POLYCASA CAST

Contents

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1. PRODUCT IDENTIFICATION

POLYCASA CAST is the brand name for cast Polymethyl methacrylate sheets from POLYCASA.

The composition of the final product is 90-95% PMMA + additives (stabilisers, plasticizers, dyes and pigments, release agents).

POLYCASA CAST possibilities, characteristics and extraordinary range of colours cover all needs in construction, industry, decoration, lighting & publicity.

POLYCASA CAST sheets are produced and tested according to UNE EN ISO 7823-1.

2. CHARACTERISTICS

POLYCASA CAST most outstanding properties are its optical transparency (93% light transmission for colourless sheets), its high impact resistance and lightness compared to glass.
POLYCASA CAST is resistant to UV rays, shows good thermal stability, low water absorption and good chemical resistance. It has the best abrasion resistance in our thermoplastic's product range.
POLYCASA CAST sheets are easy to handle and most fabricating and moulding techniques are applicable to it, allowing attractive designs.

3. APPLICATIONS

- Construction
  - Skylights
  - Vaults
  - Glasswork
  - Partition
  - Doors
  - Handrails
  - Window sills
  - Diffusing skylights
  - Enclosures
- Industry
  - Signs / Publicity
  - Security
  - Furniture
  - Sanitary furnishing
  - Gift articles
  - Industrial pieces
  - Solariums
  - Nautical
  - Projection screens

4. FABRICATION AND FINISHING TECHNIQUES

POLYCASA CAST sheets are easy to handle.
Sawing, drilling, gluing, printing, milling, mechanical polishing, vacuum forming, hot bending do not offer any problems to the POLYCASA CAST range.
More detailed information on these items can be found under point "USER GUIDE", further in this brochure.

5. STATEMENTS

5.1. MATERIAL COMPLIANCE

POLYCASA CAST complies with the international standard UNE-EN-ISO 7823-1for non-modified flat PMMA cast sheets. The sheets may be colourless, coloured and transparent, translucent or opaque. In opaque sheets, only the upper face is guaranteed against surface and inclusion defects.

5.2. FOOD APPROVAL STATEMENT

POLYCASA CAST clear material has been tested according to EU directive 10/2011. Some migration tests have been made according to European standard EN 1186. POLYCASA CAST clear can be used in contact with food.

For specific colours, please contact our technical department.

5.3. FIRE CLASSIFICATION ACCORDING TO EUROPEAN STANDARD

- Europe :
  EN 13501-1 (formerly UNE 23.727-90) — Euroclass E (formerly M4)
- USA
  UL 94 — HB

5.4. UL CERTIFICATE

Our products POLYCASA CAST and POLYCASA CAST Design are certificated according to UL requirements: UL 94

5.5. QUALITY MANAGEMENT

The industrial plant where POLYCASA CAST is produced is ISO 9001 certified: IQNet Registration No. ES-0618/2/97 states that POLYCASA Spain S.A. U (Plant La Ferrería) holds the Quality System Certificate issued by AENOR for the scope thereon and for the standard EN ISO 9001 signed for and on behalf of IQNet.

5.6. WARRANTY

All POLYCASA CAST sheets and grades are suitable for outdoor use.

POLYCASA provides a 10 year warranty for flat transparent POLYCASA CAST sheets for minimum light transmission and mechanical properties. The warranty shall come into force the day the POLYCASA CAST sheets are delivered to the customer.

This warranty applies exclusively to standard POLYCASA CAST sheets used correctly as flat sheets which are installed, handled, machined, fabricated and maintained according to POLYCASA recommendations and instructions.

No warranty will be available for sheets that have been exposed to corrosive materials or environments.

Detailed warranty terms and conditions in accordance to CISG (United Nations Convention on Contracts for de International sale of Goods) are available from our customer service department.

5.7. SAFETY DATA STATEMENT

Product Handling Information Sheet for POLYCASA CAST product range are available upon request.

6. TECHNICAL INFORMATION

6.1. TECHNICAL DATA SHEET

GENERAL			
Property	**Method**	**Units**	**POLYCASA CAST**
Density	ISO 1183	g/cm^3	1.19
Water absorption	ISO 62, Method A	%	0.2
Rockwell Hardness	ISO 2039-2	M scale	100
	ISO 2039-2	M scale	105
MECHANICAL			
Property	**Method**	**Units**	**POLYCASA CAST**
Tensile Strength	ISO 527	MPa	75
Elongation	ISO 527	%	6
Tensile Modulus	ISO 527	MPa	3400
Flexural Strength	ISO 178	MPa	120
Flexural Modulus	ISO 178	MPa	3200
Charpy (unnotched)	ISO 179	kJ/m^2	17
Charpy (notched)	ISO 179	kJ/m^2	2
THERMAL			
Property	**Method**	**Units**	**POLYCASA CAST**
Vicat Temp. (VST/B 50)	ISO 306	°C	110
Specific Heat Capacity	ISO 3146-C-60°C	J/g K	2.16
Linear thermal expansion	ISO 11359-2	mm/m °C	0.07
Thermal conductivity	DIN 52612	W/m K	0.19
Max. service temperature continuous use		°C	80
Max service temperature short term use		°C	90
Degradation temperature		°C	>280
OPTICAL			
Property	**Method**	**Units**	**POLYCASA CAST**
Light transmission)	EN 13468-2	%	92
Refractive index	ISO 489	n^D_{20}	1.492
ELECTRICAL			
Property	**Method**	**Units**	**POLYCASA CAST**
Surface resistivity	IEC 60093	Ω	10^{14}
Volume resistivity	IEC 60093	Ω x m	10^{15}
Electrical strength	IEC 60243-1	kV/mm	10
Dielectric strength	DIN EN 60243-1	kV/mm	30
Dielectrical dissipation factor 50 Hz	DIN 53483-2		0.06
Dielectrical dissipation factor 1 KHz	DIN 53483-2		0.04
Dielectrical dissipation factor 1 MHz	DIN 53483-2		0.02
Relative permittivity 50 Hz	DIN 53483-2		2.7
Relative permittivity 1 KHz	DIN 53483-2		3.1
Relative permittivity 1MHz	DIN 53483-2		2.7

Note: These technical data of our products are typical ones; the actually measured values are subject to production variations

6.2. CHEMICAL RESISTANCE

POLYCASA CAST sheets are - at room temperature - resistant to saturated hydrocarbons, aromatic free carburettor fuel and mineral oils, vegetable and animal fats and oils, water, aqueous salt solutions as well as diluted acids and alkalis.
Aromatic hydrocarbons and hydrogen chlorides, ester, ether and ketones attack POLYCASA CAST.

