

ALPOLIC®

Section 4 Appendices

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Appendix 1: Summary of technical data-ALPOLIC®/fr

1. General

ALPOLIC®/fr is an aluminum composite material (ACM) with a non-combustible mineral-filled core, used as an exterior and interior cladding and roof covering on new buildings and retrofit applications. The material is manufactured by Mitsubishi Plastics, Inc., and furnished by approved dealers or distributors.

Note:

This summary of specification data is about ALPOLIC/fr. If you need specifications of ALPOLIC composed of polyethylene core and mainly used for signage, contact local distributors or our office.

Specification data may be changed in part without affection of material quality.

2. Product composition

ALPOLIC/fr is composed of a non-combustible mineral-filled core sandwiched between two skins of 0.5mm thick aluminum alloy (3105-H14):

Composition	Skin material:	0.5mm thick aluminum alloy (3105-H14)
	Core material:	Non-combustible mineral filled core

The surface is finished with a high-performance Lumiflon-based fluorocarbon coating as standard, and the back is a wash coating or service coating. ALPOLIC/fr is available in finishes of: Solid Colors, Metallic Colors, Sparkling Colors, Prismatic Colors and NaturArt Series. In these finishes, Lumiflon-based fluorocarbon paints are applied in manufacturer's continuous coil coating lines.

The back of ALPOLIC/fr, which will face the structural wall or steel when it is installed as a cladding panel, has a polyester-based wash coating or a service coating to protect it from possible corrosion problems.

The surface is protected with a self-adhesive peel-off protective film consisting of two polyethylene layers of white and black. According to weathering tests under normal outdoor conditions, the protective film will withstand six months' exposure without losing its original peel-off characteristic or causing stains or other damages.

3. Product dimension and tolerance

- (1) Panel thickness: 3 mm, 4 mm and 6 mm
- (2) Panel size: Width = 965, 1270 and 1575 mm
 Length = less than 7200 mm

Note: Custom width can be accepted between 914 mm and 1575 mm subject to minimum quantity. Please contact local distributors or our office.

(3) Product tolerance

Width: ±2.0 mm

Length: ±4.0 mm

Thickness: ±0.2 mm in 3 and 4 mm thick, ±0.3 mm in 6 mm thick

Bow: Maximum 0.5% (5mm/m) of the length or width

Square-ness (diagonal difference):

Maximum 5.0 mm

Surface defect: The surface shall not have any irregularities such as roughness, buckling and other imperfections in accordance with our visual inspection rules. ALPOLIC/fr is supplied with a cut edge and without aluminum sheet displacement or core protrusion.

4. Principal properties

(1) Panel weight:

	Unit	3mm	4mm	6mm
Panel weight	kg/m ²	6.0	7.6	10.9

(2) Thermal expansion: $24 \times 10^{-6} / ^\circ\text{C}$

(3) Mechanical properties of Aluminum Composite Material (ACM):

	Unit	3mm	4mm	6mm
Tensile strength (ASTM E8)	MPa or N/mm ²	61	49	29
0.2% proof stress (ASTM E8)	MPa or N/mm ²	53	44	26
Elongation (ASTM E8)	%	4	5	2
Flexural elasticity, E (ASTM C393)	GPa or kN/mm ²	49.0	39.8	29.1

(4) Mechanical properties of aluminum alloy (3105-H14):

0.2% proof stress (ASTM E8): 150 MPa or N/mm²

Flexural elasticity (ASTM E8): 70 GPa or kN/mm²

(5) Deflection temperature: 115°C in 3mm, 116°C in 4mm and 109°C in 6mm

(6) Sound transmission loss (ASTM E413):

Thickness	4mm	6mm
STC (Standard Transmission Class)	27	29

5. Summary of fire tests

Extensive fire tests have been performed in accordance with standards in various countries.

ALPOLIC/fr has passed the following fire tests around the world:

Table 5-1 Fire tests for general and external cladding material

Country	Test standard	ALPOLIC/fr specimen	Results & classification
EU	EN 13823, EN ISO 11925-2, EN 13501-1	4mm, 6mm	Class B
United Kingdom	BS476 Part 7	4mm, 6mm	Class 1
	BS476 Part 6	4mm, 6mm	Class 0
Germany	DIN4102 Part 1	4mm, 6mm	Class B1
USA	NFPA 259-93 British Thermal Unit	4mm	Passed
	ASTM D1781-76 Climbing Drum Peel Test	4mm, 6mm	Passed
	ASTM E84, Steiner Tunnel Test	4mm, 6mm	Class A / Class 1
	ASTM E-108, Modified	4mm	Passed
	UBC 26-9 & NFPA 285, ISMA Test (Intermediate Scale Multi-story Apparatus)	4mm, 6mm	Passed
Canada	CAN/ULC-S 134-92, Full-scale Exterior Wall Fire Test	4mm	Passed
China	GB8625, GB8626 & GB8627	4mm	Class B1
Japan	Heat Release Test for Non-combustible Material (ISO 5660-1)	4mm, 6mm	Passed Certificate No. NM-1933

Table 5-2 Fire tests for other categories

Category	Country	Test Standard	ALPOLIC/fr specimen	Results & classification
Fire resistant rating wall	USA	ASTM E119, 1-hr Fire Rating and 2-hr Fire Rating	4mm	Passed
Roof material	USA	ASTM E108, Fire Test for Roof Covering	4mm	Passed Class A
Interior material	USA	UBC 26-3, Interior Room Corner Test	4mm	Passed
		Combustion Toxicity Test, New York State Uniform Fire Prevention and Building Code	4mm	Passed
	Japan	Heat Release Test for Non-combustible Material (ISO 5660-1) & Toxicity Gas Test	3, 4, 6mm	Passed Certificate No. NM-1933

6. Paint finish

(1) Coating system

The surface is finished with Lumiflon-based fluorocarbon coating as standard; the back is a wash coating or service coating. ALPOLIC/fr is available in finishes of: Solid Colors, Metallic Colors, Sparkling Colors, Prismatic Colors and NaturArt Series (Stone, Timber, Metal, and Abstract). In these finishes, Lumiflon-based fluorocarbon paints are applied in the manufacturer's coil coating lines.

The coating system of each finish is:

A. "Solid Colors" with two-coat two-bake system

The total dry film thickness is 25 microns (0.98 mils) minimum and consists of a conversion coating, an inhibitive primer and a Lumiflon-based fluorocarbon coating.

"Solid Colors" with three-coat three-bake system

The thickness is 33 microns (1.3 mils) minimum and consists of a conversion coating, an inhibitive primer, a Lumiflon-based fluorocarbon coating and a clear coating.

B. "Metallic Colors", "Sparkling Colors" and "Prismatic Colors" are a three-coat three-bake system.

The thickness is 28 microns (1.1 mils) minimum and consists of a conversion coating, an inhibitive primer, a Lumiflon-based metallic coating and clear coating.

C. "NaturArt Series" is coated with a unique image transfer process.

The thickness is 45 microns (1.77 mils) minimum and consists of a conversion coating, an inhibitive primer and a Lumiflon-based fluorocarbon coating including the image transfer layer.

Note 1: Lumiflon-based fluorocarbon coating has a coating warranty for 10 years.

Note 2: ALPOLIC/fr is finished with Lumiflon-based fluorocarbon paint as standard, but polyester and other coatings are also available as an option.

(2) Color and gloss

Standard colors are provided in the Color Chart. Custom colors are available for all finishes upon request subject to respective minimum quantities. The standard gloss is 30% for Solid and Metallic Colors, and 15-80% for Sparkling Colors, Prismatic Colors and for NaturArt Series (Stone, Timber, Metal, and Abstract). Custom gloss is available between 15 and 80% in all colors upon request subject to minimum quantities. Please contact local distributors or our office for custom color requests.

