

Specialty Film & Sheet



Lexan* sheet

Solid un-coated and coated sheet

Technical Manual

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For over 25 years the high performance properties of Lexan* polycarbonate resin have provided the plastics industry with a sheet material unmatched in terms of clarity, impact resistance, temperature resistance and structural strength.

SABIC Innovative Plastics, Specialty Film & Sheet is the sheet and film division of SABIC Innovative Plastics, with European headquarters and manufacturing site in the Netherlands. Additional manufacturing operations are based in Italy and Austria, and sales and marketing facilities are strategically located throughout Europe. SABIC Innovative Plastics, Specialty Film & Sheet 's range of Lexan* sheet products, directly extruded from Lexan* polycarbonate resin, offers significant advantages over many other glazing materials in terms of design freedom, light-weight, fire performance and thermal insulation.

Furthermore, Lexan* sheet combines high impact resistance with optical clarity, so providing superior safety and security protection against vandalism and intrusion.

Lexan® 9030 and 9030TG sheet

Lexan® 9030 polycarbonate is the standard sheet grade for transparent protective glazing. Used for either primary or secondary glazing for added protection against breakage or intrusion, it is a better insulator than glass and is easily fabricated for a wide range of indoor applications, machine guards or vandal-proof street furniture.

Lexan® 9030FR sheet

Lexan® 9030FR sheet is a flame retardant transparent polycarbonate sheet specially developed to satisfy the flammability requirements of the building and construction market. Lexan® 9030FR is backed by a 5 year limited warranty^Δ.

Lexan® 9030AS** sheet

Lexan® 9030AS sheet is a transparent sheet with proprietary resin technology that provides extra hardness. It is specially developed for industrial applications like scooter windshields. Lexan 9030AS is backed by a 5 year limited warranty^Δ against yellowing and loss of light transmission, and by a 10 year limited warranty^Δ against breakage.

Processing

Due to the inherent properties of the material, the processing conditions may differ from the conditions used for processing of standard Lexan® material.

Lexan® F2000 sheet

Lexan® F2000 is a standard transparent flame retardant polycarbonate sheet specially developed for industrial applications . Lexan® F2000 is backed by a 5 year limited warranty^Δ.

Processing

Due to the inherent properties of the material, the processing conditions may differ from the conditions used for processing of standard Lexan® material.

Lexan® Exell®-D Exell®-D TG sheet

Lexan® Exell®-D is a transparent polycarbonate sheet with proprietary UV protection on both sides. With its excellent weathering properties and outstanding impact resistance, it is ideally suited to a wide variety of building and construction applications.

Lexan® Exell®-D sheet can be easily cold-formed into gentle curves which makes it ideal for skylights, covered walkways, barrel vaults, etc. Lexan® Exell®-D can be thermoformed into the desired geometry whilst retaining the UV resistant coating specially developed for weather resistant applications. The superior UV resistance and toughness of Lexan® Exell®-D sheet is backed by a 10 year limited warranty^Δ against yellowing, loss of light transmission and breakage.

Lexan® Exell®-D ST sheet

Lexan® Exell®-D ST sheet is an UV protected, translucent product that yields excellent light diffusion. Its pebbled surface provides the ideal solution for privacy glazing with all the performance characteristics of standard Lexan® polycarbonate. Lexan® Exell®-D ST is backed by a 10 year limited warranty^Δ.

Lexan® Exell®-D FR sheet

Lexan® Exell®-D Flame Retardant sheet is a transparent polycarbonate sheet with proprietary UV protection on both sides and good flammability performance it is ideally suited to a wide variety of building and construction applications. Lexan® Exell®-D FR is backed by a 10 year limited warranty^Δ.

Lexan® Exell®-D VEN sheet

Lexan® Exell®-D Flame Retardant sheet is a transparent polycarbonate sheet with proprietary UV protection on both sides and good flammability performance it is ideally suited to a wide variety of building and construction applications. Lexan® Exell®-D FR is backed by a 10 year limited warranty^Δ.

Processing

Due to the inherent properties of the material, the processing conditions may differ from the conditions used for processing of standard Lexan® material.

Lexan® Exell®-D VEN sheet

Lexan® Exell®-D Venetian is Lexan® Exell®-D which has been screenprinted with white stripes on the non UV coated side. This reduces heat build up beneath the sheet, eg: inside the building (10 year limited warranty^Δ).

Lexan® Exell®-D SC IR** sheet

Lexan® Exell®-D SC IR is a transparent proprietary Infra Red absorbing polycarbonate sheet with UV protection on both sides. With its excellent weathering properties and outstanding impact resistance, it is ideally suited to a wide variety of building and construction applications.

Lexan® Exell®-D SC IR sheet can be easily cold-formed into gentle curves which makes it ideal for skylights, covered walkways, barrel vaults, etc. Lexan® Exell®-D SC IR can be thermoformed into the desired geometry whilst retaining the UV resistant coextrusion layer specially developed for weather resistant applications. The superior UV resistance and toughness of Lexan® Exell®-D SC IR sheet is backed by a 10 year limited warranty^Δ against yellowing, loss of light transmission and breakage.

^Δ See Warranty for exact details

^{**} Patented technology

Lexan® ULG1003 sheet

Lexan® ULG1003 is a non-UV protected transparent high optical quality polycarbonate sheet which is especially produced for applications which need excellent optical qualities such as symmetrical glass-pc laminates. Lexan® ULG1003 is being produced under special conditions and is checked on diopter values by means of tests based on the DIN 52305-A-AZ.

Lexan® Margard® MR5E sheet

Mar/UV resistant Lexan® Margard® MR5E sheet combines the impact strength of Lexan® polycarbonate sheet with a proprietary abrasion/UV resistant surface that is close to glass in performance. It is the only polycarbonate glazing material that is backed by a 5 year limited warranty^Δ against yellowing, loss of light transmission, coating failure and breakage.

Lexan® Margard® sheet is immune to contact with many chemicals such as cleaning fluids, paints and adhesives. Its unique coating “defies graffiti to stick”, enabling restoration to a ‘good-as-new’ condition. In addition, Lexan® Margard® MR5E sheet offers improved resistance to weathering as well as forced entry protection. It is ideal for use in shops, public buildings, schools, bus shelters and other high traffic areas. Lexan® Margard® MR5E is based on high optical Lexan® sheet checked on diopter values based on the DIN 52305-A-AZ.

Lexan® Margard® MR5E IR** sheet

Mar/UV resistant Lexan® Margard® MR5E IR sheets combine the excellent properties of Lexan® Margard® MR5E with the proprietary Infra Red absorbing properties. Lexan® Margard® MR5E IR is the ideal product to be used for flat glazing applications in which heat management is required.

Lexan® Margard® MR5 FR sheet

Lexan® Margard® MR5FR is a flame retardant version of MR5E sheet.

Processing

Due to the inherent properties of the material, the processing conditions may differ from the conditions used for processing of standard Lexan® material.

Lexan® Margard® MRA3 sheet

Lexan® Margard® MRA3 combines the impact strength of Lexan® Polycarbonate sheet with a proprietary unique abrasion resistant service on both sides. Lexan® Margard® MRA3 is immune to contact with many chemicals such as cleaning fluids, paints and adhesives. It's improved resistance to abrasion as well as its high impact resistance makes it ideal for use as secondary glazing (interior), in public buildings, schools etc. and as machineguard glazing.

Lexan® Margard® MRA3 is based on high optical Lexan® sheet checked on diopter values based on the DIN 52305-A-AZ.

Flat applications only

Due to its mar-resistant coating, Lexan® Margard® MR5E, MR5 IR, MR5FR and MRA3 sheet cannot be cold-formed. The sheet is intended for flat applications only.

Abrasion resistance

Tested for abrasion resistance, Lexan® Margard® MR5E, MR5 IR, MR5 FR and MRA3 sheet exhibits significantly less hazing than uncoated polycarbonate sheet.

Lexan® Margard® sheet FMR5 XT (Formable)

Lexan® Margard® FMR5 XT is a transparent UV and abrasion resistant glazing material based on high optical Lexan® sheet checked on diopter values based on the DIN 52305-A-AZ.

Lexan® Margard® FMR5 XT sheet combines the impact strength of Lexan® polycarbonate sheet with a proprietary formable abrasion/UV resistant surface. It has ANSI Z26.1 classification.

Processing

Lexan® Margard® FMR5 XT can be cold-curved into shallow radii. It can also be drape-formed at a maximum temperature of 165°C.

Curved applications

Design freedom, light weight and optical clarity combined with superior mechanical properties make Lexan® Margard® FMR5 XT the ideal glazing material for shaped applications such as curved windows, (e.g. revolving doors), partitions, skylights, barrel vaults, balcony glazing, stairglazing, shelters and machine safety guards.

Optical performance

Clear Lexan® glazing offers excellent clarity and has the highest transmission in the visible light and near infrared region of the spectrum. As it is essentially opaque to all wavelengths below 385 nanometres, it is ideal for protecting art, antiques, retail displays and fabrics from the damaging effects of UV rays.

Lexan® solid sheet is normally manufactured in the standard sizes and colours listed below. Ex-stock delivery of these and cut-to-size sheet is available through SABIC Innovative Plastics, Specialty Film & Sheet's wide network of specialist stockists.

Different colours and dimensions can be made available by prior arrangement. Such arrangements may affect prices and conditions of sale.

^Δ See Warranty for exact details

^{**} Patented technology

Product Range

Lexan® 9030 and Lexan® 9030TG

Standard gauge in mm 0,75-1-1,5-2-3-4-5-6-8-9,5-12-1512-15

Standard colours	Light transmission*
• clear code 112	84-87% dep. on thickness
• solar bronze code 5109	50% all thickness
• solar grey code 713	50% all thickness
• opal white 82103	64-65% dep. on thickness

Standard sizes:

1250 x 2050 mm
(the whole gauge range of both 9030 and 9030 TG)
2050 x 3050 mm
(the gauge range of 9030 as of a gauge of 2.50mm)
2050 x 6050 mm
(the gauge range of 9030 as of a gauge of 2.50mm)

Masking:

Top side:	Coex. opal white PE Blue print
Bottom side:	Coex. transparent

*Subject to a tolerance of 5%

Lexan® 9030FR

Standard gauge in mm 2-3-4-5-6-8

Standard colours	Light transmission*
• clear code 112	90% dep. on thickness
• opal white (in 6 mm)	90% dep. on thickness

Standard sizes:

1250 x 2050 mm
2050 x 3050 mm

Masking:

Top side:	Coex. opal white PE Blue print
Bottom side:	Coex. transparent

*Subject to a tolerance of 5%

Lexan® Exell®-D and Exell®-D TG

Standard gauge in mm 1,5-2-3-4-5-8-9,5-12-15

Standard colours	Light transmission*
• clear code 112	84-87% dep. on thickness
• solar bronze code 5109	50% all thicknesses
• solar grey code 713	50% all thicknesses
• opal white code WH7D2870	50% all thicknesses
• opal white code WH4D3480	25% all thicknesses

Standard sizes:

1250 x 2050 mm
(the whole gauge range of both Exell®-D and TG)
2050 x 3050 mm
(the gauge range of Exell®-D as of a gauge of 2 mm)
2050 x 6050 mm
(the gauge range of Exell®-D as of a gauge of 2 mm)

Masking:

