



# Lexan\* Polycarbonate sheets for sound screens

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## Noise pollution

Noise may not seem as harmful as the contamination of air or water, but it is a pollution problem that affects human health and can contribute to a general deterioration of environmental quality.

Noise is undesirable and unwanted sound. Not all sound is noise. What may be considered as music to one person may be noise to another! It is not a substance that can accumulate in the environment like most other pollutants. Sound is measured in a unit called the 'decibel' (dB).

There are several sources of noise pollution that contribute to both indoor and outdoor noise pollution. Noise emanating from factories, vehicles, and playing of loudspeakers during various festivals can contribute to outdoor noise pollution, while loudly played radio or music systems, and other electronic gadgets can contribute to indoor noise pollution. A study conducted by researchers from the New Delhi-based National Physical Laboratory show that noise generated by firecrackers (presently available in the market) is much higher than the prescribed levels. The permitted noise level is 125 decibels, as per the Environment (Protection) (second amendment) Rules, 1999.

The differences between sound and noise is often subjective and a matter of personal opinion. There are, however, some very harmful effects caused by exposure to high sound levels. These effects can range in severity from being extremely annoying to being extremely painful and hazardous.

### Decibel levels of common sounds

dB	Environmental Condition
0	Threshold of hearing
10	Rustle of leaves
20	Broadcasting studio
30	Bedroom at night
40	Library
50	Quiet office
60	Conversational speech (at 1m)
70	Average radio
74	Light traffic noise
90	Subway train
100	Symphony orchestra
110	Rock band
120	Aircraft takeoff
146	Threshold of pain

## Effects of noise pollution

**Physical health.** The most direct harmful effect of excessive noise is physical damage to the ear and the temporary or permanent hearing loss often called a 'temporary threshold shift' (TIS). People suffering from this condition are unable to detect weak sounds. However, hearing ability is usually recovered within a month of exposure. In Permanent loss, usually called 'noise-induced permanent threshold shift' (NIPTS) represents a loss of hearing ability from which there is no recovery.

Below a sound level of 80 dB hearing loss does not occur at all. However, temporary effects are noticed at sound levels between 80 and 130 dB. About 50% of the people exposed to 95 dB sound levels at work will develop NIPTS and most people exposed to more than 105 dB will experience permanent hearing loss to some degree. A sound level of 150 dB or more can physically rupture the human eardrum.

The degree of hearing loss depends on the duration as well as the intensity of the noise. For example, 1 hour of exposure to a 100 dB sound level can produce a TIS that may last for about one day. However, in factories with noisy machinery, workers are subjected to high sound levels for several hours a day.

Exposure to 95 dB for 8 hours everyday for over a period of 10 years may cause about 15 dB of NIPTS. In addition to hearing losses, excessive sound levels can cause harmful effects on the circulatory system by raising blood pressure and altering pulse rates.

**Mental health.** Noise can also cause emotional or psychological effects such as irritability, anxiety and stress. Lack of concentration and mental fatigue are significant health effects of noise. It has been observed that the performance of school children is poor in comprehension tasks when schools are situated in busy areas of a city and suffer from noise pollution.

As noise interferes with normal auditory communication, it may mask auditory warning signals and hence increases the rate of accidents especially in industries. It can also lead to lowered worker efficiency and productivity and higher accident rates on the job.

Thus, noise is just more than a mere nuisance or annoyance. It definitely affects the quality of life. It is therefore important to ensure the mitigation or control of noise pollution.

## Permitted noise levels

Ambient Noise Levels dB Zone	Day-time	Night-time
Silent Zone	50	40
Residential Zone	55	45
Commercial Zone	65	55
Industrial Zone	70	70

A standard safe time limit has been set for exposure to various noise levels. Beyond this 'safe' time continuing exposure over a period of a year will lead to hearing loss.

Duration	dB
8 hrs	90
4 hrs	93
2 hrs	96
1 hr	99
30 min	102
15 min	105
7 min	108
4 min	111
2 min	114
1 min	117
30 sec	120
Instantaneous rupture of membrane	150

## One of the technique to reduce the noise: Sound walls

- Can reduce the loudness of traffic noise by as much as half
- Do not completely block traffic noise
- Can be effective
- Must be tall and long with no openings
- Are most effective within 61 meters of a highway
- Must be designed to be visually appealing
- Must be design to preserve aesthetic values and scenic vistas
- Substantially reduce noise levels for people living next to highways

**Legislation for noise abatement is already in place in certain parts of Europe!**

## What type of material?

•Noise barriers can be constructed from:

- Earth
- Concrete
- Masonry
- Wood
- Metal
- Glass, Plastics, etc...



•Selection is made considering the following factors:

- Aesthetics'
- Durability
- Maintenance
- Cost
- Desires of public



**Sabic IP provides : The toughest transparent alternative!**

## Polycarbonate sheets for sound screens

**Airports**



**Roadways**

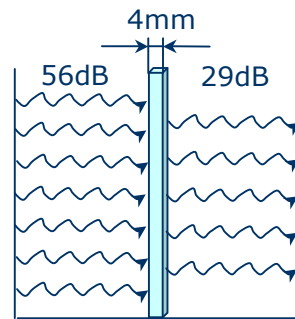


**Railways**

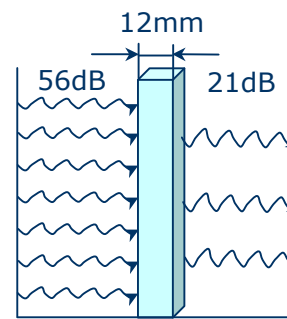


## Lexan\* sound walls

The acoustic properties of ExelD and Margard sound screens have been proven in applications all over the Europe



Thin sheet  
10-30% sound absorption



Thick sheet  
70-90% sound absorption

## Sound wall and Product Requirements

### Sound wall Requirements

**Structural Strength**

**Low Deflection Under Wind-load**

**Long Service Time**

**Resistance To Vandalism**

**Safe**

**Quiet Living Environment**

**Aesthetical good solution**

**Transparent**



### Product Features

**Stiffness**

**Easy Graffiti Removal**

**Impact Resistance**

**Transparency**

**Excellent Sheet Dioptry**

**Sound Absorption**

**Flame retardant**

**Understand the real requirements of life**

## Overview Lexan\* Sheets for Sound walls

**Lexan\* ExelID (Soundglaze)**

**Lexan\* MRX (Soundglaze SC), MR5E**

**Lexan\* Soundglaze Birdstripes**

=

**Lexan\*  
Polycarbonate  
Base Sheet**

+

**Surface Finishes**

- Optical Clarity
- Flame Retardancy
- Impact Resistance

- Abrasion resistance
- UV protection
- Chemical Resistance

**Both Base Sheet And The Surface Treatment Make The Difference**

## General Properties Lexan\* Polycarbonate Sheet

Specific Gravity (DIN 53479)	1.2	[kg/dm3]	} <b>Light Weight</b>
Tensile Modulus (DIN 53457)	2300	[N/mm2]	
Tensile Strength at yield (Din 53455)	60	[N/mm2]	} <b>High Energy Absorption</b>
Charpy Impact Notched (ISO179)	> 35	[KJ/m2]	
Vicat B120 Softening Temperature (DIN 53640)	145	[DegC]	} <b>Temperature Resistance</b>
Continuous Use Temperature	120	[DegC]	
Oxygen Index ASTM D2863	25	[%]	} <b>Safe Fire Behavior</b>