(3) Coating performance

The Lumiflon-based fluorocarbon coating meets the following criteria:

Table 6-1 General properties

Dry film property	Test method	Criteria
Gloss (60°)	ASTM D523-89	15 to 80%
Formability (T-bend)	NCCA II-19 ASTM D1737-62	2T, no cracking
Reverse impact-crosshatch	NCCA II-5	No pick off
Hardness-pencil	ASTM D3363-92a	H
Adhesion		
Dry	ASTM D3359, method 8	No pick off
Wet	37.8°C, 24 hrs.	No pick off
Boiling water	100°C, 20 min.	No pick off
Abrasive resistance	ASTM D968-93 (Falling sand)	40 liters/mil
Chemical resistance		
Muriatic acid, 10% HCl, 72hrs	ASTM D1308-87	No change
Sulphuric acid, 20% H ₂ SO ₄ , 18hrs	ASTM D1308-87	No change
Sodium hydroxide, 20% NaOH, 1hr	ASTM D1308-87	No change
Mortar, pat test, 38°C, 24hrs	AAMA 2605	No change
Detergent, 3% solution, 38°C, 72hrs	ASTM D2248-93	No change

Table 6-2 Weatherability

Dry film property	Test method	Criteria
Weather-o-meter test		
Colour retention	ASTM D2244-93	Maximum 5 units after 4000 hrs.
Gloss retention	ASTM D523-89	70% after 4000 hrs.
Chalk resistance	ASTM D4214-89	Maximum 8 units after 4000 hrs.
Salt spray resistance	ASTM B117-90	Blister-10, scribe-8, after 4000 hrs, 35°C salt fog
Humidity-thermal	ASTM D2246-87	No blister, no cracking After 15 cycles of 38°C 100%RH for 24hrs and -23°C for 20hrs
Humidity resistance	ASTM D2247-94	No change After 4000 hrs, 100%RH, 35°C

Note: The material properties or data herein are portrayed as general information or representative value only and as a guide without warranty.

Appendix 2: Optional coatings

ALPOLIC/fr and ALPOLIC have a coating finish of Lumiflon-based fluorocarbon paints as standard, but we can supply ALPOLIC/fr and ALPOLIC coated with the following distinctive paints as an option.

Table Paint options

Coating type	Characteristics	Suitable application
Conductive fluorocarbon coating	Electrically-conductive ($3 \times 10^{7-8}$ ohms)	Interior walls and partitions in factory
PVDF-based fluorocarbon coating	Ultra-weather-ability	Outdoor (external wall cladding, roof covering)
Polyester coating	Matte finish	Interior and light outdoor applications
High cross-link polyester coating	High hardness (4H) High reflectivity (80%)	Internal lining of tunnels and underpass

1. Conductive fluorocarbon coating

ALPOLIC/fr coated with conductive fluorocarbon paint is used on interior walls, partitions and ceilings of clean rooms and warehouses. With an electrically-conductive surface, the panel also has high rigidity and fire safety. The conductive paint can be applied on both sides of the panel, if necessary.

Principal coating performance:

- (1) Pencil hardness: 3H
- (2) Surface electric resistance: $3 \times 10^{7-8}$ ohms
- (3) Chemical resistance:
 - Sulfuric acid, 5% H_2SO_4 : No change
 - Sodium hydroxide, 1% NaOH: No change

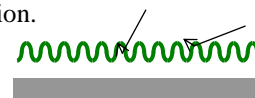
2. PVDF-based fluorocarbon coating

PVDF-based fluorocarbon coating has ultra-weatherability. The coating resists long-term exposure to outdoor conditions. Solid (enamel) and metallic finishes are available. The paints are applied in ALPOLIC's continuous coil coating lines. Contact local distributors or our office for details.

3. Polyester coating

Matte finish is available with polyester coatings, although polyester coatings have less weather-ability than fluorocarbon coatings. Matte finish is produced with a new coating technology in which microscopic wrinkles emerge over the entire surface during baking

Matte finish: Due to the different hardening speed between the outer and inner layers of the paint, microscopic wrinkles emerge over the entire surface. The wrinkled surface results in a matte appearance due to irregular light reflection.



in the coil coating line. Matte finish is available with solid (enamel), metallic and timber-patterned products.

4. High cross-link polyester coating

The high cross-link polyester coating permits high surface hardness of 4H as well as sufficient surface reflectivity of 80%. Therefore, it is suitable for an area where the panel might be scratched during maintenance work, such as an internal lining of tunnels and pedestrian's underpass. The paint is applied in the manufacturer's continuous coil coating lines, which ensures uniform coating quality of the product.

Principal coating performance:

- (1) Coating system: Two-coat two-bake system, total dry film thickness is 30 microns minimum
- (2) Pencil hardness: 4H with ASTM D522-88
- (3) Surface reflectivity: 80% in diffuse reflection (white color)

Appendix 3: Perforated panel

Perforated panels of ALPOLIC/fr and ALPOLIC have a pattern of holes at regular intervals. This provides ventilation and permits vision through the panel, making it suitable for balconies, staircases, partitions and ceilings.

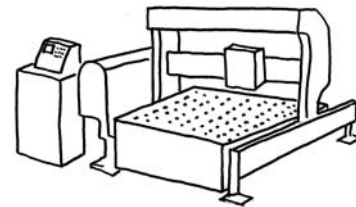
1. Panel size

- Maximum width: 1270mm (55")
- Maximum length: Approx. 3000mm (118")
- Practical examples of sizes: 1000×300mm, 1000×500mm, 1000×700mm, 1000×1000mm

2. Perforation process

As introduced in Section 3, "3. Processing method", we normally use a turret puncher for perforation of ALPOLIC/fr and ALPOLIC. Suitable clearance between punch and die is 0.1mm or smaller (material thickness × 2%). A small droop will appear at the punched edge.

Turret puncher



3. Examples of perforation pattern

The typical hole-arrangement of circle-shaped holes is as follows:

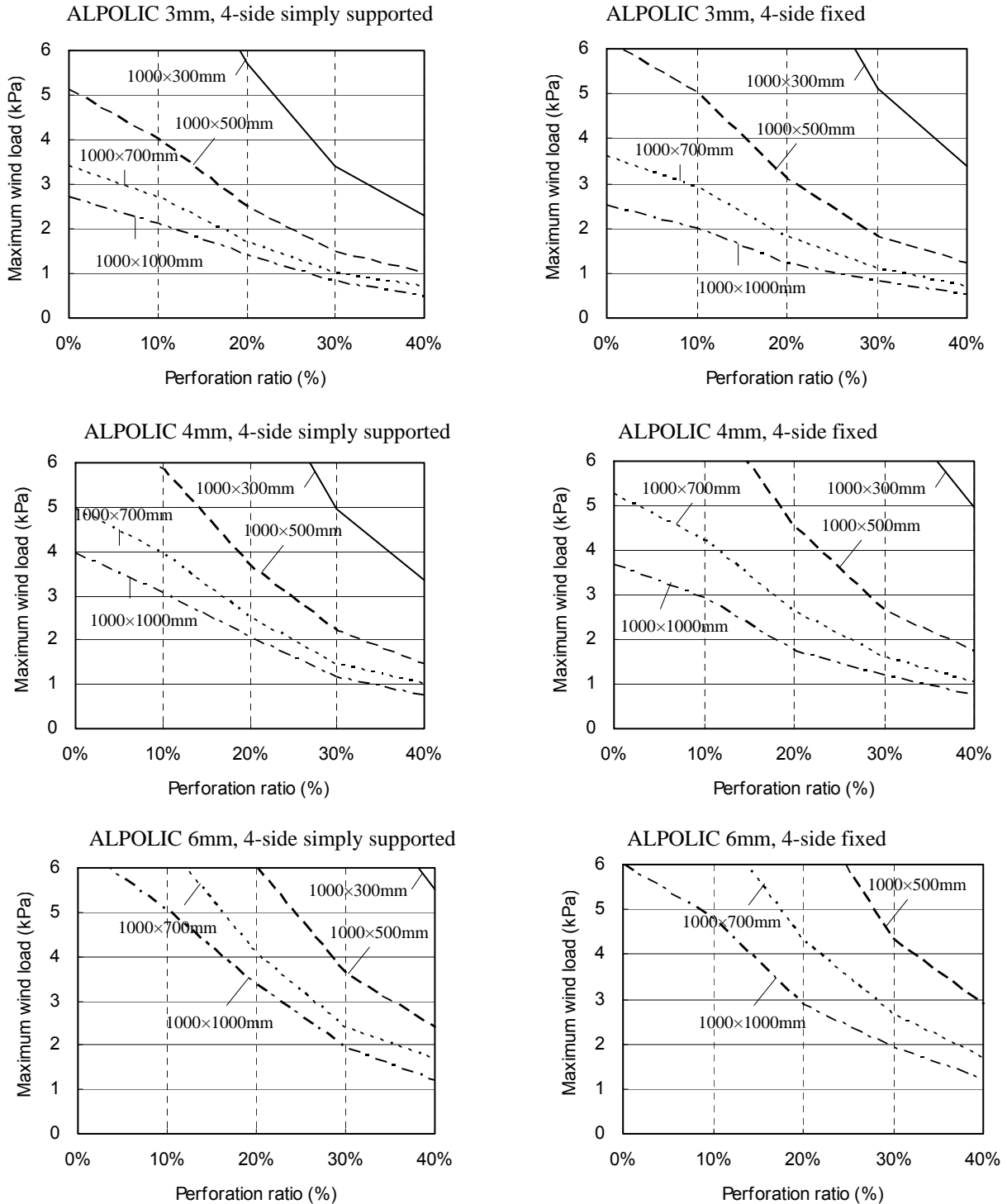
Direction	Pattern	Hole diameter	Interval (W)	Perforation ratio
Square		20mm	40mm	19.6%
60° Zigzag		5mm	10mm	22.6%
		6mm	10mm	32.6%
		7mm	10mm	44.4%
		7mm	12mm	30.8%
		8mm	12mm	40.2%
		8mm	16mm	22.6%
		10mm	15mm	40.2%
		15mm	25mm	32.6%