Top side:	Coex. opal white PE Purple print
Bottom side:	Coex. transparent PE

*Subject to a tolerance of 5%

Lexan® Exell®-D ST

Standard gauge in mm 3-4-5-6-8

Standard colours	Light transmission*
• clear code 112	84-87% dep. on thickness
• solar bronze code 5109	50% all thicknesses

Standard sizes:

2050 x 3050 mm

Masking:

Top side:	Non
Bottom side:	Coex. transparent PE

Lexan® Exell®-D FR

Standard gauge mm 2-3-4-5-8

Standard colours	Light transmission*
• clear code 112	87% dep. on thickness

Standard sizes:
1250 x 2050 mm
2050 x 3050 mm
2050 x 6050 mm

Masking:

Top side:	Coex. opal white PE Purple print
Bottom side:	Coex. transparent PE

*Subject to a tolerance of 5%

Lexan® Exell®-D Venetian

Standard gauge in mm 3-4-5-6

Standard colours	Light transmission*
• clear code 112W with white stripes	32-37% dep. on thickness

Standard sizes:

1250 x 2050 mm
1250 x 3050 mm

Masking:

Top side:	Coex. opal white PE Purple print
Bottom side:	Coex. transparent PE

*Subject to a tolerance of 5%

Lexan® Exell®-D SC IR

Standard gauge in mm 3-4-5-6-8

Standard colours	Light Transmission**	Solar Transmission
• code GN8A081T	73% all thicknesses	61% all thicknesses
• code GN9A047T	62% all thicknesses	50% all thicknesses

Standard sizes:

2050 x 3050 mm

Masking:

Top side:	Coex. opal white printed PE
Bottom side:	Coex. transparent PE

Note: top side is textured

*Subject to a tolerance of 5%

Lexan® Margard® MRA3

Standard gauge in mm 3-4-5-6**

Standard colours	Light transmission*
• clear code 112	89,5-86% dep. on thickness

Standard sizes:

1220 x 3050 mm (gauges < 3mm)
2000 x 3000 mm (gauges > 2mm)

Note: for some applications the ripple orientation may play an important role in the optical performance of the sheet. This orientation is indicated on the masking.

*Subject to a tolerance of 5%

**other gauges upon request.

Lexan® Margard® MR5E/Lexan® Margard® FMR5 XT

Standard gauge in mm 3-4-5-6-8-9,5-12

Standard colours	Light transmission*
• clear code 112	73-87% dep. on thickness
• solar bronze code 5109	50% all thicknesses

Standard sizes:

2000 x 3000 mm

Note: for some applications the ripple orientation may play an important role in the optical performance of the sheet. This orientation is indicated on the masking.

*Subject to a tolerance of 5%

Lexan® Margard® MR5 IR

Standard gauge in mm 3-6-8-12

Standard colours	Light transmission*
• code GN8A081T	74.5% (for 6 mm)
• code GN9A047T	62% (for 6 mm)

Standard sizes:

2000 x 3000 mm

Note: for some applications the ripple orientation may play an important role in the optical performance of the sheet. This orientation is indicated on the masking.

*Subject to a tolerance of 5%

Lexan® Margard® MRX

Standard gauge in mm 2-3-4-5-6-8-9,5-12-15

Standard colours	Light transmission*
• clear code 112	73-87% dep. on thickness

Standard sizes:

2000 x 3000 mm

Note: for some applications the ripple orientation may play an important role in the optical performance of the sheet. This orientation is indicated on the masking.

*Subject to a tolerance of 5%

Lexan* solid sheet

Lexan* solid sheet exhibits an excellent balance of physical, mechanical and environmental properties which are maintained over a wide range of temperature and humidity conditions.

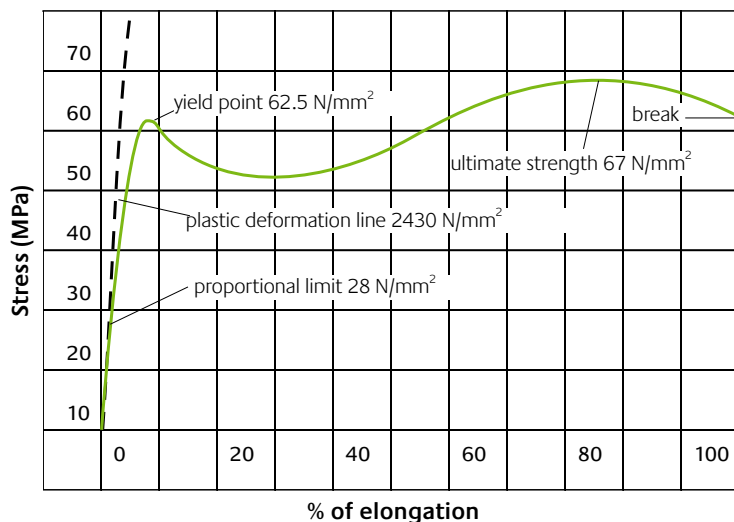
Specifics on the properties of these products are dealt with in this section.

1. Stress-strain diagram for Lexan* solid sheet

Table 1: Typical Properties Lexan* solid sheet

	Standard	Unit	Lexan* Solid Sheet
Physical Properties			
Specific gravity (non FR grades)	DIN 53479		1.20
Mechanical Properties			
Tensile strength at yield	DIN 53455	N/mm ²	>60
Tensile strength at break	DIN 53455	N/mm ²	>70
Elongation at yield	DIN 53455	%	6-8
Elongation at break	DIN 53455	%	>100
Flexural modulus	DIN 53457	N/mm ²	2500
Flexural yield strength	DIN 53452	N/mm ²	100
Impact strength (falling dart)*	SABIC Method	Nm	>200
IZOD notched (1/8") at room temp.	ASTM D 256	J/m	600-800
Thermal Properties Heat resistance temperature:			
Vicat VST/B	DIN 53460	°C	>145-150
DTUL 1,82 N/mm ²	ASTM D 648	°C	135-140
Coeff. of linear thermal expansion	VDE 0304/1	m/m°C	6.7 x 10 ⁻⁵
Thermal conductivity	DIN 52612	W/m°C	0.21

*Measured on injection moulded test specimens.



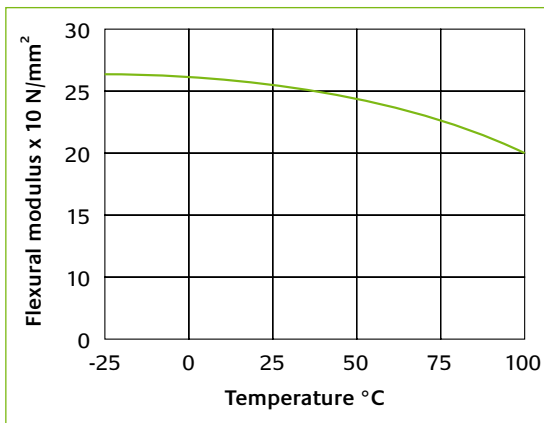
Properties vs Temperature

An outstanding feature of Lexan® solid sheet is the retention of mechanical properties over a wide range of temperatures.

Lexan® solid sheet is characterised by its excellent mechanical behaviour, maintaining high strength and stiffness when exposed to elevated temperatures over a long period of time. For example Lexan® solid sheet retains 85% of its room temperature flexural modulus at 82°C. Figure 2 shows flexural modulus as a function of temperature.

Impact strength

Lexan® polycarbonate sheet is one of the toughest, transparent thermoplastic materials. It withstands impact from all kinds of objects, from stones to hammers without shattering. Its proven energy absorbing characteristics are maintained at sub-zero winter temperatures or high summer temperatures. Polycarbonate sheet has 250 times the impact strength of glass and so gives greater protection against vandalism and forced entry.



2

SABIC Innovative Plastics falling dart impact test

When tested to the SABIC Innovative Plastics “falling dart” impact strength test, Lexan® polycarbonate sheet provided superior energy absorption, (>200 N), compared to other types of plastic glazing materials. A dart of 8 kg, with a hemi-spherical top of 12.5 mm radius is freely dropped from a height of 2.5 m onto a Lexan® sheet disc. The Lexan® sheet disc is freely supported at the edges and has a diameter of 100 mm and a thickness of 3.2 mm.

Speed of falling dart

$$V = 2gh$$

$$= 2 \times 10 \times 2,5 = 7 \text{ m/sec or}$$

$$V = 25,2 \text{ km / hour}$$

$$M = \text{Falling dart mass} = 8 \text{ kg}$$

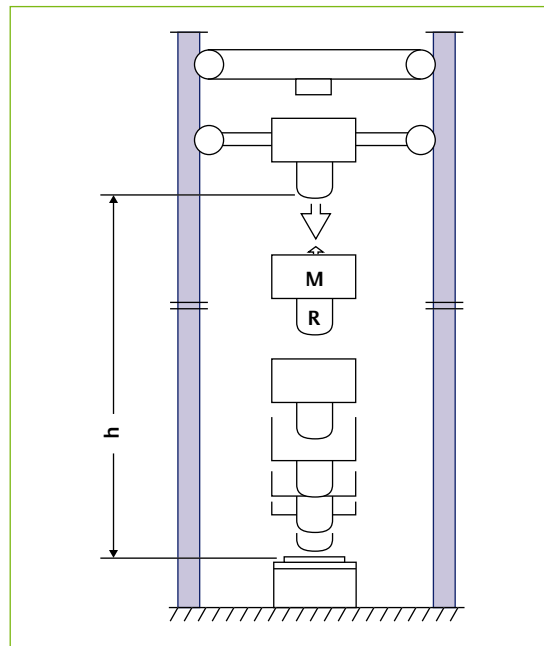
$$h = \text{Drop height} = 2,5 \text{ m}$$

$$E = M \times gh$$

$$E = 8 \times 10 \times 2,5 = 200 \text{ Nm}$$

2. Flexural modulus vs temperature

3. SABIC Innovative Plastics falling dart impact test



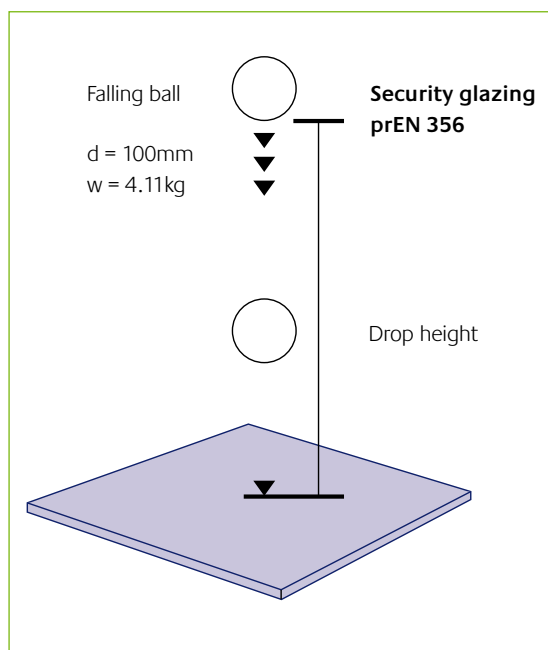
3

Across the glazing sheet range, which includes Lexan® Exell®-D, Exell®-D FR, Exell®-D VEN, Exell®-D SC IR, Lexan® Margard® MR5E, MR5 IR, MRA3, MRX and FMR5 XT, Lexan® 9030 and 9030 FR and Lexan® Exell®-D ST sheet, the outstanding toughness offers superior protection against breakage. The entire product range meets the highest impact performance required by the European Norm EN356 for security glazing.

