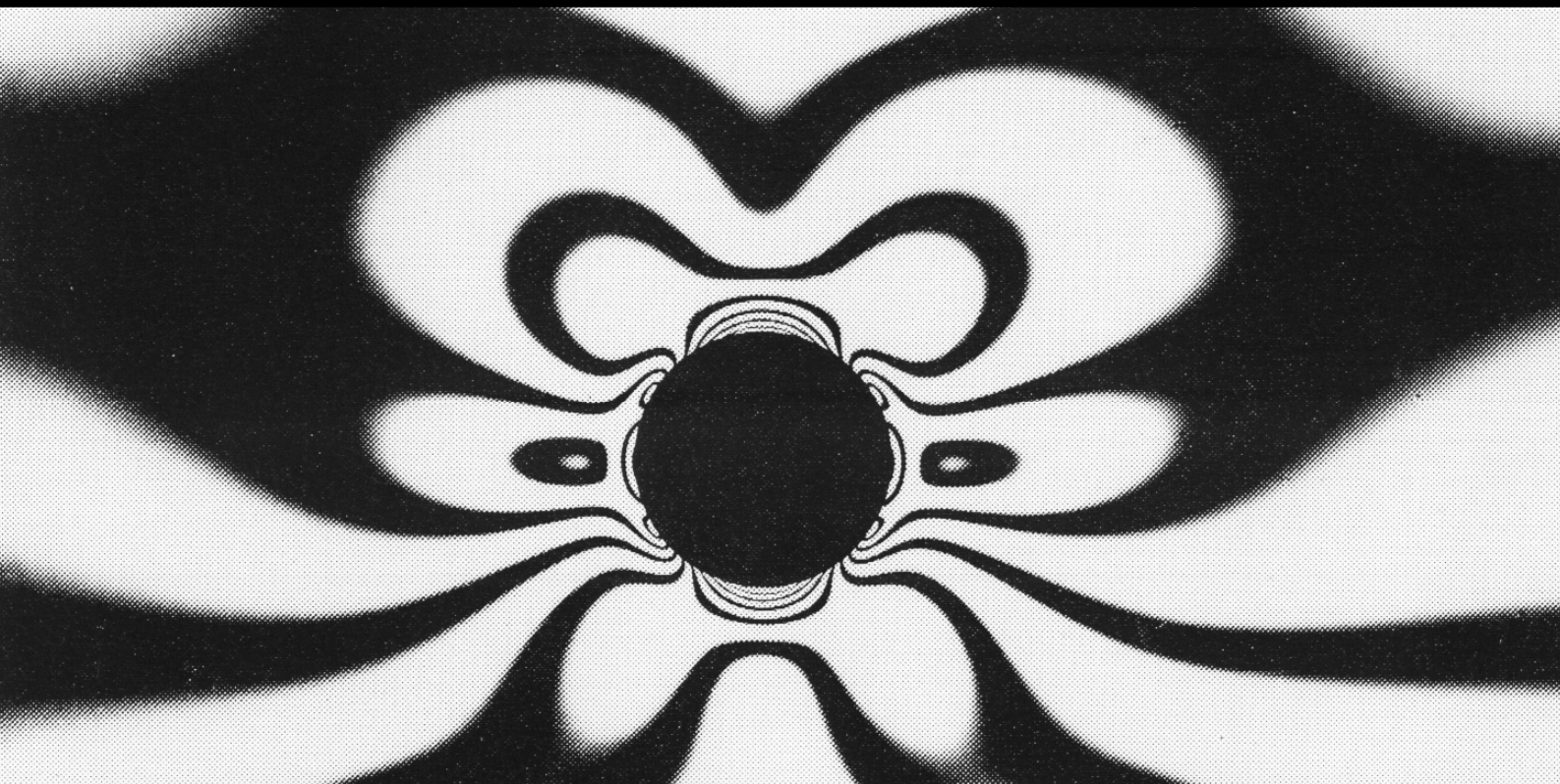


Stress in Components
Easily Visualized



Photoelasticity

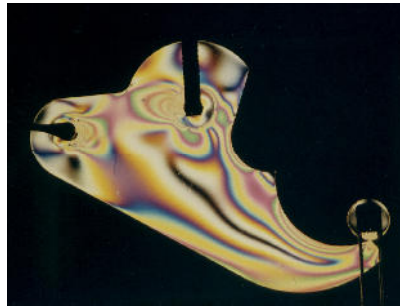
TIEDEMANN

Photoelasticity

Instruments for the Control of Stresses in Components

Photoelasticity is an experimental method to determine stress distribution in a material. The method is based on the property of birefringence, which is exhibited by certain transparent materials. Stress distribution can be studied in the translucent bodies by using polarized light. This method is mostly used in cases where mathematical methods become quite cumbersome.

