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PRODUCT SUMMARY

LLC SOTON produces sheets with the help of the method of extrusion from high quality polycarbonate granules that have high transparency, impact resistance, temperature and chemical resistance parameters.

The sheets are made "leather", "drop", "sand" embossed or smooth.

Solid polycarbonate sheets of the trademark SOTON SOLID, SOTON SOLIDPRO have significant advantages over other materials (all kinds of design, low specific gravity, fire resistance and thermal insulation). SOLID sheets combine high impact strength and optical transparency that provide good security, protection against vandalism and unauthorized entry. Application of this material reduces the cost of re-glassing and reduces the risk of resulting injury with fragments.

Application

- Covering of buildings and structures of industrial and civil construction, including structures of cultural and general purpose;
- Glassing of educational, sports and other public buildings;
- Erection of partitions in administrative and commercial buildings;
- Arrangement of verandas, winter gardens, covered pedestrian crossings;
- Installation of noise barriers along highways;
- Production of lighting equipment;
- Glassing and fencing, protective glassing, attic glassing;
- Filling of window openings, installation of rooflights;
- Production of bus stops and telephone boxes;
- Production of transparent shields and protections for law enforcement services;
- Production of protective screens for metal cutting machines, glasses and helmets;
- Glassing of water, air, rail, land passenger transport.

Product range

Solid polycarbonate sheets are intended for aviation, automobile industry and for ship-, wagon-, machine-building and other branches of national economy.

Depending on the destination, there are produced the sheets of the following brands:

SPC – single-layer opaque polycarbonate sheets;

SPC – 2 (3, 4, 5) – multilayer (2, 3, 4, 5 layers) opaque polycarbonate sheets;

SPC-UV – 2 (3, 4, 5) – multilayer (2, 3, 4, 5 layers) opaque polycarbonate sheets with coating for protection against ultraviolet radiation on the outer surface;

SPC – T – single-layer transparent polycarbonate sheets;

SPC – T – 2 (3) – multilayer (2, 3 layers) transparent polycarbonate sheets;

SPC – T – UV – 2 (3) – multilayer (2, 3 layers) transparent polycarbonate sheets with coating for protection against ultraviolet radiation on the outer surface;

Standard sizes of SOTON solid sheets

- **Length 3050 mm** + 0.3%;
- **Length more than 3050 mm** + 0.3 %
- **Width 2050 mm** + 0.3%
- **Thickness (2 - 5) ± 5 %**
- **Thickness (6- 12) ± 10 %**

Number of layers – 1-5.

By agreement with the customer it is possible to produce sheets of other length.

GENERAL PROPERTIES OF SOTON SOLID SHEETS

Solid polycarbonate sheets of the trademark SOTON SOLID, SOTON SOLIDPRO – is the material with unsurpassed combination of physical and mechanical properties, preserved under various temperature conditions and humidity levels (see table 1).

Table 1

General properties of solid polycarbonate sheets

Solid polycarbonate sheet SPC-T-UV, colorless, color code 1020000, thickness 2 mm, nominal mass 2400 g/m ² , UV protected (50 µm on the top and 50 µm on the bottom) - for roof covering for buildings and/or - for internal and external wall and ceiling finishes - uncoloured sheet, thickness 2 mm, UV protected protected (50 µm on the top and 50 µm on the bottom)	
* Reaction to fire	B -s1, d0
Water vapour permeability	3,81 x 10 ⁻⁵ mg/mh*Pa
*Mechanical resistance (deformation behaviour):	
E _{f, mean}	E _{f, mean} = 2506 Nm ²
E _{f, charac}	E _{f, charac} = 2272 Nm ²
σ _{M, mean}	σ _{M, mean} = 66,2 MPa
σ _{M, charac}	σ _{M, charac} = 59,5 MPa
*Direct airborne sound insulation	16 dB
*Thermal transmittance	U = 0,17 m ² °C / W (5,88 W/m ² -K)
*Light transmittance	T _v = 91,1 %
*Total solar energy transmittance	g = 78,3 %
Linear thermal expansion	6,52x10 ⁻⁵ K ⁻¹
Solid polycarbonate sheet SPC-T-UV, colorless, color code 1120000, thickness 12 mm, nominal mass 14400 g/m ² , UV protected (50 µm on the top and 50 µm on the bottom) - for roof covering for buildings and/or - for internal and external wall and ceiling finishes - uncoloured sheet, thickness 12 mm, UV protected protected (50 µm on the top and 50 µm on the bottom)	
Reaction to fire	E
Water vapour permeability	3,8 x 10 ⁻⁵ mg/mh*Pa
*Mechanical resistance (deformation behaviour):	
E _{f, mean}	E _{f, mean} = 2496 Nm ²
E _{f, charac}	E _{f, charac} = 2453 Nm ²
σ _{M, mean}	σ _{M, mean} = 67,6 MPa
σ _{M, charac}	σ _{M, charac} = 66,1 MPa
*Direct airborne sound insulation	32 dB
*Thermal transmittance	U = 0,227 m ² °C / W (4,4 W/m ² -K)
*Light transmittance	T _v = 79,0 %
*Total solar energy transmittance	g = 79,0 %
Linear thermal expansion	6,5x10 ⁻⁵ K ⁻¹

* The above results are average values that depend on the thickness of the sheet, its structure and color.

MECHANICAL PROPERTIES

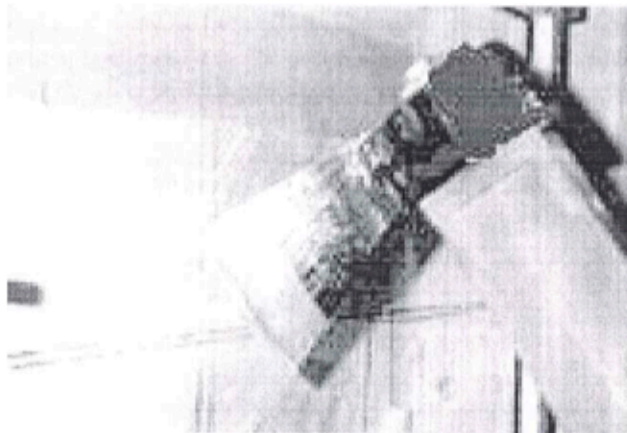
Dependence of properties on temperature

A distinctive characteristic of a solid sheet is the stability of its mechanical properties over a wide temperature range. Solid sheet is characterized by good mechanical characteristics and does not lose its high strength and stiffness at elevated temperatures for a long period of time.

Impact strength

Polycarbonate solid sheet is one of the reliable and transparent thermoplastic materials. It resists any blows, from stones to hammer, without collapsing. The polycarbonate sheet has impact strength that is 250 times higher than that of ordinary glass and 10 times than that of organic glass, thus providing reliable protection against vandalism and unauthorized entry.

Fig. 1



PHYSICAL PROPERTIES

Low specific gravity

Polycarbonate solid sheets of the trademark SOTON SOLID, SOTON SOLIDPRO are an ideal replacement for traditional glass materials. They are safe and easy to cut, assemble and operate, and are practically impossible to break. Due to their low specific gravity (see table 2), polycarbonate sheets make it significantly easier and less costly to create load-bearing structure compared to a glass structure, significantly reducing the cost of transportation, handling and installation.