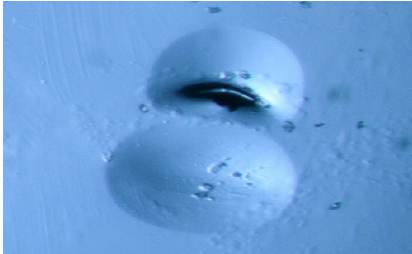
**The Light and Tough Alternative**

# Optical properties

## Optical Quality

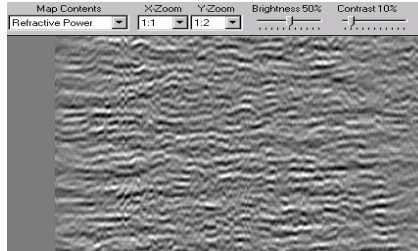
### Discrete Defect

- Microscopic Particles
- Gels (unmolten PC)
- Black Spec (burnt PC)
- Inclusion (foreign particle)



### Continuous Defect

- Extrusion Process (Wavelike Defects)
  - ripple
  - distortion



Sabic-IP SFS strives towards continuous reduction of discrete and continuous defects.

The base sheets for our sound wall products are produced under clean room conditions to reach optimal quality

## Light Transmission

Light Transmission is the [%] of visible light that get transmitted through the sheet. Typical values are:

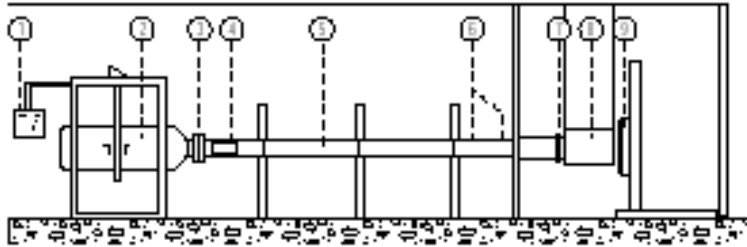
- Lexan\* Sheet Transparent (112): 88%
- Lexan\* Sheet Bronze (5109): 50%
- Light transmission of Lexan\* sheet is comparable to acrylic and glass

**Optical Quality That Ensures A Clear View**

# Impact Resistance

## Projectile Impact Testing (prEN 12415)

Shooting equipment for prEN 12415 test



The test is aimed at reproducing that hazard that occurs when parts fly at high speed into Lexan\* sheet.

A 12 [mm] Lexan\* sheet can withstand a projectile of 2.5 [kg] impacting at a speed of 63 m/s (225 km/h)

Lexan sheet thickness	9,5 mm	12 mm
Projectile dimensions in mm (DxL)	30x114x19	50x164x30
Projectile mass	0,625 kg	2,5 kg
Projectile speed	80 m/s	63 m/s
Shock energy	2000 J	4960 J

## Charpy Notched Impact Strength (ISO 179/2C)

The charpy notched impact strength for various materials was tested at room temperature.

Lexan\* sheet behaves ductile whereas glass and acrylic behave brittle. Lexan\* sheet has by far the highest Energy absorption.

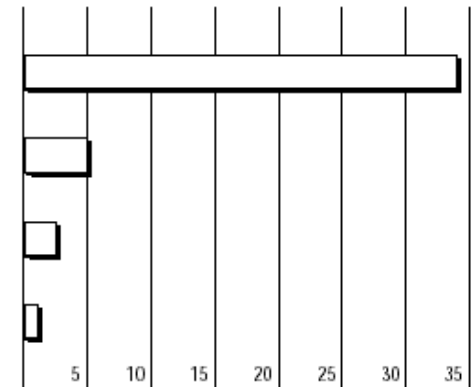
Lexan\* sheet retains the majority of its impact strength for a wide Temperature range of -30 [DegC] up to 120 [DegC]

Lexan\* Sheet -----

High Impact Acrylic ----

Standard Acrylic -----

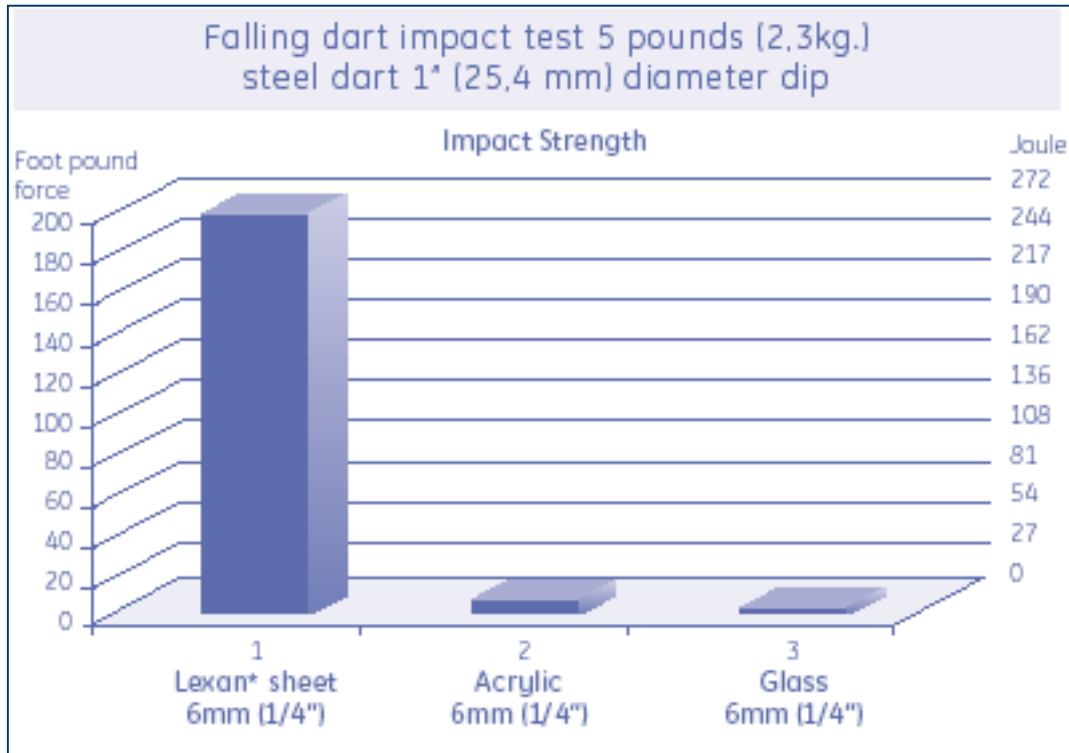
Glass -----



→ Notched Impact Strength [KJ/m2]

## Impact resistance

### Falling dart impact test



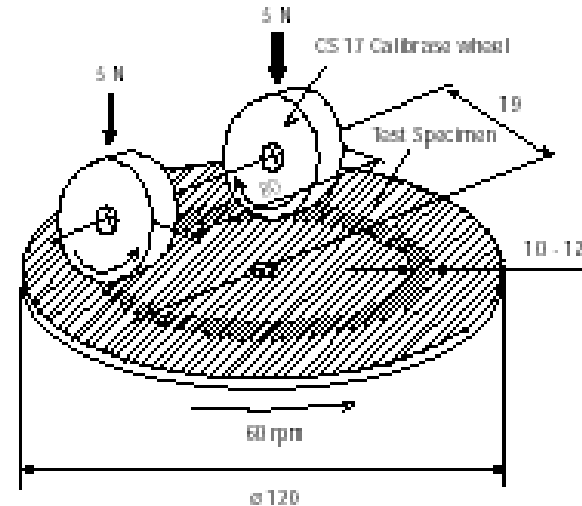
**Virtually unbreakable**

# Abrasion Resistance

## Taber Abrasion Test

Sabic-IP measures [%] Haze after 500cycles, the test is similar to DIN 52347 / ISO3537 / ASTM D1044

The % Haze means the loss of light transmission versus the light transmission of a normal PC sheet (~90 %).