Chemical resistance at 20°C

Acetone	-	Ethyl acetate	-	Acidity of wine	+
Ammonia	+	Glycerine	+	Xylene	-
Amyl alcohol	-	Fuel oil	o	Paraffin	+
Benzene, free from aromatics	+	Hexane	+	Petroleum ether	+
Benzole	-	Isopropanol	o	Phosphoric acid 10%	+
Boric acid	+	Coffee	+	Sulphuric acid 10%	+
Butanol	-	Caustic potash solution	+	Nitric acid 10%	+
Chlorinated hydro-carbon	-	Ketone	-	Hydrochloric acid 10%	+
Chloroform	-	Methylene chloride	-	Hydrochloric acid, conc. 35%	+
Chlorinated water/air	o	Lactic acid 10%	+	Sodium carbonate	+
Dibutyl phthalate	o	Mineral oil	+	Salad vinegar	+
Dioctyl phthalate	o	Caustic soda	+	Stearic acid	+
Glacial acetic acid	-	Nitrocellulose lacquer	-	Tea	+
Acetic essence	-	Oxalic acid	+	Turpentine	+
Aqueous acetic acid	+	Wax	+	Toluene	-
Ethanol	o	Hydrogen peroxide	o	Methylamine	+

\+ resistant
o limited resistance
\- not resistant

6.3. PRODUCT RANGE POLYCASA CAST

SUPPLYING PROGRAMME:

Sheets		Blocks	
Size (mm x mm)	**Thickness (mm)**	**Size (mm x mm)**	**Thickness (mm)**
3050x2030	2.5 to 30	2050 x 1330	40
2030x1520	2,5 to 30	2020 x 1320	45
3000x2000	35	2020 x 1320	50
2000x1500	35	2020 x 1320	60
2650x2030	2 to 20	2000 x 1300	70
		2000 x 1300	80
		2000 x 1300	100

THICKNESS TOLERANCES

- **Sheets**

Nominal thickness (mm)	Tolerances (mm)	Tolerances (mm) (CAST Design/ MAT)
2-5	± 0.5	± 0.6
6	± 0.6	± 0.7
8	± 0.7	± 0.8
10-12	± 0.8	± 0.9
15	± 0.9	± 1.0
18-20	± 1.0	± 1.1
25	± 1.5	± 1.5
30	± 1.8	± 1.8
35	± 1.8	± 1.8

- **Blocks**

Nominal thickness (mm)	Tolerances min (mm)	Tolerances max (mm)
	-1 mm	+2 mm
45	-1 mm	+3 mm
50	-1 mm	+3 mm
60	-1 mm	+3 mm
70	-2 mm	+4 mm
80	-2 mm	+4 mm
100	-3 mm	+5 mm

SIZE TOLERANCES

Sheets

Length or width (mm)	Tolerance (mm)
≤ 1000	+3
1001 – 2000	+6
2001 – 3000	+9
≥ 3001	+0,3%

CUT-TO-SIZE TOLERANCES (UPON REQUEST):

Length or width (mm)	Tolerance (mm)
≤ 1000	± 0.5
1001 – 2000	± 1.0

In case of several cuts on one sheet the tolerances are accumulative

FLATNESS

For sheets with thickness between 5 and 20 mm, a maximum bending of 3 mm/m is assured (measured in vertical).

6.4. SPECIAL PRODUCTS

POLYCASA CAST P

Many plastic sheets and films can be reshaped by thermoforming, and in particular cast acrylic. However, P grade are recommended to optimise the thermoforming process. The use of this speciality saves time in the process with respect to the standard product. In the heating stage of thermoforming, at the same temperature P needs shorter times of heating. That results in energy saving as well. Apart from that, the formulation of P grade allows thermoforming into difficult shapes or when deep moulds are required.

POLYCASA CAST UVP

POLYCASA CAST UVP (extra ultra violet protection) is highly protected against UV radiation. Not only does POLYCASA CAST UVP show higher absorption, but this effect is longer lasting than for the standard. Therefore, it is the optimal material for outdoor applications. Whenever special protection is required (paints, pictures)or the final part will be long and directly exposed to sunrays, POLYCASA CAST UVP is the recommended grade. (see on the plot below the radiation absorption for POLYCASA CAST UVP)

POLYCASA CAST UVT

POLYCASA CAST UVT is transparent to UV-A radiation an partially to UV-B (UV transmitted). For applications like sun beds/solariums, the cast sheets must let part of the UV radiation through. POLYCASA CAST UVT does, but it is opaque to the high energy UV radiation thus prevents fast material degradation. (see on the plot below the radiation absorption for POLYCASA CAST UVT)

POLYCASA CAST PA

A material is accepted as sound proofing when a sound classified as Sound-A conveyed by a road way, when passing through a sound fence has a reduction of the acoustic level of at least 25dB. POLYCASA CAST PA is a sound absorbing barrier that propagates light, so reduces the visual impact in the environment where it is placed. POLYCASA CAST PA (thickness 15 to 20 mm) has the physical and mechanical properties for this application together with the optical requirements like high resistance to UV radiation.

POLYCASA CAST SWS

Sanitary Ware grade is specially formulated to manufacture bathtubs, showers and shower trays. POLYCASA CAST SWS complies with the European Norm EN 263. It shows high thermal stability, optical stability of colours, hot water resistance, both of colours and dimensions, high resistance to household cleaning chemicals. POLYCASA CAST SWS has the optimal properties for the thermoforming process. All sheets are protected on their user-face by a thermo formable PE (polyethylene) film.

POLYCASA CAST

POLYCASA CAST DESIGN /MAT

POLYCASA CAST MAT is a design grade, for certain decorating or lighting application. POLYCASA CAST MAT has surface effect which results in a mat face (satin like) and a standard glossy face.

POLYCASA CAST design is an acrylic sheet with matt surfaces. Due to its intrinsic properties, it is specially designed to intensify light dispersion. Its matt surfaces increase the dispersion effect compared to POLYCASA CAST standard material and make it especially suitable for display applications. By using this material, for example in advertisements or displays, the image will be enhanced and the result will be very clear, whilst maintaining the same mechanical properties as POLYCASA CAST standard sheet.

POLYCASA CAST LUMINA

Is a CAST sheet containing a diffuser in the mass specially indicated to build ultra-slim lighting frames. Its special characteristics drive the light to the surface when the sheet is illuminated through the edges. Light is uniformly distributed in the surface avoiding disturbing shadows. For more information, refer to the technical data sheet.

POLYCASA CAST VISION

POLYCASA CAST VISION is the name for a range of products to be used as projection screens.

- **POLYCASA CAST vision front** is a white opaque rigid screen to be used in frontal projections.
- **POLYCASA CAST vision rear** is a neutral grey coloured sheet specially developed for rear projection, but due to its special transmission values, images can be seen on both sides of the screen simultaneously.
- **POLYCASA CAST vision through** is an almost transparent sheet that allows the projection of images but also permits a clear view through the sheet in zones where no image is projected.

POLYCASA CAST BEAUTÉ

POLYCASA CAST Beauté is the recommended grade for applications which demand a high chemical resistance and thermal stability. Its formulation makes POLYCASA CAST Beauté resistant to solvents, alcohols and aggressive environments. In these situations the chemical attack is delayed and a longer life of the product is ensured by using POLYCASA CAST Beauté. The excellent optical properties, stability and resistance to UV rays remain as in the standard material. Due to its special molecular structure, it would be more difficult to glue with standard acrylic adhesives.

POLYCASA CAST ANTI-BACTERIA

POLYCASA CAST Anti-bacteria is the brand name of POLYCASA PMMA cast sheet endowed with anti-microbial and fungicide protection. Its special characteristics make POLYCASA CAST Anti-bacteria the right choice for the application in places where extreme hygienic conditions are required.

POLYCASA CAST OPTIMA

POLYCASA CAST Optima is the brand name of coloured POLYCASA PMMA cast sheet specially developed to have higher light transmission in the emitting wavelength of coloured LEDs.

POLYCASA CAST FLUOEDGE

Light coloured material with fluor edges, especially for decoration and fashion designs.

