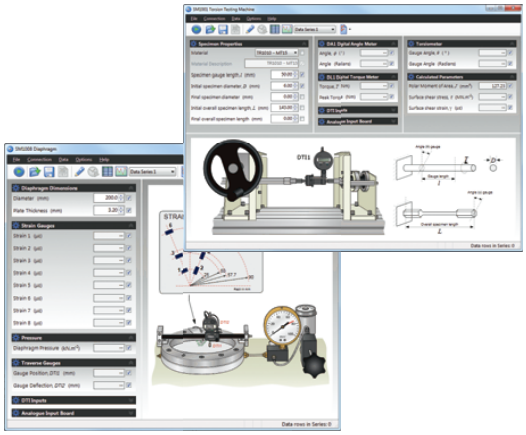
Check out our other ranges

Our **Structures** (Section 9) and **Engineering Science** (Section 1) ranges also include products that demonstrate how the choice of materials affects the performance of structural elements.

Automatic data acquisition

Many of the products in this range work with TecQuipment's unique Versatile Data Acquisition System (VDAS®). See **Section 2** for more details.

Look out for the VDAS® logo: VDAS®



VDAS®	Product	Page
●	**Thin Cylinder** (SM1007)	157
●	**Diaphragm** (SM1008)	159
●	**Thick Cylinder** (SM1011)	160
●	**Strain Gauge Trainer** (SM1009)	161
●	**Digital Strain Display** (SM1010)	162
●	**Torsion Testing Machine–30 Nm** (SM1001)	164
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Spring Testing Apparatus (SM110)

Tests extension springs to find their properties. Proves Hooke's Law and the basic rules of spring design

- Fundamental and accurate test instrument to test single springs and springs in series and parallel
- Tests springs and finds their properties – good for mechanical workshops and classroom use
- Includes a set of different springs to compare spring rates and effect of different spring sizes
- Supplied with user guide which includes theory, experiments and results

EXPERIMENTS:

- **Spring rate and Hooke's Law**
- **To prove the basic rules of spring design**
- **Simple spring scale**
- **Springs in series**
- **Springs in parallel**

The Spring Testing Apparatus uses a fundamental variable mass and scale measurement to test springs. It shows students how to find the properties of a spring and proves some basic laws of physics (Hooke's Law, Newton's Law and spring design rules). It is also a useful tool for a workshop, to check the properties of a spring before it is used, or after it has been used.

The apparatus is a compact metal frame with adjustable feet so the user can make the apparatus level. The back of the frame has a storage area for springs and masses. The front of the frame has a metric scale each side of a large slot, where the test spring hangs.

Students choose a spring and note its dimensions. They then slowly load the spring with the masses (included) and note its extension against the metric scale. Students use their results to find the properties of the spring and compare them with theory and the manufacturer's details. For more advanced studies, students can also do tests on springs in series and parallel.

The user guide (included) gives full details of how to use the equipment, spring theory, experiments and typical results.

Supplied with the apparatus is a set of extension or 'tension' springs. The user can compare different spring rates with different spring sizes to fully understand the basic rules of spring design. Tension springs also have the extra 'initial tension' that other springs do not have which increases students' learning about spring properties.

Alternative Products:	Page
• Coil Spring (SM1000f)	171
• Spring Tester Kit (ES19)	27

Stiffness of Materials and Structures (TE16)

Bench-mounting apparatus enabling a variety of investigations into material stiffness

- Allows investigations into stiffness in bending of beams of different materials and cross-section
- Easy-to-use precision parts and instruments for accurate, repeatable and reliable results
- The standard TE16 kit includes test beams of different materials and cross-section
- Optional additional kits (TE16a and TE16b) available for experiments with different beam fixings (cantilever and encastre) and torsional stiffness experiments

EXPERIMENTS:

Standard TE16 kit:

- **Investigation of the stiffness in bending of different materials of the same cross-section (Young's modulus/stiffness)**
- **Investigation of the stiffness of a single material with different cross-section geometries (second moment of area, or I value)**

When used with the optional TE16a:

- **Experiments to find the deflected shape of a beam and bending of a beam clamped at one end (a cantilever)**
- **Comparison of a simply supported beam, a cantilever and an encastre beam**

When used with the optional TE16b:

- **Experiments to find the relationship between angular deflection and the dimensional and material properties of rods and tubes (torsional stiffness)**

A compact, bench-mounting frame that holds different parts for investigations into stiffness of materials. The standard TE16 includes parts for tests in bending of beams of different materials and cross-section. Optional additional kits allow investigations into different beam fixings and torsional stiffness.

The main part is a rigid metal frame. Supplied as standard are two adjustable knife edges that work as simple supports for test beams. A linear scale on the back panel of the frame allows accurate positioning of the knife edges.

The kit also includes weights, a magnetic dial gauge and a set of different beams. Also included in the standard TE16 kit is a vernier gauge for students to accurately measure dimensions of the specimens they test.

Students add different loads to the beams using weights on a hanger. The dial gauge indicator on the back panel accurately measures beam deflection.

The Additional Experimentation Kit (TE16a, available separately) enables further investigations into a simple cantilever, a propped cantilever and an encastre beam.

The Additional Torsion Testing Kit (TE16b, available separately) allows torsion tests on solid rods of different materials and a tube.

Recommended Ancillaries:

- Additional Experimentation Kit (TE16a)
- Additional Torsion Testing Kit (TE16b)

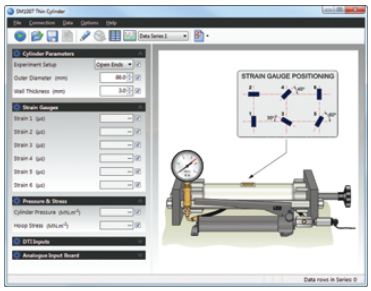
Alternative Products:

Thin Cylinder (SM1007)

Works with VDAS®

Bench-mounted machine to allow students to do stress and strain tests on a thin-walled cylinder

- Includes experiments to find Young's modulus and Poisson's ratio
- Closed-end and open-end conditions to allow circumferential or biaxial stress tests
- Includes built-in microprocessor-controlled display of strain measurements
- Self-contained, hand-operated hydraulic pressurising system for accurate pressure control



Screenshot of the optional VDAS® software

EXPERIMENTS:

Investigations into stresses and strains in a thin cylinder, to give students an understanding of:

- **Longitudinal stress, hoop (or circumferential) stress, radial stress and biaxial stress**
- **The behaviour of the cylinder under both open and closed-end conditions**
- **The use of strain gauges**
- **The stress strain relationship and value of Young's modulus for the cylinder material**
- **Indirect strain and stress**
- **The value of Poisson's ratio for the cylinder material**
- **The use of Mohr's circle to calculate the shear strain at any position in the cylinder**
- **The use of the 'superposition method' to find the principal strains**
- **The effect of the biaxial stress system**
- **Sources of error in their experiments**

TecQuipment's Thin Cylinder apparatus allows students to perform experiments that examine stress and strain in a thin-walled cylinder. It clearly shows the principles, theories and analytical techniques, and provides effective, practical support to studies.

A sturdy base contains all parts of the Thin Cylinder apparatus. This forms a compact product, ideal for use on a workbench.

The apparatus consists of a thin-walled aluminium cylinder, held in a robust frame. The frame holds the cylinder so that it is free to move along its axis. The cylinder contains oil. To stress the cylinder, students use the hydraulic hand-pump to pressurise the oil. Strain gauges on the cylinder surface measure strain, while a gauge and electronic sensor measure hydraulic pressure.

Students can measure strains with the cylinder in two 'end conditions':

- Open end: the cylinder has no axial load, so there is no direct axial stress.

  or

- Closed end: the cylinder has axial loads, so there is direct axial stress.

Continued on next page

Thin Cylinder (SM1007)
Continued from previous page

Students use a hand-wheel on the frame to set these end conditions.

To perform experiments, students choose either closed or open-end conditions. They set the gauges to zero and use the pump to pressurise the cylinder. They take readings at several stages while they increase the pressure. The results can be taken by hand using the in-built display and pressure gauge, and results plotted by hand. Alternatively, students can use TecQuipment's optional Versatile Data Acquisition System (VDAS®) to capture the data and plot the relevant graphs and export data. They then compare their results with calculations made using stress and strain theory.

A user guide is supplied with the Thin Cylinder apparatus. The guide includes full details of the equipment, detailed experiment procedures, theory and results.

For quick and reliable tests, TecQuipment can supply VDAS® which gives accurate real-time data capture, monitoring and display, calculation and charting of all important readings on a computer (computer not included).

Recommended Ancillary:	Page
• Versatile Data Acquisition System – Bench-mounted version (VDAS-B)	32

Alternative Product:	Page
• Thick Cylinder (SM1011)	160

TecQuipment Document Packs

Making it clear for the customer

We send document packs with all TecQuipment products* which contain:

- **Packing contents list** (PCL) – shows you what parts we pack with the product.
- **Test certificate** – shows you that we've thoroughly tested the product before we send it to you.
- **User guides*** and **safety information** – show you how to use the product safely and learn how it works.

Some packs also include **compact discs** (CD-ROMs) with TecQuipment software (e.g. VDAS®).

At TecQuipment we continually improve our user guides so they include pictures of the products, clear diagrams and plain English text. This helps you to understand the product more clearly. Where necessary, the guides include theory, suggested experiments and typical results to help students understand what the product teaches.

