

Metallic materials — Tensile stress relaxation testing —

Part 2: Procedure for bolted joint models

The European Standard EN 10319-2:2006 has the status of a
British Standard

ICS 77.040.10

National foreword

This British Standard was published by BSI. It is the UK implementation of EN 10319-2:2006.

The UK participation in its preparation was entrusted by Technical Committee ISE/NFE/4, Mechanical testing of metals, to Subcommittee ISE/NFE/4/1, Uniaxial testing of metals.

A list of organizations represented on ISE/NFE/4/1 can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 November 2006

© BSI 2006

ISBN 0 580 49535 3

Amendments issued since publication

Amd. No.	Date	Comments

English Version

Metallic materials - Tensile stress relaxation testing - Part 2: Procedure for bolted joint models

Matériaux métalliques - Essai de relaxation en traction -
Partie 2: Mode opératoire pour modèles d'assemblages
boulonnés

Metallische Werkstoffe - Relaxationsversuch unter
Zugbeanspruchung - Teil 2: Prüfverfahren mit
Schraubenverbindungsmodellen

This European Standard was approved by CEN on 6 August 2006.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Contents

Foreword.....	3
1 Scope	4
2 Normative references	4
3 Terms and definitions	4
4 Symbols and designations	5
5 Principle.....	6
6 Apparatus	6
6.1 Bolted joint model device	6
6.1.1 General.....	6
6.1.2 Bolted joint model A.....	7
6.1.3 Bolted joint model bolt B	7
6.2 Extension measuring device	7
6.2.1 Measuring device for the overall length.....	7
6.2.2 Measuring device for the strain.....	7
6.3 Heating device.....	7
6.3.1 General purpose	7
6.3.2 Permissible temperature deviations	7
6.3.3 Temperature measurement.....	8
6.3.4 Calibration of the thermocouples and temperature measuring system	8
7 Shape, dimensions and preparation of bolted joint models	9
7.1 Shape and dimensions.....	9
7.2 Preparation	10
7.3 Determination of the original cross-sectional area.....	10
8 Test procedure	10
8.1 General.....	10
8.2 Tensioning of the bolt	10
8.2.1 General.....	10
8.2.2 Tensioning with bolted joint model A.....	11
8.2.3 Tensioning with bolted joint model B.....	11
8.3 Determination of the initial stress of the bolt	11
8.4 Heating, holding at temperature and cooling of the bolted joint model	11
8.5 Determination of the residual elastic strain	11
8.5.1 General.....	11
8.5.2 Unloading the bolt	12
8.5.3 Residual elastic strain with bolted joint model A.....	12
8.5.4 Residual elastic strain with bolted joint model B.....	12
8.5.5 Determination of the residual stress	12
9 Accuracy of the results	13
9.1 Expression of the results	13
9.2 Uncertainty	13
10 Test report	13
Annex A (informative) Information concerning different types of thermocouples	21
Annex B (informative) Information concerning methods of calibration of thermocouples.....	22
Bibliography.....	23

Foreword

This document (EN 10319-2:2006) has been prepared by Technical Committee ECISS/TC 1 “Steel - Mechanical testing”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2007, and conflicting national standards shall be withdrawn at the latest by April 2007

This European Standard consist of the following parts under the general title *Metallic materials – Tensile stress relaxation testing*:

- *Part 1: Procedure for testing machines*
- *Part 2: Procedure for bolted joint models*

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This part of EN 10319 specifies the test method for determining the stress relaxation of bolts tensioned in bolted joint models subjected throughout the test to overall constant strain and constant temperature conditions.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Not applicable.

3 Terms and definitions

For the purpose of this European Standard, the following terms and definitions apply.

3.1

nominal diameter (d)

diameter of the bolt in the cylindrical length L_c

3.2

thread diameter (D)

diameter of the threaded ends of the bolt

3.3

cylindrical length (L_c)

length of the cylindrical reduced section of the bolt

3.4

reference length (L_r)

base length of the bolt used for calculating strain

3.5

overall length (L_t)

overall length of the bolt

3.6

original cross-sectional area (S_o)

cross-sectional area of the cylindrical length of the bolt determined at ambient temperature prior to testing:

$$S_o = \pi d^2 / 4$$

3.7

extension

increase in the overall length L_t

A distinction is made between:

3.7.1

extension during tensioning (ΔL_o)

extension of the overall length L_t of the bolt during tensioning

3.7.2**elastic reverse extension during unloading (ΔL_t)**

back extension of the overall length L_t of the bolt during unloading at the end of the test

3.8**strain**

extension divided by the reference length L_r

A distinction is made between:

3.8.1**specified initial elastic strain (ε_{eo})**

initial elastic strain of the bolt at the beginning of the test

NOTE The specified initial elastic strain is calculated from the extension during tensioning ΔL_o ($\varepsilon_{eo} = \Delta L_o / L_r$) or is measured directly on the cylindrical length of the bolt with strain gauges.

3.8.2**residual elastic strain (ε_{er})**

strain calculated from the reverse extension ΔL_t ($\varepsilon_{er} = \Delta L_t / L_r$) or directly measured in the cylindrical length of the bolt with strain gauges during unloading of the bolt at the end of the test

3.9**stress**

at any time during the test, force divided by the original cross-sectional area (S_o) of the bolt between:

A distinction is made between:

3.9.1**initial stress (σ_o)**

stress at the start of the test, expressed as a product of the static elastic modulus E_T at the test temperature and the specific initial elastic strain ε_{eo}

$$\sigma_o = E_T \times \varepsilon_{eo} \quad (1)$$

3.9.2**residual stress (σ_{rt})**

value to which the stress of the bolt has relaxed at the specified time t , after the test, expressed as the product of the elastic modulus E_T or E_{Td} and the residual elastic strain

$$\sigma_{rt} = E_T \times \varepsilon_{er} \quad (2)$$

NOTE The dynamic modulus of elasticity E_{Td} should be taken, if the static modulus of elasticity E_T at test temperature is not available.

4 Symbols and designations

The symbols and corresponding designations are given in Table 1.

Table 1 — Symbols and designations

Symbol	Unit	Designation
d	mm	Nominal diameter of the cross-section of the cylindrical length of the bolt
L_c	mm	Cylindrical length of the bolt
L_r	mm	Reference length of the bolt
L_t	mm	Overall length of the bolt
S_o	mm ²	Original cross-sectional area of the cylindrical length of the bolt
ε_{eo}		Specified initial elastic strain
ε_{er}		Residual elastic strain
E_T	GPa	Static modulus of elasticity at test temperature
E_{Td}	GPa	Dynamic modulus of elasticity at test temperature
σ_o	MPa ^a	Initial stress
σ_{rt}	MPa	Residual stress at time t
t	h	Test duration
T	°C	Specified temperature
T_i	°C	Indicated temperature
^a 1 MPa=1 N/mm ² .		

5 Principle

The test consists of tensioning a test piece in the form of a bolt in a bolted joint model device to a specified initial elastic strain, subjecting the bolt to that strain for specific temperature and time and determining the residual stress in the bolt by unloading at the end of the test.

The constant tensile strain and residual stress are derived from an extension measurement referring to the overall length of the bolt (bolted joint model A) or from strain gauge measurements at the cylindrical length of the bolt (bolted joint model B), all measurements being performed at room temperature.

6 Apparatus

6.1 Bolted joint model device

6.1.1 General

In the bolted joint model, a bolt with a cylindrical length and threaded ends is tensioned by two nuts against a flange (Figure 1).

Bolts, flanges and nuts shall be of the same material.