Tiedemann offers an extensive product range in the field of photoelasticity, ranging from polarisation films with different degrees of polarization, retardation films to device types with different light sources and filter size. We offer reflection polariscopes, projectors, stepper filter to a number of equipment for example multiplication.



extensive product range in photoelasticity, ranges from different degrees of films to device types with and filter size. We offer polariscopes for overhead motor driven polarization models and special for isochromats

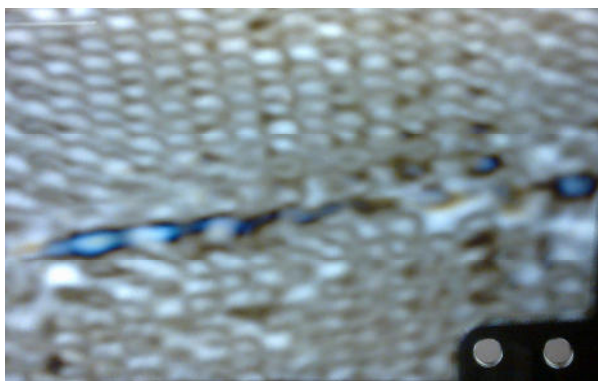
Calibration devices for determining the photoelastic constants and the elastic modulus of the model material, load frames and ring dynamometers complete the range of the standard equipment of a photoelastic laboratory.

Some of these devices are shown in detail below.

Applications

By today's available computational methods, such as the finite element method, stress test calculations are now mainly carried out on the computer. Nevertheless, photoelasticity is a good and rapid method to understand and analyse complicated stress conditions in models.

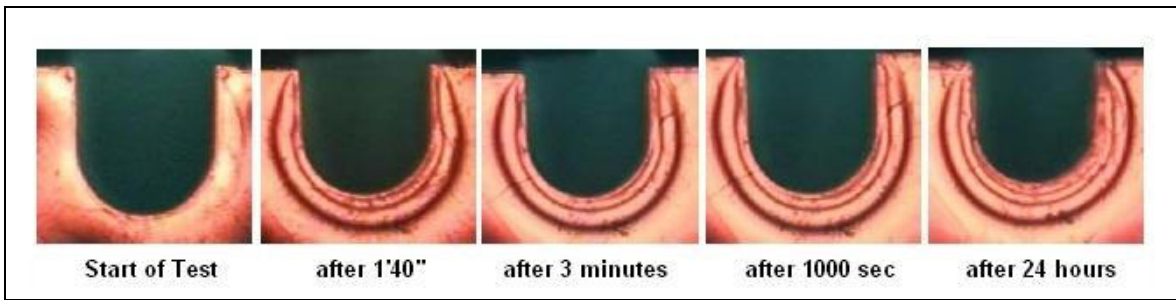
As such, today the Tiedemann photoelasticity devices are frequently used for material testing along with the quality assurance, for example by adhesive or glass manufacturers and their customers. The quality assurance can check by looking into the polariscope, if automobile windshields, headlights or glass vessels are free of stress or have reached a specific state of stress. In dental technology, for example, the adhesive force of filling material into teeth can be explored.



Safety Glass of a Tractor



*PET Bottle Blank
w/o and with faults*



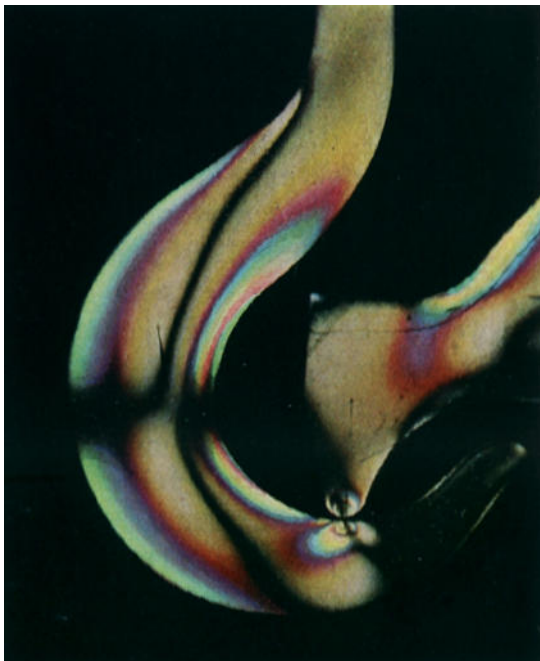
*Increasing strain by hardening the composite material in a model of tooth cavity
(Theses, Kristin Klinger, Marburg 2004)*