Norm EN356

Steel Ball Impact Test

A steel ball of 4.11 kg with a diameter of 100 mm is dropped freely from different defined heights onto the glazing specimen. In each class the steel ball must impact the specimen three times. The glazing material fulfils the requirements of the test if all impacts do not cause penetration by the steel ball. The relative classes, drop height requirements and test results are outlined in Table 2 with a diagrammatic representation of the test shown in Figure 4. Each of the products tested reached the highest standard required by the test at a thickness of 5 mm and above.



4

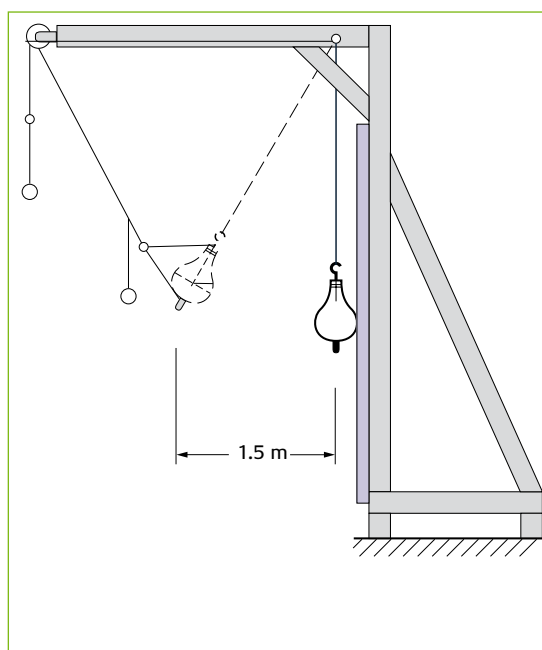
Balcony Glazing Test –

DIN 52337 Soft and Hard Body Impact

Two different aspects of this particular test simulate the types of impact that may occur on infill glazing panels for balustrades and walkways. The soft body impact involves a pendulum test with a weight of 45 kg being released from a drop height of 1.5 metres onto the specimen. The hard body impact simulates a point-load situation with a pear shaped specimen weighing 10 kg being released from a height of 1.5 metres.

In both cases the impactor must not penetrate the glazing panel which should remain in position.

All solid sheet with a thickness of 6 mm and above complies with the highest standards of the test.



5

4. Steel Ball Impact Test

5. Balcony Glazing Test DIN 52337 Hard/Soft Body Impact

Table 2:

Category of resistance	Drop height (mm)	Total number of strikes	Code designation for category of resistance	Impact energy per stroke
P1A	1500	3 in a triangle	EN 356 P1A	62 Joule
P2A	3000	3 in a triangle	EN 356 P2A	123 Joule
P3A	6000	3 in a triangle	EN 356 P3A	247 Joule
P4A	9000	3 in a triangle	EN 356 P4A	370 Joule
P5A	9000	3 x 3 in a triangle	EN 356 P5A	370 Joule

Classification table for the resistance of security glazing products according to European Norm EN356

Optical Performance

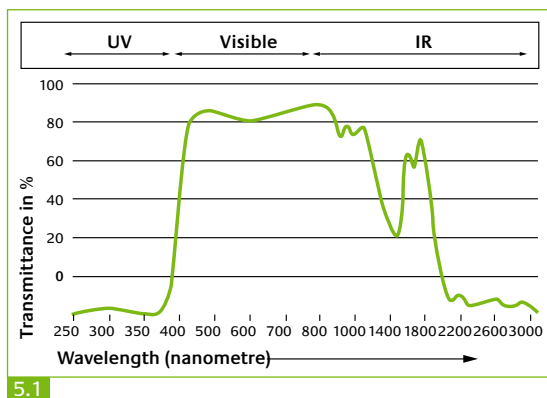
Light Transmission

The sunlight which reaches the surface of the earth has a wavelength that ranges between 295 – 2140 nanometres (10-9 metres).

The optical window is divided into the following sections.

UV-B Middle UV Region	280 - 315 nm
UV-A Near UV Region	315 - 380 nm
Visible Light Region	380 - 780 nm
Near Infra-red Region	780 - 1400 nm
Middle Infra-red Region	1400 - 3000 nm

As shown in Figure 6, Lexan® sheet products have the highest transmission in the visible light and near infra-red region of the spectrum. Lexan® polycarbonate sheet products are essentially opaque to all wavelengths below 385 nanometres. Lexan® solid sheet glazing can therefore be used to shield sensitive materials such as fabrics or other organic materials against discolouration in environments such as factory warehouses, museums or shopping centres.



Clear Lexan® solid sheet

Clear Lexan® solid sheet offers excellent clarity almost approaching that of glass, with light transmission values of 75 – 87%, depending upon the thickness of sheet. However, for buildings in hot climates or with south facing aspects, Lexan® solid sheet is available in translucent grades of bronze, grey and opal white.

Environmental factors

UV Protection

Solar radiation has a particularly harmful effect upon polymeric materials by initiating degradation through superficial surface crazing. These crazes become sites for further erosion from water, dust, chemicals, etc. The degree to which these conditions affect the polymer depend largely upon environmental parameters such as geographical location, altitude, seasonal variations etc.

Lexan® Exell®-D TG, Exell®-D ST, Exell®-D FR Exell®-D VEN and Exell®-D SC IR sheet have proprietary UV-protected surfaces, giving excellent resistance to outdoor weathering. The unique proprietary technology applied to Lexan® Exell®-D TG, Exell®-D ST, Exell®-D FR Exell®-D VEN and Exell®-D SC IR sheet ensures long-term optical quality under intensive UV exposure, and maintains the superior toughness of the polycarbonate material in comparison with other thermoplastic glazing. Under ISO 4892, a test has been developed using high intensity Xenon lamps to simulate natural sunlight. Together with UV filters and programmable rain cycles, the test is able to simulate natural conditions. Accelerated weathering tests by SABIC Innovative Plastics, Specialty Film & Sheet using in-house Xenon 1200 apparatus have been carried out according to ISO 4892. However, even tougher demands were placed on the materials by removing the UV filter for 1/6 of the cycle.

6. Light Transmission Spectrum of Lexan® Polycarbonate

△ **WARRANTY**
SABIC Innovative Plastics offers a Ten Year Limited Warranty on Lexan® Exell®-D and Lexan® Exell®-D ST sheet covering discolouration, loss of light transmission and loss of strength due to weathering. Please consult your local distributor or SABIC Innovative Plastics, Specialty Film & Sheet Sales Office for specific details.

Temperature Increase Inside the Building

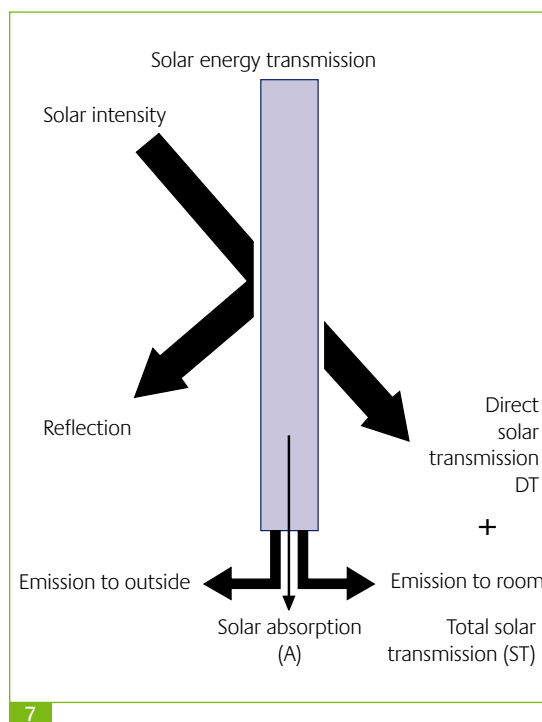
Solar Control

Transparent grades of Lexan® solid sheet have excellent light transmission of between 75 and 87% depending upon thickness. However, for buildings in hot climates or with south facing aspects, Lexan® sheet is available in translucent grades of bronze, grey and opal white and Lexan® Exell® Venetian.

These grades significantly reduce solar heat build-up, helping to maintain comfortable interior temperatures. The specially tinted sheet and Exell®-D Venetian cut down the brightness of sunlight to a pleasing level and reduces air conditioning costs in the summer.

Solar Heat Gain

The solar radiation reaching the sheet is reflected, absorbed and transmitted, as shown in Figure 7. The greatest proportion is transmitted and the total solar transmission (ST) is the sum of the direct transmission (DT) and the inwardly released part of the absorbed energy (A). Table 3 outlines the overall solar control properties of Lexan® solid sheet.



7. Solar Energy Transmission

Table 3: Solar Energy Transmission

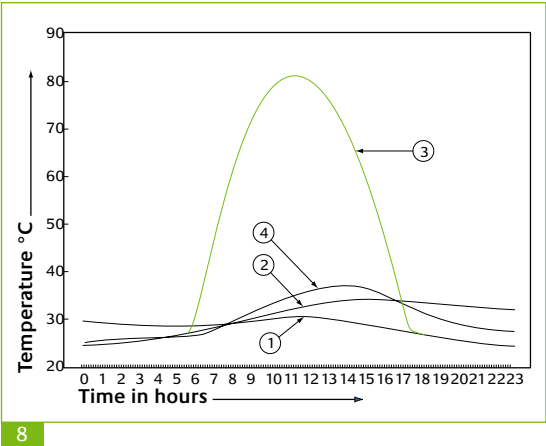
	LT	R	A	DT	ST	SC
Lexan® solid sheet Colour number	Light transm. in %	Solar reflection in %	Solar absorption in %	Direct solar	Total solar transm. %	Shading coefficient transm. %
Transparent 112	87	9	9	82	84	0.97
Bronze 5109	50	7	38	55	65	0.75
Grey 713	50	7	38	55	65	0.75
Opal white WH7D278O	54	20	29	51	58	0.67
Opal white WH4D348O	25	54	18	28	33	0.38
Exell® D VEN Transparent 112W with white stripes	37	48	-	-	51	0.59
Natural GN9A047T	62	7	57	34	50	0.57
Natural GN8A81T	73	7	40	50	61	0.71

Temperature Resistance

The heat build-up of glazing materials can be seen as a function of the absorption of the glazing material and the solar intensity.

In countries with intense sun radiation, and when high energy absorbing tinted glazing is installed, heat build-up of the glazing can be considerable. Calculations and actual measurements on installed Lexan® sheet in several projects throughout Europe have shown that sheet surface temperatures of 100°C can exist.

Figure 8 gives an example of the heat pattern of an open ventilated horizontal sloped roof glazed with bronze tinted Lexan® sheet when exposed to intense sunlight



- 1. Environment temperature
- 2. Metal construction temperature
- 3. Lexan® sheet temperature
- 4. Temperature beneath roof

Lexan® sheet is characterised by its excellent retention of impact strength and stiffness at elevated temperatures, even over an extended period.

Lexan® sheet retains 85% of its room temperature flexural modulus at 82°C. The Vicat softening temperature and the Deflection Temperature Under Load of Lexan® polycarbonate are both around 140°C.

Lexan® sheet has a continuous-use temperature of 100°C. At the other end of the scale, the minimum continuous-use temperature has been set at -40°C. Using Lexan® at lower temperatures is possible since the embrittlement temperature is as low as -110°C.

