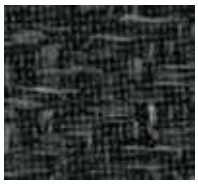
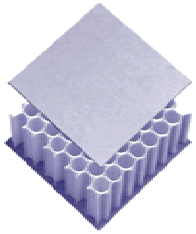
MonoPan®

The Future in Material Technology





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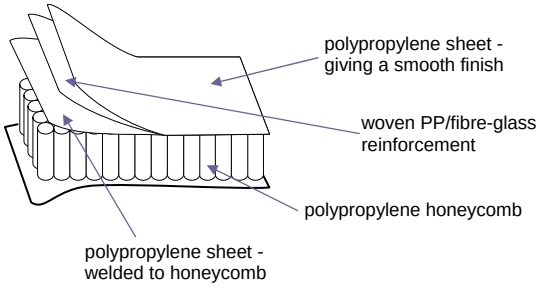
MonoPan® Overview

Structure

- MonoPan® is a composite sandwich panel
- Comprised of polypropylene, the thermoplastic lightweight panel consists of a polypropylene-honeycomb and woven fibre-glass reinforced polypropylene face-sheets
- The face-sheets are fusion bonded with the core being a world first for this remarkable new product.



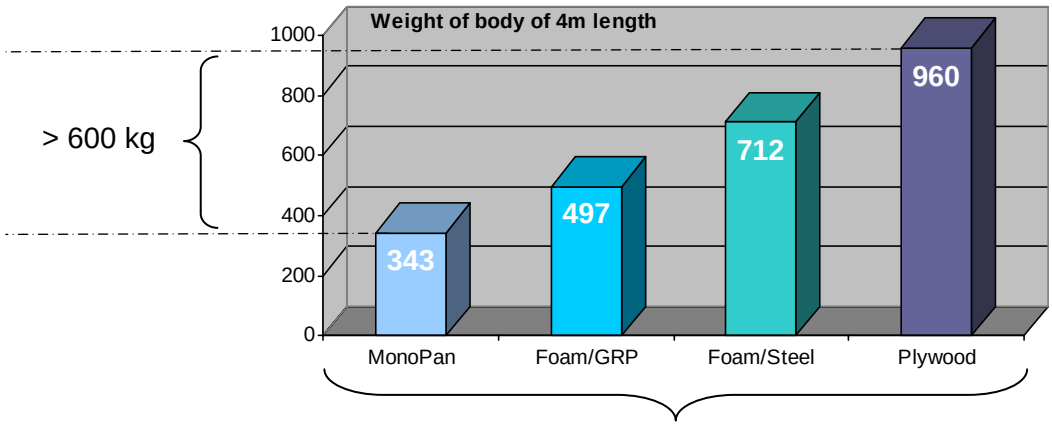
Advantages

- **DURABLE**
  MonoPan® is impressively strong, impact resistant, rigid and extremely resilient to physical stressing and damage
- **LIGHT WEIGHT**
  MonoPan® is remarkably lightweight. For example, with a MonoPan® truck-body assembly you will dramatically improve your payload ratio. You can transport up to 70% more payload with a 3.5 ton vehicle - approximately 600 kg in comparison with a truck-body assembly made of plywood
- **EASY TO JOIN AND ASSEMBLE**
  Panels can easily be joined by screws, bolts, pop-riveting, gluing and plastic-welding
- **RESISTANT TO CLIMATIC CONDITIONS**
  MonoPan® is a thermoplastic. Even so, it can be put to use in a temperature range of –40° to +80° Celsius
- **WATERPROOF AND IMPERMEABLE**
  A special property of MonoPan®. The material is impervious, resistant to salt-water and is not hygroscopic when the surface is damaged
- **EXCELLENT CHEMICAL RESISTANCE**
  MonoPan® offers high resistance against oils, fats and commonly used agents
- **WILL NOT DELAMINATE, ROT OR RUST**
- **ENVIRONMENTALLY FRIENDLY**
  When you decide on MonoPan® you are actively contributing to the preservation of the environment
  - **Eco-friendly** Vehicles that are significantly lighter consume much less fuel and produce less noxious emissions
  - **Recyclable** MonoPan® is 100% recyclable. MonoPan® is a compound of polypropylene and fibre-glass without other additives, such as adhesives.

Weight Data

MonoPan® is the lightest material which is currently used for commercial vehicles!

- Weight difference of existing materials for a 4m long rigid truck body -



- Compared to a plywood body, a weight advantage of more than 600 kg per body can be gained.

Area Weight

Calculation of the area weight per square metre

The following table shows how the area weight per m² can be calculated in a straightforward way - base weight plus add weight for core and panel thickness.

Example: MonoPan®, 30 mm thickness, standard honeycomb (PP80) and 0.7 mm face-sheets.

Base weight for MonoPan® with 0.7 face-sheets	2,38 kg/m²
Addition for core: density × thickness = 0,080 × 30 =	2.40 kg/m²
Total =	4,78 kg/m²

MonoPan® PP80		
Face sheet, mm	Base weight, kg/m²	Add core weight, ka/(m².mm) × mm
0.7	2,38	+ 0,080 × panel thickness
1.0	3,30	
1.4/2	4,26	

MonoPan® PP120		
Face sheet, mm	Base weight, kg/m²	Add core weight, ka/(m².mm) × mm
0.7	2,38	+ 0,120 × panel thickness
1.0	3,18	
1.4/2	4,12	

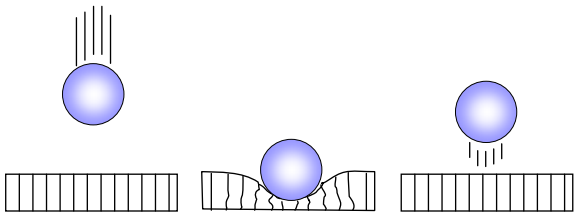
Examples:

15-MonoPan® PP80 TN1.0	= 3,30 + 0,080 × 15 = 4,50 kg/m²
30-MonoPan® PP80 TN0.7	= 2,38 + 0,080 × 30 = 4,78 kg/m²
35-MonoPan® PP120 TN1.4/2	= 4,12 + 0,120 × 35 = 8,32 kg/m²

- Standard paint weighs approximately 65g/m²

For applications, treatment and storage please pay attention to the “Technical Data Sheet” of the manufacturer.

Impact Resilient



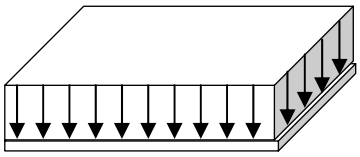
The special honeycomb core made of polypropylene is an additional flexible area, whereby high-energy absorption, without core deformation, can be achieved. The impact-resistant, load-sharing face-sheet increases the effectiveness of this property and promotes the excellent durability of MonoPan®.

Compressive Strength

The following compressive strength values can be used for MonoPan®:

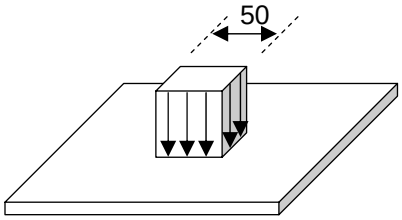
Uniformly distributed load, large area	
Material	**Load (N/mm²)**
MonoPan® PP80	1,5
MonoPan® PP120	2,5

* Estimated, not measured.



Local load on 50 × 50 mm², short term	
Material	**Last (N/mm²)**
MonoPan® PP80	2,3
MonoPan® PP120	3,7*

* Estimated not measured.