*Some products may not need user guides, as their details are already shown in their parent product, for example the optional pumps on the MFP103.

Diaphragm (SM1008)

Works with VDAS®

Bench-mounted machine to allow students to do stress, strain and deflection tests on a diaphragm

- Measurement of effect of pressure on surface profile of a diaphragm
- Measurement of circumferential and radial strains of a diaphragm under pressure
- Includes built-in microprocessor-controlled display of strain measurements
- Self-contained, hand-operated hydraulic pressurising system for accurate pressure control

EXPERIMENTS:

Experiments possible with this apparatus include the effect of pressure on:

- **Surface profile – the results are presented as a non-dimensional curve**
- **Radial and circumferential strains**
- **Radial and circumferential strain gradients across the diaphragm**

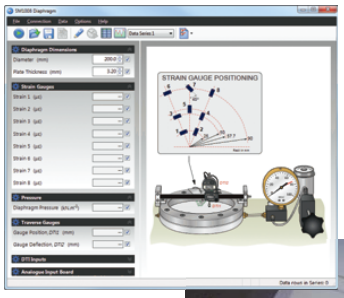
Experimental measurements are compared with theory. The student is encouraged to use their results to determine the accuracy of the location of the strain gauges.

The Diaphragm apparatus allows students to examine the effect of pressure on the surface profile of a diaphragm. They can also determine the distribution of circumferential and radial strains across its diameter.

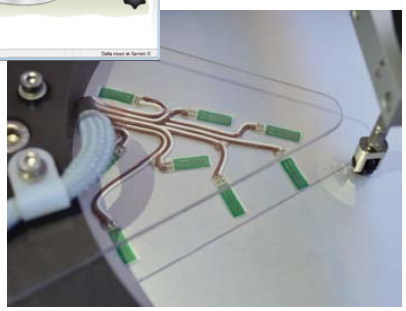
A sturdy base contains all parts of the Diaphragm apparatus. This forms a compact product, ideal for use on a workbench.

Two heavy flanges clamp the edge of the diaphragm to provide built-in edge conditions. The area directly under the diaphragm contains oil.

Eight strain gauges are cemented to the top surface of the diaphragm in various positions and at different radii. Each strain gauge circuit is a full bridge, with high-stability resistors. The signals from each strain gauge are shown on a digital display.



Screenshot of the optional VDAS® software



A digital dial gauge is fitted to a digital position indicator. The dial gauge can be traversed across the diaphragm to measure its surface profile. Both instruments can connect to TecQuipment's optional Versatile Data Acquisition System (VDAS®).

Students use a hydraulic pump to increase the oil pressure under the diaphragm. They record the strain readings and diaphragm profile at different pressures.

The results can be taken by hand using the in-built display and pressure gauge and results plotted by hand. Alternatively, the student can use VDAS® to capture the data and plot the relevant graphs and export data.

A user guide is supplied with the Diaphragm apparatus. The guide includes full details of the equipment, detailed experiment procedures, theory and results.

For quick and reliable tests, TecQuipment's optional VDAS® gives accurate real-time data capture, monitoring and display, calculation and charting of all important readings on a computer (computer not included).

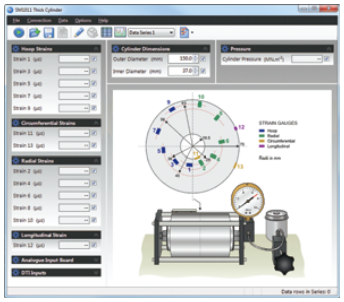
Recommended Ancillary:	Page
• Versatile Data Acquisition System – Bench-mounted version (VDAS-B)	32

Thick Cylinder (SM1011)

Works with VDAS®

Bench-mounted machine to allow students to do stress and strain tests on a thick-walled cylinder

- For comprehensive analysis of the stresses and strains in a thick-walled cylinder, under internal pressure
- Experiment results compared with Lamé predictions
- Includes built-in microprocessor-controlled display of strain measurements
- Self-contained, hand-operated hydraulic pressurising system for accurate pressure control



Screenshot of the optional VDAS® software

EXPERIMENTS:

- **Radial and hoop strains throughout the cylinder wall**
- **Radial and hoop stress distribution in the wall**
- **Longitudinal stress and strain at the outer surface**
- **Circumferential stress and strains at the inner and outer surfaces**
- **Comparison with Lamé predictions**
- **Principal stresses and maximum shear stress**
- **Appraisal of accuracy of location of strain gauges**

TecQuipment's Thick Cylinder apparatus allows students to examine radial and hoop stresses and strains in the wall of a thick cylinder. They can then compare experiment results with the theoretical Lamé predictions. It clearly shows the principles, theories and analytical techniques, and provides effective, practical support to studies.

A sturdy base contains all parts of the Thick Cylinder apparatus. This forms a compact product, ideal for use on a workbench.

The apparatus consists of a thick-walled aluminium cylinder, held in a robust frame. The cylinder is in two halves, cemented together. One face of the joint has an eccentric shallow groove that contains ten strain gauges at precise radii and orientation. These gauges measure the radial and hoop strains. Jointing cement fills the groove. Strain gauges on the inner and outer walls of the cylinder measure longitudinal and circumferential strains.

The cylinder contains oil. To stress the cylinder, students use a hydraulic hand-pump to pressurise the oil.

To perform experiments, students set the gauges to zero and use the pump to pressurise the cylinder. They take readings at several stages while increasing the pressure. The results can be taken by hand using the in-built display and pressure gauge and plotted by hand. Alternatively, they can use TecQuipment's optional Versatile Data Acquisition System (VDAS®) to capture the data and plot the relevant graphs and export data. They then compare their results with calculations made using theory.

A user guide is supplied with the Thick Cylinder apparatus. The guide includes full details of the equipment, detailed experiment procedures, theory and results.

For quick and reliable tests, TecQuipment's optional VDAS® gives accurate real-time data capture, monitoring and display, calculation and charting of all important readings on a computer (computer not included).

Recommended Ancillary:	Page
• Versatile Data Acquisition System – Bench-mounted version (VDAS-B)	32

Alternative Product:	Page
• Thin Cylinder (SM1007)	157

Strain Gauge Trainer (SM1009)

Works with VDAS®

Shows and compares how resistance strain gauges work, and how they measure strains in different structures

- Clear layout with printed graphics to help students understand how strain gauges work
- Includes electronic strain display to show all readings, and automatically calculates strain
- Fully open bridge connection with dummy resistors to allow quarter, half and full-bridge connection to show students how strain bridge connections work
- Uses strain gauges on three different, popular structures for realistic experiments

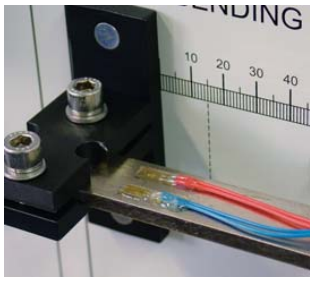
EXPERIMENTS:

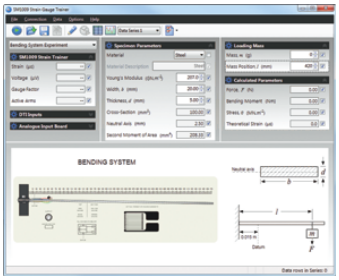
- **Introduction to the equipment and the different bridge connections (quarter, half and full-bridge)**
- **Strains and stresses in a bending system**
- **Strains and stresses in a torsion system**
- **Strains and stresses in a tension system, Poisson's ratio and Young's modulus**
- **Tensile strains and stresses in different materials (needs optional tensile specimens) and comparison of Poisson's ratio and Young's modulus**
- **Comparison of different strain measurement systems and how they could measure force**

The compact Strain Gauge Trainer fits on a bench or desktop. It contains everything needed to show students how resistance strain gauges work on three different structures. It is ideal for groups of two or more students to do experiments and for classroom demonstrations.

Students use the small set of masses to load the bending and torsion systems, and the large set of masses to load the tension system. They use theory and known dimensions to calculate the stresses and strains and compare them with the strains measured by the strain gauges. Students can also connect and compare the performance of quarter, half and full-bridge strain gauge connections for each structure.

The bending system uses gauges to measure direct tensile and compression strain. The torsion system shows the use of shear/torque strain gauges. The tension system shows the use of two gauges at right angles in a 'Tee' rosette.





Screenshot of the optional VDAS® software

For more tests with the tension system, TecQuipment can supply optional tension test specimens made of different metals. Students then use their experience from other experiments to calculate and test strains in the different metals and find their values of Young's modulus. The tension system also finds and proves Poisson's ratio for tensile and compressive strains in metals.

The strain display includes a set of high-accuracy dummy strain gauge resistors (plugs) and controls. These allow the student to connect the strain gauges on the structures as quarter, half or full-bridge networks. The strain display works with and gives correct readings for all bridge connections and different gauge factors. An extra setting on the strain display works with the tension system to prove Poisson's ratio. The strain display has a socket for connection to TecQuipment's optional Versatile Data Acquisition System (VDAS®).

The trainer shows students different types of strain gauges. A clear, hard-wearing coating protects each gauge from

Continued on next page

Strain Gauge Trainer (SM1009)
Continued from previous page

accidental damage and the environment. Enlarged mimic diagrams on the back plate of the trainer show students what each gauge looks like, how it connects and how it fits on each structure. This helps to show students how it works.