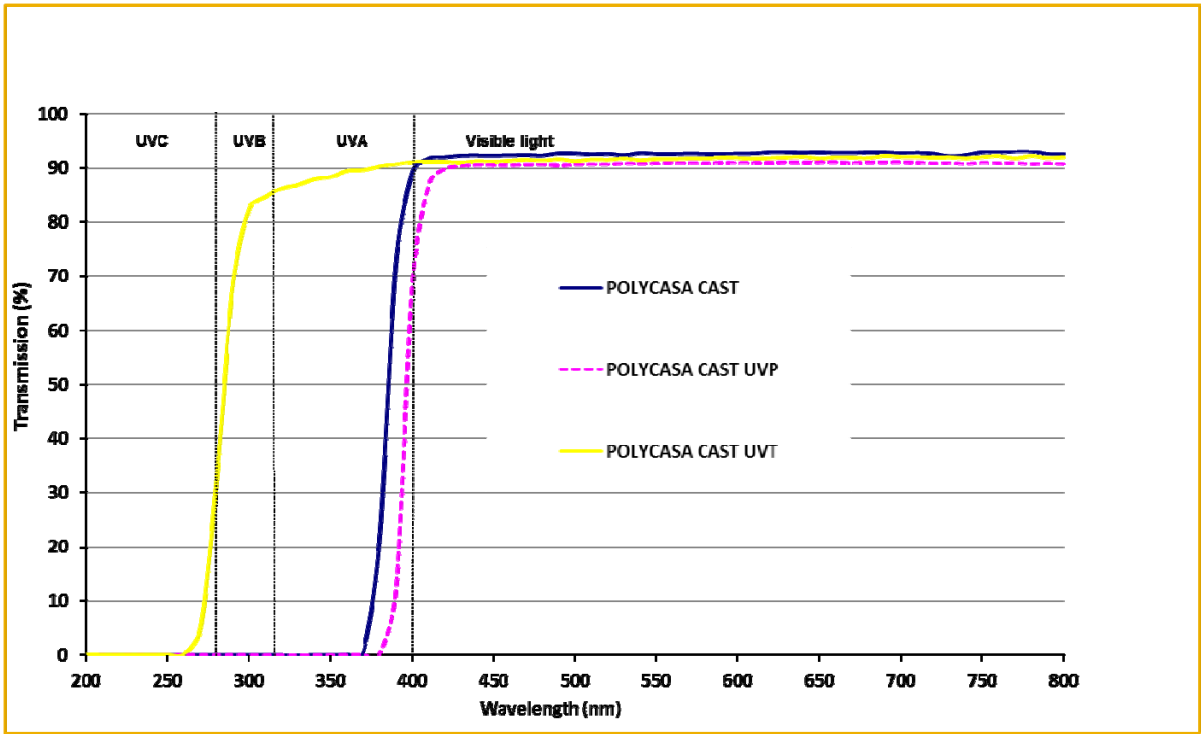
POLYCASA CAST

POLYCASA CAST ARGENTA

POLYCASA CAST Argenta is a special material with two different surfaces:
Sparkling coloured: this surface has a maximum gloss and a deepness effect
Metallic silver: opaque aspect silver metallic

Material is opaque in flat application but it can be easily thermoformed to any shape, gaining light transmission up to an average of 30% (depending on colour reference). The colour of the thermoformed piece has degraded effect changing colour intensity depending on the shape.

Due to inner composition and production process, material has a certain particle orientation. This results in a colour which has different colour shades depending on the visual angle.



Spectrums of light transmission POLYCASA CAST standard, UVP and UVT

7. USER GUIDE

7.1. INTRODUCTION

The manufacture of plastic articles from POLYCASA CAST sheet normally involves secondary fabrication operations, including sawing, drilling, bending, decorating, and assembling. This guide covers the properties and characteristics of POLYCASA CAST that need to be taken into account if secondary operations are to be performed successfully. For those operations that could produce internal stress in the sheets, it is highly recommended that a tempering process is used, as the final step of the production process or before any process as gluing. Tempering means that the sheet should be heated at 70-80°C for half an hour per millimetre of thickness, and then the sheet should be allowed to cool slowly back to room temperature. This simple process will assure a good final quality.

7.2. STORING AND HANDLING

The originally packed plastic sheets should neither be stored outside nor be exposed to great variations of weather and/or temperature. When storing under conditions with substantial variation of temperature and humidity, flat shape distortion (corrugation) of the sheet can happen, even when stored flat and stacked.
Polyethylene film protects sheets against dirt, mechanical load and scratches. It is recommended to leave the protective PE film in place until final processing.
PE protective film is not designed for long-term open-air exposure/protection - it has only moderate UV- and heat-resistance.

Standard POLYCASA CAST sheets are protected with glued film, other possibilities upon request.
When material is protected with thermoformable film (coextruded film), it is not recommended to store the sheets in vertical position.

If sheet is stored outside, without protection, the protective foil should be removed after four weeks' time, as there is a risk of brittleness and difficult removal of the degraded PE film. This could lead to the damage of the sheet surface.
If sheet is stored inside under usual and constant conditions, it is recommended to remove the film 6 months after film application latest.

Depending on storage and climatic conditions, plastic sheets absorb moisture. Although humidity absorption has no practical influence on the physical properties, it may interfere during further processing of the sheets at higher temperatures e.g. during bending, or heating before thermoforming. Therefore, according to the intended use, the sheets may have to be pre-dried (see 7.3.2. Drying).

Differences in temperature and moisture-content between top- and bottom-side of sheet or between different sheet areas can cause different dimension changes inside the sheet. This can sheet bending after short time. It is recommended to store the sheet under constant temperature- and humidity-conditions on a plane support.

7.3. MATERIAL PREPARATION

7.3.1. Cleaning

Protection film removal will induce a build-up of the electrostatic charge on the sheet surface. This electrostatic charge attracts airborne dust, and other fine particles. Therefore, prior to further processing, it is recommended to clean the sheet by antistatic treatment (e.g. blowing by ionised compressed air or cleaning by hand with a cloth wetted with suitable antistatic agents).
This is particularly important prior to thermoforming process, as dust or dirt particles will cause imprints on the moulded surface.
Water will be enough for both cleaning and care of the sheets. In case of excessive dirt, clean with warm water and a weakly alkaline or neutral, non-abrasive cleaning.
Sheets should be dried with a soft cloth or with chamois leather.
Dry scrubbing of the surface can cause scratches and possible damage.
Very greasy and oily surfaces should be cleansed with aromatic -free fuel or petroleum ether.
Other chemicals suitable for cleaning POLYCASA CAST sheets are:

- Diluted acids such as citric acid, hydrochloric acid, sulphuric acid
- Diluted caustic soda or caustic potash solution
- Common vinegar
- White spirit, neutral soap and household detergents.

7.3.2. Drying

As with most plastics, POLYCASA CAST sheets absorb moisture during storage (always less than 0.5%).

Whilst processing at higher temperatures, this can produce bubbles; therefore, pre-drying below softening point temperature is advisable. Normally the pre-drying of sheets with high moisture contents in an oven with air circulation, 24 hours at 80°C for POLYCASA CAST, will suffice.
To achieve good drying results, air circulation between the sheets must be ensured; the protection foil must be removed before drying.

POLYCASA CAST sheet must be cooled down slowly to avoid repeated induction of moisture or internal stress due to cooling down too fast after drying. The maximum cooling speed after drying has to be less than 15°C per hour; the maximum oven temperature from which the sheet may be removed is 60°C.