## Laboratory Test To Simulate Outdoor Environment

## Weathering performance

- Solar radiation initiates degradation through superficial surface crazing and these micro crazes become sites for further erosion from water, dust, chemicals, etc
- The degree to which these conditions affect the polymer depends largely upon environmental parameters such as : geographical location, altitude, seasonal variation, etc.
- All Lexan Sheet products, for the building and construction market, have proprietary UV protected surfaces, giving excellent resistance to outdoor weathering and ensures long term optical quality and maintains the superior toughness and impact strength.
- In order to prove effective UV protection, Sabic-IP Technology performs artificial weathering, correlated to real life outside exposure.

### **Accelerated weathering test according ISO 11341**

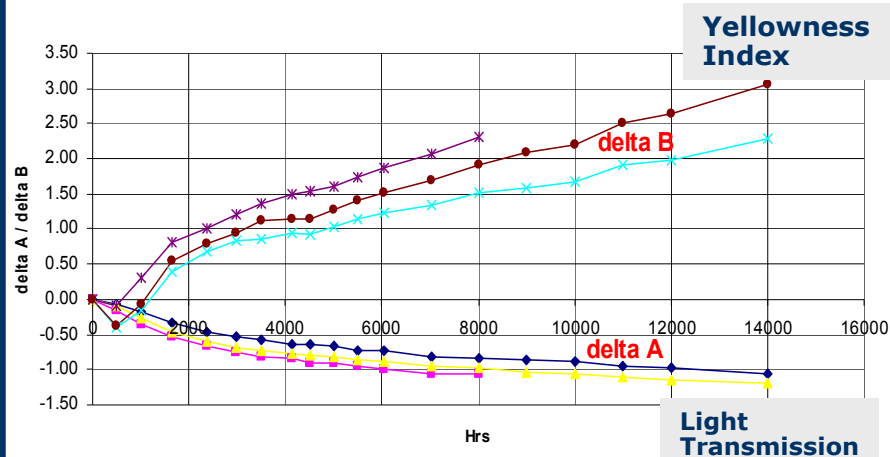
- Light source: Xenon radiation  
— 300 – 400nm – 50 W/m<sup>2</sup>
- Black panel temperature: 65 °C
- Chamber temperature: 40 °C
- Relative humidity: 70 %
- Cycle UV light: constant light
- Water spray on/off  
— 18 min. on / 102 min. off

**800 hours in the UV apparatus is equivalent to about 1 year outdoor exposition (45° south) in a moderate climate.**

**Sabic-IP SF&S Lexan\* sheets products for building and construction applications are backed by a limited written warranty covering: discoloration, loss of light transmission, loss of strength.**

## Weathering performance

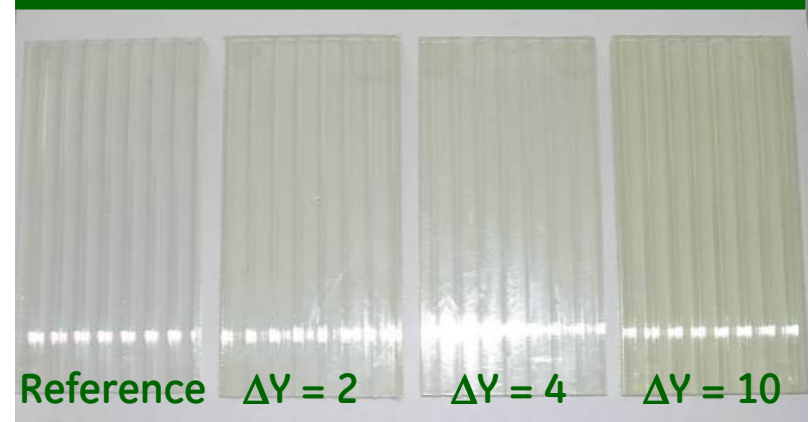
### Xenon accelerated weathering test ISO 11341 Lexan ExelID 6mm



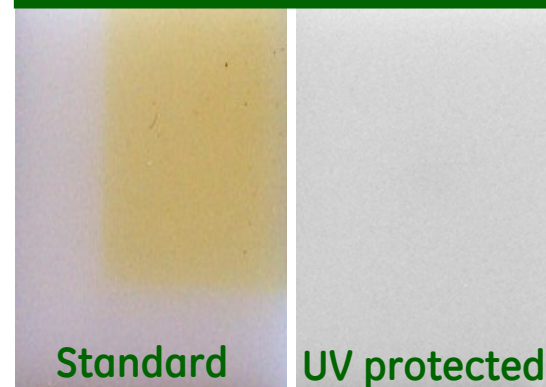
**Delta B: delta yellowing after 14000 hours (17.5 years) +/- 3**

