

SLOVENSKI STANDARD**SIST EN 12603:2004****01-september-2004**

Steklo v stavbah – Postopki ugotavljanja upogibne trdnosti in intervala zaupanja za podatke z Weibullovo porazdelitvijo

Glass in building - Procedures for goodness of fit and confidence intervals for Weibull distributed glass strength data

Glas im Bauwesen - Bestimmung der Biegefestigkeit von Glas - Schätzverfahren und Bestimmung der Vertrauensbereiche für Daten mit Weibull-Verteilung

ITEN STANDARD PREVIEW

(standards.iteh.ai)

Verre dans la construction - Procédures de validité de l'ajustement et intervalles de confiance des données de résistance du verre au moyen de la loi de Weibull

SIST EN 12603:2004

<https://standards.iteh.ai/catalog/standards/sist/fb449fe3-42a5-40d0-ab46->

[9b07cefa3e30/sist-en-12603-2004](https://standards.iteh.ai/catalog/standards/sist/fb449fe3-42a5-40d0-ab46-9b07cefa3e30/sist-en-12603-2004)

Ta slovenski standard je istoveten z: EN 12603:2002

ICS:

81.040.20 Steklo v gradbeništvu Glass in building

SIST EN 12603:2004

en

**iTeh STANDARD PREVIEW
(standards.iteh.ai)**

SIST EN 12603:2004

<https://standards.iteh.ai/catalog/standards/sist/fb449fe3-42a5-40d0-ab46-9b07cefa3e30/sist-en-12603-2004>

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 12603

November 2002

ICS 81.040.20

English version

**Glass in building - Procedures for goodness of fit and
confidence intervals for Weibull distributed glass strength data**

Verre dans la construction - Procédures de validité de
l'ajustement et intervalles de confiance des données de
résistance du verre au moyen de la loi de Weibull

Glas im Bauwesen - Bestimmung der Biegefestigkeit von
Glas - Schätzverfahren und Bestimmung der
Vertrauensbereiche für Daten mit Weibull-Verteilung

This European Standard was approved by CEN on 7 September 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.

THIS STANDARD IS PREVIEW
(standards.iteh.ai)

SIST EN 12603:2004
[https://standards.iteh.ai/catalog/standards/sist/fb449fe3-42a5-40d0-ab46-
9b07cefa3e30/sist-en-12603-2004](https://standards.iteh.ai/catalog/standards/sist/fb449fe3-42a5-40d0-ab46-9b07cefa3e30/sist-en-12603-2004)



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

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

Contents

	page
Foreword	3
Introduction	4
1 Scope	5
2 Normative references	5
3 Terms and definitions	5
4 Symbols and abbreviated terms	5
5 Goodness of fit	6
6 Point estimators for the parameters β and θ of the distribution	7
6.1 Censored sample	7
6.2 Uncensored (complete) sample	9
7 Assessment of data and tests	11
7.1 The Weibull diagram	11
7.2 Graphical representation of the estimated distribution function	11
7.3 Plotting of sample data in the Weibull diagram	11
7.3.1 Single values	11
7.3.2 Classified values	12
7.4 Assessment of sample data	12
8 Confidence intervals	12
8.1 Confidence interval for the shape parameter β	12
8.2 Confidence interval for the value of the distribution function $G(x)$ at a given value of x, of the attribute X	15
8.3 Confidence interval for the scale parameter θ	18
8.3.1 Method for all samples	18
8.3.2 Method for uncensored samples	18
8.4 Confidence interval for the value x of the attribute X at a given value $G(x)$ of the distribution function	21
8.4.1 Method for all samples	21
8.4.2 Method for uncensored samples	22
Annex A (informative) Examples	23
A.1 Uncensored sample	23
A.1.1 Data	23
A.1.2 Statistical evaluation	24
A.2 Censored sample	27
A.2.1 Data	27
A.2.2 Statistical evaluation	29
Annex B (informative) Weibull graph	32
Bibliography	33

Foreword

This document (EN 12603:2002) has been prepared by Technical Committee CEN/TC 129 "Glass in building", the secretariat of which is held by IBN.