Note: Perforation ratio is % of the total area that is perforated.

4. Panel strength:

Panel strength is lessened after perforation. Namely, the permissible load of ALPOLICs becomes smaller dependent on the perforation ratio (perforated area per total area). The following charts show the maximum limit of uniformly-distributed load, like a wind load, without causing permanent deformation. As shown in the chart, 20%-perforated ALPOLIC loses one half the original strength.

Fig. 4-1 Maximum wind load of perforated ALPOLIC



Note 1: The above charts are applicable to both ALPOLIC/fr and ALPOLIC.

Note 2: The above maximum load includes the safety factor of 1.25.

5. Notes on perforated panels

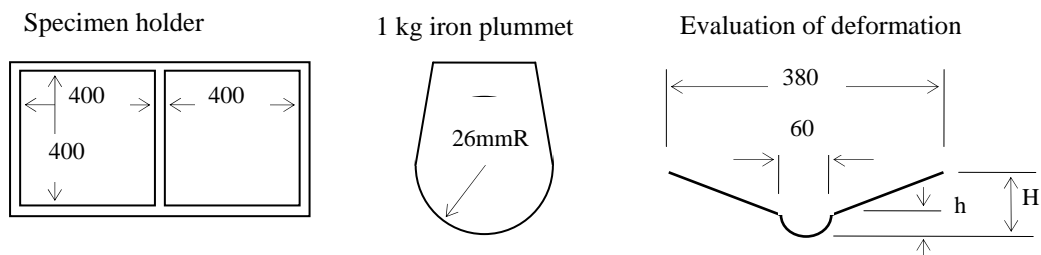
- (1) Effective surfaces are protected with protective films. Remove protective film immediately after installation.
- (2) Align the coating direction in the case of Metallic, Sparkling Colors and Stone-Timber-Metal Finishes, to avoid color difference due to coating direction.
- (3) Use aluminum or stainless steel rivets or screws for joining. If aluminum skin has contact with other metals in a humid atmosphere, corrosion of the aluminum might be accelerated by galvanic corrosion.
- (4) When re-coating ALPOLIC Perforated Panel, use air-curing type paint and dry it at 90°C or lower, to prevent the core material from overheating.

Appendix 4: Impact test with iron plummet

We conducted this test in order to check the impact resistance of ALPOLIC in comparison to other building materials. As the test result shows, ALPOLIC panels never crack, break or fracture by the impact of an iron plummet.

1. Testing method

- (1) Testing standard: JIS A 5703 “Plastic laminated or printed boards for inside use”
- (2) Specimen: 450×900 mm, placed in a specimen holder shown below.
- (3) Iron plummet: 1 kg weight shown below
- (4) Procedures: Drop the iron plummet onto a specimen from 1 or 2 meters height.
- (5) Evaluation: After the test, the specimen is evaluated on the following items:
 - a. Break or fracture by impact
 - b. Deformation of the entire area (H)
 - c. Deformation of the dropping point (h)



2. Test result

Material	Thickness (mm)	Weight (kg/m ²)	Fracture	Deformation H & h (mm)			
				1	2	3	4
ALPOLIC	3	4.6	No	○	△		
	4	5.5	No	○	△		
	6	7.4	No	○	△		
Aluminum sheet	2	5.4	No		○	△	
	3	8.1	No	○	△		
Steel sheet	1.0	7.9	No	○	△		
Veneer	15	7.5	No	○	△		
Gypsum board	12	8.9	Yes/Both (1m)	Not available			
Calcium silicate board	8	10.3	Yes/Both (2m)	○	△		
Acrylic sheet	3	3.6	Yes/Both (1m)	Not available			

Dropping height ○: 1 m △: 2 m Deformation H: —○—△ h:○.....△

Note: In the “Fracture” column shown in the table, “Both” indicates that fracture was found both in front and back. “Not available” means that it is impossible to measure the deformation value due to fracture.

Appendix 5: Panel strength

1. General calculation method

(1) Calculation to check the possibility of permanent deformation

In order to check that ALPOLIC panels can withstand the wind load condition, we calculate the maximum stress that may arise in aluminium skins of ALPOLIC with the design wind load. We use the following equation for this purpose. In our calculation, we use the same equation and parameters for both ALPOLIC/fr and ALPOLIC, because we ignore the role of the core in this calculation.

$$\text{Stress} = B \cdot w \cdot b^2 / t^2$$

- Stress: Stress that may arise in aluminum skin, in MPa or N/mm²
- b: Panel width or height, whichever is shorter, in mm
- B: Coefficient dependent on a/b ratio (panel width/height) and supporting condition, as shown in Table 4-6.
- w: Wind pressure, in MPa, 10⁻³kPa or N/mm²
- t²: Square of apparent thickness of ALPOLIC, given in the following table:

ALPOLIC Thickness	t ² (mm ²)	0.2% proof stress (MPa or N/mm ²)
3mm	6.33	150
4mm	9.25	150
6mm	15.17	150

If the stress value calculated with the equation is not larger than 0.2% proof stress above, aluminium skins withstand the wind load and the permanent deformation will not occur. A suitable safety factor should be taken into account herein.

(2) Maximum deflection

The maximum deflection of ALPOLIC panel can be calculated with the following equation:

$$\text{Deflection} = A \cdot w \cdot b^4 / E_{AP} t_{AP}^3$$

- Deflection: Deflection that may appear in ALPOLIC panel, in mm
- b: Panel width or height, whichever shorter side
- A: Coefficient dependent on a/b ratio (panel width/height) and supporting condition, as shown in Table 4-7.
- w: Wind pressure in MPa, 10⁻³kPa or N/mm²
- E_{AP}: Flexural elasticity of ALPOLIC, shown below
- t_{AP}: Thickness of ALPOLIC

ALPOLIC Thickness	E_{AP} (N/mm ²)	$E_{AP}t_{AP}^3$ (N·mm)
3mm	49.0×10^3	1323×10^3
4mm	39.8×10^3	2546×10^3
6mm	29.1×10^3	6287×10^3

Table 4-6 Coefficient B to calculate the stress

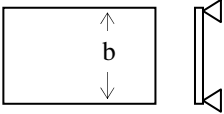
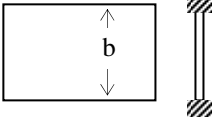
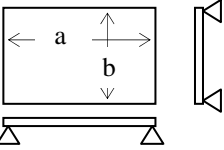
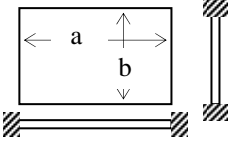
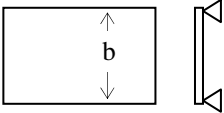
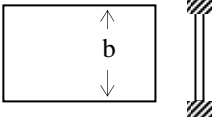
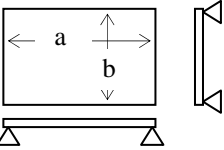
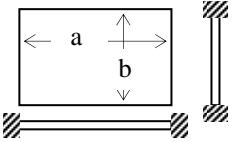
Support condition		Equation and B value
2-side simply supported and 2-side free		Stress = $0.75 \cdot w \cdot b^2 / t^2$
2-side fixed and 2-side free		Stress = $0.5 \cdot w \cdot b^2 / t^2$
4-side simply supported		Stress = $B \cdot w \cdot b^2 / t^2$
		a/b 1 1.2 1.4 1.6 1.8 2.0 3.0
		B 0.2874 0.3762 0.4530 0.5172 0.5688 0.6102 0.7134
4-side fixed		Stress = $B \cdot w \cdot b^2 / t^2$
		a/b 1 1.2 1.4 1.6 1.8 2.0 >2.0
		B 0.3078 0.3834 0.4356 0.4680 0.4872 0.4974 0.5000