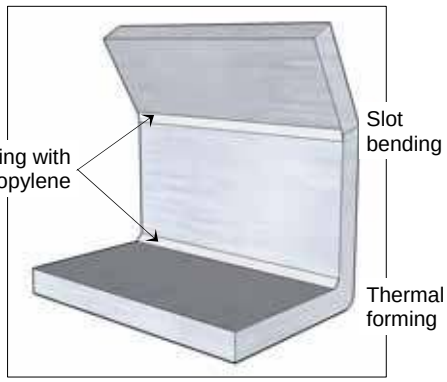
Remarks

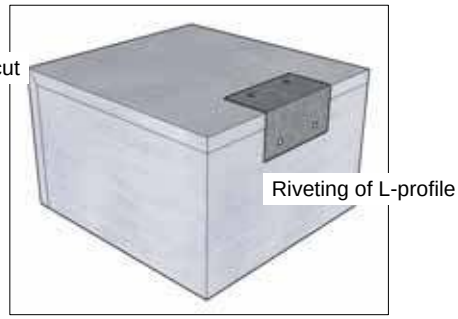
- The compressive strength is valid for short and medium term loading. When the load lasts longer than several weeks, the creep behaviour of PP should be taken into account. Allowable loads should then be reduced e.g. 50% of the values above.
- The above-mentioned compressive strength is no indication of the structural integrity of a given panel. A panel should be sufficiently supported, to achieve a load at the above-mentioned level.

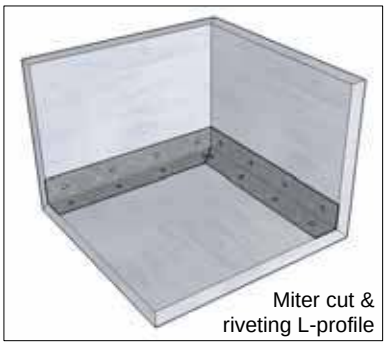
For applications, treatment and storage please pay attention to the “Technical Data Sheet” of the manufacturer.

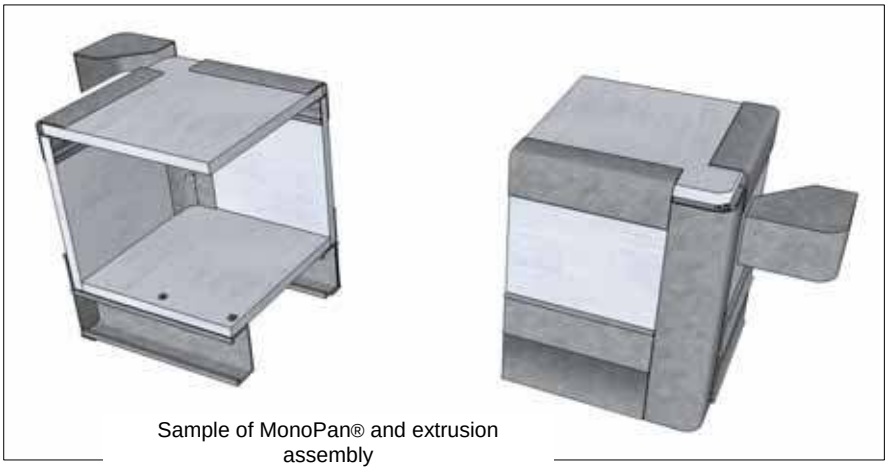
By the following methods:

- thermal forming
- slot in one side of face-sheet and bending;riveting of profile on the inner side of slot
- welding with polypropylene
- miter cut; gluing or riveting profiles from both sides.









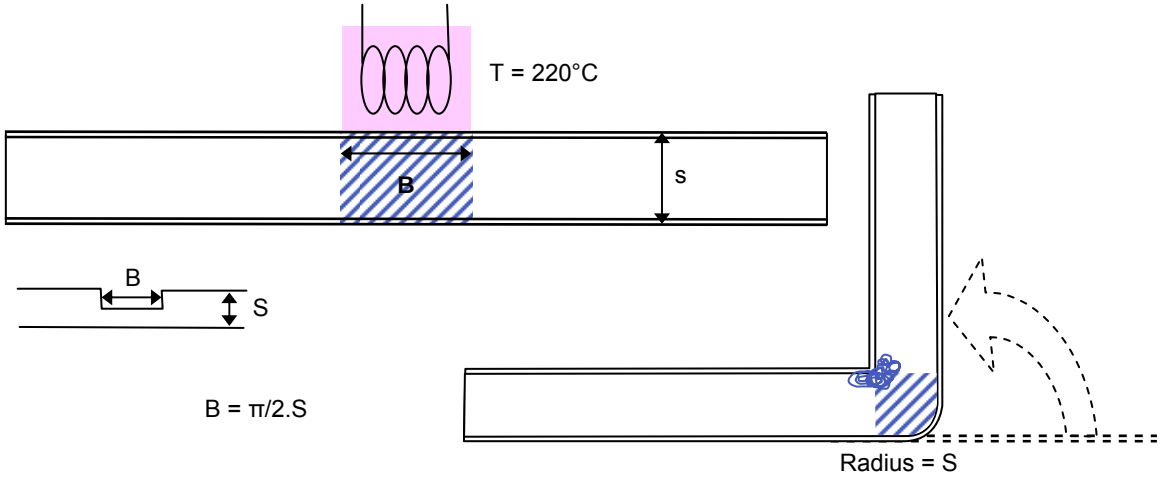
Sample of MonoPan® and extrusion assembly

Bending (i)

Thermal Forming Methods

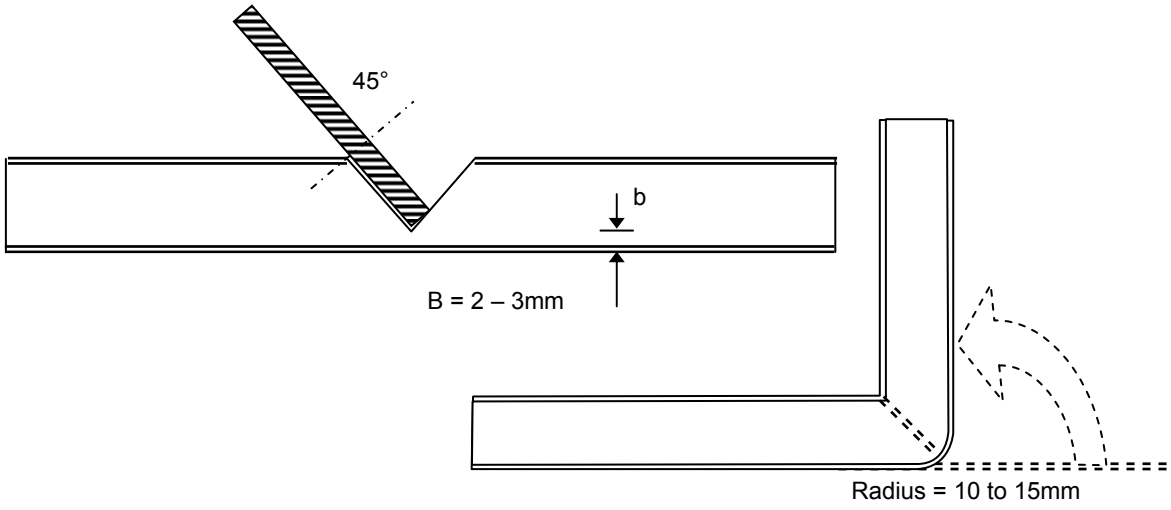
MonoPan® can be shaped easily by thermal methods because of the thermoplastic material properties. Two-dimensional shaping, like bending, is achieved with heating a localised strip of skin material. This heated strip is lightly pressed down and will disappear into the core when the panel is bent. In the ideal situation, this excessive skin material will strengthen the panel in the bending area.

Alternatively to heating the skin and pressing it into the core, it can be removed by milling. The area where the inside skin is removed, the outside skin can function as a hinge. The panel can be bent until the inner cut-out sides meet. The sides can then be welded together to create a strong profile. Without welding the shaped panel can fold back.



Mechanical Forming Methods

Small radius: For a small radius, bending the form is best done by milling the face-sheet off. A wedge is cut in the panel and the face-sheet and core material are removed as shown in the sketch. One should be careful with painted panels, the paint may crack. The inside can be strengthened by welding or by mounting a corner profile.



