English

Product portfolio

SentryGlas®

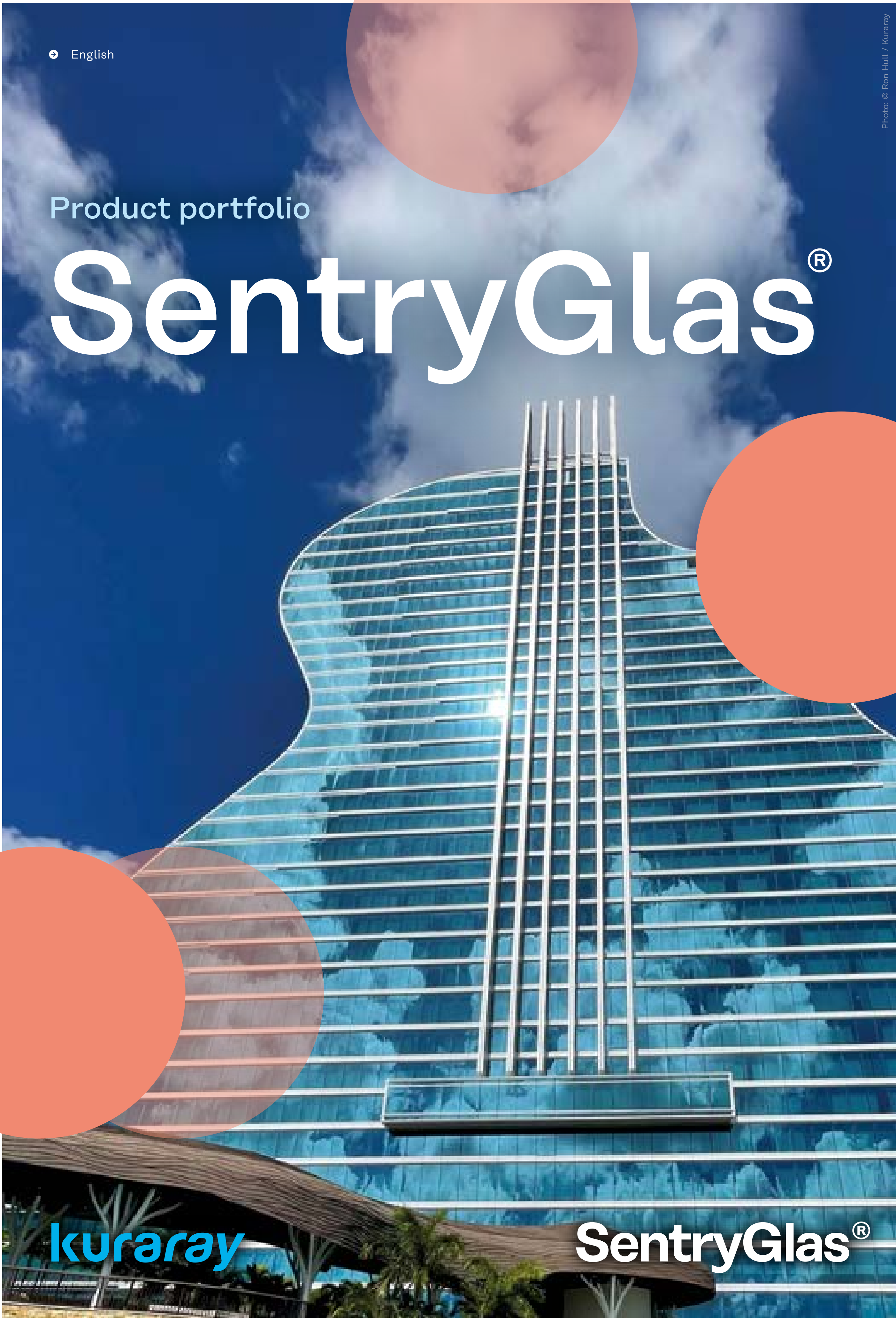


Photo: © Ron Hull / Kuraray

kuraray

SentryGlas®

Introduction

Interlayer strength, depth and capabilities

Delivering your window into the world of advanced interlayers for laminated safety glass, Kuraray's Advanced Interlayer Solutions Division (AIS) is underpinned by decades of innovation, application knowledge, domain experience and market success.

OUR ADVANCED INTERLAYER PORTFOLIO – comprising Trosifol® PVB and SentryGlas® ionoplast interlayers – has continually revolutionized aesthetic, structural and functional glass design, fabrication and installation in the architectural and automotive/ transportation segments.

Designed to benefit consumers, society and industry, our products are advancing the functionality of glass, while our engineers and consultants are setting new application benchmarks by collaborating on solutions that both sustain and inspire.

We are committed to helping you transform your mindset and take your applications to the next level – aesthetically, functionally and structurally. Enjoy greater design freedom and give your glazing strength, clarity, character and purpose with solutions that cover safety, security, sound insulation, UV/solar/energy management, color and print.

Photo: © Atlanta Hall Management Inc.

Steve Jobs Theater Pavilion, Cupertino, USA

OUR DIVERSE PRODUCT RANGE, the broadest on the global market and our domain expertise create strength; and we channel this strength into helping you succeed. We strive to be your strongest ally and supporter and will help you navigate and conquer the ever-changing demands of the global glass industry. Worldwide production, R&D and support, means we are always by your side ... no matter where you are.

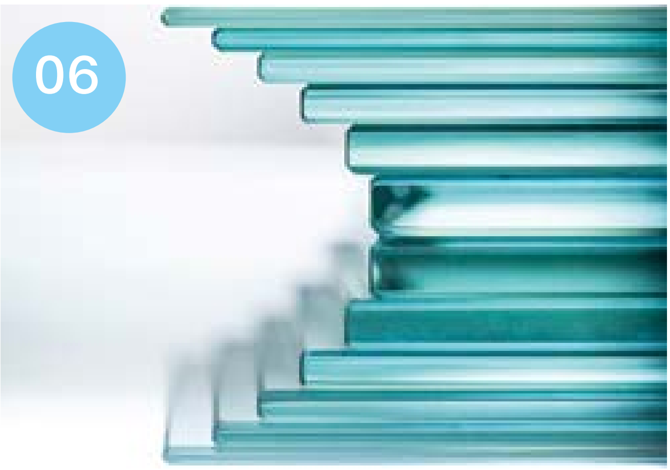
THE ORIGINAL SentryGlas®

Venice Airport, Italy


Photo: © Tom Bonner
Pacific Visions Wing
Member Services

Product lines

Contents



Kuraray's Advanced Interlayer Business – your global partner for laminated safety glass

The SentryGlas® interlayer from the Kuraray's AIS Structural product family is five times stronger and up to 100 times stiffer than conventional laminating materials. With this kind of strength the glass can be a more active structural element in the building envelope, opening up design possibilities that didn't exist before.

Besides its strength, SentryGlas® ionoplast interlayer retains its clarity – even after years of service. Unlike other interlayers, SentryGlas® ionoplast interlayer is much less vulnerable to moisture exposure or yellowing over time.

Initially developed for the high building envelope protection required for hurricane glazing in the United States, the use of SentryGlas® ionoplast interlayer has now expanded considerably as structural engineers have recognized that the performance benefits developed for hurricane applications could also be beneficial for many other aspects of a building, including façades, overhead glazing, balustrades, doors and partitions.

➲ San Francisco Conservatory of Music, USA

Stiffness and elastic properties of SentryGlas® ionoplast interlayer and Trosifol® Clear

Originally developed for glazing in hurricane zones, SentryGlas® ionoplast interlayers are significantly stiffer than standard PVBs such as Trosifol® Clear.

STIFFNESS AND ELASTIC PROPERTIES

If two sheets of glass, lying on top of one another, are placed under load, they will start to bend (distort) independently. Displacement occurs between the two inner surfaces, which are in direct contact with each other. This is because one of the two surfaces is being stretched while the other is being compressed. If both sheets are laminated with an adhesive polymer interlayer, this must be able to internally compensate for the distortional differences (i.e. absorb shear forces).

HOW ARE STIFFNESS AND ELASTICITY MEASURED?

Most laminated safety glass interlayers are viscoelastic. Viscoelasticity is the property of materials that exhibit both viscous and elastic characteristics when undergoing deformation. Viscous materials resist shear flow and strain linearly with time when a stress is applied. Elastic materials strain when stretched and quickly return to their original state once the stress is removed. Viscoelastic materials therefore have elements of both of these properties and as such exhibit time-dependent strain.

Important material design values for the calculation of stresses and deformations are represented by the elastic constants, i.e. the modulus of elasticity (Young's Modulus) and Poisson's ratio. The modulus of elasticity, which by definition can be used as a direct comparison parameter for material stiffness, shows a dependence on the material and temperature.

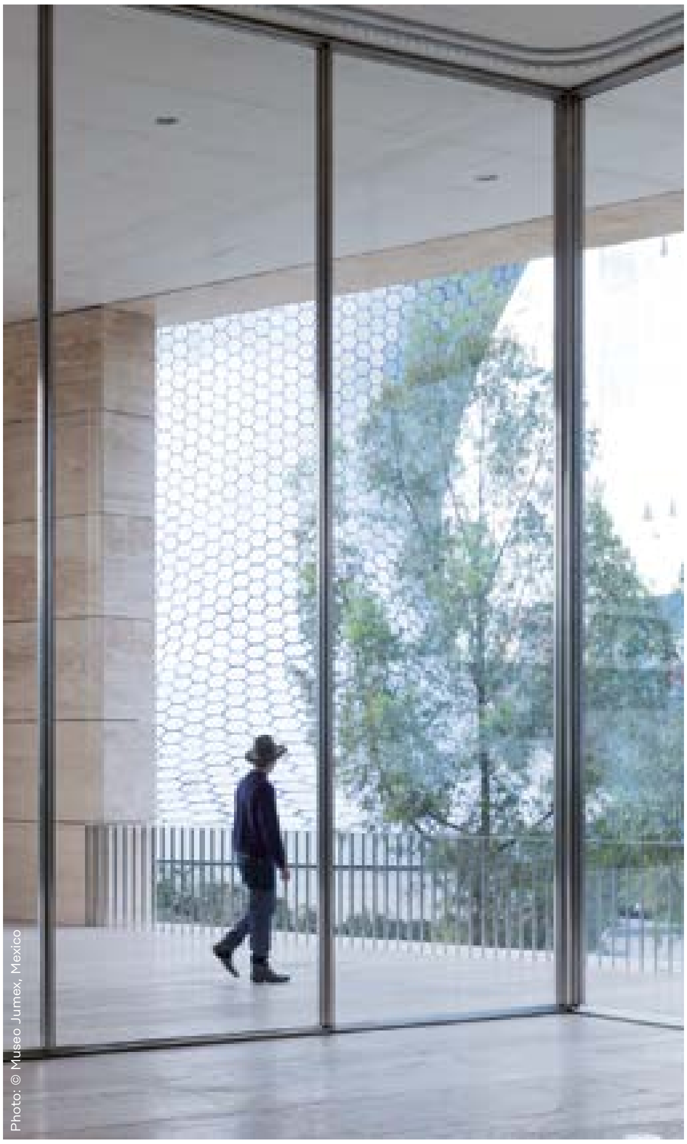


Photo: © Museo Jumex, Mexico

Comparison of short-term stiffness and strength of Trosifol® Clear and SentryGlas® interlayers

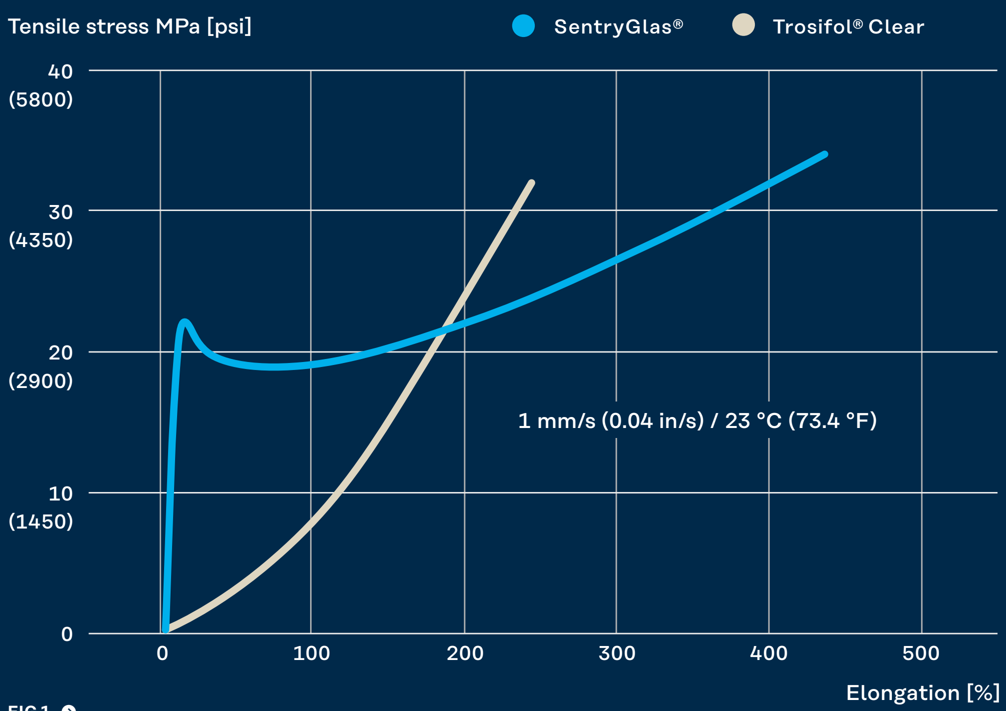


FIG 1 ➔

Shear modulus or modulus of rigidity is defined as the ratio of shear stress to the shear strain. Shear modulus' derived SI unit is the pascal (Pa), although it is normally expressed in Megapascals (MPa), or in thousands of pounds per square inch (ksi).

The shear modulus is always positive. Young's Modulus describes the material's response to linear strain. The shear modulus describes the material's response to shearing strains.

Stiffness (Young's Modulus and shear modulus) and Poisson ratio vary as a function of temperature and load duration (creep).

For designers of architectural glazing, it is therefore important to assess the likelihood of achieving full design load at the design temperature and load duration. How can structural designers ensure that the specified laminated safety glass interlayer is capable of meeting the design specification and building codes? The appropriate elastic property values need to be selected for the design case and assigned to an effective elastic interlayer. Kuraray's Advanced Interlayer Solutions can provide technical support and guidance here.

POLYMER INTERLAYER BEHAVIOR

ALL INTERLAYERS ARE VISCOELASTIC

- Evaluate properties over a range of test temperature and time using dynamic mechanical analysis and creep tests (ASTM D 4065)
- 'Small' strain values (< 20 % engineering strain)

YOUNG'S MODULUS, E, SHEAR MODULUS, G & POISSON RATIO, v

- Extract E, G and v for specified temperature and load duration
- Choose appropriate elastic property values for design case and assign to an effective elastic interlayer
- Important to asses the likelihood of achieving full design load at the design temperature and load duration

Structural properties of laminated safety glass

INTRODUCTION

The structural behavior of laminated glass is a complex topic. Many factors influence the response of a laminated plate or beam to an imposed load. Despite this complexity, much progress has been made in understanding laminated glass in the last 15 years.

The structural behavior of laminated glass is a complex topic. Many factors influence the response of a laminated plate or beam to an imposed load. Despite this complexity, much progress has been made in understanding laminated glass in the last 15 years. This progress is primarily attributable to advances in mechanics and associated computational tools (e.g. FEA software) and the development of appropriate interlayer property information that accurately captures the effects of load duration and temperature on the polymer properties.