UL Ratings

The U.S.A. Underwriters Laboratories’ continuous use temperature rating can be considered as a reliable indicator of a thermoplastic’s long-term high temperature performance. The most important properties of the thermoplastic are tested at various temperatures. Test results are extrapolated over a period of 10 years and no property may lose more than 50% of its original value. Table 4 outlines the UL-continuous use temperatures of typical thermoplastic glazing materials.

Table 4: UL Temperature Ratings UL 746B

Lexan® Polycarbonate	100°C
Acrylic	50°C
PVC	50°C

Lexan® Margard® sheet MR5E, MR5 IR, MRX, MRA3 and FMR5 XT

High resistance to abrasion

Lexan® Margard® sheet has a unique, hard surface coating which provides a high level of protection against unsightly scratching. It is therefore ideal for use in applications where frequent contact is likely. The state-of-the-art coating on both surfaces of the Margard® sheet makes it one of the most abrasion-resistant plastic safety and security glazing products available.

Mutual benefits of Lexan® Margard® MR5E, MR5 IR, MRA3, MRX and FMR5 XT

• UV protection

Whilst the coating of Lexan® Margard® is essentially an abrasion-resistant barrier, the proprietary technology also offers improved UV protection.

MRA3 is not UV protected

• High resistance to chemicals

Lexan® Margard® sheet is immune to contact with many chemicals such as cleaning fluids, paints and adhesives.

Its unique surface coating also resists graffiti, enabling easy restoration to a 'good as new' condition. Not for FMR5 XT.

• Comprehensive warranty^Δ

Lexan® Margard® sheet is backed by a five years limited warranty^Δ against loss of light transmission and coating failure, and by a ten years warranty^Δ against breakage.

^ΔSee Warranty for exact details.

Lexan® Margard® MR5E, MR5 IR, MRX and MRA3

• Flat applications only

Due to its mar-resistant coating, Lexan® Margard® MR5E/MRA3 sheet cannot be cold-formed. The sheet is intended for flat applications only.

• Anti-vandal glazing

Glazing with Lexan® Margard® sheet is the ideal solution in areas where there may be a risk of vandalism.

• Security glazing

Lexan® Margard® sheet will prevent a burglar from forcing an entry.

• Safety screens and acoustic screens

Lexan® Margard® sheet is the ideal material for safety screening in sports stadia and other outdoor applications.

MRA3 only suitable for indoor applications.

• Premises safety glazing

Lexan® Margard® sheet will not shatter or splinter, so greatly reducing the risk of accidental injury in applications like interior partitions, doors and machineguards.

Lexan® Margard® Sheet FMR5 XT (Formable)

Curved applications

Design freedom, light weight and optical clarity combined with superior mechanical properties make Lexan® Margard® FMR5 XT the ideal glazing material for shaped applications like: curved windows (e.g. revolving doors), partitions, skylights, barrel vaults, balcony glazing, stair glazing, shelters and safety guards.

Table 5: Lexan® Margard® MR5E, MRX, MRA3 and FMR5 XT Abrasion Resistance

	Test* Method	Margard** FMR5 XT	MRX	Margard** MR5E(IR)	Margard** MRA3	Glass
Taber Abrasion* CS10 F Wheels 500 gm weight	ASTM D1044 ANSI 226.1 1983	% Haze	% Haze	% Haze	% Haze	% Haze
a) 100 cycles	Plastic safety glazing test	7	5	2.1	1.8	0.5
b) 500 cycles	Extended test	-	12	8.0	3	1.0
c) 1000 cycles	Glass safety glazing test	-	-	-	9.5	2.0
Sandriesel Test*	DIN 52348	3,0	-	2.0	2.0	1.0

* These values are mean values, however the reproducibility of these test methods between laboratories can be variable.

Sound reduction

Single Glazing

Installing Lexan® solid sheet into single or double glazing systems, meets the acoustic requirements of today's glazing. Table 6 compares single glazed Lexan® solid sheet's performance with that of glass.

Table 6: Acoustic insulation DIN 52210-75 Rw (dB)

Thickness in mm	Lexan® solid sheet	Glass
4	27	30
5	28	30
6	29	31
8	31	32
12	34	34
15	pending	pending

Double Glazing

When applied together with existing glass and an air-space of >50 mm, Lexan® solid sheet considerably reduces sound transmission, particularly at low frequencies, such as traffic noise.

Table 7: DIN 52210-100 Acoustic Insulation

Sheet thickness in mm			
Lexan® solid sheet	Glass	Air Space in mm	Rw w dB
4	6	85	39
6	6	85	40
8	6	85	42
9.5	6	85	44
4	6	54	36
6	6	54	37
8	6	54	39
9.5	6	54	41

Thermal Insulation

Energy Loss Calculation

The need to reduce energy consumption, and therefore energy costs, is one of the highest priorities in any business today. Substantial savings in excess of 20% are possible when installing Lexan® solid sheet instead of mono-layer glass. When calculating according to the guidelines laid out in DIN Standard 4701, an average annual saving of between 0.9–1.3 litres of oil or 1.0–1.5 m³ of gas per m² of glazing area will be obtained by decreasing the K-value by 0.1 W/m²K.

Single Glazing

When using Lexan® solid sheet, considerable energy cost savings can be achieved by preventing excessive heat loss in winter and heat entry in summer. Heat loss is normally recorded as a K-value, which is the amount of energy transmitted through a material per square metre of glazing area and per degree of temperature difference.

Table 8: Single glazing K-values W/m²K

Thickness in mm	Lexan® Solid Sheet	Glass
4.0	5.33	5.82
5.0	5.21	5.80
6.0	5.09	5.77
8.0	4.84	5.71
9.5	4.69	5.68
12.0	4.35	5.58
15	4.17	5.45

Double Glazing

The selection of Lexan® Exell®-D or Margard® as either internal or external secondary glazing will depend upon the specific requirements of the building. Internal or external secondary glazing can improve protection against burglary. External installation can protect against vandalism. For effective insulation, the best results are obtained by leaving a 20–60 mm space between the existing glazing and the Lexan® Exell®-D, Lexan® 9030 or Margard® overglazing. Table 8.4 shows the K-value as a function of different Lexan® solid sheet thicknesses in combination with different glass thicknesses.

Table 9: Double Glazing

Thickness Glass (in mm)	Thickness Lexan® Solid Sheet (in mm)	Air Space (in mm)	K-values [W/m ² K]
4	4	20-60	2.77
4	5	20-60	2.73
5	5	20-60	2.72
4	6	20-60	2.70
6	6	20-60	2.68
5	8	20-60	2.62
6	8	20-60	2.60
6	9.5	20-60	2.56
6	12	20-60	2.54
6	15	20-60	2.50

Triple Glazing

Extremely low K-values can be obtained by overglazing Lexan® Exell®-D, Margard® or Lexan® 9030 in combination with double sealed glass units.

Table 10: Triple Glazing

*Thickness sealed glass unit in mm	Thickness Lexan® solid sheet in mm	Air Space in mm	K-values [W/m ² K]
4+4	5	30-60	1.85
6+4	6	30-60	1.82
8+4	8	30-60	1.78

*air space = 12 mm

Note: For overglazing fixing details see page 20

Light Weight

Lexan* polycarbonate sheet products are ideal replacements for more traditional glazing materials. They are safe and easy to handle, cut and install and are virtually unbreakable.

Their light weight offers significant cost savings in transportation, handling and installation; when compared with glass of the same thickness they offer a weight saving of more than 50%.

Table 11: Acoustic insulation DIN 52210-75 Rw (dB)

Thickness	Lexan* Sheet	Glass
3	3.60	7.50
4	4.80	10.00
5	6.00	12.50
6	7.20	15.00
8	9.60	20.00
9.5	11.40	23.80
12	14.40	30.00
15	18.00	37.50

Lexan® solid sheet has good fire behaviour characteristics, and receives high ratings in several major European fire performance tests. As a thermoplastic, Lexan® solid sheet will melt under the intense heat of a fire. However, it will make almost no contribution to the growth of a fire through flame spread.

The base raw material has an LOI (Limiting Oxygen Index) of 25 and does not contain additional flame retardant additives. The LOI (ISO 4589 ASTM D2863) is defined as the minimum oxygen concentration in which the material will burn for three minutes or can keep the sample burning over a distance of 50 mm. The higher the LOI value, the less the likelihood of ignition.

Large-scale roof test

When exposed to heat, the Lexan® solid sheet will soften at 150°–160°C. This creates a hole in the sheet which allows smoke and heat to escape and reduces the temperature to around 60°C. (A reference report is available upon request). Provided there is enough room to cool down and fall away from the heat source, any droplets of molten Lexan® sheet will solidify and self-extinguish. Therefore no propagation of fire takes place. Most test devices are designed in such a way that, because burner and the space measured between the test specimen is so short, solidification and the extinguishing of flames is sometimes not observed.

National Standards

In Germany the recognized practice for buildings is to measure according to DIN 4102-1 "fire performance of building materials". Thermoplastics are tested for B1 (combustible, low flammability) in the "Brandschacht test" and for B2 (combustible, moderate flammability) in the small burner test.

In France the classification of the fire performance of building materials ranges from M0 (non-combustible) to M4 (highly flammable). The épiradiateur test (NF P92-501) is the method of determining the fire performance of rigid samples.

In the UK, the performance of plastics is tested according to BS 476 part 7 "surface spread of flame". Classification ranges from class 1 (best) to class 4 (worst). A suffix "Y" is added to the result if softening or slumping occurs.

EU-classification. Under the Construction Products Directive (89/106/EG) a new system for fire classification has been introduced. Testing is according to EN-ISO 11925-2, "Small burner test" and EN 13823 "Single burning item" test. Fire classification reaches from A1 (non-combustible – F (no performance determined), smoke density S1, S2 or S3 and d0 (no flaming droplets), d1, d2.

Remark

For FR grades, please check datasheets.

Lexan® sheet is successfully used in combination with many building materials and glazing compounds. Taking into account the complexity of chemical compatibility, all chemicals which come into contact with polycarbonate should always be tested. For sheet products, the most common materials are sealants, gaskets and the various cleaning media. Chemical compatibility testing is an ongoing process at SABIC Innovative Plastics, Specialty Film & Sheet and many standard products have already been tested. A complete list of recommended cleaners, gaskets and sealants is available on request. However, a shortened list of some of the more common compounds is shown below and overleaf.

When using glazing compounds it is essential that the sealant system accepts a certain amount of movement to allow for thermal expansion, without loss of adhesion to the frame or sheet. MPM (Momentive Performance Materials) sealants are generally recommended for use with Lexan® sheet, as shown in Table 11.1. It is strongly advised when using non momentive performance materials sealing compounds to check compatibility before use.

Table 12: Recommended Sealants

Sealant	Supplier
Silpruf®	Momentive Performance Materials (MPM)
MultiSil®	Momentive Performance Materials (MPM)

Do not use PVC gaskets

Due to the migration of additives from soft PVC, the Lexan® sheet can be chemically affected resulting in surface cracks or even sheet breakage. Compatible Neoprene, EPT or EPDM rubbers with an approximate Shore Hardness of A65 are recommended. Compatibility reports for different rubber types are available upon request.