For quick and reliable experiment results, TecQuipment's optional VDAS® gives accurate real-time data capture, monitoring and display, calculation and charting of all the important readings on a computer (computer not included).

The user guide (supplied) shows how to use the equipment and includes theory and experiments.

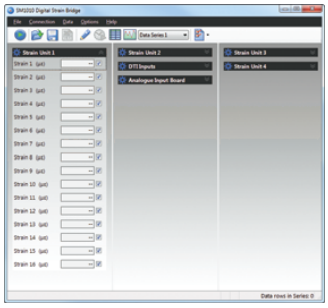
Recommended Ancillaries: Page

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 32
- Optional Tension Specimens (SM1009a) – Aluminium, brass and copper

Digital Strain Display (SM1010)

Works with VDAS®

A 16-channel instrument that connects to industry-standard strain gauges to give direct readings of strain



Screenshot of the optional VDAS® software

- Direct connections for half and full strain bridge connections, with internal 'make-up' resistors.
- Supplied with cable, self-locking connectors and a crimp tool to reduce connection problems
- Fully programmable to match most types of strain gauges and connections
- Ideal for use with TecQuipment's Strain Gauge Kit (E19)

For use with most types of metal-foil strain gauges, the Digital Strain Display connects to most types of strain bridge connections to give direct readings of strain.

The Digital Strain Display accepts up to 16 channels from strain gauges connected in quarter, half or full bridge. The display is fully programmable to match the strain gauges and their bridge connections. The display includes precision internal 'make-up' resistors to work with halfbridge connections if needed.

For quarter bridge connection you need suitable external make-up resistors or dummy gauges (not supplied). Two channels include additional individually adjusted dynamic outputs. They can connect to suitable instruments, such as an oscilloscope or a chart recorder (not supplied) for measurement of transient strains.

Supplied with the Digital Strain Display is a reel of cable and connectors to fit the input sockets of the Digital Strain Display. Also supplied is a tool that crimps the connectors to the cable. The connectors are self-locking, reliable, secure and need no soldering.

For quick and reliable tests, TecQuipment's optional Versatile Data Acquisition System (VDAS®) gives accurate real-time data capture, monitoring and display, calculation and charting of all important readings on a computer (computer not supplied).

The Digital Strain Display includes a user guide with full description, installation and operating instructions.

Recommended Ancillary: Page

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 32

Ancillary for: Page

- Strain Gauge Kit (E19) 163

Strain Gauge Kit (E19)

Selection of resistance strain gauges and necessary accessories and consumable materials – for use with TecQuipment's SM1010 Digital Strain Display

- All expendable items required for cementing gauges included
- Reduced risk of spillage of chemicals
- Refills available (E19a)
- Step-by-step instructions supplied

This kit contains a selection of resistance strain gauges, together with all the necessary accessories associated with their application. Each kit is supplied in a PVC carrying case.

The adhesive included is a cyanoacrylate single-agent pressure-sensitive type, and therefore the complete operation of deciding where the gauge is to be placed to taking strain readings can be completed in a few minutes.

Also included are the appropriate cleaning agents, terminal strips and sundry items such as tissues, pressure-sensitive tape etc.

Primarily intended as a convenient form of general-purpose kit, it will prove particularly valuable to:

- the non-specialist, who occasionally applies strain gauge techniques but has not acquired the experience to specify individual items with confidence;
- the specialist who is required to perform strain analysis outside the laboratory at short notice; and
- teaching staff in educational establishments required to demonstrate the technique and to construct experimental apparatus.

Need more information?

For the latest news, updates and product information visit our website at:

www.tecquipment.com

Strain Gauge Instrumentation

TecQuipment offers the following instrumentation for monitoring and display of strain:

- Digital Strain Display (SM1010) – see page 162

Contents

30 Bonded resistance strain gauges
1 Mounting panel
1 Bottle cyanoacrylate adhesive
1 Bottle solvent
1 4H pencil and 1 ballpoint pen
1 Bottle acid cleaner and 1 bottle neutralising cleaner
1 Pack adhesive rubber strips
1 Coil brown wire and 1 coil green wire
1 Set terminal tags
1 Pair tweezers
1 Soldering iron and 1 coil solder
1 Pair scissors
1 Magnifier
1 Roll clear adhesive tape
2 Dissecting needles
1 Pack tissues
1 Pair wire strippers
1 Pack cotton applicators
1 Pack abrasive paper
1 Instruction manual

The quantities of all items are adequate for the installation of all the strain gauges.

Recommended Ancillaries:	Page
• Digital Strain Display (SM1010)	162
• Refill Kit for E19 (E19a)	

Torsion Testing Machine – 30 Nm (SM1001)

Works with VDAS®

Bench-mounted machine to allow students to do torsion tests on different materials

- Suitable for destructive tests on specimens
- Forward and reverse loading
- Wide range of test specimens
- Optional Torsiometer (SM1001a) available for tests which need increased accuracy

EXPERIMENTS:

- **Determination of modulus of rigidity (shear modulus) and yield strength (when used with the optional torsiometer)**
- **Determination of upper and lower yield stresses for normalised steel specimens**
- **Reversed torsion tests to demonstrate the Bauschinger effect and the effects of residual body and textural stresses on torsional strength**
- **Comparison of the different elastic and plastic properties of materials (optional specimens required)**

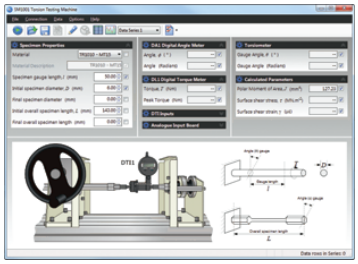
The Torsion Testing Machine is a compact machine, ideal for classroom demonstrations and for safe use by small groups of students. Its frame is a rigid, precision-engineered alloy box-section, supported at each end by adjustable feet. It carries two main parts:

- a 'strain head' at one end, and
- a torque reaction and measurement system at the other.

The specimens fit between the strain head and the torque reaction and measurement system.

The strain head is a 60:1 worm drive reduction gearbox, mounted on a platform. The platform can be moved and locked to any point along the frame. To apply torque, students turn a handle at the input of the gearbox. A keyway allows the output shaft of the gearbox to slide freely along its length. This allows for any change in length of the specimen during the tests and for easy insertion of specimens.

An accurate encoder measures the strain (angular movement) at the strain head. The encoder has a digital display and can connect to TecQuipment's Versatile Data Acquisition System (VDAS®).



Screenshot of the optional VDAS® software

The torque reaction and measurement system includes a torsion shaft supported by bearings. The shaft reacts on a strain-gauged load cell. A digital display shows the force measured by the load cell. The display can connect to VDAS®.

Hexagonal drive sockets hold the test specimens. The sockets fit on the gearbox output shaft and the torsion shaft. TecQuipment supplies two different sizes of drive sockets.

For safety, a clear guard protects the user when they perform destructive tests on standard-size specimens.

For increased strain measurement accuracy, use the optional Torsiometer (SM1001a). The increased accuracy is useful to help find the modulus of rigidity (shear modulus). The torsiometer has a digital display of angular movement, calibrated to the strain angle (in radians). The torsiometer can connect to VDAS®.

Recommended Ancillaries:

	Page
• Torsion Test Specimens (TR)	175
• Versatile Data Acquisition System – Bench-mounted version (VDAS-B)	32
• Torsiometer (SM1001a) – Mechanical torsiometer for use with 6 mm diameter specimens in both the elastic and plastic regions	

Alternative Products:

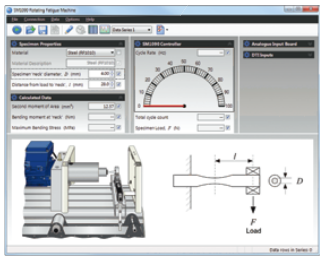
	Page
• Additional Torsion Testing Kit (TE16b)	156
• Torsion of Circular Sections (STR6)	205
• Torsion of Circular Sections Kit (ES5)	13

Rotating Fatigue Machine (SM1090)

Works with VDAS®

Demonstrates the failure of materials when subjected to an alternating stress

- Demonstrates clearly both high and low cycle fatigue
- Adjustable 'dead weight' and load cell system – to apply and measure a consistent and accurate load on the test specimens
- Automatic switch stops the experiment when the specimen breaks – lets the equipment run unattended
- Includes tools and two sets of specimens of different metals



Screenshot of the optional VDAS® software

EXPERIMENTS:

The user guide includes suggested experiments that show:

- **Low and high cycle fatigue**
- **How to create and use Wohler (S-N) curves for various materials**
- **Comparison of fatigue properties of various materials**

This machine demonstrates the fatigue failure of materials when subject to alternating stresses. Based on Wohler's design, it uses a motor to rotate a circular cantilever specimen with a load at its free end.

It is in two parts: a robust main unit, and a separate control and instrumentation unit. A variable-speed drive controls the motor to allow safe and gradual increase of the cycle rate. The motor turns a compliant coupling and a precision shaft held in sturdy bearings. A collet-type chuck on the end of the shaft grips the specimen with reliable and accurate concentricity. This reduces set up time and unwanted vibration.

The specimens have a special design that creates a point of maximum stress at their midpoint rather than at their ends. This gives a definite point of failure and avoids unwanted stress concentrations.

