



SOLID MECHANICS

Ref	Designation	Page
EX150	TENSILE AND BENDING TEST BENCH	2
EX150C1	BUCKLING KIT	4
EX150C2	MULTI LOADING KIT	4
EX150C3	COMPOSITE MATERIALS KIT	4
EX150C6	TRUSS STUDDING KIT	4
EX152-4-8	SPECIMENS FOR STUDYING STRESS DISTRIBUTION	5
EX151	DATA ACQUISITION AND ANALYSIS SYSTEM FOR TENSILE/BENDING TEST BENCH REF EX150	7
EI616	STRAIN BRIDGE	9
SAN311	UNSYMMETRICAL CANTILEVER APPARATUS	11
SAN312	UNIVERSAL STRUT APPARATUS	12
SAN313	BEAM DEFLECTION APPARATUS	13
SAN350	THIN CYLINDER APPARATUS	14
SAN400	TWIST AND BEND TESTING MACHINE	15
SAN800	TORSION OF BARS APPARATUS	16
SAN804	PORTAL FRAME APPARATUS	16
SAN806	BENDING MOMENT & SHEARING FORCE APPARATUS	17
ER400	STUDY OF THE BEHAVIOUR OF A 3D MODEL SOLICITED BY A STATIC CHARGE	18
ER420	PRESTRESSED BOLT APPARATUS	19
ER100	PHOTOELASTIC DEMONSTRATION UNIT	21
ER220	EXPERIMENTAL AND DEMONSTRATION POLARISCOPE	23
S1	STRESSMASTER POLARISCOPE	24
S18	GENERAL PURPOSE STRAIN VIEWER	25
ER300	RHEOELECTRICAL ANALOGY APPARATUS	26
EI620	STRAIN GAUGE EXTENSOMETER SYSTEM	28
EM550	UNIVERSAL TESTING MACHINE 50 KN	29
EM1100	UNIVERSAL TESTING MACHINE 100 KN	31
EM400	TORSION TESTING MACHINE	33
206RT	COMBINED MANUAL HARDNESS TESTER ROCKWELL, BRINELL AND VICKERS	35
CRBV	COMBINED DIGITAL HARDNESS TESTER ROCKWELL, BRINELL AND VICKERS	36
IT30ASTM	PENDULUM IMPACT TESTER	37
HSM19	ROTATING FATIGUE MACHINE	38
	COMPLEMENTARY EQUIPMENTS	39

Version : PC/11/2004

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SOLID MECHANICS

Strength of Materials

TENSILE AND BENDING TEST BENCH EX150

This modular experimental test bench consists of a table top rigid triangular frame on which students can mount different experiment modules. In its basic configuration ref EX150, the bench allows to demonstrate the relationships between force, stress and strain either for different tensile specimens, or different beams specimens.

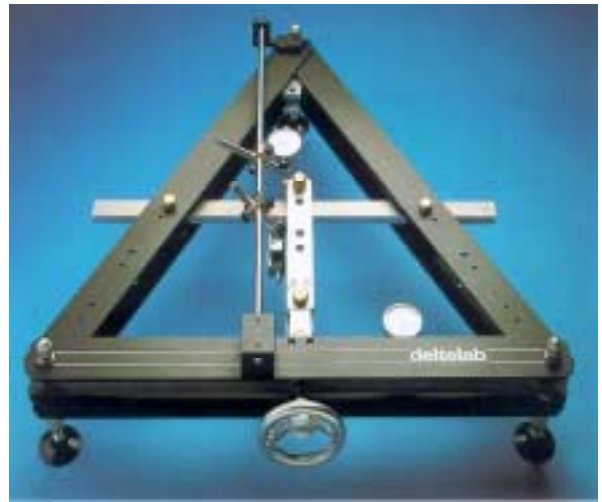
Several optional modules are available, offering many experiments in strength of materials. The modules are easy to remove and exchange with another for a different experiment.

The Deltalab EX150 test bench has become the standard for a manually operated bench-top tensile-testing machine.

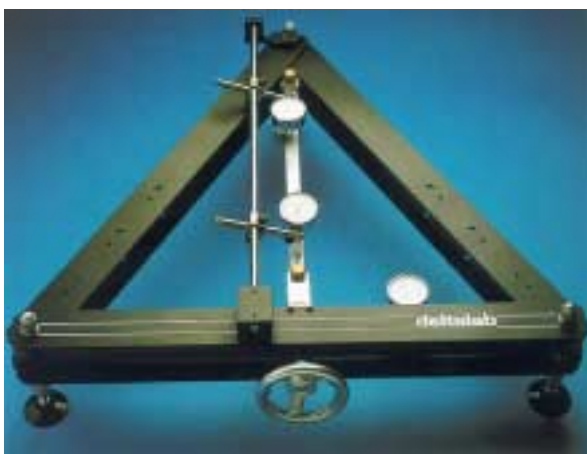
PRINCIPAL TEACHING OBJECTIVES

The test bench allows a wide range of demonstrations and experiments, including :

- Study of stretching :
 - Measurement of Young's Modulus of Elasticity for three materials
 - Effect of cross-section using a light alloy specimen
- Study of bending :
 - Effect of distance between supports
 - Effect of Second Moment of Area
 - Effect of choice of material (steel and light alloy)



EX150 Bending configuration



EX150 Tensile configuration

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TENSILE AND BENDING TEST BENCH EX150

TECHNICAL SPECIFICATIONS

The basic frame is made of three steel bars mounted in the form of a rigid triangle. The joints of the frame are mobile so that the deformation of the frame is not taken into account during experiments. It allows the determination of tensile performance for 360 mm specimens and of bending performance of beams between 400 and 500 mm from the extreme supports. The specimens can be deformed up to 25 mm. The applied load is given by the deflection of a loading beam, calibrated at the factory. Extension and deflection of the specimens are measured with the help of two dial gauges.

The system consists of :

- A bench mounted rigid triangular frame with anchor bar, dynamometer fixings, load screw, adjusting knob and guide bar, 3 feet, and equipped with a dial gauge for measurement of the applied force
- A set of accessories to mount the bench either in tensile or bending mode
- 2 dial gauges equipped with adjustable keys with setting devices to mount them in different configurations
- 1 tensile specimen piece in sheet mild steel, section 1 mm x 20 mm and length 360 mm
- 1 tensile test specimen in light sheet alloy, section 1 mm x 20 mm, length 360 mm
- 1 tensile test specimen in light sheet alloy, section 2 mm x 20 mm, length 360 mm
- 1 tensile test specimen in PVC sheet, section 2 mm x 20 mm, length 360 mm
- 1 bending test specimen in mild steel, section 15 x 30 mm. Length 600 mm
- 2 bending test specimen in light alloy, section 15 x 30 mm. Length 600 mm

EQUIPMENT PACKAGE

Standard equipment EX150:

consisting of:

- Table mounted test system
- Technical manual and teaching notes

Optional equipment:

EX152:	Tensile test specimen fitted with strain gauges
EX154:	Bending specimen fitted with strain gauges in a section of the beam
EX158 :	Bending specimen fitted with strain gauges along the beam
EI616:	Strain bridge (essential for use with EX152, EX154 and EX158)
EX151:	Data acquisition and processing system
EX156MM:	Multimedia software on bending and tension (only in French version)
EX150C1	Buckling kit
EX150C2	Multi loading system kit
EX150C3	Composite Materials kit
EX150C6	Truss studding kit

Each optional equipment is supplied with a technical manual and teaching notes.

USING YOUR EQUIPMENT

Essential requirements:

The EX150 must be mounted on a firm horizontal surface table.

Dimensions (l x w x h) and weight:

EX150: 70 x 70 x 20 cm - 25 kg

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COMPLEMENTS FOR TENSILE AND BENDING TEST BENCH EX150

BUCKLING KIT EX150C1

This buckling kit allows to applied an axial load to a specimen. It allows to study the influence of the end conditions on the buckling; articulate, fixed, or a mix of the two one. A displacement limiter avoid to damage the specimen. The Kit consists of different beams in different materials (one in PVC and two in steel with 2 different thickness) and a set of set of fixation accessories.

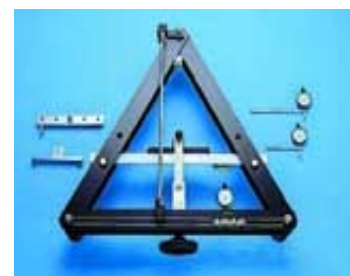


MULTI LOADING KIT EX150C2

This multi-loading kit for bending tests allows to introduce new experiments for the standard beams delivered with the EX150 bench :

- several punctual strengths
- a distributed load,
- a distributed and several punctual strengths combination,
- 4 points bending for the study of the pure bending.

This kit can also be used with the instrumented equipments ref EX154, EX158, EX151 supplied in option with the EX150 bench.



COMPOSITE MATERIALS KIT EX150C3

This composite materials kit is perfect for the studding the mechanical behaviour of composite materials. It allows to realize tensile, 3 points bending, shearing (bending on short beam) test experiments on carbon fibbers, glass fibbers oriented at 0° and 45° .

The elastic features of specimens can be determined; break strain, elastic modulus and bending modulus.

Supplied complete with all necessary accessories and 24 standard specimens for bending test and 24 standard specimens for shearing test for each of the 3 type of materials.



TRUSS STUDDING KIT EX150C6

This truss studding kit allows to measure accurately and compare strains, stresses, forces and deflections and to compare them with theory.

The kit is to place in the EX150 frame between two points.

The load is applied by the meaning of the EX150 loading device.

5 of the trusses are equipped with strain gauges. The connection with the optional strain bridge ref EI616 is easily made with the help of a connexion box.

The displacement measures are made by the 2 dial gauges of the EX150.

Other loading configuration are possible by the help of the EX150 C2 kit.



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SPECIMENS FOR STUDYING STRESS DISTRIBUTION

In simple bending, EX154



In simple tension, EX152

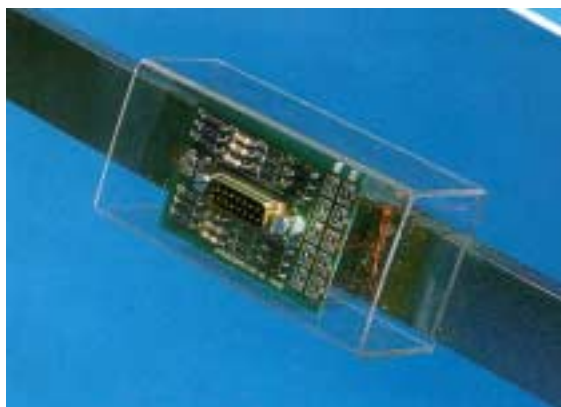


EX152 - EX154 specimens used with the EX150 Test Unit and connected to the EI 616 Strain Bridge

Although they have been designed to be used with the EX150 Tensile and Bending Test Unit, the tensile and bending specimens can also be used with any other type of loading system.

