SLOVENSKI STANDARD
oSIST prEN 16613:2013

01-september-2013

Steklo v gradbeništvu - Lepljeno steklo in lepljeno varnostno steklo - Ugotavljanje mehanskih lastnosti vmesnih slojev

Glass in building - Laminated glass and laminated safety glass - Determination of interlayer mechanical properties

Glas im Bauwesen - Verbundglas und Verbundsicherheitsglas - Bestimmung der mechanischen Eigenschaften von Zwischenschichten

Ta slovenski standard je istoveten z: **prEN 16613**

ICS:

81.040.20	Steklo v gradbeništvu	Glass in building

oSIST prEN 16613:2013 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 16613

May 2013

ICS 81.040.20

English Version

Glass in building - Laminated glass and laminated safety glass - Determination of interlayer mechanical properties

Glas im Bauwesen - Verbundglas und Verbundsicherheitsglas - Bestimmung der mechanischen Eigenschaften von Zwischenschichten

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Foreword

This document (prEN 16613:2013) has been prepared by Technical Committee CEN/TC 129 “Glass in building”, the secretariat of which is held by NBN.

This document is currently submitted to the CEN Enquiry.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

Introduction

The purpose of this European Standard is to provide the viscoelastic properties of interlayer materials in order that calculations for the load resistance of laminated glass panes can be undertaken.

In addition, this European Standard includes a procedure for categorising the interlayer materials into a families, which can be associated with shear transfer coefficients which are used in a simplified calculation method.

NOTE CEN/TC 129/WG 8 "Mechanical strength" is preparing a draft which includes the simplified calculation method [1].

1 Scope

This European Standard specifies a test method for determining the mechanical viscoelastic properties of interlayer materials. The interlayers under examination are those used in the production of laminated glass and/or laminated safety glass. The interlayer properties are needed in order to determine the load resistance of laminated glass as part of a general calculation method for the load resistance of glass.

NOTE CEN/TC 129/WG 8 "Mechanical strength" is preparing a draft for the calculation method [1].

From the tensile modulus in particular conditions of temperature and load duration, an interlayer can be placed into a family that relates to a specific interlayer shear transfer coefficient, ω. This value can be used in a simplified calculation method.

An informative annex explains the background to the determination of families relating to a specific interlayer shear transfer coefficient.

2 Normative references

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

EN 1288-3, *Glass in building - Determination of the bending strength of glass - Part 3: Test with specimen supported at two points (four point bending)*

ISO 6721-1, *Plastics – Determination of mechanical dynamic properties – Part 1: General principles*

ISO 6721-4, *Plastics – Determination of mechanical dynamic properties – Part 4: Tensile vibration – Non-resonance method*

ISO 6721-11, *Plastics – Determination of mechanical dynamic properties – Part 11: Glass transition temperature*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
glass transition temperature
interval of temperature in which a material changes from a rubbery state to a solid state

3.2
interlayer shear transfer coefficient
coefficient between 0 and 1 describing the ability of an interlayer material to transfer shear forces between the glass plies of a laminated glass plate when submitted to bending

3.3
stiffness family
group of interlayers having similar properties for the temperature range and load durations considered

3.4
vitreous polymer
polymer presenting a glass transition temperature in the range of building applications

4 Symbols and abbreviations

For the purposes of this document, the following symbols and abbreviations apply.

b	Width of the test specimen
C_1, C_2	Parameters in the WLF visco-elastic formula
e	Thickness of the test specimen
E_G	Young's Modulus of glass
E_L	Young's Modulus of the interlayer material
f	Frequency
F	Four point bend test load
G_L	Shear modulus of the interlayer material
h_k	Nominal thickness of ply k of a laminated glass
$h_{m;k}$	The distance of the mid-plane of the glass ply k from the mid-plane of the laminated glass
h_{mono}	Equivalent thickness of monolithic glass for a laminated glass deflecting under load
H	Height of the test specimen
L_S:	Distance between centre lines of the supporting rollers
L_B:	Distance between centre lines of the bending rollers
Q:	Self-weight area density of four point bend test specimen
t	Load duration
T	Temperature
T_g	Glass transition temperature
T_{ref}	Reference temperature
w:	Measured deflection of four point bend test specimen
$\alpha(T)$	Temperature transformation parameter in the WLF visco-elastic formula
θ	Temperature
μ	Poisson's number of the interlayer material
ω	Interlayer shear transfer coefficient

5 Selection of testing procedure

5.1 Isotropic interlayer materials

The commonly used interlayers are generally isotropic materials. The most practical method for testing isotropic interlayer materials consists is to undertake a tensile test which can be used to determine the shear modulus using to the following relationship:

$$G_L = \frac{E_L}{2(1+\mu)} \tag{1}$$

where

μ is the Poisson's number of the interlayer (μ equals 0,49 for an isotropic interlayer).

