

CREATING SOLUTIONS



Acoustic Barriers

Hear The Silence



Construction

Glazing

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► Acoustic Barriers - Introduction

Acoustic barriers are walls made of transparent plastic panels. They propose an excellent solution for blocking noise and environmental disturbance from traffic highways and transportation paths, as well as other acoustically polluting factors.

The wall's transparency neutralizes the shortcomings of opaque barriers by allowing admittance of sunlight, a clear view of the countryside or urban landscapes, preventing a sense of closure or disconnection and a significant reduction of acoustic and environmental pollution.



Transparent acoustic barriers' main purposes are:

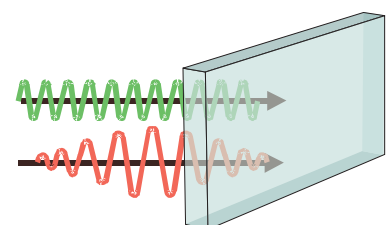
- Creating noise barriers between high traffic and populated areas
- Maintaining the landscape sequence
- Lightweight and efficient solution for bridges
- Lightweight extension for concrete walls

PALRAM's flat acrylic and polycarbonate sheets (PALGLAS® and PALSUN®) are especially suitable for transparent acoustic barriers:

- Lightweight - Less than half the weight of glass with similar thickness
- High transparency - Matching that of the clearest glass
- High resistance to impact and pounding
- Excellent resistance to UV radiation, direct sunlight and extreme conditions
- Flexibility that allows curving, bending and shaping without any special treatment
- Compliance with the most stringent international standards in the field of plastics

On Sound insulation

It is accepted to follow the German standard for transportation ZTV-LSW 88. The standard requires noise reduction measure of no less than 25dB. The sound level generated on a busy 6-lane highway can reach 110-115 dB, and is unbearable to humans for long term exposure. Sound levels above 85dB require ear protection aids, whereas a background noise level of 70-75 dB is considered comfortable enough for conversation.

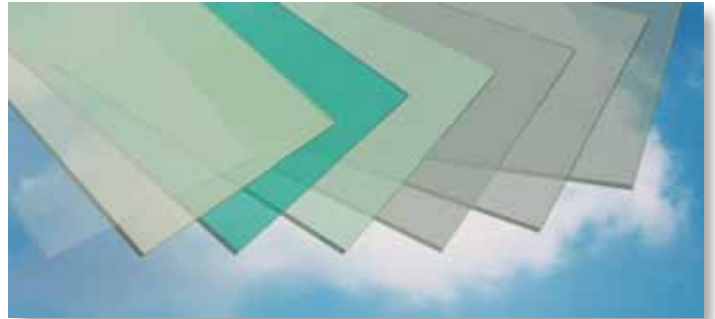


PALGLAS®

Flat Acrylic (PMMA) Sheet

Main Features

- Extruded acrylic sheet
- Thickness 15-25mm
- Inherently UV resistant
- Transparent- Above 90% light transmission
- Easily formed or fabricated
- Thermoformable



Sound Insulation

Real life measurements have shown true noise reduction offered by PALGLAS to be 30-40 dB, depending on sheet thickness and the installation details. PALGLAS has a sound insulation factor as describe in the attached table.

Thickness (mm)	Insulation Index (dB)
8	28
15	35
18	36
20	37

**Tested according to IS-1034 part 6, IS-985 part 1, ISO-140 part 6, ISO-717 part 1, DIN-52210, DIN-4109*

Transparency

Light transmission

The light transmission of clear PALGLAS is 90-93%, depending on thickness. In certain cases where a limited light transmission is preferred, the sheet can be tinted with transparent colors to lower light transmission levels. Typical tints are 50% LT Bronze or solar Grey.



Clarity (haze %)

The Haze level of the virgin sheet is very low (~1%). Haze level of all transparent sheets, including Acrylic and glass, is highly effected by smog, dust and chemicals in the environment. In order to maintain low haze (high clarity) certain guidelines have to be maintained in the installation. Following these guidelines will allow the transparent wall to maintain its optical properties for many years.

Impact resistance

Maximum impact parameters should be taken into consideration when designing an Acoustic Transparent Barrier. Anticipated scenarios should include automotive accidents and various collisions, as well as vandalism (Break from stone impact, hammers, etc.).

Life expectancy

How long should the wall serve? How long will it serve maintaining its properties?

What is the UV resistance requirement ?

What is the chemical resistance to the highway environment and to vandalism (graffiti)?

a. UV resistance

PALGLAS is manufactured from high quality extruded acrylic that offers excellent resistance to UV radiation. In fact, this property is a natural part of the acrylic sheet, with no requirement to any UV coating layer.

b. Chemical resistance in a highway environment

The main chemicals present in the highway environment are Sulfuric compounds: NO_x , CO , and H_2O . Trace quantities of O_3 (Ozone) from ignition systems are also found.

In addition to these chemicals there are continuous clouds of particulate matter such as dust (usually silicates), soot (partly oxidized hydrocarbons) and salt from anti freeze powders. Fortunately, PALGLAS is not particularly sensitive to these.

The main damage to the sheet is surface coating by particulate matter and acidic etching that might make the sheet hazy.

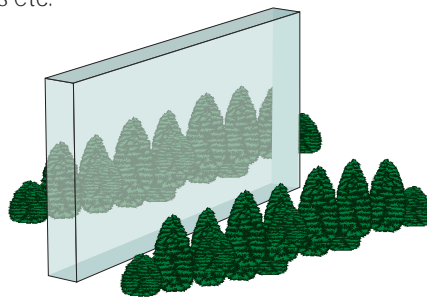
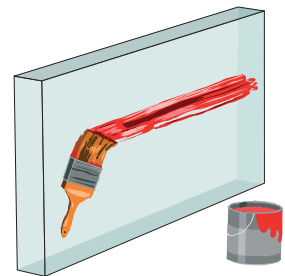
The main issue of maintaining the glazing clear is protecting it from a "Highway soup" of dust, smoke and water.

c. Graffiti

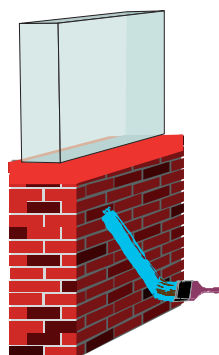
All plastic materials are sensitive to chemical solvents found in graffiti spray, and that includes PALGLAS. Solvents attack the polymer surface and impregnate the sheet in such a manner that is not fully restorable. The use of strong organic solvents and paint thinners to remove the graffiti will only cause deterioration of the situation.

The solution must be limiting the access to the transparent sheet:

- Physical barriers: green fences, trenches, drain channels etc.



- Elevation of the panels 2-3 meters above ground level.



Installation considerations

Frame size

We recommend limiting the width of a single glazing panel to 2 meters due to several reasons:

- The strength requirement of the metal frame: Above 2m the forces induced by the sheet on each individual post is so high that a very thick, unattractive and heavy metal frame is required.
- Rabbet depth has to be increased in order to avoid "pop out" during high wind loads.