The stresses at various points in the specimen are measured by pairs of strain gauges bonded using an industrial process guaranteeing a high level of measurement accuracy and stability with time.

The pairs of strain gauges are linked to a connexion terminal including compensation resistors on the beam equipped with a multi-pin socket allowing rapid connection, via a single cable, to the EI616 Strain Bridge (or to any other suitable measuring unit). The connexion terminal is protected by a plexiglass guard.



EX154 beam for bending tests

The three specimens EX152, EX154 and EX158 can be used to check specific stress distributions in cases of simple tension and simple bending. These strain gauge arrangements are ready-to-use and do not require any handling or adjustment of the strain gauges, or any knowledge of electrical strain gauge theory.

The manual provided with each specimen does, however, give an overview of the operating principle of strain gauges and Wheatstone bridge measurements.

PRINCIPAL TEACHING OBJECTIVES

EX152 Tensile Specimen

- Demonstration of small strains.
- Measuring the longitudinal and transverse distribution of stresses at different points.
- Determination of the longitudinal modulus of elasticity of the material (aluminum alloy).
- Determination of Poisson's coefficient.

EX154 Beam for bending tests

- Demonstration of small strains.
- Measuring the stress distribution in a straight section of a beam, under bending loads
- Measuring the stress variation along the beam as a function of bending moment
- Determination of the longitudinal modulus of elasticity of the material (steel).

EX158 Beam for bending tests

- Longitudinal distribution of strain in various points

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SPECIMENS FOR STUDYING STRESS DISTRIBUTION

TECHNICAL SPECIFICATIONS

Each of the specimens is provided with:

- 12 constantan strain gauges, 350 Ω (gauge factor, $K = 2.04$)
- One connexion terminal for setting up the gauges in a full bridge configuration
- One test certificate
- One Sub D15 shielded connexion cable, one meter long, to connect the beam to Strain Bridge ref EI616.

EX152 Tensile Specimen

- Material: light alloy
- Cross-section: 2 x 20 mm
- Length: 360 mm
- Provided with clamping fixtures.

EX154 Bending Specimen – strain gauges in a section of the beam

- Material: steel
- Cross-section: 15 x 30 mm
- Length: 600 mm

EX158 Bending Specimen – strain gauges in the length of the beam

- Material: steel
- Cross-section: 15 x 30 mm
- Length: 600 mm

OPTIONAL EQUIPMENT

EX151 Data Logging And Processing System

The EX151 Data acquisition system is a complementary kit that can be adapted to the EX150 Tensile and Bending Test Unit. By logging and processing data on a microcomputer, the system gives the student much greater flexibility in terms of the variety of possible experiments, thereby leading to a better understanding of the physical phenomena. To use the EX151 unit, an EI616 strain bridge and a PC compatible microcomputer are required.

The specification of the EX151 unit and the associated experiments are described in the corresponding data sheet.

USING YOUR EQUIPMENT

Essential requirements :

Strain bridge ref EI616
Tensile and bending test bench ref EX150

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Strength of Materials

DATA ACQUISITION AND ANALYSIS SYSTEM FOR TENSILE/BENDING TEST BENCH REF EX150 EX151

The tensile and bending bench ref. EX150 is the basic element of a series of experiments in strength of materials. In its standard configuration, this bench allows the study of pure traction and bending with conventional measuring instruments: dial gauges: two dial gauges are used for measurements of deformation of the beams; a third for the determination of the strength applied to the specimens during the tests.

To complete these global observations, bending and tensile specimens equipped with strain gauges are proposed to check the distribution of the deformations according to the section and the length of these simple structures. The experiments are directly realizable and exploitable with the 6 ways strain bridge ref. EI616.



The use of this instrumented specimens led us to the design strain gauges incremental position sensors with all the necessary accessories in order to replace the dial gauges.

All these components used together constitute a complete computerized data acquisition system ref. EX151 that allow the students to conceptualise easily the principles of elasticity theory and to introduce the use of data acquisition processing into the experiments. This tool brings flexibility, speed and allows to link theory and experiments results.

The user can interchange very simply the dial gauges by the sensors and upgrade the bench to the instrumented version or return to the basic configuration, knowing that there is no consequence on the physical phenomena observed.

PRINCIPAL TEACHING OBJECTIVES

The software allows the following studies:

Configuration 1: Study of stiffness

- For this experiment, the four tensile specimens and the two bend-test specimens provided with bench ref. EX150 are used.

Configuration 2: the study of deformations distribution according to the force applied.

- In bending mode, the beam ref. EX154 is equipped with strain gauges and the strength sensors ref. EI682 are used. Four pairs of gauges in a cross-section are used to show the distribution of the deformations (the neutral fibre), as well as a fifth pair of gauges placed in another section.
- In traction mode, the beam ref. EX152 is equipped with strain gauges and the strength sensor ref. EI682 are used. Four pairs of gauges are used to show the uniformity of the deformations in the tensile direction. A fifth pair of gauges makes it possible to measure the deformation perpendicular to tensile direction and to deduce the Poisson's ratio.

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DATA ACQUISITION AND ANALYSIS SYSTEM FOR TENSILE AND BENDING TEST BENCH REF EX150 EX151

TECHNICAL SPECIFICATIONS

The data acquisition and processing system ref. EX151 is design for microcomputer IBM PC or compatible, and is to used in complement of bench ref. EX150.

It is composed of:

- Data acquisition card
- Interface connexion unit
- Set of cables
- Software for data acquisition and processing

To allow the use of the 6 ways bridge ref. EI616, a switch on the connexion unit allows two configurations to be used further to the desired experiments:

Configuration 1: Study of stiffness; 3 ways data acquisition: 2 strain gauges incremental position sensors and the strength sensor, ref. EI 682.

Configuration 2: Study of the deformations distribution according to the force applied; 6 ways data acquisition: 5 strain gauges on the beam and 1 on the strength sensor, ref. EI682.

SOFTWARE

The software, with drop-down menu, control all the experiments,

It has the following functions:

- File management: opening - closing - backup - recall of the data present in memory or separate drive
- Calibration of the sensors: Strength - displacement
- Experiments: stiffness - distribution of the deformations
- Help menu: experiments - functionality.

ADDITIONAL NECESSARY EQUIPMENT

- Tensile and bending test bench ref EX150
- Specimens with strain gauges ref EX152, EX154, EX158 further to the experiments
- Strain bridge ref EI616
- A microcomputer IBM PC or compatible with a free PCI slot

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STRAIN BRIDGE

EI616

The Deltalab strain bridge has six independent channels. It is designed for measuring strains using standard strain gauges. It can also be used for measuring other parameters with the appropriate sensors.

The high-contrast digital display gives a direct reading in micro-strains, for connection in half or full bridge on the six ways. Measurements with a quarter bridge configuration can also be made by adding resistors. The gauge factor can be adjusted between 1 and 5. Each channel can be balanced separately by means of multi-turn potentiometers.

An analogue output for each channel permits the display of the signals using an oscilloscope or a plotter, and also data acquisition system with the help of module ref EI617.

The excitation voltage of 2.5 V allows using of strain gauges of 120 Ω minimum. These can be in Constantan, Isoelastic, Karma or Platinum - Tungsten alloys.

The 20 000 point digital display allows measurements in the range $\pm 20\,000$ $\mu\text{m/m}$, whatever the gauge alloy used.



Strain bridge ref EI616

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STRAIN BRIDGE EI616

TECHNICAL SPECIFICATIONS

Number of channels:	6
Operating range:	$\pm 20\,000\ \mu\text{m/m}$
Resolution:	$\pm 1\ \mu\text{m/m}$
Bridge energisation:	2.5 V - Stability: 10^{-4}
Gauge configuration:	Full or half bridge with strain gauges of 120 to 5000 Ω , quarter bridge with additional resistor
Input impedance:	$10^{10}\ \Omega$
Balance:	<ul style="list-style-type: none">• using multi-turn potentiometers• $\pm 1000\ \mu\ \Omega / \Omega$
Gauge factor	<ul style="list-style-type: none">• read directly on display adjustable from 1 to 5 by multi-turn locking potentiometers.• resolution: 0.001
Amplifier:	<ul style="list-style-type: none">• accuracy 1 %• linearity: $\pm 0.002\ \%$• drift: $0.25\ \mu\text{V}/^\circ\text{C}$• noise: less than $13\ \mu\text{V}$ per Hz• common mode rejection: $< 100\ \text{dB}$
Analogue outputs:	<ul style="list-style-type: none">• independant output for the 6 channels, using Cannon 9 pin connectors• max. output voltage: 10 Vbandwidth: 0 - 10 kHz• 2 V for 20000 $\mu\ \Omega / \Omega$• minimal charge: 22000 Ω
Gauge connections:	<ul style="list-style-type: none">• by 15 pin Cannon connectors• by 24 way rapid connector

OPTION

- **Data acquisition and processing system EI617**
With an IBM-PC or compatible micro-computer, the system can configure and read the six channels simultaneously. It comprises three elements:
- **Software package EI626**
Allows for each series of measurements:
 - A complet configuration of the data acquisition (channel selection, gain, configuration (full or half-bridge), gauge factor, graph configuration, sampling rate until 10 kHz, total number of acquisitions,...)
 - A manual data capture with data acquisition card
 - A direct data acquisition of the data under chart form
 - A data processing of curves
 - Saving the data with possibilities to export them to Excel[®].
- **Card-bridge connecting cable, EI692**
- **Analogue / Digital data acquisition card, EI690**
Features:
 - reading of 16 single analogue inputs or 8 differential analogue inputs
 - 12 bit digital conversion, or a resolution of 4096 points on the full scale
 - accepts maximum voltages of 0 to 10 volts in unipolar mode and ± 5 volts in bi-polar mode
 - fixed frequency data acquisition, through built-in time

The strain bridge is supplied with a technical manual with theory about strain gauges measurement.

USING YOUR EQUIPMENT

Essential requirements :

Voltage : 220 V, 50 or 60 Hz

Dimensions and weight :

Dimensions : 265 x 105 x 84 mm

Nett weight : 1.8 Kg

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Strength of Materials

UNSYMMETRICAL CANTILEVER APPARATUS SAN311

The Unsymmetrical Cantilever Apparatus is intended to demonstrate the unsymmetrical bending of beams.