Table 13: Recommended Gasket Systems

Gasket Type	Supplier
EPDM R27* Chloropene, RZ4-35-81	Helvoet
EPDM 4330, 4431, 5530, 5331	Vredestein
EPDM 3300/670, 64470	Phoenix

*more grades available

In case of doubt about any aspect of the chemical compatibility of the Lexan® sheet range, always consult your nearest SABIC Innovative Plastics, Specialty Film & Sheet Sales Office for further advice.

Chemical Resistance of Lexan® Margard®

The "mar" resistant coating of Lexan® Margard® provides an additional benefit in terms of chemical resistance.

The proprietary coating is resistant to a range of chemicals that under normal circumstances is detrimental to Lexan® polycarbonate.

Periodic cleaning using correct procedures with compatible household cleaners is recommended to prolong service life. For general cleaning, it is recommended that the following instructions are adhered to.

Table 14: Recommended Solvent Cleaners

Cleaner/Solvent	Supplier
White Spirit	various
Petroleum Ether (BP65 °)	various
Hexane	various
Heptane	various

Procedure 1 - Small Areas

1. Rinse sheet with lukewarm water.
2. Wash sheet with a solution of mild soap or household detergent and lukewarm water, using a soft cloth or sponge to loosen any dirt and grime.
3. Rinse with cold water and dry with a soft cloth to prevent water spotting.

Procedure 2 - Large Areas

1. Clean surface with a high pressure water and/or steam cleaner.
2. Use of additives to the water should be restricted to those compatible with Lexan® sheet.

Recommended Cleaner Supplies

JohnsonDiversey

Web page:

www.johnsondiversey.com

Recommended cleaners

SUMALIGHT D12

BRUCODECID

Points to remember

- Don't use abrasive or highly alkaline cleaners.
- Never scrape the sheet with squeegees, razor blades or other sharp instruments.
- Don't clean Lexan® sheet products in the hot sun or at elevated temperatures as this can lead to staining.

Recommendations for Cleaning Lexan® Margard® MR5E , MR5 IR and MRA3

The unique surface of Lexan® Margard® sheet provides superior protection against chemical attack. Even graffiti, such as spray paint, are easily and quickly removed. However, because of this material's mar resistant coating, the use of abrasive cleaners and/or cleaning implements that may damage or scratch the coating should be avoided.

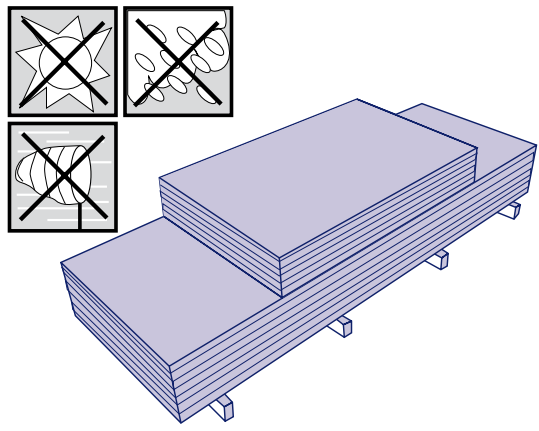
The recommended cleaning procedure for the removal of graffiti, etc., is as follows:

- Paints, marking pens, inks, lipstick, etc. use graffiti remover.
- Labels, stickers use kerosene or white spirit.
- Final wash with warm soap solution, followed by rinse with clean water.

Note: The edges of the sheet are not protected! Protect edges before cleaning.

Storage

Lexan® solid sheet should be stored and protected against atmospheric influence like sun, rain, etc. Lexan® solid sheets of the same length should be stacked together horizontally or, if different lengths, graded with the longest sheet at the bottom of the stack in order to avoid unsupported overhangs. Do not stack



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where they can be walked on or driven into.

Handling

As with all glazing materials, care should be exercised when handling and transporting Lexan® sheet in order to prevent scratches and damage to sheet edges. Each sheet is packaged to minimise the risk of these problems.

Cutting and Sawing

Lexan® polycarbonate sheet products can be cut and sawn easily and accurately using standard workshop equipment.

General guide-lines are listed below with specific recommendations outlined in each cutting section.

- The sheet must always be securely clamped to avoid undesirable vibration and roughly cut edges.
- All tools should be set for cutting plastics with fine toothed panel blades.
- The protective masking should be left on the sheet to prevent scratching and other surface damage.
- When finished the edges of all Lexan® sheet products should be clean and free of notches.
- If possible swarf and dust build-up should be blown away with a compressed air supply.

Circular Saws

This type of cutting operation is the most common and, whilst cutting speeds and feeds are not so critical as with other thermoplastics, it is important to follow the recommended guide-lines.

- Always use a low feed to get a clean cut.
- Always start cutting with the blade at full speed.
- For single sheets less than 3 mm thick, bandsaws or jig saws are preferred to circular saws.

Bandsaws

These can be of the conventional vertical type or the specially developed horizontal type suitable for plastic sheet materials. In both cases it is vital that the sheet is adequately supported and clamped during the cutting operation. The saw guides should be as close to the sheet as possible to reduce blade twist and off-line cutting.

Jig Saws and Hacksaws

The most important consideration with this type of cutting is support and clamping, particularly when using a jig saw. Blades with a tooth spacing of 2–2.5 mm are ideal and low cutting feeds are recommended.

Drilling

Standard high speed steel twist drills or drills with an angular wedged bit can be used for drilling Lexan® sheet products. Carbide-tipped drills can also be used since they retain their sharp cutting edge.

The most important factor to consider when drilling Lexan® sheet products is the heat generated during the actual process. In order to produce a clean, well-finished hole that is stress-free, the heat generated must be kept to an absolute minimum.

By following a few basic guide-lines, clean, stress-free holes can be produced easily.

- The drill hole must be cleared frequently to prevent swarf build-up and excessive frictional heat.
- The drill must be raised from the hole frequently and cooled with compressed air.
- The sheet or product must be adequately clamped and supported to reduce vibration and ensure a correctly sized hole.
- Holes should not be drilled closer to the edge of the sheet than two times the diameter of the hole.
- All holes must be larger than the bolt (1.5 times), screw or fixing to allow for thermal expansion and contraction.

9. Figure 9

Dynamic Wind Pressure

The wind speed is used to determine the actual loading upon the glazing panels. In mathematical terms, the pressure loading is calculated by multiplying the square of the design wind speed by 0.613.

$$q = KV^2$$

where:

q = dynamic wind pressure in N/m^2

$K = 0.613$

V = design wind speed in metres/second

Table 16: Values of q in SI units (N/m^2)

Wind speed m/s	Wind pressure N/m^2	Wind speed m/s	Wind pressure N/m^2
10	61	40	981
15	138	45	1240
20	245	50	1530
25	383	55	1850
30	552	60	2210
35	751	65	2590

For glazing projects with an unusual loading condition, please contact your local SABIC Innovative Plastics, Specialty Film & Sheet Sales Office.

Pressure Coefficient

To allow for local fluctuations in the acceleration/ deceleration of the wind by building or glazing geometry, it is necessary to include an appropriate pressure coefficient. The wind loading is obtained by multiplying the dynamic wind pressure by the pressure coefficient. Detailed pressure coefficient values can be found in the appropriate building norms.

Snow Loading

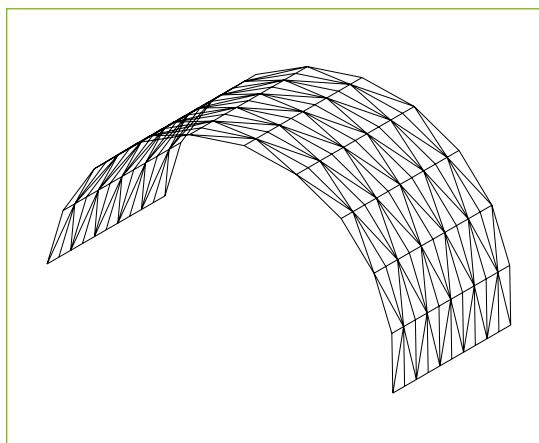
Snow loading on roof glazings can be considered equivalent to a vertically, uniformly distributed load, acting per m^2 of the horizontal projection of the glazing. Snow loading factors can be obtained from the appropriate building norm.

Computer Aided Sheet Engineering

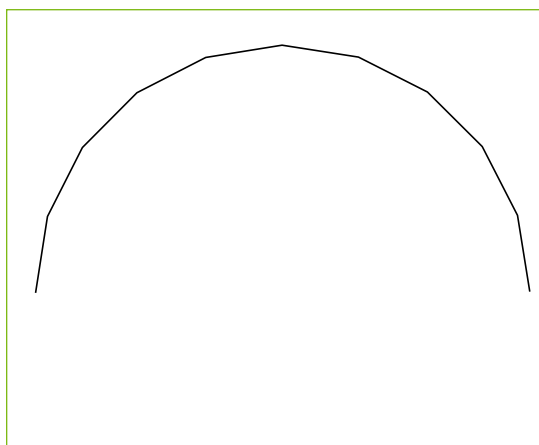
A computer aided design programme has been developed especially for large glazing projects, or projects with an uncommon shape or unusual loading conditions. The programme creates the finite element model of a particular glazing design, applies the specified loads and edge conditions and runs the deflection analysis. Consult your nearest SABIC Innovative Plastics, Specialty Film & Sheet Technical Service Centre for further advice.

Wind and Snow Load Consideration

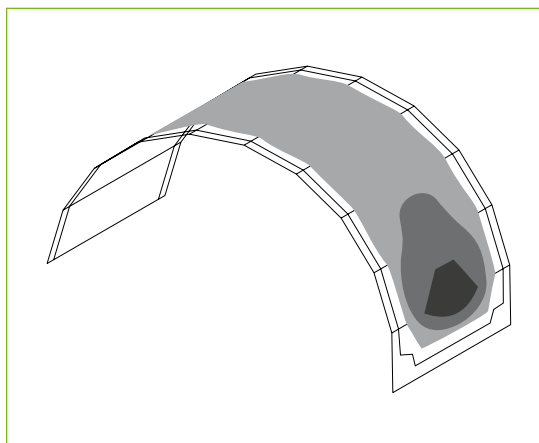
The results shown in Tables 16, 24–28 are applicable for loads varying from 600 up to 2000 N/m^2 . These loads cover most of the normal glazing projects fulfilling requirements according to European standards BSI - CPS chapter V part 1, NEN 3850 and DIN 1055.



10



11



12

10. Finite element model

11. Deflection plot

12. Deflection contour plot

Glazing Precautions

- Glazing of Lexan® sheet should be considered a finishing operation and should be scheduled as a final step in the completion of a building.
- Care should be taken to avoid surface marring during storage, cutting, transporting and installation.
- After installation and removal of masking, Lexan® sheet should be protected from paint, plaster and other contamination by polyethylene or other covering taped to the framing members.
- Check compatibility of the Lexan® sheet with the suppliers of the selected glazing tapes, gaskets and sealants.

Thermal Expansion Allowance

Since Lexan® sheet has a larger coefficient of linear thermal expansion than that of the glazing profiles commonly used, care should be taken to allow free expansion of the sheet to avoid bowing and thermal stress. Linear Thermal Expansion Coefficients for various materials are shown below:

Table 17:

Material	m/m °C x 10-5
Lexan® Sheet	6.7
Glass	0.7 - 0.9
Aluminium	21. - 2.3
Steel	1.2 - 1.5

Allowance for thermal expansion must be made for both the length and the width of the Lexan® sheet. The recommended allowances for various sheet dimensions are outlined in Table 18.