Bending (ii)

Mechanical Forming Methods

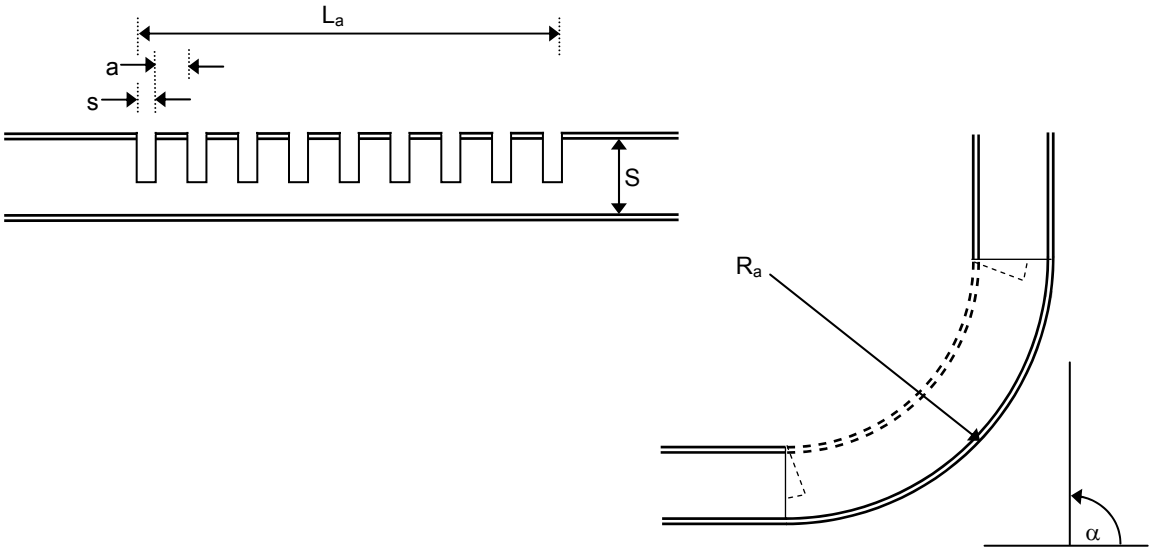
Large radius: Bending a large radius can be done by cutting many small slits on the inside face-sheet. By choosing the right combination of the number and width of slits, the desired radius can be achieved.

The following tables and diagram show the preparation of bending:

starting data			**calculated data**		
outside radius	R_a	100 mm	outside curve length	L_a	$L_a = R_a \cdot \pi/2$
panel thickness	S	30 mm	e.g.	$L_a = 100 \cdot \pi/2 = 157{,}1$ mm	
bending angle	α	π/2 (90°)	total cutting width	l_s	$l_s = S \cdot \pi/2$
			e.g.	$l_s = 30 \cdot \pi/2 = 47{,}1$ mm	

parameter of choice			**resulting parameter**		
number of slits	n	10	slit width	s	$s = l_s / n$
or			e.g.	s = 47,1/10 = 4,7 mm	
slit width	s	5 mm	number of slits	n	$n = l_s / s$
			e.g.	n = 47,1/5 = 9,4 rounded: 9	

resulting calculation		
material width between slits	a	$a = (R_a \cdot \pi/2 - s)/(n - 1) - s$
	e.g.	a = (157,1 – 5)/(9 – 1) – 5 = 14 mm



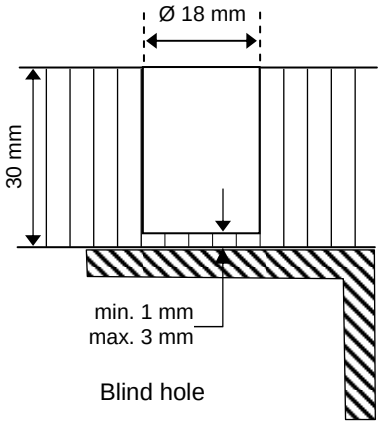
For applications, treatment and storage please pay attention to the “Technical Data Sheet” of the manufacturer.

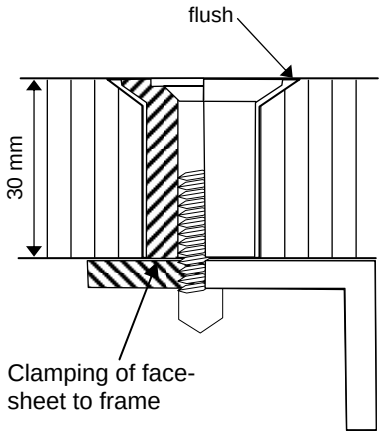
MonoLock-screw connection

The MonoLock-connection was developed to ensure a strong and durable screw connection of MonoPan® with load-sharing supports of aluminium, steel or other materials. The connection consists of a self-drilling screw in a clamp sleeve.

First a blind hole must be drilled into MonoPan®. The self-drilling screw is screwed into the support together with the clamp. The clamping of the lower face-sheet and support bears the main load. Additionally, the flange of the sleeve clamps the upper face-sheet and provides a flat surface.

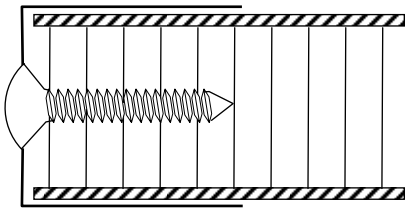
Assembly instruction:
MonoLock-sleeve and drill screw: EJOT Saphir JT2-STS-6-6.3×60
Forstner-drill diameter 18 mm
Torque: 6-10 Nm.
Frame: aluminium 3-5 mm, steel 2-4 mm

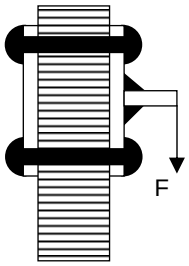




Other connections using screws or bolts

Edge closings and other non-load bearing connections can be achieved by assembling a profile to the edge with woodscrews in a sideward direction (figure left). Though bolting can be done, possibly by the use of load distribution plates to enable a higher loading capacity, the core should not be crushed. (figure right)



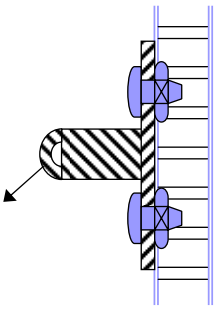


Fasteners – blind rivets

Fasteners, especially with a flange counter head, are well suited for joining MonoPan®.

The high elongation-to-break of PP and high strength of the fibre-glass yield a high load capacity. Because of the welding process of the skins to the core, no delamination caused by rivets will occur.

With load distribution plates an even higher load can be introduced (see figure right)



Rivets not only offer a higher load capacity, but can also be applied easily.

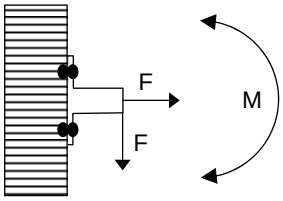
The table below shows various types of rivets. Use this table to choose the best rivet for your application.

Table of blind rivets

	Manufacturer	Rivet type	Pull-out Strength [N]	Shear· Strength [N]	Remarks
Load Capacity: Low → High	Avdel-Textron	Bulbex® BF01 (bulge counter head)	-	-	- fibre-glass failure + low price
		Avex® BE1692-0613 (bulge counter head)	-	~800	+ low price
	Avdel-Textron	Avibulb® BN01-0614 (bulge counter head)	300-500	650-900	+ cost efficient
		Avibulb® BN01-6013 (bulge counter head)			
		Hemlok® 2221·0812 (bulge counter head)	~400	~750	± medium costs
		Eurosert® 39006-28035 (blind rivet nut)	350-450	1100-1200	bulge counter head ± medium costs
		Eurosert® 09406-02822 (blind rivet nut)			
	Titgemeyer	Plusnut® SM06P0751 (blind rivet nut, flange)	200-250	~100	± medium costs
		Plusnut® SM08P0751 (blind rivet nut flange)			
		Plusnut® SM1 OP0801 (blind rivet nut, flange)	~350	~150	
	Avdel-Textron	TLR® 3904-0623 (Aluminium, Ø 5,5 mm)	650-800	1100-1200	(All: flange counter head) + suitable for vibrations + best results in applications ± relatively high costs
		TLR® 3904-0832 (Aluminium, Ø 6,5 mm)			
	KVT-König	POP SCD 608 BS (galv. steel, Ø 5,0 mm)			
		POP SCD 612 BS (galv. steel, Ø 5,0 mm)			
	Titgemeyer	Olympic Bulb-tite® RV 6604 6-4 (aluminium Ø 5,0 mm)			
		Olympic Bulb-tite® RV 6606 8-4 (aluminium, Ø 6,5 mm)			
		Olympic Bulb-tite® RV6676 8-4 (galv. steel, Ø 6,5 mm)			
	Gesipa	Bulb-tite® RV 6604-6-4 (aluminium, Ø 5,5 mm)			
		Bulb-tite® RV 6604-8-4 (aluminium, Ø 6,5 mm)			
		Bulb-tite® RV 6676-8-4 (galv. steel, Ø 6,5 mm)			
		Bulb-tite® RV 6696-8-4 (stainless steel, Ø 6,5 mm)			
	Avdel-Textron	Fab-Lok® FAC-10-4 (flange counter head)	1400	1800	+ disassembly possible - no metric head

The above methods and products are guidelines and are based on WIHAG experience.