PRINCIPAL TEACHING OBJECTIVES

Simple experiments may be carried out to determine the deflections Δ_U and Δ_V at the free end of cantilevers of various sections for varying angles of applied load

from which the relationship between $\frac{\Delta_U}{W}$ and

$\frac{\Delta_V}{W}$ may be determined graphically.



TECHNICAL SPECIFICATIONS

- The apparatus consists of a vertical cantilever rigidly clamped at its lower end to the main column which is attached to a rigid base. Beams of varying sections may be used.
- A loading head, located at the upper end of the column, can rotate freely about the vertical axis of the beam and a locating pin enables the head to be locked at 15° intervals through 180°.
- A horizontal load may be applied to the free end of the beam by means of a cord attached to the beam and passing over a pulley mounted on the rotating head.
- The Δ_U and Δ_V deflections of the beam are measured by means of two dial gauges mounted at 90° to each other on the head.
- To compensate for any lateral deflection of the beam, the line of action of the applied load can be adjusted by lateral adjustment of the load pulley.
- The apparatus is portable and is intended for bench mounting, requiring no fixing.
- The basic apparatus is supplied with a cantilever specimen of 12 x 12 x 3 mm equal angle section bright mild steel.
- Experiment manual

USING YOUR EQUIPMENT

Additionally required equipment:

A set of masses Ref SAN 311/W

Other specimens are available on special inquiry

Dimensions and weight

Dimensions : 300 x 300 x 400 mm

Nett Weight : 14 kg.

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Strength of Materials

UNIVERSAL STRUT APPARATUS SAN312

The Universal Strut Apparatus has been developed to enable students to carry out a series of tests to determine the crippling load for struts of varying slenderness ratios and end fixing conditions.

PRINCIPAL TEACHING OBJECTIVES

Reversible hardened load blocks are provided so that the struts can be tested under the following conditions:

1. Both ends pinned.
2. Both ends fixed.
3. One end pinned, one end fixed.

TECHNICAL SPECIFICATIONS

- The apparatus has been designed to accommodate struts of suitable lengths within the range 400/800 mm.
- The struts are rectangular in section, thus ensuring that the deflection occurs in a predetermined plane.
- The load is applied to the strut by means of a spring balance and a loading beam.
- The beam pivots on a nut which can be adjusted vertically so that the beam can be maintained in the horizontal position during loading, thus ensuring that a true axial load can be supplied throughout the test.
- A light lateral load is applied to the strut to ensure the direction of deflection, the magnitude of which can then be measured by means of a dial indicator.
- One set of struts for each end condition is supplied with the apparatus.
- One set of masses
- Experiment manual



USING YOUR EQUIPMENT

Optional equipments

A set of load blocks, bushes and specimens are available to allow experiments to be conducted on round specimens.

Dimensions and weight

Dimensions : 880 x 580 x 1240 mm approx.

Nett Weight : 56 kg.

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Strength of Materials

BEAM DEFLECTION APPARATUS SAN313

PRINCIPAL TEACHING OBJECTIVES

The Beam Deflection Apparatus has been designed to enable students to carry out experiments on simply supported and cantilever beams in order to investigate the relationship between the deflections and the applied loads and the effect of variations in length and cross sectional dimensions on the beam deflection.



TECHNICAL SPECIFICATIONS

- The Apparatus consists of a rigid main support beam on which the hardened Knife Edge and Cantilever supports for the test beams can be easily positioned.
- Hardened steel knife edge load hangers and the dial gauge support, which slides freely on the main support beam, can be readily moved to the selected point where the deflection is to be measured.
- A suitably marked scale is secured to the main support beam so that the test beam supports, the load hangers and the dial gauge may be quickly and accurately located.
- The standard equipment includes three test beams of the same material having suitable cross sectional dimensions.
- Experiment manual

USING YOUR EQUIPMENT

Additionally required equipment:

A set of masses, Ref SAN 313/W

Dimensions and weight

Dimensions : 420 x 420 x 1220 mm approx.

Nett Weight : 26 kg.

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Elasticity and Photoelasticity

THIN CYLINDER APPARATUS SAN350

The Thin Cylinder Apparatus permits the investigation of stresses and strains in a thin cylinder under internal pressure. The thin walled alloy cylinder, supported by a cradle is mounted on a base board together with the hydraulic hand pump for pressurising the system. Six strain gauges are fitted to the cylinder to permit the measurement of surface strains at various angles. A pressure gauge indicates the cylinder pressure.

Two stress conditions are available:

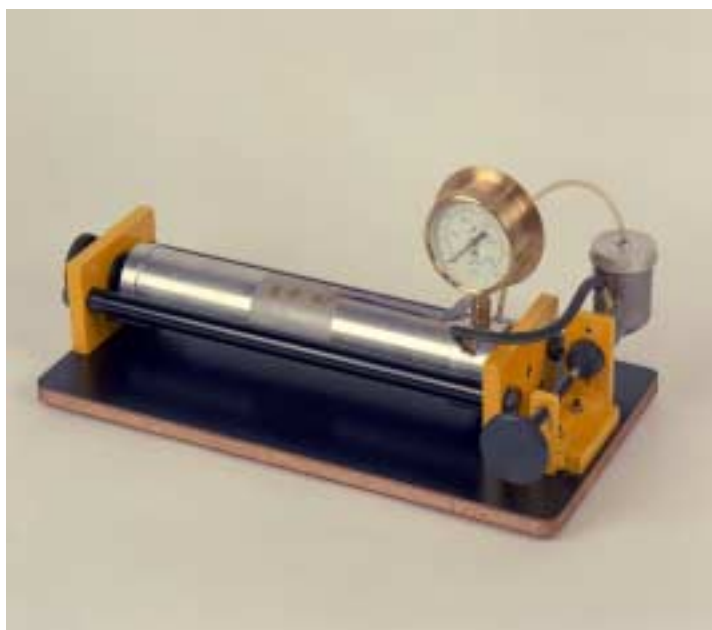
1. Open ends - circumferential stress.
2. Closed ends - bi-axial stress.

PRINCIPAL TEACHING OBJECTIVES

- Quantitative study with Mohr circle
- Determination of the different strains in a thin cylinder with strain gauges
- Determination of circumferential and biaxial stresses
- Determination of the Young modulus and Poisson coefficient

TECHNICAL SPECIFICATIONS

- Cylinder material Aluminium Alloy
- Length: 375 mm O/D 76.2mm
- Bore : 70 mm
- Manometer (0-50 bar)
- Max Test Pressure 35 bar
- 6 Strain gauges - Electrical resistances
- The cradle is designed to allow rapid selection of either condition.
- Experiment manual



USING YOUR EQUIPMENT

Additionally required equipment

Digital Strain Bridge, REF EI616

Dimensions and weight

Dimensions : 420 x 200 x 200 approx

Nett Weight : 20 kg.

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TWIST AND BEND TESTING MACHINE SAN400

The SAN400 is a combined twist and bend testing machine for use both in pupil's laboratory exercises and in conjunction with theoretical work on twist and bending. Its size and weight make it easy to carry between the different classrooms.

Twist

In twist tests you can determine and compare the modulus of rigidity for different materials and demonstrate the deformation formula.

Bending

In bending tests you determine with SAN400 the modulus of elasticity of different materials and demonstrate, for example, the relation between load, moment of inertia, distance between supports, modulus of elasticity and deflection.

The test pieces for bending tests are different dimensions, so that you can determine the relation between moment of inertia and dimensions of a material.



PRINCIPAL TEACHING OBJECTIVES

- Investigation of the relationship between load, span, width, height and deflection of a beam.
- To ascertain the coefficient of elasticity for steel, brass, aluminium and wood.
- Investigation of the relationship between torsional moment, clamping length and torsional angle of a shaft.
- To determine the shear modulus of steel, brass and aluminium.

TECHNICAL SPECIFICATIONS

- Twist and Bend machine
- Two loading devices
- Two 1N masses
- Two 0.5N masses
- Test pieces of rectangular cross section
- Test pieces 8 mm dia. In steel aluminium, brass and wood
- Experiment manual

USING YOUR EQUIPMENT

Dimensions and weight

Dimensions : 800 x 225 x 350 mm

Nett weight : 13 kg

The manufacturer reserves the right to modify the apparatus without notice – 11/04

Headquarters:

259, rue du Rocher de Lorzier

38430 MOIRANS – France

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SOLID MECHANICS

Strength of Materials

TORSION OF BARS APPARATUS SAN800

This simple piece of apparatus has been designed for student laboratory exercises to investigate the elastic torsion characteristics of circular bars.

PRINCIPAL TEACHING OBJECTIVES

The range of experiments include:

- The verification of the elastic torsion equation
- The determination of the Modulus of Rigidity for different materials.

TECHNICAL SPECIFICATIONS

- Torque is applied to the specimen bars by means of a spring balance and torque arm and a dial gauge in contact with the arm enables the angle of twist to be measured.
- A range of specimens in different materials is supplied as standard.
- Experiment manual
- Dimensions: 522 x 260 x 496 mm - Nett weight : 9.5 kg



PORTAL FRAME APPARATUS SAN804

A simple piece of apparatus designed for use in conjunction with theoretical studies in the deflections of a simple rectangular portal frame subject to varying applied loads.

PRINCIPAL TEACHING OBJECTIVES

It can be used by the student to determine experimentally

- The deflection of the frame when subject to horizontal loading
- The deflection of the frame when subject to vertical loading

TECHNICAL SPECIFICATIONS

- The specimen portal frame is attached to a rigid base by simple clamps and loads can be applied by mass hangers and a suitable range of masses.
- The horizontal and vertical deflections of the frame can be conveniently measured by means of dial gauges.
- A set of masses
- Experiment manual
- Dimensions: 700 x 204 x 495 mm - Nett weight : 10 kg



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SOLID MECHANICS

Strength of Materials

BENDING MOMENT & SHEARING FORCE APPARATUS SAN806

This apparatus has been designed for use in either the classroom or laboratory.