Table 2

Comparison by weight in kg/m²

Thickness, mm	Solid sheet SOTON SOLID, SOTON SOLIDPRO	Glass
2	2.40	-
3	3.60	-
4	4.80	10.00
5	6.00	12.25
6	7.20	15.00
8	9.60	20.00
10	12.00	24.50
11	13.20	27.25
12	14.40	30.00

Light transmission

Sunlight reaching the earth's surface has a wavelength of 295 – 2140 nm. This spectrum is customarily divided into the following sections:

- UV-b ultraviolet radiation 280 – 315 nm
- UV-a (near) ultraviolet radiation 315 – 380 nm
- Visible light emission 380 – 780 nm
- Infrared (near) radiation 780 – 1400 nm
- Infrared radiation 1400 – 3000 nm

Since solid polycarbonate does not initially emit a wavelength of less than 385 nm, it is an ideal solution for the protection of sensitive materials, such as fabrics or other organic materials, from discoloration.

Transparent solid polycarbonate sheets allow up to 90% of light in comparison with conventional glass transmittance. Table 3 presents the coefficients of directional transmittance of solid sheets of different colors.

Table 3

Directional light transmission

Colour	Thickness, mm	Colour code	T, %			
			Visible range		I _r	
			T _{max} , %	At λ, nm	T _{avg} , %	At λ _{avg} , nm
Blue	10	1100102	65.9	452	87.8	886
Bronze	5	1050301	42.7	576	56.7	886
	8	1080302	18.0	576	33.9	886
Opal	3	1030601	2.0	576	14.9	886
	4	1040601	0.5	576	5.2	886
Green	8	1081001	64.5	510	65.0	886
	10	1101001	65.3	508	66.8	886
Smoky	4	1040901	23.6	654	33.2	886
	8	1080901	15.7	658	24.0	886
Yellow	6	1061201	60.0	540	68.5	886
Red	8	1081301	53.4	650	65.8	886
Colourless	4	1040000	88.3	626	89.9	886
	5	1050000	87.7	538	89.8	886
	6	1060000	86.4	516	88.6	886
	8	1080000	85.2	650	88.3	886
	10	1100000	82.3	480	87.8	886
Beige	5	1050401	0	-	0	-
White	5	1050701	0	-	0	-

Note: where the first digit is the type of sheet (solid, cellular);
The second and the third – thickness of the sheet.

SOLAR ENERGY TRANSMISSION

UV protection

solar radiation has a detrimental effect on polymeric materials, causing their destruction and causing cracking of the surface of the materials. These small cracks further increase under the influence of water, dust, chemicals. The speed of aging of the material depends on the climate, geographical location, altitude, seasonal temperature fluctuations, etc.

Polycarbonate solid sheets of the trademark SOTON SOLID, SOTON SOLIDPRO have a surface with the applied protective layer against ultraviolet radiation, which provides resistance to weathering.

Control of solar radiation

Transparent solid sheet has excellent light transmittance (75-90% depending on the thickness of the sheet).

However, for buildings located in hot climates or part of the façade facing south, the solid sheet is made in a translucent design, with bronze and matte shades.

These types of sheets significantly reduce the heating of the room by sunlight, which helps maintain the set temperature in the building.

a specially tinted sheet reduces the brightness of sunlight to a pleasant level and reduces the cost of air conditioning in the summer.

Heat resistance

The heating of a material can be considered as a function of the material absorbed by the solar energy and the intensity of the light flux passing through it. In countries with intense solar radiation, when installing materials with a tinted coating and high absorption of solar energy, the heat accumulation can be quite significant (see fig. 2).

Fig. 2

1. Air temperature
2. Metal structure temperature
3. Sheet temperature
4. Temperature under the roof



Polycarbonate solid sheets of the trademark SOTON SOLID, SOTON SOLIDPRO are characterized by good mechanical characteristics, they do not lose their high strength and stiffness with increasing temperature over a long period of time.

solid sheet deformation temperature and VICK softening temperature are 140°C.

the SOTON solid sheet is intended for long-term use at temperatures from -40°C to 120°C. It is possible to use the sheet even at lower temperatures, since the transition temperature to the fragile state is very low and is -110°C.

SOUND INSULATION AND THERMAL INSULATION PROPERTIES

Sound insulation

Single glassing

Single and double glassing with solid sheets SOTON SOLID, SOTON SOLIDPRO meets all the requirements for acoustics in modern glass. Table 4 shows the comparative characteristics of single glassing with solid sheets and glass in terms of sound insulation.

Table 4

Sound insulation (dB)		
Thickness, mm	Solid sheet SOTON	Glass
2-4	27	30
5	28	30
6	29	31
8	30	32
10	31	33
12	33	34

Double glassing

When used in conjunction with ordinary glass over distances of >50 mm, solid sheets significantly reduce sound transmission, especially low frequency, for example, urban noise (see table 5).

Table 5

Sound insulation			
Sheet thickness, mm		Distance, mm	Change, dB
Solid sheet	Glass		
4	6	54	36
6	6		37
8	6		39
10	6		41
4	6	85	39
6	6		40
8	6		42
10	6		44

Thermal insulation

The thermal characteristics of polycarbonate solid sheets, depending on the thickness of the sheets are not lower than the norms shown in table 6.

Table 6

Parameter	Thickness, mm					
	2-4	5	6	8	10	12
Heat transfer resistance, $m^2 \cdot \text{°C(K)} / W$	0.17	0.19	0.2	0.21	0.21	0.22

Single glassing

When using SOTON SOLID polycarbonate solid sheet, SOTON SOLIDPRO can significantly reduce heating costs by preventing excessive heat loss in winter and heat in the summer. The heat loss in the structure depends on the indicator K – heat transfer coefficient (see table 7), which determines the amount of energy passing through the material per 1 m² of the glassed surface and 1 degree of temperature difference.

Table 7

Single glassing, coefficient K ($W/m^2 \cdot K$)

Thickness, mm	Solid sheet SOTON	Glass
2.0-4.0	5.88-5.56	5.82
5.0	5.26	5.80
6.0	5.00	5.77
8.0	4.76	5.71
10.0	4.76	5.68
12.0	4.40	5.58

Double glassing

The choice of SOTON sheets for both internal and external double glassing depends on the requirements of the job.

Internal or external double glassing can greatly enhance the protection against burglary. Exterior glass is a good protection against vandalism.

Table 8 shows the values of the heat transfer coefficient K, depending on the thickness of the solid SOTON sheets and glass, which are jointly used in structures and installed at a certain distance from each other.

Table 8

Double glassing

Glass thickness, mm	Solid sheet thickness, mm	Distance, mm	Coefficient K ($W/m^2 \cdot K$)
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	10	20-60	2.56
6	12	20-60	2.54

Triple glassing

a very low value of the heat transfer coefficient K can be obtained by additionally glassing with the sheets SOTON SOLID, SOTON SOLIDPRO in combination with double sealed glass.

FIRE SAFETY

Fire-fighting characteristics

Polycarbonate sheets of the trademark SOTON SOLID, SOTON SOLIDPRO – a flash-resistant self-extinguishing material. Its ignition temperature is 570°C. Under the influence of open flames, the material does not ignite but melt, but in the absence of permanent external sources of high melting point quickly ceases.

The raw material from which the polycarbonate sheets are made has an OLI (oxygen limit index) of 25 and contains no additives that reduce flammability. OLI is the value that characterizes the minimum amount of oxygen at which the material will burn for 3 minutes or can support the burning of the sample at a distance of 50 mm. The higher the OLI, the less the probability of ignition.