Preliminary tests are recommended.

In general, POLYCASA CAST sheets not need to be pre-dried prior to thermoforming, provided that the material has been adequately stored and the foil is undamaged.
To minimise costs, the drying heat should be exploited by immediate follow-on forming after the drying process.

7.3.3. Dimensional change

There are no orientation forces involved in cast process, although during polymerisation some stress can remain on the final sheet.

When the sheet is to be heated e.g. before thermoforming, this stress became apparent in shrinkage of the sheet. The shrinkage is homogeneous in both directions (non directional process).

Such dimensional change has to be taken into consideration when cutting sheets to be thermoformed.

When the material is heated and fixed in a clamping frame, no material shrinkage will arise.

As the shrinkage value depends on both heating temperature and heating time, preliminary tests are advisable.

Maximum shrinkage values of POLYCASA CAST safely comply with ISO 7823-1:

Sheet Thickness	Amount of shrinkage
up to 6 mm	≤1.5%
8 mm up to 12mm	≤2.0%
15 mm up to 30 mm	≤ 2.5%

7.3.4. Thermal linear change

Like nearly all materials and especially thermoplastic materials, POLYCASA CAST is subject to linear change at variable temperatures. Plastics show higher linear change than metals, and this must be taken into account when mounting POLYCASA CAST sheets into frames.

POLYCASA CAST shows a coefficient of linear thermal expansion of 0.07 mm/m °C.

When mounting POLYCASA CAST sheets, attention must be paid to the elongation clearance in order to avoid damage during material usage.

For more technical data - see chapter „7.8 Glazing“.

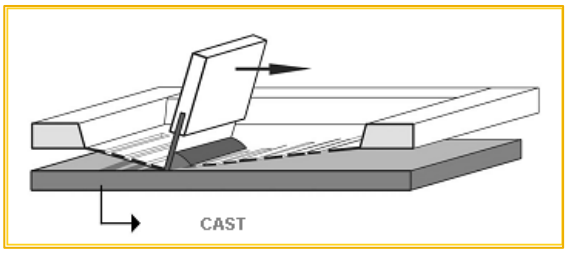
7.3.5. Dimensional change effected by moisture content

POLYCASA CAST absorbs moisture during storage and application. Beyond the thermal linear change, the content of moisture can effect an additional dimensional change up to 0.5%. When mounting POLYCASA CAST sheets, attention must be paid to the elongation clearance in order to avoid damage during material usage.

Variation and differences in moisture content between interior and outside surface of a sheet (e.g. swimming-pool glazing, terrarium, greenhouse, winter garden) effect different elongation between the sheet surfaces. This difference can cause curvature of the mounted sheet. This curvature can be avoided by choosing an applicable higher thickness of sheet, in order to get inherent stability. Preliminary tests are recommended.

7.4. SURFACE TREATMENT

7.4.1. Printing



Silk-screen printing is the most commonly used method for printing POLYCASA CAST and allows the creation of a wide range of graphics.
Distortion screen printing allows the flat sheet to be formed after printing into a three dimensional article with correct print register. Allowance must be made for "stretching" of the image when designing the graphics.
Halogen spotlight systems should not be used when thermoforming printed sheets.

During the silk-screen print process, the high-viscous ink is pushed through a photochemical pre-treated screen print fabric (polyamide or polyester) by mechanical action or by means of a hand-operated scraper. The ink is transferred to the sheet beneath the screen fabric.
In order to avoid stress cracking of POLYCASA CAST, only acrylic compatible inks must be used. The lacquer systems must be suitable for the intended application. Where necessary the sheet has to be tempered, pre-dried or cleaned before application of ink, to avoid stress cracks and adhesion problems. Preliminary tests are recommended.

Addresses of appropriate ink suppliers can be obtained from the Technical Service Department upon request.

Spray painting is another popular method for decorating sheet after moulding. Only ink or paints suitable for use with acrylic sheets should be used.

7.4.2. Laminating

The application of decorating foils or self-adhesive lettering or transfers is only suitable for flat or slightly curved sheets. Care should be taken that adhesive foils are used which not produce stress cracking of POLYCASA CAST sheets.
Evaporation may cause partial separation of the self-adhesive film; therefore POLYCASA CAST sheets should be pre-dried overnight at a temperature of 70 - 80°C. Impurities such as dust particles can also lead to partial foil removal, which will impair the appearance of delamination. Where necessary the sheet has to be tempered or cleaned before application of ink, to avoid stress cracks and adhesion problems. Preliminary tests are recommended.

Addresses of appropriate adhesive foil suppliers can be obtained from the Technical Service Department upon request.

7.5. MACHINING

7.5.1. General recommendations

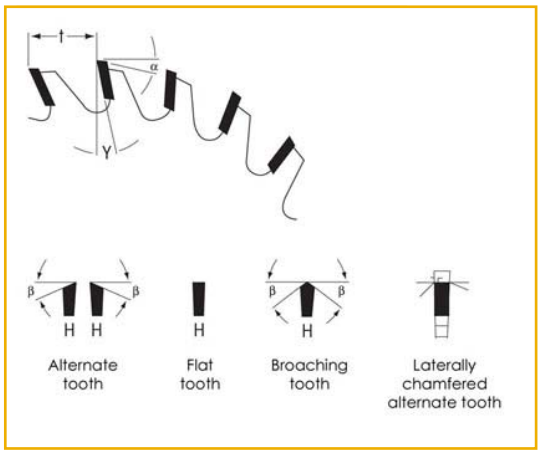
POLYCASA CAST sheet can be worked with most tools used for machining wood or metal. However, the experience gained in machining metals cannot be directly transferred to plastics.

- Plastics do not conduct heat as effectively. Therefore, the heat resulting from friction during machining does not dissipate readily from the material. The heat generated by machining operations must be absorbed by the tool or carried away by coolant. A jet of air directed on the cutting edge aids in cooling the tool and in removing chips.
  Plain water or soapy water is sometimes used for cooling unless the trim scrap is to be reused.
- Plastics exhibit a high degree of thermal expansion. When plastics are cut, the saw blade may become stuck or undesired dimensions obtained when drilling.
- Plastics are sensitive to notch and crack. Machined cuts must be smooth to maintain the mechanical load-bearing capacity of the plastic.
- Plastics exhibit less strength than metals. Machining therefore requires lower forces.

It is important to keep cutting tools sharp at all times. Hard, wear-resistant tools with greater cutting clearances than those used for cutting metal are suggested. High-speed or carbon-tipped tools are efficient for long runs and provide accuracy and uniformity of finish.

7.5.2. Sawing

Circular saws, band saws and jig saws can easily be used to work POLYCASA CAST. The use of new and well sharpened tools is recommended. When using circular saws, blades with tungsten carbide-tipped cutting edges have proven effective. At very high cutting speeds and cut-off frequency respectively, the saw blade should be cooled by compressed air, water spray or using an adequate cooling emulsion.



It is very important to employ an efficient saw dust extraction system to remove saw dust and chips generated by the saw blade.

Band saws are frequently used to trim the mouldings. The cut edge remains quite "rough" due to the slightly "crossed" saw teeth.
Jigsaws can cut out recess clearances. The cut edge often turns out to be rough.
Only saw blades should be used which are suitable for acrylic treatment.
When working with jigsaws, the shoe of the jigsaw must be tightly pressed to the surface of the sheet and a high cutting speed should be selected. The rotary stroke should be switched off, especially when using thin sheets.