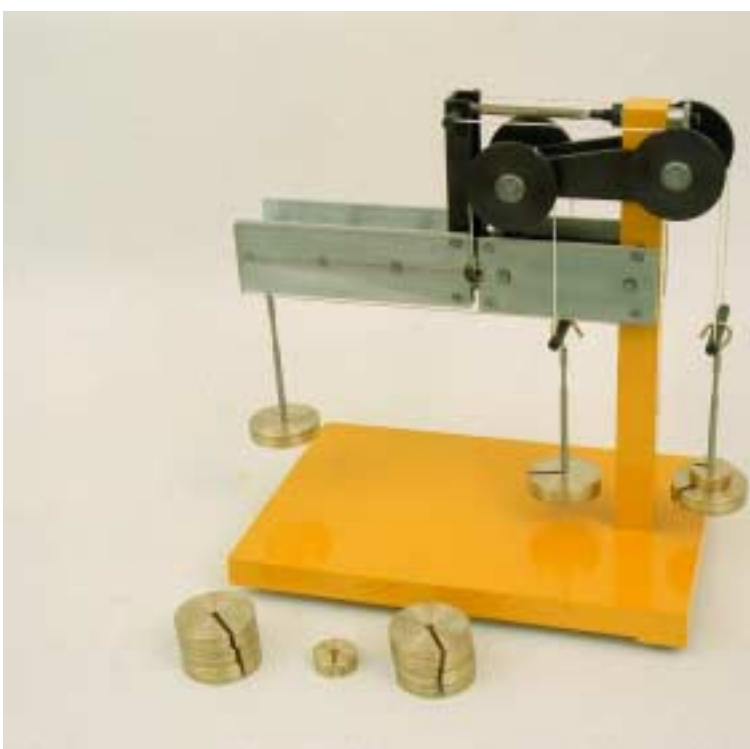
PRINCIPAL TEACHING OBJECTIVES

This apparatus may be used to show that in a beam subject to transverse loads, at any section of the beam :

- The shearing force is the algebraic sum of the transverse components of the forces to one side of the section.
- The bending moment is the algebraic sum of the moments of the forces to one side of the section.

TECHNICAL SPECIFICATIONS

- The beam is hinged at a typical transverse section and loads may be applied at varying positions on the beam.
- For the purposes of obtaining equilibrium, balancing forces are applied at the hinge point by suitable masses attached to cords passing over ball bearing pulleys.
- A set of masses
- Experiment manual



USING YOUR EQUIPMENT

Dimensions and weight

Dimensions : 340 x 202 x 335 mm

Nett weight : 7.50 kg

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SOLID MECHANICS

Elasticity and Photo elasticity

STUDY OF THE BEHAVIOUR OF A 3D MODEL SOLICITED BY A STATIC CHARGE ER400

This apparatus is composed of a piece used in ATR42 aircraft at half scale. This piece, made of light alloy is used to support aeration piping situated in the wings of the plane. A measuring bench is used to accurately reproduce the link and loading conditions on this piping support. The student after having measured certain displacements, having determined the stresses and having justified the shapes of the part, compares these results with those obtained by a finite elements software.

PRINCIPAL TEACHING OBJECTIVES

Knowing the complete geometry of this support, its links with the external parts and the applied efforts, we can :

- Measure displacements, strains, stresses in judiciously selected points.
- Confront the experimental results obtained by the strains recorded by each of the 5 strain gauges and the displacements measured by the 4 dial gauges with those obtained by finite elements software in the case of simple efforts.

The student will carry out a static justification of the dimensioning based on the simplified theory of beams.



TECHNICAL SPECIFICATIONS

The apparatus includes :

- The measuring bench accurately reproducing the links and loading conditions of the piping support. It includes:
 - 1 loading screw operating on the compensator by means of a strength sensor of capacity 500 daN. This one carries out a mechanical action on the piping support and makes it possible to measure the static charge applied.
 - 4 mechanical dial gauges allowing to measure the 2 components of displacement in 2 points.
- Piping support in aluminium AU4G equipped with 5 strain gauges:
 - 4 strain gauges stuck on external outline of the piece allowing to determine locally, the normal stress σ_n
 - 1 strain gauge stuck on the core of a U-shaped section allowing to determine locally, the tangential stress ζ .
 - 1 connector 15 pins for connection with the strain bridge ref EI616.

USING YOUR EQUIPMENT

Essential requirements :

Electrical supply : 220 V at 50 Hz

Additionally required equipment:

- Strain bridge ref EI616
- Computer IBM PC or compatible
- Finite elements software : recommended "RDM LE MANS"

Dimension and weight : 350 x 350 x 80 mm - Net Weight: 7 kg

The manufacturer reserves the right to modify the apparatus without notice – 11/04

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SOLID MECHANICS

Elasticity and Photoelasticity

PRESTRESSED BOLT APPARATUS ER420

This equipment has been designed to study the mechanical behaviour of bolted assemblies. It allows to analyse the stresses and strains in a bolt further to different methods of tightening, and the behaviour of a bolted assembly axially loaded : loading diagram, influence of the loading position.

The bolt is equipped with strain gauges of which two are 3 directions rosettes at (45°) enabling the measure of the extension and torsion. An hydraulic tightener with manual high pressure hydraulic pump allows to applied a pure tensile strength. A dial gauge allows measurement of extension. Two strain gauges fixed on the internal side of the tube allow compression stresses measurement.

PRINCIPAL TEACHING OBJECTIVES

The apparatus allows the following experiments:

- Deformations in a bolt by tightening with a spanner
- Deformations in a bolt by tightening with a torque wrench
- Influence of prestress using an hydraulic tightener
- Influence of the loading plane position
- Influence of the contact materials
- Drawing of the Mohr's Circles , principal stresses and directions



TECHNICAL SPECIFICATIONS

The prestressed bolt assembly is composed of :

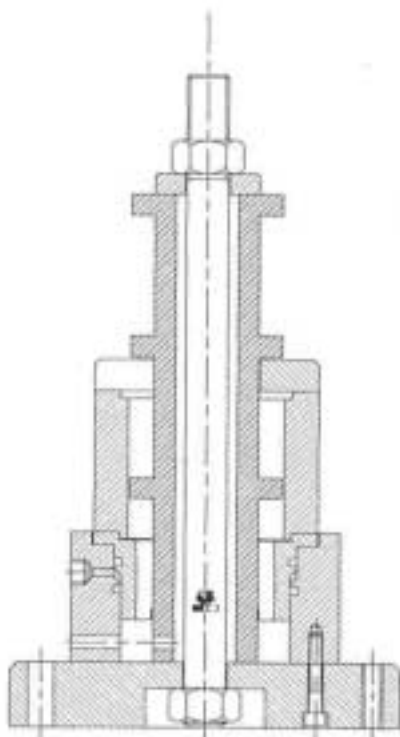
- A 16 mm diameter bolt on which are fixed two diametrically opposed rosette strain gauges at 45°.
- A tubular component with 2 strain gauges mounted at 180° to measure the compression stresses in the assembly at different heights
- A tightener device to apply a pre-load on the bolt or to apply an external loading force at various positions along the bolted assembly
- A manually operated hydraulic pump
- A micrometer dial gauge with fixing device to measure extensions over the complete assembly
- Nuts and washers of various materials
- To function the apparatus need a strain bridge as DELTALAB model ref EI 616

The manufacturer reserves the right to modify the apparatus without notice – 11/04

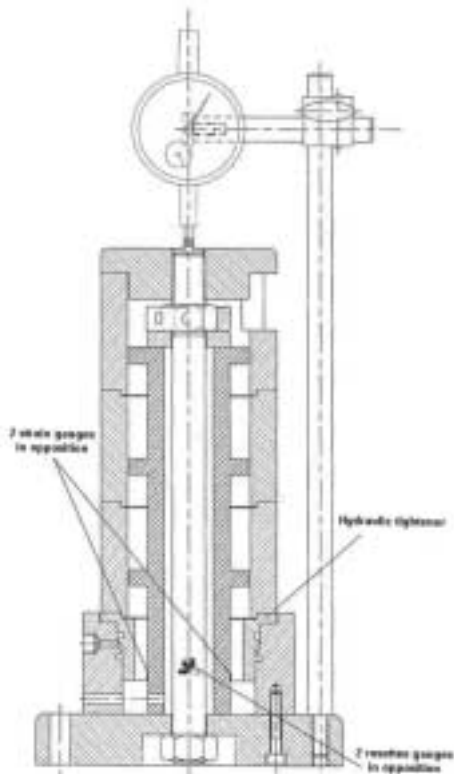
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STUDY OF A PRE-TENSIONED BOLT ER420



Influence of the loading position



Screwing using an hydraulic tightener



EQUIPMENT PACKAGE

Standard equipment ER420

- Prestressed bolt assembly with hydraulic loading system and manual pump
- Technical manual with experiments notes

USING YOUR EQUIPMENT

Essential requirements:

Electrical supply : 220V, 50 Hz (for the strain bridge)

Additional required equipment:

- Strain bridge: EI616
- A torque wrench of capacity 40 to 200 Nm with hexagonal adaptation piece dia. 24 mm

Dimensions (l x w x h) and weight:

Bolt assembly: diam.15 x 37 cm - 3,5 kg

Hydraulic pump: 40 x 10 x 14 mm - 12 kg

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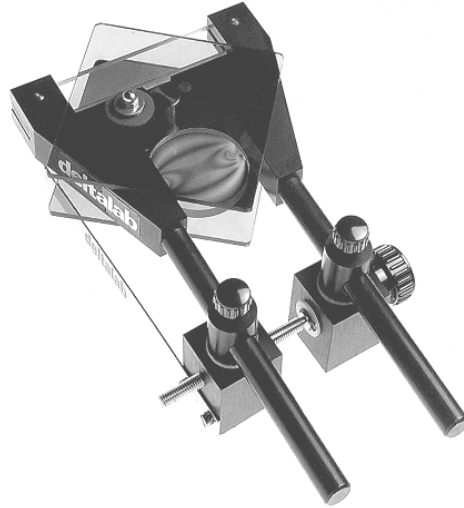
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SOLID MECHANICS

Elasticity and Photoelasticity

PHOTOELASTIC DEMONSTRATION UNIT ER100



The ER100 Photoelastic Demonstration Unit can be used by the teacher or student to perform introductory demonstrations or experiments in photoelasticity.

The ER100 allows the student to gain a better idea of the concept of stresses by direct visualisation.

Extremely compact and easy to operate, the instrument can be used in ambient light by the teacher or the student. By placing the ER 100 on an overhead projector, the teacher or speaker has an ideal means of illustrating stress analysis to an audience.

Each instrument is supplied with a manual which explains the principles of photoelasticity and presents a series of experiments and demonstrations.



Information pack ER100

PRINCIPAL TEACHING OBJECTIVES

- Study of effects of loading conditions on beam stresses.
- Demonstration of stress distribution in a deflected rectangular beam.
- Demonstration of the influence of geometry and local contacts on stress distribution.
- Demonstration of stress concentrations.

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PHOTOELASTIC DEMONSTRATION UNIT ER100



Example of result obtained on a rectangular beam specimen

TECHNICAL SPECIFICATIONS

Mounted in the Demonstration Unit, the specimens are subjected to different type of mechanical stresses (tension, bending, compression) by applying a force at the end of the loading arms. The stress field in the bi-refringent specimen can be demonstrated by observing certain optical phenomena : isoclinics extinction, isochromatics and the tint of passage.