Pop-rivets



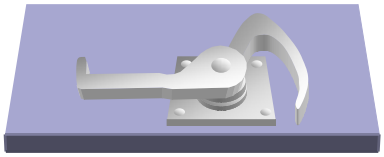
Load distribution plate:

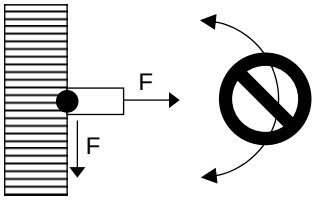
All loads can be applied: yield, shear and bending

Examples:

a) Steel plate riveted to MonoPan®
b) Application (e.g. fixed boards, big locks) fixed to steel plate

Example of load distribution plate



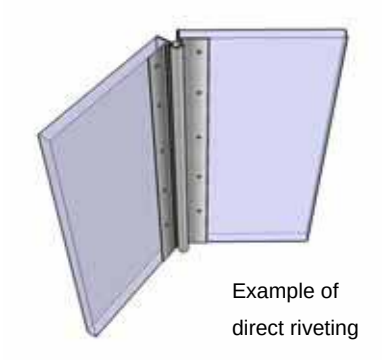


Direct riveting:

Two forces can be applied: yield and shear

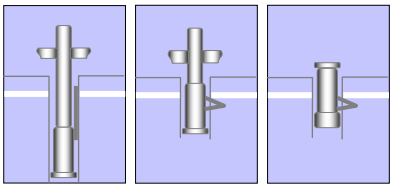
Example:

Hinge (with moveable board) riveted to MonoPan®



Example of direct riveting

Pop-rivets with flange counter heads (examples)



Aluminium:

Avdel Textron TLR® 3904-0832

Titgemeyer Olympic Bulb-tite® RV 6606 8-6

Gesipa Bulb-tite® RV 6604-8-4

Galvanized/stainless steel:

Titgemeyer Olympic Bulb-tite® RV 6676 8-4 (galvanized)

Gesipa Bulb-tite® RV 6696-8-4 (galv.), RV 6696-8-4 (stainless steel)

The above methods and products are guidelines and are based on WIHAG experience.

For applications, treatment and storage please pay attention to the “Technical Data Sheet” of the manufacturer.

Adhesive Bonding (i)

Untreated/unpainted surface

Adhesive bonding to materials with low surface energy like MonoPan® should be done by properly trained personnel.

* Surfaces to be bonded need to be clean and free of grease/oil, even if no cleaner is specified.

The following table shows a selection of possible adhesive systems:

Strength	Application	Manufacturer	System*	Processing	Remarks
+	Strips/ Profiles	SABA	Cleaner 48 Primer 4518 Sealtack 750/780	1-component gun/ 1-component application system	Cured after 1 week (humidify surroundings!) Application temperature +15 to +30°C
+	Small parts/ Profiles	3M	Hotmelt: 3764TC or 3748TC	Hotmelt gun	Cured after cooling down. Tempering base materials is possible before bonding
++	Small parts/ Profiles	3M	DP8005 or DP8010	2-component application system	Cured after 1-2 days Application temperature +10 to +30°C
++	Small parts	Sichel	PowerPrimer Superglue 99	Low viscosity: manual application	Cured after 1-2 days Application temperature +10 to +30°C

The SABA adhesive system has proved to be especially suitable for trucking applications. For this system the process information is given below:

Process steps:	Bonding details:
1) Clean with SABA cleaner 48	• Before applying the adhesive be sure to humidify the surroundings, providing moisture for the adhesive to cure. Do not wet the bonding surfaces.
2) Prepare with surface primer: SABA 4518	• Apply adhesive
3) Bond with adhesive: SABA Sealtack 750 or 780	• Wait 2-3 minutes for adhesive to absorb moisture • Join parts • Let cure (~3 days)

Bonding after surface treatment

- Surface treatments are very useful, make effective preparations for bonding, e.g. Plasma-, Corona-treatment and flaming.
- For smaller parts, fluorination is also recommended.
- Please get advice from companies providing the services or machinery concerning these surface treatments.

Adhesive Bonding (ii)

Bonding to a painted surface

Bonding to pre-painted MonoPan® is less critical than on unpainted. The paint system with adhesion promotor already provides the necessary adhesion to the low surface energy material. However, it is of utmost importance to use adhesive systems that are compatible with the paint system.

In case of 1-component adhesive please note that the adhesive can cure, exposure to humidity and air is necessary. In case of doubt, please use a 2-component adhesive system.

* Surfaces to be bonded need to be clean and free of grease/oil, even if no cleaner is specified.

The following list shows our selection of possible adhesives.

Strength	Application	Manufacturer	System*	Processing	Remarks
+	Strips/Profiles	Sika	Activator Sikaflex 252	1-component gun/ 1-component application system	Cured after 1-2 weeks (unnecessary when rivets are used) Application temperature +10 to +30°C Cured after ca. 2 days Application temperature +10 to +30°C
+	Strips/Profiles	Sika	Activator Sikaflex 254 + Booster	2-component application system	Cured after 1-2 weeks (unnecessary when rivets are used) Application temperature +10 to +30°C Cured after ca. 2 days Application temperature +10 to +30°C
+	Strips/Profiles	Kömmerling	Körabond HG 81 Körapop 225	1-component gun/ 1-component application system	Fully cured after 1 week (unnecessary when rivets are used) Application temperature +5 to +30°C
+	Strips/Profiles	Kömmerling	Körabond HG 81 Körapop 225/2K	MIXPAC® 2KPneumat gun or 2-component application system	Cured after ca. 2 days Application temperature +10 to +30°C
+	Strips/Profiles	SABA	Sealtack 750 or 780	1-component gun/ 1-component application system	Cured after 1 week (humidify surroundings!) Application temperature +15 to +30°C

Remarks

- Cleaning the surface from dust and grease/oil is essential.
- Similar adhesive systems may be used, making adjustments for local supply and conditions. Please follow instructions provided by the manufacturers in all cases
- The above methods are guidelines only and are based on WIHAG experience.
- Further information of the mentioned suppliers can be found on the Internet under following links:

  www.saba.nl
  www.mmm.de
  www.sichel.de
  www.sika.de
  www.titgemeyer.de
  www.koe-chemie.de

Painting a standard MonoPan® surface

MonoPan® can be delivered with standard factory paint (white RAL 9010). The current paint system is built up as follows:

1) Adhesion promoter (transparent),
2) White filler: RAL9010 or DB9147
3) Topcoat

- For untreated MonoPan® surface a pre-treatment of the surface is absolutely necessary, e.g. the process described above.
- Alternative methods of surface treatment can also be used. Please contact various companies which offer these kinds of treatment, e.g. flaming and plasma.

Overcoating a painted MonoPan® surface

To overcoat a standard painted panel, use products such as *Paintsystem PETER-LACKE GmbH*.

The panels can be repainted in desired colours according to the following steps.

1.	Clean	Cleaner	Clean from dust, degrease, e.g. Special Thinner P86001 (Peter-Lacke)
2.	Primer	Adhesion promoter Pehafix P71975	
3.	Filler	2K-Filler Pehapol P81914	With hardener P85045
4.	Topcoat	Typical 2-component car spray-paint	

Remarks

- Cleaning the surface from dust and grease/oil before painting is essential.
- Similar paint systems may be used, making adjustments for local supply and conditions. Please follow instructions provided by paint manufacturers in all cases
- The above methods are guidelines only and are based on WIHAG experience.
- Further information of the mentioned supplier can be found on the Internet under following link:
  www.peter-lacke.de

For applications, treatment and storage please pay attention to the “Technical Data Sheet” of the manufacturer

Environmentally friendly

When you decide on MonoPan® you are actively contributing to the preservation of the environment.