The sheets must be adequately fixed to avoid saw chattering or vibrating.

Table 1
Sawing recommendations

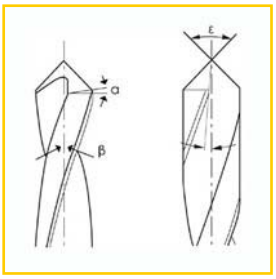
Band saw/circular saw machining	**Band saw**	***Circular saw***	**Jigsaw**
Clearance angle α	30-40°	15-20°	Commercially available saw blades suitable for acrylic
Rake angle γ	0-8°	0-5°	
Cutting speed	1000-3000 m/min.	3000 m/min.	
Circular pitch t	3-8 mm	10-20 mm	

7.5.3. Drilling

Commercial quality twist drills for metal can be used. The point angle should be adapted to about 60°-90°. Best drilling capacity is achieved with a cutting speed of 25-80 m/min and a feed rate of 0.1-0.2 mm p. r.
Excessive feed rate will cause brittle fracture of material; low feed rate at high cutting speed will lead to material overheating.
Material thickness beyond 5 mm will require cooling and lubrication with acrylic compatible drilling emulsion or bore oil.

Deep-hole boring requires frequent airing of the drill in order to prevent local overheating.
When drilling thin sheets, it is advisable to fix them on a solid, flat support to avoid brittle breaks of the lower edge of the drilled hole.

Drilling of POLYCASA CAST	
Clearance angle α	3 – 8°
Twist angle ß	12 – 16°
Point angle ε	60-90°
Rake angle γ	0 – 4°
Cutting speed (m/min)	25 - 80



7.5.4. Thread cutting

Internal thread cutting in POLYCASA CAST sheets is feasible with commercially available taps. Tools producing threads with slightly rounded core diameters are particularly suitable. Compared to steel, the core drilling clearance should be about 0.1 mm larger. Thread cutting requires frequent chip discharge with compressed air. Only cooling lubricants compatible with acrylic should be used.

Follow-on screw fitting implies that the metal screws employed are oil film-free or protected against corrosion by means of an oil compatible with acrylic. Fixings which are frequently removed should be provided with threaded inserts.

7.5.5. Milling

Universal, profile, spindle moulding and hand milling cutters at cutting speeds up to 4500 m/min can be used for milling POLYCASA CAST sheets.
Small tool diameters require the application of one or two-edged milling cutters. They offer perfect removal of chips, high cutting speed and an excellent milling pattern.
When using one-edged milling cutters, the clamping chuck must be carefully tightened to avoid component marks on the sheet.
Cooling is not always required when milling POLYCASA CAST sheets with one or two-edged end mills, as they produce less heat than multi-edged end mills.

7.5.6. Laser cutting

POLYCASA CAST sheets are easy to cut with a CO_2- laser. Brilliant edges can be achieved but this can vary depending on type, thickness and surface treatment. The laser operating efficiency should amount to 200 – 1000W. Inert gas rinsing and extraction of monomer vapours must be ensured. Final edge appearance will be related to a good balance between power and speed (too much power can burn the material; too much speed can cause stripes in the edge due to laser vibration).
Some specific opaque colours, due to the high charge of pigment, might have a less brilliant appearance in the edge after laser cutting.

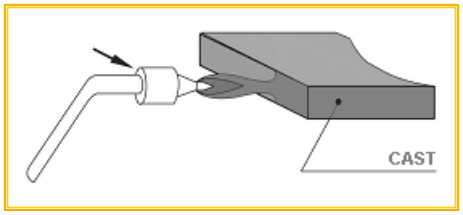
Preliminary tests are essential in order to determine exact positioning in each case.
Inclined edges of cut, not being square to the sheet surface, will result from increasing material thickness. Nd-YAG lasers permit excellent engraving of POLYCASA CAST. Sheets can be engraved inside keeping flat surfaces.
High thermal load in the cut edge zone generates stresses liable to produce stress cracking when being in contact with corrosive substances (during bonding process for example).
Tempering of components will prevent cracking by stress relief at a temperature of 80°C (see chapter 7.7.3 „Tempering“).

7.5.7. Water jet cutting

Similarly to laser cutting, the possible cutting speed depends on both thickness of the material to be cut and desired cutting quality.
Unlike laser cutting, the cut edges look “sand-blasted” as a result of water jet cutting. No thermal stresses occur in the material when using water jet cutting technique.
The water used for cutting POLYCASA CAST sheets contains abrasive additives.
Good results are achieved with a cutting speed of 1500 - 2000 mm/min and a material thickness of 4 mm.
A feed rate of 400 - 800 mm/min and a material thickness of 10 mm will produce good results.

7.5.8. Polishing

Prior to hand-operated polishing, the sheet must be ground. Hand-operated grinding requires the use of 80-600-grit abrasive paper as well as several grinding work cycles from rough-grind up to finish-grind. Mechanical grinding should be done with belt grinders and a belt speed of 5 - 10 m/s. High surface temperatures can be avoided by lightly pressing on the work piece. Polishing is made with buffing or fleece polishing wheels, polishing felts and adequate polishing wax.

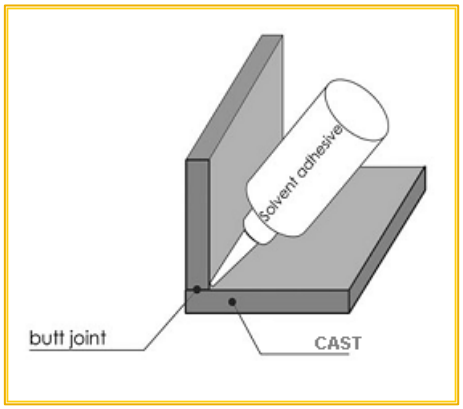


Polish-milling with diamond-tipped tools is another process option. The surface quality is such that no further treatment is required. Polish-milling - in one single work cycle without rough-grinding – will produce excellent finish. No internal stress occurrence; tempering which is essential to other procedures, becomes redundant.

Flame-polishing of POLYCASA CAST does not require additional grinding work cycles. The edges to be polished must be sawdust free and oil free.
Sawing and milling lines may still be visible - even after polishing. Improved surface finish is achieved by treating the sawn edge with an iron scraper prior to flame polishing.
Coloured material with a high quantity of pigment in the formula often shows matt edges.
Flame polishing is not recommended for sheets with a thickness of more than 20 mm because of local overheating and resultant stresses.
If followed by contact with corrosive substances such as solvents, glues or inappropriate cleaning agents, tempering will be essential.

7.6. JOINTING

7.6.1. Bonding

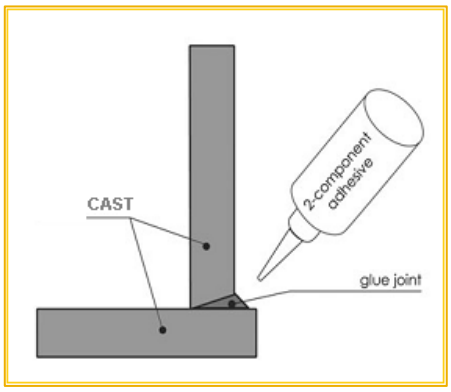


The joint faces must be cleaned prior to bonding. Use warm water containing some washing-up liquid, if necessary; dry with an absorbent, lint free fabric (e.g. glove material). Highly greasy or oily surfaces can be washed with hexane or petroleum ether.
The components to be bonded should be tempered to release stresses prior to bonding in order to avoid potential stress cracking (crazing) due to the reaction with the solvent glue; this applies especially to components having been machined by metal-cutting tools or cut by laser.