The instrument is supplied complete with a case, a loading clamp, a set of polarizing filters, an instruction manual and 7 specimens :

- Beam,
- Beam with straight "saw-cut" notch,
- Beam with two straight "saw-cut" notches,
- Beam with central hole,
- Beam with V-notch,
- Tensile specimen with straight and radiused shoulders,
- Compression disc.

USING YOUR EQUIPMENT

Additional Equipment required

Overhead projector – not essential

Dimensions and weight

- Dimensions of the apparatus : 240 x 120 x 46 mm
- Overall dimensions of case: 315 x 225 x 60 mm
- Net weight of the apparatus in its case: 1.5 kg.



Examples of loading configuration

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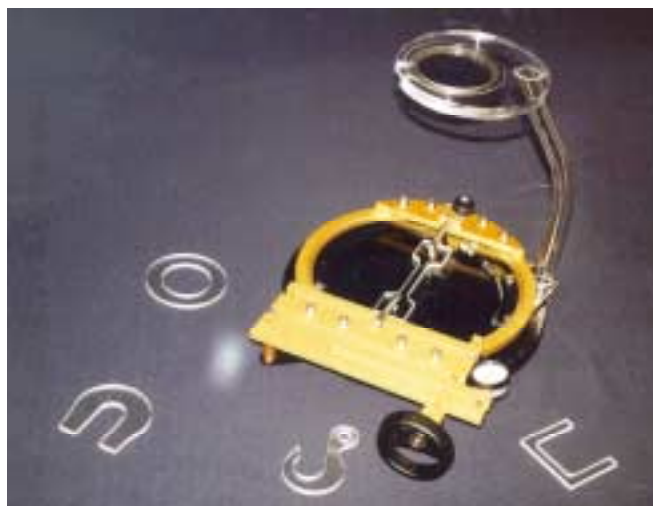
SOLID MECHANICS

Elasticity and Photoelasticity

EXPERIMENTAL AND DEMONSTRATION POLARISCOPE ER220

The ER220 Polariscope is a powerful tool for teaching and demonstration of stress analysis using the photoelasticity technique. Placed on an overhead projector (not supplied), it allows, with the image projected on to a screen, either in a laboratory or a lecture theatre, a very clear demonstration of stresses in the loaded specimens.

The original design of the loading system allows to applied a progressive and accurate load to the specimens in tensile, compression or bending mode. Moreover, a system allows the simultaneous rotation of the polarizer and the analyser for the isoclinics lines observation.



TECHINICAL SPECIFICATIONS

The Polariscope consists of the following elements :

- An accurate loading frame.
- An elastic strength measuring device, which uses a steel spring beam, and a micrometer dial gauge. The device has a linear deflexion/load relationship.
- An adjustable circular polarizing unit, graduated, situated under the loading frame.
- A quarter wave plate.
- A circular analyser which can be rotate through 180°.
- The polarizer and the analyser are coupled so that they can turn simultaneously.
- A complete set of fixtures required for the application of the loads to all the models supplied.
- A set of 8 models in photoelastic material : disk, hook, ring, U, horseshoe, 3 tensile specimens
- Polarizer Diameter : 200 mm
- Clearance between the loading arms : 190 x 220 mm
- Light source : standard overhead projector source (white light).
- Maximum load : ± 40 kg.

PRINCIPAL TEACHING OBJECTIVES

- Study of the stresses in a disc loaded in 2 points
- Study of stresses concentration in a specimen with 2 notches in tensile and pure bending mode

Fields of application

- Strength of materials,
- Structures, civil engineering and architecture.
- Applied mechanics, machine design, and welding technology,
- Soil mechanics,
- Biomechanics.

USING YOUR EQUIPMENT

Additional Equipment required

Overhead projector.

Complementary equipment

Analogue field plotters, 24 channels, ref. ER300. This unit can be used in conjunction with the Polariscope for the separation of the principal stresses.

Dimensions and weight

420 x 320 x 350 mm - Nett weight : 4 kg.

The manufacturer reserves the right to modify the apparatus without notice – 11/04

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SOLID MECHANICS

Elasticity and Photoelasticity

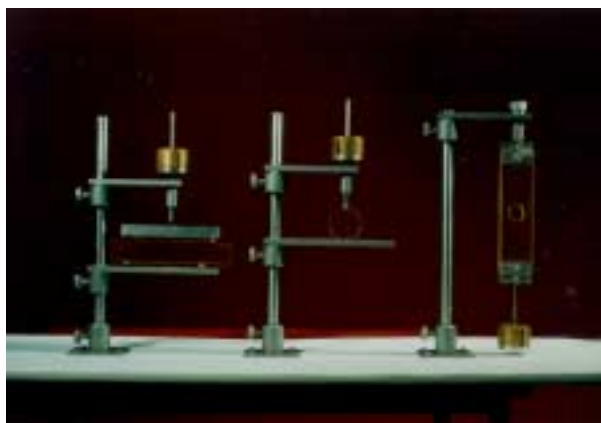
STRESSMASTER POLARISCOPE S-1

This Stressmaster is an economically-priced polariscope which has a 152 mm optical field and offers a full analytical capability in photoelastic stress analysis. Primarily designed for educational use, on the basis of an instrument for each student in a study group, the polariscope can also be used to advantage in industry for the optimisation of new product designs.

TECHNICAL SPECIFICATIONS

The facilities offered with the Stressmaster polariscope cover the study of both isoclinics and isochromatics, as well as the measurement of fractional fringe orders by the Senarmont or Tardy methods.

A wide variety of model shapes can be analysed using the table-top polariscope. Photoelastic models, produced in Photoflex material, may be loaded in tension, compression or bending to suit analytical requirements. The loaded models can be viewed in white light or, alternatively, in an approximate monochromatic light by simply swinging a green filter into the polarising field.



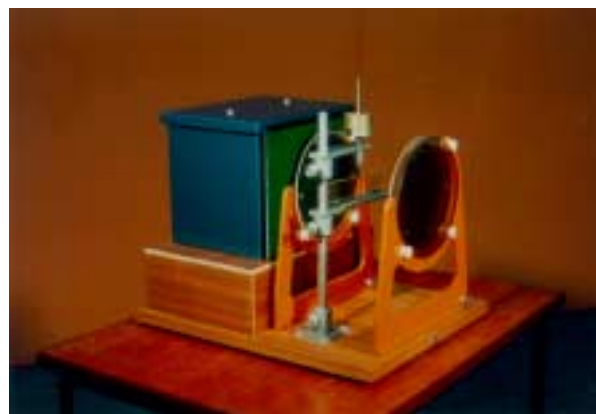
-Model loading on the Stressmaster polariscope is made by means of a deadweight system, utilising various attachments for tensile, compressive and bending loads, as shown.

-Optical Field : 152mm diameter

-A wooden cover is provided for enclosure of the polariscope when the unit is not in use.

-Standard model shapes include beams, tension members, discs and hooks.

- A standard set of six photoelastic models is supplied, together with step-by-step instructions and experimental results.



PRINCIPAL TEACHING OBJECTIVES

The Stressmaster polariscope can be utilised for the programmed learning of photoelastic principles.



USING YOUR EQUIPMENT

Dimensions and weight

Width : 305mm; Length: 380mm; Height: 310mm

Unit Weight : 9Kg

The manufacturer reserves the right to modify the apparatus without notice –11/04

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SOLID MECHANICS

Elasticity and Photoelasticity

GENERAL PURPOSE STRAIN VIEWER S-18

This General Purpose Strain Viewer has been designed to cover a wide range of strain viewing applications. It can be applied to the quality control inspection of glass and plastics components and may be employed as a vertical or horizontal viewing instrument. The working space available within the unit enables a wide variety of components to be accommodated for band held examination in polarised light.



The General Purpose Strain Viewer being used in the vertical working position.

APPLICATION

Two alternative sources of illumination are available with the General Purpose Strain Viewer. The instrument can be supplied either with 'white light' illumination for the strain viewing of glass and acrylic articles or with 'white light' and monochromatic light for the additional inspection of components produced in such materials as polystyrene, plastics etc.

TECHNICAL SPECIFICATIONS

- The standard General Purpose instrument incorporates a light source, an analyser with quarter wave plate and a polarising element with quarter wave plate. For the strain viewing of glass and acrylic components, a full wave plate can be incorporated in the optical system.
- Removable covers on the instrument facilitate the insertion and withdrawal of the full wave plate and also provide easy access to the light sources.
- Two sets of rubber mounting feet are provided on the casing of the instrument to allow vertical or Horizontal modes of operation.
- Viewing Field : 260 mm x 260 mm square
- Working Throat: 260 mm



USING YOUR EQUIPMENT

Optional Equipment

Monochromatic illumination (Ref. S-18a)
Full Wave Plate : (Ref. S-18b)

Dimensions and weight

445 x 280 x 280mm – 15 Kg

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SOLID MECHANICS

Elasticity and Photoelasticity

RHEOELECTRICAL ANALOGY APPARATUS ER300

Many physical problems depends on the Laplace equation and can be solved by numerical analysis. This rheoelectrical analogy apparatus, using conductor paper to form the model, gives a rapid experimental method of solution.

The simplicity of the method makes it an ideal tool for practical works or for solving problems in a wide variety of fields as stress analysis, heat transfer, fluid mechanics, aerodynamics, soil mechanics, electrical and magnetic fields, etc.

The rheoelectrical analogy apparatus is a compact and very accurate instrument thanks to its stabilized power supply and digital voltmeter. It is also suitable for industrial applications as well as for experiments and for research purposes.

The apparatus include 24 independent channels, each adjustable by different potentiometers on a range of 0 to 20 volts by controlling the voltage on a digital voltmeter. The current is of 15 mA at the maximum potential.

The independent design of each channel allows to eliminate any electronic interaction between each channel and makes it possible to adjust quickly a large number of channels simultaneously.



The scale model, geometrically similar to the piece to study, is cut out from a sheet of conducting paper. The electrical potentials are then applied proportionally to the known limit conditions. Edges or other boundaries requiring a constant potential are drawn using a conducting silver paint.

TECHNICAL SPECIFICATIONS

Mains fuse	100 mA, 250 V
Voltmeter	0 – 20 VDC with digital display
Number of channels	24 potentiometers
Maximum current	15 mA per channel
Conducting paper resistance	1000 Ω per square
Number of connexion plugs	6
Voltage probe (stylus)	1
Number of connexion wires	24

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ANALOGUE FIELD PLOTTER ER300

TEACHING OBJECTIVES AND APPLICATIONS

Photoelasticity

The apparatus can be used for the separation of principal stresses and for the determination of stress trajectories.

Beam theory

Shear stresses in deflected beams can be studied with the apparatus.