ECO-FRIENDLY

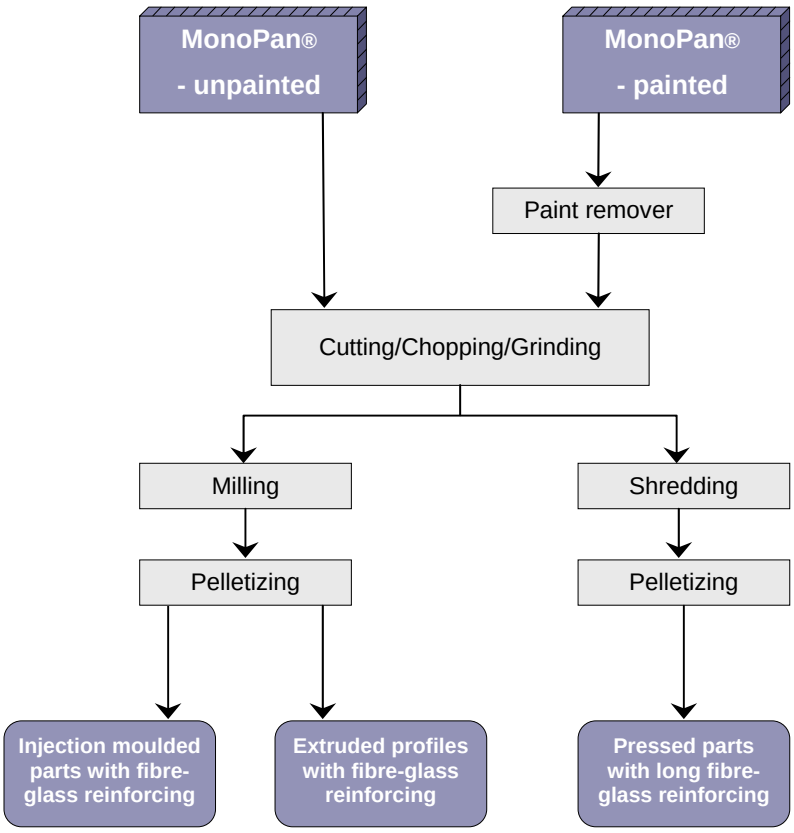
Vehicles that are significantly lighter consume less fuel and produce much less noxious emissions.

RECYCLABLE

MonoPan® is 100% recyclable. MonoPan® is a compound of polypropylene and fibre-glass without any other additives, such as adhesives.

The combination of polypropylene and fibre-glass allows for reprocessing of fibre-reinforced pellets with the features similar to a new material. It can therefore be utilised for technically demanding products such as extrusion profiles.

Recycling process

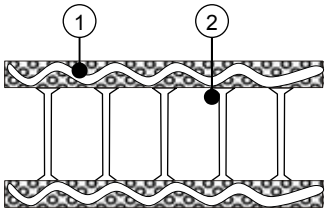


This process is an example of recycling plastics. Please contact your local approved recycling company.

Technical Data Sheet (i)

Panel structure

MonoPan® is a thermoplastic sandwich panel, consisting of polypropylene honeycomb and fibre-glass reinforced polypropylene face-sheets, which are uniformly joined by a lamination/melting process.



1. Longitudinal and transverse filaments in PP matrix
2. Honeycomb with cell walls melted to face sheets

Face sheets

Face sheets on both sides are of the same thickness and have the following specifications:

Standard: single-layered on each side, natural colour (milky white) with a thickness of 0.7 mm (980/m² in fabric).

Standard:	0.7 mm natural colour	980 g/m²
On request:	0.7 mm black	980 g/m²
	1.0 mm natural colour/black	1,485 g/m²
	1.4 mm natural colour/black	2 x 980 g/m²

Honeycomb

Standard:	PP honeycomb	density 80 kg/m³
On request:	PP honeycomb	density 100 kg/m³
	PP honeycomb	density 120 kg/m³

Surface coating

Optional:	Painting RAL 9010, system:	Polypropylene - bonding agent, filler and PU - final coat
On request:	Special colour	
	Anti-slip-surface	
	Fabric made from natural fibre	

Fabric made from natural fibre can be used, as surface is ready for bonding.
A painted surface can be overcoated with accepted vehicle paints and glued with PUR- and MS-polymer industrial adhesives.

- - - Special specifications on request from 500m² - - -

Delivery conditions

Panel Sizes					
Length	2,000 to 13,600 mm				
Width	2,000 to 2,750 mm				
Tolerances	**Length**	**Width**			
	± 2 mm		If:		length ≤ 2,750
	± 4 mm		If:	2,750 <	length ≤ 6,800
	± 8 mm	± 4 mm	If:		length > 6,800
Planarity[1]	± 4 mm/m				

[1]The surface flatness tolerance refers to the state of panels upon dispatch from WIHAG. Influences after delivery and during the transport system can affect the planarity.

- - - Special sizes on request - - -

Panel thickness		
Standard	25 and 30 mm	Tolerance: ± 0.3 mm
On request	15 to 100 mm (from 500 m²)	Tolerance: ± 0.5 mm

Properties

Weight

- A panel comprises the weight of the facesheets and the weight of the honeycomb core. It is 4.4 or 4.8 kg/m² for a 25 or 30 mm panel.

Impact strength

- At room temperature the impact strength, appraised by a Falling Dart Impact Test with a Ø20 mm spherical head, is >80 J (translated >250 J/m²), at -20°C it is 35 J.

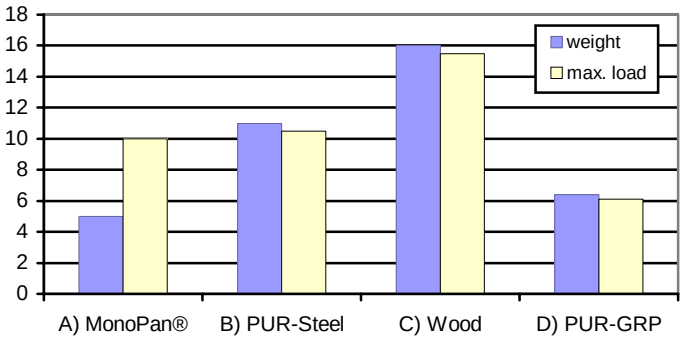
Weather resistance

- The face-sheets guarantee excellent UV-protection according to manufacturer's tests in a desert area of Arizona. The panel has excellent UV resistance with no important signs of aging compared to similar plastic materials, which have a stronger tendency to surface cracks at intensive UV-irradiation.
- MonoPan® does not decompose and is resistant to salt water.
- Chemical resistance is very high and the product also offers high resistance against oil, fats, and the most commonly used agents.
- According to internal tests the water absorption of panels is below 1.5%.

Compression strength

- The compression strength of a short-term load,to an area of 50 × 50 mm², is 2.3 MPa.

Bending Properties



The figure shows the strength in kg/cm width at centre-line load on a panel having a bearing distance of 750 mm compared to a weight per unit area of kg/m².

Materials:

A) 30 mm Standard MonoPan®
B) 40 mm PUR, 0.6 mm Steel
C) 16 mm Plywood
D) 40 mm PUR, 2 mm GRP

Fire

- Uncoated MonoPan® is normally inflammable according to DIN 4102 - meaning B2.
- A standard coating has a fire precaution, class F1according to DIN 53438-3.

Heat insulation

Thermal Insulation Behaviour of Standard Panels			
25 mm	Heat transfer coefficient K	2.5	W/m²K
30 mm	Heat transfer coefficient K	2.2	W/m²K

Treatment

- MonoPan® can be shaped by stock removal or thermal forming.
- Suitable techniques for joining parts are riveting, welding or gluing.

Burn behaviour of unpainted MonoPan®

The burn behaviour of MonoPan® originates mainly from the polypropylene material content, therefore the classification “normal flammability” applies.