In general: Thermal expansion of the sheet is approximately 3 mm per linear metre.

Sheet Edge Engagement/Rebate Depth Requirements

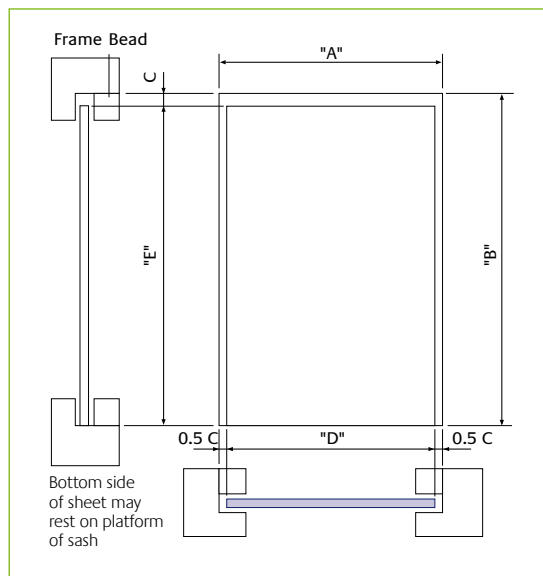
Table 15.2 indicates the minimum required sheet edge engagement of Lexan® sheet in the glazing profiles. The rebate depth is the sum of the specific edge engagement and the expansion allowance. The total rebate depth should include a minimum edge engagement and an allowance for thermal expansion.

Table 18: Thermal Expansion/Sheet edge engagement

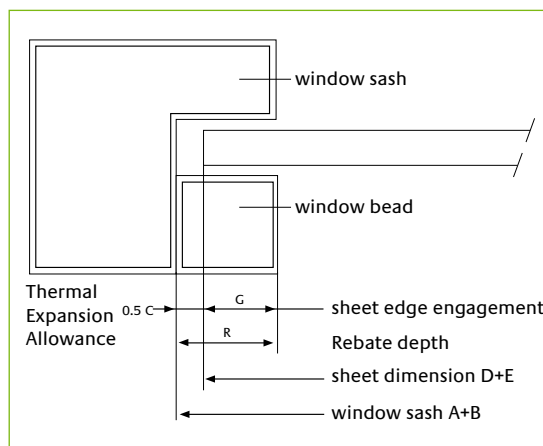
Sash Dimensions (A-B) (mm)	Trim Sheet by C (mm)	Sheet edge engagement G (mm)
300	1	6
300 - 600	1 - 2	6 - 9
600 - 900	2 - 3	9 - 12
900 - 1200	3 - 4	12 - 15
1200 - 1500	4 - 5	15 - 18
1500 - 1800	5 - 6	18 - 20
1800 - 2100	6 - 7	20
2100 - 2400	7 - 8	20
2400 - 2700	8 - 9	20
2700 - 3000	9 - 10	20

13. Figure 13

14. Figure 14



13



14

Glazing Systems

Figures 15 and 16 illustrate typical installations for dry and wet glazing systems using Lexan® polycarbonate sheet products.

It is extremely important when installing Lexan® sheet that the edges are correctly clamped, whether the application involves wet or dry glazing conditions.

See page 22 for thermal expansion clearance and minimal sheet edge engagement.

Wet Glazing Systems

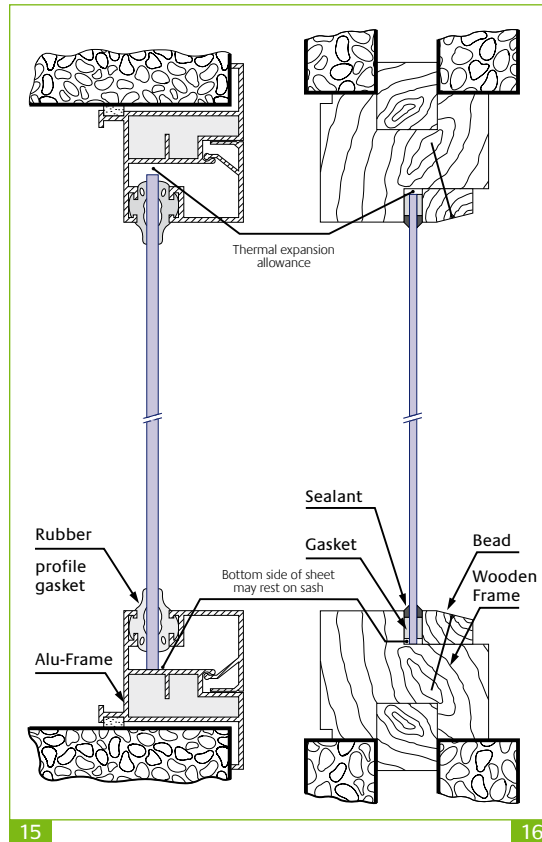
Lexan® sheet can be glazed using standard metal or wooden window frames in combination with glazing tapes and non-hardening glazing compounds. Polybutylene glazing filler tapes are suitable.

When using glazing compounds it is essential that the sealant system accepts a certain amount of movement, to allow for thermal expansion, without loss of adhesion to the frame or sheet. Silicone sealants are generally recommended for use with Lexan® sheet, but it is strongly advised when using sealing compounds to check compatibility before use.

Care should be taken not to use Amine nor Benzamide curing silicone sealants, which are not compatible with Lexan® sheet and result in crazing, particularly when stress is involved. See page 15 for suitable sealants.

Dry Glazing Systems

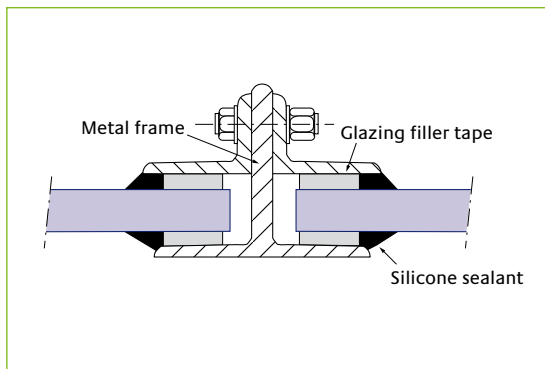
The advantage of dry glazing is that the rubber gaskets snap-fit into the glazing bars which allows free movement of the sheet during expansion and contraction. This should be considered therefore for both aesthetic reasons and for applications where sheet expansion exceeds sealant limitations. Neoprene, EPT or EPDM rubbers, ± 65 shore, are recommended.



15. Dry glazing installation

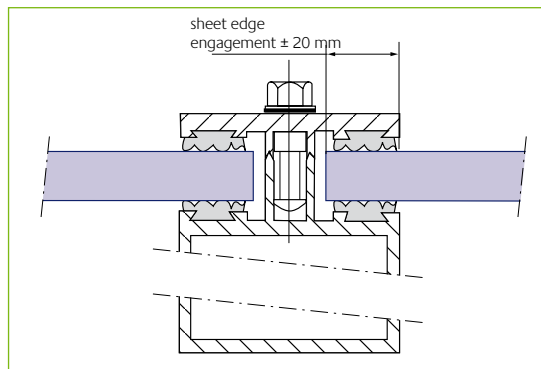
16. Wet glazing installation

Wet Glazing



17

Dry Glazing



18

13. Figure 13

14. Figure 14

Do's

- Clean the window frame. Remove old putty or broken glass, if necessary.
- Measure the sheet edge engagement area and internal window frame dimensions, i.e. the space into which the Lexan* sheet will be fitted.
- Calculate the sheet size, allowing clearance for thermal expansion (3 mm per linear metre).
- Select the right thickness to fulfil loading requirements.
(See Tables 18.5 and 18.6)
- Clamp the Lexan* sheet to a support table to avoid vibration and rough cutting.
- Cut the sheet to the required size, using a standard electric circular or jig saw.
- Remove any sharp edges and irregularities from the sheet.
- Peel back approximately 50 mm of the masking film from all edges of the cut sheet on both sides.
- For wet glazing, apply single-sided self-adhesive glazing tape or rubber profile to both the window frame and the bead.
- For dry glazing, snap-fit compatible neoprene rubber gaskets in place in the support profile as well as in the clamping cover profile.
- Insert the Lexan* sheet into the window frame.
- Fix the window bead or the clamping cover profile in place.
- For wet glazing, apply an approved silicone sealing compound, such as Silglaze/Silpruf between the sheet and the window frame/bead.
- Remove all masking film immediately after installation.
- Clean the window carefully with warm soapy water and with a soft cellulose sponge or woollen cloth.

Dont's

- Do not use plasticised PVC or incompatible rubber sealing tapes or gaskets.
- Do not use Amine, Benzamide or Methoxy based sealants.
- Do not use abrasive or highly alkaline cleaners.
- Never scrape Lexan* sheet with squeegees, razor blades or other sharp instruments.
- Do not walk on Lexan* sheet at any time.
- Do not clean Lexan* sheet in hot sun or at elevated temperatures.
- Benzene, gasoline, acetone, carbon tetrachloride or butyl cellosolve should never be used on Lexan* sheet.

Overglazing Double Glazing

The selection of Lexan® 9030, Exell®-D or Lexan® Margard® sheet as either internal or external secondary glazing will depend upon the specific requirements of the building: external or internal secondary glazing for improved burglar resistance and externally for protection against vandalism.

Specialised companies, recognising the need for more substantial and secure overglazing designs, have developed pre-assembled profile systems. These systems allow for easy pre-fabrication and the rubber gaskets are interchangeable to hold sheet thicknesses of between 5–10 mm.

Figures 19 and 20 show typical examples of overglazing installations.

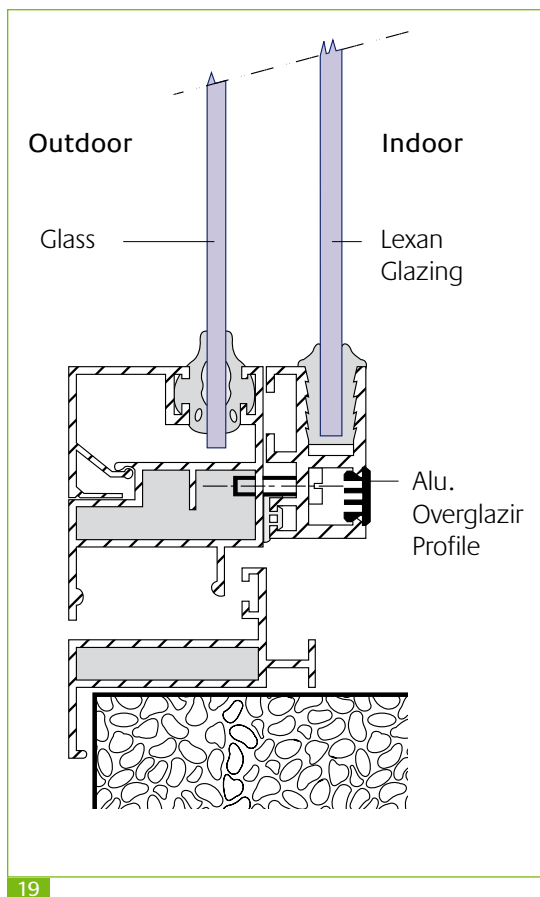
Internal Overglazing

Lexan® Margard® sheet is also an ideal glazing material for interior applications, (Figure 19).