Fire safety

The solid sheet softens at a temperature of 150-160°C, when the action of similar temperatures in the sheet forms an opening that promotes smoke and heat, and the temperature drops to 60°C.

Table 8a

Parameter	SOTON SOLID, SOTON SOLIDPRO	
	thickness 2- 3 mm	thickness 4- 12 mm
Reaction to fire	B -s1, d0	E

CHEMICAL RESISTANCE

Polycarbonate solid sheets SOTON SOLID, SOTON SOLIDPRO are successfully used in combination with various building materials and chemical compositions. Considering the complexity of the chemical compatibility, all additional materials that come into contact with polycarbonate must be pre-tested.

Polycarbonate has high resistance to many chemically active media. Its chemical resistance depends on the concentration of chemicals and the ambient temperature when exposed.

Table 9 presents the chemical resistance data of polycarbonate to some substances.

Table 9

Substance	+ resistant	O limited resistance	- not resistant
Acetaldehyde			-
Acetone			-
Petrol			-
Benzene			-
Boric acid	+		
Butyl acetate			-
Butyl alcohol	+		
Hexane	+		
Aluminum hydroxide powder	+		
Sodium hydroxide dehydrated	+		
Glycerol	+		
Dimethylformamide			-
Octyl			-
Dibutyl phthalate			-
Isopropyl alcohol		O	
Maleic acid	+		
Meta-cresol			-
Methyl acetate	+		
Methylene chloride			-
Methyl alcohol			-
Alumina	+		
Copper oxide	+		
Ammonium oxalate	+		
Octane alcohol	+		
Oleic acid	+		
Palmitic acid	+		
Potassium permanganate			-
Pyridine			-
Sodium chloride, 10%	+		
Polyethylene glycol	+		
Propane	+		
Propylene	+		
Salicylic acid	+		
Sulfuric acid 70%			-
Sulfuric acid 5%			-
Hydrochloric acid, concentrated, 25%			-
Hydrochloric acid, 20%	+		

Sorbitol	+		
Aniline sulfate	+		
Tetrahydrofuran			-
Trichlorethylene			-
Carbon tetrachloride			-
Thioacetic acid	+		
Toluene			-
Acetic anhydride			-
Phenol-acetic acid	+		
Formaldehyde solution 37%	+		
Formalin	+		
Phosphoric acid 1%	+		
Phosphoric acid 10%			-
Hydrogen fluoride 25%	+		
Hydrogen chloride 20%	+		
Hydrogen chloride 25%			-
Chlorobenzene			-
Chloroform			-
Hydrogen tetrachloride			-
Alkaline solutions			-
Ethyl acetate			-
Ethyl bromoacetate	+		
Ethylene glycol	+		
Ethylene chloride			-
Ethanol			-

Note: good resistance of polycarbonate to chemicals does not affect its properties regardless of the duration of exposure and the load when exposed to chemically corrosive media.

CLEANING AND WASHING

Cleaning / washing

To increase the service life of SOTON SOLID, SOTON SOLIDPRO solid polycarbonate sheets, it is recommended to clean them periodically with compatible household detergents. This will extend the life of the polymer material.

Polycarbonate surfaces can be cleaned in the following ways:

1. Cleaning of little soiled surfaces:
 - 1.1. Static electricity removal with further dust removal:
 - 1.1.1. Treatment with an ionizer;
 - 1.1.2. Antistatic treatment;
 - 1.1.3. Dust removal;
2. Cleaning of heavily soiled surfaces:
 - 2.1. Cleaning with isopropyl alcohol;
 - 2.2. Treatment with special cleaning products.

Cleaning of lightly mudded polycarbonate surfaces

Treatment with an ionizer

When ionizing the air near the surface of the polycarbonate sheets, the electrostatic charge is removed. You can then remove the dust with a vacuum cleaner or a slightly damp, soft cotton cloth. The antistatic effect of the ionizer is not constant. It is neutralized by rubbing or touching the sheet.

Treatment with antistatic agents

Antistatic substances are alcohol or aqueous solutions that form a thin antistatic film on the surface of a polycarbonate sheet. They are applied by spraying or wiping the surface with a cloth soaked in antistatic solution. They are effective immediately after evaporation of the solvent, when the coating turns into a thin conductive layer.

The use of antistatic cleaners gives good results. They eliminate the accumulation of electrostatic charges on the surface of the plastic and at the same time clean the surface of dust.

Polycarbonate sheets can be cleaned with 100% cotton fabric and plenty of soft neutral non-abrasive detergents and water (soft dishwashing detergents may be used). Formulations containing ammonia, caustic alkali, chlorine should be avoided as they destroy polycarbonate.

Cleaning of heavily mudded polycarbonate surfaces

Purification with isopropyl alcohol

It is recommended to use isopropyl alcohol to clean the heavily soiled surfaces of the polycarbonate sheets. If the isopropyl alcohol contains water and the water droplets remain on the surface after the alcohol has evaporated, they should be wiped with a dry cloth. This method can also be used to get rid of residues on polycarbonate after removing the protective film.

Treatment with spray cleaners

Dust cleaners containing special paraffins and solvents can be used to clean the dust. They leave a glossy protective layer on the material to protect against static build-up and dust. The ideal way of servicing is to clean and polish the sheets once every two weeks with such a spray cleaner and soft 100% cotton cloth.

Recommended method No.1 for small areas:

1. Rinse the sheet with warm water.
2. Wash the sheet with a mild soap solution or household detergent and warm water using a soft cloth or sponge to remove any dirt and soot.
3. Rinse with cold water and dry, remove the water with a soft cloth.

Recommended method No.2 for large areas:

1. Clean the surface with high pressure water and / or steam cleaner.
2. Use only detergents and additives that are recommended for the sheet.

Attention!

- Never use abrasive or alkaline cleaners to clean the sheet;
- Detergents and additives, which are usually recommended for polycarbonate sheets, are not always compatible with the special coating of sheets to protect against the effects of ultraviolet radiation;
- DO NOT USE alcohol-based cleaners to clean the surface of sheets with coating against UV rays;
- Never rub the surface of the sheet with brushes, metallic cloth or other abrasive materials;
- Do not wash the sheet under scorching sun or high temperatures as this may cause stains.

GENERAL RECOMMENDATIONS

Handling

At handling and transporting SOTON SOLID, SOTON SOLIDPRO solid polycarbonate sheets should be handled with care to avoid scratches and damage to the edges of the sheet. Each sheet must be packed in such a way as to minimize the risk of such damage:

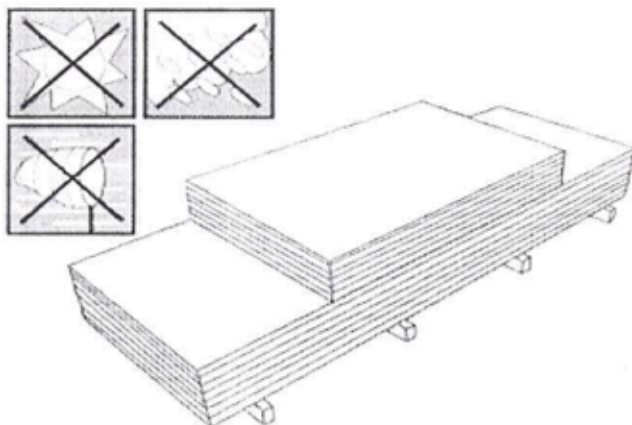
- loading / unloading of bundles of sheet fixed to the pallet (standard size) is carried out by means of a loader with specially equipped arms;
- Sheets packs may be loaded in the vehicle in stacks, but no more than four packs in the stack;
- when loading / unloading polycarbonate sheets, any impact of the sheets or bundles of sheets against foreign objects which may cause damage to the sheets shall not be allowed.