**Delta A: loss of light transmission after 14000 hours (17.5 years) +/- 1.5 %**

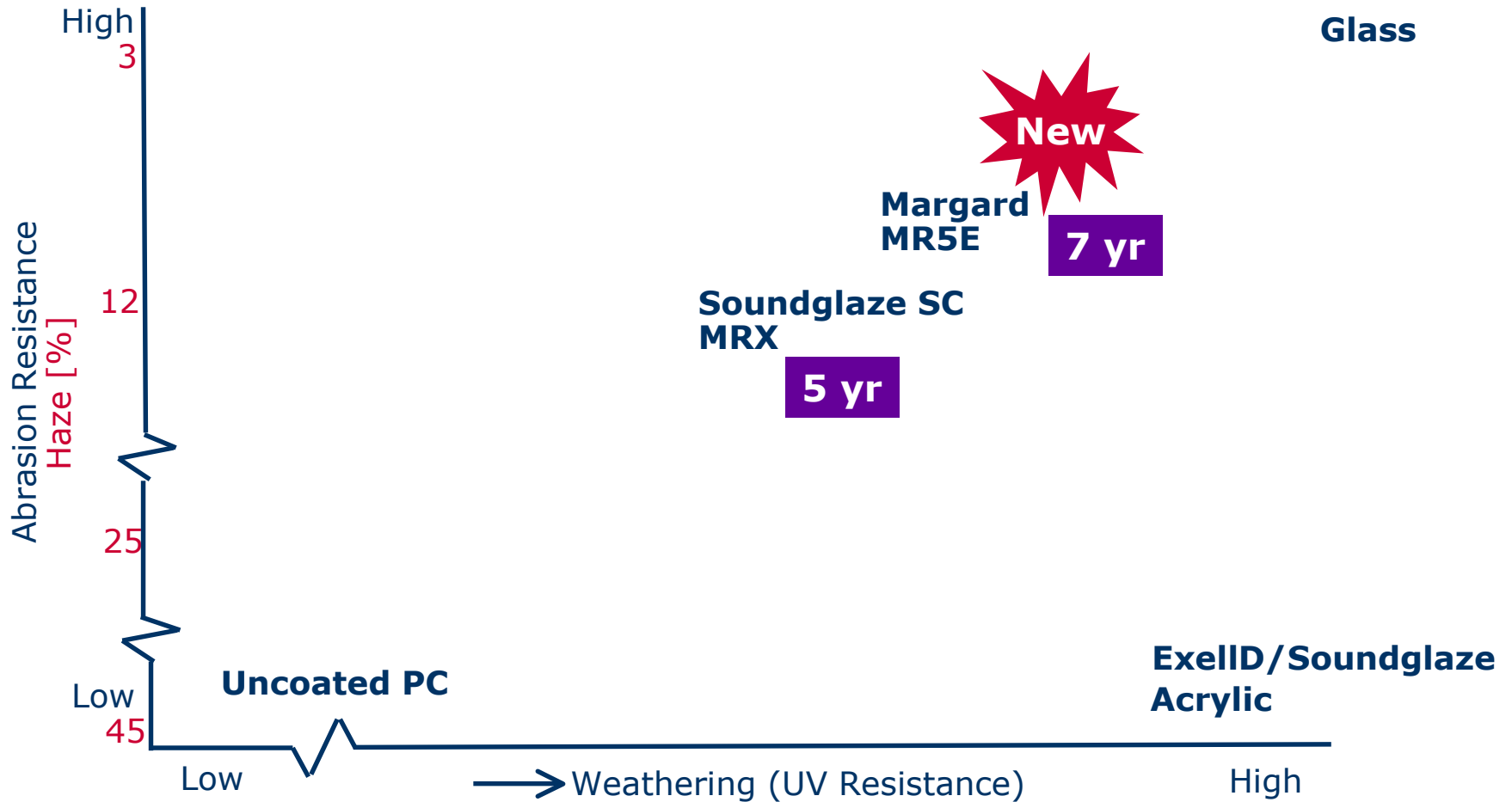
### Transparent Lexan\* sheet



### Opal white Lexan\* sheet



## Abrasion Resistance & Weather-ability



## Combining Abrasion Performance and Resistance to Yellowing

# Chemical Resistance / Cleaning

## Chemical Resistance

Chemical	Uncoated	Coated
Toluene	W/S	OK
Acetone	S	OK
Methylethylketone	S	OK
Dichloromethane	W/S	OK
Sulfuric acid (95%)	OK	OK
Hydrochloric acid (32%)	OK	OK
Ammonia (25%)	OK	OK
Thinners (Sikkens1-2-3)	W/S	OK
Super Gasoline (Esso)	W/S	OK
Diesel fuel ( Esso)	OK	OK

Key: W = Surface whitening S=Surface dissolution

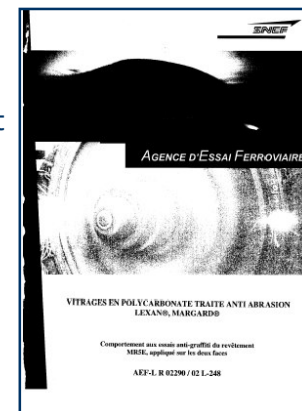
Note: This information applies to Margard\* MR5E/MRX/SoundglazeSC.

## Graffiti Resistance

The SNCF (French Railways) Have tested Lexan\* Margard Sheet on its resistance against graffiti

Sheet were cleaned with three commonly used cleaning agents for removal or graffiti.

**Report Conclusion:** graffiti could be successfully removed with without damaging the margard coating



AEA TECHNOLOGY

Onderzoek Lexan Margard MR5E

Opdrachtgever: : General Dutch Plastic

Referentie: : Y11475

Formaat: : A4 (210x297) mm

Opdracht: : Onderzoek Lexan Margard MR5E

Opdrachtgever: : General Dutch Plastic

Projectnummer: : 1000000

Datum: : maart 2005

## Use In Railway Environment

AEA Technology has tested Lexan soundglaze SC at Utrecht Central station. The material was tested against graffiti and material deposition of breaking trains.

**Report Conclusion:** Lexan\* Soundglaze SC Sheet can be used as sound walls in the harsh railway environment. The cleanability is good

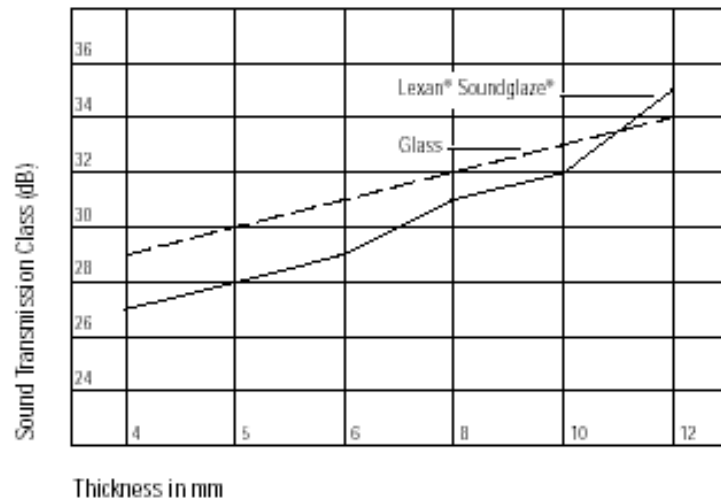
# The Margard\* Hard Coatings are a barrier against chemicals

## Sound Muffling Performance (1)

### 1 Acoustic insulation DIN 52210-75 $R_w$ (dB)

Sheet thickness	8 mm	9,5 mm	12 mm
Lexan	31 dB	32 dB	35 dB
Glass	32 dB	33 dB	34 dB

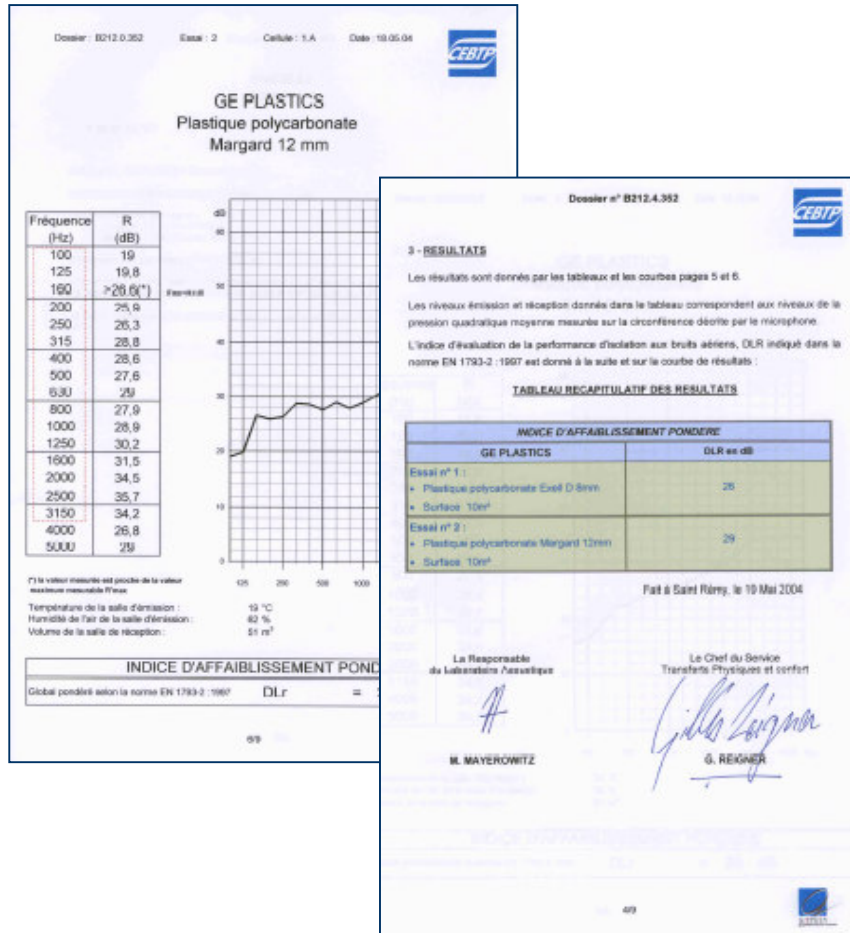
### 2 Influence of Sheet Thickness on STC (dB) ISO 717 / DIN 52210 test method



- Tests have been carried out to determine sound reduction properties of Lexan\* polycarbonate sheet.
- [Picture 1&2](#) provide a comparison on the acoustic insulation provided by glass and Lexan\* at equal gauges
- At gauges between 8 and 12 [mm] equal performance is observed.
- At 12 [mm] gauge Lexan\* Sheet provides 35 [dB] acoustic insulation.