Another application is the use in school lessons and university teaching engineers in materials science and design, because photoelasticity is the only method to make stress in components visible. The transparent resin models of birefringent materials are investigated for charges that may arise in practical application. These loaded models are simply placed in the polariscope. The stress distribution in the model is compatible with that in the real component.

Principles

Photoelasticity evaluates stress of models or components made of transparent birefringent plastics by polarisation optics. The loaded model will be investigated between crossed polarizing filters. In the transmitted light two systems of lines appear as result of birefringence. The "isochromatics" (lines of the same colour) are a measure of the principal stress difference. The black lines are called "isoclines". They depend on the direction of the tension.

Such a fringe pattern with "linearly polarized light" can be obtained even without the often annoying isoclines when "circularly polarized light" is used. This can be achieved by placing additional quarter wavelength plates in front of and behind the model in the optical path of the polariscope.



*Loaded hook in
linearly polarized white light*



*Loaded hook in
circularly polarized white light*

The Polariscope

For more than 60 years Tiedemann has been built a large number of suitable polariscopes for different applications and customer demands.

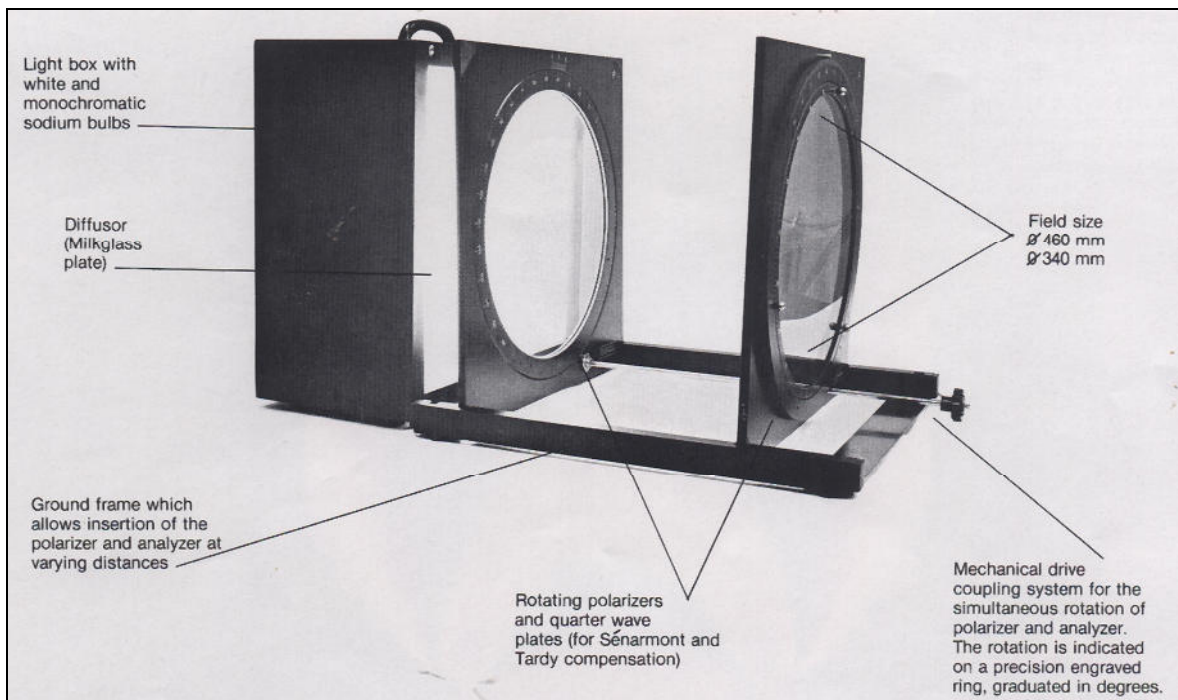
Diffuse Light Polariscope

One popular device is the Tiedemann diffuse light polariscope with compensation analyser. This polariscope can be conducted in the most qualitative and quantitative photoelastic studies. All filters are glued between glass plates to avoid scratches and newton rings and lead to the best optical quality and life time. The device consists of several components:

- Light box with diffuse white and monochromatic light source
- Frame for different distances of the filters and load frames
- Polarizer/quarter wavelength combination
- Compensation analyser with two scaled and pivoted polarizing filter and quarter-wave plate for Sénarmont and Tardy method for quantifying orders of main stress at each point in the model or tested sample.