Transportation of pallets with polycarbonate sheets is carried out only in the horizontal position.

Recommendations for keeping sheets

1. Storage of pallets with polycarbonate solid sheets is carried out in a horizontal position in closed warehouses, on the floor or on specially equipped racks.
2. It is allowed to store pallets with sheets in stacks.
3. Total weight of the stack on the floor should not exceed 8400 kg and the number of pallets in the stack – 6 pcs.
4. Total weight of the stack on the racks shall not exceed 5600 kg, and the number of pallets in the stack 4 pieces.
5. Distance between the stacks on the floor must be at least 200 mm.
6. It is not allowed to transport and store sheets together with chemical products.
7. The product pallets should be stored one meter (1 m) away from the heating appliances.
8. Packs of sheets should lie on wooden boards. Packs of sheets should not be put in the places, where there will be the possibility to walk on or drive in them.
9. SOTON SOLID, SOTON SOLIDPRO solid sheets of the same length should be laid horizontally on top of each other. If sheets of different length are packed, then longer sheets should be packed to the bottom in order to avoid bending and hanging of the edges of the sheet due to lack of support (fig. 3).

Fig. 3



Drilling

Standard high-speed metal drill bits and carbide-tipped drill bits are used for sheet metal drilling because they maintain the sharpness of the cutting edges.

The most important factor to consider when drilling polycarbonate sheets is that heat is released during the drilling process. To obtain a clean, well-machined hole without mechanical stress, it is necessary to reduce the amount of heat released.

Following a few basic guidelines, you can easily get clean, well-machined holes:

- periodically clean holes from chips;
- from time to time cool the drill with compressed air;
- to obtain a hole of the required size, the sheets must be secured appropriately and have a support to reduce vibration;
- the holes can be drilled from the edge of the sheet at a distance no closer than double the diameter of the hole;
- the diameter of the hole must take into account the thermal expansion / compression tolerance and be larger than the diameter of the fastening element (bolt, screw, etc.).

Cutting and sawing

Polycarbonate sheets cutting

Polycarbonate sheets can be accurately and easily cut with the use of standard metalwork equipment: metal saw, hand saw, circular saw, jigsaw.

The following are general guidelines and specific guidelines for each cutting section:

- when using an automatic saw or hacksaw, the sheet should be pressed against the machine so as to avoid unwanted vibration and uneven cutting of the edges;
- all the tools must be adjusted for cutting plastics with small knives with small teeth;
- saw teeth must be sharpened;
- protective cover should remain on the sheet to prevent the emergency of scratches and other damages of the surface;
- at the end of the work, the edges of all sheets should be clean, without chipping and burrs;
- chips and dust should be blown with compressed air.

Laser cutting. Polycarbonate sheets can be cut using a laser. Thickness should be controlled more carefully than usual machine operations. The laser power and cutting speed must be carefully selected to avoid the whitening effect of the sheet at the cutting point. At laser cutting the edge of the cut always has a brown tint, so if you need to get a clean-cut edge – it is better to refuse from laser cutting.

Polycarbonate sheets sawing

Sawing of the polycarbonate sheets can be performed by band, circular saw, hand saw or jigsaw. New or well-sharpened tools must be used to obtain a good sawing result. At high processing speeds, it is recommended to use compressed air cooling.

Circular saws:

This type of sawing is the most widely used, and although cutting speeds and feed rates are not as critical as when working with other thermoplastics, it is important to follow these guidelines:

- always use a low-speed clean cut slice;
- to start cutting only at the saw operating speed;
- single sheets less than 3 mm thick are cut with band saws and saw blades.

Band saws.

These can be saws of the ordinary vertical type or specially designed horizontal type, suitable for plastic sheet materials. In both cases, it is important that the sheet is well secured

when cutting. Guide saws should be as close as possible to the blade to minimize blade distortion and cut curves.

Table 10 presents the main characteristics of band saws compared to circular saws, which are optimal for sawing polycarbonate sheets.

Table 10

Parameter	Saw type	
	Band	Circular
Tooth distance(t)	1-2 mm (for sheet thickness <3 mm) 2-3 mm (for sheet thickness 3-12 mm)	8-12 mm
Back edge angle (α)	30-40°	15°
Front cut angle (ν)	15°	10°
Cutting angle (β)	-	15°
Cutting speed	1200-1700 m/min.	2500-4000 m/min.
Sawing speed	-	20 m/min.

Formation

When forming SOTON SOLID, SOTON SOLIDPRO polycarbonate sheets, the forming zone must be at a temperature above the glassing temperature (T_{gl}) of about 150°C. Any failure to comply with this condition will result in high internal stress sheets, which can dramatically reduce the impact strength and increase the sensitivity to chemical action. Unlike other plastic materials, these internal stresses are not visible to the naked eye. Can only be detected using a polarized light polarimeter. In some cases, the internal stress can be removed by temperature treatment. However, the difficulties encountered in temperature treatment make this method difficult and inefficient.

Thermoforming

In thermoforming, it is always recommended to pre-dry the sheet. Pre-dried sheet can be safely heated to 180 ° – 200°C. At this temperature, the sheet is easily subjected to deep drawing and bending according to a given profile.

Pre-drying conditions

SOTON sheets should be dried at 120°C.

The duration of pre-drying depends on the amount of moisture absorbed by the sheet and its thickness. Therefore, the best way to determine the required drying time is as follows:

- 2 – 3 small samples of material should be cut from the test batch sheet;
- these specimens should be placed in an oven preheated to a pre-drying temperature (110° – 120°C);
- every 2 – 3 hours, remove the next sample from the oven and heat it to the forming temperature (170° – 180°C);
- it is necessary to monitor the emergency of bubbles on the sample. If no bubbles are formed after 10 minutes, the material is dried. If the bubbles appear, this will require extra drying;
- having determined the duration of drying, it is necessary to proceed to pre-drying of the whole batch of polycarbonate sheets.

Vacuum forming

Vacuum forming of the pre-dried polycarbonate sheet is easily carried out on any modern vacuum forming machine. It is advisable to use automatic machines for this purpose, which capture the sheet on all sides and hold it throughout the process. This is especially important when working with thin sheets with a thickness of ~ 2 mm. Such sheets can shrink up to 5% and therefore must be firmly attached to the frame. Vacuum forming without pre-drying should be carried out very carefully. The temperature of the sheet should not be higher

than 160°C. Uneven heating, which leads to local overheating above 160° -165°C, causes the formation of bubbles on the overheated area.

Forming under pressure

Pressure forming is a process similar to vacuum forming. It makes it easy to mold domed surfaces and covers. This method can also be used without pre-drying, since it requires little relative extraction and the shape of the product is very simple (spherical or almost spherical).

Free forming

Free forming can be performed without pre-drying, but this process also requires careful temperature control. If the sheet has not been pre-dried, only ovens with well-regulated air circulation should be used to avoid local overheating. It is necessary to inspect the sheet and determine its shrinkage, since in this method of forming the sheet is not fixed on the frame that would prevent shrinkage.