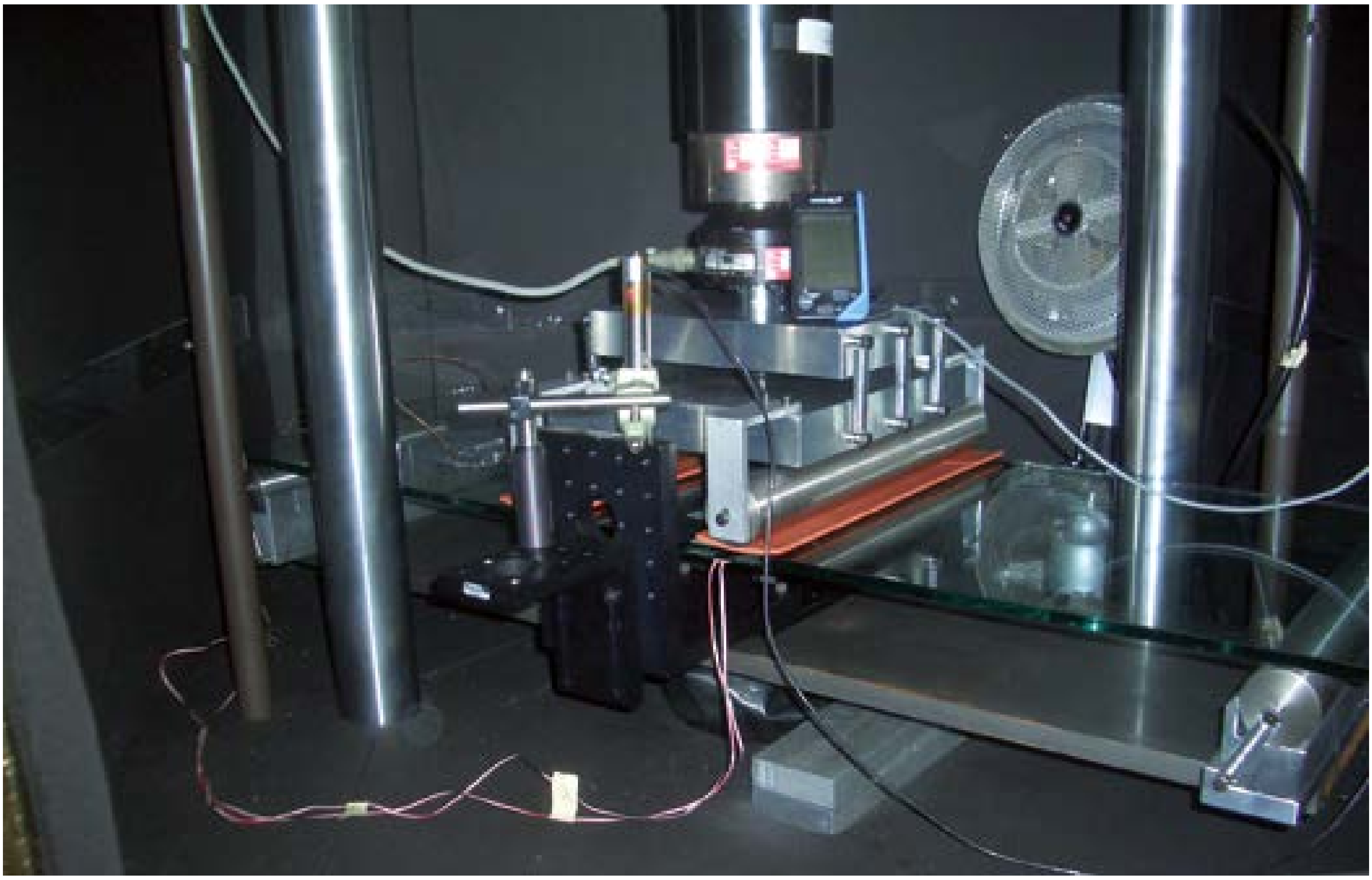
The result of this body of work is the capability to now model accurately the structural behavior of laminated glass using modern finite element analysis (FEA) methods. However, the glass design industry often takes the approach of using simplified calculation methods for engineering laminated glass due to the slow adoption of FEA technology. These simplified design approaches are often inaccurate, although usually conservatively so. Such conservative approaches tend to result in an abundance of over-designed laminated glass systems, which in turn leads to unnecessary extra cost. Accordingly, there is a need to develop calculation methods that capture accurately the mechanical response of laminated glass while being relatively straightforward to implement in standards and existing calculation methodologies.

This chapter outlines the properties and structural advantages of laminated safety glass and how common interlayer types (i.e. PVB and SentryGlas® ionoplast interlayer) perform under various test conditions. This includes tests that enable comparisons to be made between the structural performance of PVB laminates, laminates with SentryGlas® ionoplast interlayer and monolithic / tempered glass. These tests include bending / deflection tests (four-point bending), as well as tests that enable the effective thickness of laminated glass to be determined accurately.

→ Post-glass breakage performance of Laminated Safety Glass

This chapter also describes the various methods currently available for comparing and calculating the strength of laminated safety glass.

➔ SentryGlas® vs PVB – deflection



BENDING TESTS

In the glazing industry, the Four-Point Bending Test is the industry-standard test for determining the strength and stress properties of laminated glass and monolithic tempe-red glass. These tests are defined in EN ISO 1288-3 stan-dards and ASTM C158.

EN ISO 1288-3 is a useful test for studying laminated glass, including load-bearing capacity (i.e. applied load-glass stress behavior and laminate deflection behavior). The effective thickness of laminate can be extracted directly from these tests. Temperature and load duration effects can also be analyzed.

The Four-Point Bending test involves measuring the glass stress (using strain gauges) and sample deflection. These are normally short duration tests that also involve simulating sudden gusts of wind. During these tests, the temperature is normally varied from room temperature up to around 70 °C (158 °F).

Comparison of SentryGlas® vs Trosifol® Clear PVB interlayers

Effect under bending load

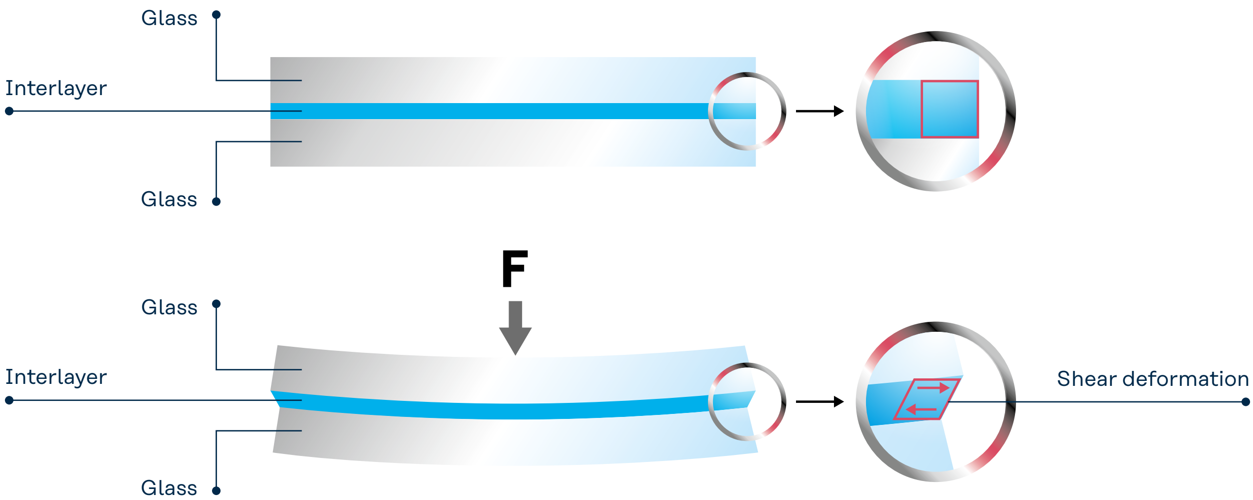


FIG 2

When exposed to sudden, short temporary loads, PVB interlayers such as Trosifol® Clear are able to internally compensate for the distortional differences (i.e. absorb shear forces) due to the glass sheets. Therefore, laminated safety glass produced with PVB interlayer provides excellent protection against, for example, the effects of vandalism, hurricanes or explosions. However, standard PVB is a soft polymer that starts to creep under long-term loads. As a result, two glass sheets laminated together using PVB – and exposed to a long-term flexural load and / or high temperatures - worst case behave in exactly the same way as two sheets that have not been joined together. Therefore, static calculations to date only consider the properties of the glass components and not of the overall laminate coupling effect of laminated safety glass.

Laminated safety glass with SentryGlas® interlayers react quite differently to PVB interlayers. In tensile tests, the strength of SentryGlas® is considerably higher than PVB. In addition, the stiffness of SentryGlas® is up to 100 times greater than PVB.

Seattle Space Needle

Stiffness (shear modulus) of Trosifol® Clear PVB and SentryGlas® interlayers at room and elevated temperatures

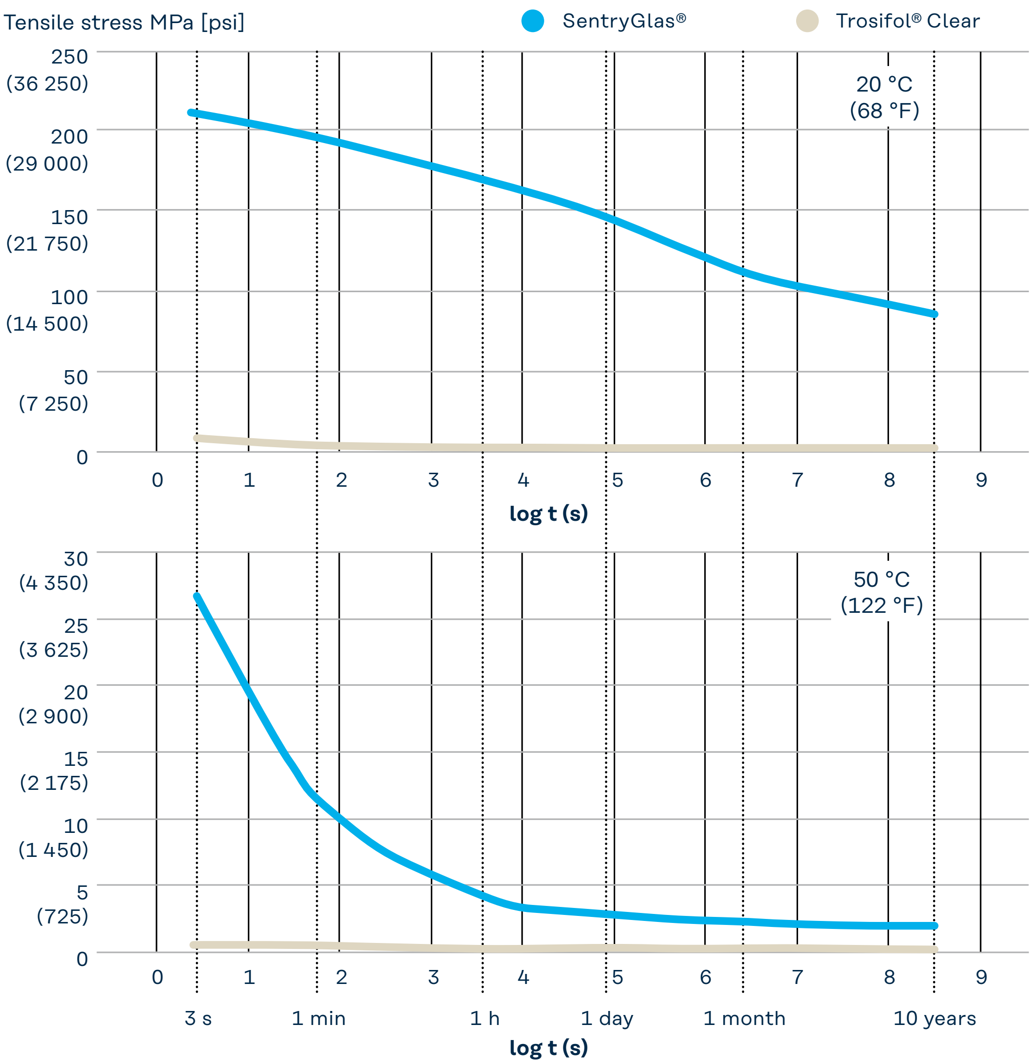


FIG 3 ➔ The stiffness behavior of SentryGlas® at increased temperatures also shows improvements compared to PVB.

When designing static-loaded laminated glass panels, structural engineers must consider the changes in the mechanical properties and behavior of the interlayer, in particular, the constraints when using PVB rather than SentryGlas® ionoplast. In order to evaluate the elastic properties of laminated safety glass interlayers over a range of specific test temperatures and load duration (time), Kuraray's Advanced Interlayer solutions has conducted a series of tests on SentryGlas® (SG5000) interlayers, using dynamic mechanical analysis and creep tests (according to ASTM D 4065). In these tests, the interlayer was subjected to a specific load at different temperatures from 10 °C (50 °F) up to 80 °C (176 °F) for a duration of time ranging from 1 second up to 10 years.

As well as internal tests by Kuraray's Advanced Interlayer solutions, external independent tests have also been conducted, including comparison tests of SentryGlas®, PVB and monolithic / tempered glass.

→ see APPENDIX in this chapter

CONCLUSIONS

The stiffness of SentryGlas® interlayer is so high that there is an almost perfect transfer of load between the glass sheets. This applies to a wide temperature range and also under long-term conditions. This means it is possible to produce high load-bearing laminates from SentryGlas® with exceptional performance / weight ratio.

For users, this enables both a reduction in costs and a reduction in the overall weight of the glazing.

SIGNIFICANT BENEFITS:

Compared to PVB laminates, laminates with SentryGlas® provide significant opportunities for designers in the following areas:

- Reduction of glass thickness (often in the region of one to two standard glass thicknesses)
- Installation of larger glass panels at determined loads
- Or, a reduction in the number of fixing points for frameless glazing
- Significant increase in post-glass breakage performance

Kuraray's Advanced Interlayer Solutions has collaborated with various material research institutes to investigate and compare the performance of laminated safety glass interlayers made from SentryGlas® and PVB, as well as monolithic glass.

THE MATERIALS COMPARED IN THE TESTS WERE:

- Monolithic glass: nominal 10 mm (3⁄8 in) annealed
- Trosifol® Clear PVB laminated glass: nominal 5 mm (3⁄16 in) | 0.76 mm (30 mil) | nominal 5 mm (3⁄16 in)
- SentryGlas®: nominal 5 mm (3⁄16 in) | 0.76 mm (30 mil) | nominal 5 mm (3⁄16 in)

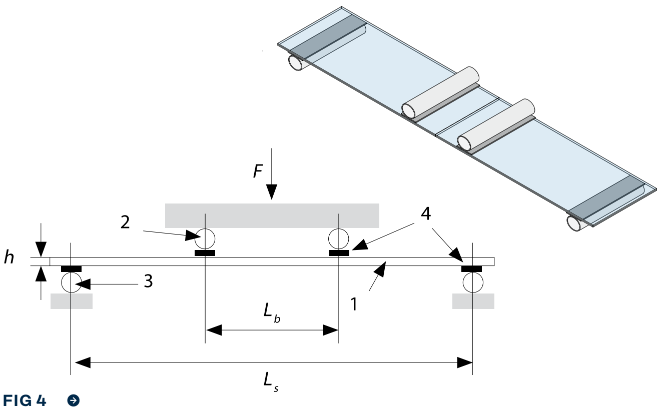


FIG 4 ➔

From the test results it can be seen that laminates with SentryGlas® develop the least glass stress at a specified applied load.