Table 4-7 Coefficient A to calculate the deflection

Support condition		Equation and A value
2-side simply supported and 2-side free		Deflection = $0.156 \cdot w \cdot b^4 / (E_{AP} \cdot t_{AP}^3)$
2-side fixed and 2-side free		Deflection = $0.0313 \cdot w \cdot b^4 / (E_{AP} \cdot t_{AP}^3)$
4-side simply supported		Deflection = $A \cdot w \cdot b^4 / (E_{AP} \cdot t_{AP}^3)$
		a/b 1 1.2 1.4 1.6 1.8 2.0 3.0 >3.0
		A 0.044 0.062 0.077 0.0906 0.1017 0.1110 0.1335 0.1422
4-side fixed		Deflection = $A \cdot w \cdot b^4 / (E_{AP} \cdot t_{AP}^3)$
		a/b 1 1.2 1.4 1.6 1.8 2.0 >2.0
		A 0.0138 0.0188 0.0226 0.0251 0.0267 0.0277 0.0284

2. Calculation results of stress

The following tables are calculated results of stress on the following cases.

Table 4-8 ALPOLIC 3mm, 4-side simply supported and 4-side fixed

Table 4-9 ALPOLIC 4mm, 4-side simply supported and 4-side fixed

Table 4-10 ALPOLIC 6mm, 4-side simply supported and 4-side fixed

If you need exact calculations, calculations entailing stiffener, and calculations of deflection, please contact local distributors or our office. The calculation requires the following parameters: (A) Wind load, (B) ALPOLIC thickness, (C) Supporting condition, (D) ALPOLIC panel size.

Table 4-8 ALPOLIC 3mm

Supporting condition: 4-side simply supported

Maximum stress (N/mm²)

w, kPa (kg/m ²)	Panel width (b) in mm	Panel length (a) in mm								
		900	1200	1500	1800	2100	2400	2700	3000	>3000
1.0 (102)	600	28	35	38	41	43	43	43	43	43
	900	37	55	68	78	82	87	91	96	96
	1200	55	65	90	110	126	139	145	151 >	171 >
	1500	68	90	102	134	161 >	184 >	202 >	217 >	267 >
1.5 (153)	600	41	52	56	61	64	64	64	64	64
	900	55	82	103	117	124	130	137	144	144
	1200	82	98	135	166 >	190 >	208 >	217 >	226 >	256 >
	1500	103	135	153 >	201 >	242 >	276 >	303 >	325 >	400 >
2.0 (204)	600	55	69	75	81	85	85	85	85	85
	900	74	109	137	156 >	165 >	174 >	183 >	192 >	192 >
	1200	109	131	180 >	221 >	253 >	278 >	289 >	301 >	341 >
	1500	137	180 >	204 >	267 >	322 >	368 >	404 >	434 >	533 >

Supporting condition: 4-side fixed

Maximum stress (N/mm²)

w, kPa (kg/m ²)	Panel width (b) in mm	Panel length (a) in mm								
		900	1200	1500	1800	2100	2400	2700	3000	>3000
1.0 (102)	600	26	28	28	28	28	28	28	28	28
	900	39	53	61	64	64	64	64	64	64
	1200	53	70	90	103	110	113	114	114	114
	1500	61	90	109	136	155 >	166 >	173 >	177 >	178 >
1.5 (153)	600	39	42	43	43	43	43	43	43	43
	900	59	80	91	95	96	96	96	96	96
	1200	80	105	135	154 >	165 >	170 >	171 >	171 >	171 >
	1500	91	135	164 >	204 >	232 >	250 >	260 >	265 >	267 >
2.0 (204)	600	51	57	57	57	57	57	57	57	57
	900	79	107	121	127	128	128	128	128	128
	1200	107	140	180 >	206 >	219 >	226 >	227 >	227 >	227 >
	1500	121	180 >	219 >	273 >	310 >	333 >	346 >	354 >	355 >

How to read the table: “>” indicates that the maximum stress becomes larger than 0.2% proof stress of aluminum skin (150 N/mm²). Stiffener will be required in this range. In other ranges where calculated stress is lower than 150 N/mm², the panel will withstand without stiffener. Take into account a safety factor.

Table 4-9 ALPOLIC 4mm

Supporting condition: 4-side simply supported

Maximum stress (N/mm²)

w, kPa (kg/m ²)	Panel width (b) in mm	Panel length (a) in mm								
		900	1200	1500	1800	2100	2400	2700	3000	>3000
1.0 (102)	600	19	24	26	28	29	29	29	29	29
	900	25	37	47	53	56	59	62	66	66
	1200	37	45	62	76	87	95	99	103	117
	1500	47	62	70	92	110	126	138	148	182 >
1.5 (153)	600	28	36	39	42	44	44	44	44	44
	900	38	56	70	80	85	89	94	99	99
	1200	56	67	92	113	130	142	149	155 >	175 >
	1500	70	92	105	137	165 >	189 >	208 >	223 >	274 >
2.0 (204)	600	38	47	52	56	58	58	58	58	58
	900	50	75	94	107	113	119	125	131	131
	1200	75	89	123	151 >	173 >	190 >	198 >	206 >	234 >
	1500	94	123	140	183 >	220 >	252 >	277 >	297 >	365 >
2.5 (255)	600	47	59	64	69	73	73	73	73	73
	900	63	93	117	134	141	149	156 >	164 >	164 >
	1200	93	112	154 >	189 >	216 >	237 >	248 >	258 >	292 >
	1500	117	154 >	175 >	229 >	275 >	315 >	346 >	371 >	456 >
3.0 (306)	600	57	71	77	83	88	88	88	88	88
	900	76	112	141	160 >	169 >	178 >	187 >	197 >	197 >
	1200	112	134	185 >	227 >	260 >	285 >	297 >	309 >	350 >
	1500	141	185 >	210 >	275 >	331 >	377 >	415 >	445 >	547 >

Supporting condition: 4-side fixed

Maximum stress (N/mm²)

w, kPa (kg/m ²)	Panel width (b) in mm	Panel length (a) in mm								
		900	1200	1500	1800	2100	2400	2700	3000	>3000
1.0 (102)	600	18	19	19	19	19	19	19	19	19
	900	27	37	42	44	44	44	44	44	44
	1200	37	48	62	70	75	77	78	78	78
	1500	42	62	75	93	106	114	119	121	122
1.5 (153)	600	26	29	29	29	29	29	29	29	29
	900	40	55	62	65	66	66	66	66	66
	1200	55	72	93	106	113	116	117	117	117
	1500	62	93	112	140	159 >	171 >	178 >	181 >	182 >
2.0 (204)	600	35	39	39	39	39	39	39	39	39
	900	54	73	83	87	88	88	88	88	88
	1200	73	96	123	141	150	155 >	156 >	156 >	156 >
	1500	83	123	150	187 >	212 >	228 >	237 >	242 >	243 >
2.5 (255)	600	44	48	49	49	49	49	49	49	49
	900	67	91	104	109	109	109	109	109	109
	1200	91	120	154 >	176 >	188 >	194 >	195 >	195 >	195 >
	1500	104	154 >	187 >	233 >	265 >	285 >	296 >	302 >	304 >
3.0 (306)	600	53	58	58	58	58	58	58	58	58
	900	81	110	125	131	131	131	131	131	131
	1200	110	144	185 >	211 >	225 >	232 >	234 >	234 >	234 >
	1500	125	185 >	225 >	280 >	318 >	342 >	356 >	363 >	365 >

How to read the table: “>” indicates that the maximum stress becomes larger than 0.2% proof stress of aluminum skin (150 N/mm²). Stiffener will be required in this range. In other ranges where calculated stress is lower than 150 N/mm², the panel will withstand without stiffener. Take into account a safety factor.