Heat transfer

Heat conduction problems in furnaces, insulated pipes, etc... sources and sinks of heat can be study by rheoelectrical analogy. Materials of different thermal conductivity can be study.

Aerodynamics

The flow pattern around various obstacles can be drawn quickly.

Fluid mechanics

The streamlines and equipotentials can be drawn and the velocity values calculated. The effects of a source or a sink can be vizualized.

Soil mechanics

The complete flow network in a porous medium can be drawn. From this network, the rates of seepage, uplift pressures and the hydraulic gradients can be determined. Using an adjustable potential from one of the channels allows the effects of drainage on the seepage flow to be investigated.

Electrical and magnetic fields

Problems of electrical and magnetic fields can be investigated with the aid of this apparatus. It is possible to incorporate capacitance, inductance and impedance effects.

USING YOUR EQUIPMENT

Power supply : 220V - 50Hz

Conducting paper :

The apparatus is designed for using with Anaplot conducting paper with a resistance of about 1000 Ω by square.

Dimensions and weight

Dimensions : 250 x 325 x 150 mm

Net weight : 4.5 kg

The manufacturer reserves the right to modify the apparatus without notice – 11/04

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MECHANICAL TESTS

Testing Machines

STRAIN GAUGE EXTENSOMETER SYSTEM EI620

Extensometer are used to measure elongation during the mechanical testing of test specimens, models and structures. The DELTALAB EI602 is a strain gauge extensometer with a reference length of 20 mm. It can be used with the DELTALAB EI612 dual channel transducer indicator. It can also be connected to other measuring equipment including strain bridges or universal testing machines.

TEACHING OBJECTIVES AND APPLICATIONS

Measurement of samples and structures elongation during elastic and plastic deformation prior to rupture.

TECHNICAL SPECIFICATIONS

- Reference length: 20 mm
- Sensitivity: 0.1 mV / micro-strain
- Resolution: + 5 micro-strains
- Measurement range : +/- 20 000 $\mu\text{m/m}$
- Linearity: 0.1%
- Dynamic response: 10 Hz
- Gauges resistance: 350 Ohms
- Strain gauge: platinum-tungsten
- Supply voltage: 5 V
- Extensometer weight: 20 g
- Extensometer dimensions: 31 x 25 x 10 mm

Description of the transducer / indicator EI612

Designed for direct connection to strain gauges, the unit powers the extensometers, amplifies the signals and displays the result in μdef on a digital format. The unit can be used simultaneously with two extensometers and each values can be displayed with the help of a switch. Two analogue outputs (+/-2V) allow simultaneous data acquisition and recording of both channels.

Description of the strain gauge extensometer EI602

The extensometer can be fixed to the test sample by the help of springs or circlips. The platinum tungsten strain gauges are mounted in full bridge configuration and are hot bonded at high



Extensometer conditioner readout EI612 for two extensometers EI602

EQUIPMENT PACKAGE

Standard equipment EI620

- Extensometer EI602
- Two-channel signal transducer / indicator EI612
- Technical manual

The EI602 is to use only in the elastic or plastic field. It is suited for using with metals samples NB. The EI602 may be used with other signal transducers.

temperature on a high elastic limit material. The reference length of the extensometer can be adjusted with the help of a central pawn after mounting on the test sample. End stops built into the extensometer prevent plastic deformation during the fixing or during testing going to the breaking of the test sample.

USING YOUR EQUIPMENT

Essential requirements

230 V, single phase, 50 Hz or 60 Hz
Fixing springs or circlips

Dimensions (l x w x h) and mass

EI612: 256 x 105 x 84 mm - 1.8 kg

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SOLID MECHANICS

Testing Machines

UNIVERSAL TESTING MACHINE 50 KN EM550

This 50 kN electro-mechanical universal testing machines is used in a wide range of applications in strength of materials for static tests. The testing machine accept many types of materials and components as well as complete assemblies and structures.

The EM550 is an industrial design electro-mechanical testing machine with a capacity of 50 kN in tensile and compression mode, adapted for the particular needs of engineering colleges, research and quality control . Tests may be carried out as a function of speed, stress or strain.

The analogue/digital interface and the software provided with the EM550 form a complete package allowing control, data acquisition and analysis using a PC computer. The advanced, user-friendly software is presented in toolbox form that demands no particular programming knowledge.

Data analysis and presentation can be effected off-line. Data from current and previous runs may be transferred as ASCII files for use with spreadsheet and other software.



TECHNICAL SPECIFICATIONS

- Machine control through PC compatible microcomputer
- Dedicated interface card with 4 simultaneous channels (force, cross-head displacement, extension and additional analogue input)
- CN Interface mounted in PC
- 12-bit data acquisition and control
- 0-50 kN tensile/compression load range
- 1 000 mm height under cross-head
- 400 mm column clearance
- 0.5 - 350 mm/mn cross-head speed
- 2 twin row recirculating ball screw drives
- Resolution of the displacement sensor : 0.01 mm
- Screen display of force and displacement
- DC motor with tachometric generator (or optional Brushless induction motor, recommended for servo-driven creep testing)
- Safety shield around test zone

PRINCIPAL TEACHING OBJECTIVES

The universal test machine allows a wide range of tests, including :

- Tension, compression and bending
- Standard specimen testing
- Cycling up to 1 Hz
- Creep testing
- Fretting and fatigue
- Assembly and structure tests

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UNIVERSAL TESTING MACHINE 50 KN EM550

EQUIPMENT PACKAGE

We offer the following equipment :

Standard equipment EM550

- Universal testing machine of 50 kN capacity
- Analogue/digital interface
- Control and data acquisition software
- Technical manual



Extensometer ref V25/10

Additional required equipment :

- Strain-gauge load cells with capacities 50 kN ref EM650/1
- Strain-gauge load cells with capacities 5 kN ref EM605
- Set of 3X10 cylindrical test samples (Brass, Dural, steel) ref EM560
- We can offer the following precision extensometers:
 - LVDT induction extensometer Lo 25 to 200 mm ΔL 10 mm ref V25/10
 - Strain gauge extensometer ref EI602

Other extensometers may be adapted for particular requirements

- Set of chuck grip 50 KN ref TH89-50
- Set of wedge grip 50 KN ref TH243-50
- Set of jaws flat 1X45° pyramid ref TH243-BP
- Set of V-jaws for round samples 4-12 mm ref TH243-BV12
- Consult Deltalab for supply of special grips, compression platens, or any other special accessories
- PC computer
- Printer



TH 89-50 & EI602



Compression platen TH23-156

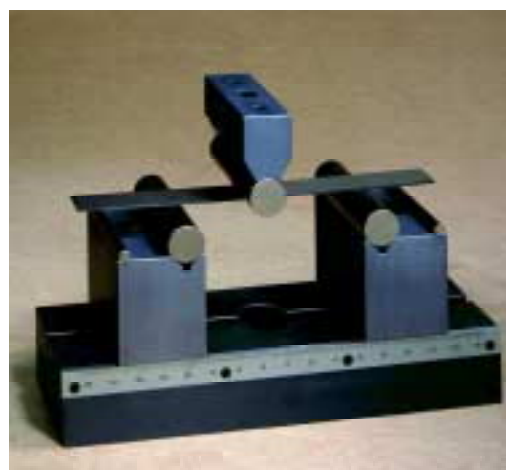
USING YOUR EQUIPMENT

- 230 V single phase, 50 Hz, 1 kW
- Personal computer, IBM compatible with RS232 free port

Dimensions (l x w x h) and weight

Dimensions : 700 x 600 x 1600 mm

Weight : 250 Kg



Bending grip ref TH22 360

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SOLID MECHANICS

Testing Machines

UNIVERSAL TESTING MACHINE 100 KN EM1100

This 100 kN electro-mechanical universal testing machine is used in a wide range of applications in strength of materials for static tests. The test machine accept many types of materials and components as well as complete assemblies and structures.

The EM1100 is an industrial design electro-mechanical testing machine with a capacity of 100 kN in tensile and compression mode, adapted for the particular needs of engineering colleges, research and quality control.

Tests may be carried out as a function of speed, stress or strain.

The analogue/digital interface and the software provided with the EM1100 form a complete package allowing control, data acquisition and analysis using a PC. The advanced, user-friendly software is presented in toolbox form that demands no particular programming knowledge.

Data analysis and presentation can be effected off-line. Data from current and previous runs may be transferred as ASCII files for use with spreadsheet and other software.



PRINCIPAL TEACHING OBJECTIVES

The universal test machine allows a wide range of tests, including :

- Tension, compression and bending
- Cycling up to 1 Hz
- Fretting and fatigue

- Standard specimen testing
- Creep testing
- Assembly and structure tests

The manufacturer reserves the right to modify the apparatus without notice – 11/04

Headquarters:

259, rue du Rocher de Lorzier

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Tél. : 33 (0)4 76 35 05 35 – Fax : 33 (0)4 76 35 14 19

www.deltalab.fr

UNIVERSAL TESTING MACHINE 100 KN EM1100

TECHNICAL SPECIFICATIONS

- Fully computer-controlled via PC
- Specific interface :
 - 4 channels
 - Acquisition and control : 12 bits
- Force range : 0 to 100 kN Traction and Compression
- Speed range : 0.5 mm/min to 350 mm/min
- Drive system : Brushless motor with twin recirculating ball screws
- Maximum crosshead travel : 1200 mm
- Horizontal clearance : 600 mm
- Extension measurement : integral crosshead movement encoder. Resolution : 0.01 mm
- Full control of all test functions and analysis from PC.
- Strain gauge load cell Capacity ± 100 KN - grade 1 (other on special requirement)
- Display of the de strength and the displacement on screen
- Extensometer input compatible with all LVDT or strain gauge extensometers
- Conform to EMC regulation.

EQUIPMENT PACKAGE

Standard equipment for EM1100

- Universal test machine of 100 kN capacity
- Analogue/digital interface
- Control and acquisition software
- Technical manual

Additional required equipment :

- Strain-gauged load cells with capacities 100 kN or others ref EM6110
- We can offer the following precision extensometers:
 - LVDT induction extensometer Lo 25 to 200 mm dL 10 mm ref V25/10
 - Strain gauge extensometer ref EI602

Other extensometers may be adapted for particular requirements

- One set of wedge grip 100 kN, Ref. TH109-100
- One set of flat jaws 1x45° pyramid 0-20 mm, Ref. TH109-EBP20
- One set of jaws for samples \varnothing 5-20 mm, Ref. TH109-EBV20
- Consult Deltalab for supply of special grips, compression platens, or any other special accessories
- PC computer
- Printer

USING YOUR EQUIPMENT

Essential requirements

- 380 V three phase, 50 Hz, 3.5 kW
- Personal computer, IBM compatible with RS232 free port

Dimensions (l x w x h)

1180 x 800 x 2200 mm

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Extensometer ref V25/10



Wedge grip 100 kN, TH109-100



SOLID MECHANICS

Testing Machines

TORSION TESTING MACHINE EM400

The DELTALAB EM400 torsion testing machine has been design to perform torsion testing on a broad range of specimens. It has a maximum torque rating of 600 Nm and a rotation speed that can be varied between 0.1 and 250 radians/min. The headstock is electro-mechanically operated.