Bending along the heating line

Bending along the heating line can be carried out without pre-drying, but precise temperature control is also required. Initially, overheating will occur at the ends of the bend line, where the sheets heat up faster. Particular care should be taken to ensure that bending is not carried out in areas below 155°C. Otherwise internal stresses may occur through which the sheet will lose a significant portion of its impact strength. It is recommended to experiment with small curved specimens of material and to test their impact strength by striking a heavy hammer along the bend of the specimen laid on the floor or on the desktop with the bend line up. Destruction of the specimen will mean that the bending temperature was chosen too low. When bending sheets with a thickness greater than 3 mm, satisfactory results can only be obtained on the equipment, which allows to perform two-sided bending along the line. Bending along the heating line can be carried out with the preservation on the product of a protective plastic film only for sheets less than 6 mm thick. In the case of bending of sheets 6 mm or more thick, the heating time and temperature on the surface of the sheet will be too high, which will cause local melting of polyethylene. Before forming, it is possible to remove the polyethylene along the heating line, thereby preventing it from melting, and to retain the polyethylene coating on most of the rest of the sheet surface, which will facilitate handling after forming.

Parts connection

Welding

Polycarbonate sheets can be welded with hot air using a welding wire. In this case, the preliminary drying of the welded sections should be carried out within 12 hours. Polycarbonate sheets can be welded at a bar temperature of 120-130°C also by ultrasonic method in the form of spot and rivet welding or when laying metal parts.

Gluing

Solid polycarbonate sheet parts can be joined using solvents, varnishes (polymer solutions in a solvent) or adhesives. In case of complex joints, varnishes have a greater advantage than solvents.

Gluing requires some mandatory recommendations:

- the ends of the sheets should be free from any contamination;
- the surfaces should be smooth and smooth;
- the solvent or lacquer must be able to remain operable throughout the working period (use of effort);
- when using solvents to connect polycarbonate parts, the climatic conditions in the workplace must be controlled. Maintaining of low humidity will eliminate the whitening effect and use inactive varnishes;
- the application of pressure when fixing the connection must be carried out before its complete curing;
- ensure good ventilation of the room when handling the solvents.

Polycarbonate sheets can be bonded to other plastics with clean contact surfaces. Recommendations on gluing depending on the nature of the material used. For small products in which high impact strength is not crucial, it is convenient to use glue guns for hot curing

adhesives. Hot polyamide-based hot-melt adhesives have the best properties, although other, for example, ethylene vinyl acetate adhesives, also have good results.

For use in heavy-duty structures, which must have high impact strength and weather resistance (for example, gluing the edges of a sheet to a frame or other sheet in domes of headlamps, aquarium construction, sealing of car windows, etc.) use silicone glue.

In cases where high bond strength, shock and chemical resistance, as well as high transparency are required, polyurethane adhesives are recommended. These are adhesives of two-component type, which are more difficult to work with than one-component adhesives. Therefore, they should be used only when extremely high mechanical and optical properties are required, for example, in the manufacture of "unbreakable glass", when glass and polycarbonate are glued.

For gluing flat sheet parts, such as mirrors or shelves, to flat surfaces: walls, doors, ceramic tiles, etc. – it is recommended to use double-sided adhesive tape. This is an acrylic foam adhesive that ensures good adhesion of polycarbonate to flat surfaces. There are many other adhesives compatible with polycarbonate materials, however, the use of any solvent-based adhesives should be carefully avoided. Such adhesives cause serious damage to critical parts of the product. It should also be borne in mind that some adhesive tapes that provide gluing when pressed contain a solvent or traces of solvent, which can cause cracking under stress several months after gluing.

Mechanical connection

Polycarbonate sheets can be mechanically joined using screws, nuts, screws, screws and other elements. The mechanical coupling method can be used in any case where there is no risk of damage to the appearance of the product. This method of connection is economical, reliable and does not require much time.

Additional operations

Grinding

SOTON SOLID, SOTON SOLIDPRO polycarbonate solid sheets are well exposed to grinding in the wet way as opposed to the dry method, in which the frictional heat is released. For best treatment efficiency, use chilled water. For grinding with good results, it is best to use silicon sand paper (for rough processing with a grain size of 80, for fine – 280). A 400 or 600 grain size paper is recommended for grinding.

Edge sawing

Sawing of many thermoplastics, including polycarbonate, forms a powder that clogs the files. Therefore, for cutting polycarbonate sheets, large-toothed 45° inclined file made of aluminum should be used.

Coloring and printing

Printed images can be printed on SOTON SOLID, SOTON SOLIDPRO polycarbonate sheets using the appropriate equipment method. However, it should be borne in mind that the paints do not fit on the plastic as well as on paper or cloth and that they may peel off. This effect can be minimized by resorting to additional varnishing of the painted surface.

Many coloring agents can be used to color the sheets. Usually two-component paints based on polyurethane or epoxy are suitable for this purpose. It is recommended to avoid solvent-based inks as most solvents or thinners can damage polycarbonate sheets. However, if very fast drying is possible and all traces of solvent are evaporated immediately, standard printing equipment and screen stencils with standard inks can be used. Most paint suppliers have standard polycarbonate compatible paints.

INSTALLATION INSTRUCTIONS

Installation

Glassing with SOTON SOLID, SOTON SOLIDPRO polycarbonate solid sheets should be planned as the final stage in the finishing of the building.

It should be borne in mind that the condition for obtaining certain optimal technical parameters of the design created with the use of polycarbonate sheets is the use of appropriate accessories for installation and glass recommended in this technical guide, and strict adherence to the installation recommendations specified in this guide.

ATTENTION! Design and installation of structures using polycarbonate sheets should be handled by appropriate companies that have licenses for this type of activity and qualified personnel. The appearance of polycarbonate sheets and the service life of structures with their application depend on the quality of the installation.

Pre-installation recommendations

Allowance for thermal expansion

When mounting SOTON SOLID, SOTON SOLIDPRO polycarbonate sheets it is necessary to take into account the thermal expansion of sheets, equal to $6.7 \cdot 10^{-5}$ m/m $^{\circ}$ C. Since polycarbonate solid sheets have a higher coefficient of linear thermal expansion than traditional glass materials, a gap should be left for such expansion that will help to prevent sheet bending in the structure, deformation of sheets, slipping from the fastening elements or even splitting elements due to the occurrence of critical internal stresses. Table 11 shows the comparative coefficients of linear thermal expansion for different materials:

Table 11

Material	Linear thermal expansion coefficient, 1/ $^{\circ}$ C
SOTON sheet	$6.7 \cdot 10^{-5}$
Glass	$(0.7-0.9) \cdot 10^{-5}$
Aluminium	$(2.1-2.3) \cdot 10^{-5}$
Steel	$(1.2-1.5) \cdot 10^{-5}$

To prevent the effect of thermal expansion on the quality of the construction, which is mounted with the use of solid polycarbonate sheets, the following should be considered:

- leave the required gap of 5-6 mm in the profile to connect the solid sheets;
- when fixing the sheets to the frame with screws, the holes in the sheet should be made 3-6 mm larger than the diameter of the screw itself;
- if the length of the structure is longer, the panels should be additionally secured to the frame to compensate for thermal expansion;
- the holes in the sheet should be at least 40 mm from the edge;
- do not overtighten screws and other fasteners when mounting polycarbonate sheets, leaving the allowance for free lift.

Thermal expansion tolerances should be provided for both the length and width of the SOTON SOLID, SOTON SOLIDPRO sheets.

