SLOVENSKI STANDARD
SIST EN 10314:2003

01-april-2003

Nadomeġļa:
SIST ENV 22605-1:1997
SIST ENV 22605-2:1997
SIST ENV 22605-3:1997

Metoda za izpeljavo najmanjġih vrednosti napetosti teļ enja jekel pri poviġanih temperaturah

Method for the derivation of minimum values of proof strength of steel at elevated temperatures

Verfahren zur Ableitung von Mindestwerten der Dehngrenze von Stahl bei erhöhten Temperaturen

Méthode de dérivation des valeurs minimales de la limite conventionnelle d'élasticité des aciers a températures élevées

Ta slovenski standard je istoveten z: **EN 10314:2002**

ICS:

77.140.30 Jekla za uporabo pod tlakom Steels for pressure purposes

SIST EN 10314:2003 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 10314

November 2002

ICS 77.140.30

Supersedes ENV 22605-1:1991, ENV 22605-2:1991 and ENV 22605-3:1991

English version

Method for the derivation of minimum values of proof strength of steel at elevated temperatures

Méthode de dérivation des valeurs minimales de la limite conventionnelle d'élasticité des aciers à températures élevées

Verfahren zur Ableitung von Mindestwerten der Dehngrenze von Stahl bei erhöhten Temperaturen

This European Standard was approved by CEN on 19 August 2002.

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 Management Centre 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 Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, 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

Ref. No. EN 10314:2002 E

Contents

Foreword

This document (EN 10314:2002) has been prepared by the ECISS/TC 22 "Steels for pressure purposes - Qualities", the secretariat of which is held by DIN.

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 May 2003, and conflicting national standards shall be withdrawn at the latest by May 2003.

This document supersedes ENV 22605-1:1991, ENV 22605-2:1991 and ENV 22605-3:1991.

This standard includes a Bibliography.

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

Introduction

Minimum values for tensile properties are specified in European Standards for steels and other metals for elevated temperature service. Such values are used to determine design strength values particularly where the materials are used in pressure systems.

Two International Standards, ISO 2605-1 and ISO 2605-2 are available and have been adopted by CEN as European Prestandards, ENV 22605-1 and ENV 22605-2. They set out procedures, based on statistical assessments of bodies of data, for the derivation and verification of minimum values of 0,2% proof strength at elevated temperatures. These procedures determine the minimum values from lower confidence lines. A third International Standard, ISO 2605-3, adopted by CEN as ENV 22605-3, sets out procedures for determining minimum values from the average trend behaviour of the property of interest as a function of temperature.

One of the purposes of the procedures in ISO 2605-1 and ISO 2605-2 (ENV 22605-1 and ENV 22605-2) is to reduce the requirement for elevated temperature tensile acceptance tests on individual products by organizations and manufacturers contributing data for assessment.

Experience has shown that the procedures in ISO 2605-1 and ISO 2605-2 (ENV 22605-1 and ENV 22605-2) have limitations affecting the relationship between derived minimum property values and the minima of the test data arising from the statistical and some subjective decisions at various stages of the procedures. They also require relatively large amounts of data to produce an acceptable level of accuracy.

The procedure set out in ISO 2605-3 (ENV 22605-3) requires less data but because it is designed to always give conservative values from few data, it like the other procedures, can give non-representative results. However, the principle of this procedure is considered to be more realistic and is adopted as the basis of this European Standard; the objective being to produce an assessment procedure for tensile property data which is simple to operate, gives representative results and is usable in computerised form.

This European Standard, replacing ENV 22605-1, -2 and -3, sets out a method for deriving minimum proof strength values for steels at elevated temperatures with the intention that such values are specified in relevant product standards.

This European Standard does not specify a verification procedure. Verification of tensile properties at elevated temperatures is normally specified in the relevant product standard using the minimum property values derived by the procedure established in this European Standard.

The method proposed has been tested for proof strength values of steel. However, it is considered that the method can also be applied for other metals and for the derivation of minimum values of tensile strength at elevated temperatures.

1 Scope

This European Standard specifies a method for deriving the minimum proof strength values for steels at elevated temperatures.

However, this standard does not specify a verification procedure.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 10002-1, *Metallic materials - Tensile testing - Part 1: Method of test (at ambient temperature).*

EN 10002-5, *Metallic materials - Tensile testing - Part 5: Method of testing at elevated temperature.*

EN ISO 377, *Steel and steel products - Location and preparation of samples and test pieces for mechanical testing (ISO 377:1997).*

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions applies.

3.1
data set
property value data from room and elevated temperatures from the product selected for testing

NOTE This data can include averaged values where more than one set of tests at a given temperature representing one location is carried out.