A gimbal-mounted, self-aligning bearing holds the 'free end' of the specimen. The gimbal assembly links to a short load arm. This applies a purely vertical load even when the specimen deflects under load. A load cell links the short load arm to a longer load arm. The longer load arm has an integral moveable dead weight that sets the load. The load cell measures the load and an electronic sensor measures shaft rotation.

The separate control and instrumentation unit shows the load, speed (cycle rate) and the number of cycles. A switch cuts power to the drive motor when the specimen fails, stopping the test. This freezes the cycle display at failure to record the result, even without the operator being present. Unlike some designs, the mechanism shuts off the motor only when the specimen actually breaks (not when the specimen is near to failure).

A removable clear guard covers the rotating parts. It has an interlock switch to stop the motor if you remove the guard.

The machine includes aluminium and steel specimens and tools to fit and remove them. TecQuipment can also supply extra specimens to work with this machine. The base of the main unit includes a handy storage area to store the tools and specimens when not in use.

The control and instrumentation unit connects to TecQuipment's Versatile Data Acquisition System (VDAS®). This gives accurate real-time data capture, monitoring and display, calculation and charting of all important readings on a computer (computer not included). This may allow you to use a networked computer and remotely monitor your tests. This could be especially useful during tests of long duration.

Note: You must contact your local computer engineer to set up suitable software (not supplied) for remote monitoring.

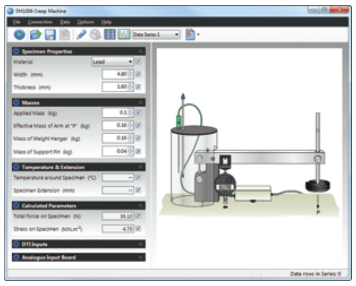
Recommended Ancillaries:

	Page
• Versatile Data Acquisition System – Bench-mounted version (VDAS-B)	32
• Additional specimens: RF1010 (steel), RF1020 (aluminium) and RF1030 (brass)	175

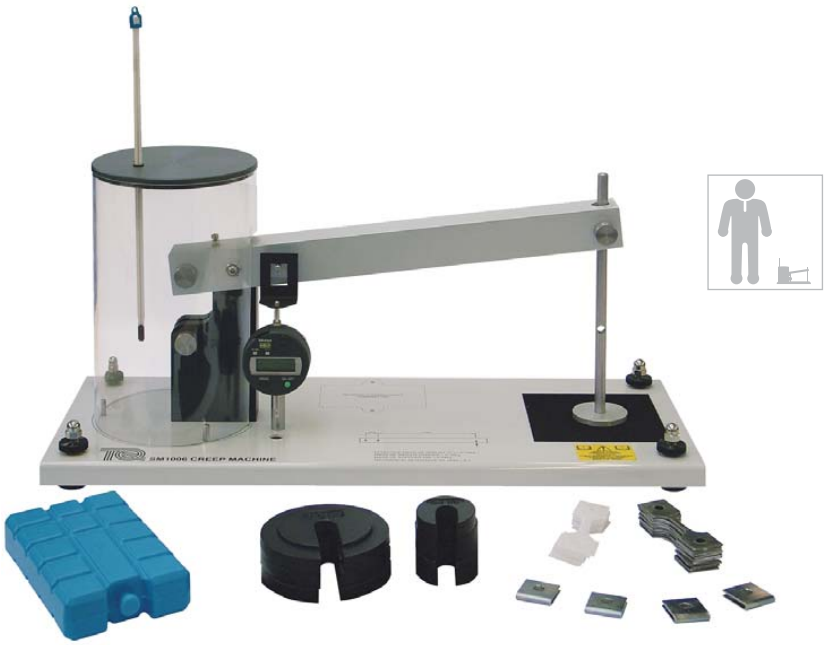
Creep Machine (SM1006)

Works with VDAS®

Bench-mounted machine which demonstrates the phenomenon of creep under different conditions and in different materials



Screenshot of the optional VDAS® software



- Demonstrates the three phases of creep
- Demonstrates effect of temperature on creep
- Supplied with weights and test specimens
- Inexpensive specimens readily available in lead and plastics

EXPERIMENTS:

An extensive range of experiments may be carried out with this apparatus, including:

- **The normal breaking load of a specimen over a fixed time**
- **Relationship between breaking load and time for lead specimens**
- **Time extension curves to show the three phases of creep (primary, secondary and tertiary)**
- **The effect of temperature on the creep rate of specimens**
- **Creep recovery**

This simple machine uses specimens of lead and different plastics which creep significantly at room temperature and under low loads.

Its main part is a simple lever (load beam) with a mechanical advantage of 8:1. The load beam gives a steady and uniform tensile load. A digital indicator measures the extension (creep) of the specimen under load. To ensure correct loading of the specimen, the load beam has a ball-bearing pivot.

To apply a load, students add weights to a weight hanger and measure time and the creep. For effect-of-temperature tests, the student freezes or heats a cool-pack and places it next to the specimen. They then fit the transparent enclosure to preserve the temperature around the specimen during the test.

Students may record and plot results by hand, using a timer (not supplied) and the readings from the digital indicator and thermometer. Alternatively, the student can use TecQuipment's optional Versatile Data Acquisition System (VDAS®) to capture the data, plot charts and export data.

A user guide is supplied with the Creep Machine. The guide includes full details of the equipment, detailed experiment procedures, theory and results.

For quick and reliable tests, TecQuipment can supply VDAS® which gives accurate real-time data capture, monitoring and display, calculation and charting of all important readings on a computer (computer not included).

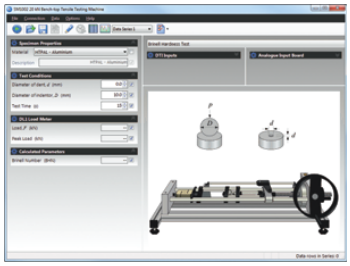
Recommended Ancillaries:

	Page
• Creep Test Specimens (CP)	175
• Versatile Data Acquisition System – Bench-mounted version (VDAS-B)	32

Bench-Top Tensile Testing Machine (SM1002)

Works with VDAS®

A laboratory-scale, hand-driven bench-top tensile testing machine, 20 kN capacity



Screenshot of the optional VDAS® software

Optional Extensometer (SM1002a) fitted to TL specimen

FEATURES:		BENEFITS:
Simple hand-operated load application	→	**For safe and easy operation that minimises risks to students**
Supplied with chucks for standard 20 mm² specimens	→	Compatible with older Hounsfield specimens and chucks – cost saving
Optional Extensometer (SM1002a)	→	**For tests of Young's Modulus**
Optional Compression Cage and Brinell Test Set (SM1002b and SM1002c)	→	Combines hardness testing with tensile testing for flexibility and cost saving

EXPERIMENTS :

- **Tensile tests up to 20 kN on specimens made of different metals, to find material characteristics such as upper and lower yield strengths, tensile strength and overall extension.**
- **Tests of Young's modulus (*E*) for the specimen material (needs SM1002a and TL specimens).**

A small-scale machine that fits on a bench-top and allows simple tensile tests of metal specimens up to a maximum load of 20 kN. This machine is a good partner to TecQuipment's Torsion Testing Machine (SM1001).

The machine has an extruded aluminium bed that holds the load application and load measuring mechanisms. 'Tie bars' add rigidity to the structure.

The load application mechanism includes a hand-driven worm-and-wheel gearbox, driving a lead screw with approximately 400 mm of travel. The mechanism uses ball races and self-aligning ball thrust races in the direction of loading. These low-friction bearings, with the large handwheel, allow the user to apply maximum load with minimum effort. They also give smooth and progressive operation, necessary to help the user apply a steady strain rate for best results.

The unit also has a smaller 'quick advance' handwheel that allows the user to set the distance between the chucks simply and quickly before each test.

The load measuring mechanism is a strain-gauged load cell that connects to a microprocessor-controlled digital display.

Continued on next page

Bench-Top Tensile Testing Machine (SM1002)
Continued from previous page

The load display unit has a 'peak hold' function to register the maximum load before the specimen breaks.

A sliding digital display measures the tensile displacement (extension) over the entire movement. An optional precision extensometer (SM1002a) is available for increased strain measurement accuracy to allow measurements of the material's Young's modulus.

Both the load, extension and extensometer displays can connect to TecQuipment's optional VDAS®.

The tensile specimens mount between the load application mechanism and load cell, in collet chucks via ball-jointed spigots. This ensures purely axial loading.

The equipment includes collet chucks to fit both the long and short style of TecQuipment's 20 mm^2 specimens.

TecQuipment supplies a starter set of tensile specimens with the machine, made of two different carbon steel alloys (each in their 'as drawn' and their annealed condition), brass and aluminium. TecQuipment can also supply extra specimens (contact our sales team for details). The user guide includes drawings to allow the user to make their own specimens, if needed.

For quick and reliable tests, TecQuipment's optional VDAS® gives accurate real-time data capture, monitoring and display, calculation and charting of all important readings on a computer (computer not included).