Solvent adhesives are particularly suitable for small and plane bonding surfaces. As the solid content of such glues is low, they have no joint filling capability. When bonding the sawn edge, smoothing the surface to be bonded using sharp edge scraper can reduce possible bubble formation.
Immersion technique implies that the edge to be glued is dipped into solvent or solvent adhesive, which is poured approx. 1 mm high onto a glass or PE sheet; the parts are afterwards firmly jointed.

POLYCASA CAST

Capillary method offers a simple technique for jointing and fixing of the parts. Solvent adhesive/solvent, is applied onto the bonding surface by means of a PE-vial and is soaked into the glued seam due to the capillary effect; a few seconds later, the joint should be firmly pressed together to set the joint.



Polymerisation adhesives are also suitable for large and uneven bonding surfaces. Planar bonding is possible.
The pasted seam must be prepared by chamfering; this does not apply to butt joint bonding. The adjacent sheet area must be masked with an adhesive compatible tape. The adhesive must be mixed as prescribed by the adhesive supplier. Removal of bubbles in vacuum is possible.
The adhesive must be applied bubble-free by means of a PE-vial or a disposable syringe. Excess adhesive must be provided, as the polymerisation adhesive exhibits volume shrinkage during curing.
Silicones are often used to seal glazing. For this purpose, only silicones compatible with acrylic must be employed. Silicone sealants as found in DIY centres, give off substances during curing which will result in stress cracks of the glued components.

When using solvents in POLYCASA CAST sheet assembly, it is advisable that the work area be climate controlled with low humidity to minimise joint "whitening". If this is not possible, the addition of 10% glacial acetic acid to the solvent or use of a slower curing cement-type bond is suggested.
Fixture pressure must be maintained to prevent movement of the joint until it is solid.
Good ventilation is required when working with solvents. Exposure levels must be controlled according to OSHA guidelines

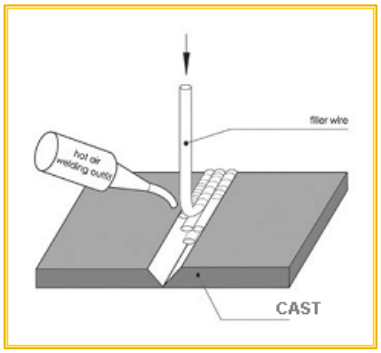
Our technical service department will provide you with information on appropriate products.

POLYCASA can provide the following*:

Glue	Base	Description
Colacril 20	Solvent	Does not fill in joints
Colacril 30	Solvent/polymer	Fills in joints, UV protected
Colacril 75	2 component	Strong bonding, Fills in joints, UV protected, Free of solvents

* Please, ask your sales representative if glues are available for your geographical zone

7.6.2. Welding



Hot-gas welding is the most frequent welding technique used for POLYCASA CAST sheets.

The strong heating of the weld zone and the cooling effect from the adjacent sheet surface areas result in tensile stress formation after cooling which must be relieved by tempering, as they will lead to stress cracking when in contact with solvent and adhesives. Quadratic sheet strips of POLYCASA CAST, round rods or sheet strips of PVC rigid will serve as filler material.

Gas-welding temperature should amount to 280 - 350°C.

More technical data:

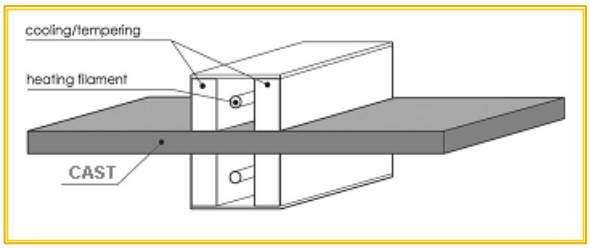
Welding pressure/3 mm rod:	20 Newton
Welding speed:	150 to 250 mm/min
Distance from nozzle to Welded joint:	10 to 20 mm
Air mass:	about 25 l/min

The die diameter should be more or less the same as the filler rod diameter.

7.7. FORMING

7.7.1. Hot bending

Hot bending technique means extended heating of the sheets followed by bending and fixing until the sheets have cooled down.



Extended heating is carried out by filaments or heating rods.

The heating time depends on the equipment employed and will rise considerably according to increased material thickness.

The bend radius must be twice as big as the material thickness in order to prevent wrinkles and high stresses.

Visual appearance of the inner bend can be improved by using the biggest possible bend radii and thin sheets.

The heating width should be at least 3 to 5 times larger than the sheet thickness. A heating width of 3 times the sheet thickness is adequate for small bend radii.

Too small heating zones will lead to excessive elongation and straining in the bend area and - as a result - to optical impairment.

Large heating widths will enable production of big bend radii.

Due to the memory effect, the exact angle specifications must be determined by preliminary tests.

If bending is performed too cold, stresses will be created that will result in a brittle part; however, overheating can cause bubbles in the bent area. Before heating, the protection film must be removed from at least the two sides of the zone to be heated.

7.7.2. Thermoforming

There are a number of different thermoforming techniques that can be used to form POLYCASA CAST sheet, once heated, into the shape of a mould by mechanical, air pressure, or vacuum forces. Both male (plug) and female (cavity) moulds are used. Tooling can range from low cost plaster moulds to expensive water cooled steel moulds, but cast aluminium is more commonly used. Other materials including wood, gypsum, and epoxy can also be used. Forming processes to be discussed include straight vacuum, drape, matched mould, pressure-bubble plug-assist, plug-assist pressure, vacuum snap-back, pressure-bubble vacuum snap-back, trapped-sheet contact-pressure, free, and mechanical. In the event that during the heating up of POLYCASA CAST small bubbles appear, this is due to the fact that the sheets have absorbed moisture during storage. In general, POLYCASA CAST does not need pre-drying. Successful forming will be achieved if homogeneous temperature in the sheet is ensured when heating.

The average forming temperature varies between 140° and 190°C (depending on the heating equipment, the type of material, the degree of forming and the material thickness). The mean value of the forming temperature is about 175°C. The mould temperature should be 60° - 85°C. After thermoforming, the cooling procedure must be slow and uniform. Standard glued film is removed prior to heating. Coextruded film can be supplied upon request for thermoforming applications.