Framing Method

The sheet must be installed floating in a frame, as glass. It is not allowed to fix the sheet with screws or rivets due to the stresses that such methods induce.

Standard glazing frames and profiles for PALGLAS can be suitable, using adequate EPDM profiles (Shown on page 36-37). For safety reasons it is possible to attach one screw to every sheet to secure it in cases of extreme impact. This screw should be 10-12 mm diameter and the hole should be well oversized.

The safety screw should not touch the sheet or limit its thermal expansion!

Architectural Considerations

To reduce light transmission a tinted sheet can be used. This will also help to hide the dust and smoke contaminating the sheet.

We recommend 50%-60% LT.

In Germany "Glass Green" is popular.

Other colors can be supplied upon request.

Install the sheets as far away from pollution sources as possible.

The heavy smog on jammed intersections and bridges or in polluted industrial areas will cause any transparent sheet to lose its transparency very rapidly.

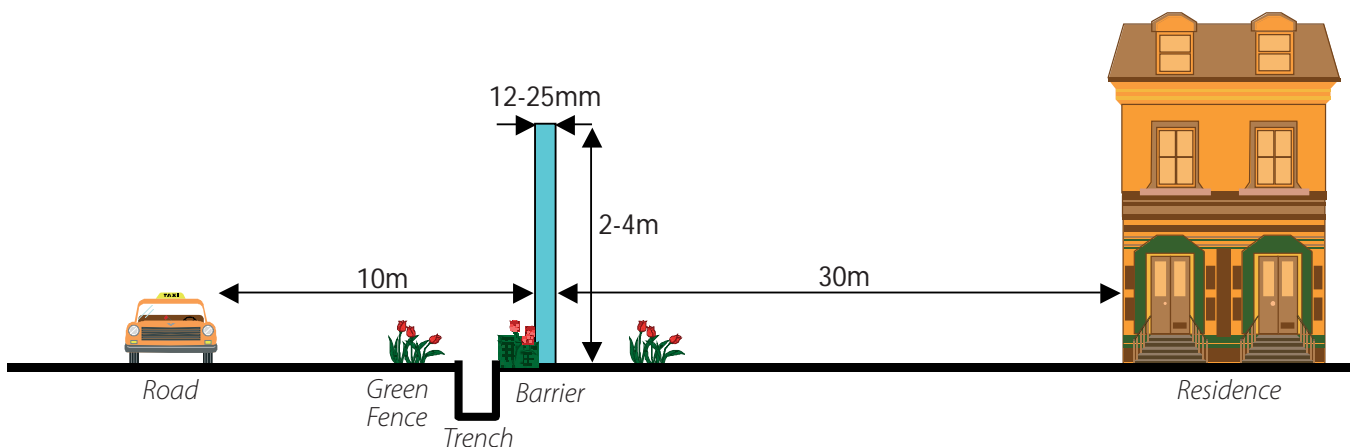
Cleaning

As for today we do not know of any successful method to clean plastic Acoustic Barriers from pollution and graffiti. So for the time being the best method is preventive care as explained above.

Summary

The following guidelines should be considered when planning a transparent acoustic barrier:

- The Sheets width should not be more than 2 meters.
- Install the sheets at least 5, preferably 10 meters away from traffic, the further the better.
- Provide physical barriers of green fences, protection walls or trenches between the sheet and the road.
- Where severe graffiti and vandalism is expected, lift transparent parts of the wall 2-3 meters above ground.



► Physical Properties and Test Reports Reference List

Category	Property	Unit	Data	Control Code	(referred test)
Transparency	Colourless	%	92	EN 2155	(a)
	Transparent brown R7053	%	34	EN 2155	
	Transparent blue R7015	%	64	EN 2155	
	Transparent green R7022	%	92	EN 2155	
Transparency after 10Years	Transparency change	%	92.5 - 92.3	ASTM D1925/DIN EN-410	(a)
	Yellow Index change	%	0.55 - 0.47	ASTM D1925/DIN EN-410	(a)
Mechanical Properties	Tensile Strength B by 23 C	N/mm	82	DIN 53 455/ISO 527/-2/1B/50	(b)
	Tensile Elongation at break R (v=5 mm/min)	%	5.5	DIN 53 455/ISO 527/-2/1B/50	(b)
	Tensile Modulus of elasticity	N/mm	3652	DIN 53 457/ ISO 527/-2/1B/50	(c)
	Flexural Strength	N/mm	103	DIN 53 452/ISO 178	(d)
	Impact strength	Kj/m	16.6	DIN 53 453/ISO 179-1	(e)
	Impact strength after 10Year aging	Kj/m	15.4	DIN 53 453/ISO 179-1	(e)
	Bending Resistance	mPA	110	DIN 53 452/ISO 178	(f)
	Resilience	J/m	1590	DIN 53 453/ISO 180	(g)
Thermal Properties	Density	g/cm	1.197	DIN 53 479/UNI 7093	(h)
	Vicat softening temp	C	123	DIN 53 460/ISO 306/A120	(i)
	Thermoforming temperature	C	160	-	
	Resilience temperature	C	>75	-	
Weight by Thickness	Coefficient of thermal expansion	1/ C	6.1 E-5	DIN 53752/ASTMD-696	(j)
	15mm	kg/m	17.9		
Noise Protection Wall Test	20 mm	kg/m	23.8		
	Stability under wind load		passed	DIN 20 140/ ZTW-Lsw 88	(l)
Noise reduction	Deflection under load and heat		passed	DIN 20 140/ ZTW-Lsw 88	(m)
	Resistance to Stone Throwing		passed	DIN 20 140/ ZTW-Lsw 88	(k,n)
Toxicity	Fire resistance		passed	DIN 20 140/ ZTW-Lsw 88	(o)
	8mm: Sound reduction range 100-3150Hz	dB	28	ISO 140 6 & DIN 52210	(t)
	15mm: Sound reduction range 100-3500Hz	dB	32	ISO140/3/1995 & ISO717/1/1996	(p)
Toxicity	20 mm: Sound reduction range 50-5000Hz	dB	30	DIN 20 140-3	(q)
	Toxicity of decomposition effluences		Complies with	DIN 53 436	(r)