Available Experiment Module: Page

- Brinell Test Set (SM1002c) 168

Recommended Ancillaries: Page

- Versatile Data Acquisition System – Bench-mounted version (VDAS-B) 32
- Extra TS and TL specimens 176
- Extensometer (SM1002a)

Alternative Products: Page

- Universal Testing Machine (SM1000) 169
- Materials Laboratory with Data Capture (MF40) 173
- Tensile Tester Kit (ES6) 14

Brinell Hardness Test Set (SM1002c)

Fits in the Compression Cage (SM1002b) of the Bench Top Tensile Testing Machine (SM1002) for Brinell hardness tests

- Fits in TecQuipment's Bench Top Tensile Testing Machine (SM1002) for Brinell hardness tests of different materials
- Includes specimens of different basic engineering materials
- Includes magnifier with graticule to accurately measure the indentation
- Works with TecQuipment's hardness test specimens (HTP)

The optional Compression Cage (SM1002b) fits into the tensile test area, adapting the machine for experiments that need a compressive load.

EXPERIMENTS:

- **Brinell hardness tests of different basic engineering materials**

An extra experiment module for the test machine, parts of this test set fit into the optional Compression Cage (SM1002b) for simple Brinell hardness tests. The set includes a magnifier with graticule (measurement scale) and test specimens made of basic engineering materials.

An essential ancillary to the Brinell Hardness Test Set, this compression cage fits into the tensile test area of the Bench-Top Tensile Testing Machine (SM1002), adapting the machine for experiments that need a compressive load.

Essential Base Unit: Page

- Bench-Top Tensile Testing Machine (SM1002) 167

Essential Ancillary:

- Compression Cage (SM1002b)

Recommended Ancillary: Page

- Extra hardness specimens (HTP) 176

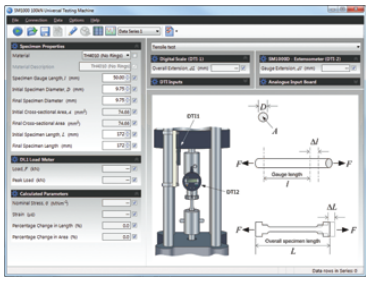
Alternative Products: Page

- Materials Laboratory with Data Capture (MF40) 173
- Brinell Indenter (SM1000e) 170

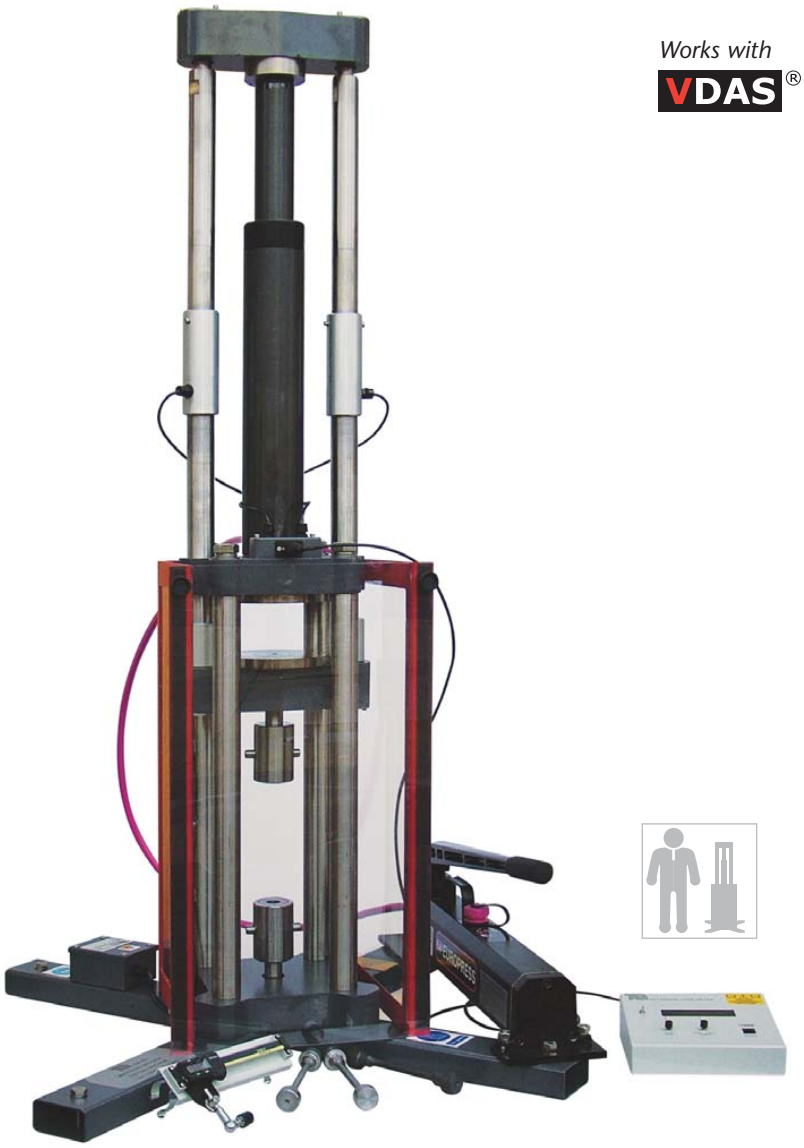
Universal Testing Machine (SM1000)

Works with VDAS®

A compact machine for compressive and tensile tests on different materials and structures



Screenshot of the optional VDAS® software



FEATURES:		BENEFITS:
Finds tensile properties and compressive properties of many materials and structures	→	**Provides an excellent introduction to the field of materials testing**
Includes set of tensile test specimens of different grades of steel for comparison experiments	→	Self-contained package enables basic testing 'out of the box'
TecQuipment can supply range of optional parts for experiments in beam deflection, hardness testing and spring rate and deflection	→	**Allows more advanced topics to be explored**
Optional Extensometer (SM1000d)	→	For accurate tests of Young's modulus of tensile specimens

EXPERIMENTS:

- **Tensile tests on different materials**
- **Compression tests on different materials**

The Universal Testing Machine is ideal for classroom demonstrations and for safe use by small groups of students. It fits onto any suitable strong desk or bench top, but TecQuipment offers the optional Support Table and Cupboard (SM1000a).

A steel frame with four columns supports a hydraulic ram. The ram pushes up a loading platform. The area above the loading platform is for compression tests on a wide range of materials such as wood, brick and mortar. The space below the platform is for tensile tests.

A high-impact strength clear-plastic guard protects the user during tests.

Continued on next page

Universal Testing Machine (SM1000)
Continued from previous page

During tests, force sensors measure the load applied by the ram. A digital load meter shows the real-time force and stores the peak force. A digital displacement indicator measures and displays the vertical movement of the loading platform or part of the structure under test.

Students use the force and the dimensions of the part under test to find the applied stress. They also use the vertical displacement to find the strain.

For accurate measurements of the small changes in length of a specimen tested in its elastic region, TecQuipment offers the optional Extensometer (SM1000d). Students use this to find the Young's modulus of a tensile test specimen.

Students can use the Universal Testing Machine to test many materials, engineering parts and structures, but TecQuipment also offers optional parts for the machine. These allow students to do Brinell hardness tests on materials, and tests on coil springs, leaf springs and beams.

Included with the Universal Testing Machine is a set of different grade steel tensile test specimens. These allow students to compare the tensile qualities of steel in its 'as drawn' state and 'normalised' steel. You can order extra specimens, and the user guide includes a diagram to help you create your own tensile test specimens from suitable materials.

For quick and reliable tests, TecQuipment can supply the optional Versatile Data Acquisition System (VDAS®). This gives accurate real-time data capture, monitoring and display, calculation and charting of all important readings on a computer (computer not included).

Available Experiment Modules:	Page
• Brinell Indenter (SM1000e)	170
• Coil Spring (SM1000f)	171
• Beam and Leaf Spring (SM1000g)	172

Recommended Ancillaries:	Page
• Bench-mounted version of the Versatile Data Acquisition System (VDAS-B)	32
• Support Table and Cupboard (SM1000a) – A steel-frame table with a pre-drilled work-top to accept the Universal Testing Machine. Includes a cupboard underneath.	
• Extensometer (SM1000d) – A precision sliding gauge with a digital indicator	
• Tensile test (TH) specimens	175

Alternative Products:	Page
• Materials Laboratory with Data Capture (MF40)	173
• Bench-Top Tensile Testing Machine (SM1002)	167
• Tensile Tester Kit (ES6)	14

Brinell Indenter (SM1000e)

Fits in the Universal Testing Machine (SM1000) for Brinell hardness tests

- Fits in the compressive test area of TecQuipment's Universal Testing Machine (SM1000) for Brinell hardness tests of different materials
- Includes magnifier with graticule to accurately measure the indentation
- Includes specimens of different basic engineering materials
- Works with TecQuipment's hardness test specimens (HTP)

EXPERIMENTS:

- **Brinell hardness tests of different basic engineering materials**

The Brinell Indenter (SM1000e) fits in the area above the loading platform of TecQuipment's Universal Testing Machine (SM1000).

The indenter uses a hardened steel ball in a holder that pushes down onto a suitable test specimen and creates a small dent. The hand-held magnifier has a measurement scale or 'graticule' for accurate measurement of the dent. Using the dimensions of the dent, the indenter ball and the force applied gives the Brinell hardness number of the specimen material. TecQuipment includes a set of their hardness test specimens (HTP) with this product.