Glass stress development

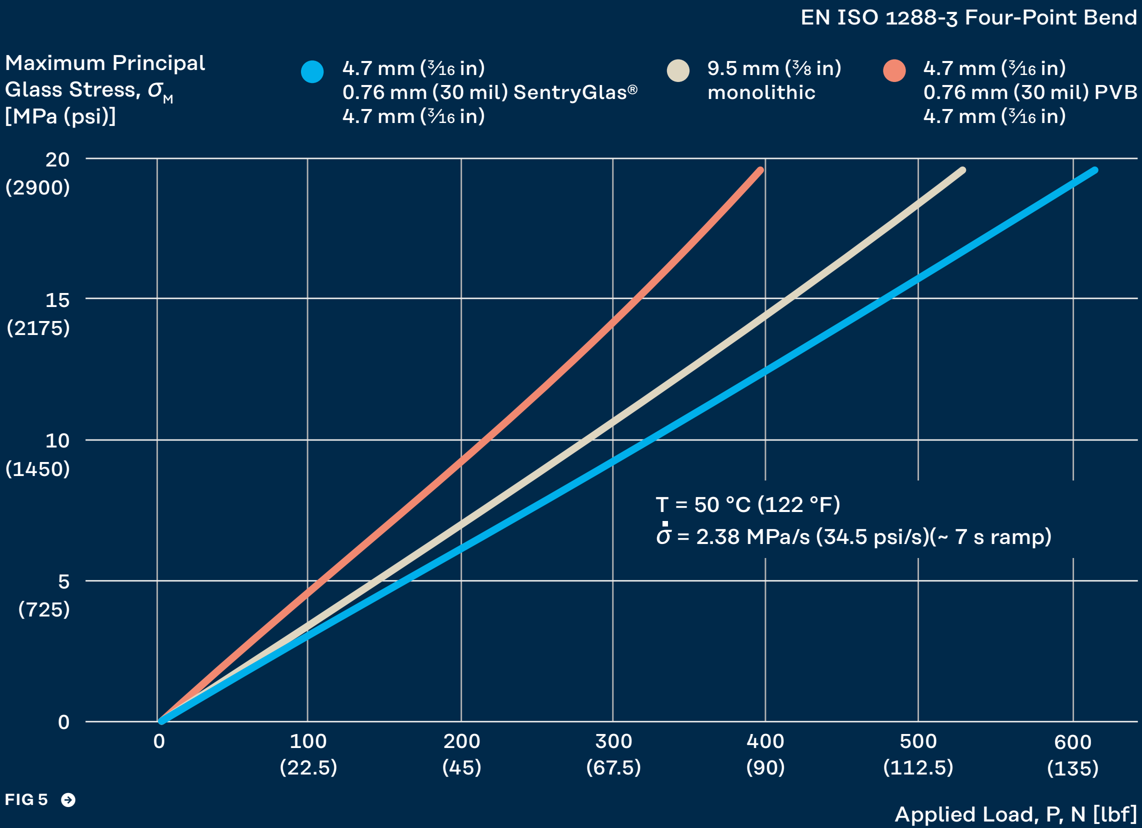


FIG 5 ➔

Deflection data

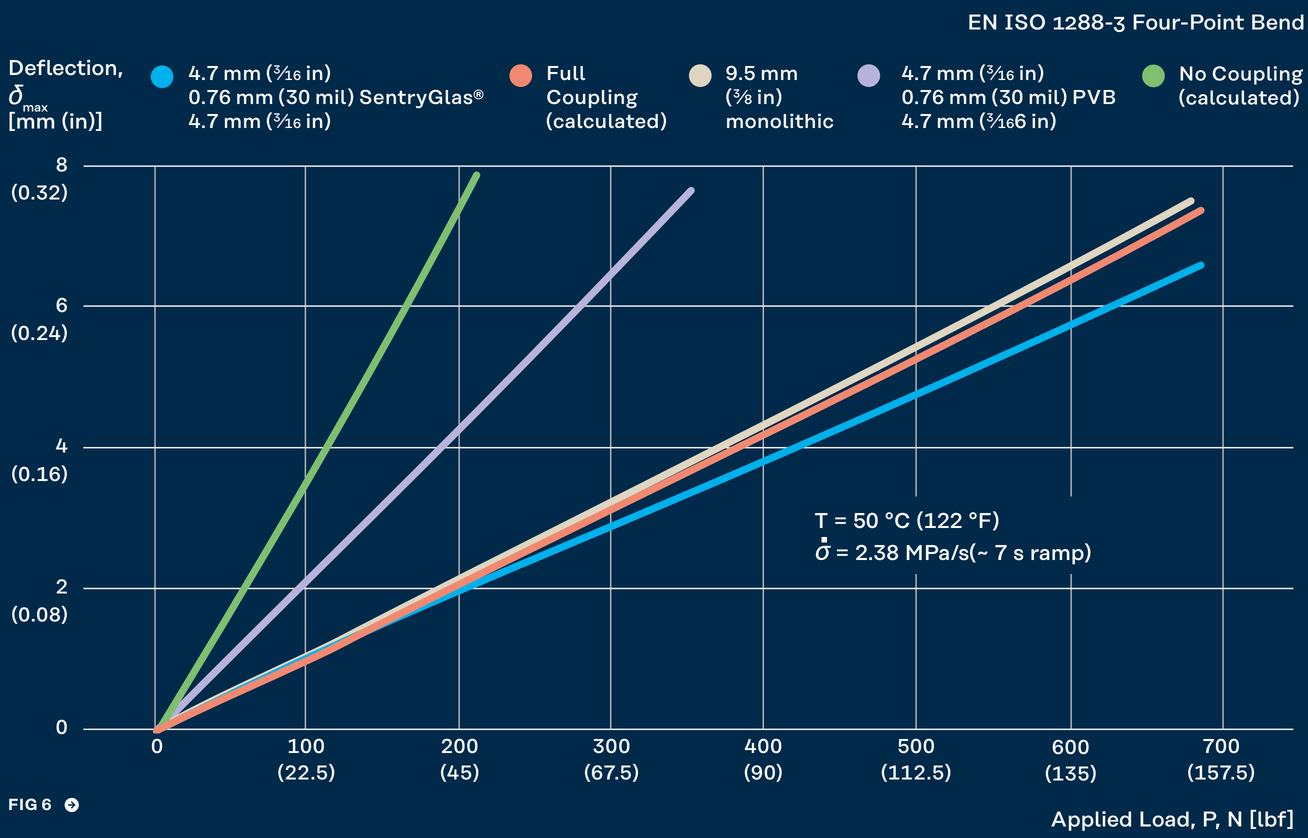


FIG 6

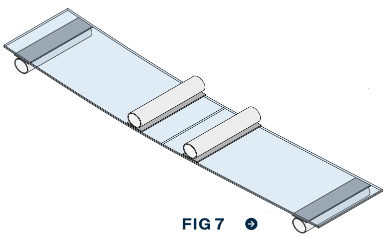


FIG 7

The test results show that laminates with SentryGlas® develop the least deflection at a specified load.

Bending tests – Effect of temperature

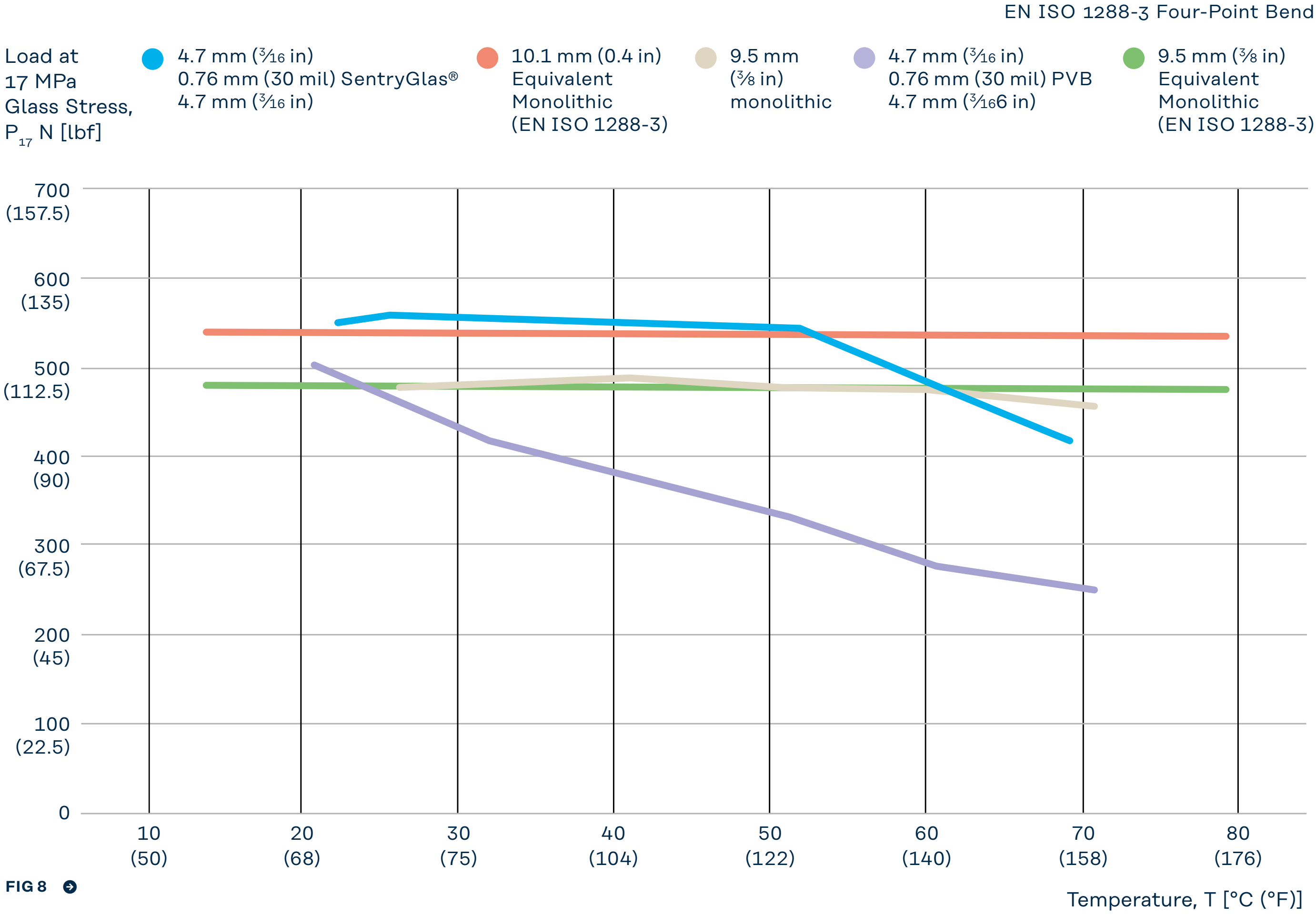


FIG 8

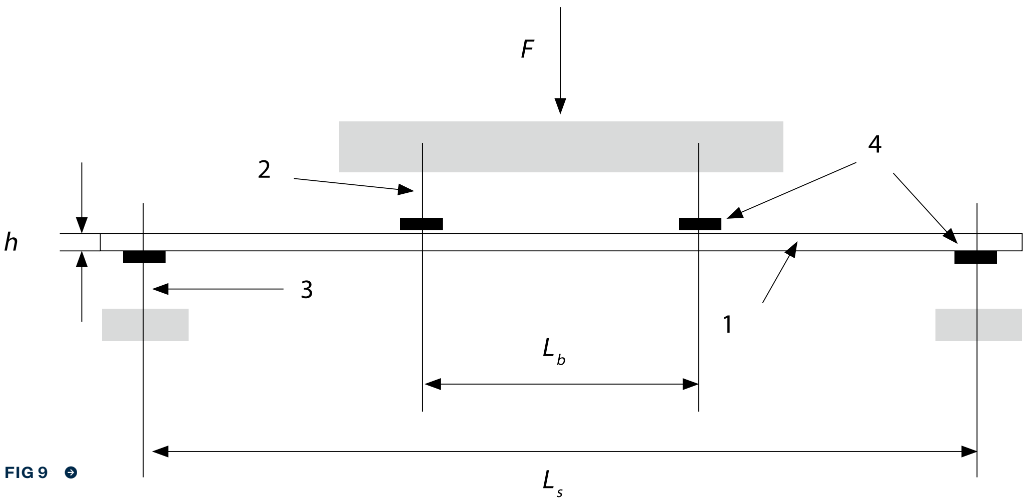


FIG 9

When the samples were heated in a temperature-controlled chamber, the test results show that laminates with SentryGlas® were insensitive up to around 50 °C (122 °F). However, the structural performance of PVB laminate is temperature-sensitive. For short duration loads, PVB laminates show reduced strength (compared to the equivalent monolithic glass) above 20 °C (68 °F).

BENDING TESTS ON BALUSTRADES

Kuraray's Advanced Interlayer Solutions has also collaborated with an independent research institute in the UK to compare the structural performance of glass balustrades made from PVB laminates, SentryGlas® and monolithic glass.

The Balustrade Test Program, which was developed by UK consultant John Colvin, compared the pre-glass breakage strength and deflection properties of the glass panels, which were manufactured by UK company Kite Glass.

These tightly controlled tests used common loading and support systems. Cantilever supports or bolted infill panels were used according to BS 6180. Line load and point load testing was carried out in accordance with BS 6399-1. Glass strength and deflection were measured at a temperature of 23 °C (73.4 °F).

THE PANELS MEASURED AS FOLLOWS:

- **19 mm (¾ in) tempered monolithic**
- **10 mm (⅜ in) tempered**
  1.52 mm (60 mil) PVB
  10 mm (⅜ in) tempered
- **10 mm (⅜ in) tempered**
  1.52 mm (60 mil) SentryGlas®
  10 mm (⅜ in) tempered

FREESTANDING BARRIER (CANTILEVER)

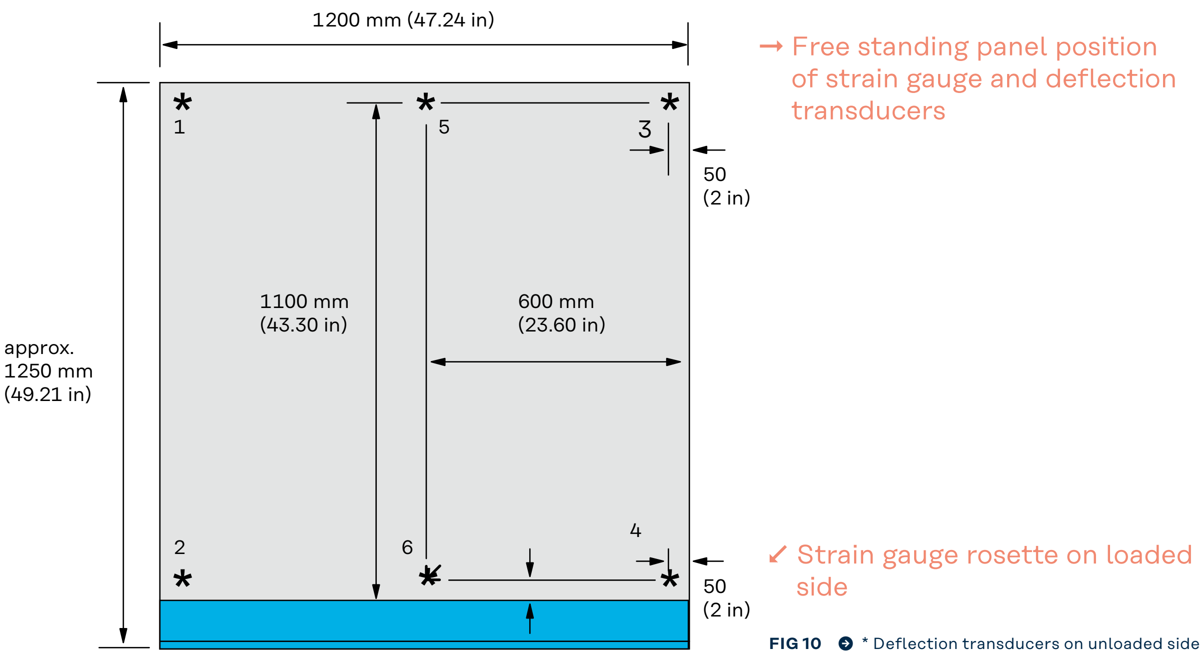


FIG 10 ➔ * Deflection transducers on unloaded side

In these tests, a line load of 1.5 kN/m (8.5 lbf/in) was applied to the top edge of the glass panel. In the center and corners of the panel, concentrated load of 1.5 kN (337 lbf) was also applied.

Freestanding Barrier – Deflections

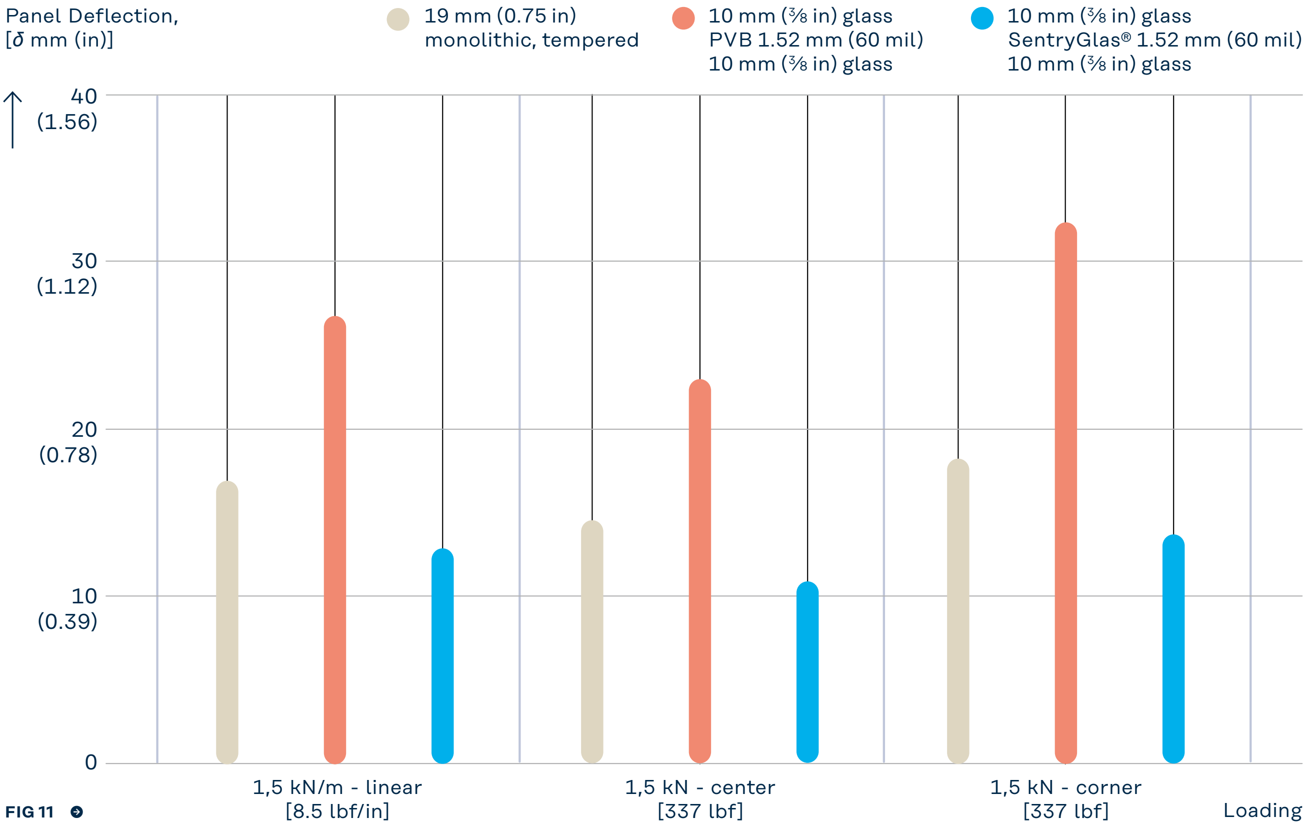


FIG 11 ➔

The test results clearly demonstrate that laminates with SentryGlas® interlayer develops the least deflection under the same load conditions.