* Test reports consequent for the table above appear on the next page

Test, Institute and Certificate no.	Pages
a) ASTM D1925-DIN EN 410, Ist. Giordano, test no. 143086	
b) ISO 527-1, Ist. Giordano, test number 145353	
c) ISO 527-1, Fugro Technical Services, Report no. 053506ST51467(1)	7
d) ISO 178, Fugro Technical Services, Report no. 053506ST51467	8
e) ISO 179-1 (CSTB) Test no. CPM 05-006/1	
f) UNI EN ISO 178, Ist. Giordano, test no. 145352	
g) UNI ISO 180, Ist. Giordano, test no. 141839	
h) UNI 7092, Ist. Giordano, test no. 141749	
i) ISO 306/A120, Ist. Giordano, test no. 142059	
j) UNI 9730, Ist. Giordano, test no. 143472	
k) BS EN 1794-1, Fugro Technical Services, Report no. 053506ST51467(03)	9
l) DIN 20 140 / ZTV-LSW 88, MPA NRW, Certificate no. 220002172-02 section 7.2.3	11-16
m) DIN 20 140 / ZTV-LSW 88, MPA NRW, Certificate no. 220002172-02 section 7.2.4	11-16
n) DIN 20 140 / ZTV-LSW 88, MPA NRW, Certificate no. 220002172-02 section 7.2.5	11-16
o) DIN 20 140 / ZTV-LSW 88, MPA NRW, Certificate no. 220002172-02 section 7.2.6	11-16
p) ISO 140-3, Ist. Giordano, test no. 145352	
q) DIN 20 140-3 / ZTV-LSW 88, MPA NRW, Certificate Nr. 220002172-25	17-22
r) DIN 53 436, epa GmbH, Report Nr. 3/2006	25
s) BS 6206, Fugro Technical Services, Report no. 053506ST51467(03)	10
t) ISO 140 6 & DIN 52210, SII, Report no. 053506ST51467(03)	23-24

► PALGLAS® Tensile Strength Test (ISO 527-1)

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 Tai Lam, Tuen Mun, N.T., Hong Kong. Website : www.fugro.com

MaterialLab

Client Ref. : --
 Report No. : 053506ST51467(1)

Page 1 of 8

REPORT ON THE DETERMINATION OF TENSILE STRENGTH OF PMMA SHEET

Information Supplied by Client

Client : Palram Industries Limited
 Project : Testing of PMMA Sheet
 Sample Description : "Palglas" PMMA extruded acrylic sheet R7000 Clear and
 "Plazcryn" PMMA extruded acrylic sheet R7000 Clear
 Nominal Thickness : 15mm

Laboratory Information

Lab. Sample I.D. : ST51467/6-10
 Date Received : 09 November 2005
 Date Tested : 13 November 2005
 Gauge Length : 50mm
 Loading Rate : 50mm/min
 Test Method : ISO 527-1 : 1993

Test Results

Lab. Sample I.D.	Width of Sample (mm)	Thickness of Sample (mm)	Maximum Applied Load (N)	Tensile Strength (MPa)	Tensile Modulus of Elasticity (MPa)
ST51467/6	9.97	14.59	10675	73.4	3129
ST51467/7	10.20	14.59	11538	77.5	3894
ST51467/8	9.99	14.59	8580	58.9	3493
ST51467/9	10.21	14.60	11963	80.2	3808
ST51467/10	10.16	14.59	12250	82.6	3931
			Average	74.5	3651
			Standard Deviation	9.4	339

Remarks : 1.) The test results relate only to the samples tested.
 2.) The force-extension graphs are shown on pages 2 to 6 of this report.
 3.) The test configuration, sample before test and failure modes are shown in the photographs on pages 7 and 8 of this report.

Checked by : [Signature] Date : 15-11-2005 Certified by : [Signature] Date : 15/11/05
 Gary Winstanley

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GEN01/0203

MaterialLab

► PALGLAS® Flexural Strength Test (ISO 178)

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Client Ref. : --
 Report No. : 053506ST51467

Page 1 of 8

REPORT ON THE DETERMINATION OF FLEXURAL STRENGTH OF PMMA SHEET

Information Supplied by Client

Client : Palram Industries Limited
 Project : Testing of PMMA Sheet
 Sample Description : "Palglas" PMMA extruded acrylic sheet R7000 Clear and
 "Plazcryn" PMMA extruded acrylic sheet R7000 Clear
 Nominal Thickness : 15mm



Laboratory Information

Lab. Sample I.D. : ST51467/1-5
 Date Received : 09 November 2005
 Date Tested : 12 November 2005
 Support of Support : 240mm
 Loading Rate : 6mm/min
 Test Method : ISO 178 : 1993

Test Results

Lab. Sample I.D.	Width of Sample (mm)	Thickness of Sample (mm)	Maximum Applied Load (N)	Flexural Strength (MPa)
ST51467/1	20.07	14.57	1189	100.4
ST51467/2	19.98	14.59	1204	101.9
ST51467/3	19.91	14.57	1259	107.2
ST51467/4	20.01	14.58	1230	104.1
ST51467/5	19.78	14.59	1221	104.4
			Average	103.6
			Standard Deviation	2.6

Remarks : 1.) The test results relate only to the samples tested.
 2.) The force-deflection graphs are shown on pages 2 to 6 of this report.
 3.) The test configuration, sample before test and failure modes are shown in the photographs on pages 7 and 8 of this report.

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► PALGLAS® Stone Impact Resistance Test (BS EN 1734-1)

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Website : www.fugro.com

MaterialLab

Client Ref. : --
Report No. : 053506ST51467(3)

Page 1 of 2

REPORT ON THE STONE IMPACT RESISTANCE TEST OF PMMA SHEET

Information Supplied by Client

Client : Palram Industries Limited
Project : Testing of PMMA Sheet
Sample Description : "Palglas" PMMA extruded acrylic sheet R7000 Clear and
"Plazcryl" PMMA extruded acrylic sheet R7000 Clear
Nominal Thickness : 15mm



Laboratory Information

Lab. Sample I.D. : ST51467/11A-11F
Date Received : 09 November 2005
Date Tested : 12 November 2005
Test Impact Energy : 80Nm
Test Method : BS EN 1794-1 : 1998

Test Results

Lab. Sample I.D.	Impact Height (mm)	Observation
ST51467/11a	2000	No breakage
ST51467/11b	2000	No breakage
ST51467/11c	2000	No breakage
ST51467/11d	2000	No breakage
ST51467/11e	2000	No breakage
ST51467/11f	2000	No breakage

Remarks : 1.) The test results relate only to the samples tested.
2.) The test configuration and samples after test are shown in the photographs on page 2 of this report.

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GEN01/0200

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► PALGLAS® Impact Test (BS 6206)

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Client Ref. : -- Page 1 of 4
 Report No. : 053506ST51467(2)

REPORT ON IMPACT TEST ON LAMINATED GLASS

Information Supplied by Client

Client : Palram Industries Limited
 Project : Testing of PMMA Sheet
 Location : Kam Tin Laboratory of MaterialLab
 Sample Description : "Palglas" PMMA extruded acrylic sheet R7000 Clear and
 "Plazcryl" PMMA extruded acrylic sheet R7000 Clear
 Nominal Thickness : 15mm

Laboratory Information

Lab. Sample I.D. : ST51467/12-15
 Date Received : 07 November 2005
 Date Tested : 12 November 2005
 Nominal Size : 1930 x 865mm
 Test Method : BS 6206 : 1981 (Class A)

Test Results

a) Test for Behaviour on Impact

Test Class	Drop Height (mm)	Lab. Sample I.D.	Observation	Mass Equivalent Area of 10 Largest Crack Free Particles (mm ²)	Specification of BS 6206 : 1981 (Clause 5.3b)
A	1219	ST51467/12	No breakage	--	1.) Numerous cracks or fissures appear in the test piece, but no shear, or opening, develops through which a 76mm diameter sphere can be passed freely. 2.) When breakage occurs which results in the production of separate fragments containing pointed protrusions, then such fragments shall be permitted provided that any pointed protrusion satisfies the following. The length of the chord between the two points which are established when an arc of radius 25mm, whose centre is the apex of the protrusion, crosses the perimeter on each side of the apex shall be not less than 25mm.
		ST51467/13	No breakage	--	
		ST51467/14	No breakage	--	
		ST51467/15	No breakage	--	

Remarks : 1.) The test results relate only to the samples tested.
 2.) The test results **comply** with the requirements of BS 6206 : 1981, Class A.
 3.) The test configuration and sample after test are shown in the photographs on pages 2 to 4 of this report.