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.

In this standard the annexes A, B and C are informative.

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.

iTeh STANDARD PREVIEW (standards.iteh.ai)

SIST EN 12603:2004

<https://standards.iteh.ai/catalog/standards/sist/fb449fe3-42a5-40d0-ab46-9b07cefa3e30/sist-en-12603-2004>

Introduction

This European Standard is based on the assumption that the statistical distribution of the attribute taken into consideration can be represented by one single Weibull distribution function, even where in certain cases (e.g. lifetime measurements) mixed distributions have frequently been observed. For this reason, the user of the standard has to check by a goodness of fit test whether the measured data of a sample can be represented by means of one single Weibull function. Only in this case can the hypothesis be accepted and the procedures described in this standard be applied.

The user decides on this question also considering all previous relevant data and the general state of knowledge in the special field. Every extrapolation into ranges of fractiles not confirmed by measured values requires utmost care, the more so the farther the extrapolation exceeds the range of measurements.

NOTE The three-parameter Weibull function is:

$$G(x) = 1 - \exp\left[-\left(\frac{x - x_0}{\theta}\right)^\beta\right] \quad (1)$$

If $x_0 = 0$ is assumed, the two-parameter Weibull function results:

iTeh STANDARD PREVIEW
(standards.iteh.ai)

$$G(x) = 1 - \exp\left[-\left(\frac{x}{\theta}\right)^\beta\right] \quad \begin{matrix} \text{SIST EN 12603:2004} \\ \text{https://standards.iteh.ai/catalog/standards/sist/fb449fe3-42a5-40d0-ab46-} \\ \text{9b07cefa3e30/sist-en-12603-2004} \end{matrix} \quad (2)$$

which can be written as:

$$x = \theta \left[\ln\left(\frac{1}{1 - G(x)}\right) \right]^{\frac{1}{\beta}} \quad (3)$$

The calculation can be based either on an uncensored or a censored sample. There are several methods of censoring. In this standard only the following method of censoring is considered:

- given a number $r < n$ of specimens of which attribute values x_i were measured.

1 Scope

This European Standard specifies procedures for the evaluation of sample data by means of a two-parameter Weibull distribution function.

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 its amendment or revision. For undated reference, the latest edition of the publications referred to applies (including amendments).

ISO 2854:1976, *Statistical interpretation of data - Techniques of estimation and tests relating to means and variances*.

ISO 3534, *Statistics - Vocabulary and symbols*.

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in ISO 3534 apply.

**iTech STANDARD REVIEW
(standards.iteh.ai)**

4 Symbols and abbreviated terms

[SIST EN 12603:2004](#)

X attribute taken into consideration; <https://standards.iteh.ai/catalog/standards/sist/fb449fe3-42a5-40d0-ab46-9b07cefa3e30/sist-en-12603-2004>

x, x_i, x_r values of X ;

$G(x)$ distribution function of X = percentage of failure;

x_0, β, θ parameters of the three-parameter Weibull function;

$\hat{\beta}, \hat{\theta}, \hat{G}$ identification label for point estimators (e.g. $\hat{\beta}, \hat{\theta}, \hat{G}$);

$1-\alpha$ confidence level;

ℓ_i value used in the goodness of fit test;

L value used in the goodness of fit test;

n sample size;

r number of specimens of which attribute values x_i were measured;

NOTE The sample is ordered, i.e. $x_1 \leq x_2 \leq x_3 \dots \leq x_r, r \leq n$;

f, f_1, f_2 degrees of freedom;

$K_n, K_{r,n}$ factors used in estimating $\hat{\beta}$;

EN 12603:2002 (E)

- $C_{r,n}$ factor used in estimating $\hat{\theta}$;
 s $\text{int}(0,84n) = \text{largest integer} < 0,84n$;
 η, ξ ordinate and abscissa of the Weibull diagram;
 χ^2 chi-square distribution function;
 y, v, γ auxiliary factors used in estimating the confidence limits of $G(x)$;
 A, B, C constants used in evaluating v ;
 $H(f_2)$ variable used in evaluating γ ;
 $T_{n;\alpha/2}, T_{n;1-\alpha/2}$ coefficients used in estimating the confidence limits of θ ;

Subscripts:

- un lower confidence limit;
 ob upper confidence limit;
 z confidence interval limited on two sides.

iTeh STANDARD PREVIEW (standards.iteh.ai)

Sort the r values of x into rank ascending order.