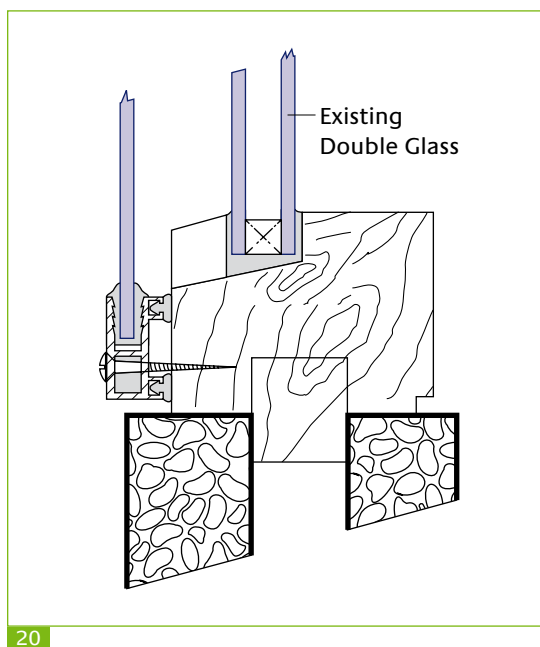
When Lexan® Margard® sheet is installed internally, the criteria for deflection under wind load (as indicated in Table 19) no longer apply and therefore the recommended sheet thickness can be reduced.

External Overglazing

Depending upon requirements, either Lexan® Margard® or Lexan® Exell®-D can be used (Figure 20). Taking into account the functional and aesthetic requirements with respect to deflection under wind load, the sheet thickness recommendations given in Table 18.4 are suitable.



19



20

19. Internal Overglazing

20. External Overglazing

Double Glazing Units

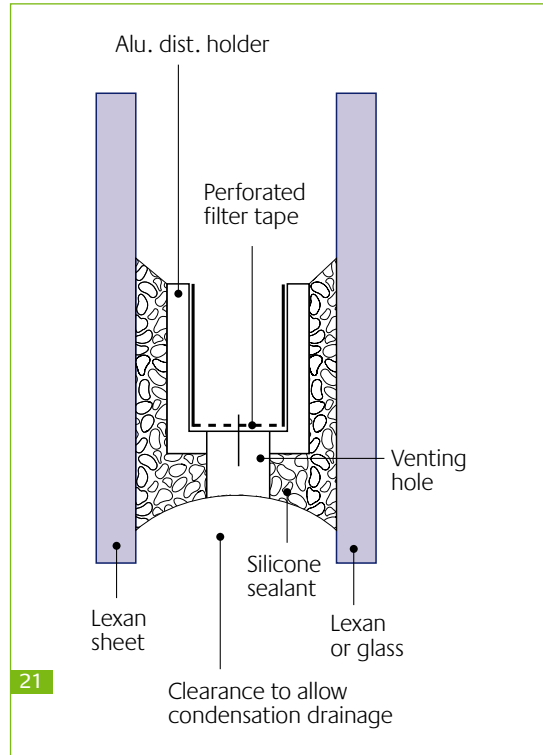
Due to the water vapour permeability of Lexan® sheet, condensation in the cavity using either Lexan®/Lexan® or Lexan®/glass sealed units is not inconceivable. Permanent condensation inside the cavity may occasionally be a problem and algae growth in the form of green deposit can occur. There is a technique that can be adopted to significantly reduce the condensation. U-shaped aluminium distance holders ± 20 mm can be used to create an airgap.

Holes of 6 mm diameter c.t.c. ± 200 mm should be drilled in the aluminium U profile used for the bottom of the glazing.

These venting holes allow for some air ventilation and prevent excessive condensation through drainage to the outside. To avoid dust/insect penetration, the holes inside the cavity must be sealed with a perforated filter tape such as Multifoil AD 3429. To seal the Lexan® sheet onto the alu spacer, silicone sealant can be used. Care should be taken to provide clearance between both the sheet edge and the sash platform to allow for condensation drainage.

These guide-lines are recommendations only.

No guarantee can be given since the above mentioned problems depend largely on the prevailing environmental conditions.



21. Figure 21

Four sides clamped Lexan® sheet

The deflection characteristics in this particular configuration are dependent upon the ratio of the support bar spacing a:b, (see Figure 22).

In practice “a” represents the centre to centre distance of glazing profiles on the short glazing side i.e. the width of sheet.

“b” represents the centre to centre distance of glazing profiles on the long glazing side i.e. length of sheet.

Table 18 indicates the maximum allowable short glazing side of three different ratios of glazing bar spacing.

Ratio sheet width “a”: sheet length “b” 1:>2

Ratio sheet width “a”: sheet length “b” 1:2

Ratio sheet width “a”: sheet length “b” 1:1

The chart assumes an edge engagement as indicated in Table 20, page 30, on all four edges.

Safety Factor

Tables 18.1 and 18.2 indicate the maximum allowable sheet sizes at a specified loading which results in an acceptable sheet deflection behaviour without the risk of sheet buckling or pop-out effect. To calculate the allowable deflection, divide the shortest sheet side “a” by 20. A maximum deflection of 50 mm is recommended.

Example I

Window size: Width: 1600 mm Length: 3200 mm

Ratio a:b = 1:2

Loading: 1000 N/m²

Required sheet type: 12 mm

Maximum deflection: 50 mm

Example II

Window size: Width: 1000 mm Length: 4000 mm

Ratio a:b = 1:>2

Loading: 800 N/m²

Required sheet type: 8 mm

Maximum deflection: 50 mm

Two sides clamped Lexan® sheet

a = centre to centre distance of glazing profiles

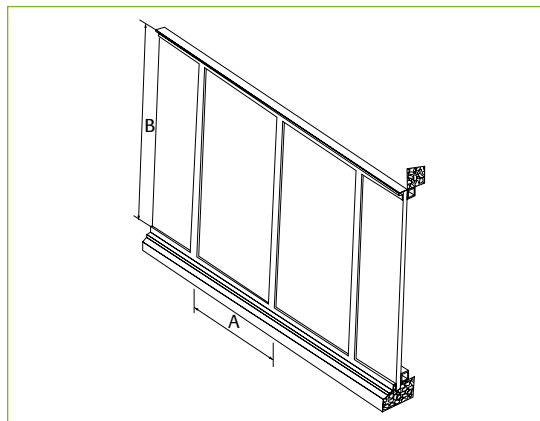
b = sheet length

The major factor determining the sheet deflection behaviour is the distance “a” between the centre points of two adjacent supports. Since any length of sheet can be selected, the measurement “b” does not influence the overall deflection performance.

General Comments

For sloped glazing applications a minimum slope of 5° (9 cm/m sheet length) is advised to allow for rain-water drainage).

Table 19 assumes an edge engagement as indicated in Table 20, page 30, on both edges.



22

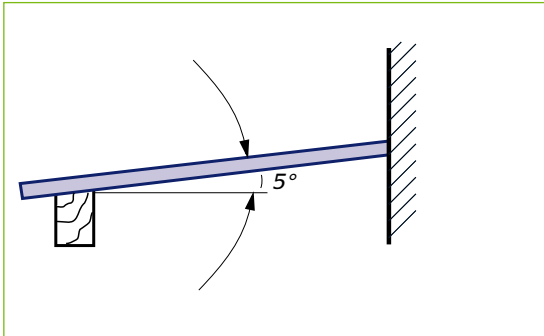
Table 19: Centre to centre distance of glazing profiles (shortest side a)

Lexan® sheet thickness in mm	Ratio sheet width: sheet length																							
	1:1	1:2	1:2	1:1	1:2	1:2	1:1	1:2	1:2	1:1	1:2	1:2	1:1	1:2	1:2	1:1	1:15	1:>15	1:1	1:2	1:2	1:1	1:2	1:2
3	775	600	400	700	550	375	650	500	-	600	450	-	575	400	-	550	-	-	525	-	-	500	-	-
4	1050	800	550	950	700	490	875	650	450	825	600	425	780	550	400	740	500	-	710	475	-	685	450	-
5	1300	975	675	1180	875	625	1100	800	575	1025	750	550	975	700	510	930	670	490	900	625	470	875	560	450
6	1475	1150	800	1375	1010	725	1300	960	680	1225	900	650	1175	850	600	1125	800	575	1075	710	550	1025	650	525
8	1850	1450	1150	1700	1350	1000	1600	1275	925	1525	1200	860	1475	1150	810	1425	1075	775	1375	100	750	1325	950	725
9,5	2050	1600	1300	1950	1475	1150	1850	1400	1075	1750	1350	1025	1675	1300	975	1625	1250	925	1575	200	880	1525	1100	850
12	2050	1750	1500	2050	1700	1400	2050	1600	1325	2050	1525	1275	2000	1475	1225	1950	1450	1175	1875	1400	1125	1800	1350	1075
15																								
Loading in N/m ²	600				800				1000				1200				1400				1600			

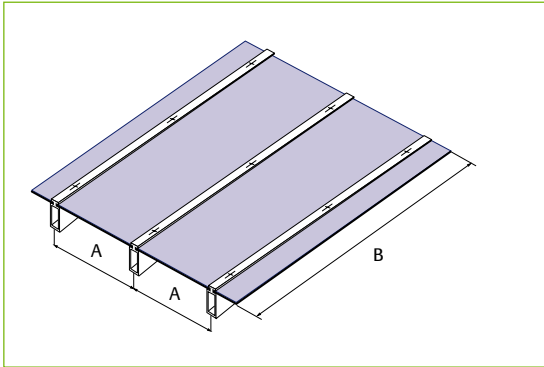
22. Figure 22

Two sides bolted Lexan® sheet

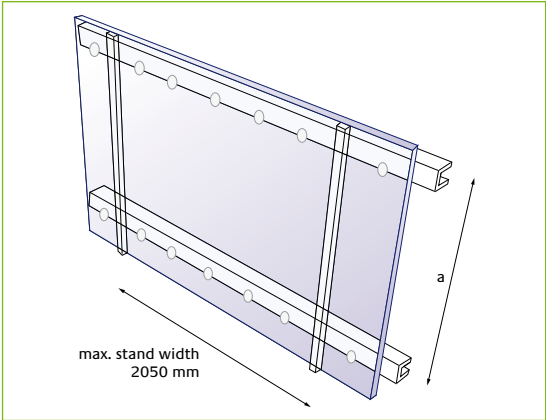
Fastening Lexan® sheet to the intermediate purlins using conventional nuts, bolts and washers is possible. However, all joints and clamping areas require support in the form of compatible rubber washers to distribute the clamping force over as wide an area as possible. Large metal washers laminated with compatible rubber should be used. Bolts should not be tightened so that the force permanently deforms the sheet or restricts its natural expansion and contraction. When using any type of bolt assembly it is important to remember that the spacing between the hole and the sheet edge should be at least two times the hole diameter. To calculate the allowable deflection for both glazings, divide the unclamped sheet side “a” by 20. A maximum deflection of of 50 mm is recommended.