- **Straight vacuum forming:**

Vacuum forming is the most versatile and widely used forming process. The equipment costs less and is simpler to operate than most pressure or mechanical systems. In straight vacuum forming, POLYCASA CAST is clamped in a frame and heated. When the hot sheet is in an elastic state, it is placed over the female mould cavity. The air is then removed from the cavity by vacuum, and atmospheric pressure then forces the hot sheet against the contours of the mould. When the POLYCASA CAST sheet has cooled sufficiently, the formed part can be removed. Thinning at the upper edges and narrow angles of the part usually occurs with relatively deep moulds. The hot sheet being drawn to the centre of the mould first causes thinning. Straight vacuum forming is normally limited to simple, shallow designs. See figure 3

- **Drape forming:**

Drape forming is similar to straight vacuum forming except that after the POLYCASA CAST sheet is framed and heated, it is mechanically stretched, and a pressure differential is then applied to form the sheet over a male mould. In this case, however, the sheet touching the mould is close to its original thickness. It is possible to drape-form items with a depth-to-diameter ratio of approx. 4 to 1; however, the technique is more complex than straight vacuum forming. Male moulds are easier to build and generally cost less than female moulds; however, male moulds are more easily damaged. Drape forming can also be used with gravitational force alone. For multi-cavity forming, female moulds are preferred because they do not require as much spacing as male moulds. See figure 4

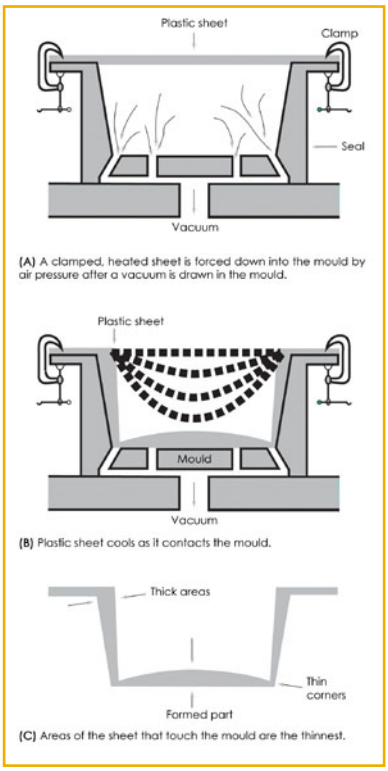


Figure 3

Straight Vacuum Forming

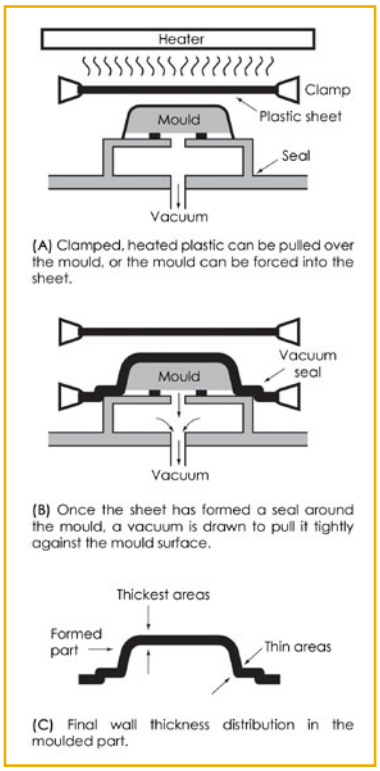


Figure 4

Drape Forming

Matched mould forming:

Matched-mould forming is similar to compression moulding in that heated POLYCASA CAST sheet is trapped between male and female dies made of wood, plaster, epoxy or some other material. Although they have a higher cost, water-cooled matched moulds produce more accurate parts with close tolerances.

Pressure-bubble plug assist vacuum forming:

The pressure-bubble plug-assist vacuum forming technique can be used when POLYCASA CAST sheet is to be formed into deep articles that must have good thickness uniformity. The sheet is placed in a frame and heated, and controlled air pressure is used to create a bubble. When the bubble has been stretched to a predetermined height, the male plug-assist (normally heated) is lowered to force the stretched sheet into the cavity. Plug speed and shape can be varied for improved material distribution; however, the plug is made as large as possible so that the plastic material is stretched close to the shape of the finished product. The plug should penetrate 75 to 85% of the mould cavity depth. Air pressure is then applied from the plug side while a vacuum assist is being drawn on the cavity. The female mould must be vented to allow the escape of trapped air.

Plug-assist pressure forming:

Plug-assist pressure forming is similar to plug-assist vacuum forming in that a plug forces the hot POLYCASA CAST sheet into a female cavity. Air pressure applied from the plug then forces the plastic sheet against the walls of the mould. Plug design and plug speed can be varied to optimise material distribution.

Plug-assist vacuum forming:

Corner or periphery thinning of cup- or box-shaped articles can be prevented by use of a plug-assist to mechanically stretch and pull additional plastic material into the female cavity. The plug should be 10 to 20% smaller than the mould and should be heated to just under the forming temperature of the sheet. Once the plug has forced the hot sheet into the mould cavity, air is drawn from the mould to form the part.

Plug-assist vacuum forming and plug-assist pressure forming (see previous section) allow deep drawing and permit shorter cooling cycles and good wall thickness control. Both processes require close temperature control and are more complex than straight vacuum forming.

Free forming:

In free forming, air pressures of about 2.76 MPa can be used to blow a hot POLYCASA CAST sheet through the silhouette of a female mould. Air pressure causes the sheet to form a smooth bubble shaped article such as used in skylight panels or window well covers. Since only air touches each side of the pad, there will be no mark-off unless a stop is used to form a special contour in the bubble.

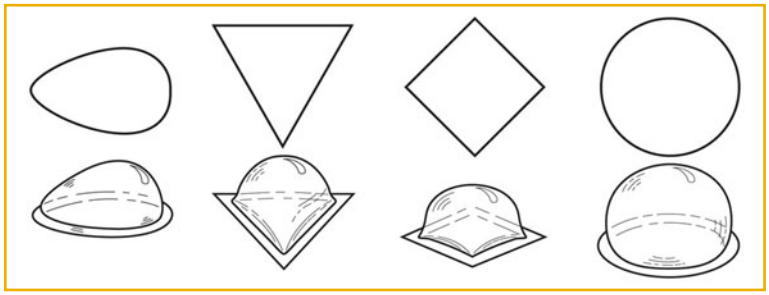


Figure 5
Examples of free-form shapes that can be obtained with openings

7.7.3. Tempering

POLYCASA CAST has a low residual stress after production, not causing any problem in normal applications. Tensile stresses are induced by machining, laser-cutting, thermoforming, varying heating and external stresses, for instance.

Tensile stresses expand the material structure thus reducing the resistance to environmental conditions. The effect of printing ink solvents, monomer vapours, sealing and foil plasticisers as well as inappropriate cleaning agents may result in crack formation when stress is present.

Crack formation will be excluded by stress free components. Therefore, generation of tensile stresses and contact with corrosive substances must be avoided.

As accidental contact with corrosives cannot be ruled out, tensile stresses must be avoided. Stress relief tempering of the parts can achieve reduction of internal stresses. External stresses must be excluded by using adequate fastening systems.

Tempering of POLYCASA CAST should take place in heating cabinets with air circulation, at a temperature of 70 - 80°C.
It is recommended to temper without protection film.

Material thickness (mm)	2	3	4	5	6	8	10	12	15	20	25	30
Tempering duration (h)	2	2	2	2	3	3	4	4	5	6	7	8

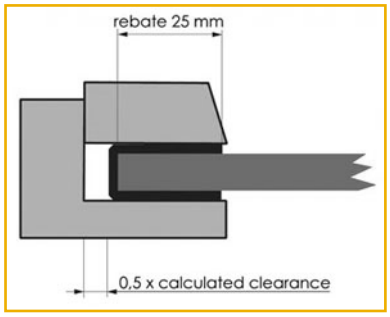
POLYCASA CAST sheets must be cooled down slowly to avoid repeated induction of the internal stress or moisture due to cooling down too fast after annealing. The maximum cooling speed after annealing has to be less than 15 °C per hour.

The maximum oven temperature from which the material may be removed is 60°C.

