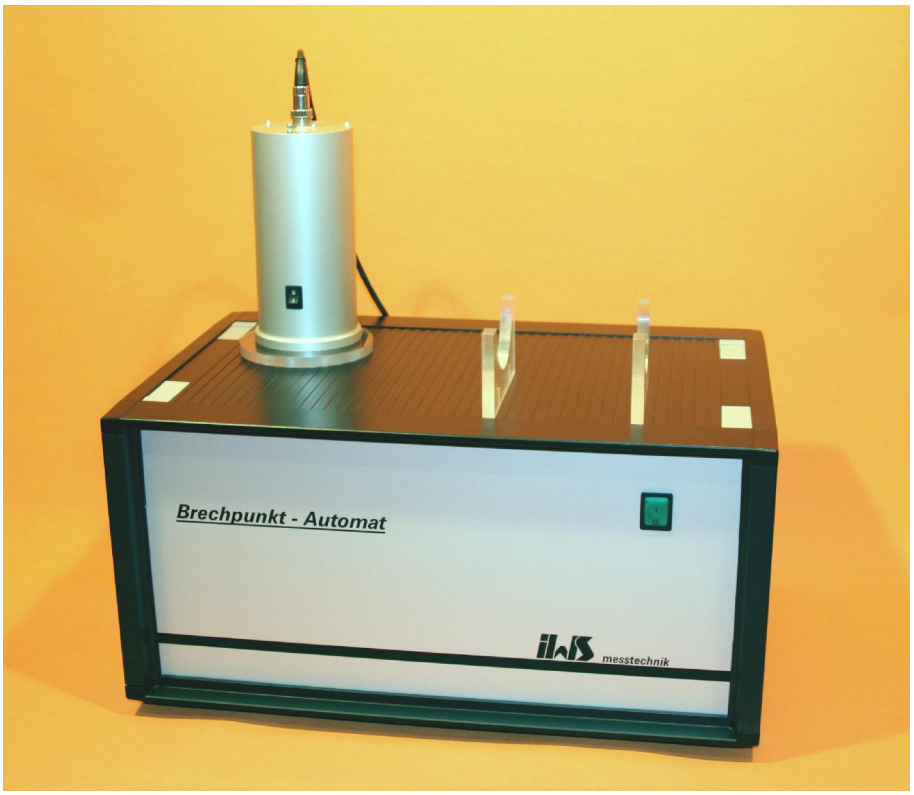


Automatic Breaking Point Analyser IWS- BPA®

for determining the Fraass breaking point according to EN 12593

messtechnik

Your partner for innovative material testing and quality assurance in road construction

Frostiness is a significant stress factor for bituminous road pavements. Bituminous material is thus tested under sub-zero temperature for a long time.

For many decades the "determination of the Fraass breaking point" has been proved to be a reliable indicator for the rheological characteristics of bitumen and bituminous binders at low temperature.

Unfortunately the hand operated test procedure according to the standard has several drawbacks.

For more than 10 years we have been able to offer an automatic analyser which optimises the test procedure:

Breaking Point Analyser IWS- BPA®

The construction and the measurement procedure of the Automatic breaking point analyser IWS – BPA® is based on to the European Standard EN 12593 (Bitumen and bituminous binders: determination of the Fraass breaking point).

It offers the following features to facilitate your work and further to improve the quality of the results:

- **continuous force measurement up to detection of the breaking-point**
- **fully-automatic regulation of the flexure-run of the test plate**
- **PC-based, fully-automatic cooling and regulation of the test chamber temperature**
- **glass insert for easy cleaning of the test chamber**
- **digital camera integrated into the wall of the test chamber for continuous monitoring of the test plate**
- **fully-automatic heating of the test chamber up to the surrounding temperature after the breaking point has been attained. This considerably reduces the amount of the condensation water in the test chamber and on the bending apparatus.**

- **realisation of a very fast test procedure by optimised regulation within the range of permissible cooling rates specified in the standard.**

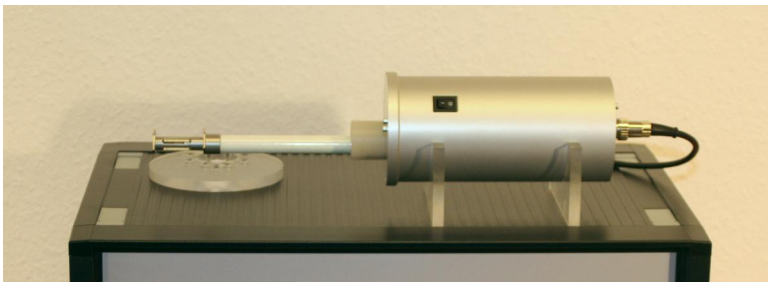
  Cooling is carried out at a cooling rate of approx. 4-5°C/ min until the moment the cooling chamber has reached a temperature approx. 12° C higher than the temperature at the beginning of the flexure. Thereafter the cooling rate gradual decreases up to 1 °C/ min according to the standard or up to the selected cooling rate of your special test. The stipulated cooling rate of the test is achieved when the temperature of the test chamber is approx. 3°C higher than the temperature of the first flexure.