The Polariscope are available in two diameters:

- Type A and AS: Field of view 340 mm in diameter
- Type B and BS: Field of view 460 mm in diameter



Polariscope Type AS or BS

Portable Polariscopes

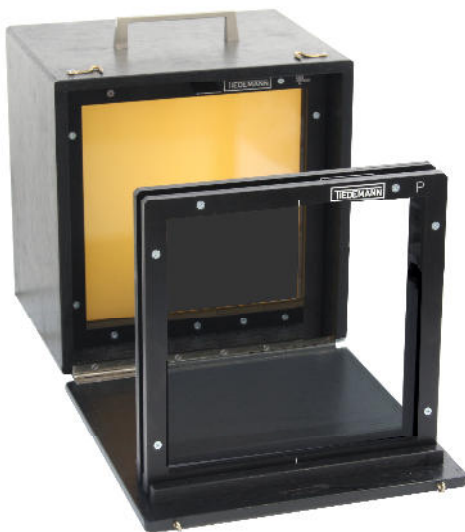
Portable polariscopes are diffuse light polariscopes for linear and circular semi quantitative photoelasticity. Because of its versatility, its ease of handling and reasonable price, it is very often used. All parts of the polariscope (lamps, diffuser, polarizers and cable) are in the housing virtually packable. The fold-down front lid serves as a base plate, into which the filter can be inserted, and the model is placed. All filters are glued between glass plates as well. Furthermore, the filters can also be used for other applications.

Tiedemann offers different portable polariscopes:

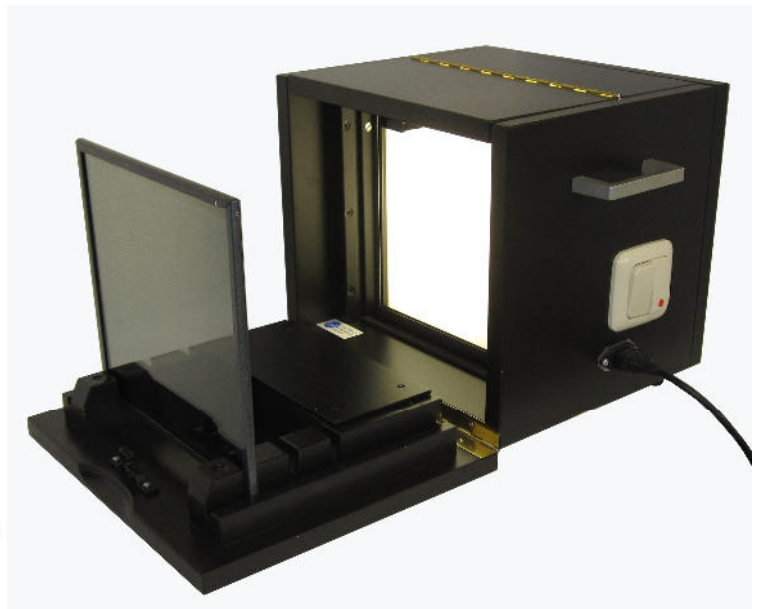
The Type C has white light only and two single polarization filters for linear polarisation. The field of view is 190 x 190 mm.

Type D is somewhat larger with a field of 215 x 215 mm. The light can be switched between white and sodium light. The filters for D and the following polariscopes are made for linear and circular photoelasticity. The filters of polariscope D can be fixed in a special attachment for overhead projectors.

The larger polariscopes are Type AQ with a field of view of 390 x 390 mm and Type BQ with 470 x 470 mm.