MonoPan® is classified as “normally flammable” B2 or in some cases B3 “easily flammable” according to DIN 4102

Procedure:	Burn rate test according to DIN 4102-B2
Test result:	“The component 20-MonoPan® PP80 TN 0.7, panel thickness 20 mm, fulfils the requirements of DIN 4102-B2”
Test class:	B2
Laboratory:	Ostthüringische Materialprüfungsgesellschaft für Textil und Kunststoffe mbH (DAR – accreditation, Reg. No. DAP-P-0, 397-00-97-01)

General test of plastics, standard paint

Testing the burn behaviour of MonoPan® with standard paint (12.12.2002)

A standard painted MonoPan® meets the criteria of not easily flammable materials, material class F1 according to DIN 53438-T3.

Procedure:	Flaming of surface with burner according to DIN 53438-T3
Test result:	“The tip of the flame from the burning specimen does not reach the gauge mark (the test specimen is self extinguishing before reaching the mark)”.
Test class:	F1
Laboratory:	Ostthüringische Materialprüfungsgesellschaft für Textil und Kunststoffe mbH (DAR – accreditation, Reg. No. DAP-P-01,397-00-97-01)

Classification of building materials, special coating

Testing the burn behaviour of MonoPan® with flame retardant paint (spray paint) (12.12.2002)

MonoPan® with special coating meets the material class B1 according DIN 4102-1 “Fire behaviour of building materials and elements” (May 1998), chapters 6.1.2.3 and 6.2.2.

Procedure:	DIN 4102-14 (May 1990)
Test class:	Material Class B1
Laboratory:	MPA NRW Materialprüfungsamt Nordrhein – Westfalen
Certificate:	No. 230002835, July 26th 2002.

Paint:

Coating	Designation	Quantity, wet
1	Peter Lacke PEHAFIX PP-primer P 71975 (tested: precursor with the laboratory designation VPAA06093, see certificate)	20-50 g/m²
2	Peter Lacke PEHAPOL 2K-filler P 81914 with Peter Lacke PEHAPOL hardener P 85045	ca. 90 g/m² (incl. hardener)
3	Nullifire PP2000	ca. 300 g/m²
4	Tremco Cartoline 134	ca. 70 g/m²

Coating: Pre-coating of layers 1 and 2 may be done by WIHAG in an online-process or by spray paint.
The solvent-based paints 3 and 4 may be sprayed in one coating procedure, respectively (airless).

The Nullifire PP2000 paint is a protective coating, which is activated below 165°C. The flame retardant effect is achieved by the creation of an insulating non-flammable carbon foam and by energy dissipation from the flame.

For applications, treatment and storage please pay attention to the “Technical Data Sheet” of the manufacturer.

Chemical Resistance

The following list shows the resistance of MonoPan® against various chemicals. The resistance correlates with the properties of MonoPan® i.e. polypropylene and glass.

Chemical	Resistance	Chemical	Resistance
Acetone	+	Hexene	0
Formic acid	+	Cresol	+
Ethyl alcohol	+	Lyes, aqueous	+
Ammonia (aqueous)	+	Methanol	+
Petrol / gasoline	0	Mineral oil / grease	+
Benzene	0	n-Hexane	0
Butane	+	Neopentane	+
Butyl acetate	-	Nitrides, concentrated	--
Butanoic acid 10%	+	Ozone	0
Chlorbenzene	+	Pentane	0
Chloroform	0	Perchloroetylene	-
Cyclohexane	--	Hydrochloric acid 35% max.	0
Cyclohexanone	+	Carbon disulphide	+
Dekaline	--	Sulphuric acid 45% max. cold	0
Dichlormethane	0	Sulphuric acid, hot	--
Diesel/ fuel oil	+	Sulphuric acid, gas	--
Diethyl ether	0	Detergents	+
Dioxane	+	Tetra-chlorinated hydrocarbon	-
Acetic acid 10%	+	Tetraline	--
Ethyl acetate	0	Toluene	-
Ethyl benzene	-	Trichlorethane	-
Ethyl chloride	-	Trikresyl phosphate	--
Ethylene oxide	+	Water, cold	++
Fluorocarbon	0	Water, hot	+
Ethyl ether	0	Xylene	-

++ Highly resistant + Resistant 0 Conditionally resistant - Not resistant -- Very damaging

This overview refers to the chemical resistance of the polypropylene surfaces. The valuation is not binding, it is based on bibliographical references. In every specific case the chemical resistance must be predefined and verified.

For applications, treatment and storage please pay attention to the “Technical Data Sheet” of the manufacturer.

Thermal Insulation

The following table shows the thermal insulation values for MonoPan®. For comparison, the values for plywood and a typical foam-FRP sandwich panel are added for reference.

Thermal Insulation

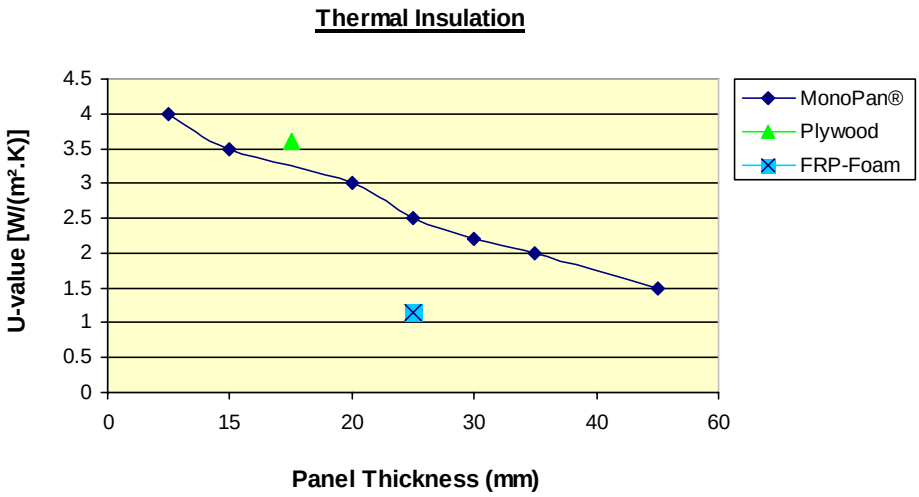
MonoPan®	
Thickness (mm)	U-value [W/(m².K)]
10	4
15	3,5
20	3
25	2,5
30	2,2
35	2
50	1,5

These values are indicative and can be used for every typical face-sheet thickness.