SIST EN 12603:2004

Compute for each value from $i=1$ to $i=r-1$:
<https://standards.iteh.ai/catalog/standards/sist/fb449fe3-42a5-40d0-ab46-9b07cefa3e30/sist-en-12603-2004>

$$\ell_i = \frac{\ln(x_{i+1}) - \ln(x_i)}{\ln\left(\frac{4(n-i-1)+3}{4n+1}\right) - \ln\left(\frac{4(n-i)+3}{4n+1}\right)} \quad (4)$$

Compute the quantity:

$$L = \frac{\sum_{i=\lfloor r/2 \rfloor + 1}^{r-1} \frac{\ell_i}{\lfloor (r-1)/2 \rfloor}}{\sum_{i=1}^{\lfloor r/2 \rfloor} \frac{\ell_i}{\lfloor r/2 \rfloor}} \quad (5)$$

where the symbol $\lfloor r/2 \rfloor$ is used to denote the largest integer less than or equal to $r/2$.

Reject the hypothesis that the data is from a Weibull distribution at the α significance level if:

$$L \geq F_\alpha(2\lfloor(r-1)/2\rfloor, 2\lfloor r/2 \rfloor) \quad (6)$$

The values of the fractiles of the F distribution can be found for example in Table IV of ISO 2854:1976.

6 Point estimators for the parameters β and θ of the distribution

6.1 Censored sample

$$\hat{\beta} = \frac{n \kappa_{r;n}}{r \ln x_r - \sum_{i=1}^r \ln x_i} \quad (7)$$

$$\hat{\theta} = \exp \left[\ln x_r - C_{r;n} \frac{1}{\hat{\beta}} \right] \quad (8)$$

The factors $\kappa_{r;n}$ and $C_{r;n}$ are listed in Table 1 and Table 2.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

SIST EN 12603:2004
<https://standards.iteh.ai/catalog/standards/sist/fb449fe3-42a5-40d0-ab46-9b07cefa3e30/sist-en-12603-2004>

EN 12603:2002 (E)

Table 1 — Coefficient $\kappa_{r,n}$

n	r/n									
		0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9
5				0,2231		0,4813		0,8018		
10		0,1054	0,2172	0,3369	0,4667	0,6098	0,7715	0,9616	1,202	
20	0,0513	0,1583	0,2721	0,3944	0,5277	0,6756	0,8448	1,048	1,316	
30	0,0684	0,1759	0,2904	0,4137	0,5482	0,6979	0,8697	1,077	1,357	
40	0,0770	0,1848	0,2996	0,4233	0,5584	0,7090	0,8822	1,092	1,378	
50	0,0821	0,1901	0,3051	0,4291	0,5646	0,7158	0,8898	1,101	1,391	
60	0,0855	0,1936	0,3088	0,4330	0,5687	0,7202	0,8949	1,108	1,400	
70	0,0879	0,1961	0,3114	0,4357	0,5717	0,7235	0,8985	1,112	1,406	
80	0,0898	0,1980	0,3134	0,4378	0,5739	0,7259	0,9012	1,115	1,410	
90	0,0912	0,1995	0,3149	0,4394	0,5756	0,7277	0,9033	1,118	1,414	
100	0,0924	0,2007	0,3162	0,4407	0,5770	0,7292	0,9050	1,120	1,417	
κ_p	0,10265	0,21129	0,32723	0,45234	0,58937	0,74274	0,92026	1,1382	1,4436	
d_1	-1,0271	-1,0622	-1,1060	-1,1634	-1,2415	-1,3540	-1,5313	-1,8567	-2,6929	
d_2	0,000	0,030	0,054	0,089	0,145	0,242	0,433	0,906	2,796	
Asymptotic estimate for large n : $\kappa_{r,n} = \kappa_p + d_1/n + d_2/n^2$										