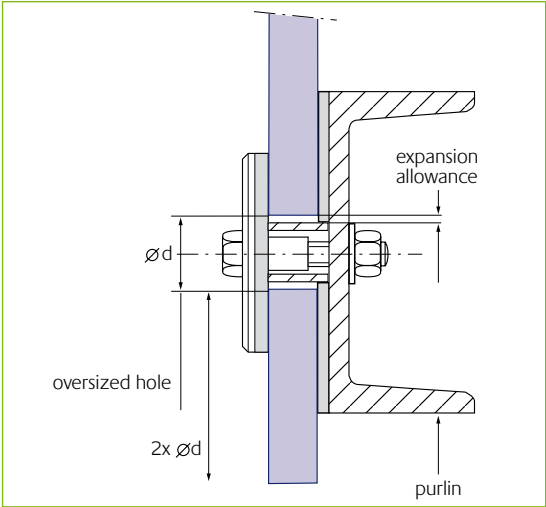
23



24



25



26

23. Figure 23

24. Figure 24

25. Figure 25

26. Figure 26

Table 20:

Lexan® sheet thickness mm	Centre to centre distance glazing profiles “a”							
3	400	375						
4	550	480	425	400	375			
5	620	565	525	495	470	450	430	420
6	750	675	625	595	560	540	510	500
8	1000	900	840	790	750	720	690	660
9.5	1200	1075	1000	930	890	850	820	790
12	1425	1325	1250	1190	1125	1075	1030	1000
15								
Loading in N/m²	600	800	1000	1200	1400	1600	1800	≥2000

With the exception of Lexan® Margard® MR5-E and MRA3, all Lexan® sheet can be successfully cold-curved over curved support glazing profiles, to suit many glazing applications, e.g domes, roof-lights, etc. Providing the radius is not below the minimum recommended value, then the introduced stress by cold-curving will not have any adverse effect upon the mechanical performance of the sheet. Sheets must always be bent longitudinally, never across the width of the sheet. The minimum radius values are outlined below.

Table 21:

Lexan® 9030, 9030 FR thickness in mm	Minimum allowable radius in mm
3	300
4	400
5	500
6	600
8	800
9.5	950
12	1200
15	1500

Table 22:

Lexan® Exell®-D, D ST, D FR and D VEN thickness in mm	Minimum allowable radius in mm
3	525
4	700
5	875
6	1050
8	1400
9.5	950
12	1200
15	1500

Table 23:

Lexan® Margard® FMR5-E thickness in mm	Minimum allowable radius in mm
3	900
4	1200
5	1500
6	1800
8	2400

Note:

Lexan® 9030 and 9030 FR sheet is recommended for internal curved glazing applications only.

Lexan® Exell®-D ST sheet is suitable for curved privacy glazing: stair glazing, balcony glazing. Lexan® Exell®-D, Exell®-D FR, Exell®-D SC IR and Lexan® Exell®-D VEN*) sheet is ideal for external architectural curved glazing applications: skylights, roofing.

*The decorated side of Exell®-D Venetian is not allowed to have contact with UV rays and moist

Lexan® Margard® FMR5 XT is recommended for curved revolving doors, partitions, walkways, etc.

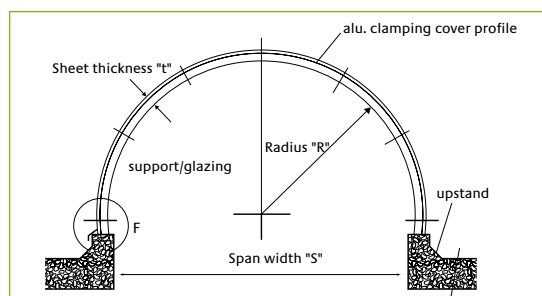
Lexan® Sheet curved glazing using standard metal profiles

this section illustrates the possibilities of curved glazing, combining standard profiles with Lexan® sheet. When specially developed patented glazing systems are not required, good possibilities still exist for Lexan® sheet curved glazing by using standard metal profiles in combination with glazing tapes and non-hardening glazing compounds. See page 15, Table 5 for suitable sealants.

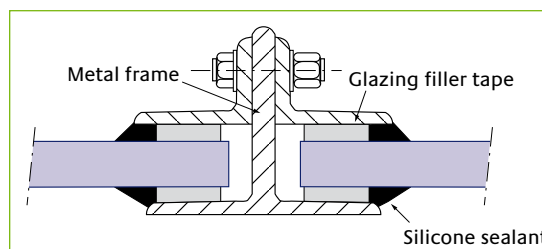
This type of installation system is mainly used in small domestic type applications, carports, warehouses, conservatories and other glass replacement situations.

Lexan® Sheet curved glazing using patented glazing systems

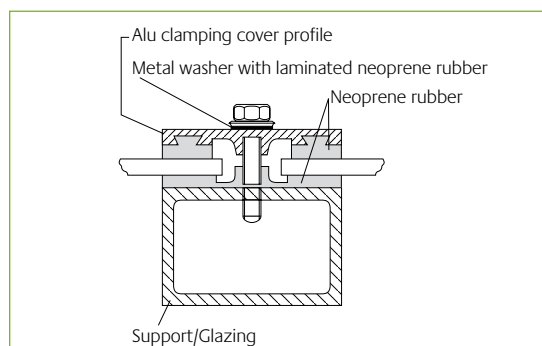
A wide range of patented glazing systems is commercially available. Many of these systems have already proved to be suitable for curved constructions in combination with Lexan® sheet. Through close contact with system manufacturers and professional installers, SABIC Innovative Plastics, Specialty Film & Sheet can advise and assist architects and engineers on the feasibility of a curved design concept with Lexan® sheet in combination with a selected patented glazing system. Metal or wooden structural support bars with a rubber gasket and an aluminium cover clamping strip with integrated rubber gaskets are often used. See page 15, Table 6 for suitable gaskets.



27



28



29

27. Figure 27

28. Figure 28

29. Figure 29

Curved Glazing Sheet Thickness Selection

Curvature, as well as the span and curved profile distance, influence the cylindrical shell behaviour and the buckling load.

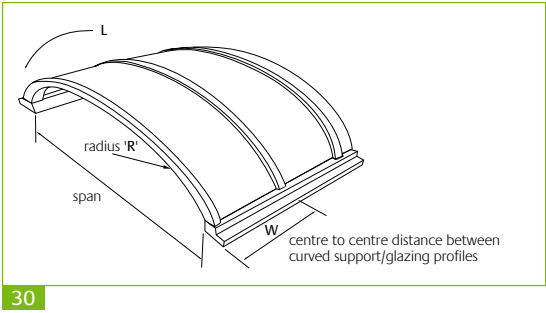
The critical load at which buckling occurs is calculated as a function of the shell geometry and the intrinsic properties of the Lexan® sheet. With reference to the calculated linear buckling load as well as the stability, a safety factor of 1.5 is applied.

In this way correct sheet thickness and dimensions can be calculated under given load situations. The stiffness of Lexan® sheet in curved glazing applications is mainly determined by the radius “R” and the distance “W” between the curved profiles. Sheet length “L” needs to be greater than sheet width “W” to facilitate curvature; in practice, a ratio of 1:2 or less is never contemplated because of the practicalities of installation.

Notes on Table 25

At a specified load the distance between the curved profiles can be found for different sheet thicknesses and radii. In the dark tinted section a maximum standard sheet width of 2.05 m may be used.

The light tinted section indicates that the curvature of relevant sheet thickness at that particular loading does not contribute any more to increased stiffness of the sheet. The stiffness of the sheet can be considered the same as flat sheet, and the last value is therefore applicable for all larger radii.



30. Figure 30

Table 24:

Example:	
Roof-light Radius: 2800 mm	
Loading: 1000 N/m²	
c.t.c. distance curved profiles	Lexan® sheet thickness
400 mm	3 mm
530 mm	4 mm
650 mm	5 mm
1000 mm	6 mm
1950 mm	8 mm

Table 25: Centre to centre distance of curved support/glazing profiles in metres

Lexan® sheet thickness in mm	Radius in metres																					Loading in N/m²		
		0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4			
	3	2.05	1.83	1.26	1.0	0.8	0.7	0.55	0.48	0.40														600
	4			2.05	2.0	1.62	1.35	1.15	0.97	0.85	0.75	0.68	0.6	0.55										
	5						2.05	1.98	1.68	1.45	1.3	1.15	1.03	0.95	0.88	0.8	0.74	0.68	0.63					
	6									2.05	2.0	1.8	1.6	1.46	1.34	1.24	1.14	1.05	1.0	0.9	0.85			
	8																	2.05	1.9	1.82	1.7			
	3	2.05	1.34	0.98	0.76	0.6	0.5	0.44																800
	4		2.05	1.95	1.50	1.2	1.0	0.86	0.75	0.65	0.58	0.53												
	5					2.05	1.75	1.48	1.26	1.1	0.98	0.88	0.8	0.73	0.67	0.6	0.56							
	6							2.05	1.95	1.72	1.52	1.36	1.22	1.12	1.02	0.95	0.87	0.8	0.75					
	8													2.05	2.0	1.85	1.72	1.6	1.5	1.4	1.3			
	3	1.60	1.1	0.8	0.6	0.5	0.4																	1000
	4		2.05	1.58	1.25	0.98	0.82	0.7	0.6	0.53														
	5				2.05	1.65	1.38	1.18	1.02	0.9	0.8	0.72	0.65	0.6										
	6						2.05	1.87	1.58	1.37	1.22	1.1	1.0	0.9	0.8	0.77	0.7							
	8											2.05	1.95	1.8	1.63	1.5	1.4	1.3	1.2	1.13	1.06			
	3	1.40	0.9	0.66	0.52	0.42																		1200
	4	2.05	1.88	1.36	1.02	0.83	0.7	0.6	0.5															
	5			2.05	1.78	1.43	1.2	1.0	0.86	0.76	0.67	0.6												
	6					2.05	1.80	1.53	1.32	1.16	1.03	0.93	0.85	0.77	0.7									
	8										2.05	1.85	1.66	1.50	1.38	1.28	1.17	1.1	1.02	0.96	0.9			
	3	1.25	0.8	0.58	0.45																			1400
	4	1.9	1.67	1.13	0.9	0.71	0.6	0.5	0.45															
5			2.05	1.54	1.22	1.0	0.86	0.75	0.66	0.6														
6				2.05	1.96	1.59	1.34	1.15	1.0	0.9	0.8	0.7												
8									2.05	1.78	1.58	2.43	1.32	1.2	1.1	1.02	0.95	0.9	0.8					
3	1.02	0.7	0.51	0.4																		1600		
4	1.65	1.36	1.0	0.8	0.64	0.53	0.45																	
5		2.05	1.7	1.32	1.07	0.9	0.8	0.66	0.6															
6				2.05	1.66	1.38	1.17	1.0	0.9	0.8	0.7													
8								2.05	1.75	1.57	1.42	1.27	1.15	1.06	1.0	0.9	0.85	0.8						
3	0.9	0.6	0.45																			1800		
4	1.5	1.22	0.92	.07	0.57	0.47																		
5		2.05	1.52	1.2	1.0	0.8	0.7	0.6																
6			2.05	1.82	1.47	1.23	1.04	0.9	0.8	0.7														
8							2.05	1.85	1.6	1.4	1.25	1.15	1.05	0.95	0.9	0.8								
3	0.84	0.56	0.42																			2000		
4	1.35	1.12	0.82	0.64	0.51	0.43																		
5	2.05	1.8	1.4	1.1	0.9	0.7	0.62																	
6			2.05	1.68	1.35	1.12	0.96	0.83	0.7															
8						2.05	1.9	1.6	1.45	1.27	1.14	1.03	0.94	0.86	0.8									

Loading in N/m²

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