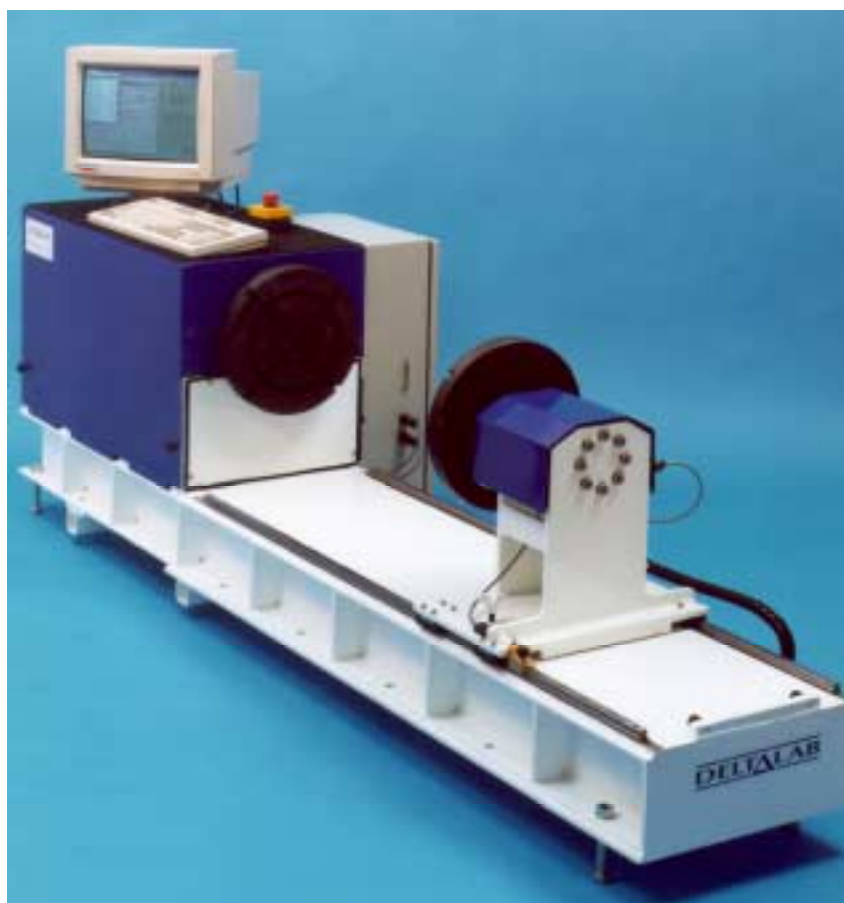
The integrated analogue/digital interface and software are used for control, data acquisition and analysis using an IBM compatible PC.

Specimens and components of various sizes and materials can be used with the EM400. Tests may be carried out at fixed or variable speed, in continuous or alternate mode as a function of torque, speed or acceleration.

APPLICATION

The torsion test machine allows a wide range of tests and experiments, including :

- Torsion in solid rod, transmission components (cable, clutch etc)
- Fatigue testing in torsion up to 1 Hz



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TORSION TESTING MACHINE EM400

TECHNICAL SPECIFICATIONS

The EM400 is based on a horizontally mounted rigid frame including:

- An electro-mechanical driven system
 - An adjustable tailstock mounted on rails with a locking facility
-
- Maximum torque : ± 600 Nm
 - Distance between platens : from 0 to 1 000 mm
 - Axis high: 300 mm
 - Specimen grips : grooved platens of 300 mm diameter and a set of conical jaws
 - Torsion measurements are made using two strain gauges torque meters, one of capacity 600 Nm the other 60 Nm, class 0.5
 - Rotation speed : 0.1 to 250 radians/mn (other ranges on request)
 - LVDT linear transducer : +/- 5 mm stroke for measuring tailstock displacement
 - Incremental angle transducer : accuracy 0.002 radians
-
- Integrated control, data acquisition and processing system:
 - Control and data acquisition interface
 - Software on Windows® 98 to XP
 - Machine control in torque or displacement mode
 - Torsion tests in continuous or alternate mode
 - Creep and relaxation tests

EQUIPMENT PACKAGE

We offer the following equipment :

- Standard equipment EM400
- Test machine with welded steel chassis for floor mounting
- Control and acquisition interface
- Software

Optional equipment

- Test furnace for tests up to 500°C
- Special capacity torque meter

USING YOUR EQUIPMENT

Essential requirements

Personal computer IBM compatible with RS232 free port.
230 V single phase or 380 V 3 phases, 50 Hz

Dimensions (l x w x h) and mass

EM400 : 226 x 70 x 70 cm - 280 kg

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SOLID MECHANICS

Testing Machines

COMBINED MANUAL HARDNESS TESTER ROCKWELL, BRINELL AND VICKERS 206RT

- It can be used for any type of metallic material and plastics as well.
- It is possible to carry out tests on any parts even if small dimensioned.
- The sturdy piece-holder column assures an exact measurement on any detail.
- The bellows guard guarantees a constant and safe motion with no need of maintenance.
- It has been designed to obtain the best reliability through time and result accuracy as well.
- The proof loads can be selected by a rotary knob and accuracy index.
- The operating principle is the classic Rockwell's principle with direct Rockwell's hardness on a large dial.
- Brinell's hardness is also obtained directly with application of a graduated dial, or by tables.
- Preload takes place by the contact of the piece with the indenter.

TECHNICAL SPECIFICATIONS

Preload	10 kgf (98,07 N)
Test loads	60-100-150 Rockwell (588-980-1470) N 62,5-125-187,5 Brinell (612-1225-1838) N 10-60 Vickers (98,07-588) N
Working	Rockwell traditional
Possible tests	Rockwell HRC A-D-B-F-G-L-M-R Brinell HB 30, HB 10, HB 5
Reading	Rockwell, Brinell + Vickers
Reading resolution	0,5 HR
Conform standard	EN-ISO 10109 / 6508 / 10003
Height capacity	215 mm
Depth capacity	190 mm
Diameter of column	60 mm
Diameter of anvil	60 mm
Max load of test piece	1000 kg
Field of application	For all metals, steel, hard steel, cast iron, bronze, aluminium over 0,6 mm, plastics, soft and hard rubber
Net weight	65 kg
Packing weight	85 kg
Packing measures	3740x102 cm

Standard

- 1 HRC diamond penetrator
- 1 HRB ball penetrator Ø 1/16"
- 1 HRC test block
- 1 HRB test block
- 1 Flat anvil
- 1 "V" anvil
- 1 Combined spot "V" + flat anvil
- 1 Wooden case
- 1 Calibration certificate
- 1 Hardness conversion table
- 1 Dust cover

At request

- Ball penetrator in hard metal Ø 5-2,5-1 mm (1/2" - 1/4" - 1/8") for plastic
- Vickers penetrator
- Brinell test block
- Vickers test block
- Microscope 1216 Model for Vickers measures
- Special penetrator art. 604 for tests insides of tubes
- Large flat anvil 140 mm Ø



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SOLID MECHANICS

Testing Machines

COMBINED DIGITAL Hardness Tester ROCKWELL, BRINELL AND VICKERS CRBV

For Laboratories, tool rooms, inspection departments, educational institutions, foundries etc. requiring accurate and reliable measurement of hardness in metals, alloys and plastics by Rockwell, Brinell or Vickers methods. Suitable for all types of material, hard or soft, whether flat, round or irregular in shape. RS232 output as standard to printer or computer. Also Accept/Reject signals and Upper and Lower limit selection. Other features include automatic zero setting, controlled dead weight and lever system, bellows covering, and robust, totally enclosed anti-deflection frames for keeping mechanism free from dirt.

For all Rockwell Hardness testing on 17 scales at loads of 60, 100, and 150 Kgf.

For Brinell testing at 187.5Kgf load on 2.5mm ball ($F/D^2 = 30$) for either conventional Brinell testing using Brinell microscope or by direct reading repetition testing. For Vickers testing at loads of 30 Kgf .

TECHNICAL SPECIFICATIONS

- For Rockwell Hardness testing on 15 scales at loads of 60, 100, and 150 Kgf.
- For Brinell testing at 187.5Kgf load on 2.5mm ball ($F/D^2 = 30$) for conventional Brinell testing using Brinell microscope or by direct reading repetition testing.
- For Vickers testing at loads of 30 Kgf (HV30) on 3kgf pre-load
- Maximum Test Height: 275 mm
- Depth of Throat: 133 mm
- Electronic Digital Display
- RS232 Statistics output for printer or computer
- Upper and lower limit selection
- Accept/Reject Signals
- Auto Zero
- Controlled dead weight and lever system
- Robust, totally enclosed anti-deflection frames

Standard equipment

- Pre-Load Selection – 3 or 10kgf
- Weights for Main Load 30, 60, 100, 150kgf (Rockwell)
- Weights for 187.5kgf (Brinell)
- Weights for 30 kgf (Vickers)
- Diamond Indentor for Rockwell Test
- $1/16$ th" dia Ball indentor for Rockwell Test with additional balls
- 2.5mm dia Ball indentor for Brinell Test with additional balls
- Diamond Indentor for Vickers Test
- Test Blocks B and C Scales, also Brinell and Vickers
- Flat Anvil 50mm Hardened and Ground
- Vee Anvil 35mm Hardened and Ground
- Bellows Cover for protection of elevating column
- Allen Keys and Dashpot oil
- Instruction Manual

Optional equipment

- Flat Anvil 200mm Hardened and Ground
- Raised Centre Spot Anvil 16mm Hardened and Ground
- Vee Anvil 70mm Hardened and Ground
- $1/8$ ", $1/4$ ", $1/2$ " dia Ball Indentors
- Brinell Microscope
- Printer