- **The computer stores the complete data of each test procedure in a separate file. The software offers data evaluation and issue of test certificates with graphic charts.**

Test assembly:

The test assembly of the Automatic Breaking Point Analyser consists of the following components:

- **Automatic Breaking Point Analyser IWS-BPA® with the bending apparatus places on the device**



The bending apparatus has a **fully-automatic bending mechanics**, which moves the retention clips by means of a stepping motor. The **integrated force sensor** measures the forces being generated during the bending process.

To minimize the effects of cooling on the bending mechanics and also to minimise cooling losses from the test chamber the tubes and sealing of the bending

apparatus are made of fiber-glass reinforced plastic with very low heat conductance.

Additionally, the breaking point analyser operates with a **complex temperature sensor system**.

The temperature sensor behind the retention clips monitors the temperature of the test chamber temperature within the range of the test plate (temperature of the chamber). The temperature sensor in the lower range of the wall of the test chamber monitors the housing temperature. Finally a temperature sensor on the cooling element of each Peltier element detects the temperature of the cooling water flow.

The measured temperature data displayed on the monitor are continuously updated. This permits permanent controlling of the automated cooling process.

The test chamber is surrounded by a microprocessor controlled cooling system based on **Peltier elements**. The secondary circuit including a cooling water connection allows test to be carried out with an additional refrigerated/ heating circulator.

A glass insert permits easy cleaning of the test chamber.

A digital camera integrated into the wall of the test chamber permits continuous monitoring of the test plate during the entire test procedure.

The electronic measurement equipment based on microprocessors controls the test run and storage of the measured data via serial interface.

The Windows®-based software was developed for user-optimised operation of the device and data recording. Additionally, the software permits data evaluation and output of test certificates.

- **computer unit**

- **refrigerated/ heating circulator or tap water supply**

The automatic breaking point analyser can be connected to a tap water supply. The possible temperature

range for breaking point testing depends on the temperature of the tap water.

For lower breaking point temperatures it is necessary to use a refrigerated/ heating circulator.

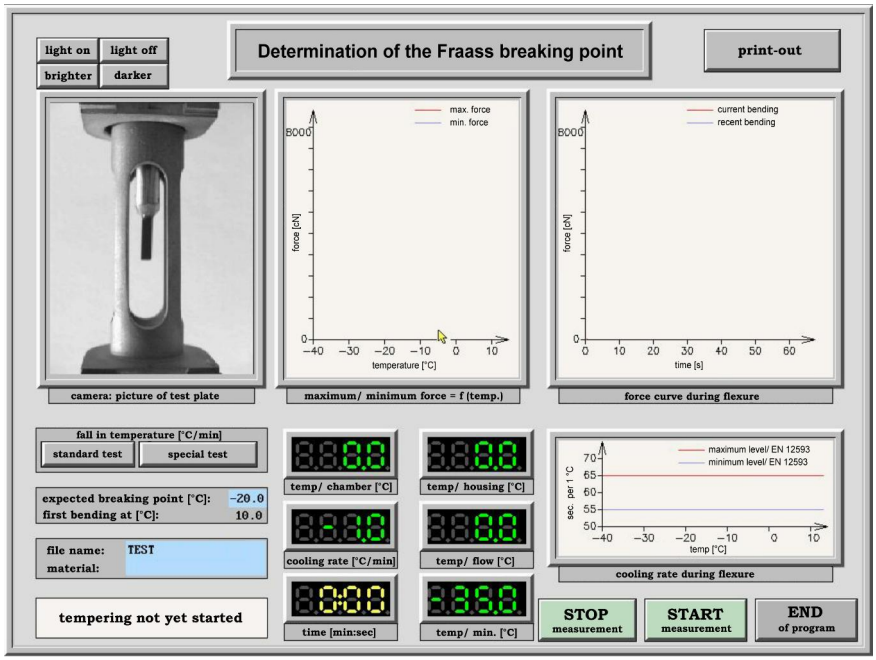
Reference values for cooling:

tap water (flow temperature: 10°C):
possible breaking point: approx. – 30°C
refrigerated/heating circulator (flow temperature: -10°C):
possible breaking point: approx. – 45°C
refrigerated/heating circulator (flow temperature: -20°C):
possible breaking point: approx. – 50°C

Graphic monitor chart of the IWS-BPA®

All functions of the automatic breaking point analyser are controlled by the PC software. Operation of the device is simply and user-optimised.