3.2
data group
property value data from 'X' data sets as used for each assessment

3.3
result set
ratio values for each data set

4 Symbols

For the purposes of this European Standard the following symbols apply:

- t elevated temperature in °C;
- $f_{(t)}$ ratio value; property value at elevated temperature t (in °C) divided by property value at room temperature;
- $f_{av(t)}$ average $f_{(t)}$ value for a specified temperature (see Figure 1);
- R_e yield strength (in MPa[1)]);
- R_p proof strength (in MPa[1)]);
- $R_{p(t)}/R_{p(20)}$ ratio value; proof strength at elevated temperature t divided by proof strength value at room temperature (20 °C);
- s_r residual scatter.

5 Method

5.1 Input data groups

5.1.1 For a given steel grade, input data, to form a data group, shall be established by tensile tests at:

a) room temperature in accordance with EN 10002-1;

b) elevated temperature in accordance with EN 10002-5.

5.1.2 The data shall be identified by reference to a product standard and a steel grade (steel name and/or steel number as appropriate).

Where input data predates the publication of the European Standards detailed in 5.1.1a) and 5.1.1b) the sampling and tensile testing shall have been carried out in accordance with the relevant product standard.

5.1.3 Test pieces for tensile tests both at room and elevated temperatures shall be taken from the same product. The location of the test piece shall be in accordance with EN ISO 377. Test pieces shall be taken as close to each other as possible.

5.1.4 Input data shall clearly identify the test method used and all data within each set (see definitions) shall have been determined by the same method.

5.2 Ratio values

Property values resulting from the tensile tests at elevated temperature in accordance with 5.1.1 b) are normalised by expressing each value as a ratio $f_{(t)}$ of the equivalent property value at room temperature obtained in accordance with section 5.1.1 a) for the same batch of material, i.e.:

[1)] 1 MPa = 1 N/mm²

$$f_{(t)} = \frac{\textit{property value at elevated temperature t in °C}}{\textit{property value at room temperature in °C}}$$

The ratio values $f_{(t)}$ obtained for each data set constitute a result set. Each result set is plotted as a function of temperature and the average value $f_{av(t)}$ at each temperature determined from a trend curve which passes through a ratio value of 1,0 at room temperature, see Figure 1. The trend curve should be determined by a recognised procedure, normally a polynomial curve with degree 1-4, using a recognised statistical procedure such as a "least squares" technique.

Before fitting the trend curve the data shall be examined to determine whether it forms more than one population; where that is the case the data shall be examined in detail with respect to its pedigree (see 6.2) and where deemed necessary treated separately (see also 6.1 and 6.3).

5.3 Minimum proof strength values

From the trend curve established and average ratio values $f_{av(t)}$ derived in accordance with 5.2, the minimum proof strength values $R_{p(t)min}$ (where appropriate R_e may be used instead of R_p) are determined by alternative application of one of the following procedures, depending on the lowest value of $f_{av(t)}$ achieved over the temperature range for which minimum proof strength values are required:

a) when $f_{av(t)} \geq 0{,}4$ within the range of temperature values of interest:

$$R_{p(t)min} = R_{p(20)min}\,(1{,}1\,f_{av(t)} - 0{,}1)$$

NOTE In deriving the formula a linear relationship has been anticipated between $R_{p(t)}$ and $R_{p(20)}$ at a given temperature t where the average ratio value $f_{av(t)}$ is the slope of the regression line which passes through the zero point, and where the standard deviation of the residual scatter s_r is set equal to 0,05 $R_{p(20)min}$.
For the purpose of this standard the specified minimum proof strength value $R_{p(t)min}$ at a given temperature t is defined as the proof strength value derived from the lower ($-2\,s$) confidence level value for proof strength at a room temperature which is 0,1 $R_{p(20)min}$ higher than the specified minimum proof strength value at room temperature.
In terms of probability the minimum proof strength value $R_{p(t)min}$ approximately represents the value of $R_{p(t)}$ on the $-2\,s$ confidence level of a virtual data set the lowest room temperature proof strength value of which is equal to $R_{p(20)min}$.
In special cases, where $R_{p(t)min}$ values on the -3 s confidence level are requested, but for $R_{p(20)min}$ only the value on the - 2 s level is available, the $R_{p(t)min}$ values can be derived by:

$$R_{p(t)min} = 0{,}9\,R_{p(20)min}\,(1{,}15\,f_{av(t)} - 0{,}15)$$

b) when $f_{av(t)} < 0{,}4$ within the range of temperature values of interest:

b1) for $20\ °C \leq t < 250\ °C$

$$R_{p(t)min} = R_{p(20)min}\left[\,f_{av(t)} - \frac{0{,}05\,(t-20)}{230}\,\right]$$

b2) for $t \geq 250\ °C$

$$R_{p(t)min} = R_{p(20)min}\,(f_{av(t)} - 0{,}05)$$