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The tests took place in accordance with Section 7.2.3 in combination with Section 2.1 ZTV-Lsw 88. According to the customer the construction of the test setup corresponded to the planned construction. The dimensions can be seen in the drawings in **Annexes 9, 10 and 11**. The deflection measurements were carried out at 5 measuring points with the largest assumed deflections on the middle line between the clamps on both sides. The loads took the form of concrete cubes and other suitable masses to generate an even surface load corresponding to the wind load (calculation of the load masses, distribution or load schema, see **Annexes 6 and 7**).

Load application points : Width 1/8 - 1/4 - 1/4 - 1/4 - 1/8
 : Height 1/10 - 1/5 - 1/5 - 1/5 - 1/10)

The load and the measuring of the deflection were chosen in the current form because the planned frame reinforcement of the construction at the upper and lower edge of the elements excludes the use of line loads in accordance with Fig. 5 of ZTV-Lsw 88.

Weighing an element made of PMMA (2000 x 2000 x 20) mm resulted in the mass of 91.3 kg. **Fig. 1** shows the element as available for weighing.



Fig. 1: Element as available for weighing.

1.2 Test results

See Annexes 1 to 4.

1.3 Evaluation in accordance with ZTV-Lsw 88

The tested system complies with the requirements of Section 7.2.3 of ZTV-Lsw 88.

2 Test of stability under load and heat (ZTV-Lsw 88, 7.2.4)

2.1 Applicable regulations/description of the test

Additional technical regulations and guidelines for constructing noise protection walls along roads (ZTV-Lsw 88) issued by the Federal Minister of Transport, Highways Construction Department, 1988 edition.

The tests took place in accordance with Section 7.2.4 in combination with Section 2.1 ZTV-Lsw 88. For other data see Section 1.1 of this test certificate or Annexes 6, 8, 9, 10 and 11.

Load application points: Width 1/4 – 1/2 – 1/4

Height 1/10 - 1/5 - 1/5 - 1/5 – 1/5 - 1/10

The test set-up was documented with Fig. 6.

2.2 Test results

See Annex 5.

2.3 Evaluation in accordance with ZTV-Lsw 88

The tested system complies with the requirements of Section 7.2.4 of ZTV-Lsw 88.

3 Test of resistance to stone throwing (ZTV-Lsw 88, 7.2.5)

3.1 Applicable regulations/description of the test

Additional technical regulations and guidelines for constructing noise protection walls along roads (ZTV-Lsw 88) issued by the Federal Minister of Transport, Highways Construction Department, 1988 edition.

The test was carried out in accordance with Section 7.2.5 ZTV-Lsw 88. The mass of the element made of PMMA (2000 x 2000 x 20) mm was 91.4 kg on weighing. See Annexes 9 to 11 for the test set-up and dimensions. The element shown stood for at least 18 hours at an ambient temperature of -10°C. At this temperature the impact test was carried out with the concrete test hammer "Schmidt", model M (approx. 30 Nm) at the impact points stipulated in ZTV-Lsw 88, p. 49.

3.2 Test results

After the impacts applied horizontally to the built-in element made of PMMA (2000 x 2000 x 20) mm no damage was detected on a visual inspection of the impact points.

3.3 Evaluation in accordance with ZTV-Lsw 88

The tested system complies with the requirements of Section 7.2.5 of ZTV-Lsw 88.

4 Test of a noise protection wall in accordance with ZTV Lsw 88, Section 7.2.6

4.1 Description of the noise protection wall

The tested noise protection wall consisted of an element (PMMA) designated "Plazcryl", dimensions 3960 mm x 1500 mm (width x height). The element was 20 mm thick. It was transparent and colourless. The panel was fitted with an EPDM U-section on three sides and then mounted in a suitable frame made of a steel U-section.

The element weighed 140 kg.

Before the tests a 25 cm high pedestal was made of foam mortar stones. The noise protection wall for the fire tests was placed on this pedestal flush with the front edge of the U-section. For more details see Figs. 2 and 3.



Fig. 2: Test wall during the fire tests

4.2 Fire test

Test date: 05.02.2003

Ignition source: 600 g wood shavings no. 20, spruce in accordance with DIN 4077
in a wire basket (300 mm x 200 mm x 300 mm)

Ambient temperature at start of test: 18 °C

Course of test

First of all a block of wood shavings was placed directly in front of one side of the test wall in each of the thirds and ignited. Approx. 1 hour after the first two wood shavings blocks that were ignited simultaneously had burnt out, two additional wood shavings blocks were placed on the other side of the wall and ignited.

Observations during the fire tests

During the two fire tests no ignition of the test wall was seen. A slight brown colouring of the surfaces of the test wall was detected in the area of the primary flames.

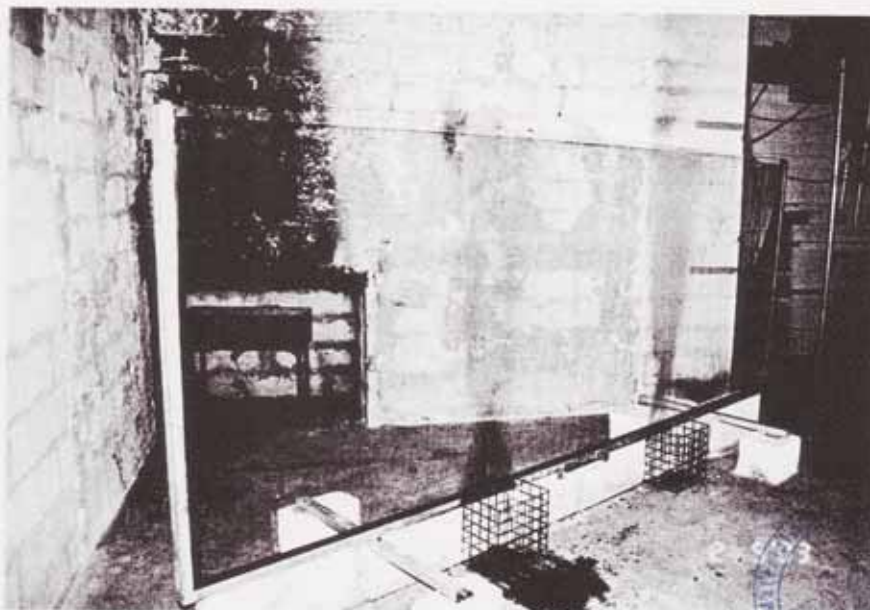


Fig. 3: Test wall after the fire test

4.3 Evaluation

No ignition of the examined noise protection wall occurred during the tests. The static and noise protection reliability performance of the test wall was not impaired by the effect of the fire load. No holes and cracks appeared during the tests.