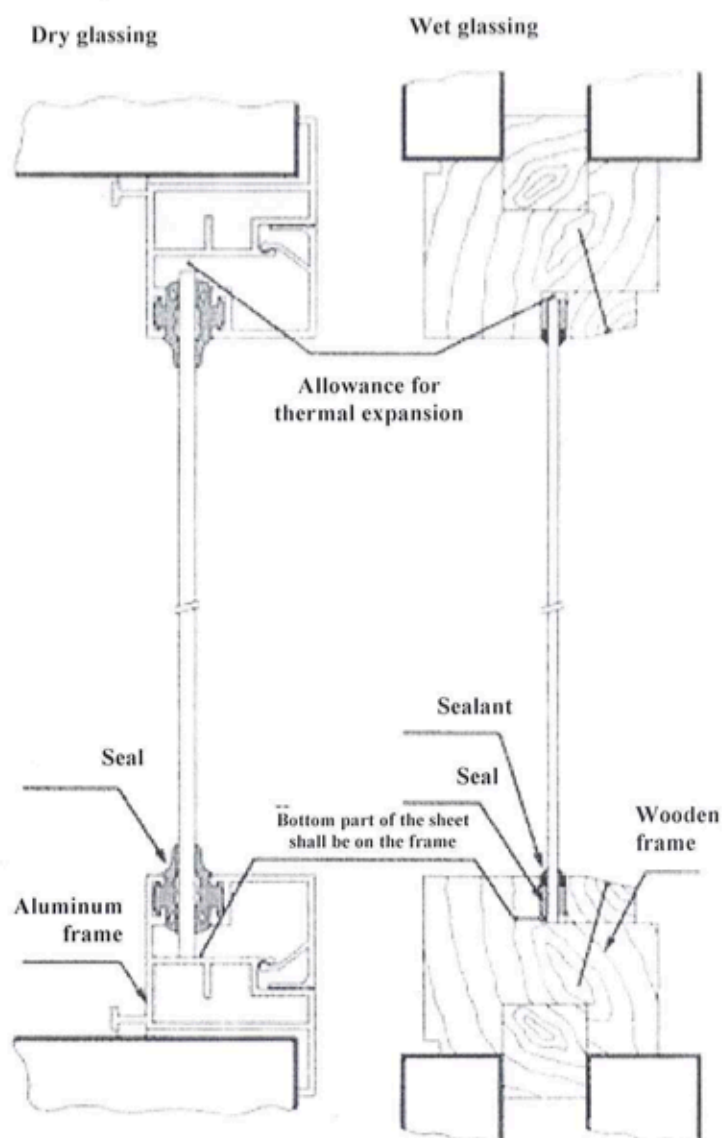
The minimum clearance for thermal expansion when installing polycarbonate sheets should be provided depending on the length of the sheet (see table 12).

SOTON sheet length, mm	Minimal clearance for thermal expansion, mm
500	3.0
1000	5.0
1500	7.0
2000	10.0
3000	15.0

As a general principle, one should take into account 5-6 mm tolerance for thermal expansion for each linear meter of colorless sheet and 6-8 mm – for each linear meter of colored sheet (figs. 4, 5).

Fig. 4

Fig. 5



When glassing with SOTON SOLID, SOTON SOLIDPRO polycarbonate solid sheets should always take into account the minimum angle of inclination from the end to the end of the structure, equal to 15° for normal runoff of condensate and rain water (see fig. 6).

WINDOW AND SNOW LOAD

Dynamic wind load

Wind speed determines the actual wind load on the SOTON solid sheets used for glass. The load is calculated by multiplying the square of the design wind speed by a factor of 0.613.

$$Q = kv^2,$$

where q is the dynamic wind load, N/m^2 ;

$K = 0.613$;

v – design wind speed, m/s .

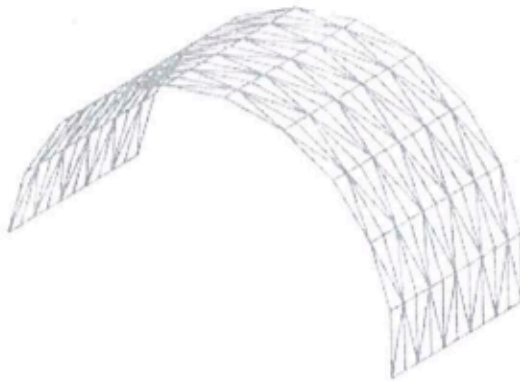
Table 13

		Value of q in SI units N/m^2											
Wind speed, m/s		10	15	20	25	30	35	40	45	50	55	60	65
Dynamic wind load, N/m^2		61	138	245	383	552	751	981	1240	1530	1850	2210	2590

Pressure factor

The pressure factor takes into account fluctuations in the design of the glass while accelerating / slowing down the wind. The wind load is calculated as the product of the dynamic wind pressure q at the corresponding pressure factor. The list of pressure coefficient values can be found in the relevant national building regulations.

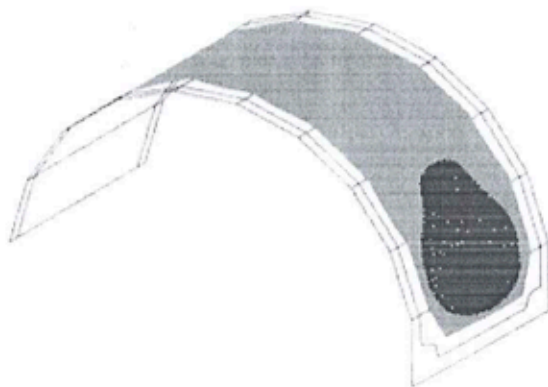
Fig. 9. Load distribution affecting the SOTON SOLID, SOTON SOLIDPRO solid sheets



1) Final model



2) Deflection scheme



3) Scheme of deflection contour

Snow load

The snow cover load on the roof glassed surfaces should be considered as a vertical, evenly distributed load, acting on 1 m² of horizontal glass projection.

The exact values of the snow load coefficients can be found in the relevant national building regulations.

GLASSING SYSTEMS

Glassing systems

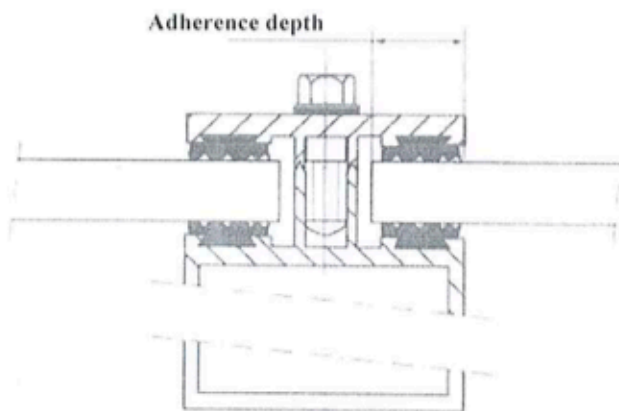
Figures 10 and 11 show typical installation diagrams for dry and wet glassing using SOTON SOLID, SOTON SOLIDPRO polycarbonate solid sheets.

When installing SOTON SOLID, SOTON SOLIDPRO sheet it is very important that the edges are securely fixed, regardless of whether they require dry or wet glass conditions.

Dry glassing systems

The advantage of dry glassing is that the rubber seals are inserted directly into the groove of the window frame, allowing for the free movement of the sheet during expansion and compression. This should be taken into account both for aesthetic purposes and for applications where the expansion of the sheet exceeds the plasticity limits of the sealing compound.

Fig. 10. Dry glassing system.