**Lexan\* Sheet has a better sound insulation at 12mm comparing to 12mm glass**

## Sound Muffling Performance (2)



### Testing at CEBTP

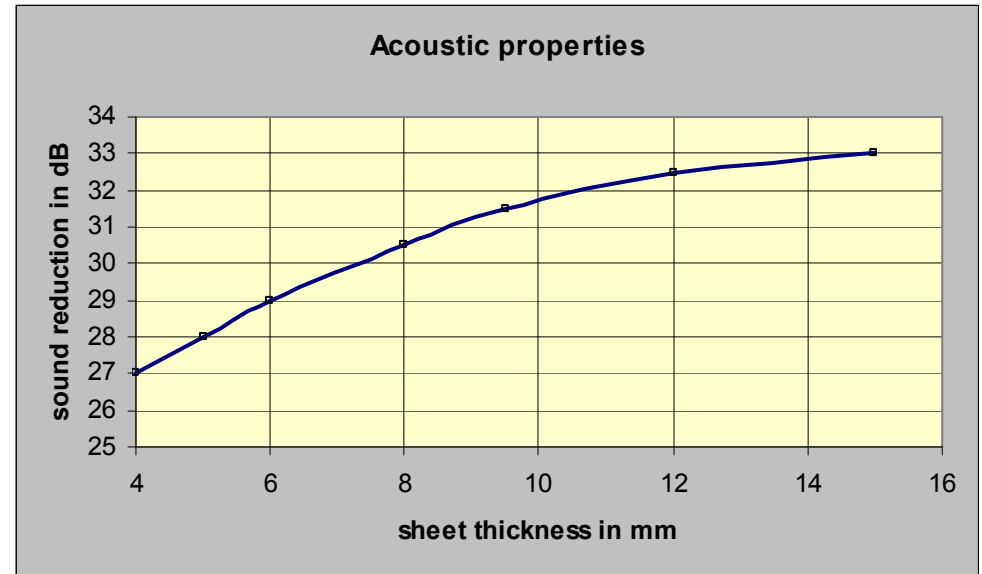
- Lexan\* Sheets were tested at the CEBTP (French Research Center for Building and Construction and Civil Works
- The sheet were tested against the NF EN ISO 140-3 and EN-ISO 717-1 procedures as defined in the EN 1793-2 Sound Insulation.
- For 8 and 12 mm gauges the respective sound reduction values of 26 and 29 were obtained

**Official Certificate: 29 dB Sound Reduction at 12mm gauge .**

## New 15 mm Lexan sheet

### Available in 9030 and ExelID grades

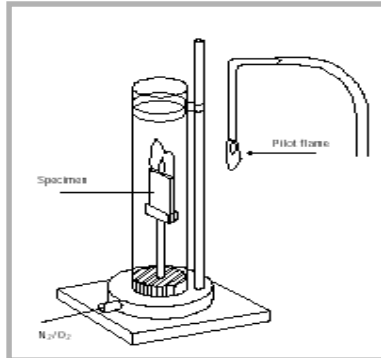
- Complete portfolio with respect to gauges
- Excellent choice for variety of applications in Industry as well as B&C market segment
  - Sound walls
    - Improved sound absorption
    - Allows more distance between pillars
    - Can be used as direct replacement of acrylic screens
  - Machine guards
    - Higher energy absorption
- **Exell-D A4 samples available at service centre .**
- **MOQ = 2 pallets**



**New 15 mm!**

# Flammability (1)

## Test Oxygen Index



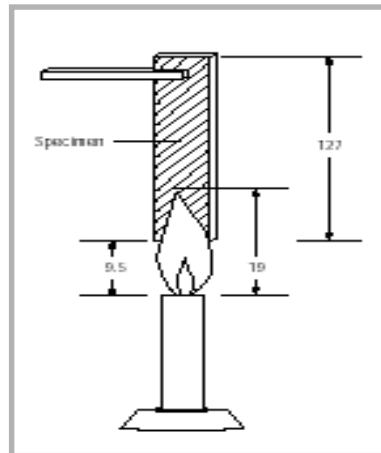
## Limited Oxygen Index Description (ISO4589 (ASTM D2863))

- The oxygen index represents the minimum level of oxygen in the atmosphere which can sustain flame on a thermoplastic material. The Limited Oxygen Index or LOI is defined as the minimum oxygen concentration in which the material will burn for three minutes or can keep burning over a distance of 50 [mm]

- LOI Lexan\* sheet: 25 [%]
- LOI Acrylic sheet: 18 [%]

- Air contains only 20 [%] oxygen. Lexan\* sheet requires more oxygen than available in air to contribute to flame spread.

## Test UL94



## UL94 Test Description

- The UL94 test describes a materials ability to extinguish a flame once ignited. Ratings are based on the burning rate, time to extinguish and dripping behavior. The ratings are dependent on gauge

- **V0**: burning stops in 10 seconds, no drips allowed
- **V1**: burning stops in 30 seconds, no drips allowed
- **V2**: burning stops in 30 seconds, drips allowed

- Lexan\* Sheet **V0** at 6 [mm] (transparent)

**Lexan\* Polycarbonate Contributes To Flame Spread Control**

## Flammability (2)



The Netherlands – location: Dordrecht A-16 the main motorway between the ports of Rotterdam and Antwerp the material burning is acrylic sheet; the acrylic material costs was not even Eur 50K, damage > Eur 500K.