The tested system complies with the requirements of Section 7.2.6 of ZTV-Lsw 88.

► Sound Insulation Test (ZTV Lsw-88)

Test Report

No.: 220002172 - 25

Test laboratory: Department 2
Building science

Customer

Palram Israel Ltd.
Ramat yohanan 30035
Israel

Date of commission: 11.10.2003
Material received: 05.12.2002/13.01.2003
Date of test: 21.03.2003
Sampling: Delivery by customer
without official sampling

Commission

Measuring the airborne sound insulation of a noise protection wall with polyacrylic panels.
Calculating the characteristics for the airborne sound insulation and evaluating in accordance with ZTV-Lsw 88.

Description of the test object / quantity and designation

Noise protection wall made of two "Plazcryn" polyacrylic panels, 20 mm thick, an IPB steel beam 160 with base plate, a steel frame made of angle and U-sections and U-section seals (sectioned), approx. 4 mm thick

Description of the test / of the basic test procedures

Additional technical regulations and guidelines for constructing noise insulation walls along roads (ZTV-Lsw 88) issued by the Federal Minister of Transport, Highways Construction Department, 1988 edition, Section 7.2.1.

Measuring the airborne sound insulation of the noise protection wall was carried out in accordance with DIN EN 20 140 – 3, Edition May 1995. DIN 52 210 quoted in ZTV-Lsw 88 was replaced by DIN EN 20 140 –3.

This test report expires on 21.01.2008

The results of the test refer exclusively to the test object described above. Test reports may not be published or reproduced with changes to their form and contents without the approval of MPA NRW. The abbreviated reproduction of a test report requires the approval of MPA NRW.

This test report contains 6 pages and 1 annex and a form with 5 annexes. The form with the appropriate annexes may be used separately from the test report.

The material was supplied to the agency without any markings from an official sampling and was installed by the customers in the test room of the building acoustics laboratory.

The size of the noise protection wall was 4.01 m x 2.01m.

Structure of the test object

The structure of the wall construction and the installation in the test room can be seen in the 4 drawings made by the customer which are attached to the form for this test report. The drawings are designated as follows: "3.1 view, 3.2 Cross section view, 3.3 JOINTING TO THE WALL AND IN THE MIDDLE IPB 160 and Black EPDM 65 % ± 5 %"

A 3 mm thick and 50 mm wide foam tape was inserted between the steel angle sections and the concrete pedestal (below), the side-mounted steel U-sections and the walls. In addition, the wall outlets and the ceiling outlet were stuffed with rock wool and sealed on both sides with a permanently elastic material. The U-section seals were cut through and mitred at the corners of the acryl panels. The contact depth of the polyacrylic panels in the centre posts was 59 mm and 66 mm and approx. 77 mm in each of the wall outlet sections (steel U-sections).

Ascertained dimensions and masses:

"Plazcryl" polyacrylic panels

Height	1967	mm
Length	1940	mm
Thickness	19.6	mm
Total mass of panels	178.8	kg
Mass per unit area	23.0	kg/m ²

Centre posts IPB steel beam 160 with base plate, threaded bolts welded on and steel angle sections

Length	2013	mm
Width	162	mm
Depth	153	mm
Material thickness	6.5 / 8.7	mm
Mass	95.0	kg
Base plate	240 mm x 320	mm
Thickness of the base plate	10.3	mm
Angle sections (with drill holes)	70 mm x 70	mm
Material thickness of the angle section	7.2	mm
Mass per metre of the angle section	7.2	kg/m

Steel angle sections with welded-on threaded bolts

Length	1800	mm
Flange length	100 mm x 100	mm
Material thickness	9.5	mm
Mass per metre	14.6	kg/m

Steel angle sections with drill holes

Length	1800 mm / 2000	mm
Flange length	70 mm x 70	mm
Material thickness	7.2	mm
Mass per metre	7.2	kg/m

Steel U-sections with base plate and welded-on threaded bolts

Length	2000	mm
Width	155	mm
Height	89	mm
Material thickness	6.8	mm
Mass	42.6	kg
Base plate	203 mm x 150	mm
Thickness of the base plate	12.0	mm

U-section seals sectioned

Material thickness	4	mm
Height	44	mm
Width (outside)	33.6	mm
Mass per metre	674	g/m

Foam tape (self-adhesive)

Thickness	3	mm
Width	50	mm
Mass per metre	8.9	g/m

Implementation of the trials

The airborne sound insulation was measured in accordance with DIN EN 20 140-3 - Measurement of sound insulation in buildings and of building elements, Part 3: Measurement of the airborne sound insulation of building elements in test rooms (ISO 140-3: 1995) German version EN 140-3: 1995 - May 1995.

The sound reduction indices were determined in accordance with DIN EN 20 140-3, Section 3.2, in relation to the test area of 8.1 m^2 in dependence on the frequency.

The measuring apparatus was a class 1 two-channel real-time third-octave analyser, make: Norsonic, type: 830-2, with two $\frac{1}{2}$ " capacitor microphones, make: Brüel & Kjaer, type: 4165, and the appropriate pre-amplifier, type: 1201, make: Norsonic. The measuring apparatus with the accessories was last calibrated by the State Office for Surveying and Calibrating, NRW, Office for Special Commissions, Calibration Agency in Dortmund in July 2002. The calibration is valid until 31.12.2004.

The loudspeaker, designed as a dodecahedron type: 229, was supplied with pink noise and moved along an approx. 1.8 m long path during the measuring. Third-octave filters in accordance with IEC 225 were used as filters in the measuring apparatus. The microphones were moved on 2 inclined circuits with a radius of 1.1 m. The sound pressure levels were averaged energetically from 4 measuring series.

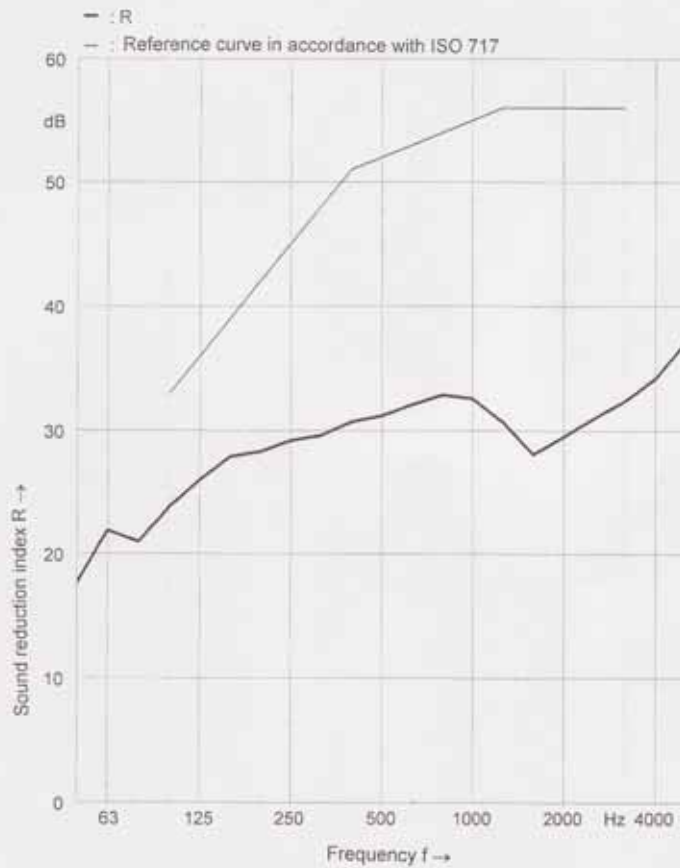
The test room conformed to the requirements for test rooms in DIN EN ISO 140-1 - Acoustics, measurement of sound insulation in buildings and of building elements, Part 1: Requirements for laboratory test facilities with suppressed flanking transmission (ISO 140-1: 1997), edition 1997, Section 3.