Freestanding Barrier – Stress

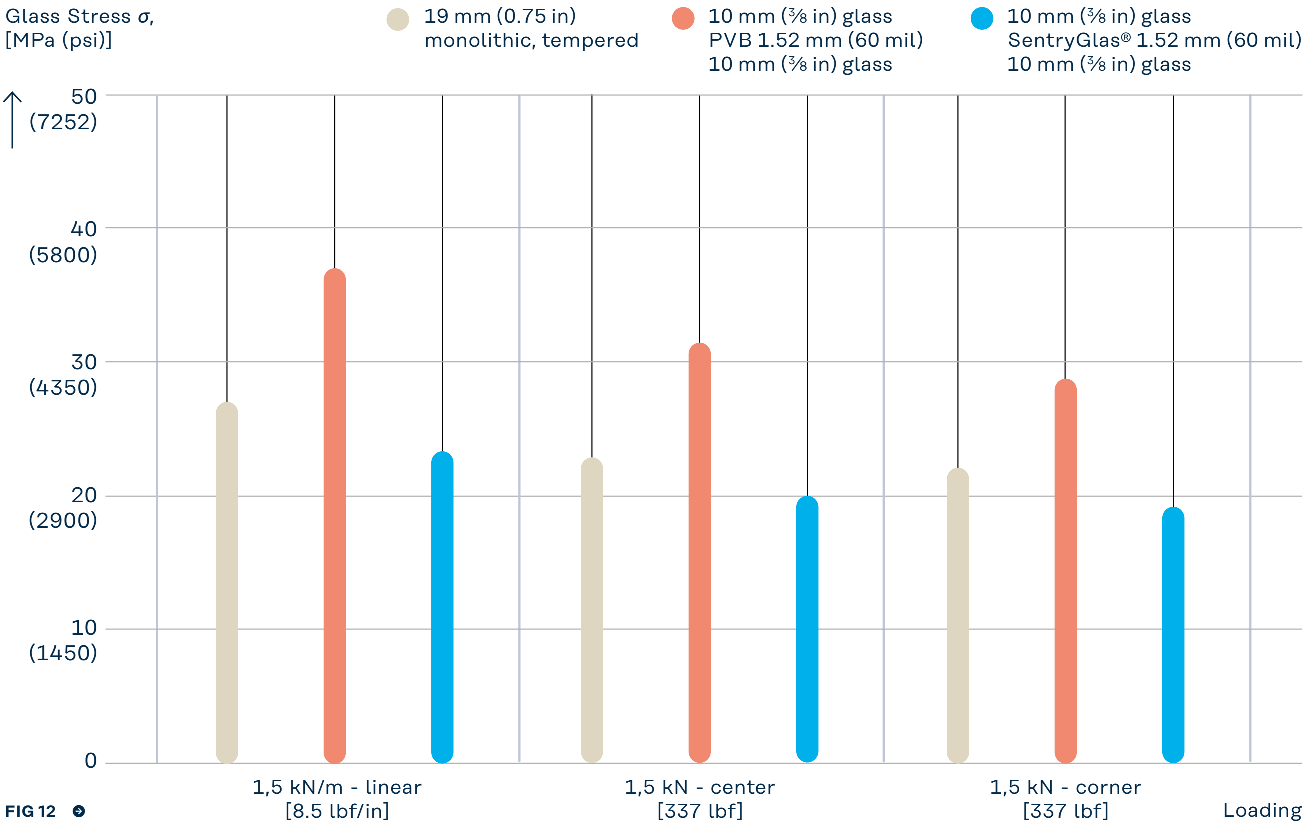


FIG 12 ➔

The test results also show that laminates with SentryGlas® interlayer develops the least glass stress under the same load conditions.

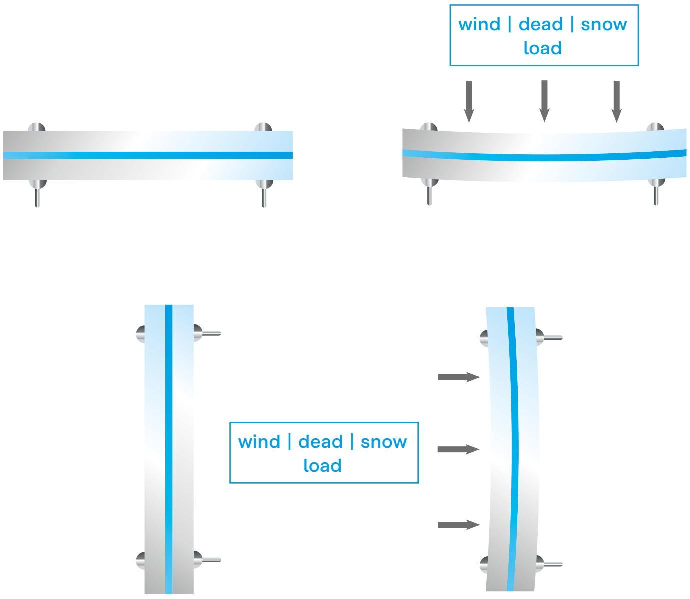


FIG 13

CONCLUSIONS

In both sets of tests, laminates with SentryGlas® interlayer performed in a manner that was similar to the equivalent thickness of monolithic glass, both in terms of the deflections and the stresses induced.

However, the PVB laminates developed significantly higher stresses and deflections than the equivalent thickness of monolithic glass. Therefore, laminated glass manufactured with PVB interlayer cannot be considered as having a performance equivalent to monolithic glass of similar thickness when it is used in barrier / balustrade glass panes, subject to concentrated loads and / or fixed loads at discrete points.

Effective thickness

The structural performance of laminated glass is commonly considered by defining the effective thickness, i.e. the thickness of a monolithic glass beam with equivalent bending properties in terms of stress and deflection. This method captures many of the important variables that influence performance. General expressions have been proposed on the basis of simplified models, but these are either difficult to apply or inaccurate.

How is it measured? In 2009, a method for determining the effective thickness for laminated glass for use in numerical analysis was added to ASTM E1300. A similar approach is also proposed in the latest European standard, prEN 13474 (2009), which uses OMEGA numbers for the ‘Coupling Approach’. Previously, glass thickness selection was limited to laminated glass charts presented in the ASTM E1300 Standard with a PVB interlayer. The effective thickness methodology provides an equivalent monolithic thickness based on the interlayer properties and glass geometry. Utilizing the effective thickness with a numerical analysis method, stresses and deflections for laminated glass can be easily modeled.

ASTM E1300 effective thickness approach with analytic expression for the bending case is an acceptable approach, but the key here is to have analytic expressions that are close to the problem being investigated.

Effective thickness

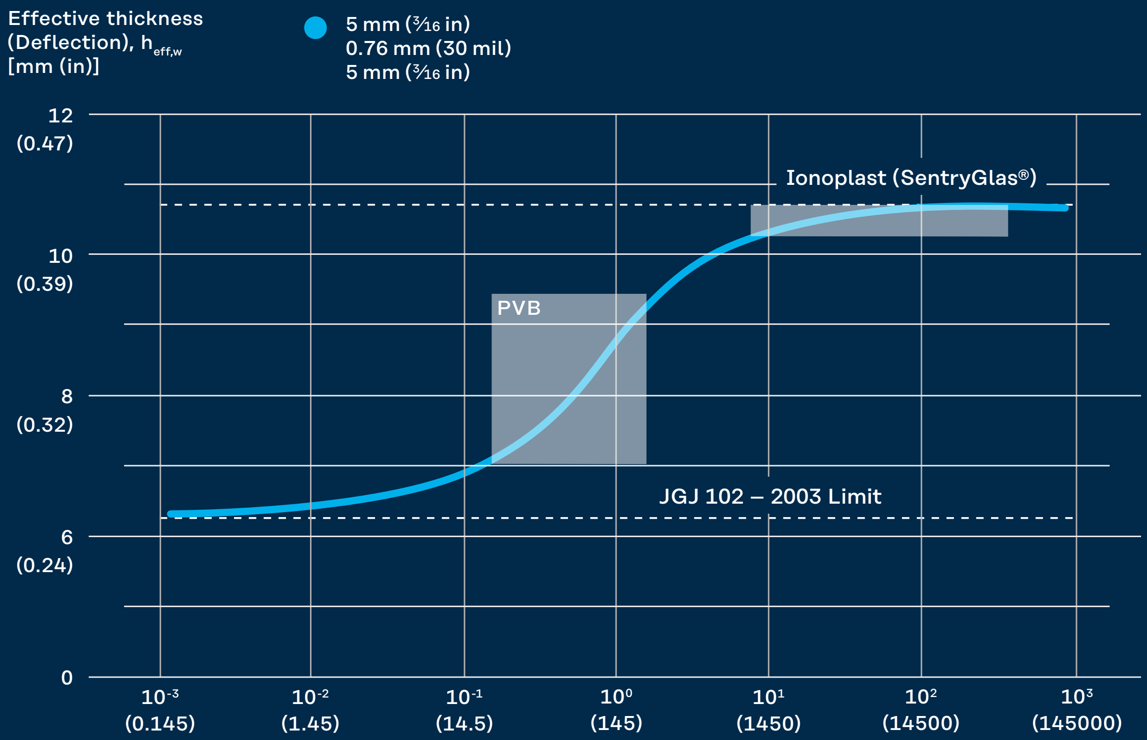


FIG 14 ➔

FIG 15 ➔

$$h_{ef;w} = \sqrt[3]{h_1^3 + h_2^3 + 12\Gamma I_s}$$

$$h_s = 0.5\,(h_1 + h_2) + h_v$$

$$h_{s;1} = \frac{h_s h_1}{h_1 + h_2}$$

$$h_{s;2} = \frac{h_s h_2}{h_1 + h_2}$$

$$I_s = h_1 h_{s;2}^2 + h_2 h_{s;1}^2$$

$$\Gamma = \frac{1}{1 + 9.6\,\dfrac{EI_s h_v}{G h_s^2 a^2}}$$

Γ = Measure of shear transfer ($0 \rightarrow 1$)

Other test methods

Other test methods for determining the structural properties of laminated safety glass include the use of 3D finite element analysis methods with full viscoelastic models. This method is accurate and captures the rate and temperature effects and is capable of modeling complex loading / support conditions. Test results can be validated for a range of rates, temperatures and bending states.

2D finite element methods with effective interlayer stiffness is also an acceptable method, although this method is conservative and so does tend to overestimate stress. However, it is useful for evaluating the effect of different interlayer types.

Calculating and comparing the strength of different laminates

GLASS STRENGTH CALCULATOR

In order to help designers and structural engineers estimate the stress and deflection behavior of glass laminates, Kuraray has developed an online software tool, which can be accessed via the Trosifol™ website. 'The Strength of Glass Calculator Tool' enables users to compare different types and thicknesses of laminates made from SentryGlas® or PVB interlayers.

THE TOOL CAN BE USED TO CALCULATE THE FOLLOWING:

- **Maximum glass stress under load and comparison to design strength specified in various standards such as ASTM E1300**
- **Laminate deflection**
- **Effective laminate thickness**
- **Laminate behavior as a function of time and temperature**

STRENGTH OF GLASS CALCULATOR
The easy-to-use Calculator is designed to help designers and architects accurately model a variety of glass-mounting solutions in combination with glass types, interlayer materials and external factors such as loads, load duration and temperatures.

Structural benefits of SentryGlas®

From the various tests outlined, it can be concluded that SentryGlas® interlayer extends the performance of laminated glass.

THIS ENHANCED STRUCTURAL PERFORMANCE ALLOWS LAMINATE DESIGNS WITH:

- **Thinner glass systems (Downgauging glass thickness)**
- **Larger panel sizes**
- **Extended pressure / temperature performance ranges**
- **Minimal support in frameless glazing systems**

SentryGlas® Elastic properties

SPECIFYING AND TECHNICAL DATA

The following information is presented to help you evaluate or order SentryGlas® ionoplast interlayers. SentryGlas® interlayer is available on roll or as sheet and has a Yellowness-Index (YID) of < 2.0.

In addition to the standard stock sizes above, SentryGlas® can be ordered as 'cut-to-size', 'cut-to-fit' or 'cut-to-form' sheet, which means that none of the material is wasted. In all cases, sheet thickness is 0.89 mm (35 mil), 1.52 mm (60 mil) or 2.28 mm (90 mil). As these custom sizes require special handling/cutting, lead times are longer. For details about the 'cut-to-size', 'cut-to-fit' or 'cut-to-form' sheet offering feel free to contact us.

Laminate properties SentryGlas®

Property	Units metric (English)	Value	Test
Haze	%	< 2	ASTM D1003
Impact test 227 g (0.5 lb)	m (ft)	> 9.14 (> 30)	ANSI Z26.1
Boil test 2 hr	–	No defects	ANSI Z26.1
Bake test 2 hr/100 °C	–	No defects	ANSI Z26.1

TAB 1 ➔

Interlayer typical properties SentryGlas®

Property	Units metric (English)	Value	ASTM Test
Young's Modulus	Mpa (kpsi)	300 (43.5)	D5026
Tear Strength	MJ/m^3 ($ft\ lb/in^3$)	50 (604)	D638
Tensile Strength	Mpa (kpsi)	34.5 (5.0)	D638
Elongation	%	400 (400)	D638
Density	g/cm^3 (lb/in^3)	0.95 (0.0343)	D792
Flex Modulus 23 °C (73 °F)	Mpa (kpsi)	345 (50)	D790
Heat Deflection Temperature (HDT) @ 0.46 MPa	°C (°F)	43 (110)	D648
Melting Point	°C (°F)	94 (201)	(DSC)
Coeff. of Thermal Expansion (-20 °C to 32 °C)	10^{-5} cm/m °C (mils/in °C)	10 – 15 (0.10 – 0.15)	D696
Thermal Conductivity	W/M-K (BTU-in/hr-ft^2 °F)	0.246 (1.71)	

TAB 2 ➔

Conversion table MPa to kpsi

MPa	kpsi	MPa	kpsi
10	1.450	90	13.053
15	2.175	100	14.503
20	2.900	200	29.007
25	3.625	300	43.511
30	4.351	400	58.015
35	5.076	500	72.519
40	5.801	600	87.023
45	6.526	700	101.526
50	7.251	800	116.030
60	8.702	900	130.534
70	10.513	1000	145.037
80	11.603	1100	159.542

TAB 3

Photo: © www.aey.me

SentryGlas® Xtra™ (SGX™) interlayer

SentryGlas® Xtra™ (SGX™) is the latest generation SentryGlas® ionoplast interlayer from Trosifol® designed to improve lamination performance and efficiency.

SGX™ has robust adhesion to the air side of glass without the need for primer making lamination of multi ply laminates easier. SGX™ optical performance and haze formation are much less sensitive to the autoclave cooling rate giving peace of mind to the laminator that the final laminate will have consistently high quality. The lower haze also makes producing very thick laminates of outstanding optical quality easily achievable.

SGX™ complies with global safety glazing codes such as ANSI Z97.1, EN14449, EN12543, EN12600, EN356 and Safety Glazing Certification Council (SGCC). Properly laminated and installed SGX™ laminates of 2.53 mm caliper have been tested and pass the large missile impact test per ASTM E 1996.

Interlayer typical properties SentryGlas® Xtra™

Property	Method	Value	Units metric (English)
Tensile strength	ASTM D638 (23°C/50% RH) ISO 527(23°C/50% RH)	43.5 (6.3) 42.9 (6.2)	Mpa (Kpsi) Mpa (Kpsi)
Elongation	ASTM D638(23°C/50% RH) ISO 527(23°C/50% RH)	320 600	% %
Specific gravity	ASTM D792	0.95	
Coeff. of thermal expansion (-20 °C to 32 °C)	ASTM D696	10×10^{-5}	mm/mm/°C
Heat deflection temperature	ASTM D648	37 (99)	°C (°F)

TAB 4 ➔

Laminate typical properties* SentryGlas® Xtra™

Property	Method	Value [%]
Light transmission	EN410 (ASTM G 173-03)	90 (90)
UV transmission	ISO 9050	< 1
Haze	ASTM D1003	< 1
Yellowness	ASTM D313	≤ 0.3

TAB 5 ➔ * 0.89 mm with 4 mm clear glass

Robust adhesion – adhesion less effected by glass orientation and moisture content

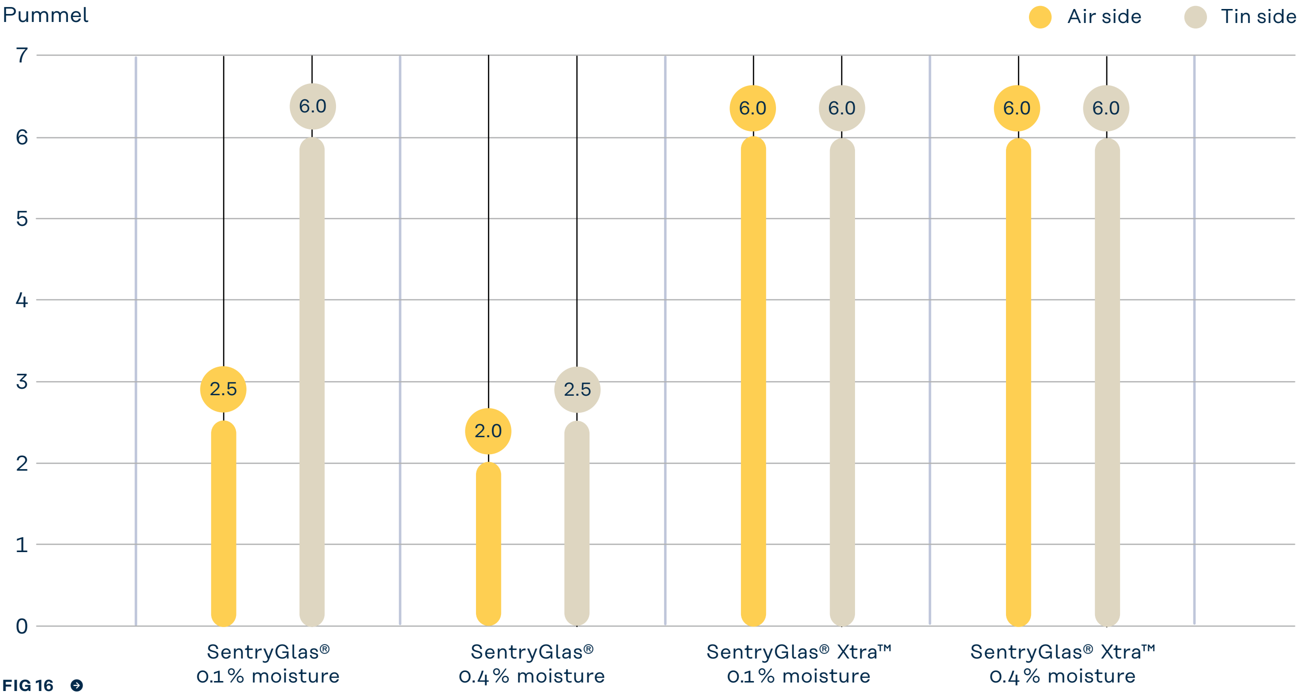


FIG 16 ➔

ADVANTAGES OF SGX™

- Less concern for the laminator on interlayer storage condition and higher confidence in final laminate adhesion
- Superior adhesion to air side of glass without the use of primers