**The Acrylic sheets were replaced by Lexan MR5E polycarbonate sheet!**



- Lexan\* sheet is classified as self extinguishing and will not contribute to fire propagation

- Fire classification

- France NFP92-501/505 – M1 / M2
- Germany DIN 4102 part 1 – B1 /B2
- Italy UNI 9174 - Class 1 /2
- United Kingdom BS476 PART7 Class 1y / 2 y
- Netherlands NEN6065 – Class 1 / 2

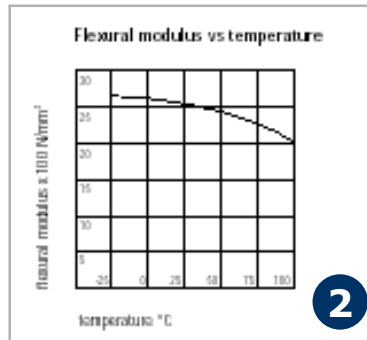
**Lexan\* sheet is classified as self extinguishing and will not contribute to fire propagation**

# Sheet stiffness & behavior under Wind Loads

wind loading 1000 N/m <sup>2</sup>		
Sheet thickness	Width	Height
8 mm	1600 mm	2000 mm
8 mm	1500 mm	2500 mm
8 mm	1400 mm	> 3000 mm
9,5 mm	2000 mm	2000 mm
9,5 mm	1750 mm	2500 mm
9,5 mm	1650 mm	> 3000 mm
12 mm	2000 mm	> 3000 mm

wind loading 1500 N/m <sup>2</sup>		
Sheet thickness	Width	Height
8 mm	1400 mm	2000 mm
8 mm	1300 mm	2500 mm
8 mm	1200 mm	> 3000 mm
9,5 mm	1700 mm	2000 mm
9,5 mm	1600 mm	2500 mm
9,5 mm	1500 mm	> 3000 mm
12 mm	2000 mm	2000 mm
12 mm	1900 mm	2500 mm
12 mm	1800 mm	> 3000 mm



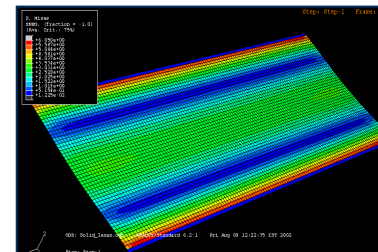
Maximal continuous use temperature according UL746B: -40°C till + 120°C

Lexan\* sheet products retain 85% of their stiffness at 82°C

1

## Deflection under wind loads

- Picture 1 provides the maximum sheet sizes allowed for two wind loads (1000 and 1500 N/m<sup>2</sup>) at which the sheet center will not deflect more than 50 mm
- This results are valid when the sheets are clamped at four sides with an overlap of 25 mm
- A major advantage of Lexan\* sheet is it's stiffness retention at higher temperatures. At 100 °C 80% of the original stiffness at room temperature remains. See picture 2.
- For specific designs, simulations can be made to estimate deflection and stress in the sheet. For an example see picture 3.



**Lexan sheets are stiff even at higher temperatures**

## Cold curving and line bending



**Cold line bending process**



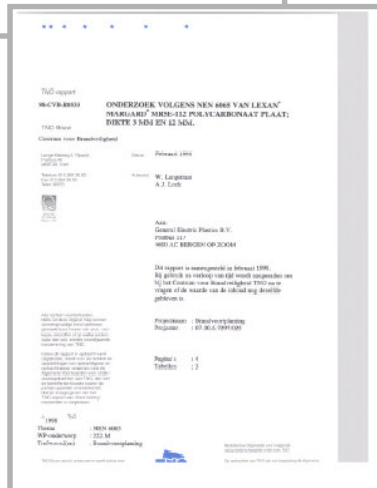
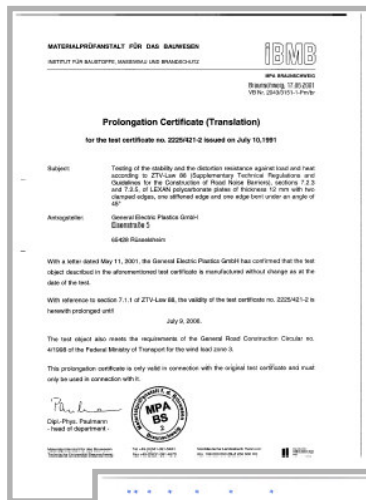
**Sound barriers**



## Comparison with other transparent sound wall materials

Properties	Lexan ExelID (Soundglaze)	Lexan Margrd MR5E, MRX (Soundglaze SC)	Acrylic	Glass
Light weight	++	++	++	-
Optical quality	++	++	++	+++
Impact resistance	+++	+++	- for HI: +/-	--
Chemical resistance	+/-	++	+	+++
Graffiti removal	-	++	-	+++
Resistance to yellowing	+	+	++	+++
Railway applications	No	Yes	No	Yes
Flammability	++	++	-	+++
Cold bending	Yes	Yes	Yes	No
Curved surfaces	Yes	Minimal	Yes	No
Price/kg	+	+/-	+	++
Max thickness (mm)	15	15, MR5E: 12	> 15	> 15
Max size (mm)	2050 x 6050	2000 x 3000	2000 x 4000	Larger

# Certification



## Soundwall Specific Certifications

IBMB extension cert. valid till 09/07/06, for original cert. 2225 / 421-2, covering stability & shape under heat & load testing for ZTV-Lsw 88 parts 3 / 4 tested on 12 mm Lexan® sheet, clamped on two sides, and one side with a 45 degree bend.

IBMB extension valid till 09/07/06, for original cert. 2225 / 421-3, covering stability & shape under heat & load testing versus ZTV-Lsw 88 parts 7.2.3 / 4 tested on 12 mm Lexan® sheet, clamped on two sides, and one side with a stiffener bar 500 mm from the top edge.

IBMB extension valid till 09/07/06, for original cert. 2225 / 421-4, covering stability & shape under heat & loading testing for ZTV-Lsw 88 parts 7.2.3 / 4 tested on 12 mm Lexan® sheet, clamped on two sides and one side with a stiffener bar 1000 mm from the top edge.

ALU cert. 1040/3/83/91 of 02/05/91 covering sound reduction properties for ZTV-Lsw 88 part 7.2.1 tested on 12 mm Lexan® sheet.

## Nen6065: Flammability

- Lexan\* Margard\* Sheets were tested class 2 for gauges 3-12 [mm]

## Product Availability & Warranties

### Lexan\* ExelID (Soundglaze)

<b>Description</b>	PC Sheet, 2-sides UV Caplayer
<b>Gauges</b>	8/9.5/12/15 mm
<b>Sizes</b>	Max. 2 x 6 m
<b>Colors*</b>	Transparent (112), Bronze (5109)
<b>Limited Warranty</b>	Delta Yellowness Index <12 after 10 years Retention of Impact Strength after 10 years

### Lexan\* MRX (Soundglaze SC)

<b>Description</b>	PC Sheet, 2-sides Hard Coating
<b>Gauges</b>	8/9.5 /12/ 15 mm
<b>Sizes</b>	Max. 2 x 6 m
<b>Colors*</b>	Transparent (112), Bronze (5109)
<b>Limited Warranty</b>	Delta Yellowness index < 10 after <b>5 years</b> Retention of Impact Strength after 10 years

\*Special colors available on request

### Lexan\*Margard MR5E

<b>Description</b>	PC Sheet, 2sides Hard Coating
<b>Gauges</b>	8/9.5/12 mm
<b>Sizes</b>	Max. 2 x 3 [m]
<b>Colors*</b>	Transparent (112), Bronze (5109)
<b>Limited Warranty</b>	Delta Yellowness index < 10 after <b>7 years</b> Retention of Impact Strength after 10 years