Essential Base Unit:	Page
• Universal Testing Machine (SM1000)	169

Recommended Ancillary:	Page
• Extra hardness specimens (HTP)	176

Alternative Products:	Page
• Materials Laboratory with Data Capture (MF40)	173
• Brinell Hardness Test Set (SM1002c)	168

Coil Spring (SM1000f)

Fits in the Universal Testing Machine (SM1000) for compression spring tests on a coiled spring

- Fits in the compressive test area of TecQuipment's Universal Testing Machine for tests on a coiled compression spring
- Includes fittings to hold the spring securely
- Shows Hooke's Law and how to find 'spring rate' by experiment
- Heavy-duty coil spring for a more practical experience

EXPERIMENTS:

- **Compression tests on a coiled spring**

The Coil Spring (SM1000f) fits in the area above the loading platform of TecQuipment's Universal Testing Machine (SM1000).

The spring is of the same heavy-duty design as those used in vehicle suspensions. This give students a better understanding of a 'real world' engineering component.

Two metal 'bosses' hold the spring securely in the testing machine, which compresses the spring. The digital indicator of the testing machine measures the change in spring length (displacement) for a given change in applied force. Students use the displacement and force values to find the actual spring rate and compare it with the theoretical value, based on the spring dimensions. The experiment helps to show Hooke's Law for the relationship between force and displacement on a spring.

Essential Base Unit:	Page
• Universal Testing Machine (SM1000)	169

Alternative Products:	Page
• Spring Testing Apparatus (SM110)	155
• Spring Tester Kit (ES19)	27

Have you also seen our Engineering Science range?

Designed by our engineers for future engineers is our versatile Engineering Science range covering the following areas:

- **Materials testing**
- **Vibration**
- **Mechanisms**
- **Forces and moments**
- **Simple machines**
- **Friction**

The ES range is a modern, high-quality, low-cost modular system which requires minimum maintenance.

See **Section 1** for full details.

Tensile Tester Kit (ES6)

Beam and Leaf Spring (SM1000g)

Fits in the Universal Testing Machine (SM1000) for tests on bending beams and a leaf spring

- Includes two different test beams – flat steel and channel section aluminium
- Knife-edge supports for the beams, and rollers for the leaf spring for accurate results
- Includes tools needed to fit the parts to the testing machine
- Heavy-duty leaf spring for a more practical experience

EXPERIMENTS:

- **Beam bending tests on beams of different shape, material and length**
- **Spring rate tests on a leaf spring**

The Beam and Leaf Spring (SM1000g) parts fit into the compressive test area of TecQuipment's Universal Testing Machine (SM1000).

The heavy-duty box-section support beam works as the main support underneath the test beams and the leaf spring during the tests.

The spring is of the same heavy-duty design as those used in vehicle suspensions. This give students a better understanding of a 'real world' engineering component.

For beam tests, the test beam rests across two knife-edge supports fixed to the support beam. This forms a 'simply supported beam'. The testing machine applies a compressive bending force and measures the beam deflection. Students may adjust the position of the knife-edge supports to set the length of beam under test.

For leaf spring tests, the spring rests on its rollers on two flat supports fixed to the support beam. Again, the testing machine applies a compressive force and measures the leaf spring deflection.

For the beams, students use the deflection and force values to find the relationship between force and deflection for the different beams. They can then compare the results with those predicted by theory.

For the leaf spring, students use the deflection and force values to find actual leaf 'spring rate'.

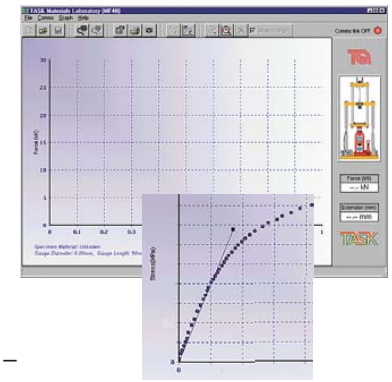
TecQuipment includes the spanner and hexagon tools needed to fix the parts to the testing machine.

Essential Base Unit:	Page
• Universal Testing Machine (SM1000)	169

Alternative Products:	Page
• Beam Apparatus (SM1004)	178
• Deflection of Beams and Cantilevers (STR4)	203
• Deflection of Beams Kit (ES4)	12
• Continuous and Indeterminate Beams (STR13)	212
• Stiffness of Materials and Structures (TE16)	156
• Plastic Bending of Beams (STR15)	215

Materials Laboratory with Data Capture (MF40)

A hydraulic machine with electronic instruments and software, it tests the hardness and tensile properties of materials



- For Brinell Hardness tests and tensile tests of materials
- Includes an Extensometer for accurate tensile test results
- Supplied with a set of test specimens – additional test specimens available separately
- Includes software to automatically record results and produce charts (you need a suitable computer – not supplied)

EXPERIMENTS:

- **Tensile testing to destruction and Brinell hardness testing of various specimens**
- **Modulus of elasticity**
- **Yield stress**
- **Ultimate tensile stress**
- **Percentage elongation**
- **Brinell hardness test and hardness number derivation**

A hydraulic tensile and Brinell hardness testing machine. The machine tests any suitably shaped specimens of various materials. The material must not exceed the maximum strength or hardness limits specified. TecQuipment can also supply additional low-cost test specimens.

The main parts of the equipment are a:

- load frame,
- display unit with a digital display of force (load),
- ball indenter for Brinell hardness tests, and an
- extensometer with a digital display for tensile tests.

The load frame bolts to a bench (template included). To apply loads, students pump a handle connected to a hydraulic ram. The display unit shows force and works as an interface to send data to a suitable computer (computer not included). The extensometer has a digital display of extension and connects to the display unit for data capture.

Included is TecQuipment's MF40 software to allow students to use the equipment with a suitable computer (computer not included). The software records the data and produces detailed graphs of force against elongation and stress against strain.

Typically, students will work in small groups, with one student working the hydraulic ram, while others note readings or use the software.

To do a hardness test, students put a hardness specimen on the platen and lock the guard in position. They apply a suitable load with the ball indentor and measure the impression in the specimen. They then use an equation to calculate Brinell hardness.

To do a tensile test, students fit a specimen to the machine, attach the extensometer to the specimen, and zero the display unit and extensometer. They then lock the guard and apply loads, taking various readings, until the specimen breaks. Students use the results to find the ultimate tensile strength, the proof stress and Young's modulus of the material.

The Materials Laboratory comes with a teacher guide that shows experiment methods, information, references and tips. A student guide shows students how to do the experiments.

Recommended Ancillaries:

Page

- Computer (not supplied by TecQuipment)
- Additional tensile test specimens of different materials: 176

  ML1MS – Mild Steel
  ML2CS – Carbon Steel
  ML3SS – Stainless Steel
  ML4AL – Aluminium
  ML5BR – Brass
- Hardness test specimens of different materials: 176

  HTPAL – Aluminium
  HTPBR – Brass
  HTPMS – Mild Steel
  HTPNY – Nylon

Alternative Products:

Page

- Universal Testing Machine (SM1000) 169
- Bench-top Tensile Testing Machine (SM1002) 167
- Tensile Tester Kit (ES6) 14

Energy Absorbed at Fracture (TE15)

Compact, bench-mounting apparatus for introducing students to impact testing

- Many safety features including enclosure of all moving parts and mechanically interlocked guard
- Allows investigations into the resistance of materials to crack propagation
- Includes digital display of energy absorbed at impact, and angular position before and after impact
- Visually effective, interesting and motivating experiments

EXPERIMENTS:

- **Introduction to the principles of common impact testing methods, such as Izod and Charpy tests**
- **Investigations into the resistance of materials to crack propagation**

A small-scale, bench-mounting, notched-bar impact tester. The equipment provides an effective, convenient and safe introduction to the principles of common impact testing techniques, enabling investigations into the resistance of materials to crack propagation.

The apparatus consists of a main unit, an instrumentation unit and a power supply. The main unit consists of a pendulum supported in a rigid frame by low-friction bearings. The pivot arrangement includes an angular encoder to measure the angular position of the pendulum over its range of movement. The apparatus is fully enclosed with an interlocked guard covering all moving parts. Adjustable feet on the base of the unit enable accurate levelling of the equipment.

To perform a test, students raise the pendulum to the start position, where it is held by an electromagnet. They then clamp a specimen in a holder, which safely slots into the base of the frame at the lowest point of the pendulum swing. The separate instrumentation unit controls the release of the pendulum and measures and displays its angular position before and after the impact. The unit also directly displays energy absorbed by the impact in Joules.

The equipment is designed to fracture plain carbon steel, brass, copper or aluminium specimens. Lengths of each of these materials are included, along with a hacksaw and cutting jig to enable cost-effective and convenient manufacture of test specimens. The cutting jig ensures repeatability of the notch position in each specimen and therefore valid comparisons of test results.

The equipment is supplied with a comprehensive user guide which includes equipment description and technical specification, installation and assembly, background theory, experiment procedures with results, and maintenance instructions.

Creep Test Specimens (CP)

Creep test specimens of different materials for use with TecQuipment's Creep Machine (SM106 or SM1006)

CP1010: Lead, to British Standard BS1178

CP1020: Polypropylene

CP1025: Nylon 66 (unfilled)

CP1030: Unplasticised PVC

Tensile Test Specimens (TH)

Tensile test specimens of different grade steel for use with TecQuipment's Universal Testing Machine (SM100 or SM1000)

TH4010: 0.1% Carbon Steel. As drawn. To British Standard Specification 230M07. Has no identity rings.

TH4015: 0.1% Carbon Steel. Normalised at 900°C. To British Standard Specification 230M07. Has one identity ring.

TH4035: 0.4% Carbon Steel. Normalised at 860°C. To British Standard Specification 212A42. Has two identity rings.