Table 4-10 ALPOLIC 6mm

Supporting condition: 4-side simply supported

Maximum stress (N/mm²)

w, kPa (kg/m ²)	Panel width (b) in mm	Panel length (a) in mm								
		900	1200	1500	1800	2100	2400	2700	3000	>3000
1.0 (102)	600	12	14	16	17	18	18	18	18	18
	900	15	23	29	33	34	36	38	40	40
	1200	23	27	38	46	53	58	60	63	71
	1500	29	38	43	56	67	77	84	91	111
1.5 (153)	600	17	22	24	25	27	27	27	27	27
	900	23	34	43	49	52	54	57	60	60
	1200	34	41	56	69	79	87	91	94	107
	1500	43	56	64	84	101	115	127	136	167 >
2.0 (204)	600	23	29	31	34	36	36	36	36	36
	900	31	46	57	65	69	73	76	80	80
	1200	46	55	75	92	106	116	121	126	142
	1500	57	75	85	112	134	153 >	169 >	181 >	222 >
2.5 (255)	600	29	36	39	42	44	44	44	44	44
	900	38	57	71	81	86	91	95	100	100
	1200	57	68	94	115	132	145	151 >	157 >	178 >
	1500	71	94	107	139	168 >	192 >	211 >	226 >	278 >
3.0 (306)	600	35	43	47	51	53	53	53	53	53
	900	46	68	86	98	103	109	114	120	120
	1200	68	82	113	138	158 >	174 >	181 >	188 >	214 >
	1500	86	113	128	167 >	202 >	230 >	253 >	272 >	334 >

Supporting condition: 4-side fixed

Maximum stress (N/mm²)

w, kPa (kg/m ²)	Panel width (b) in mm	Panel length (a) in mm								
		900	1200	1500	1800	2100	2400	2700	3000	>3000
1.0 (102)	600	11	12	12	12	12	12	12	12	12
	900	16	22	25	27	27	27	27	27	27
	1200	22	29	38	43	46	47	47	47	47
	1500	25	38	46	57	65	69	72	74	74
1.5 (153)	600	16	18	18	18	18	18	18	18	18
	900	25	33	38	40	40	40	40	40	40
	1200	33	44	56	64	69	71	71	71	71
	1500	38	56	68	85	97	104	108	111	111
2.0 (204)	600	21	24	24	24	24	24	24	24	24
	900	33	45	51	53	53	53	53	53	53
	1200	45	58	75	86	92	94	95	95	95
	1500	51	75	91	114	129	139	145	148	148
2.5 (255)	600	27	30	30	30	30	30	30	30	30
	900	41	56	63	66	67	67	67	67	67
	1200	56	73	94	107	114	118	119	119	119
	1500	63	94	114	142	162 >	174 >	181 >	184 >	185 >
3.0 (306)	600	32	35	36	36	36	36	36	36	36
	900	49	67	76	80	80	80	80	80	80
	1200	67	88	113	129	137	142	142	142	142
	1500	76	113	137	171 >	194 >	208 >	217 >	221 >	222 >

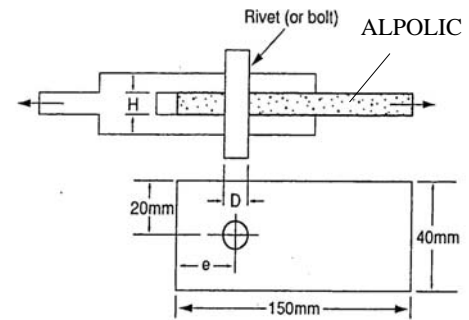
How to read the table: “>” indicates that the maximum stress becomes larger than 0.2% proof stress of aluminum skin (150 N/mm²). Stiffener will be required in this range. In other ranges where calculated stress is lower than 150 N/mm², the panel will withstand without stiffener. Take into account a safety factor.

Appendix 6: Strength of joining hole

Rivets, bolt/nuts and tapping screws are quite often used for joining between ALPOLIC panels and aluminum profiles. When a tensile force loads on the joining point, stress will be placed on the joining hole of the ALPOLIC panel. In order to evaluate the maximum elastic limit of the joining hole, we performed the following tensile test.

1. Test method:

Do tensile tests with 5mm and 10mm holes (D) that are located different distances from edge (e). Determine the maximum elastic limits by means of stress-strain curve.



2. Test result:

The following table shows the maximum elastic limits.

Hole diameter (D) in mm	Hole center to edge (e) in mm	e/D	Maximum elastic stress, (S) MPa or N/mm ²			Max. tensile force (F) in N		
			3mm	4mm	6mm	3mm	4mm	6mm
5	5	1	21	23	18	320	430	530
	10	2	48	44	38	720	880	1150
	15	3	55	46	40	820	920	1210
10	10	1	20	21	17	590	820	1000
	20	2	38	33	25	1150	1330	1530
	30	3	39	38	25	1170	1530	1470

3. How to use the above data:

To utilize the above data, we convert the above value to meet our particular case with the equation:

$$F = S \times t \times D$$

S: Maximum elastic stress in MPa or N/mm²

F: Maximum tensile force in N

t: Thickness of ALPOLIC in mm

D: Diameter of hole in mm

Calculation example:

Premise: ALPOLIC 3mm, D = 4mm, e = 8mm,

Result: $F = S \times t \times D = 48 \times 3 \times 4 = 576$ N per joining point (Take a safety factor).

According to the above table, a sufficient hole-strength cannot be expected, if the position is quite near the edge. In order to ensure a reasonable strength of joining hole, the distance from hole-center to edge (e) should be larger than twice the hole-diameter (D). Namely, we should keep $e > 2 \times D$.

Appendix 7: Modified non-penetrating rivet

1. General

The modified non-penetrating rivet method offers a new fixing method of ALPOLIC panels. This fixing method is an alternative to adhesives and double-sided tapes, but this non-penetrating rivet, unlike adhesives or double-sided tapes, functions as mechanical fixing. Therefore, the non-penetrating rivet is suitable for areas where a reliable fixing is required even in the event of fire or other accidents.

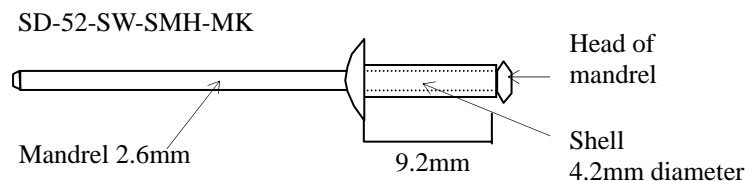
It is important that this rivet is not usable on all ALPOLIC panels, but usable only on the low-gloss finishes, because the trail of concealed rivet is visible from the front, if the surface is glossy. This modified non-penetrating rivet is suitable only to the following ALPOLIC products.

ALPOLIC thickness	Applicable gloss level
4mm, 6mm	Low-gloss only (30% gloss or less)
3mm	Matte finish only (polyester coating)

2. Installation method

(1) Rivet

Use the rivet, SD-52-SW-SMH-MK, (4mm) shown in the diagram.

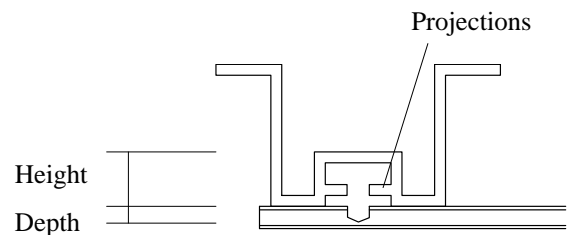


(2) Aluminum profile

Although many shapes are applicable, the aluminum profile must allow the following fixing height and must have projections, as shown in the diagram to prevent lifting of the aluminum skin.

Suitable fixing height and depth

ALPOLIC thickness	Height, mm	Depth, mm
3mm	7.5	2.5
4mm	7.5	3.0
6mm	6.0	3.5



(3) Riveting procedures

Refer to Fig. 4-2 and 4-3 below.

4. Design strength

Use the following pulling strength for design as a net value. It includes a processing factor of 1.3, but it does not include a safety factor. Divide it by the safety factor, if necessary. Keep the distance from the rivet center to the edge at least 20mm to ensure this strength.