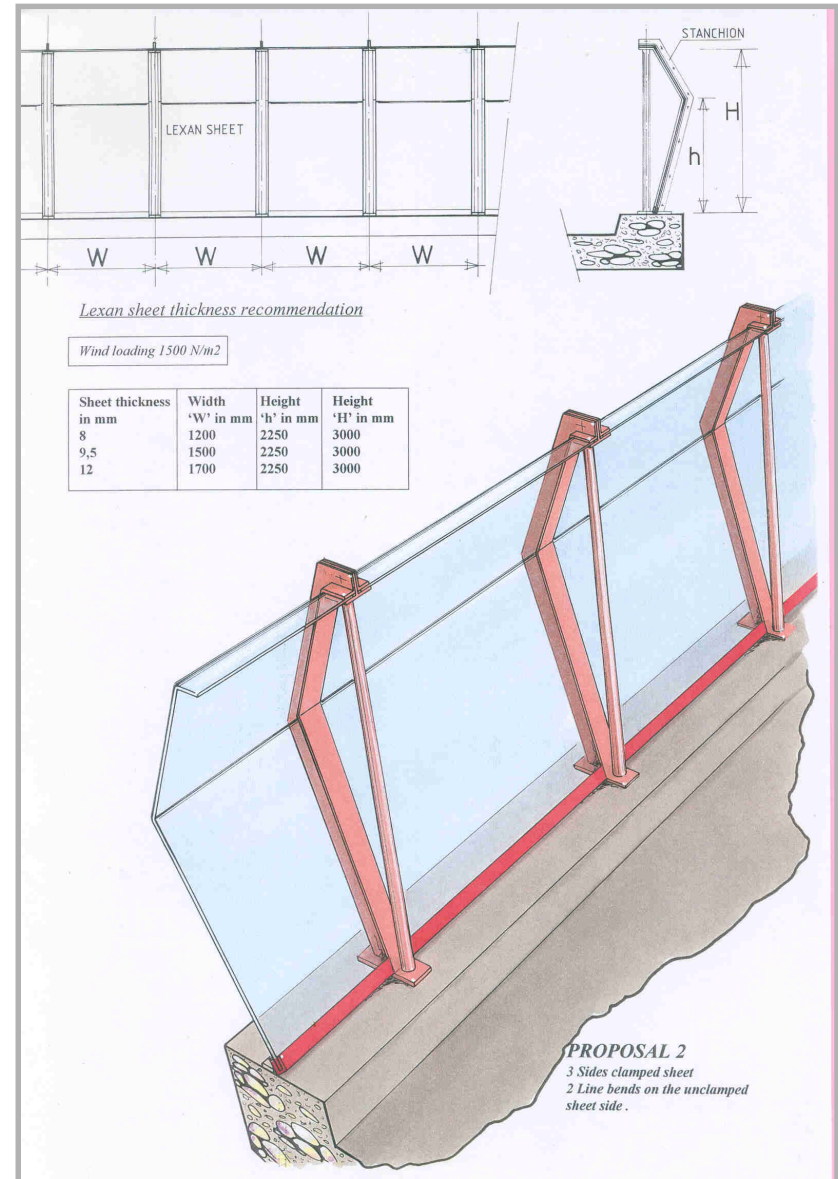
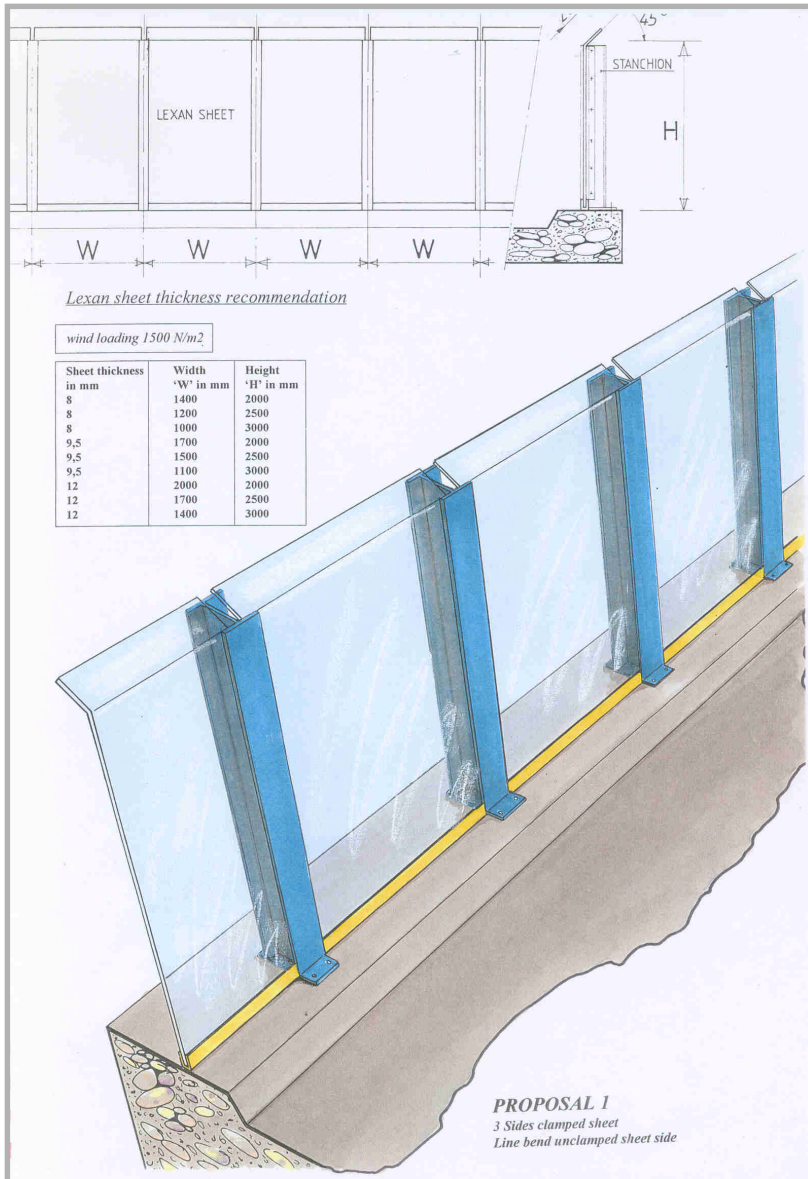
**Products backed up by warranties**