Rotating Fatigue Specimens (RF)

Fatigue test specimens of different metals for use with TecQuipment's Rotating Fatigue Machine (SM1090)

RF1010: Mild Steel

RF1020: Aluminium

RF1030: Brass

Torsion Test Specimens (TR)

Torsion test specimens of different metals for use with TecQuipment's Torsion Testing Machine (SM1 or SM1001)

TR1010: 0.1% Carbon Steel. As drawn. To British Standard Specification 230M07. No grooves.

TR1011: 0.1% Carbon Steel. Normalised at 900°C. To British Standard Specification 230M07. 1 groove.

TR1020: 0.4% Carbon Steel. As drawn. To British Standard Specification 212A42. 2 grooves.

TR1021: 0.4% Carbon Steel. Normalised at 860°C. To British Standard Specification 212A42. 3 grooves.

TR1040: Half-hard Brass. 60% Copper, 40% Zinc. To British Standard Specification CZ121. No grooves.

TR1050: Cast iron. Grade 260. To British Standard BS1452. 4 grooves.

Always here to help you

Whether you have a technical enquiry, need spare parts or support material you can contact our Customer Care team at:

customer.care@tecquipment.com

Tensile Test Specimens (TL and TS)

Long (TL) and short (TS) tensile test specimens of different metals for use with TecQuipment's Tensile Testing Machine (SM1002). Will also fit Hounsfield or Monsanto tensometer.

TL1010 and TS1010: 0.1% Carbon Steel. As drawn. To British Standard Specification 220M07 or 230M07.

TL1011 and TS1011: 0.1% Carbon Steel. Normalised at 900°C. To British Standard Specification 220M07 or 230M07.

TL1020 and TS1020: 0.4% Carbon Steel. As drawn. To British Standard Specification 080M040.

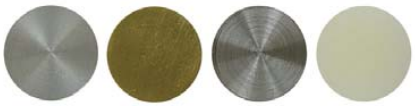
TL1021 and TS1021: 0.4% Carbon Steel. Normalised at 860°C. To British Standard Specification 080M040.

TL1030 and TS1030: Aluminium 2011 – T3.

TL1040 and TS1040: Half hard Brass. To British Standard Specification CZ121.

Hardness Test Specimens (HTP)

Hardness test specimens of different materials for use with the Materials Laboratory with Data Capture (MF40), Bench-Top Tensile Testing Machine (SM1002) and Brinell Indenter (SM1000e)



HTPAL: Aluminium (6026-T9)

HTPBR: Brass (CZ121/CW614N)

HTPMS: 0.1% Carbon steel (230M07)

HTPNY: Nylon 6

Tensile Test Specimens (ML)

Tensile test specimens of different materials for use with the Materials Laboratory with Data Capture (MF40)

ML1MS: Mild steel – specification EN1A or 230M07

ML2CS: Carbon steel – specification EN8 or 080M40

ML3SS: Stainless steel – specification SAE303

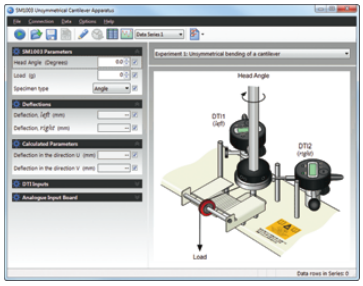
ML4AL: Aluminium – specification 2011-T3

ML5BR: Brass – specification CZ121

Unsymmetrical Cantilever Apparatus (SM1003)

Works with VDAS®

Examines and displays bending of an unsymmetrical cantilever



Screenshot of the optional VDAS® software

- Self-contained – needs no other parts
- Explains 'shear centre' and the use and construction of Mohr's circle
- Supplied with structural and stress analysis textbook with full theory
- Supplied with set of different specimens

EXPERIMENTS:

Investigations into bending of unsymmetrical cantilevers, including:

- **Vertical and horizontal displacement measurement for varying angles of applied load**
- **Demonstration that maximum and minimum vertical deflection occurs when horizontal deflection is zero**
- **Use of Mohr's circle**
- **Experimental and theoretical determination of the principal moments of area of test sections**
- **Location of shear centre of each section**

The Unsymmetrical Cantilever Apparatus allows students to load a cantilever and accurately measure its deflection in any coplanar direction.

Students mount a test beam vertically in a frame. The top of the test beam fixes to a holding ring that can rotate through 360 degrees.

Students apply a horizontal load in set increments (weights included) to the bottom (free end) of the test beam. Digital indicators measure the test beam deflections in two directions, at right-angles to each other. Each indicator has a socket for connection to TecQuipment's optional Versatile Data Acquisition System (VDAS®) and a suitable computer (computer not included).

Students apply loads to the beam in set increments and record its displacement. Students can then rotate the beam to another position and repeat the experiment. This allows students to use the Mohr's circle method to find the principal second moments of area of each section.

To find the shear centre of a test beam, students attach a cross-piece to the free end. The cross-piece allows students to apply loads at different positions across and outside the section of the cantilever.

The equipment includes a user guide which describes how to assemble and use the equipment, with practical theory, experiment procedures and typical results. The textbook, 'Structural and Stress Analysis' by T H G Megson, is included with the equipment.

For quick and reliable tests, TecQuipment's optional VDAS® gives accurate real-time data capture, monitoring and display, calculation and charting of all important readings on a computer (computer not included).

Recommended Ancillaries:

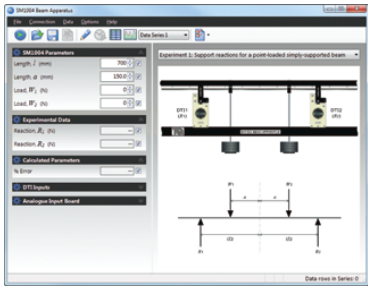
	Page
• Versatile Data Acquisition System – Bench-mounted version (VDAS-B)	32
• Unsymmetrical Bending and Shear Centre (STR7)	206

Beam Apparatus (SM1004)

Works with VDAS®

Examines the deflection and forces on different types of beams for a wide range of supports and loads

- Includes textbook with full theory
- Simply supported and cantilever beam tests with up to four supports with any loading
- Three load cells with digital indicators measure reaction forces or act as rigid sinking supports
- Precision digital indicators for accurate deflection measurements



Screenshot of the optional VDAS® software

EXPERIMENTS:

- **Verification of the bending equation**
- **Determination of flexural rigidity and elastic modulus (Young's modulus)**
- **Verification of static equilibrium**
- **Deflection of beams on two simple supports with point loads**
- **Reciprocal properties for loads and deflection**
- **Simple and propped cantilevers with any loading**
- **Continuous beams – statically indeterminate cases for simply supported beams and cantilevers on more than two supports with any loading (including measurement of unknown reactions)**
- **Simply supported and cantilever beams with sinking supports**

With the SM1004a Specimen Beams, these additional experiments can be done:

- **The effects of material and section shape on flexural rigidity**
- **Bending characteristics of a brass/steel compound beam, with and without shearing connection between the two layers**
- **Equivalent sections – characteristics of a metal-faced wooden beam**
- **Deflections on a non-uniform (tapered) beam or cantilever**

The Beam Apparatus allows an extensive range of experiments to cover virtually all course requirements relating to bending of beams. The basic unit provides facilities for supporting beams on simple, built-in and sinking supports, applying point loads, and measuring support reactions and beam deflections. It includes five different test beams. A pack of ten additional specimen beams (SM1004a) is available for further experiments.

The Beam Apparatus can be used for an almost limitless number of experiments ranging from determination of the elastic modulus for beams of different materials, through to studies of continuous beams with any loading. Great care has been taken at the design stage to ensure maximum flexibility and ease of use.

The main frame of the apparatus consists of an upper cross-member carrying graduated scales and two lower members bolted to T-legs to form a rigid assembly. The three load cells and cantilever-support pillar slide along the lower members and can be clamped firmly in any position. The load cells have direct digital readout and each is fitted with a hardened steel knife edge which can be adjusted to set the initial level or to simulate a sinking support. Locking pins can convert each load cell to a rigid support when required.

The cantilever support is a rigid pillar with a sturdy clamping arrangement to hold the beams when built-in end conditions are required. Four weight hangers and a set of weights are supplied to apply static loads. Three digital indicators measure all beam deflections. The indicators mount on magnetic carriers that slide along the upper cross-member. The indicators, carriers, load cells and weight hangers all have cursors that register on the scale (located on the upper cross-member) to ensure easy, accurate positioning. All digital indicators and load cells have sockets for connection to TecQuipment's optional Versatile Data Acquisition System (VDAS®).

The standard test beams are in three thicknesses and include three different materials. They are suitable for the complete range of experiments covering different loading and support configurations. The optional set of beams provide for experiments on different types of beam including compound, channel and non-uniform beams of various materials.

The Beam Apparatus comes complete with the laboratory handbook 'Structural and Stress Analysis' by T H G Megson, and a comprehensive user guide.

For quick and reliable tests, TecQuipment's optional VDAS® gives accurate real-time data capture, monitoring and display, calculation and charting of all important readings on a computer (computer not included).