Haze less sensitive to autoclave cooling rate SentryGlas® Xtra™ vs. SentryGlas®

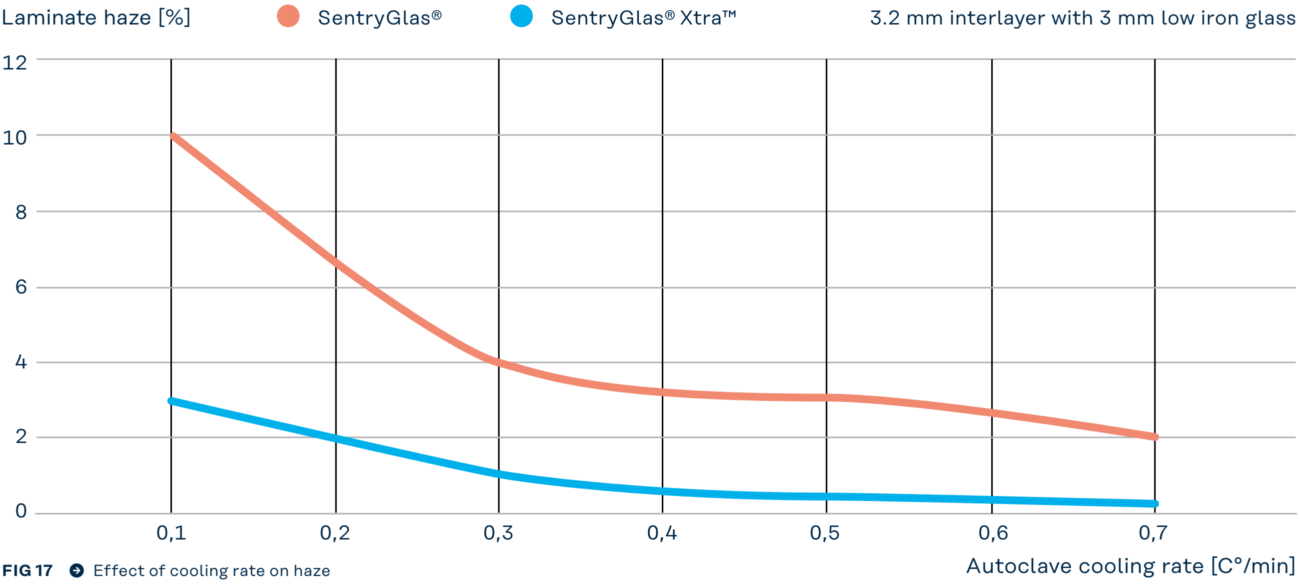


FIG 17 ➔ Effect of cooling rate on haze

ADVANTAGES OF SGX™

- Haze formation less sensitive to autoclave cooling rate
- Potential to increase autoclave laminate loading
- Greater confidence in consistently achieving the highest quality of optics

Appendix

ELASTIC PROPERTIES OF SENTRYGLAS® FOR STRUCTURAL CALCULATIONS

Data has been evaluated according to ASTM.

Young's Modulus E(t) / MPa SentryGlas®

Temperature	Load duration										
	1 sec	3 sec	5 sec	10 sec	30 sec	1 min	5 min	10 min	30 min	1 hour	6 hours
-20°C (-4°F)	838	835	835	832	832	829	821	818	815	809	806
0°C (32°F)	749	743	740	737	732	726	717	714	708	703	680
10°C (50°F)	693	661	678	664	661	651	638	618	629	597	574
20°C (68°F)	629	612	606	594	602	567	549	525	511	493	458
25°C (77°F)	511	485	474	456	433	413	340	334	308	294	263
30°C (86°F)	443	413	405	381	349	342	243	220	194	178	162
35°C (95°F)	338	302	287	266	230	209	158	141	112	103	78.2
40°C (104°F)	229	187	167	143	109	92.0	57	46.9	34	27.8	17.1
50°C (122°F)	108.6	78	66.3	55.1	40	33.8	21.7	18.57	14.6	12.6	9.72
60°C (140°F)	35.4	24.5	20.67	17.2	12.8	10.9	7.6	6.75	5.5	5.1	4.26
70°C (158°F)	11.31	8.8	8.13	7.3	6.3	5.64	4.2	3.45	2.9	2.5	1.95
80°C (176°F)	4.65	4.0	3.66	3.31	2.9	2.5	1.7	1.35	1.1	1.0	0.9

Temperature	Load duration									
	12 hours	1 day	2 days	5 days	1 week	3 weeks	1 month	1 year	10 years	50 years
-20°C (-4°F)	804	801	798	795	795	792	786	772	749	720
0°C (32°F)	668	665	654	648	645	639	636	605	579	559
10°C (50°F)	560	553	543	516	519	498	499	467	448	421
20°C (68°F)	438	428	406	380	368	336	330	282	256	223
25°C (77°F)	250	234	206	177	160	131	123	93.3	70.6	52.6
30°C (86°F)	153	146	105	72	66.0	38	35	20.3	15	11.9
35°C (95°F)	68.4	60.1	48.9	36.7	33.8	24.6	22.1	14.7	12.2	9.03
40°C (104°F)	15.0	13.5	12.3	11	10.9	10	9.9	9.3	8.84	6.86
50°C (122°F)	8.94	8.4	8.01	7.2	7.26	6.5	6.5	6.3	6.0	5.46
60°C (140°F)	4.05	3.8	3.78	3.6	3.54	3.3	3.3	3.0	2.9	2.22
70°C (158°F)	1.89	1.8	1.74	1.6	1.62	1.5	1.5	1.4	1.3	1.05
80°C (176°F)	0.9	0.8	0.87	0.7	0.75	0.6	0.8	0.6	0.5	0.48

TAB 6 ➔ E(t) was calculated according E(t) = 2 x G(t) x (1+v) for isotropic materials with: v = 0.48; the Poisson ratio v was measured in accordance to EN ISO 527 (23°C, 30% r. H.).

Shear Modulus G(t) / MPa SentryGlas®

Temperature	Load duration									
	1 sec	3 sec	5 sec	10 sec	30 sec	1 min	5 min	10 min	30 min	1 hour	6 hours
-20°C (-4°F)	291	290	290	289	289	288	285	284	283	281	280
0°C (32°F)	260	258	257	256	254	252	249	248	246	244	236
10°C (50°F)	240	236	235	230	228	225	216	214	217	206	199
20°C (68°F)	217	211	209	205	206	192	185	181	175	169	158
25°C (77°F)	176	167	163	157	149	142	117	115	106	101	90.6
30°C (86°F)	151	141	138	130	119	110	85.5	75.2	66	60	55.3
35°C (95°F)	114	102	96.9	89.9	77.7	70.5	53.4	47.7	37.9	34.7	26.4
40°C (104°F)	77	63	56.4	48.1	37	31	19.7	15.8	11.4	9.3	5.76
50°C (122°F)	36.2	26.4	22.1	18.5	13.5	11.3	7.38	6.19	4.9	4.2	3.24
60°C (140°F)	11.8	8.2	6.89	5.76	4.3	3.6	2.56	2.25	1.9	1.7	1.42
70°C (158°F)	3.77	2.9	2.71	2.45	2	1.9	1.34	1.15	1.0	0.8	0.65
80°C (176°F)	1.55	1.3	1.22	1.11	1.0	0.8	0.53	0.45	0.4	0.3	0.3

Temperature	Load duration									
	12 hours	1 day	2 days	5 days	1 week	3 weeks	1 month	1 year	10 years	50 years
-20°C (-4°F)	279	278	277	276	276	275	273	268	260	250
0°C (32°F)	232	231	227	225	224	222	221	210	201	194
10°C (50°F)	194	190	188	178	180	172	171	161	153	146
20°C (68°F)	151	146	140	130	127	115	112	96.5	86.6	77.1
25°C (77°F)	86.2	80.5	70.8	60.8	55.1	45.1	42.4	32.1	24.3	18.1
30°C (86°F)	52.3	50	35.9	24.7	22.5	12.9	11.6	6.8	5.31	4.05
35°C (95°F)	23.1	20.3	16.5	12.4	11.4	8.31	7.45	4.95	4.11	3.05
40°C (104°F)	5.06	4.5	4.16	3.6	3.66	3.4	3.3	3.1	2.9	2.31
50°C (122°F)	2.98	2.8	2.67	2.4	2.42	2.2	2.2	2	2	1.82
60°C (140°F)	1.35	1.3	1.26	1.2	1.18	1.1	1.1	1.0	0.97	0.74
70°C (158°F)	0.63	0.6	0.58	0.5	0.54	0.5	0.5	0.5	0.45	0.35
80°C (176°F)	0.3	0.3	0.29	0.2	0.25	0.2	0.2	0.2	0.2	0.16

TAB 7 ➔ G(t) data were determined by Dynamic-Mechanical-Analysis in accordance to EN ISO 6721 within the linear range of deformation. All samples were stored at 23°C for 4 weeks before measurement. G(t) data were experimentally verified by 4-Point-Bend-Tests on laminated glass following prEN 16613 at third party labs for selected time-load combinations.

Poisson Ratio SentryGlas®, SentryGlas® Xtra™

Temperature	Load duration						
	1 sec	3 sec	1 min	1 hour	1 day	1 month	10 years
10°C (50°F)	0.442	0.443	0.446	0.450	0.454	0.458	0.463
20°C (68°F)	0.448	0.449	0.446	0.459	0.464	0.473	0.479
24°C (75°F)	0.452	0.453	0.458	0.465	0.473	0.482	0.489
30°C (86°F)	0.463	0.466	0.473	0.485	0.488	0.497	0.499
40°C (104°F)	0.481	0.484	0.492	0.498	0.499	0.499	0.499
50°C (122°F)	0.491	0.493	0.497	0.499	0.499	0.500	0.500
60°C (140°F)	0.497	0.498	0.499	0.500	0.500	0.500	0.500
70°C (158°F)	0.499	0.499	0.500	0.500	0.500	0.500	0.500
80°C (176°F)	0.500	0.500	0.500	0.500	0.500	0.500	0.500

TAB 8 ➜

ELASTIC PROPERTIES OF SENTRYGLAS® XTRA™

Young's Modulus E(t) / MPa – SentryGlas® Xtra™

Temperature	Load duration									
	1 sec	3 sec	5 sec	10 sec	30 sec	1 min	5 min	10 min	30 min	1 hour	6 hours
-20°C (-4°F)	725	719	719	716	710	705	699	670	672	669	654
0°C (32°F)	601	589	580	571	551	536	512	500	474	426	367
10°C (50°F)	536	530	527	521	509	503	477	423	373	355	271
20°C (68°F)	480	459	426	400	389	370	355	340	296	237	163
25°C (77°F)	417	403	373	346	340	289	238	187	136	110	79.9
30°C (86°F)	314	299	283	270	250	237	163	148	113	77.0	48.0
35°C (95°F)	233	208	194	182	163	133	85.8	65.1	40.0	29.6	13.6
40°C (104°F)	149	137	120	105	98.0	79.9	44.4	35.5	20.7	15.4	7.81
50°C (122°F)	65.4	37.6	25.0	17.7	14.5	11.5	8.02	7.25	5.92	5.03	3.55
60°C (140°F)	14.5	11.2	9.86	7.51	6.36	5.57	4.14	3.70	2.96	2.66	2.01
70°C (158°F)	6.51	5.12	4.23	3.85	3.11	2.66	2.01	1.92	1.33	1.18	0.83
80°C (176°F)	0.92	0.80	0.68	0.53	0.30	0.27	0.18	0.15	0.12	0.12	0.09

Temperature	Load duration								
	12 hours	1 day	2 days	5 days	1 week	3 weeks	1 month	1 year	10 years	50 years
-20°C (-4°F)	631	619	568	554	551	544	522	471	411	388
0°C (32°F)	317	299	282	252	248	222	209	162	127	115
10°C (50°F)	252	199	170	138	126	109	101	66.9	48.8	39.1
20°C (68°F)	148	118	109	87.3	79.6	62.8	54.4	32.9	19.8	14.9
25°C (77°F)	62.2	55.1	53.0	45.6	42.0	32.9	31.4	16.6	9.80	7.22
30°C (86°F)	31.4	26.6	24.7	21.1	18.3	16.4	15.3	9.09	5.86	4.47
35°C (95°F)	11.8	9.80	9.56	8.17	7.79	6.87	6.35	4.47	3.11	2.58
40°C (104°F)	5.89	5.51	5.45	4.65	4.11	3.52	3.28	2.07	1.39	1.10
50°C (122°F)	3.26	3.11	2.96	2.72	2.20	1.81	1.59	1.27	0.68	0.50
60°C (140°F)	1.81	1.72	1.27	1.18	1.13	0.92	0.84	0.53	0.36	0.27
70°C (158°F)	0.77	0.71	0.59	0.49	0.41	0.36	0.32	0.21	0.15	0.12
80°C (176°F)	0.09	0.06	0.03	0.03	0.03	-	-	-	-	-

TAB 9 ➔ Poisson ratio (v) = 0.48 E = G*2 (1+v)

Shear Relaxation Modulus G(t)/MPa – SentryGlas® Xtra™

Temperature	Load duration										
	1 sec	3 sec	5 sec	10 sec	30 sec	1 min	5 min	10 min	30 min	1 hour	6 hours
-20°C (-4°F)	245	243	243	242	240	238	236	233	227	226	221
0°C (32°F)	203	199	196	193	186	182	172	169	160	144	124
10°C (50°F)	181	179	178	176	172	170	161	143	126	120	91.6
20°C (68°F)	162	155	144	135	131	125	120	115	100	80.1	55.1
25°C (77°F)	141	136	126	117	115	97.9	80.4	63.3	45.8	37.2	27.0
30°C (86°F)	106	101	95.6	91.2	84.8	80.1	55.1	50.0	38.2	26.0	16.2
35°C (95°F)	78.7	70.3	65.5	61.5	55.1	44.9	29.0	22.0	13.5	10.0	4.60
40°C (104°F)	50.3	46.3	40.5	35.5	33.1	27.0	15.0	12.0	6.99	5.20	2.64
50°C (122°F)	22.1	12.7	8.45	5.98	4.90	3.89	2.71	2.45	2.00	1.70	1.20
60°C (140°F)	4.90	3.78	3.33	2.54	2.15	1.88	1.40	1.25	1.00	0.90	0.68
70°C (158°F)	2.20	1.73	1.43	1.30	1.05	0.90	0.68	0.65	0.45	0.40	0.28
80°C (176°F)	0.31	0.27	0.23	0.18	0.10	0.09	0.06	0.05	0.04	0.04	0.03

Temperature	Load duration									
	12 hours	1 day	2 days	5 days	1 week	3 weeks	1 month	1 year	10 years	50 years
-20°C (-4°F)	213	209	192	187	186	184	176	159	139	131
0°C (32°F)	107	101	95.3	85.1	83.8	75.0	70.6	54.7	42.9	38.9
10°C (50°F)	85.1	67.2	57.4	46.6	42.6	36.8	34.1	22.6	16.5	13.2
20°C (68°F)	50.0	39.9	36.8	29.5	26.9	21.2	18.4	11.1	6.69	5.03
25°C (77°F)	21.0	18.6	17.9	15.4	14.2	11.1	10.5	5.61	3.31	2.44
30°C (86°F)	10.6	8.97	8.35	7.13	6.18	5.54	5.17	3.07	1.98	1.51
35°C (95°F)	3.99	3.31	3.23	2.76	2.63	2.32	2.15	1.51	1.05	0.87
40°C (104°F)	1.99	1.86	1.84	1.57	1.39	1.19	1.11	0.70	0.47	0.37
50°C (122°F)	1.10	1.05	1.00	0.92	0.74	0.61	0.54	0.43	0.23	0.17
60°C (140°F)	0.61	0.58	0.43	0.40	0.38	0.31	0.28	0.18	0.12	0.09
70°C (158°F)	0.26	0.24	0.20	0.17	0.14	0.12	0.11	0.07	0.05	0.04
80°C (176°F)	0.03	0.02	0.01	0.01	0.01	-	-	-	-	-

TAB 10 ➔ Poisson ratio (v) = 0.48 E = G*2 (1+v)

Optical, visual and sound control properties

Laminated architectural glass is being used increasingly to meet modern safety codes and to save energy through added daylighting and solar design.

INTRODUCTION

Laminated architectural glass also adds anti-intrusion security, sound reduction and protection from UV rays. Some applications require laminated glass with high UV-transmittance properties, allowing more natural light into the building.

Two common types of interlayers for laminated glass are films made from PVB and SentryGlas® ionoplast interlayers. The optical, visual clarity and acoustic performance of these interlayers are often critical design considerations for architects and structural designers.