## Application Examples



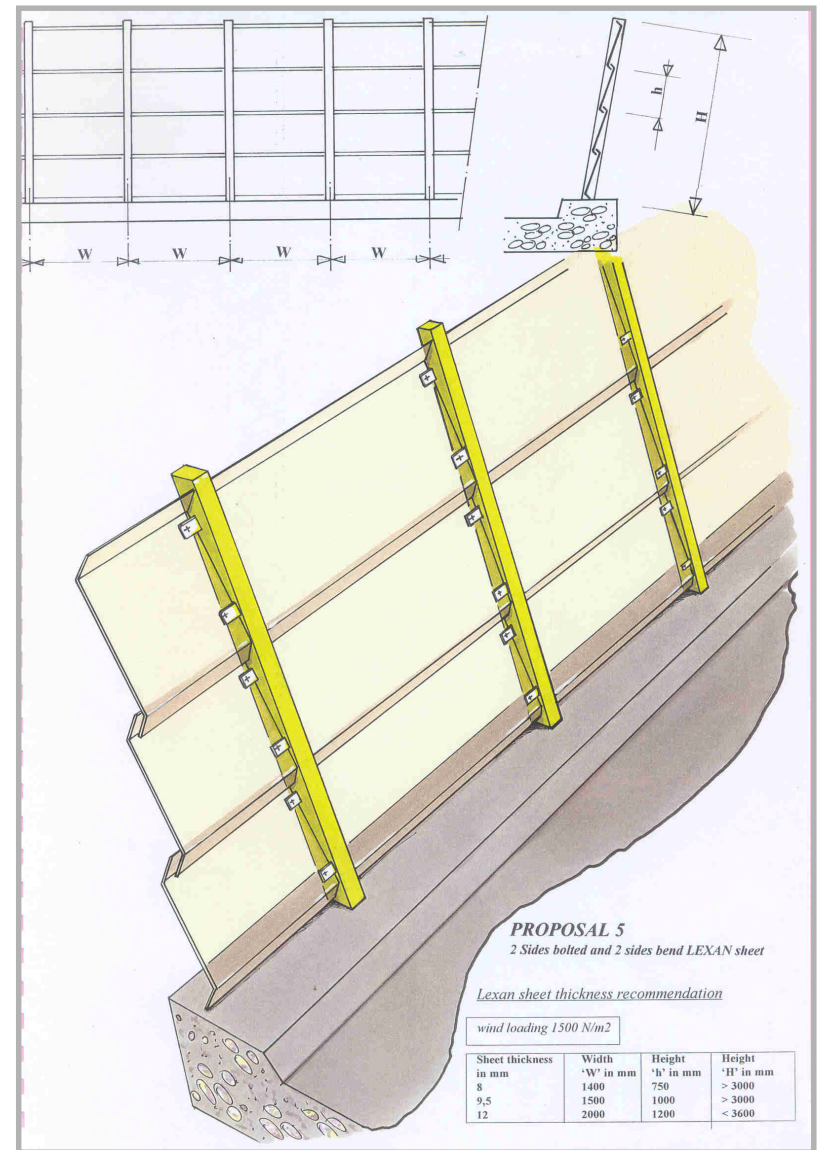
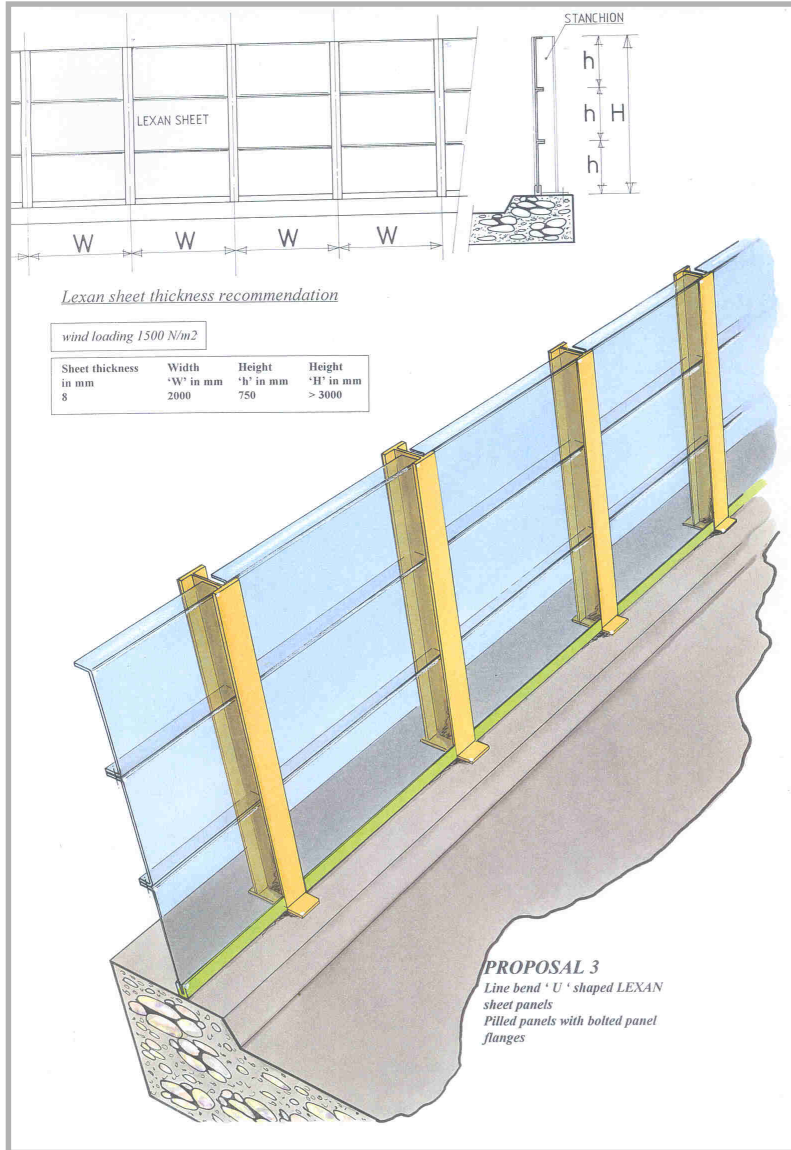
**Lexan\* Soundwalls in many countries**

# Design examples (1)



## Design Examples (2)

### Design examples (2)



## Overview Reference Projects



Example of bird-stripes printed



Lexan\* Soundglaze,  
Warsaw Poland



Lexan\*Margard MR5E , A-16  
Dordrecht , the Netherlands  
after arson attempt



Lexan\* Margard \*MR5E HSL  
Lotte Belgium



Lexan\*Margard MR5E  
Bird-stripes, HSL Rotterdam  
The Netherlands

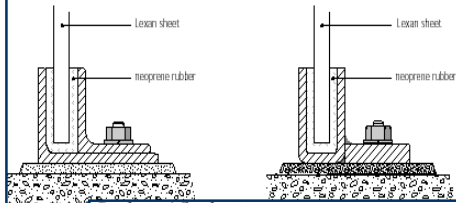


Lexan\*Margard MR5E  
Bird-stripes, Oslo Norway

# Installation Guidelines

## Thermal Expansion Allowance

When installing Lexan Soundglaze or Soundglaze SC into a sound barrier frame, an allowance should be made to allow for free expansion and contraction of the sheet. In general, the thermal expansion is approximately 3 mm per linear meter.



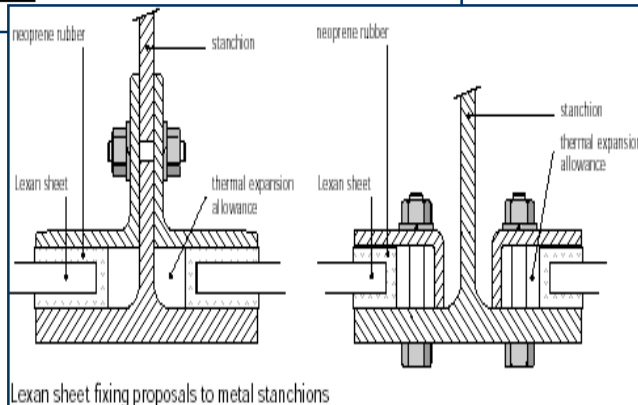
## Gaskets / Sealants

Silicone sealants or compatible Neoprene, EPT or EPDM rubber gaskets with an approximate Shore hardness of A65 are generally recommended for use with Lexan Soundglaze and Soundglaze SC. Compatible reports for different rubber types are available on request. Recommended gasket systems and sealants are given in the following tables.

### Recommended Sealants

Sealant	Supplier
*Silpruf®	GE Silicones

\*more grades available



Lexan sheet fixing proposals to metal stanchions

## Installing Lexan Sheets

For processing and installing Lexan sheet certain guidelines need to be followed, for example:

- Allowance for thermal expansion
- Type of sealants and gasket systems
- Type of saw blades to be used

## Available information

- Datasheets\*
- Processing Manual Solid Sheet\*
- Technical Manual Solid Sheet\*
- Certificates

\* Above information can be provided in printed and electronic "pdf" format.

## Tailored Technical Service

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