The volume of the source room was 49.3 m^3 .
The volume of the receiving room was 52.4 m^3 .

The calculation of the sound reduction index $\Delta L_{A,R,Stf}$ was carried out in accordance with ZTV-Lsw 88, Section 7.2.1.

Test results

The following diagram and the form in accordance with DIN EN 20 140-3, May 1995 each show the sound reduction index of the test object in dependence on the frequency.



The reference curve for 1/3 octaves in accordance with DIN EN ISO 717-1 - Rating of sound insulation in buildings and of building elements, Part I: Airborne sound insulation (ISO 717-1: 1996) German version EN ISO 717-1: 1996 - January 1997 is included in the diagram for rating the achieved sound insulation.

The sound reduction index R_w and the spectrum adaptation terms C and C_{tr} , measured and rated in accordance with DIN EN ISO 717 Part 1, January 1997, Section 4, are shown below.

Noise protection wall made of two "Plazcryn" polyacrylic panels, 20 mm thick, an IPB steel beam 160 with base plate, a steel frame made of angle and U-sections and U-section seals (sectioned), approx. 4 mm thick

$$R_w (C; C_{tr}) = 31 (0; -1) \text{ dB}$$

The maximum weighted sound reduction index $R'_{w,max}$ of the test room, in relation to the surface area of the test object was 55 dB on installation of a lightweight wall.

The sound reduction index $\Delta L_{A,R,St}$ for the tested system measured in accordance with the "Additional Technical Provisions and Guidelines for Constructing Noise Protection Walls along Roads" (ZTV-Lsw 88), Edition 1988, Section 7.2.1, is **30 dB**.

The form may be used separately from the test report but only with the 4 drawings made by the customer and belonging to this form and with the annex "Measured dimensions and masses". The drawings are designated as follows: "3.1 view, 3.2 Cross section view, 3.3 JOINTING TO THE WALL AND IN THE MIDDLE IPB 160 and Black EPDM 65 % \pm 5 %"

The individual values and the sound reduction indices R in the frequency range 50-5000 Hz may be seen in the enclosed laboratory report.

Evaluation under ZTV-Lsw 88

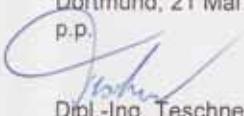
Under Section 7.2.1 of the ZTV-Lsw 88 the sound reduction index $\Delta L_{A,R,St}$ must be at least 25 dB. The tested system **conforms** to the requirements of Section 7.2.1 of the ZTV-Lsw 88 with $\Delta L_{A,R,St} = 30 \text{ dB}$.

Note:

The single value for airborne sound insulation DL_R that is to be determined in accordance with DIN EN 1793-2 - Road traffic noise reducing devices - Test method for determining the acoustics performance, Part 2: Intrinsic characteristics of airborne sound insulation, German version EN 1793-2: 1997 - November 1997, Section 5.2, for the above-mentioned noise protection wall is 31 dB. In accordance with DIN EN 1793-2, Annex A, the airborne sound insulation characteristics of the tested noise protection wall with 20 mm thick "Plazcryn" polyacrylic panels are to be classified in group B3.

Dortmund, 21 Mai 2003

p.p.


Dipl.-Ing. Teschner
Scientific Assistant



In the event of any disputes the German version shall prevail.

► PALGLAS® Acoustic Insulation Properties (ISO 140 6 & DIN 52210)



Yuly Keller, D.Sc.

ACOUSTIC and ELECTRO-ACOUSTIC DESIGN
NOISE & VIBRATION CONTROL

SAVION STREET 18 C, P.O.BOX 5030, QIRYAT YAM, 29500, ISRAEL

TEL: 972-4-8759875

FAX: 972-4-87600079

To:
Mr. Amir Sade
Paltough - Palram Ltd.
Kibutz Ramat-Yohanan 30035

22-11-1998

Dear sir,

AKRIL XT

Subject: Acoustic insulation properties of Palglas sheets

Due to your order, measurements of acoustic insulation properties of the Palglas sheets manufactured by the Paltough Palram factory have been carried out.

The acoustic measurements have been conducted in accordance with the Israeli standard 1034 part 6 (compatible to ISO 140 part 6, DIN 52210).

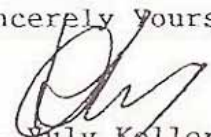
The calculation of the insulation index I_a has been carried out in accordance to the Israeli standard 985 part 1 (compatible to ISO 717 part 1, DIN 4109).

The noise insulation values as a function of 1/3 octave band frequencies and the values of the insulation indexes for Palglas sheets of several thickness are presented in the table.

Table - Insulation Values of Palglas Sheets.

8 mm thickness	Frequency, Hz
16	100
17	125
18	160
19	200
21	250
22	315
23	400
24	500
25	630
26	800
28	1000
30	1250
31	1600
31	2000
30	2500
33	3150
28	Insulation Index, dB

Sincerely Yours,



Dr. Puly Keller

► Decomposition Effluents Toxicity (DIN 53 436)

CERTIFICATE

The decomposition effluents at 400°C (VKT) according to DIN 53 436
from

PALGLAS

of

Palram Germany
Westöninger Hellweg 11
59457 Werl

documented with test report-no: 3/2006, corresponding to the valid test conditions are
considered – with regard to the acute inhalation toxicity – to be

non toxic.