This leads to the approximation.

$$E_L \approx 3G_L \tag{2}$$

A typical test piece is shown in Figure 1.

Figure 1 — Dimensions of the isotropic interlayer test piece used for tensile test

Typical dimensions of the test piece are:

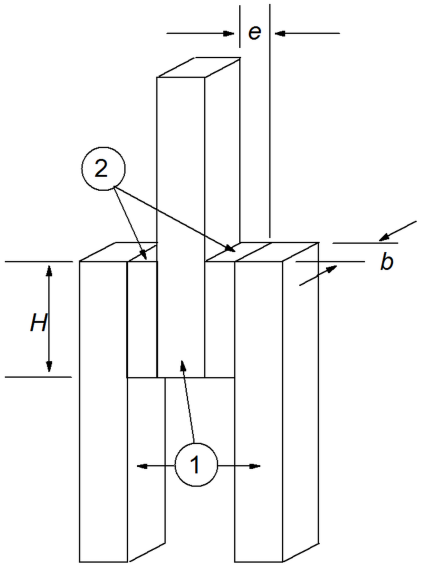
— *H* = 10 mm

— *b* = 5 mm

— *e* ~ 2,3 mm (equivalent to stacking 6 plies of interlayer each with nominal thickness of 0,38 mm).

5.2 Non-isotropic interlayer materials

In the case of interlayers which are not isotropic materials (an example is the acoustic tri-layer pvb), it is necessary to assess the shear stress directly by using a dynamic shear test method. The principle of the test piece is presented in Figure 2.



Key

1 glass

2 interlayer

Figure 2 — Principle of a test specimen for dynamic shear test of an anisotropic interlayer

Typical dimensions of the test piece are:

— H = 10 mm

— b = 5 mm

— e ~ 2.3 mm (equivalent to stacking 6 plies of interlayer each with nominal thickness of 0.38 mm).

Critical dimensions of the sample are $H > 4\ e$ and 10 mm < H < 15 mm.

5.3 Interlayers which cannot be formed into small test pieces

There are some interlayers which cannot be formed into test pieces like those described in 5.1 and 5.2 or which are not stable with exposed edges in such small sizes.

For these interlayer materials, the relevant interlayer properties can be determined by calculation from the results of bending tests. A method for doing this is given in Annex A.

6 Test procedure

6.1 General

The method uses the tests described in ISO 6721-1, 6721-4, and 6721-11. ISO 6721-1 gives an overview of the principles of these tests.

6.2 Test specimens

The test specimens shall be manufactured from samples representative of normal interlayer material production. The test specimens shall be processed under normal laminating conditions (see Annex B).

The thickness, *e*, of the test specimens should be not less than 2.2 mm thick and not more than 4.0 mm thick. The layering and stacking of the interlayer material to achieve an appropriate thickness shall be representative of normal production processes.

The test specimen size and tolerances on dimensions shall be determined according to the requirements of ISO 6721-4.

Two sets of test specimens are required. One set is used for determining the glass transition temperature, T_g, (see 6.3.1). The other set is used for the evaluation of the $E_L(T_{ref},f)$ curve (see 6.3.2, 6.4).

6.3 Test method

6.3.1 Glass transition temperature, T_g

Initial tests shall be conducted on at least three test specimens according to ISO 6721-11 to determine the glass transition temperature of the interlayer material. This is used to refine the temperatures assessed in 6.3.2.

NOTE If the interlayer material is not a vitreous polymer, it may not be possible to determine a glass transition temperature.

6.3.2 Determination of $E_L(\theta,f)$

A series of tests shall be conducted according to ISO 6721-4 to evaluate $E_L(\theta,f)$ for a range of frequencies, f, and a range of temperatures, θ, sufficient to define the interlayer modulus, E_L.

The test temperatures shall be selected as follows.

(a) If a glass transition temperature has been determined:

- One test temperature is the glass transition temperature, T_g, determined in 6.3.1
- One test temperature is T_g–3°C
- One test temperature is T_g+3°C
- One test temperature is 20°C
- Other test temperatures shall be selected to give coverage of the temperature range, -20°C to +60°C.
- A minimum of 15 different test temperatures shall be used.

(b) If a glass transition temperature has not been determined:

- One test temperature is 20°C
- One test temperature is 17°C
- One test temperature is 23°C
- Other test temperatures shall be selected to give coverage of the temperature range, -20°C to +60°C.
- A minimum of 15 different test temperatures shall be used.

The frequencies to be tested at each temperature are 1Hz, 1.3 Hz, 1.8 Hz, 2.5 Hz, 3.3 Hz, 4.5 Hz, 6 Hz, 8 Hz, 11 Hz, 15 Hz, 20 Hz, 27 Hz, 36 Hz, 49 Hz, 66 Hz, 90 Hz, 120 Hz, 160 Hz, 220 Hz, 300 Hz and 400 Hz.