ALPOLIC thickness	Design strength/piece
4mm, 6mm	330 N
3mm	160 N

Fig. 4-2 Riveting procedures

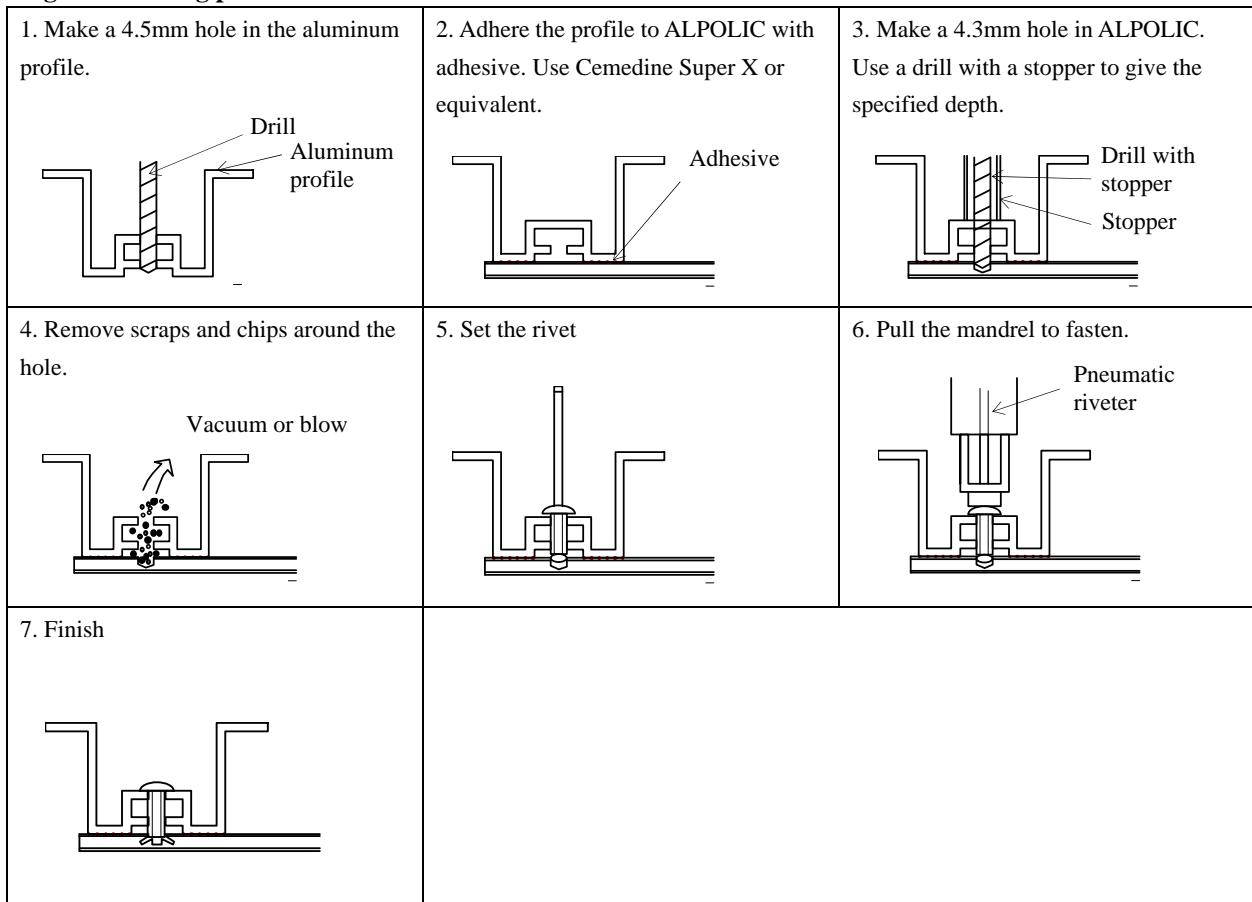
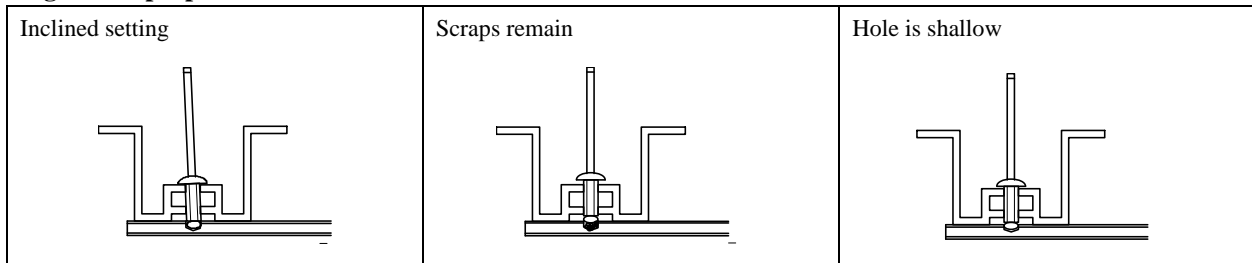


Fig. 4-3 Improper installation



Appendix 8: Examples of complicated panels

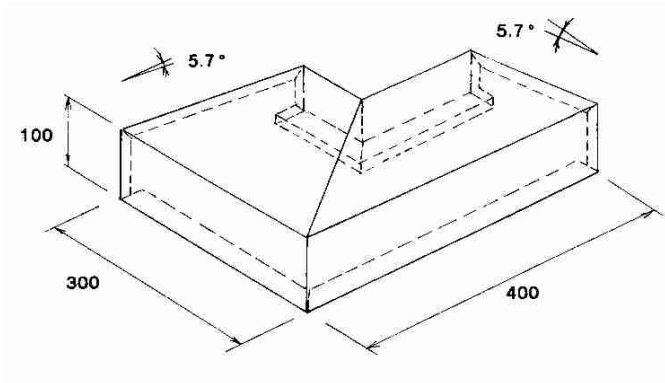
We sometimes encounter unusual designs including 3-dimensional shapes. Mostly, the required quantity is only several pieces, but we wish to fabricate the ALPOLIC panels in such a manner that they achieve long-lasting performance with satisfactory appearance. Examples of these panels are attached here for your reference. If you have similar difficulties in an actual project, please contact local distributors or our office. We would like to study together.

The attached examples are based on those panels produced for actual projects. We scaled down the panel size by 1/2 to 1/5 for transportation. Please correct the dimensions so as to fit to your case.

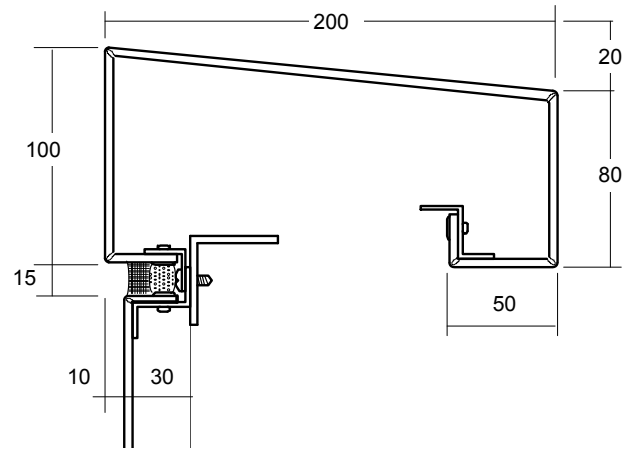
- Example 1 Outside angle panel of coping
 A corner panel of coping that is located on top of buildings
- Example 2: Outside angle panel of sunshade (cornice)
 A corner panel of a sunshade above an entrance or window
- Example 3: Outside angle panel with water drip
 A corner panel with a water drip that is normally located at the lower portion of buildings
- Example 4: Inside angle panel for recessed windows
 Recessed windows sometimes require this type of panel, depending on the position of the vertical and horizontal joints.
- Example 5: Three-dimensional curved panel
 This is a convex panel with a flat return (folded edge). This panel is applicable when the curve radius is larger than 1300mmR in 4mm thick ALPOLIC.