Portable Polariscope Type C



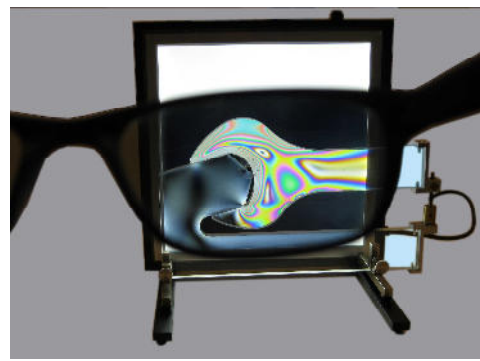
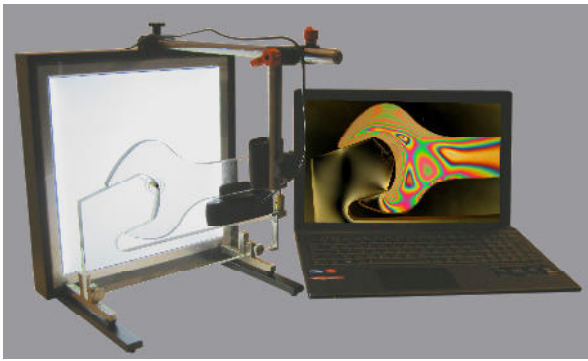
Portable Polariscope Types D, AQ and BQ

Lecture Polariscopes

Special polariscopes are needed for lectures in bigger auditoriums. We offer two different options, the LED polariscope for beamer and another one for overhead projector.

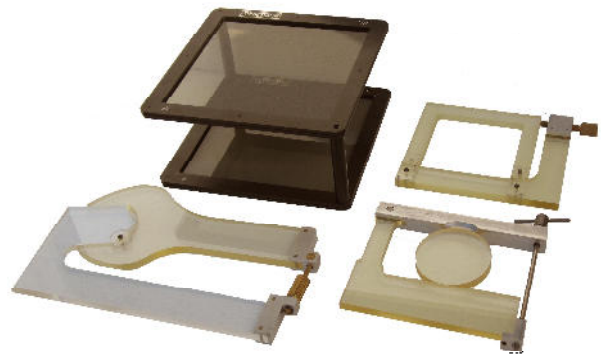
LED Polariscope for Beamer

This polariscope is made by a flat light box for white light with filter for circular polarisation. Further a camera is mounted in the right position with the second circular polarization filter. The camera can be connected via USB to a computer. This polariscope may be placed vertical or horizontal and fits with all our demonstration models. The lecturer may explain the stress pattern in the models with a view on his monitor or by using our analysis glasses. Of course all our polariscopes can be adapted to a camera for beamer presentations.



Polariscope for Overhead Projector and Flat Models

A simple way to demonstrate stress conditions in models by photoelasticity offers the overhead projector attachment. Between two frames with stretched polarization films simply placed on the overhead projector, flat loadings frames can be placed.

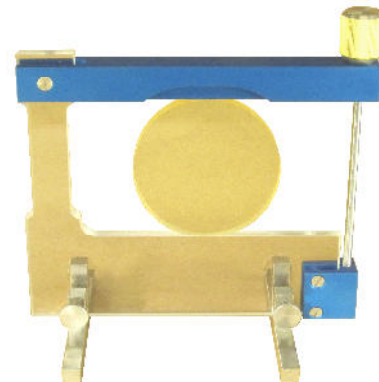


Specifications

Field of view: 250 mm x 250 mm

Load frames: 3 pieces

Models: screw wrench,
L-frame with bearing
circular disc,
U-frame

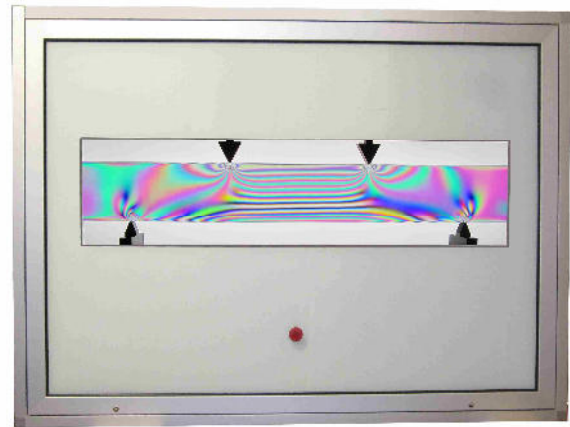


Special Polariscopes

Besides the polariscope models shown above we offer special solutions for large industrial applications or museums. Polariscopes with nearly any size can be created. They are used e.g. for the investigation of safety glass in the automotive industry, stretched films in the plastic industry or for presentations on exhibitions or museums.

