

Stiffness family determination – Saflex® Interlayers

Saflex® interlayers are plasticized polyvinyl butyral (PVB) sheeting produced by Eastman Chemical Company and its affiliates. These interlayers are bonded through a heat and pressure process to two or more pieces of glass to produce laminated glass with impact and glass containment properties, as well as other added features. Laminated glasses with the properly selected type of Saflex interlayer are capable of being classified as safety glass in accordance with, but not limited to, various regulations such as ANSI Z26.1, ANSI Z97.1, AS/NZS 2208; CNS 1183, CPSC 16 CFR 1201, EN 12600 and ISO 29584.

This document provides a stiffness family determination for Saflex Clear (R-series, all product types RA and RB) and Saflex Structural (DG41 and DG41 XC) interlayers according to paragraph 7.3 of EN 16613 *Glass in building - Laminated glass and laminated safety glass - Determination of interlayer viscoelastic properties*. The stiffness family determination as executed for Saflex Clear may also be applied to Vanceva® Color and Vanceva Earth Tone interlayer products. In addition, the stiffness family determination does not depend on product thickness and applies to all products supplied in the 0.38 – 1.52 mm range. No stiffness family determination for Saflex Acoustic has been executed, as the associated ω value for this interlayer category is always 0 according to EN 16612 *Glass in building - Determination of the lateral load resistance of glass panes by calculation*.

Select physical and mechanical properties of Saflex Clear and Saflex Structural PVB interlayers are provided in their Product Technical Datasheets (PTS). The interlayer shear and Young's modulus are important parameters for engineers to calculate the stresses and deflections that occur as a result of specific loads on laminated glass building elements. The values of these properties for viscoelastic interlayers, such as Saflex Clear and Saflex Structural, are a strong function of temperature and load duration. Although reference is made to certain values listed in standards EN 16612 and EN 16663, the text of these standards as published by the various Nation Standardization Bodies takes precedence and should be reviewed for proper use of the information in this document.

Normative context

Informative Annex D of EN 16612 provides a simplified calculation method to calculate the effective thickness for deflection and stress for laminated glass panes that have linearly supported edges and are subject to uniformly distributed loads. The calculation method relies on default shear transfer coefficients (ω) for stiffness families as determined according to paragraph 7.3 of EN 16613. In this paragraph, different ω values are provided for a set of twelve different load conditions. The determination of interlayer stiffness family is a function of the interlayer's Young's modulus. Values for this property are provided in the PTS for each Saflex® interlayer product. The stiffness family determination may yield a different result for each individual load scenario.

The use of laminated glass designed to Annex D should fit the scope of EN 16612. This standard provides the general method of calculation and guidance for lateral load resistance of linearly supported glazed elements used as infill panels, and it covers those infill panels that are in a class of consequence lower than those covered in EN 1990. It is unclear if the balustrade and maintenance loads as introduced in Table D2 of Annex D would classify as uniformly distributed loads as mentioned in the main body of the text. The applicability of Annex D of EN 16612 for glass design to a specific glazing remains the sole responsibility of the designer.

Stiffness family determination

Based on the interlayer Young's modulus values as listed in the product PTS, an interlayer stiffness family was calculated for the load scenarios as per EN16613. The stiffness family criteria and associated shear transfer coefficients are listed in Annex 1. Permanent loads were excluded, as a zero-shear transfer coefficient is associated with this load type, regardless of stiffness family.

The results are listed in Table 1. It was verified that the stiffness family classification did not change for Poisson's ratios values between 0.4 and 0.5.

Saflex Clear can be considered a Stiffness family 1 material for all load scenarios in EN 16613.

Saflex Structural can be considered a Stiffness family 2 material for all load scenarios in EN 16613, except balustrade loads - crowds. For the latter load scenario, a direct FEM approach based on actual modulus values or calculated ω value is recommended, see also note (2).

Table 1. Stiffness family classification of Saflex Clear and Saflex Structural

Load Scenario	Saflex Clear (R series)		Saflex Structural (DG)	
	Young's Modulus E (MPa)	Stiffness Family	Young's Modulus E (MPa)	Stiffness Family
Wind gust load (Mediterranean areas) (3s, 35 °C)	2.5	1	25	2
Wind gust load (other areas) (3s, 20 °C)	33	1	1005	2
Windstorm load (Mediterranean areas) (10 min, 35 °C)	1.1	1 ⁽¹⁾	1.7	2
Windstorm load (other areas) (10 min, 20 °C)	2.3	1	254	2
Balustrade loads - no crowds (30 s, 30 °C)	2.1	1	33	2
Balustrade loads - crowds (5 min, 30 °C)	1.4	1	7.1 ⁽²⁾⁽³⁾	1
Maintenance loads (30 min, 40 °C)	0.80	1	1.2	2
Snow load external canopy/unheated buildings ⁽⁴⁾ (3 weeks, 0 °C)	2.3	1	26	2
Snow load external roofs of heated buildings (5 days, 20 °C)	0.96	1	4.2	2
Cavity pressure variation IGU: summer (6 hours, 40 °C)	0.19	1	1.1 ⁽³⁾	2
Cavity pressure variation IGU: winter (12 hours, 20 °C)	1.2	1	18	2

Notes to Table 1

- (1) The modulus value for Saflex Clear in this particular determination just exceeded the Stiffness family 1 threshold, but classification is as normal quality PVB as per Table 14 of EN 16613 and thus Stiffness family 1 is recommended
- (2) As a result of the more harmonized threshold modulus in EN 16612 as compared to earlier versions, Saflex Structural no longer qualifies as Stiffness family 2 for this load scenario. The calculated ω value according to ASTM 1300 Annex X9 for a 1010.4 configuration (1000 m short side) for Saflex Structural is 0.3. This value is confirmed by testing of cantilevered balustrades at 30 °C at the Politecnico di Milano. Alternatively, the use of FEM or other methods using the actual relevant interlayer shear modulus is recommended.
- (3) An independent determination of the stiffness family (TU Darmstadt; Schuster & Schneider) provided the same classifications as listed in the Table 1, except for these marked load scenarios: Saflex Structural was classified in Stiffness family 2 for balustrade loads - crowds; and in Stiffness family 1 for cavity pressure variation summer. In both cases, this is a result of slightly different modulus values in their evaluation. The report can be made available upon request.
- (4) The 0 °C modulus values are not listed in the Product Technical Sheet. The value for Saflex Structural was calculated based on Annex 1 of German National Approval abZ-70.3-230 *Laminated safety glass based on product family Saflex (Structural) DG*. The values for Saflex Clear were calculated according to the model published by Stevels, W.; D'Haene, P. *Determination and verification of PVB interlayer modulus properties*, In Proceedings to Challenging Glass 7, Bos, F.; Louter, C.; Belis, J. (eds), Gent, 2020.

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