The certificate is valid until 14.02.2008. The product may be marked with the sign

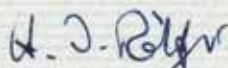
Im Brandfalle
rauchgastoxikologisch

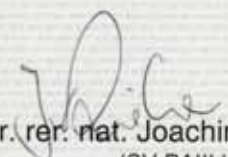


unbedenklich
PB-Nr. 3/2006

Elektro-Physik Aachen GmbH
Jülicher Strasse 338
52070 Aachen
www.epa-aachen.de

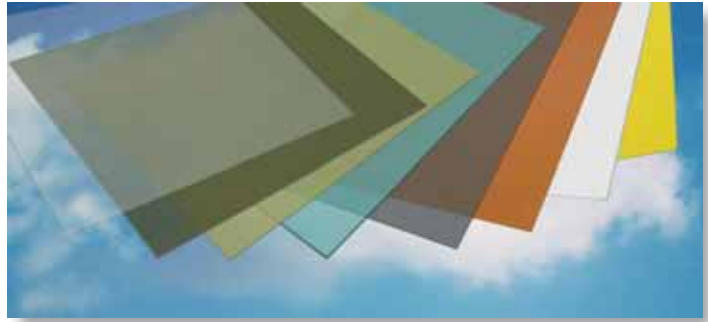
Aachen, 14. Februar 2006


Dr.-Ing. H.J. Röttger
(Prüfstellenleiter)


Dr. rer. nat. Joachim Pieler
(SV PAIII beim DIBt)

PALSUN®

Flat Solid Polycarbonate Sheet



► Main Features

- Applied thickness 8-12mm
- Main advantage - Virtually unbreakable
- Easy to mount and install
- Flexible, Formable, Machinable
- Good fire resistance
- Transparent as glass
- Abrasion resistant coating - Optional

► Standards Compliance

- ASTM-V638 Test method for tensile properties of plastics.
- ASTM-D-790 Test method for flexural properties of plastics.
- ASTM-1-648 Test method for deflection temperature of plastics under flexural load.
- ASTM-792 Test method for specific gravity (Relative density) and density of plastics by displacement.
- ISO 6603/1 Determination of multi-axial impact behavior of rigid planes - Falling dart method.
- ASTM-D-1003 Test method for haze and luminous transmittance of transparent plastics.
- ASTM-D-1925 Test method for yellowness index of plastics.
- ASTM-G-53 Recommended practice for operating light and water exposure apparatus (fluorescent I-v-condensation type) for exposure of nonmetallic materials.
- ISO 140-6 & DIN 52210 Test Method for measurement of acoustic insulation (Pages 27-28).

► PALSUN® Acoustic Insulation Properties (ISO 140-6 & DIN 52210)



Yuly Keller, D.Sc.

ACOUSTIC and ELECTRO-ACOUSTIC DESIGN
NOISE & VIBRATION CONTROL

SAVION STREET 18 C, P.O.BOX 5030, QIRYAT YAM, 29500, ISRAEL

TEL: 972-4-8759875

FAX: 972-4-87600079

נספח טכני
10-01-1999

To:
Mr. Amir Sade
Paltough - Palram Ltd.
Kibutz Ramat-Yohanan 30035

22-11-1998

Dear sir,

Subject: Acoustic insulation properties of Palsun sheets
=====

Due to your order, measurements of acoustic insulation properties of the Palsun sheets manufactured by the Paltough Palram factory have been carried out.

The acoustic measurements have been conducted in accordance with the Israeli standard 1034 part 6 (compatible to ISO 140 part 6, DIN 52210).

The calculation of the insulation index I_a has been carried out in accordance to the Israeli standard 985 part 1 (compatible to ISO 717 part 1, DIN 4109).

The noise insulation values as a function of 1/3 octave band frequencies and the values of the insulation indexes for Palsun sheets of several thickness are presented in the table.

-2-

Table - Insulation Values of Palsun Sheets.

12 mm thickness	10 mm thickness	8 mm thickness	Frequency, Hz
21	19	17	100
20	20	17	125
22	20	18	160
24	23	20	200
24	22	21	250
26	24	22	315
26	25	23	400
28	27	24	500
30	28	25	630
32	31	27	800
32	31	28	1000
34	33	30	1250
34	33	30	1600
35	33	31	2000
33	33	31	2500
35	34	33	3150
31	30	28	Insulation Index, dB

-3-

Due to the results of the measurements and calculation of acoustic indexes, the following conclusion can be achieved:

The acoustic insulation index of the transparent "Palsun" sheets rises 5 dB per doubling of the thickness.

An equation for evaluation of insulation indexes of Palsun sheets has been developed on the basis of the measurements:

$$R_v = 22 + 0.75 \cdot h + 0.5 \text{ dB}$$

h - thickness of the sheet, mm.

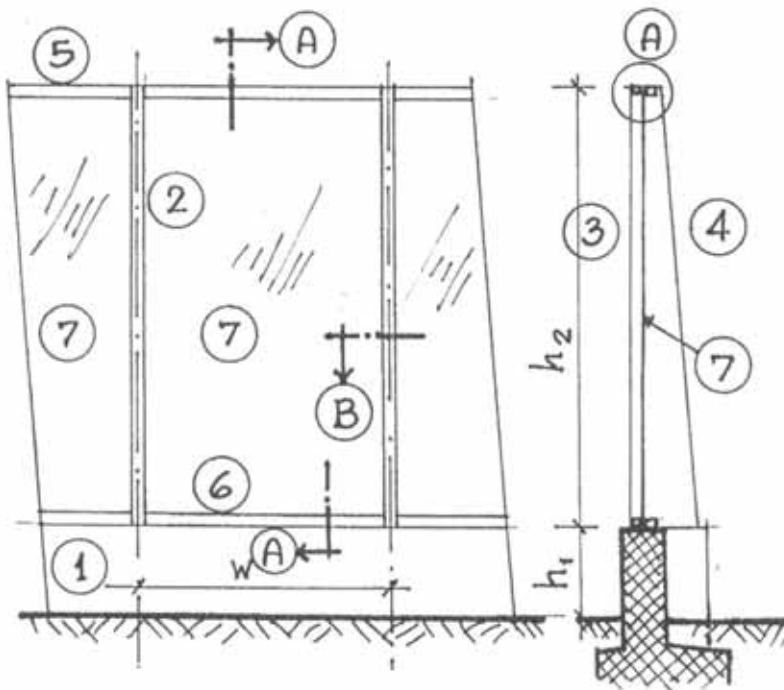
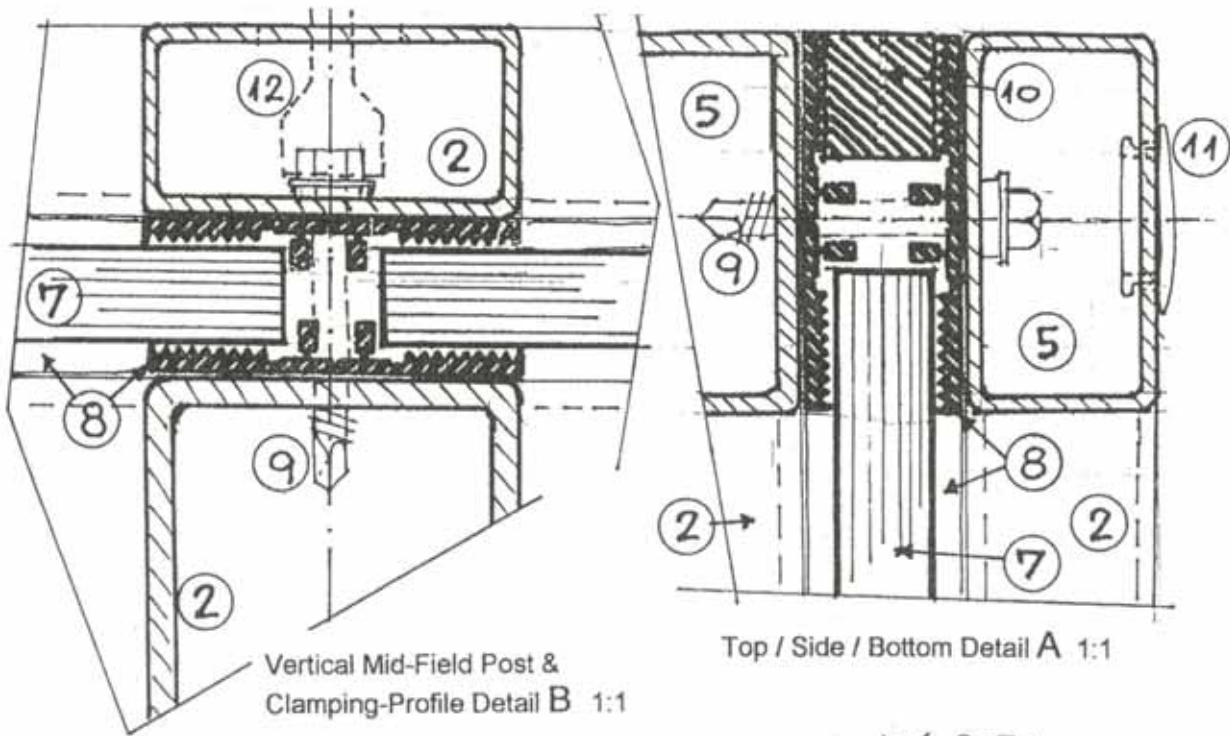
Sincerely Yours,