The previously manufactured special polariscopes range from fields of view of 48 x 48 cm up to 191 x 126 cm. They can be standing or hanging. They consist of a light box with white lighting, a frosted glass and the circular polarization film. The analyser could be stretched in a frame the same size. Alternatively, instead of a large analyser a portable analyzer in the size of about 48 x 48 cm is an option as well as our analyser glasses.

These special polariscopes are available on request only.



Reflection Polariscope

Unlike the transmitted light polariscopes above the reflection polariscope works as an incident light polariscope, even over long distances. The model is irradiated with almost parallel light. On the back of the only a few millimeters thick model a matte silver paint is applied. The model can then be loaded in the loading frame or alternatively is glued on the body to be examined.



The polarized light passes through the model that is reflected on the back side and passes through the analyser to a camera that displays the result on a computer screen. The filter are stepper motor driven. Due to the double pass through the model the reflection polariscope is twice as sensitive as the transmitted light polariscope.

Load Frames and Models

For accompanying explanation of the method of photoelasticity, the demonstration of elementary and complex stress states and for practical experiments in engineering education different photoelasticity models have been developed. With the models tension rod, bending beams smooth or with different notches, frame corners, screw wrench, wall and disks etc. Tiedemann offers a comprehensive overview of experimental strength theory and for structural design. Beside the flat models (s. above) we offer a kit 16 models or 5 models, always including the fitting load frame.

Load Frame with Large Model Kit

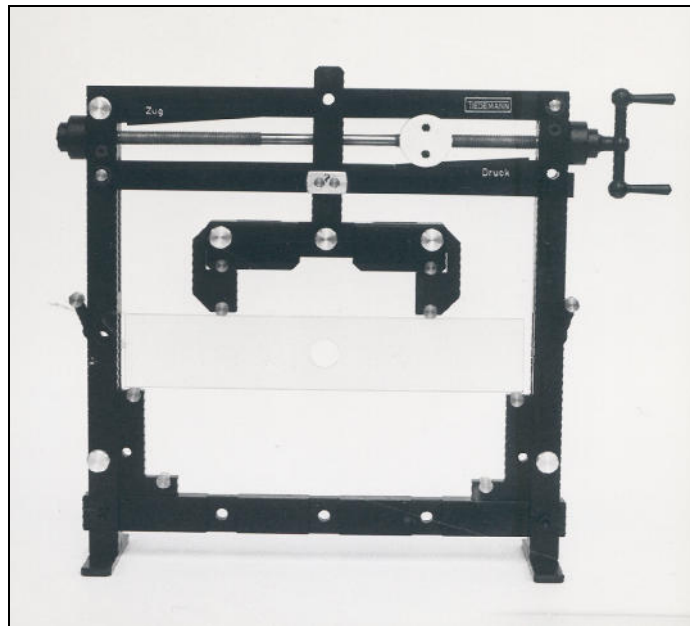
The stresses in the components can be ideally demonstrated through this load frame placed in a polariscope. Tensile, compressive and bending forces can be applied.

With its models, it is often used in technical training for materials science and structural design. It is particularly impressive to demonstrate the influence of notches or holes on the stress distribution.

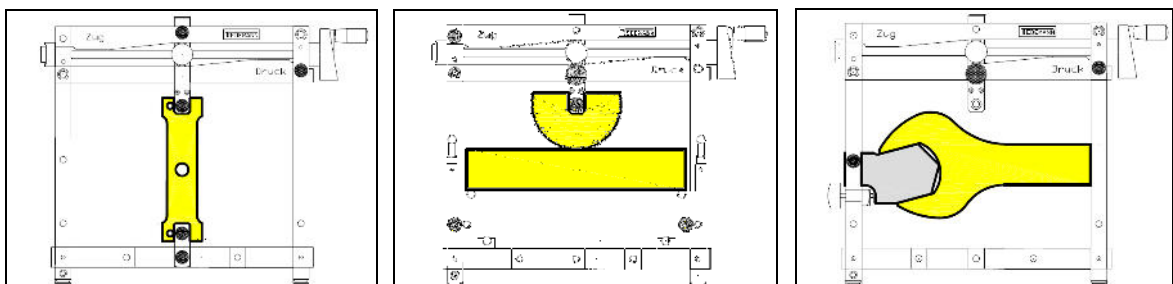
Tiedemann has compiled a set with 16 models, which provides a comprehensive overview of the basic strength and constructive design. All 16 models can be loaded in this frame, usually two loaded models can be viewed simultaneously. The load and fasteners are attached with locking pins and are easily replaceable.