USING YOUR EQUIPMENT

Essential requirements

Voltage supply : 220 V – 50 Hz

Dimensions (l x w x h) and mass

500x220x800 mm – 80Kg

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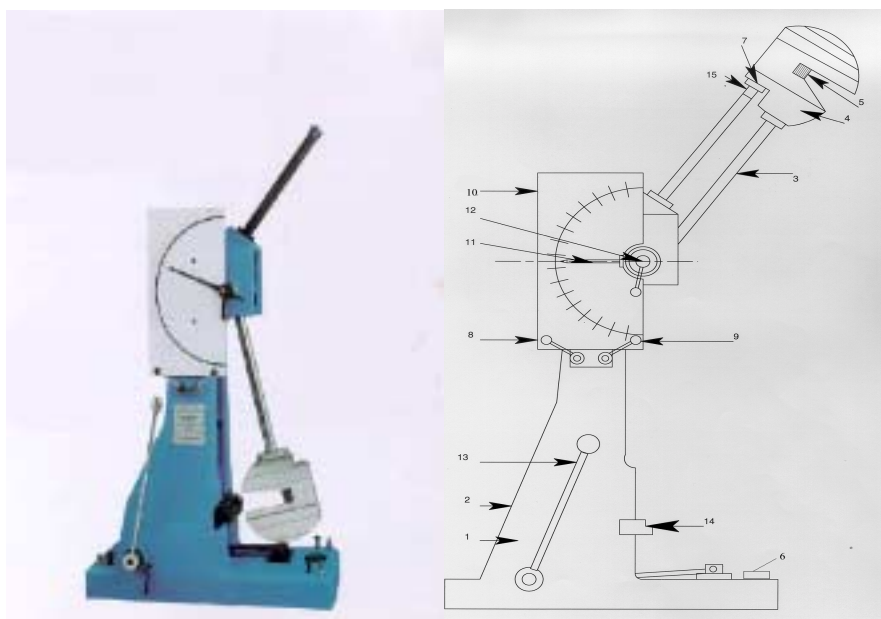


SOLID MECHANICS

Testing Machines

PENDULUM IMPACT TESTER IT 30 ASTM

The Pendulum impact tester consists of a falling pendulum hammer supported by a sturdy frame. The pendulum is assembled between two columns via anti-friction bearings which limit the losses by friction to 0,75% of maximum energy. Solid cast construction ensures high accuracy. The pendulum, in the high position, has a given potential energy which is converted into kinetic energy during its fall. The maximum kinetic energy is reached immediately before the impact. The absorbed energy by the test-sample at the instant of the failure is measured by the height of the pendulum after impact, on a scale graduated in Joules. All the hammers, fasteners and gauges for adjustment are provided. Samples can be prepared with different kind of notches.



1. Base equipped with test sample support
2. Column
3. Pendulum tube
4. Pendulum hammer
5. Striker for Charpy test
6. Spirit level
7. Lock for Charpy test
- 8.9. Unlock arm of the pendulum
10. Dial
11. Pointer indicating
12. Pointer support
13. Brake
14. Support of test-sample
15. Tube for locking Charpy test

TECHNICAL SPECIFICATIONS

Test Angle of fall	140°
Pendulum weight	21.3 Kg
Kinetic Energy	300J
Graduation of the scale	2 J
Distances between the rotation axis and the test sample	775 mm
Height between the point of percussion above the center of the test sample	+/- 7.75 mm
Impact speed	5.182 m/s
Apparatus certified to European standards EN-UNI-ISO-DIN-BS-NF	
Manual lift system of the load	

- Tooling to prepare the samples are not supplied as standard and can be supplied on special inquiry
- Samples are not supplied as standard

USING YOUR EQUIPMENT

Optional equipment

- Electronic data acquisition system 3CA03
- A steel safety guard with pneumatic triggering ref 3CA02

Dimensions (l x w x h) and weight

L x W x H : 1400 x 500 x 1900 mm
Weight : approx 450 Kg

Other equipment :

- IZOD and CHARPY pendulum ref IT30
- Other pendulum in 15N, 25N, 100 N, 400N

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SOLID MECHANICS

Testing Machines

ROTATING FATIGUE MACHINE

HSM 19

- Self-contained and bench mounted
- Fully guarded
- Digital readout of revolutions to failure
- Motor stops when specimen fails
- Necked specimens, steel, aluminium alloy and brass
- Optional extra for alternating bending fatigue



PRINCIPAL TEACHING OBJECTIVES

1. To make an introductory study of fatigue using a Wohler rotating fatigue apparatus, including the time to failure caused by various stress levels and materials.
2. The accessory, HSM19X affords bending fatigue of a cantilevered strip of metal or plastic in modes varying from alternating to fluctuating stresses.

TECHNICAL SPECIFICATIONS

This machine has been designed to introduce students to the effects of fatigue. A simple cantilever specimen rotates at about 5700 or 1425 revs/min, inducing a sinusoidal variation of bending stress. At the faster speed, a third of a million stress reversals occur each hour, so failure should occur within a day. Failure can be hastened by using a specimen with a stress raiser. The loading system cancels its own self weight enabling any desired value of bending stress to be applied, ten mild steel specimens are supplied. Axiality has been ensured, and care has been taken to reduce the effects of vibration. When failure occurs, a micro switch stops the motor and the cycles to failure are registered on a 5 digit revolution counter.

All rotating parts are shielded and a safety guard is provided to restrain the broken specimen. The apparatus is mounted on a heavy steel base plate and is designed to overhang the bench or pedestal on which it is placed. Ideally a heavy pedestal (eg concrete), isolated from the floor by rubber matting, should be used to minimise shock loads. An additional accessory for alternating bending fatigue and additional specimens are available. This equipment is part of a range designed to both demonstrate and experimentally confirm basic engineering principles. Great care has been given to each item so as to provide wide experimental scope without unduly complicating or compromising the design. Each piece of apparatus is self-contained and compact. Setting up time is minimal, and all measurements are made with the simplest possible instrumentation, so that the student involvement is purely with the engineering principles being taught. A complete instruction manual is provided describing the apparatus, its application, experimental procedure and typical test results.

USING YOUR EQUIPMENT

Essential requirements

Electrical Supply, Single Phase 220/240 V AC - 50 Hz, 110/120 V AC - 60 Hz. To be specified on order.

Optional equipment

- HSM19X Alternating Bending Fatigue supplement for HSM19

This provides an alternating displacement of 0 to 20mm at the free end of a cantilevered strip 20 to 60mm long, 5 to 10mm wide and up to 5mm thickness. For testing plastics a lower frequency of about 24Hz can be used. By adjusting the position of the cantilever clamp any stress regime from fully alternating to fluctuating can be selected. The instruction manual for this accessory contains full details and monograms to assist in setting up the test specimens.

- HSM19a (for HSM19 only) Mild steel specimen (10 off), HSM19b Aluminium alloy specimen (10 off), HSM19c Brass specimen (10 off)

Dimensions (l x w x h) and weight : 600x230x360 mm – 37 Kg

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COMPLEMENTARY EQUIPMENTS

We can supply on special request with prior authorization complementary equipments in the following fields :

Strength of Materials :

SM1011	Thick cylinder apparatus
SM1008	Diaphragm apparatus
SM106	Creep machine
HSM1:	Deflection of Beams Apparatus
HSM1B:	Deflection of Beams Apparatus
HSM1C:	Advanced Beam Testing Apparatus
HSM2:	Torsion of Bars Apparatus
HSM3:	Eccentrically Loaded Tie Apparatus
HSM5:	Extension of Wires Apparatus
HSM6:	Compound Wires Apparatus
HSM7:	Extension of Springs Apparatus
HSM8:	Compression of Springs Apparatus
HSM9:	Internal Elastic Forces Apparatus
HSM10:	Deflection of Curved Bars
HSM11:	Combined Bending and Torsion Apparatus
HSM12:	Critical Load on Struts
HSM15:	Critical Conditions of Struts
HSM16:	Torsion of a Spiral Spring
HSM17:	Calibration of Electrical Resistance Strain Gauges
HSM18:	Electrical Resistance Strain Gauge
HSM18C:	Compression Accessory
HSM18T:	Tension Accessory
HSM20:	Alternating Bending Fatigue Machine
SAN801:	Strut Buckling Apparatus

Structures :

HST1 :	Standard frame for HST experiments
HST1/0:	Tensile Modulus of Elasticity
HST1/1:	Equilibrium of Forces
HST1/2:	Equilibrium of Parallel Forces
HST1/3:	Equilibrium of a Rigid Body
HST1/4:	Equilibrium of a Beam
HST1/5:	Member Forces in a Truss (Resolution)
HST1/6:	Member Forces in a Truss (Sections)
HST1/7:	Suspension Cable
HST1/8:	Simple Suspension Bridge
HST1/9:	Electronic Measurement of Strain
HST1/10:	Shear Force
HST1/11:	Bending Moment
HST1/12:	Deflection of Beams
HST2/1:	Tension Coefficients
HST2/2:	Three Dimensional Equilibrium

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COMPLEMENTARY EQUIPMENTS

HST2/3:	Torsion of Rods and Tubes
HST2/4:	Deflection of Beams and Cantilevers
HST2/5:	Laminated Spring
HST2/6:	Area-Moment Method
HST2/7:	Deflection of an Eccentric Tie
HST2/8:	Shear Centre Apparatus
HST2/9:	Unsymmetrical Bending
HST2/10:	Strain Measurement for Structures
HST2/11:	Calibration of Electrical Strain Gauges
HST2/12:	Column Buckling Failure
HST2/D:	Euler Struts
HST3/1:	Deflection of Beams
HST3/2:	Deflection of Trusses
HST3/3:	Deflection of Frames
HST3/4:	Deflection of Curved Bars
HST3/5:	Three-Hinged Arches
HST3/6:	Shear Force Influence Lines
HST3/7:	Bending Moment Influence Lines
HST3/8:	Suspended Centre Span Bridge
HST3/9:	Suspension Bridge
HST3/10:	Beam Stiffness and Carry Over Factors
HST3/11:	Continuous Beam
HST3/D:	Moment Distribution
HST4/1:	Virtual Work
HST4/2:	Plastic Bending
HST4/3:	Plastic Bending of Portals
HST4/4:	Redundant Truss
HST4/5:	Two-Hinged Parabolic Arch
HST4/6:	Parabolic Arch with Fixed Ends
HST4/7:	Deflection of Ring and Square Frame
HST4/8:	Deflection of Rectangles
HST4/9:	Three Span Continuous Bridge
HST4/10:	Two Dimensional Bending
HST4/D:	Maxwell-Betti Theorem
HST5/1:	Free Vibration of Horizontal Cantilever
HST5/2:	Free Vibration of Vertical Cantilever
HST5/3:	Forced Vibration of a Cantilever
HST5/4:	Transient Force at Cantilever Base
HST5/30:	Structural Dynamics Kit
SAN 802 :	Suspended beam apparatus
SAN 803 :	Two hinged arch beam apparatus
SAN 805 :	Deflection of curved bars apparatus

Other equipments on special request.

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