Table 2 — Coefficient $C_{r,n}$

n	r/n									
		0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9
10	-2,880	-1,826	-1,267	-0,8681	-0,5436	-0,2574	0,0120	0,2837	0,5846	
20	-2,547	-1,658	-1,147	-0,7691	-0,4548	-0,1727	0,0979	0,3776	0,7022	
30	-2,444	-1,605	-1,108	-0,7364	-0,4253	-0,1443	0,1269	0,4098	0,7446	
40	-2,394	-1,578	-1,089	-0,7202	-0,4106	-0,1301	0,1415	0,4262	0,7664	
50	-2,365	-1,562	-1,077	-0,7105	-0,4018	-0,1216	0,1503	0,4360	0,7796	
60	-2,345	-1,522	-1,069	-0,7040	-0,3959	-0,1159	0,1562	0,4426	0,7885	
70	-2,331	-1,544	-1,064	-0,6994	-0,3917	-0,1118	0,1604	0,4473	0,7949	
80	-2,321	-1,539	-1,060	-0,6959	-0,3886	-0,1088	0,1635	0,4509	0,7998	
90	-2,313	-1,534	-1,056	-0,6932	-0,3861	-0,1064	0,1660	0,4537	0,8035	
100	-2,307	-1,531	-1,054	-0,6911	-0,3841	-0,1045	0,1679	0,4559	0,8065	
c_p	-2,2504	-1,4999	-1,0309	-0,67173	-0,36651	-0,08742	0,18563	0,47589	0,83403	
a_1	-5,5743	-3,0740	-2,2859	-1,9301	-1,7619	-1,7114	-1,7727	-2,0110	-2,7773	
a_2	-7,201	-1,886	-0,767	-0,335	-0,091	0,111	0,369	0,891	2,825	
Asymptotic estimate for large n : $C_{r,n} = c_p + a_1/n + a_2/n^2$										

6.2 Uncensored (complete) sample

$$\hat{\beta} = \frac{n \kappa_n}{\frac{s}{n-s} \sum_{i=s+1}^n \ln x_i - \sum_{i=1}^s \ln x_i} \quad (10)$$

$$\hat{\theta} = \exp \left[\frac{1}{n} \sum_{i=1}^n \ln x_i + 0,5772 \frac{1}{\hat{\beta}} \right] \quad (11)$$

The factors κ_n are listed in Table 3.

EN 12603:2002 (E)

Table 3 — Coefficient κ_n

n	κ_n	n	κ_n
2	0,6931	32	1,4665
3	0,9808	33	1,4795
4	1,1507	34	1,4920
5	1,2674	35	1,5040
6	1,3545	36	1,5156
7	1,1828	37	1,5266
8	1,2547	38	1,4795
9	1,3141	39	1,4904
10	1,3644	40	1,5009
11	1,4079	41	1,5110
12	1,4461	42	1,5208
13	1,3332	43	1,5303
14	1,3686	44	1,4891
15	1,4004	45	1,4984
16	1,4293	46	1,5075
17	1,4556	47	1,5163
18	1,4799	48	1,5248
19	1,3960	49	1,5331
20	1,4192	50	1,5411
21	1,4408	51	1,5046
22	1,4609	52	1,5126
23	1,4797	53	1,5204
24	1,4975	54	1,5279
25	1,5142	55	1,5352
26	1,4479	56	1,5424
27	1,4642	57	1,5096

ITEH STANDARD PREVIEW
(standards.iteh.ai)

SIST EN 12603:2004

<https://standards.iteh.ai/catalog/standards/sist/fb44963-42a5-40d0-ab46-9b07cefa3e30/sist-en-12603-2004>