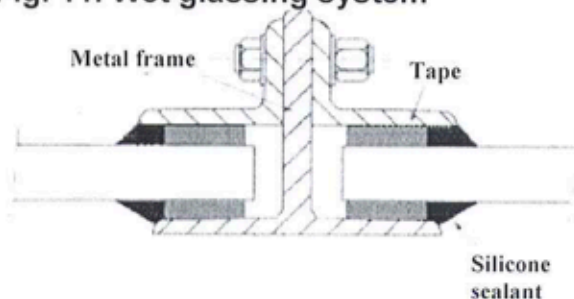
Wet glassing systems

SOTON SOLID, SOTON SOLIDPRO polycarbonate sheets can be used for glassing using standard mechanical or wooden window frames using tapes and non-curing compositions. Polybutylene tapes are well suited for this.

When using glassware, it is important that the sealing systems have a backlash to allow thermal expansion without loss of adhesion to the frame or sheet. Usually it is recommended to use silicone sealants, and when using other sealants – to check their compatibility with the sheet in advance.

Neither amino nor benzamide-curing silicone sealants can be used as they are incompatible with polycarbonate, which can lead to the formation of microcracks, especially in the presence of stresses.

Fig. 11. Wet glassing system



PLANE STRUCTURE GLASSING

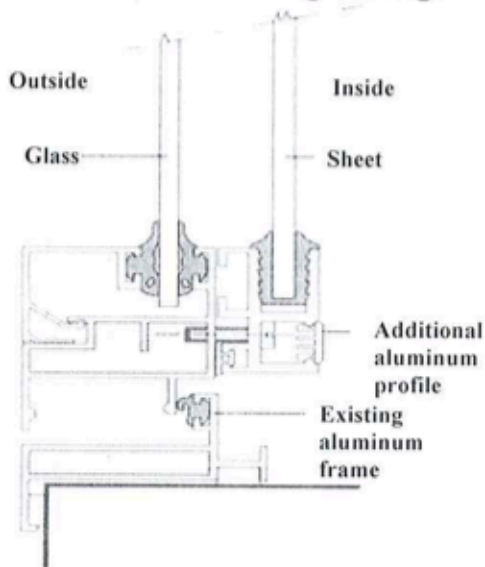
Additional glassing

The choice of SOTON SOLID, SOTON SOLIDPRO polycarbonate sheets as internal or external secondary glassing will depend on the specific requirements of the structure: external/internal secondary glassing is used to enhance protection against unauthorized intrusion.

Internal additional glass

The SOTON SOLID, SOTON SOLIDPRO sheet is an ideal material for interior glassing (see fig. 12). When the SOTON sheet is installed indoors, the wind deflection parameters (as indicated in table 13) may not be taken into account and the sheet thickness can be reduced.

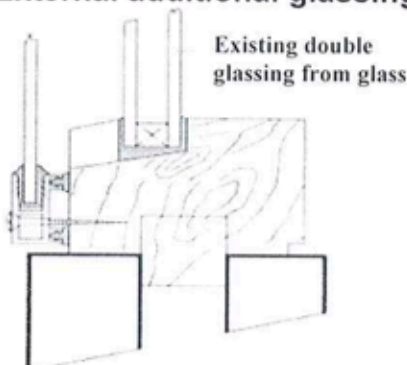
Fig. 12. Internal additional glassing.



External additional glassing

Depending on the design requirements, different SOTON SOLID, SOTON SOLIDPRO polycarbonate sheets may be used as external glassing (see fig. 13). Taking into account the functional and aesthetic requirements for the deflection value under the influence of wind, the sheet thickness recommendations contained in table 14 are applicable (see below).

Fig. 13. External additional glassing.



SELECTION OF SHEET THICKNESS FOR PLANE GLASSING

Fastening of SOTON SOLID, SOTON SOLIDPRO solid sheets from four sides

Permissible load parameters in this configuration depend on the ratio of the distances of the supporting part of the frame – a: b, where "a" represents the distance between the centers of the glass transition profiles on the transverse side of the glass, i.e. the width of the sheet, and "b" is the distance between the centers of the glass profiles on the longitudinal the side of the glass, i.e. the length of the sheet (see fig. 14).

Fig. 14

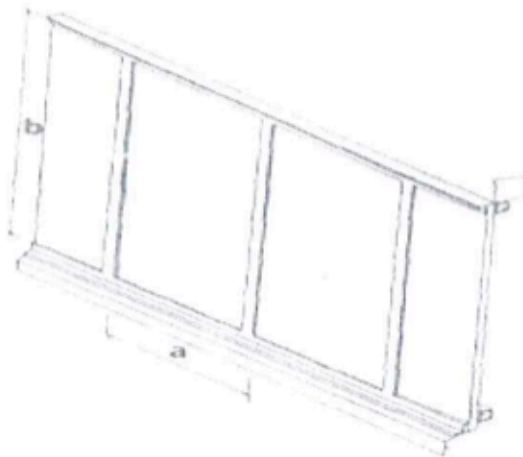


Table 14 shows the maximum allowable dimensions of the sheet at a certain load, which is expressed in the acceptable deviation of the sheet (within the elastic deformation) without the risk of bending and internal stresses.

Table 14

Distance between the centers of the glass profiles (transverse side "a")

Sheet width to length ratio	Sheet thickness, mm							Load, N/m ²
	3	4	5	6	8	10	12	
1:1	775	1050	1300	1475	1850	2050	2050	600
1:2	600	800	975	1150	1450	1600	1750	
1:>2	400	550	675	800	1150	1300	1500	
1:1	700	950	1180	1375	1700	1950	2050	800
1:2	550	700	875	1010	1350	1475	1700	
1:>2	375	490	625	725	1000	1150	1400	
1:1	650	875	1100	1300	1600	1850	2050	1000
1:2	500	650	800	960	1275	1400	1600	
1:>2	-	450	575	680	925	1075	1325	
1:1	600	825	1025	1225	1525	1750	2050	1200
1:2	450	600	750	900	1200	1350	1525	
1:>2	-	425	550	650	860	1025	1275	
1:1	575	780	975	1175	1475	1675	2000	1400
1:2	400	550	700	850	1150	1300	1475	
1:>2	-	400	510	600	810	975	1225	
1:1	550	740	930	1125	1425	1625	1950	1600
1:2	-	500	670	800	1075	1250	1450	

1:>2	-	-	490	575	775	925	1175	
1:1	525	710	900	1075	1375	1575	1875	1800
1:2	-	475	625	710	1000	1200	1400	
1:>2	-	-	470	550	750	880	1125	
1:1	500	685	875	1025	1325	1525	1800	2000
1:2	-	450	560	650	950	1100	1350	
1:>2	-	-	450	525	725	850	1075	

Examples of table use:

- window size: width 1600 mm, length 3200 mm (a: b = 1: 2 ratio).
load: 1000 N/m^2 . Required sheet thickness: 12 mm.
- window size: width 1000 mm, length 4000 mm (ratio a: b = 1: >2).
load: 800 N/m^2 . Required sheet thickness: 8 mm.

Fastening of the SOTON SOLID, SOTON SOLIDPRO solid sheets from both sides

The sheet can be fixed to the intermediate beams using conventional nuts, bolts and washers. However, all joints and locking areas require support – common rubber washers – to distribute the clamping force over the widest area.

It is necessary to use large metal washers, laminated with rubber, compatible with polycarbonate sheet. The bolts should not be tightened too much as this may distort the sheet or limit the natural expansion and contraction of the sheet.