Example 1: Outside angel panel of coping

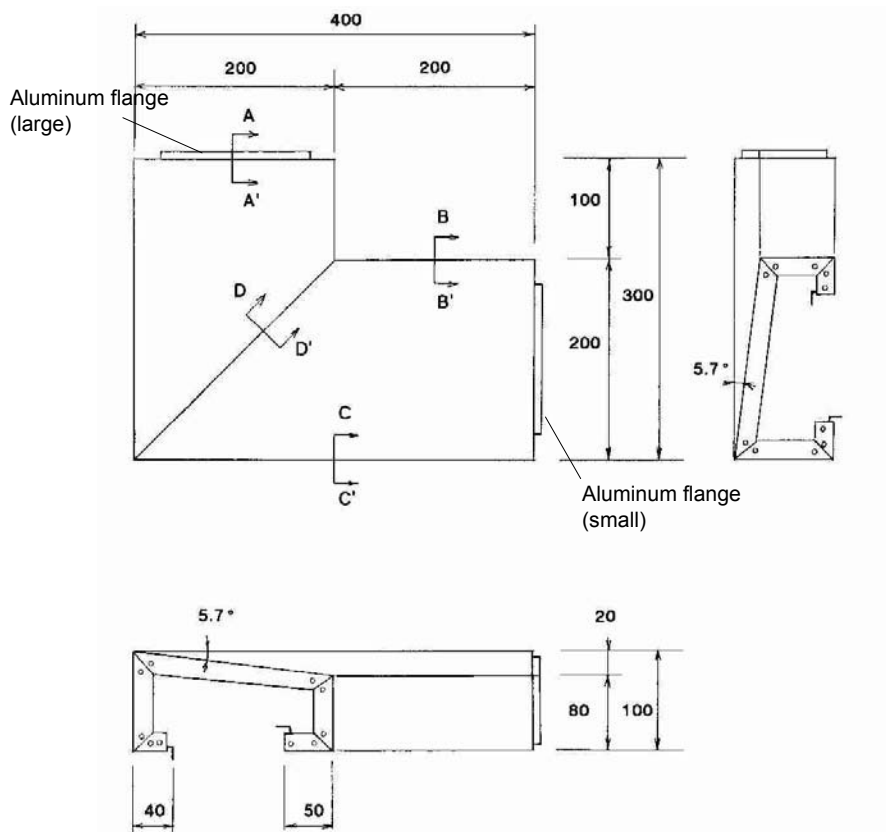
Completed panel



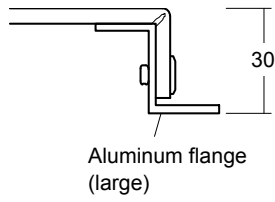
Section detail



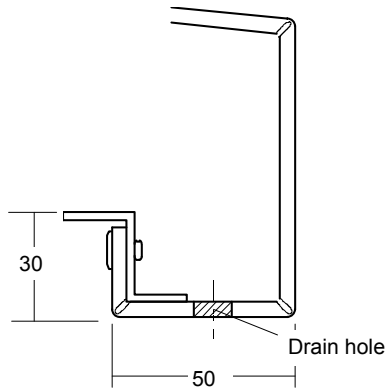
Elevations and plan



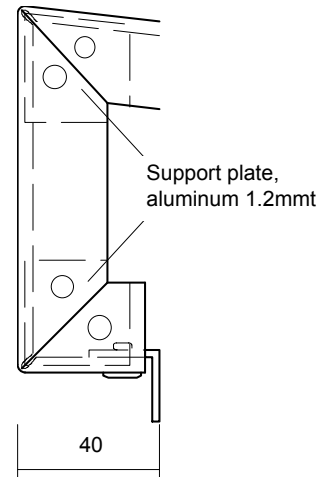
A-A' detail



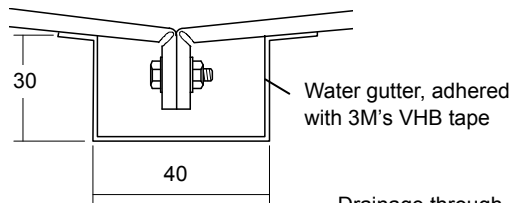
B-B' detail



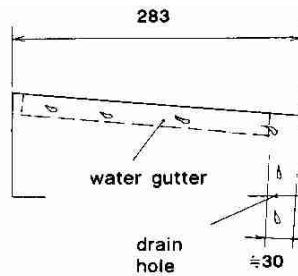
C-C' detail



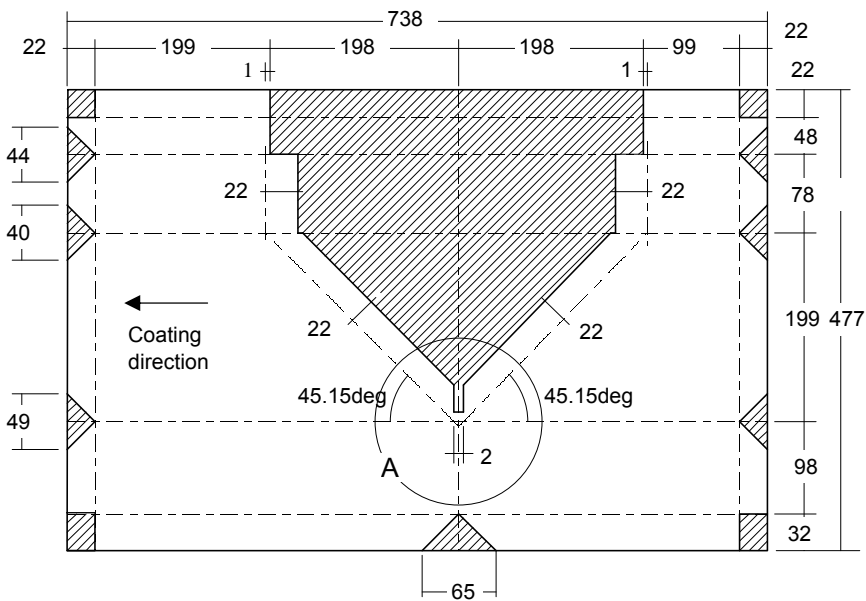
D-D' detail



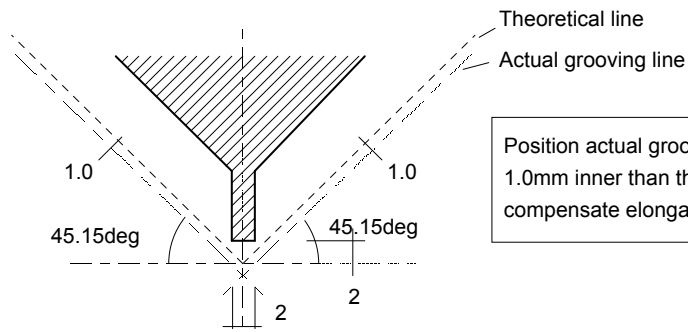
Drainage through gutter and hole



Cut & groove



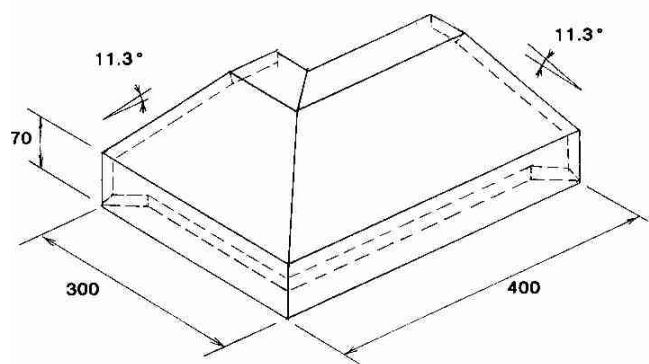
A detail



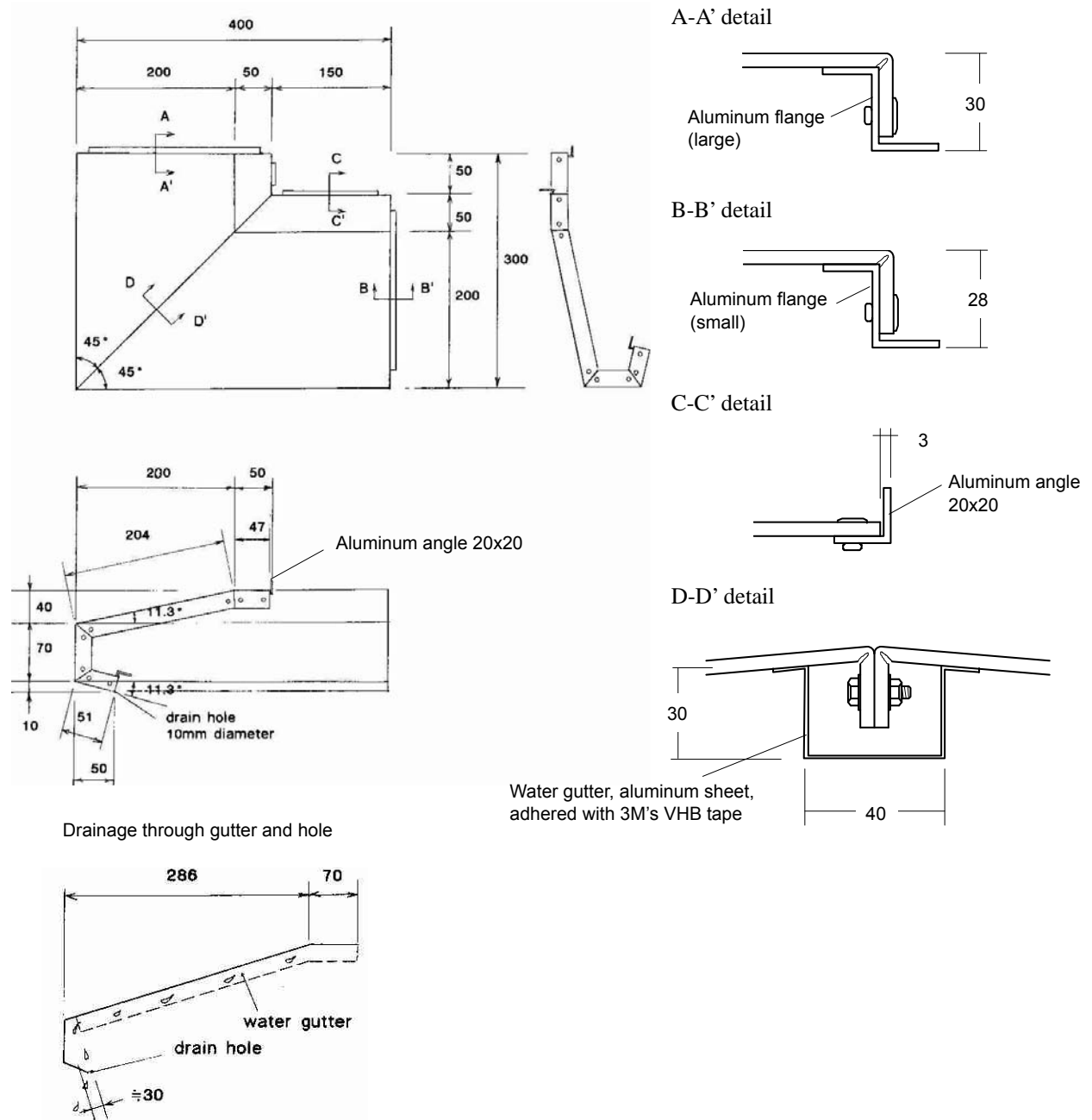