The load frame and the models are clearly laid out in an aluminum case. We include a textbook, outlining all experiments described here.



Load frame with circular hole model



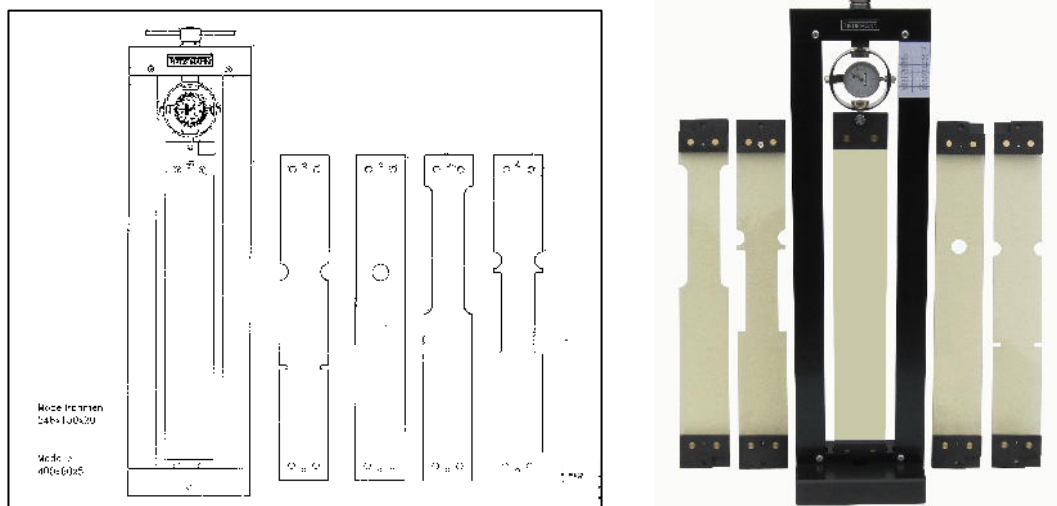
Specifications

Load frame:	Mechanical framework for tensile, compressive and bending forces
Models:	1 wall model with cuts 1 flat wrench model 6 tension models (different widths, circular hole, with a notch, two notches, with rib) 7 beam of bending models (with different heights, centric circular hole, with a notch, with two notches, with rib, model of armoured concrete with a limp and prestressed reinforcement) The seven bending models can be mounted as a cantilever as well 1 frame model for tensile and compressive force
Model material:	Polycarbonate
Packaging:	all conveniently in aluminum laminated suitcase

Tension Frame with Five Models

Tiedemann also provides a framework for quantitative tensile load. The frame has a drawing spindle, an analogous ring dynamometer for force measurement and a holder for the tension models.

The set of five different models are included. The models can be easily fixed by plugging in the frame. The framework and the models are designed for the large polariscope.



Tension force frame with dynamometer and five models

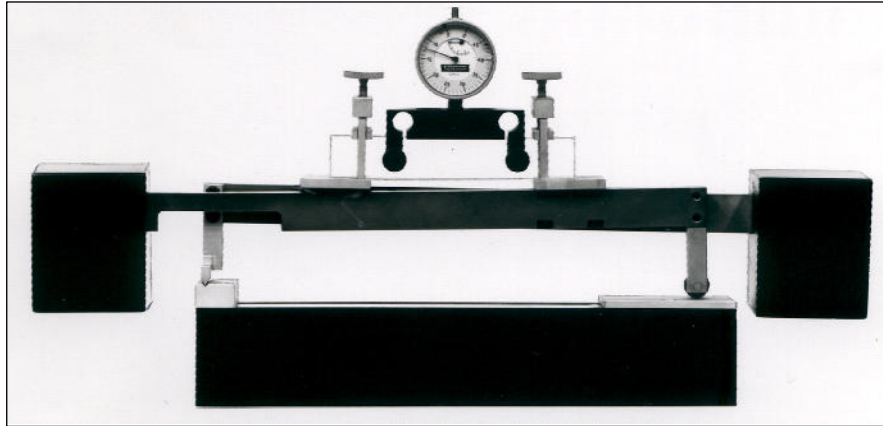
Specifications

Load frame:	Mechanical load frame for tension forces
Tension measurement:	analog ring dynamometer 10 kN
Models:	5 models (without a notch, with a circular hole with two notches, with constriction, with constriction and notch)

