

# FORCE DUCTILITY

## EN 13589: Bitumen and bituminous binders – Determination of the tensile properties of modified bitumen by the force ductility method

### Overview

The test is used to determine the tensile properties of specially shaped specimens of bituminous binders under defined conditions of temperature, and speed of elongation.

The test results are used to address the cohesion characteristics of modified bitumen and bituminous binders.

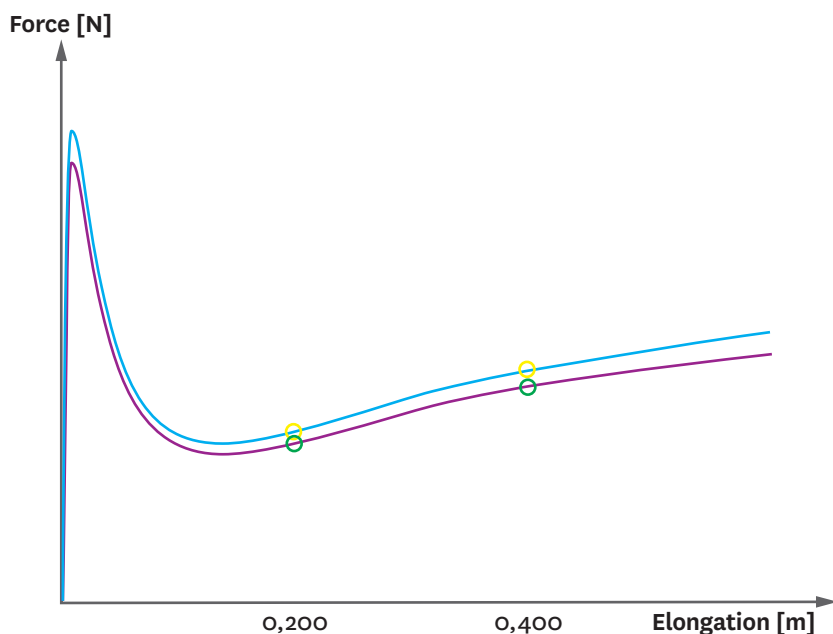
The test is performed in a water bath and usually carried out at 5 °C, but other test temperatures are also used.

### Definition and Terminology

Deformation energy  $E_i$ : Energy in Joules (J) applied in a specific specimen by elongation at the deformation,  $i$ .

Cohesion energy  $E_i^*$ : Quotient of deformation energy,  $E_i$  (in Joules) and the initial cross section of the specimen (in square centimetres).

Tensile force  $F$ : Force experienced by a specimen subjected to extension, expressed in N.



At the time of publication of this document, EN 13589:2018 'Bitumen and bituminous binders – Determination of the tensile properties of modified bitumen by the force ductility methods' was the reference for testing. This document does not overrule the test standard EN 13589, but is intended to help users of the standard to be aware of the important factors. However, the reference for testing remains EN 13589. Temperatures, times, and dimensions and their tolerances must be strictly observed, that is checked for accuracy and for maintaining the tolerance during application. From experience, tests should preferably be carried out by laboratory technicians trained in the individual procedures to be applied.

## Practical Information:

**The behaviour of bitumen is highly temperature-dependent, therefore precise temperature control of the water bath is critical.**

- The temperature of the water bath should be checked regularly for accuracy.
- The temperature measuring device should be regularly verified and/or calibrated.
- The thermostat of the water bath also needs to be checked regularly in case of off-sets.
- The sample must be given sufficient time to adjust to the test temperature, see section 6 of EN 13589. Also, respect the information given on maximum storage time in section 6 of EN 13589.
- Soft binders could require lower testing temperature; if the test temperature is 0 °C, ethanol or glycerol can be added to the water bath, see section 5.1.2 of EN 13589.

**The sample needs to be prepared for testing.**

- The sample preparation is described in EN 12594 and section 6 of EN 13589.
- The sample must not adhere to the base plate or the lateral walls of the mould.  
Apply a thin film of release agent, see section 6 of EN 13589.
- Be careful not to apply release agent to any other surfaces of the mould.
- The mould should be slightly heated and the sample poured in carefully to prevent air bubbles.
- The sample should be allowed to cool to room temperature for 1 - 2 h before trimming.
- Trimming of the sample should be done carefully to achieve an even sample surface and thus sample thickness.
- The trimmed samples need to be conditioned to the test temperature in the water bath for 80 - 100 minutes.
- Practical experience recommends being prepared for repeated testing by pouring more than three specimens.

**Testing and calculation of results.**

- All parts of the equipment should be regularly verified and/or calibrated.
- The test is usually carried out at 5 °C, but other test temperatures are also used.
- Three valid determinations are necessary for calculating test results.
- If the binder does not adhere completely to the clips (ends of the mould) during the test, discard the result and start testing with a new filled mould.
- In case of unknown binder grade, it is recommended to start testing at 5 °C with only one specimen. If the elongation of 0,400 m cannot be reached, increase the temperature by 5 °C and test a second specimen, otherwise maintain the temperature for testing three parallel specimens.
- Practical experience recommends a testing device with separate load cells to avoid interference of specimens.
- The sample is usually stretched for 0,400 m; if the sample breaks before an elongation of 0,400 m is achieved, both the cohesion and elongation must be reported.  
Only cohesion results obtained at elongation of 0,400 m can be used for specification purposes.
- Test results are calculated according to section 8 of EN 13589; this also defines acceptability criteria for test results.
- Results are usually given for cohesion energy together with the value for the elongation reached, and the test temperature.
- The cohesion energy is expressed as the arithmetic mean of three acceptable determinations, rounded to the nearest 0,01 J/cm<sup>2</sup>, if  $E_i^* < 1,0 \text{ J/cm}^2$ , and to the nearest 0,1 J/cm<sup>2</sup>, if  $E_i^* > 1,0 \text{ J/cm}^2$ ; see section 8 of EN 13589.
- After testing, the bitumen should be removed from the mould by placing it in an oven at 100-150 °C for 15-30 minutes. When the moulds are cooled, any remaining bitumen can be removed with a small amount of solvent.