Recommended Ancillaries:	Page
• Versatile Data Acquisition System – Bench-mounted version (VDAS-B)	32
• Additional Specimen Beams (SM1004a)	

Alternative Products:	Page
• Stiffness of Materials and Structures (TE16)	156
• Beam and Leaf Spring (SM1000g)	172
• Deflection of Beams and Cantilevers (STR4)	203
• Continuous and Indeterminate Beams (STR13)	212
• Deflection of Beams Kit (ES4)	12

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Visit our YouTube channel to see demonstrations and promotional videos of some of our products:

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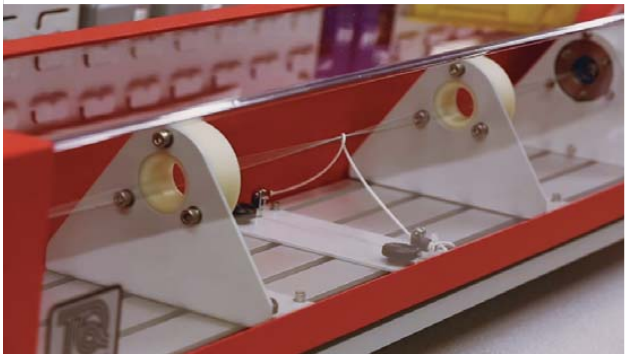
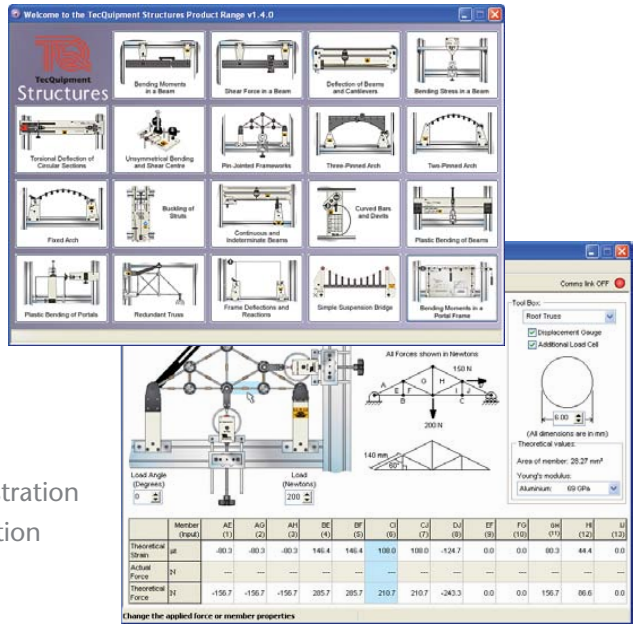


Have you seen our Structures range?

This cost-effective and flexible teaching system consists of 19 different desk-mounting hardware experiment modules, supported by full automatic data acquisition, including accurate simulation software.

The equipment uses the latest developments in educational design to teach many structural engineering principles, from simple bending moments and equilibrium to indeterminate structures and plastic collapse.

Turn to **Section 9** to see the full range.



Request a copy of our **FREE** demonstration CD to see our highly realistic simulation software.

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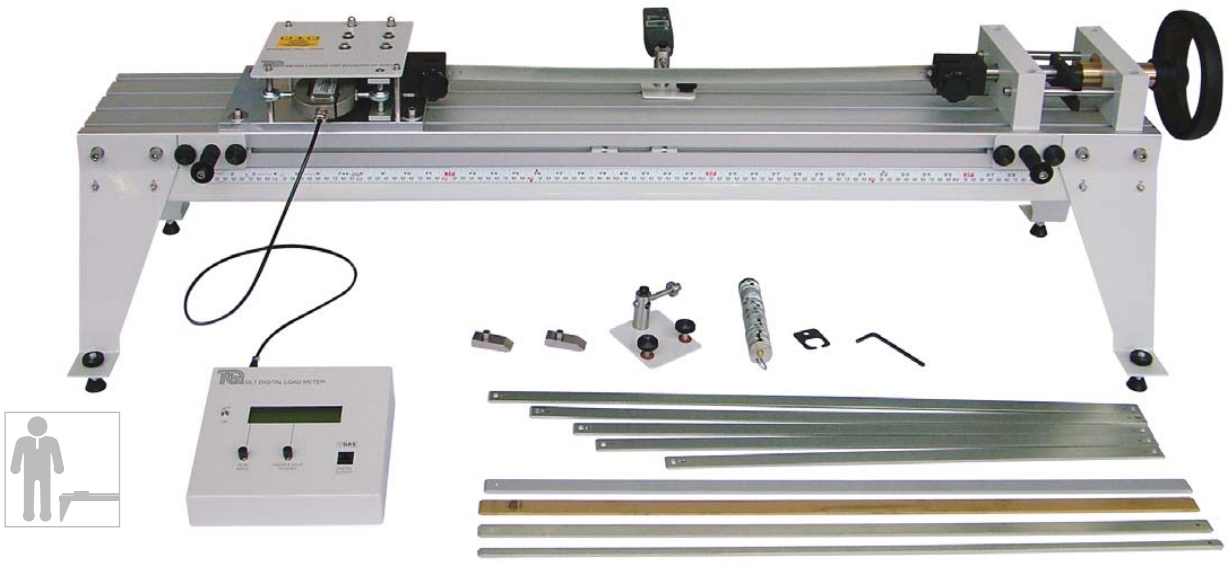
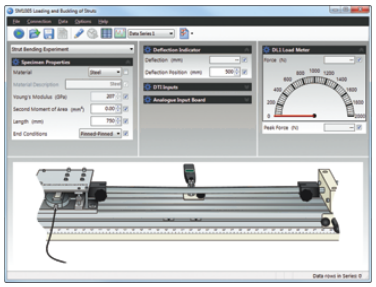
Loading and Buckling of Struts (SM1005)

Works with VDAS®

Tests different types of struts and shows how they deflect under load



- Can also test struts as simply supported beams – to extend experiments and find flexural rigidity of the struts
- Buckling tests cover pinned and clamped (encastre) ends for various strut lengths and cross sections
- Special end fittings allow tests with eccentric loading
- Range of ten struts supplied as standard
- Extra specimen struts available for more advanced experiments



Screenshot of the optional VDAS® software

EXPERIMENTS:

With the standard set of ten specimens:

- **Demonstration of buckled (crippled) shape of struts with different end conditions.**
- **Determination of load/deflection curves and buckling loads for struts of different lengths and cross-sections, with any combination of 'pinned' or clamped end fixings.**
- **Comparing experiment results with those using Euler's buckling theory**
- **Investigation of the effects of side load and eccentric loading on strut buckling characteristics.**
- **Flexural rigidity and buckling loads for struts of different materials.**
- **The use of Southwell's method to estimate buckling loads and strut eccentricities from experimental results.**
- **Determination of flexural rigidity and comparison with calculated values.**
- **Deflections of a simply supported beam with a point load including the verification of general deflection formulae, and the deflected shape.**

With the SM1005a optional set of additional struts:

- **Flexural rigidity and buckling loads for struts of a further range of different materials.**
- **Tests on typical engineering sections (circular, angle, channel and irregular section specimens); the significance of the neutral axes; combined bending and twisting due to eccentric loading.**
- **The effect of flexibility in end fixings.**
- **Tests on a compound strut with imperfect shearing connections between the two components.**

Continued on next page

Strut Apparatus (SM1005)
Continued from previous page

The Loading and Buckling of Struts apparatus allows tests on a full range of struts. It shows load and deflection characteristics and buckling loads for various strut lengths, cross-sections and end conditions. It also allows studies of the effect of eccentric loading. An optional set of extra specimens (SM1005a) allows extra tests to show students some of the more complicated problems found in strut design.

The main part of the apparatus is a precision-engineered, rigid aluminium base, with legs and levelling feet. At one end is a loading device which uses a screw to apply loads to the struts. The screw is in fixing blocks with bearings to give precise and easy load application.

At the opposite end is the load-measuring device. This is a precision mechanism that resists the bending moments produced by the struts as they deflect, and transmits the pure axial force to an electronic load cell. This gives an accurate measurement of buckling load. A digital load meter (DL1, included) shows the load.

Students may move the load-measuring device along the base to work with struts of different lengths and fixing conditions. A digital dial indicator fixed to a movable slide measures the deflected shapes of the struts. A scale shows the position of the indicator. The digital load meter and the digital dial indicator can connect to TecQuipment's optional Versatile Data Acquisition System (VDAS®).

Holders are at both the loading and load-measuring ends. They allow students to create any combination of 'pinned' or clamped-end conditions for the strut under test.

Supplied is a set of special end fittings for tests with various eccentricities to show the effect of eccentric loading. The equipment includes a lateral pull attachment for students to apply light biasing loads, or larger side loads, as needed.

Students can also set up the apparatus to examine flexural rigidity and general beam deflection theory. The standard set of ten struts (included) covers the primary variables of length, cross-section and end conditions. The optional set of additional struts (SM1005a) includes struts of different materials, typical engineering sections, and two special struts. The two special struts show how buckling loads may be lower than the ideal values because of two reasons:

- Flexure of the end fixings
- Imperfect shearing connections between the parts of a compound strut

For quick and reliable tests, TecQuipment can supply the optional Versatile Data Acquisition System (VDAS®). This gives accurate real-time data capture, monitoring and display, calculation and charting of all important readings on a computer (computer not included).

Recommended Ancillaries:	Page
• Versatile Data Acquisition System – Bench-mounted version (VDAS-B)	32
• Set of Additional Struts (SM1005a)	

Alternative Product:	Page
• Buckling of Struts (STR12)	211