VISUAL CLARITY

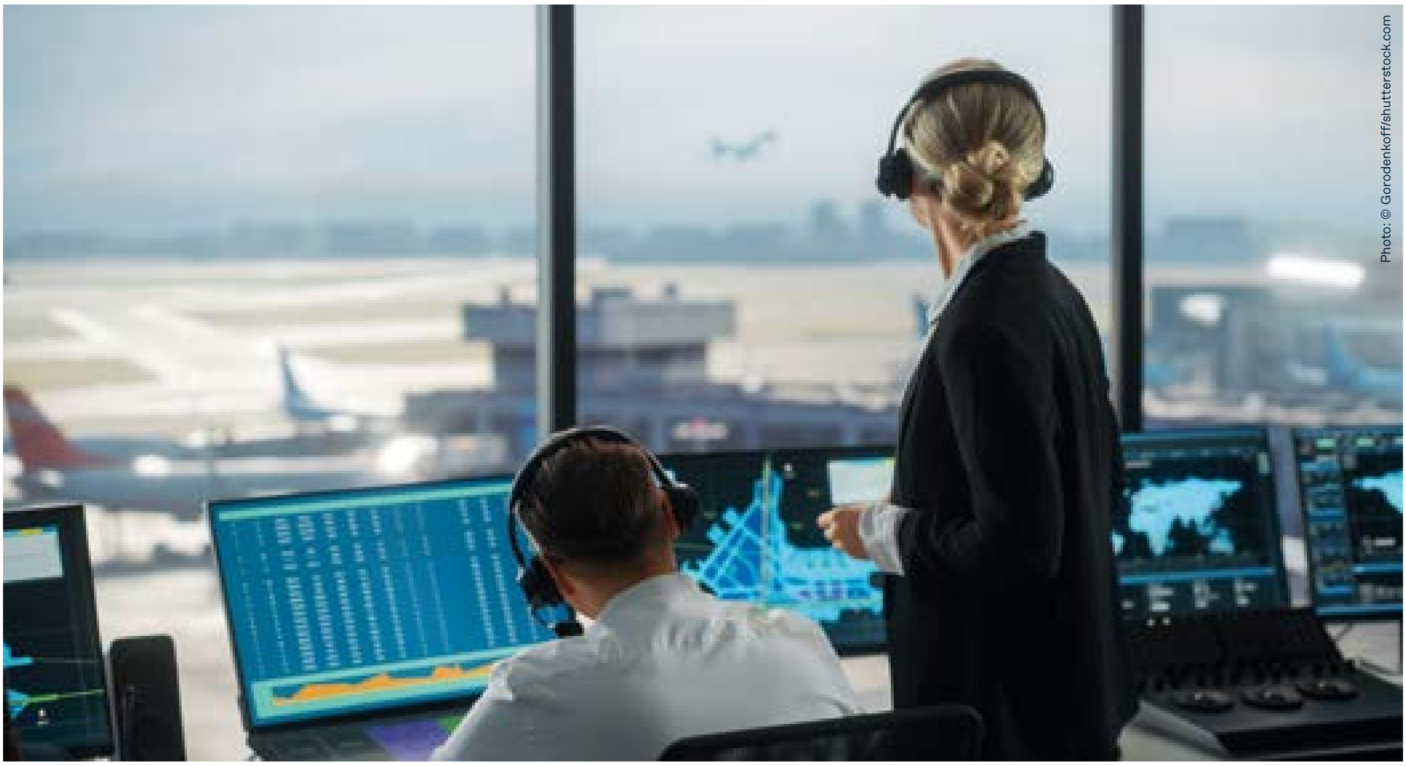
In terms of architectural glazing applications, choosing the right laminated safety glass can improve the visual clarity (visibility) and visual comfort of people occupying the building, primarily by protecting the human eye from glare due to sunlight.

HOW IS VISUAL CLARITY MEASURED?

The visual clarity (transparency) of laminated glass is normally measured by using the Yellowness Index (YID). YID is a number calculated from spectrophotometric data that describes the change in color of a test sample from clear or white toward yellow.

This yellowing / coloration process is described by the DeltaE value (see ASTM D1925 'Test Method for Yellowness Index of Plastics'). These tests are most commonly used to evaluate color changes in a material caused by real (or simulated) outdoor exposure.

➔ Laminated safety glass made with Kuraray interlayers can help reduce sound transmission through glass or let more natural light into the building.



DESIGNING WITH LOW-IRON GLASS

Visual clarity and optical quality are therefore important design considerations. Low-iron glass (i.e. glass with reduced iron content) provides improved visual clarity by increasing light transmission and reducing the greenish tint in clear glass that is most apparent when viewed from the edge. This green tint becomes more visible as the thickness of the glass increases.

Due to its high clarity, SentryGlas® ionoplast interlayers enable architects and structural designers to achieve their ultimate visions in low-iron safety glass. SentryGlas® interlayer eliminates the undesirable 'yellow' or 'greenish' tint that affects safety glass produced with conventional interlayers such as most PVB products, even at the outermost edge of weather-exposed laminates. This means that for the first time, designers can specify low-iron and safety glass, but still achieve the full clarity they require for the application, without sacrificing visibility, clarity or the overall beauty of their designs. This is particularly important in critical clarity applications such as skylights, doors, entranceways, display cases and retail storefronts.

For laminated safety glass products made of heat-strengthened or fully tempered glass, we also recommend high adhesion, e.g. Trosifol® UltraClear. Besides salt spray test demonstrates the outstanding open edge performance with Trosifol® Ultra Clear.

SENTRYGLAS® IONOPLAST INTERLAYER VS PVB

Not only does SentryGlas® interlayer start clearer than other safety glass interlayers, it also remains clearer throughout its life. With a Yellowness Index (YID) that starts at 1.5 or less (compared to 6-12 YID for PVB alternatives), SentryGlas® interlayer keeps its initial clarity after years of service. This means extra transparency and a more predictable color in laminated glass, which is more consistent with the glass color selected for the project.

With a higher YID than SentryGlas® interlayer, PVB interlayers often cause a 'greenish' tint effect in the glass after years of service, whereas SentryGlas® ionoplast interlayer takes on a more favorable 'blue' tint over time. The clarity of SentryGlas® interlayer is permanent and the laminate will under normal conditions such as proper lamination not turn yellow. SentryGlas® is therefore ideally suited to a wide range of architectural safety glass applications, including overhead glazing, façades, balustrades, staircases, flooring, storefronts (retail outlets), and other typical low-iron glass applications.

SOLAR ENERGY CONTROL

Architectural design is enhanced with an abundance of natural light. Energy savings can often be achieved by considering the solar control properties of glass design. Sunlight can cause heat gain within a structure, which is sometimes undesirable in terms of the costs of energy and air conditioning. However, at other times, for example in colder climates, it may be appropriate to maximize the heat retention in order to reduce heating costs. For laminated safety glass, there are no obvious technical advantages in terms of solar energy control by specifying either PVB, monolithic or SentryGlas® ionoplast interlayers.

Solar control characteristics of clear glass laminated with SentryGlas® interlayer

Nominal laminate thickness [mm]	[in]	SentryGlas® [mm]	[mil]	Glass type	U–Value [W/m²K]	SHGC	SC	Tvis [%]
6	1⁄4	1.52 2.28	60 90	Clear Clear	5.57 5.39	0.76 0.74	0.88 0.86	88 85
11	7⁄16	1.52 2.28	60 90	Clear Clear	5.49 5.31	0.73 0.71	0.84 0.82	86 84
15	9⁄16	1.52 2.28	60 90	Clear Clear	5.82 5.82	0.81 0.81	0.94 0.94	85 85
6	1⁄4	1.52 2.28	60 90	Low-iron Low-iron	5.90 5.90	0.91 0.91	1.04 1.04	91 91
11	7⁄16	1.52 2.28	60 90	Low-iron Low-iron	5.85 5.31	0.90 0.81	1.04 0.94	91 87
15	9⁄16	1.52 2.28	60 90	Low-iron Low-iron	5.43 5.25	0.84 0.81	0.96 0.93	90 87

TAB 11 ➔

Solar control characteristics of tinted glass laminated with SentryGlas® interlayer

Nominal laminate thickness [mm]	[in]	SentryGlas® [mm]	[mil]	Glass type	U–Value [W/m²K]	SHGC	SC	Tvis [%]
6	1⁄4	1.52 2.28	60 90	Bronze Bronze	5.57 5.39	0.58 0.57	0.67 0.66	49 47
6	1⁄4	1.52 2.28	60 90	Grey Grey	5.57 5.39	0.53 0.52	0.62 0.61	40 38
11	7⁄16	1.52 2.28	60 90	Bronze Bronze	5.49 5.31	0.51 0.50	0.59 0.59	37 36
11	7⁄16	1.52 2.28	60 90	Grey Grey	5.49 5.31	0.46 0.46	0.54 0.53	28 27
15	9⁄16	1.52 2.28	60 90	Bronze Bronze	5.43 5.25	0.47 0.47	0.55 0.55	31 30
15	9⁄16	1.52 2.28	60 90	Grey Grey	5.43 5.25	0.43 0.43	0.50 0.50	22 21

TAB 12 ➔

The tables above show the solar control values for a limited number of laminated glass configurations. These values were calculated using the LBNL (Lawrence Berkeley National Laboratory) OPTICS and WINDOW software calculation programs. The table only provides a subset of the possible configurations that can be calculated using this software. Specific configurations can be calculated by downloading the WINDOW software or by requesting help from Kuraray.

WINDOW is a publicly available software program for calculating total window thermal performance indices (i.e. U-values, solar heat gain coefficients, shading coefficients, etc.). The software allows users to model complex glazing systems using different glass types and to analyze products made from any combination of glazing layers, frames, spacers and dividers under any environmental conditions and at any tilt angle.

WinSLT is an app for calculating the light, solar and heat parameters of glazing containing interlayers from the Kuraray's Advanced Interlayer Solutions product range. What's new about this app is that the characteristics of specific laminated safety glass configurations can now be calculated for the deployment of laminates from the Kuraray's Advanced Interlayer Solutions product range.

From various glass and interlayer thicknesses and compositions, the tool calculates all the relevant data inclusive of the Ug-value of the complete panel. With the aid of an intuitive input mask, Trosifol™ WinSLT determines the necessary light, solar and heat characteristics of any desired configuration. All the calculations are in line with the latest standards, such as EN ISO 673 (Ug-value), EN 410 (g-value, reflection, absorption, transmittance), EN ISO 52022-3 (gtotal-value, previously EN ISO 13363) and ISO 15099 / ASHRAE (Ug-value, SHGC-value, reflection, absorption, transmittance). For the last-mentioned standard, the radiative and thermal characteristics are determined in accordance with ISO 15099 and the stipulations of ASHRAE. All the relevant data for the various Trosifol™ PVB and ionoplast interlayers (SentryGlas®) have been pre-loaded and stored in an extensive database. For input, only the desired products have to be selected along with the thickness of the glass ply, gas space, laminated layer and the desired window composition. The app then outputs the functional data, calculating the reflection, transmittance and absorption and, in addition, the cross-sectional temperature curve.

DEFINITIONS

The U-Value is a measure of the rate at which heat is lost through a material.

The Solar Heat Gain Coefficient (SHGC) measures how well a product blocks heat caused by sunlight. The lower a window's SHGC, the less solar heat it transmits.

The Shading Coefficient (SC) is the ratio of total solar transmittance to the transmittance through 3 mm (⅛ in) clear glass.

The visible light transmittance (VLT or Tvis %) is the percentage of visible light that is transmitted through a material. The VLT is measured in the 380-780 nm wavelength range perpendicular to the surface. The higher the percentage, the more daylight. Also known as Tv, LT and VT.

Ultraviolet Elimination is the percentage of ultraviolet radiation eliminated by the glass, measured over the 290-380 nm wavelength range. The higher the percentage, the less UV is transmitted. This value is calculated from the percentage transmission of ultraviolet (TUV). Therefore UV Elimination = 100 - TUV.

- **Minimum and maximum thickness tolerances are defined by ASTM C 1172. Actual laminates measured were within 8 % of total nominal thickness.**
- **Nominal total visible light transmittance measured as CIE standard illuminate C. Actual values may vary.**
- **Shading Coefficients (SC) and summer U-values based on ASHRAE standard summer conditions where outdoor temperature is 32 °C (89 °F), indoor temperature is 24 °C (75 °F,) incident solar radiation is 248 BTU/hr/ft², and outdoor wind velocity is 7.5 mph; calculated per guidelines in 1985 ASHRAE Fundamentals Handbook, Chapter 27.**
- **Relative total instantaneous heat gain is: SC*SHGF + U-value* (To-Ti) Based on a Solar Heat Gain Factor (SHGF) of 200 BTU/hr/ft² and an outdoor temperature -10 °C (14 °F) higher than indoor (To-Ti).**

TROSIFOL® WINSLT
For calculating the light, solar and heat parameters of glazing specifically containing films from the Trosifol® & SentryGlas® product range.

UV-Transmittance

Some buildings require glass with high UV transmittance properties, others with low transmittance. For example, when designing controlled environments for animals or plants, extra caution must be taken to supply unfiltered, broad-spectrum light, as close as possible to the species' normal habitat and environmental conditions. Full spectrum light includes ultraviolet (UV) rays in wavelengths that are too short for the human eye to detect. Wavelengths of light in the UV-A and UV-B ranges, for example, are of particular interest to the health and survival of many natural species.

Other laminated glass applications may require lower transmittance properties. For example, a UV blocker may be used in the glass to minimize the amount of natural UV light through a retail storefront, in order to protect the textiles on display from being damaged.

SentryGlas® Natural UV is a structural interlayer for safety glass that combines the strength, safety and edge stability of SentryGlas® interlayer with increased transmittance of natural ultraviolet (UV) light. Unlike most safety glass interlayer technologies, SentryGlas® ionoplast requires no UV protection for lasting strength and clarity. SentryGlas® interlayer can be manufactured in a special, high UV-transmittance sheet, which is suitable for use in botanical gardens or other special environments where exotic plants, fish, reptiles and insects demand unique UV light requirements.

Using SentryGlas® interlayer Natural UV with float glass or low-iron float glass can dramatically increase the UV-transmittance through the resulting laminated glass panels. The UV-transmittance level of a glass laminate is highly dependent on the transmittance level of the chosen glass at the required thickness for a given structure. Generally, by specifying SentryGlas® Natural UV over other types of laminated glass, the level of UV light transmittance is inherently higher due to the reduced glass thickness required.

UV light transmittance curves

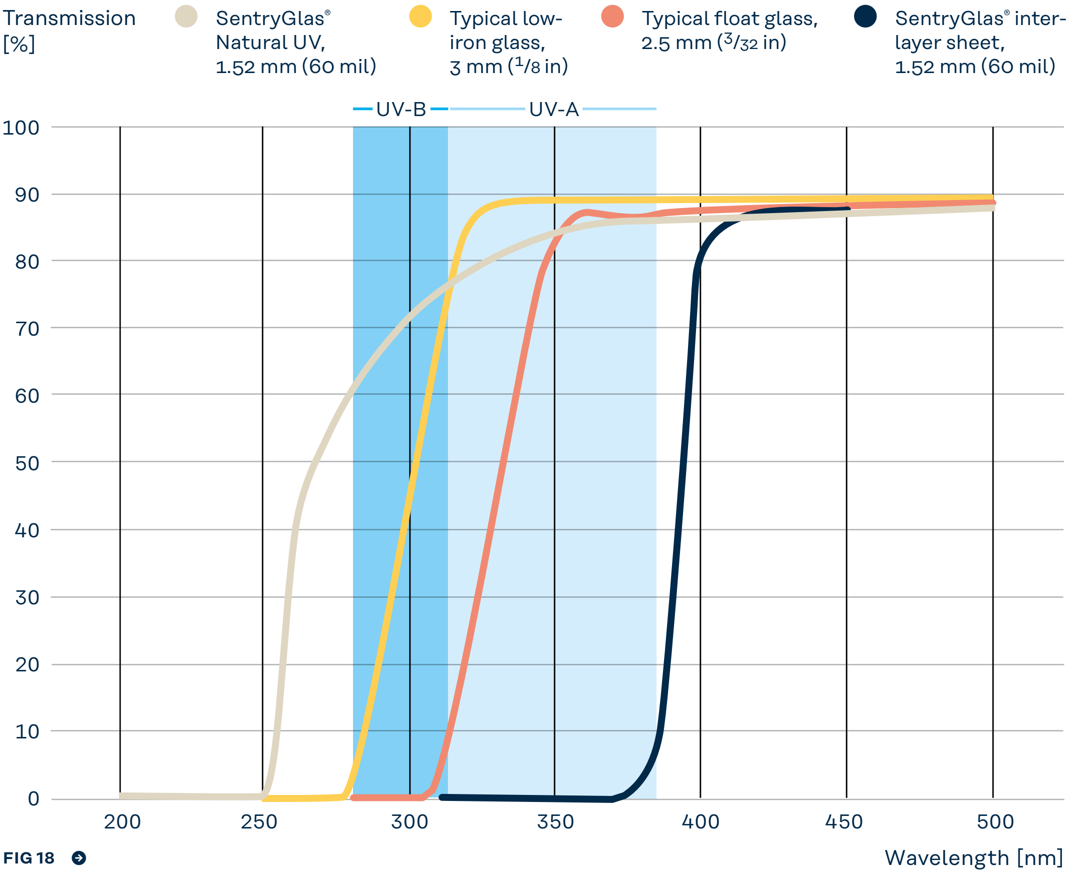


FIG 18

High levels of UV-A and UV-B light pass through a SentryGlas® Natural UV interlayer. However, other glazing materials, including monolithic glass, block out much of the UV-A and UV-B energy.