All instructions, measured variables and camera pictures are displayed in one chart on the computer screen, which is updated continuously. This permits permanent monitoring of the measurement status.



(Schematic presentation)

- test run settings, lower left:
  In this part of the monitor chart the settings for the next test run can be chosen:
  - temperature cooling rate according to the standard or special rates
  - temperature of the expected breaking point
  - file name and material

- camera picture:
  The camera of the BPA continuously records the retention clips with test plate. Clicking the button "light on" activates the LED-lamp in the test chamber. The brightness of the image presentation can be regulated with the buttons "light" or "dark".

- graphic diagram in the middle:
  This diagram shows the maximal and minimal force measured at the test plate during bending as a function of temperature over the cooling period.

- graphic diagram top right:
  This diagram shows the force curve of the current bending test (red line) and the previous bending (blue line).

- graphic diagram bottom right:
  This diagram shows the cooling rate during the complete bending test. The red and blue lines indicate the maximum and minimum cooling rates according to EN 12593. The requirement of the standard is 1°C/ min (60 seconds).

To minimise the duration of the test runs the regulation of the cooling rate has been optimised in accordance with the requirements of the standard.

Cooling is carried out at a cooling rate of approx. 4-5°C/ min until the moment the cooling chamber has reached a temperature approx. 12° C higher than the temperature at the beginning of the flexure. Thereafter the cooling rate gradual decreases up to 1 °C/ min according to the standard or up to the selected cooling rate of your special test. The stipulated cooling rate of the test is achieved when the temperature of the test chamber is approx. 3°C higher than the temperature of the first flexure.

In the upper middle of the monitor chart the following parameter are displayed:

- **"temp/ chamber [°C]":**
  temperature of the test chamber. The temperature sensor is installed behind the test plate retaining clips. This temperature is the reference temperature for the determination of the Fraass breaking point.

- **"temp/ housing [°C]":**
  temperature of the chamber housing (measured for regulation reasons)

- **"cooling rate [°C/min]":**
  cooling rate in the test chamber in degree per minute. According to the standard this cooling rate has to be 1°C per minute, if the temperature is higher than the temperature of the first flexure plus 3°C (temporary deviations between 0,9°C/1,1°C are permissible according to the tolerance).

- **"temp/ flow [°C]":**
  mean temperature of the coolant. This temperature is measured for control purposes. A difference between this flow temperature and the temperature of the housing of about 3-4°C indicates an incorrect rate of flow caused for example by clogged cooling ducts or a pump failure.

- **"time [min:sec]":**
  elapsed time for the current test run.

- **"temp/ min [°C]":**
  temperature up to which the prescribed cooling rate of 1°C/min (or special rate) can be complied with. This value is calculated on the basis of the flow temperature ands provides an indication the pre-cooling rate for the current test run has been correctly set.

The button on the lower left displays the current or the next working step (for example: "tempering not yet started").

Measurement procedure:

The operation of our automatic breaking point analyser is simply and user-optimised.

The test run consists of the following working steps:

1. **The test plate is placed in the retention clips of the bending apparatus.**
2. **The bending mechanics is lowered into the test chamber.**
3. **The temperature of the expected breaking point is entered into the computer.**
   The temperature for the first flexure will be determined automatically (= 10° C above the expected breaking point)
4. **Input of the file name of the test run:**
   The measured data are stored in a separate file under this name.
5. **Input "material":**
   This is intended for inputting individual material specifications.
6. **The test run is started by clicking the button „START measurement":**
   - The automatic breaking point analyser starts cooling at the highest possible cooling rate until a temperature approx. 12°C above the temperature of the first flexure is attained.
   - After reaching this temperature the cooling rate is automatically reduced.
   - At a temperature of approx. 3°C above the temperature of the first bending the cooling system works automatically with the standard cooling rate of 1°C/ min (or selected special cooling rate).
   - At 10°C above the temperature of the expected breaking point the bending apparatus performs the first flexure automatically.
   - Bending will be repeated automatically every minute up to the breaking of the test material.
   - If the test specimen doesn't break within the specified temperature, the test run can be stopped by clicking the button "STOP measurement". The test run can be stopped at any time by clicking this button.

At the end of the test run the test chamber is heated at the maximum speed up to 20°C. The housing temperature is afterwards maintained in the range + 15°/ + 30° C.

When the temperature of the test chamber is almost the same as the ambient temperature, the bending apparatus can be removed from the test chamber.

Printout:

At the end of the test run the measured data for the full duration of the test are stored in the data file allocated to the test run. It is now possible to evaluate the data or to print out a test certificate containing all relevant data and graphic diagrams (format of the printout: A4).