7.8. GLAZING

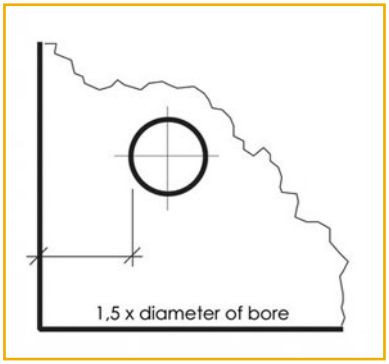
POLYCASA CAST expands under heat and moisture absorption and contracts in cold and dry weather. The linear change solely due to the change in temperature can be determined by calculating the coefficient of thermal expansion.

POLYCASA CAST shows a coefficient of thermal expansion of 0.07 mm/m °C.



The linear change must be allowed during the sheet's storage time. The maximum expected value of linear deformation depends on the temperature used when mounting the sheets.
An adequate free space of 5 mm/m should be kept with POLYCASA CAST.
The rebate should be approx. 20 – 25 mm deep.

To achieve glazing impermeability to rain water, only sealing agents shall be used which are compatible with acrylic sheet Construction and sealing material must allow the movement of sheet inside the profiles due to dimensional changes of sheet.
Profiled EPDM joints, preferably in white, have proven to be successful in heat loss avoidance. In most cases, profiled joints of non-rigid PVC and PUR foam are incompatible, due to the migration of plasticizers.



The drilled holes must be adequately dimensioned when fixing to specific points, in order to also allow for a sheet length clearance of 0.07 mm/m °C.

In that case, sheet length is deemed to be the greatest existing distance between two holes. To avoid material breaking at the sheet edge, a distance of 1.5 times the hole diameter must be left.

7.8.1. Vertical and horizontal glazing

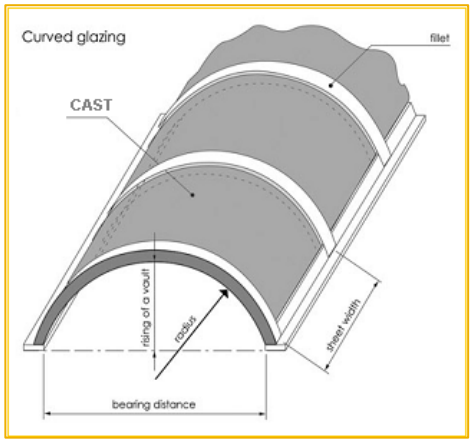
The required material thickness for glazing can specified according to the following table. Material thickness needed for glazing primarily depend on sheet size.

A static charge of 750 N/m^2 is taken as basis for the recommended material thickness in mm.

POLYCASA CAST (material thickness)										
		Length (m)								
		0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
Width (m)	0.5	3	4	4	4	4	4	4	4	4	4
	1.0	4	6	8	8	8	8	8	8	8	8
	1.5	4	8	10	10	12	12	12	12	12	12
	2.0	4	8	10	12	15	15	-	-	-	-

Information on deviating surface loads or sizes is available from our application technology department upon request.

7.8.2. Barrel vaults



POLYCASA CAST is suitable for cold bending technique. This method facilitates the application of thinner material gauges compared to plane roofing, as an increased self-rigidity of the sheet is achieved due to the change in geometry.

In order to exclude material damage caused by tension stress and environmental influences, the min. bending radius must not be less than 330 x the sheet thickness. As far as fixing and sealing are concerned, only materials not having corrosive (crazing) effect on POLYCASA XT should be used.

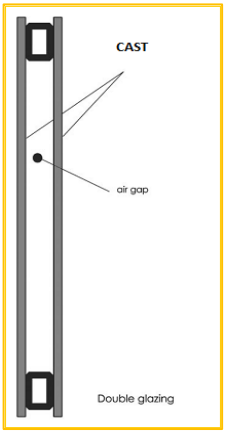
Recommended material thickness in mm at a given surface load of 750 N/m^2 can be obtained from the following table.

Information on recommended material thickness in case of various surface loads is available from our Technical Service Department upon request.

POLYCASA CAST						
		Fixing span (mm)				
		500	750	1000	1250	1500
Radius r (mm)	1000	3	3	3	3	
	1500	3	3	4	4	4
	2000	3	4	4	5	5
	2500	4	4	5	5	6
	3000	4	5	5	6	6
	3500	4	5	6	6	8
	4000	5	5	6	8	8
	4500	5	6	8	8	8
	5000	5	6	8	8	8

POLYCASA CAST

7.8.3 Thermal insulation



POLYCASA CAST sheets when used for glazing represent considerable energy cost savings as they prevent excessive heat loss in winter and heat intrusion in summer. The heat loss factor of POLYCASA CAST normally referred to as K-value is significantly lower than for glass of the same thickness. The K-value is the parameter which identifies the heat loss of a building with glazed walls.

Definition: The K-value (U-value) identifies the heat loss in watt per m^2 wall surface and per °C difference in ambient temperature of premises separated by the sheet.

The K-value depends on the glazing assembly. Examples of the thermal insulation power of POLYCASA CAST in single, double and triple glazing systems are indicated below. Compared to glass, they show significant advantages as to insulating effect and weight reduction.

Installation			POLYCASA CAST		Window glass	
Sheet thickness (mm)	Air gap (mm)	Composite strength (mm)	K-value (W/m^2*K)	Weight (kg/m^2)	K-value (W/m^2*K)	Weight (kg/m^2)
Single glazing						
2	-	2	5,54	2,38	5,83	4,96
3	-	3	5,39	3,57	5,80	7,44
4	-	4	5,24	4,76	5,77	9,92
5	-	5	5,10	5,95	5,74	12,40
6	-	6	4,96	7,14	5,71	14,88
8	-	8	4,72	9,52	5,66	19,84
10	-	10	4,49	11,90	5,60	24,80
Double glazing						
2	5	9	3,34		3,55	
2	10	14	2,94	4,76	3,10	9,92
2	15	19	2,77		2,91	
3	5	11	3,23		3,53	
3	10	16	2,85	7,14	3,09	14,88
3	15	21	2,69		2,90	
4	5	13	3,12		3,50	
4	10	18	2,77	9,52	3,07	19,84
4	15	23	2,62		2,88	
5	5	15	3,02		3,48	
5	10	20	2,69	11,90	3,05	24,80
5	15	25	2,55		2,87	
Triple glazing						
2	2 x 5	16	2,39		2,55	
2	2 x 10	26	2,00	7,14	2,11	14,88
2	2 x 15	36	1,84		1,94	
3	2 x 5	19	2,30		2,53	
3	2 x10	29	1,94	10,71	2,10	22,32
3	2 x 15	39	1,79		1,93	
4	2 x 5	22	2,22		2,52	
4	2 x 10	32	1,88	14,28	2,09	29,76
4	2 x 15	42	1,74		1,92	
5	2 x 5	25	2,15		2,50	
5	2 x 10	35	1,83	17,85	2,08	37,20
5	2 x 15	45	1,70		1,91	

8. CONCLUDING REMARKS

For more details on further processing methods, please contact our technical customer service.

NOTE:

Our technical recommendations are without legal obligation.

The information given in this brochure is based on our knowledge and experience to date. It does not release the user from the obligation of carrying out their own tests and trials, in view of the many factors that may affect processing and application; neither do they imply any legally binding assurance of certain properties or of suitability for a specific purpose.

It is the responsibility of those to whom we supply our products to ensure that any proprietary rights and existing laws and legislation are observed.

Technical data of our products are typical ones; measured values are subject to production variation.