Structural & Security Interlayers* – physical properties

Type	Adhesion	Film thickness [mm]	[mil]	Color	Light transmittance*1 [%]	UV transmittance*1 [%]	Solar absorption*1 [%]
SentryGlas®	high	0.76	30	Clear	88	< 1	19
SentryGlas®	high	0.89	35	Clear	88	< 1	19
SentryGlas®	high	1.52	60	Clear	88	< 1	20
SentryGlas®	high	2.28	90	Clear	88	< 1	21
SentryGlas® Translucent White	high	0.80	31	Translucent White	76	43	26
SentryGlas® Xtra™	high	0.89	35	Clear	88	< 1	20
SentryGlas® Xtra™	high	1.27	50	Clear	88	< 1	19
SentryGlas® Xtra™	high	1.52	60	Clear	88	< 1	21
SentryGlas® Xtra™	high	2.28	90	Clear	88	< 1	22
SentryGlas® Xtra™	high	2.53	100	Clear	88	< 1	22

TAB 13 ➔ * LSG with 2 x 4 mm Floatglass according EN 410 / ISO 9050
*1 Values calculated using Lawrence Berkeley National Laboratory Optics 5 and Windows 5 software.
Not all products are available in all regions.

Acoustic / sound performance

In architectural applications, improving the acoustic / sound insulation properties of the building and any glass structures is increasingly important. People in a building may need to be insulated from noisy traffic, aircraft from a nearby airport or simply from the noise generated by pedestrians walking by.

HOW IS IT MEASURED?

One test standard used for acoustical performance measurement is ASTM E90 ‘Laboratory Measurement of Airborne Sound Transmission of Building Partitions’. There are several ratings derived by testing according to this standard. Acoustical test results are presented below for both monolithic and insulating glass (IG) units made from Kuraray interlayers.

COMPARISON OF INTERLAYERS

In terms of architectural glass, there are many different methods of improving the acoustic properties of a building, including the use of double skin façades or double / triple insulated glazing units (IGU).

Trosifol® Clear PVB and SentryGlas® interlayers are used in many monolithic and insulated glass (IG) architectural applications where sound attenuation is desirable. One test standard used for acoustical performance measurement is ASTM E90 ‘Laboratory Measurement of Airborne Sound Transmission of Building Partitions’. There are several ratings derived by testing according to this standard. Acoustical test results are presented in the table below for monolithic and insulating glass (IG) units made with Kuraray interlayer.

Sound Transmission Loss (TL) measurements: SentryGlas® and Trosifol® Clear PVB laminated glass interlayers

Nominal Thickness [mm (in)]	Glass Make up [mm (in)]	Kuraray Interlayer [mm (mil)]	STC [a]	OITC [b]	80* [Hz]	100* [Hz]	125* [Hz]	160* [Hz]
14.29 (9/16) lam	2 lites 6.35 (1/4)	1.52 (60) Trosifol® Clear	37	34	25	25	30	29
14.29 (9/16) lam	2 lites 6.35 (1/4)	1.52 (60) SentryGlas®)	35	32	25	24	30	30
14.29 (9/16) lam	2 lites 6.35 (1/4)	0.89 (35) SentryGlas®	35	33	25	25	31	29
30.23 (3/16) IG	6.35 (1/4) | 12.7 (1/2) air | 11.11 (7/16) lam	1.52 (60) Trosifol® Clear	40	33	25	24	24	30
30.23 (3/16) IG	6.35 (1/4) | 12.7 (1/2) air | 11.11 (7/16) lam	1.52 (60) SentryGlas®	38	32	25	24	23	28
30.23 (3/16) IG	6.35 (1/4) | 12.7 (1/2) air | 9.52 (3/8) lam	0.89 (35) SentryGlas®	38	32	24	24	26	28
30.27 (5/16) IG	6.35 (1/4) | 12.7 (1/2) air | 14.29 (9/16) lam	1.52 (60) Trosifol® Clear	41	33	25	25	26	30
30.27 (5/16) IG	6.35 (1/4) | 12.7 (1/2) air | 14.29 (9/16) lam	1.52 (60) SentryGlas®	39	33	25	25	25	29
30.27 (5/16) IG	6.35 (1/4) | 12.7 (1/2) air | 12.7 (1/2) lam	0.89 (35) SentryGlas®	39	33	25	27	24	30

TAB 14 ➔ ATI Test Report 86743.01 completed 2008 at Architectural Testing, Inc. (ATI)

(a) Sound Transmission Class (STC) assesses privacy for interior walls. It is achieved by applying the Transmission Loss (TL) values from 125 Hz to 4 000 Hz to the STC reference contour found in ASTM E413. STC is the shifted reference contour at 500 Hz.

(b) Outside Inside Transmission Class (OITC) assesses exterior partitions exposed to outside noise. It covers the 80 Hz to 4 000 Hz range. The source noise spectrum is weighted more to low frequency sounds, such as aircraft, train, and truck traffic. The OITC rating is calculated in accordance with ASTM E1332.

STC and OITC values can be affected by glass thickness, interlayer thickness, air space and framing. An in-depth acoustical analysis may be required to understand project-specific factors.

SOUNDLAB AI
First global acoustic calculator based on artificial intelligence for calculating/estimating acoustic performance of monolithic, double and triple glazed units.

200* [Hz]	250* [Hz]	315* [Hz]	400* [Hz]	500* [Hz]	630* [Hz]	800* [Hz]	1000* [Hz]	1250* [Hz]	1600* [Hz]	2000* [Hz]	2500* [Hz]	3150* [Hz]	4000* [Hz]	5000* [Hz]
30	30	31	33	35	36	37	37	35	36	39	43	46	49	52
29	30	31	34	33	35	34	33	31	34	37	41	44	46	48
30	29	32	33	34	36	35	33	31	35	38	42	45	46	49
25	27	32	35	38	40	42	44	45	44	43	43	49	52	58
26	26	32	35	37	38	39	39	40	40	40	40	44	48	53
25	26	31	34	37	39	40	40	40	40	40	40	45	47	53
27	28	33	35	38	39	41	43	44	44	44	44	49	52	57
27	28	33	34	35	37	39	41	41	42	43	42	46	48	54
27	28	33	35	36	38	39	41	41	43	43	43	48	50	56

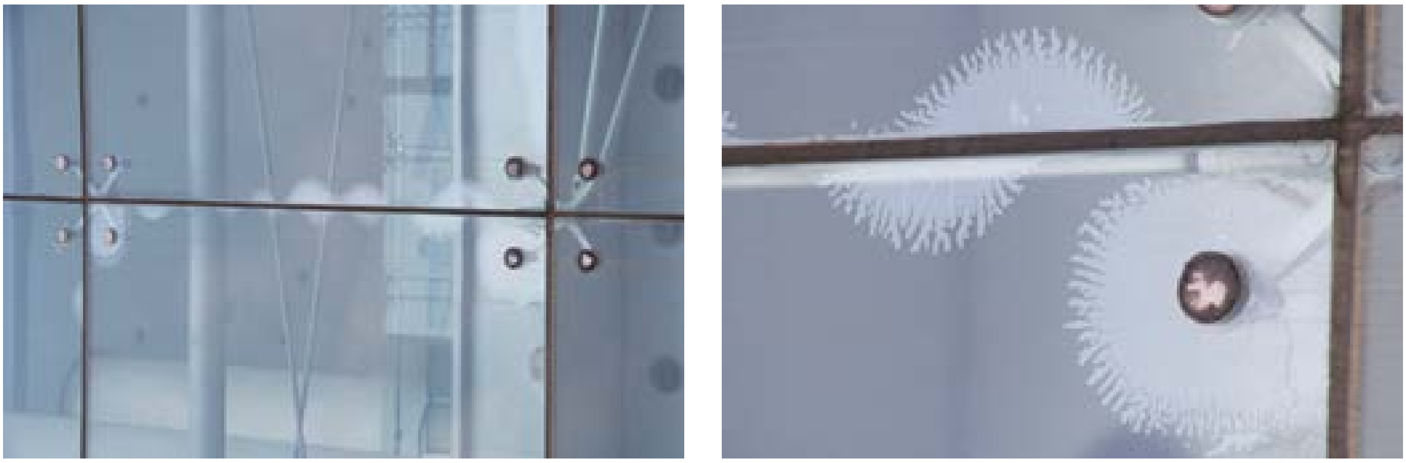

Photo: © Scheuten Solar Glass

Edge stability, durability and weathering

Despite the long history of the use of laminated glass in buildings, there is still a concern for some architects and designers about the potential for serious delamination problems, durability and edge stability of laminated glass, as well as how well the laminated glass will perform under different climatic conditions, including high humidity, tropical climates, storm zones, low and high temperatures, and high saltwater conditions.

INTRODUCTION

This chapter provides some examples of test data on the edge stability and weathering performance of SentryGlas® interlayer, as well as salt spray fog tests, sealant compatibility, ceramic frit compatibility, high temperature bake tests and adhesion to low-E and other solar glass coatings.



➔ Typcial defects caused by delamination

WHAT IS EDGE STABILITY?

Edge stability is defined as a laminate's resistance over time to form defects along its edge. These defects can arise in the form of small 'bubbles' in the laminate or as discoloration of the laminate itself. For designers and architects, edge stability is therefore critical. Ideally, laminated glass should show no signs of delamination over the complete life of the building.

TESTS AND COMPARISON OF INTERLAYERS

Compared to standard conventional laminated glass interlayers, SentryGlas® ionoplast is more resistant to moisture and the effects of weather, particularly at temperatures between -50 °C (-58 °F) and +82 °C (180 °F). These are the consistent findings of laboratory tests and research in real-life projects.

Due to the exceptional edge stability of SentryGlas® interlayer, no undesired changes such as delamination have been found to date on any of its applications, even on panels with open edges that have been exposed to hot and humid climates such as Florida. This proven edge stability opens up many new design possibilities for SentryGlas®, enabling designers to create stronger, larger expanses of safety glazing including openedged, structural and butt-glazed installations.

When used in combination with standard silicon sealing material, butt-joined glass elements with SentryGlas® interlayers show no discoloration or other forms of damage to their edges, even after years of weathering. Years later these interlayers still provide the same level of safety and feature the same intact edging, as they did when they were first installed.

FLORIDA 25 YEAR TEST

In 1997 a test program for laminated glass with Sentry-Glas® interlayer was started in Florida. The open-edge test samples are installed in open air conditions, fully exposed to the Florida climate. Since their installation, the samples with SentryGlas® interlayer have been tested annually for signs of weathering and delamination.

After 20 years of exposure to the weather, the edges of the laminates with SentryGlas® showed no visible sign of weathering, including no visible moisture ingress or delamination effects in open edge applications. In addition, with silicone butt-joined applications, the edges of the laminated glass also showed no visible moisture intrusion or delamination effects.

The table below shows test results after 149 months of exposure. After this time, SentryGlas® was assigned an Edge Stability Number (ESN). This weighted system assigns higher importance to progressively deeper defects. A laminate with no defects would have an ESN of 0 (zero), while the maximum would be 2,500 (equivalent to continuous defects measuring > 6.4 mm [¼ in] around the entire perimeter).

Edge Stability Number (ESN) RWB-824

Laminate ID Number	Exposure Time [yts]	Laminate Perimeter [mm]	[in]	Defect Length [in] 1/16"	1/8"	3/16"	1/4"	1/4"	ESN	Comments
63-1	20.5	3912	154	0	0	0	0	0	0	No edge bubbles or delaminations observed
48-3	20.5	3912	154	0	0	0	0	0	0	No edge bubbles or delaminations observed
46-4	20.5	3912	154	0	0	0	0	0	0	No edge bubbles or delaminations observed
97-5	20.5	3912	154	0	0	0	0	0	0	No edge bubbles or delaminations observed
74-13	20.5	3912	154	0	0	0	0	0	0	No edge bubbles or delaminations observed
71-10	20.5	3912	154	0	0	0	0	0	0	No edge bubbles or delaminations observed
56-11	20.5	3912	154	0	0	0	0	0	0	No edge bubbles or delaminations observed
75-12	20.5	3912	154	0	0	0	0	0	0	No edge bubbles or delaminations observed

TAB 15

ESN data in the table above includes test samples with open-edge exposure, as well as samples that are butt-joined using silicone sealant.

WEATHERING TEST REPORT FOR LAMINATED GLASS WITH SENTRYGLAS®

Samples of laminated glass with SentryGlas® interlayer were weathered according to a test method outlined in ANSI Z97.1: 'Safety Glazing Materials Used in Buildings – Safety Performance Specifications and Methods of Test'. The test results are shown below.

RESULTS

After the samples of laminated glass with SentryGlas® interlayer were irradiated and conditioned, the exposed samples were examined and compared visually with unexposed controls, as detailed in ANSI Z97.1. These samples were found to be visibly acceptable. No bubbles or delamination effects were visible and no crazing, cracking or discoloration was observed.

Weathering testing

Test	Compliance
ANSI Z97.1 (3,000 hours Xenon)	Pass
EN12543 4000 hours	Pass

TAB 16

Xenon-Arc Type Operating Light Exposure

Apparatus	Atlas Ci5000 Xenon Weather-Ometer®
Exposure Time	Specimens were exposed for 3 000 hours
Filter Type	Borosilicate inner and outer
Cycle	102 mins of irradiation, 18 mins of irradiation & water spray
Black Panel Temp	70 °C ± 3 °C (158 °F ± 5 °F)
Relative Humidity	50 % ± 5 %
Spray Water	De-ionized
Level of Irradiance	0.35 W/m² @ 340 nm
Exposure	Xenon-Arc Exposure: 3780 kJ/m² @ 340 nm

TAB 17

Note: on average, a 3 000-hour Xenon arc exposure approximates to a one-year direct South Florida exposure at 26° North Latitude, facing South.

Application examples of the superior edge stability of SentryGlas® interlayer

As well as test reports supporting the superior edge stability performance of SentryGlas®, there are numerous real life examples to support the test data.

For example, the BellSouth building in Fort Lauderdale, USA, silicone sealed, butt joined safety glass made with SentryGlas® helped the architects deliver panoramic corner office views, while meeting tough wind and storm protection codes.

Elsewhere in the USA, cold winters, shadeless summer heat and occasional Mississippi River floodwaters were among the design challenges for a bandshell built on an island in St Paul, Minnesota. Open edged, buttsealed glazing panels made with SentryGlas® interlayer remain free of any visual defects after years of exposure.
The extra strength of the interlayer also helped to create a uniquely shaped overhead structure.

BellSouth building, Fort Lauderdale, USA

➔ Marina Bay Sands SkyPark Infinity Pool, Singapore

Edge stability of laminates with SentryGlas® in coastal climatic conditions

For all marine and some architectural applications, prolonged exposure to salt water can cause defects in the laminated glass. However, laminates with SentryGlas® demonstrate excellent durability performance in coastal regions or landscapes with high concentration of salt water (e.g. due to high use of road salts due to snow).

Extensive product testing, including salt spray fog testing (carried out by TÜV Süd Singapore, according to ASTM B 117-11) during which the glass panels laminates with SentryGlas® with open edges were exposed to salt spray solution continuously for 3,000 hours. Three 15 by 10 cm (5.93 by 3.93 in) glass panels were placed in a climatic chamber for 3,000 hours under the following experimental conditions:

- **NaCl-concentration: 5 %**
- **Volume of condensate: 1.0-2.0 ml / HR / 80 cm²**
- **pH of the solution: between 6.5 and 6.9**
- **Test chamber temperature: 35 +/- 2°C**

After the test, the glass panels were visually inspected and evaluated. The results showed that the panels remained unchanged in terms of their transparency. The PVB laminates showed edge clouds after 500 hours of testing. Due to the excellent edge stability of SentryGlas® interlayer, no undesired changes such as edge cloudiness, delamination caused by the humidity occur. Copies of the test report are available on request. Other salt spray tests have been conducted on laminated glass with SentryGlas® interlayer.
In Germany for example, similar tests were carried out on SentryGlas® ionoplast interlayer by the Fachhochschule München as part of a DIBT approval for SentryGlas® ionoplast interlayer(Germany's regulatory body for products used in the construction industry).

Sealant usability with SentryGlas® interlayer

A wide variety of sealants are used by the glazing industry, and it is therefore critical to understand the chemical and mechanical usability of these sealants with the interlayer produced in a glass laminate. Laminates prepared with SentryGlas® demonstrate excellent performance with different types of sealants used in glazing applications. This is supported by tests conducted internal method but also by studies carried out by sealant manufacturers. These tests include accelerated QUV weathering and modified ASTM C1087 test methods as well as DI guideline, IFT Rosenheim, UV radiation tests, high-temperature, and high humidity test scenarios.
Portland cement-based and gypsum-based products are not compatible with SentryGlas® (or PVB) laminates and should not be used with laminated glass.

OUTDOOR TESTING

Laminates with SentryGlas® show no edge defect formation, even after more than 20 years of natural outdoor weathering in Florida when tested with different types of sealants. In these tests, laminates with SentryGlas® have shown no signs of degradation from interactions with any of the sealants tested. Details of all sealant tests carried out by Kuraray and by sealant manufacturers are available on request from Kuraray. For a complete list of usable sealants for SentryGlas® interlayer, please refer to the following table.