Comparison

Plywood	
Thickness (mm)	U-value [W/(m².K)]
18	3,60

FRP-Foam	
Thickness (mm)	U-value [W/(m².K)]
25	1,14

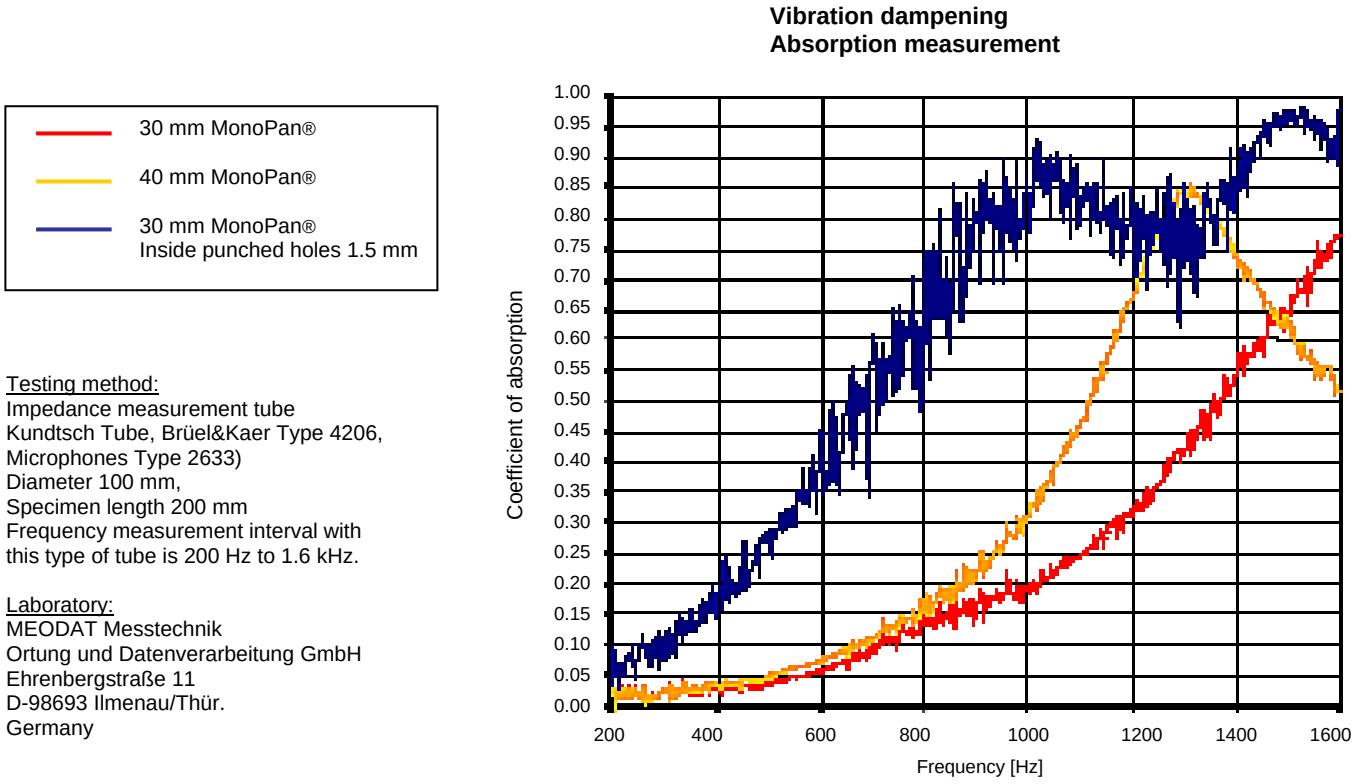


The U-value is calculated according to DIN 4108.

For applications, treatment and storage please pay attention to the “Technical Data Sheet” of the manufacturer.

Acoustics and Vibration

- Information on the sound and vibration dampening properties of MonoPan® is limited (see graph)
- Dampening of imposed vibration is also promising, because of the elastic characteristics of PP in MonoPan®
- The properties can be improved substantially by developing an optimized surface material.



Testing method:
Impedance measurement tube
Kundtsch Tube, Brüel&Kaer Type 4206,
Microphones Type 2633)
Diameter 100 mm,
Specimen length 200 mm
Frequency measurement interval with
this type of tube is 200 Hz to 1.6 kHz.

Laboratory:
MEODAT Messtechnik
Ortung und Datenverarbeitung GmbH
Ehrenbergstraße 11
D-98693 Ilmenau/Thür.
Germany

For applications, treatment and storage please pay attention to the “Technical Data Sheet” of the manufacturer.

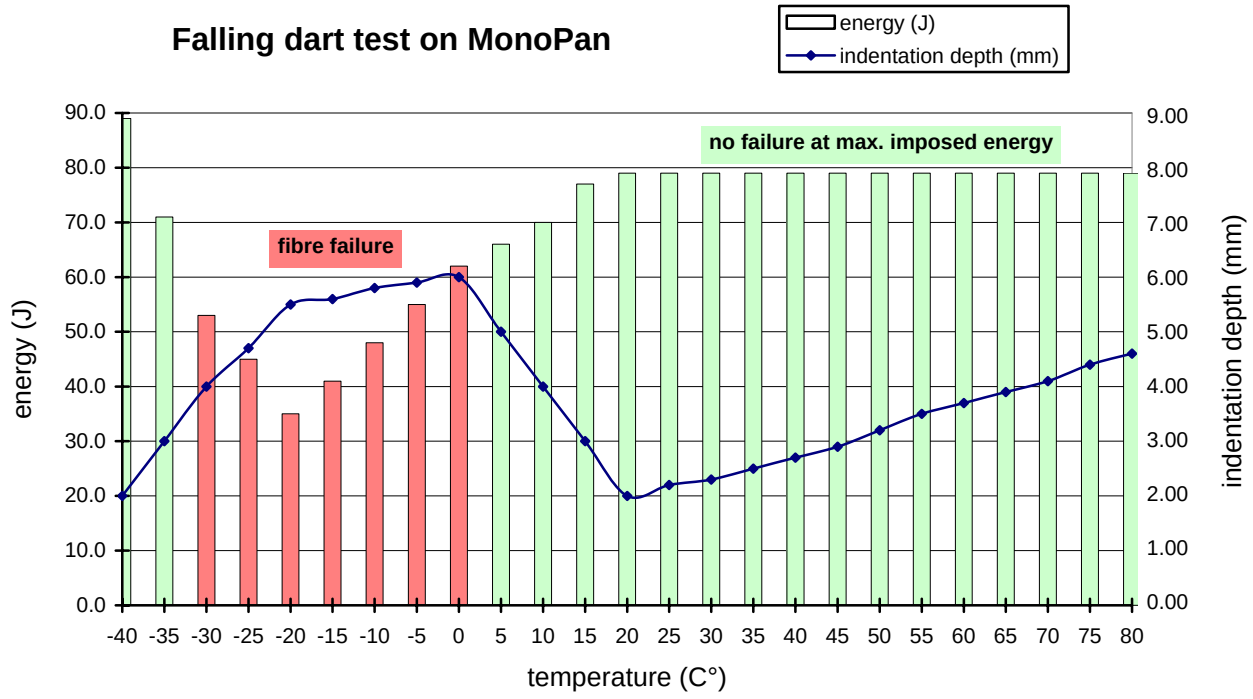
Falling dart test

MonoPan® offers remarkable strength and impact resistance. The following test results show the impact strength in a temperature range of -40°C to +80°C.

The impact strength of MonoPan® has been determined with a falling dart test. The test described as follows:

> A specified weight mounted on a half sphere, Ø 20 mm, falls on the MonoPan® surface. The minimal energy value that causes surface failure (first visible break of glass fibres) is registered. Furthermore, the indentation depth and the area of the imprint are determined.

For visualisation, the impact of a concrete block of 4 litres (8 kg) falling from a 1-m height on the MonoPan® surface equals 80 J impact energy:

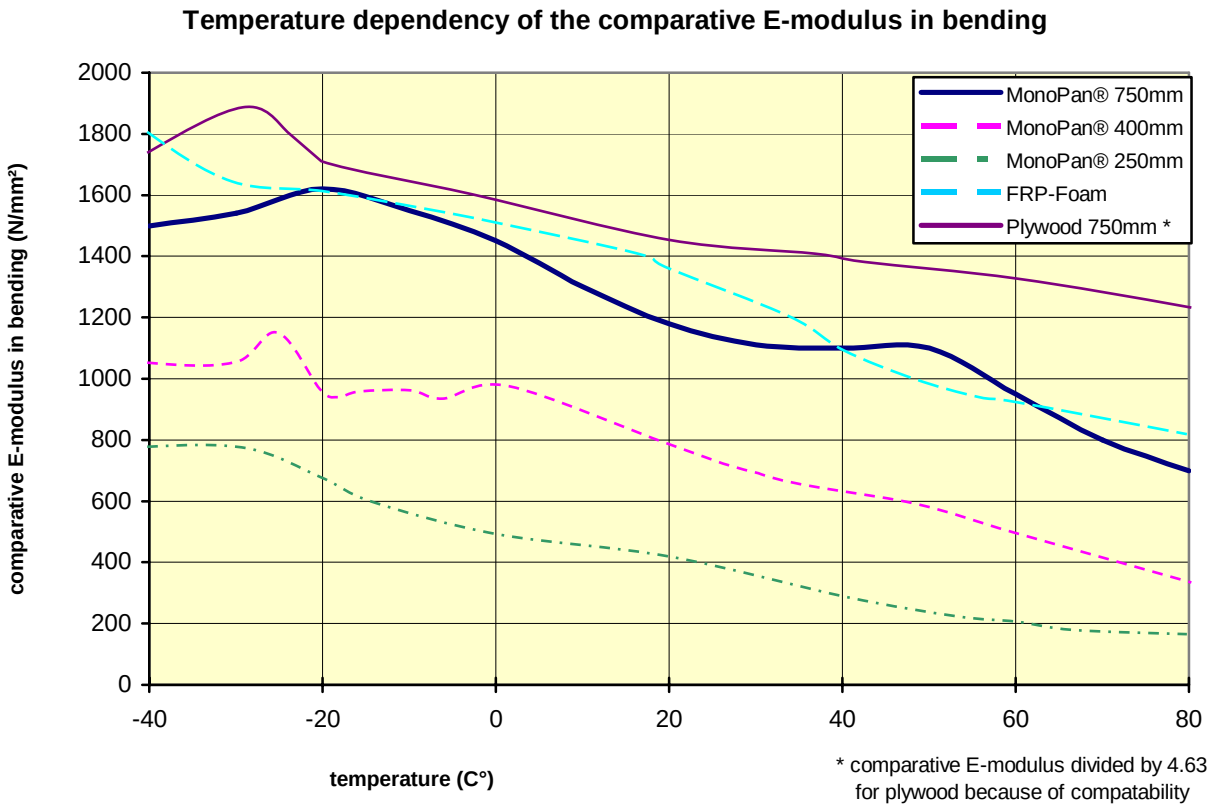


For applications, treatment and storage please pay attention to the “Technical Data Sheet” of the manufacture