Dr. Yuly Keller

► PALGLAS® Typical Details - RHS Closed Profiles

Transparent Acoustic Barrier
 Concrete Foundation & Parapet
 Galvanized Steel Supporting Structure
 Heavy Duty High-gauge Acrylic Glazing



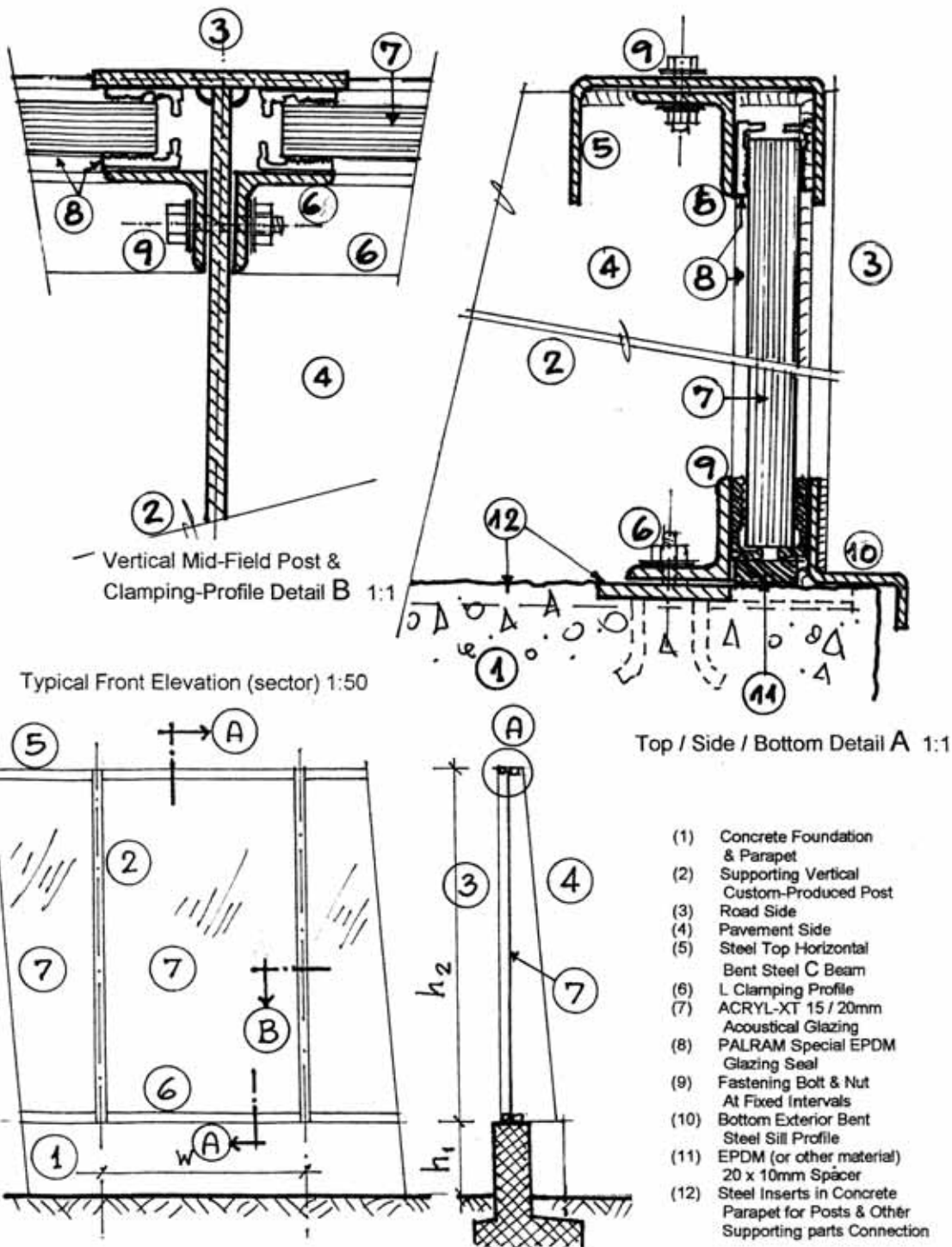
- $w \leq 2050 \text{ mm}$
 $h_2 \leq 5000 \text{ mm}$
- (1) Concrete Foundation & Parapet
 - (2) Supporting Vertical Post
 - (3) Road Side
 - (4) Pavement Side
 - (5) Steel Top Horizontal Beam & Clamping Profile
 - (6) Steel Bottom Horizontal Beam & Clamping Profile
 - (7) PAL SUN / PALGLAS 15 / 20mm Acoustical Glazing
 - (8) PALRAM Special EPDM Glazing Seal
 - (9) Concealed Fastening Screw At Close Intervals
 - (10) EPDM (or other material) 15 / 20mm Spacer
 - (11) Plastic Cap / Stopper for Fastener Hole
 - (12) Indicated Socket Entry for Fastener Tightening

Typical Front Elevation (sector) 1:50

Typical Cross-Section 1:50

PALGLAS® Typical Details - RHS Closed Profiles Alt. II: Open C, L & I Profiles

Transparent Acoustic Barrier
 Concrete Foundation & Parapet
 Galvanized Steel Supporting Structure
 Heavy Duty High-gauge Acrylic Glazing



$W \leq 2050\text{mm}$
 $h_2 \leq 5000\text{mm}$