Calibration Device

Calibration Device EV 208 with Elastic Modulus Measurement Tool

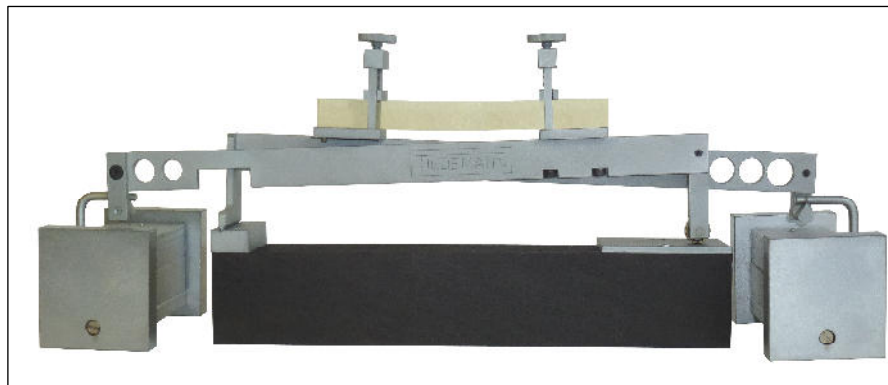
In the calibration device EV 208 a prismatic test bar with rectangular cross section is loaded with a pure bending moment of 8 Nm. The device is designed primarily for the testing of plastics and is preferably used to determine the photoelastic constant S - in conjunction with the elastic modulus tool EW 220 - also for determining the modulus E .



Calibration device EV 208 together with the elastic modulus measurement tool EW 220

Bending Crawling Expansion Device BK 230

The device allows the same measurements as the EW 220, but in addition to the investigation of bending crawling expansion of plastics. Into the bending crawling expansion device a prismatic test specimen is loaded with a rectangular cross section for a pure bending moment. For generation of the bending moment two load levers act (lever arm 30 cm) with weight forces caused by weight sets, which can (50 g to 2 kg, gradation 50 g) be varied for a 0.5 to 6.5 Nm bending moment.



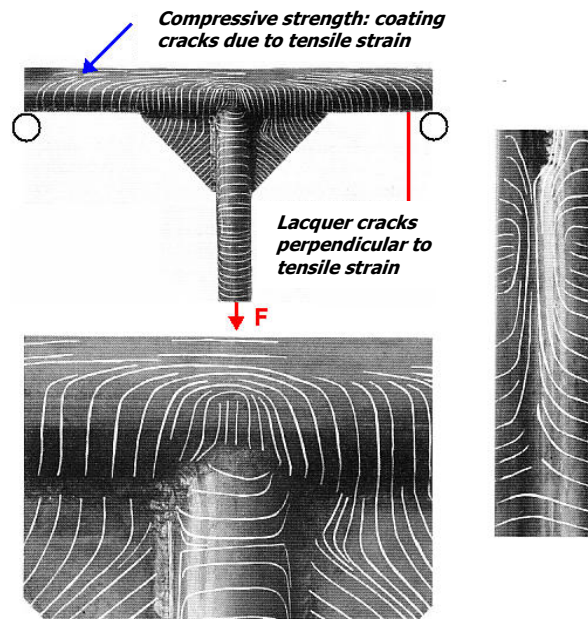
Specifications

Dimension of test bar:	Height:	14 mm - 24 mm
	Width:	20 mm
	Length:	min. 60 mm to determine S min. 100 mm to determine E
Weight:	EW 220: 6,5 kg	BK 230: 5,4 kg
Tool Dimension:	EW 220:	410 x 60 x 170 mm
	BK 230 :	410 x 120 x 170 mm

Lacquer Crack Technique - Makes Tiny Strains Visible

With the lacquer crack technique from Tiedemann smallest variable loads and expansions can be easily seen on the original functional element.* The lacquer crack was originally introduced by Maybach, 1924 and Stress coat, 1938.

As a result of using this technology you will get the main strain directions, areas of strain concentrations and the order of magnitude of the biggest main expansion. You can estimate strain below 10^{-4} .



T-tube with support tin, W. Bergmann (1956)

The well-tried, ready-made „Maybach-Lacquer“ needs to be heated and painted on the heated functional element. After cooling you can put strain on the functional element. The areas of expansion become directly visible for direct evaluation or photo documentation.

The Tiedemann Lacquer Crack is made from natural ingredients, nontoxic and environmental friendly.

Lacquer crack: 500g-container, ready for use incl. paint brush



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