Company / Grade	Description	Test method
DOWSIL™		
DOWSIL™ 375	2-component polyurethane	
DOWSIL™ 756-SMS	1-component silicone sealant, neutral-cure	ASTM C1087, ETAG 002, IFT-Guideline DI-02engll/1
DOWSIL™ 757	1-component silicone sealant, neutral-cure	ASTM C1087, ETAG 002, IFT-Guideline DI-02engll/1
DOWSIL™ 790	1-component silicone sealant, neutral-cure	ASTM C1087, ETAG 002, IFT-Guideline DI-02engll/2
DOWSIL™ 791	1-component silicone sealant, neutral-cure	ASTM C1087, ETAG 002, IFT-Guideline DI-02engll/3
DOWSIL™ 795	1-component silicone sealant, neutral-cure	ASTM C1087, ETAG 002, IFT-Guideline DI-02engll/3, GANA LD 103-14
DOWSIL™ 895	1-component silicone sealant, neutral-cure	ASTM C1087, ETAG 002, IFT-Guideline DI-02engll/1
DOWSIL™ 983	2-component silicone sealant, neutral-cure	ASTM C1087, ETAG 002, IFT-Guideline DI-02engll/2
DOWSIL™ 993	2-component silicone sealant, neutral-cure	ASTM C1087, ETAG 002, IFT-Guideline DI-02engll/3
DOWSIL™ 995	1-component silicone sealant, neutral-cure	ASTM C1087, ETAG 002, IFT-Guideline DI-02engll/3, GANA LD 103-14
DOWSIL™ 3362	2-component silicone sealant	ASTM C1087, ETAG 002, IFT-Guideline DI-02engll/1
GE ADVANCED MATERIALS		
GE SCS1200	1-component silicone sealant, neutral-cure	UV chamber 7,5/8+ months exposure
GE Silglaze® II SCS2800	1-component silicone sealant, neutral-cure	UV chamber 7,5/8+ months exposure
GE SilPruf® SCS2000	1-component silicone sealant, neutral-cure	UV chamber 7,5/8+ months exposure
GE SilPruf® NB SCS9000	1-component silicone sealant, neutral-cure	UV chamber 7,5/8+ months exposure
GE SWS	1-component silicone sealant, neutral-cure	UV chamber 7,5/8+ months exposure

Company / Grade	Description	Test method
GE UltraGlaze® SSG4000	1-component silicone sealant, neutral-cure	UV chamber 7,5/8+ months exposure
GE UltraGlaze® SSG4000 AC	1-component silicone sealant, neutral-cure	UV chamber 7,5/8+ months exposure
GE UltraGlaze® SSG4400	2-component silicone sealant, neutral-cure	Xenon radiation (ISO 4892-2) 21 days or 8 weeks, UV chamber 7,5/8+ months exposure
GE UltraGlaze® SSG4600	2-component silicone sealant, neutral-cure	Xenon radiation (ISO 4892-2) 21 days or 8 weeks, UV chamber 7,5/8+ months exposure
KÖMMERLING		
GD 116	2-component polysulfide sealant, solvent-free	IFT Guideline DI-02/1
GD 677 NA	2-component polyurethane sealant, solvent-free	IFT Guideline DI-02/1
SIKA		
SikaForce®-735 GG	2-component polyurethane sealant, solvent-free	CQP 593-7, IFT Guideline DI-02/1
Sikasil® IG-16	1-component silicone sealant, neutral-cure	CQP 593-7
Sikasil® IG-25	2-component silicone sealant, neutral-cure	CQP 593-7
Sikasil® IG-25 HM Plus	2-component silicone sealant, neutral-cure, high modulus	CQP 593-7
Sikasil® SG-20	1-component silicone sealant, neutral-cure	CQP 593-7
Sikasil® SG-500	2-component silicone sealant, neutral curing	CQP 593-7
Sikasil® SG-500 CN	2-component silicone sealant, neutral-cure, high modulus	CQP 593-7
Sikasil® SG-550	2-component silicone sealant, neutral-cure	CQP 593-7
Sikasil® WS-605 S	1-component silicone sealant, neutral-cure	CQP 593-7
Sikasil® WT-480	2-component silicone sealant, neutral-cure, high modulus	CQP 593-7
Sikasil® WT-485	2-component silicone sealant, neutral-cure	CQP 593-7
TREMCO		
Tremglaze S600	1-component silicone sealant, neutral-cure	UV for 21 days at 48°C based on ASTM standards
Tremglaze S700	1-component silicone sealant, neutral-cure	UV for 21 days at 48°C based on ASTM standards
Tremglaze S900	1-component silicone sealant, neutral-cure	UV for 21 days at 48°C based on ASTM standards
Proglaze II-NF	2-component silicone sealant, neutral-cure	UV for 21 days at 48°C based on ASTM standards

TAB 18 ➔ For a complete list of Compatible Sealants for SentryGlas® interlayer, please contact your Kuraray representative.

DISCLAIMER:

The usability results provided on this sealant list have been determined in collaboration with the relevant sealant manufacturers. However, it is important to note that the information on this list may not be complete or up-to-date, and Kuraray does not guarantee the accuracy or completeness of the information provided.

Users are advised to consult with the sealant suppliers for the latest information, processing guidelines, and any additional advice before using any of the products listed on this sealant list. Kuraray shall not be held liable for any damages or losses arising from the use of any product listed on this list or for any reliance placed on the information provided.

By providing this sealant list, Kuraray does not assume any warranties or make any representations regarding the suitability or fitness for a particular purpose of any product listed herein. Users are solely responsible for verifying the compatibility of the sealant products with their intended applications and for determining the suitability of such products for their specific needs.

High temperature performance of SentryGlas® interlayer

Properly laminated glass made with SentryGlas® interlayer has demonstrated capability of withstanding an environment of 100 °C (212 °F) for at least 16 hours, without bubble formation in the major viewing area. For more prolonged periods of time, of greater than 16 hours, a temperature limit of 82 °C (180 °F) or lower is recommended.

This information is based on the visual inspection of a glass laminate after a high temperature bake test. In this test, a test specimen of laminated glass is heated to a temperature of 100 °C (212 °F). Bubble formation within the major viewing area of the laminate (typically excluding 12 mm or ~½ in from the laminate edge) constitutes a failure of this test. Based on this limited data, properly laminated specimens with SentryGlas® appear capable of meeting these test conditions.

As with any application, specific glass constructions and designs may vary and prototype testing of systems is advisable.

Compatibility with ceramic frit coatings

Used for both internal and external decorative glass, ceramic frit coatings can be specified in a wide variety of colors and patterns for improved aesthetics or solar control in laminated glass. These vitreous compounds are applied to the glass by screen-printing, roll coating, spraying or curtain coating, closely following the frit supplier's processing instructions. These are then heat-treated in order to create a permanent coating. When such a fritted surface comes into contact with the glass laminate interlayer, it is important to verify the lasting compatibility between the frit and the interlayer. Moisture and salts, for example, can be detrimental to frit coatings over time.

Testing therefore requires extended contact between materials under controlled conditions. The table next page lists the various tests that Kuraray uses to assess the compatibility of interlayers and ceramic frit.

Tests to assess the compatibility of interlayers and ceramic frit

Method	Standard	Intervals
76 Bake Test	Internal Method	500 & 1 000 hour
Coffin	ANSI Z26.1 (5.3 -3)	2, 5 & 10 weeks
UV (UVA-340)	ASTM G151, 154-06, ISO4892-1 & 4582	30 days
Natural Weathering	ASTM G 7-05 and G 147-02	1 year

TAB 19

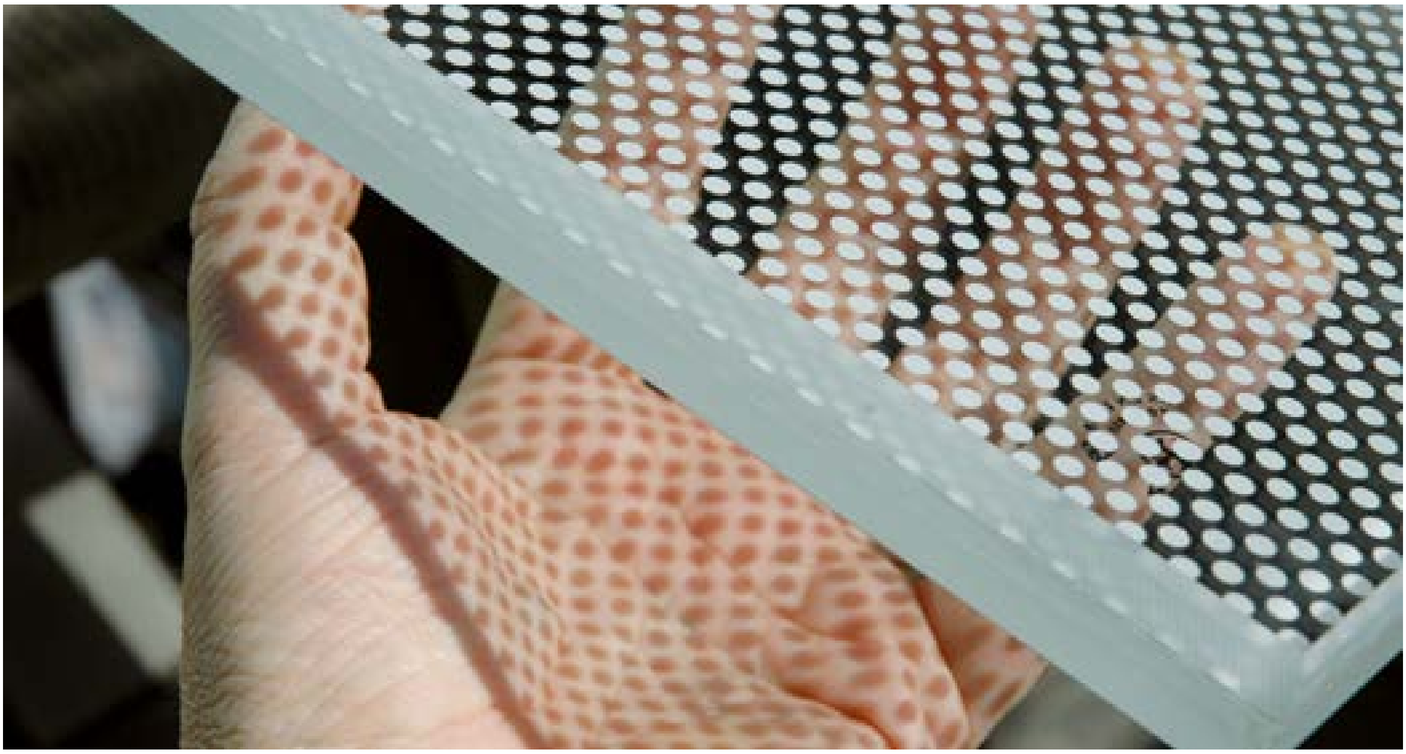
Kuraray has conducted these tests on laminates made with SentryGlas® ionoplast and fritted glass, in order to observe changes in color, appearance or defects such as corrosion of the coating, bubbles, delaminations and other defects.

Ceramic frits compatible with SentryGlas®

Manufacturer	Product code	Product name
FERRO	20-8496-1597	20-8496 ETCHIN 1597, 24-8029 BLACK IN 1544
FERRO	24-8029-1544	Medium, 24-8075 WARM GREY IN
FERRO	24-8075-1544	1544 Medium
Glass Coating Concept (GCC)	SX8876E808	SPANDREL WHITE
Glass Coating Concept (GCC)	SX3524E808	WARM GRAY

TAB 20

In the tests above, SentryGlas® interlayer showed no visual defects. In addition, adhesion was assessed before and after testing and no measurable differences were found. For other types of frit coatings not listed above, users should conduct their own tests or seek guidance from Kuraray. To ensure that glass meets safety codes, additional testing, including adhesion strength tests, may be required.



Telecom, Maroc

Compatibility with solar shading or glass coatings

The growing importance of the environment, energy efficiency and renewable building technologies are creating added value for glass manufactured with low-E (low emissivity) coatings. Often, in architectural applications, this coated glass also requires high impact strength, which can be achieved by laminating with SentryGlas® ionoplast interlayers.

When placing any interlayer into contact with a glass coating, it is critical to test the chemical and mechanical compatibility between the materials. Moisture and salts can be detrimental to coatings over time.

SentryGlas® interlayer shows excellent compatibility with many different low-E coatings, and this compatibility is enhanced by the interlayer's low moisture absorption and low ionic content.

For information on specific coating compatibility, please contact your Kuraray representative or coated glass manufacturer.

Fire performance

The U.S. codes have fire performance requirements for doors and other areas. In hazardous locations, the glass must be able to pass the fire test and comply with safety glazing standards (CPSC 16 CFR 1201).

A hose stream test follows the fire test to demonstrate the response of the glass to water after it has been exposed to high temperatures during the fire test. There are many standards to which the glass is tested. Fire resistant glass is tested and labeled by a third party as part of a certification process. Neither laminates with SentryGlas® ionoplast interlayer nor with PVB interlayer are not fire rated products.

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SentryGlas® shows better performance than PVB in terms of flame spread and flammability, indicated by testing done on the interlayers. Below is a table comparing PVB and SentryGlas® interlayer properties according to flammability ASTM standard tests. Please note that these are not tests of laminates. Actual performance of laminates may vary.

ASTM STANDARDS

- ASTM D1929: Standard test method for determining ignition temperature of plastics
- ASTM E84: Standard test method for surface burning characteristics of building materials
- ASTM D635: Standard test method for rate of burning and / or extent and time of burning of plastics in a horizontal position

EMERGENCY ACCESS:

For information regarding fireman or other emergency access through laminated glass, refer to the following reference:

'Emergency Egress Through Laminated Glazing Materials', which can be found on website: www.glasswebsite.com

'Forcible Entry Demonstrations Airblast Resistant Window Systems', which can be found in the reference section of the following website: www.oca.gsa.gov

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SentryGlas® applications

Product offering

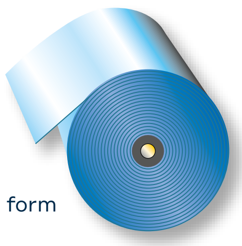
Structural & Security Interlayers* – dimensions for products on rolls

Type	Thickness [mm]	[mil]	Color	Roll widths [mm]	Roll widths [in]	Roll lengths [m]	[ft]
SentryGlas® / SGX™ *2	0.76	30	Clear	1050/1150/1220/1300/1530/1600/1830/2250/2400/2500/2600/2700 /3300	41/45/48/51/60/63/72/88/94/98/102/106/130	250	820
SentryGlas®	0.76	30	Clear	1530	60	50	164
SentryGlas® / SGX™	0.76	30	Clear	1050/1530/1600/2250/2400/2500/2700/3300	41/60/63/88/94/98/106/130	60	197
SentryGlas® / SGX™	0.89	35	Clear	1220/1530/1830/2250/2400/2500/2700/3300	48/60/72/88/94/98/106/130	200	656
SentryGlas® / SGX™	0.89	35	Clear	1530/2250/2400/2500/2700/3300	60/88/94/98/106/130	50	164
SentryGlas® / SGX™	1.27	50	Clear	1070/1320/1830/2240/2250	42/52/72/88/89	166	545
SentryGlas® Translucent White	0.80	31	Transl. White	1220/1830 1530/3300	48/72 60/130	200 200/50	656 656/164
SentryGlas® Natural UV	0.76	30	Clear	1220/1830 1530/3300	48/72 60/130	200 200/50	656 656/164

TAB 21 ➔ * The table shows the global product program. Not all products are available in all regions.
*2 SGX™ = SentryGlas® Xtra™

Structural & Security Interlayers* – dimensions for sheet products

Type	Thickness [mm]	[mil]	Sheet widths [mm]	Sheet widths [in]	Sheet lengths [m]	[ft]
SentryGlas®	0.89	35	610-2160*3	24-85*3	6	19
SentryGlas®	1.52	60	610-2160*3	24-85*3	6	19
SentryGlas®	2.28	90	610-2160*3	24-85*3	6	19
SentryGlas®	2.53	100	610-1830	24-72	6	19
SentryGlas®	3.04	120	610-1830	24-73	6	19
SentryGlas® Xtra™	0.89	35	610-2160*3	24-85*3	6	19
SentryGlas® Xtra™	1.52	60	610-2160*3	24-85*3	6	19
SentryGlas® Xtra™	2.28	90	610-2160*3	24-85*3	6	19
SentryGlas® Xtra™	2.53	100	610-2160*3	24-85*3	6	19


Roll form


Sheet form

TAB 22 ➔ * The table shows the global product program. Not all products are available in all regions.
*3 Oversize shipment possible up to 2500 mm / 99 inches

Tools & Apps

TROSIFOL® WINSLT
For calculating the light, solar and heat parameters of glazing specifically containing films from the Trosifol® & SentryGlas® product range.

SOUNDLAB AI
First global acoustic calculator based on artificial intelligence for calculating/ estimating acoustic performance of monolithic, double and triple glazed units.

SOLUTION FINDER
For finding the right product of your project.

TROSIFOL® GLASGLOBAL
For performing structural analysis for glass.

STRENGTH LAB AI
The goal of the Strength Lab AI tool is to provide designers, engineers, and architects with an efficient tool to facilitate the design and evaluation of glazing systems in terms of structural properties. This tool provides rapid analysis of virtually any glazing configuration, dimension and load case. Additionally, standard modules allow easy evaluation of results according to ASTM, EN and DIN standards.

* Only available as web app

Contact

FOR FURTHER INFORMATION
on products from Kuraray, please visit www.kuraray.com.
You can find further information on our Trosifol® and SentryGlas® products at www.trosifol.com.

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10/2023

WORLD OF INTERLAYERS

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