Flexibility of MonoPan® properties

Like most materials, the material properties of MonoPan® depend on temperature. The graph shows the temperature dependency of the comparative value of the E-modulus in bending at different lengths. Additionally, two curves for a typical FRP-foam panel (30 mm) and for plywood (18 mm) at 750 mm length are added for reference.

Determination of the comparative value of the E-modulus in bending was established at maximum load (short term).

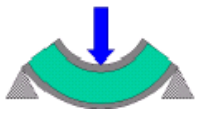
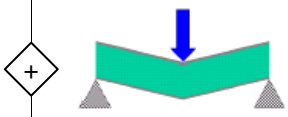
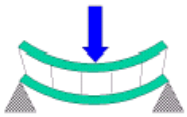


For applications, treatment and storage please pay attention to the “Technical Data Sheet” of the manufacture

E-Modulus in Bending (i)

Comparative values for MonoPan®

The values for the E-modulus in bending are determined for three-point-bending at a unit load of 1 N per mm panel width. Example: A 10 kg load on a panel of 100 mm width corresponds to 100 N /100 mm = 1 N/mm.

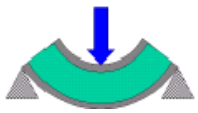
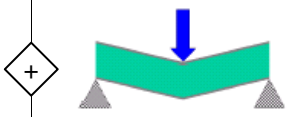
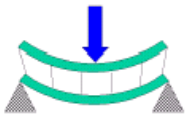
				Comparative E-Modulus in bending
Span length	Bending deformation	Shear deformation	Total deformation	
mm	mm	mm	mm	N/mm²
10-MonoPan® 0.7				
230	0,68	0,41	1,09	2786
300	1,52	0,53	2,05	3294
600	12,13	1,07	13,20	4092
1000	56,16	1,78	57,93	4315
15-MonoPan® 0.7				
230	0,29	0,27	0,56	1600
300	0,64	0,36	1,00	2000
600	5,15	0,71	5,86	2730
1000	23,83	1,19	25,02	2960
1500	80,44	1,78	82,22	3040
20-MonoPan® 0.7				
230	0,16	0,21	0,36	1043
300	0,35	0,27	0,62	1358
600	2,83	0,54	3,37	2005
1000	13,11	0,89	14,00	2232
1500	44,24	1,34	45,57	2314
25-MonoPan® 0.7				
230	0,10	0,16	0,26	735
300	0,22	0,21	0,44	987
600	1,79	0,43	2,22	1560
1000	8,28	0,71	8,99	1780
1500	27,93	1,07	29,00	1862
2000	66,21	1,43	67,64	1892
2500	129,32	1,78	131,10	1907
30-MonoPan® 0.7				
230	0,07	0,14	0,21	546
300	0,15	0,18	0,33	752
600	1,23	0,36	1,59	1260
1000	5,70	0,59	6,29	1472
1500	19,23	0,89	20,12	1553
2000	45,57	1,19	46,76	1584
2500	89,00	1,49	90,49	1599

The given values are calculated values and not experimental data. The data has been created with great care. However, they can only be used as an indication. The values are valid for MonoPan® with 80kg/m³ honeycomb core.

E-Modulus in Bending (ii)

Comparative values for MonoPan®

The values for the E-modulus in bending are determined for three-point-bending at a unit load of 1 N per mm panel width. Example: A 10 kg load on a panel of 100 mm width corresponds to 100 N /100 mm = 1 N/mm.

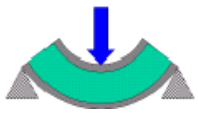
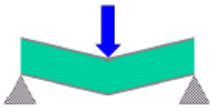
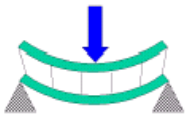
				Comparative E-Modulus in bending
Span length	Bending deformation	Shear deformation	Total deformation	
mm	mm	mm	mm	N/mm²
15-MonoPan® 1.0				
230	0,20	0,27	0,47	1912
300	0,44	0,36	0,80	2510
600	3,53	0,71	4,24	3771
1000	16,35	1,18	17,54	4224
1500	55,19	1,78	56,97	4389
20-MonoPan® 1.0				
230	0,11	0,20	0,31	1215
300	0,24	0,27	0,51	1665
600	1,92	0,53	2,45	2753
1000	8,88	0,89	9,77	3199
1500	29,96	1,34	31,30	3370
2000	71,03	1,78	72,81	3434
25-MonoPan® 1.0				
230	0,07	0,16	0,23	840
300	0,15	0,21	0,36	1186
600	1,20	0,43	1,63	2121
1000	5,56	0,71	6,28	2549
1500	18,78	1,07	19,85	2720
2000	44,52	1,43	45,94	2786
2500	86,94	1,78	88,73	2818
30-MonoPan® 1.0				
230	0,05	0,14	0,18	615
300	0,10	0,18	0,28	889
600	0,82	0,36	1,18	1695
1000	3,81	0,59	4,41	2102
1500	12,86	0,89	13,75	2272
2000	30,49	1,19	31,68	2338
2500	59,55	1,49	61,03	2370

The given values are calculated values and not experimental data. The data has been created with great care. However, they can only be used as an indication. The values are valid for MonoPan® with 80kg/m³ honeycomb core.

E-Modulus in Bending (iii)

Comparative values for MonoPan®

The values for the E-modulus in bending are determined for three-point-bending at a unit load of 1 N per mm panel width. Example: A 10 kg load on a panel of 100 mm width corresponds to 100 N /100 mm = 1 N/mm.

				Comparative E-Modulus in bending
Span length	Bending deformation	Shear deformation	Total deformation	
mm	mm	mm	mm	N/mm²
20-MonoPan® 1.4/2				
230	0,09	0,20	0,29	1312
300	0,19	0,27	0,46	1850
600	1,52	0,53	2,05	3294
1000	7,02	0,89	7,91	3952
1500	23,69	1,33	25,02	4215
2000	56,16	1,78	57,93	4315
2500	109,68	2,22	111,90	4364
25-MonoPan® 1.4/2				
230	0,05	0,16	0,22	897
300	0,12	0,21	0,33	1303
600	0,94	0,43	1,37	2521
1000	4,37	0,71	5,08	3149
1500	14,75	1,07	15,82	3414
2000	34,96	1,42	36,38	3518
2500	68,27	1,78	70,05	3569
30-MonoPan® 1.4/2				
230	0,04	0,14	0,17	652
300	0,08	0,18	0,26	967
600	0,64	0,36	1 ,00	2000
1000	2,98	0,59	3,57	2591
1500	10,06	0,89	10,95	2855
2000	23,83	1,19	25,02	2960
2500	46,55	1,49	48,04	3012
35-MonoPan® 1.4/2				
230	0,03	0,12	0,14	495
300	0,06	0,15	0,21	746
600	0,47	0,31	0,77	1631
1000	2,16	0,51	2,67	2184
1500	7,29	0,76	8,06	2443
2000	17,29	1,02	18,30	2548
2500	33,76	1,27	35,03	2601

The given values are calculated values and not experimental data. The data has been created with great care. However, they can only be used as an indication. The values are valid for MonoPan® with 80kg/m³ honeycomb core.