When using bolts of any type, it is important to remember that the distance between the hole and the edge of the sheet should be at least two hole diameters. The deflection criterion for both types of glass transition is the side "a" of the unfixed sheet, that is, the distance between the centers of the glass profiles (see figs. 15 and 16). The distance "b" determines the length of the sheet and does not affect the overall deflection, since any length of the sheet can be selected.

Fig. 15

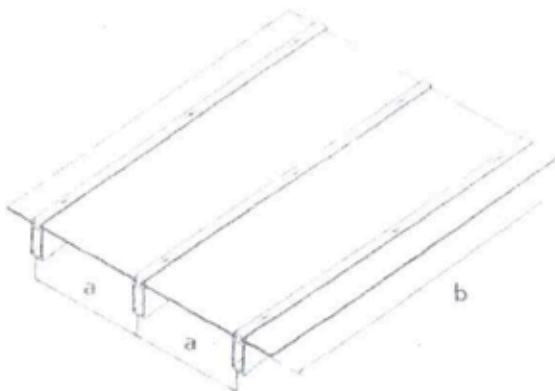


Fig. 16

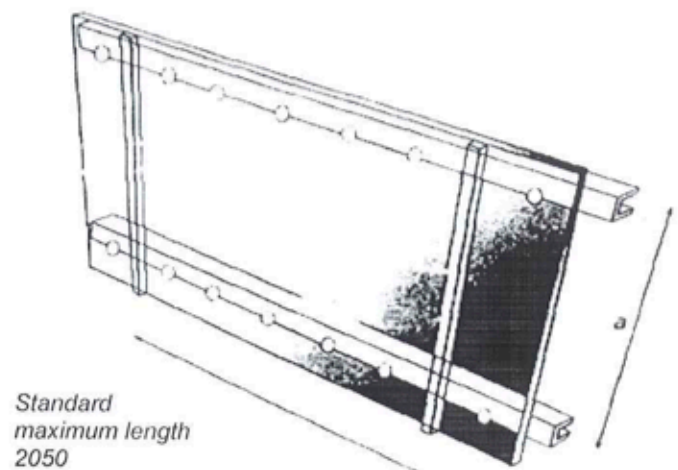


Table 15 presents data based on the values of engagement of the edge of the sheet on both sides, shown in table. 14 (see earlier).

Distance between the centers of the glass profiles (transverse side "a")

Load, N/m ²	Sheet thickness, mm						
	3	4	5	6	8	10	12
600	400	550	620	750	1000	1200	1425
800	375	480	565	675	900	1075	1325
1000		425	525	625	840	1000	1250
1200		400	495	595	790	930	1190
1400		375	470	560	750	890	1125
1600			450	540	720	850	1075
1800			430	510	690	820	1030
2000			420	500	660	790	1000

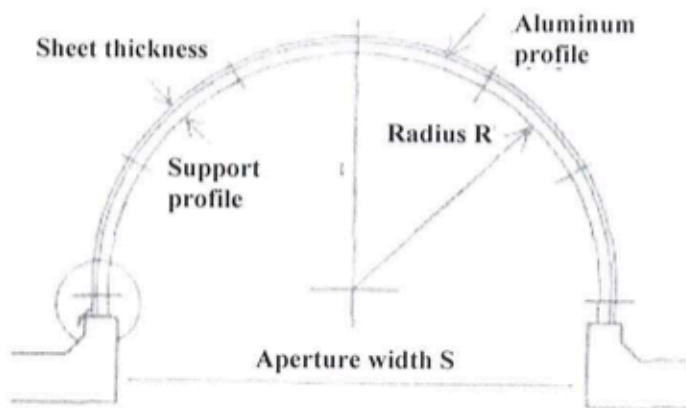
ATTENTION! Walking on roof structures and SOTON SOLID, SOTON SOLIDPRO polycarbonate sheets during mounting or washing is not allowed. This should always be done using a wooden beam or other device that rests on the roof.

BENDED STRUCTURES GLASSING

Arch glassing

All polycarbonate solid sheets of the trademark SOTON SOLID, SOTON SOLIDPRO are subjected to cold forming on curved supporting glass profiles (see fig. 17). Provided that the bending radius of the sheet is greater than the minimum recommended value, the mechanical stress obtained by cold forming will not affect the mechanical properties of the sheet.

Fig. 17



The minimum values of bending radius for polycarbonate solid sheets of different thicknesses are presented in table 16.

Table 16

SOTON sheet thickness, mm	Minimal acceptable bend radius, m
2	0.30
3	0.45
4	0.60
5	0.75
6	0.90
8	1.20
10	1.50
12	1.75

For arch glassing, SOTON SOLID, SOTON SOLIDPRO sheets can be used with standard metal profiles, glass strips and non-hardening glass compositions.

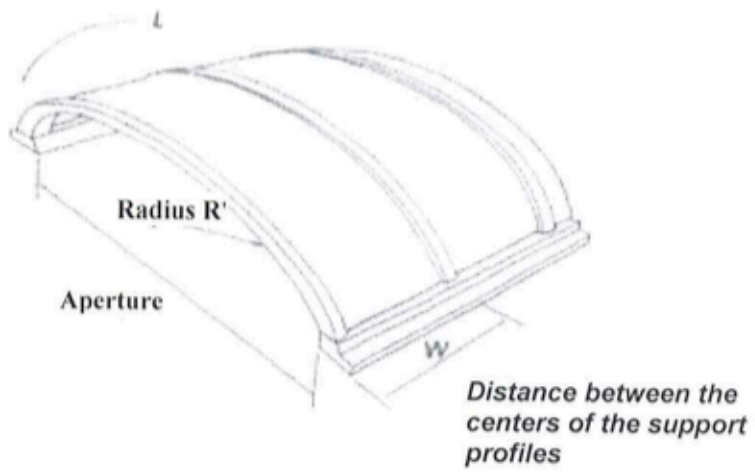
For greater economic effect, it is advisable to use rubber seals for metal or wooden structural support beams and for aluminum locking rails.

Selection of sheet thickness for arch glassing

The radius of curvature, as well as the span and distance between the curved profiles, affect the properties of the resulting structure and the critical longitudinal loading. The critical longitudinal load at which the bending occurs is calculated as a function of the geometric parameters of the sheet surface from the properties of the SOTON sheet.

The rigidity of the sheet in curved glass is mainly determined by the radius "R" and the distance between the curved profiles "W". The length of the sheet "L" should be greater than the width of the sheet "W" to facilitate bending (see fig. 18). In practice, a length to width ratio of less than 1:2 is not considered.

Fig. 18



GUARANTEE

For **SOTON SOLID, SOTON SOLIDPRO** sheets made of polycarbonate with UV protective layer (SPC-UV) LLC SOTON provides a guarantee period of sheet of exploitation – 10 years.

The guarantee period of the sheets is calculated:

- for non-market consumption – from the date of receipt of the product by the buyer (consumer);
- when sold through a retail network – from the date of retail sale.

Note: All materials presented above are for reference only and are provided voluntarily by the LLC SOTON. The product characteristics and performance indicators described in this document are generic and require self-review by the consumer for the suitability of the product for consumer purposes. As LLC SOTON is unable to control the use and use of its products, as well as products produced on its basis by the consumer, the responsibility for the use and use of the products of the enterprise is entirely borne by the consumer. In case of violation of the order of use and use of the products provided by this technical manual by the consumer, LLC SOTON is not responsible.