Position actual grooving center line 1.0mm inner than the theoretical line to compensate elongation after folding

Example 2: Outside angle panel of sunshade (cornice)

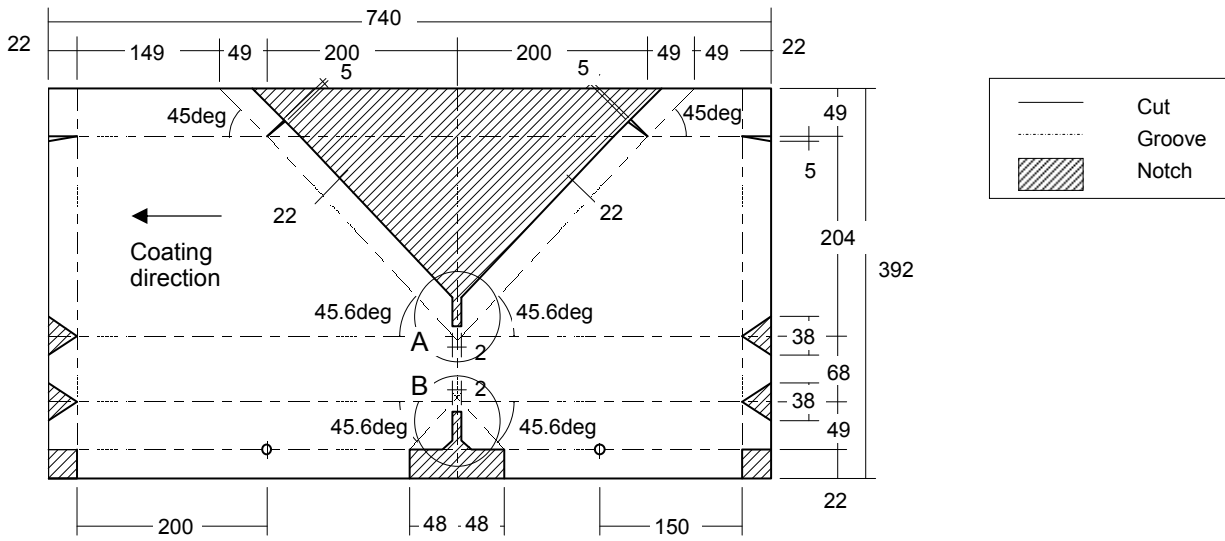
Completed panel



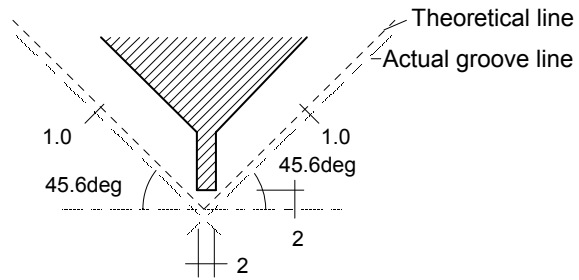
Elevations



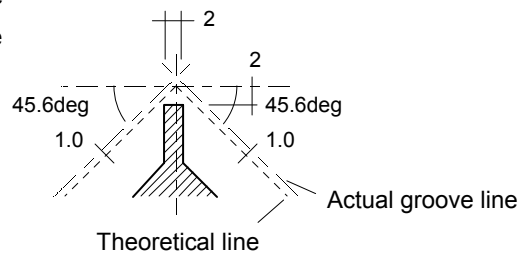
Cut & groove



A detail



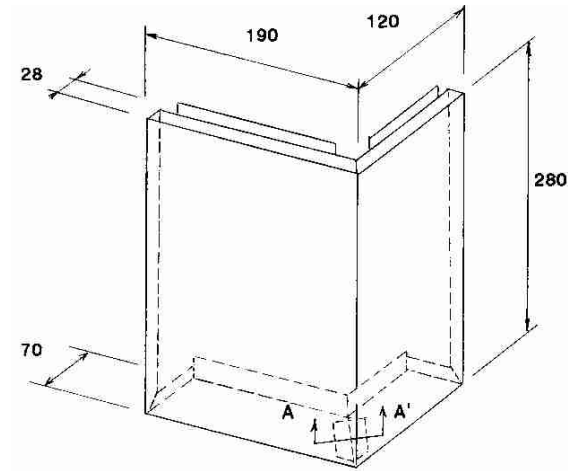
B detail



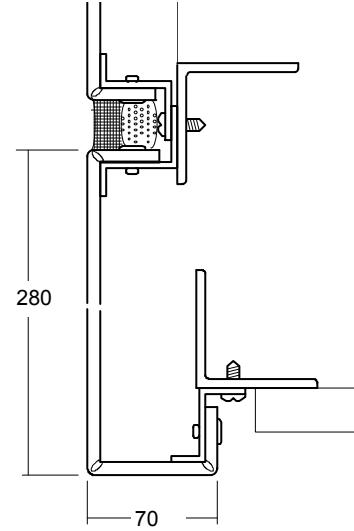
Position actual grooving center line
1.0mm inner than the theoretical line to
compensate elongation after folding

Example 3: Outside angle panel with water drip

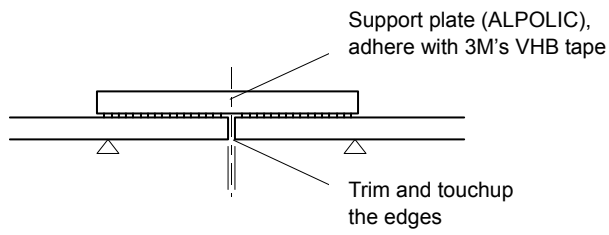
Completed panel



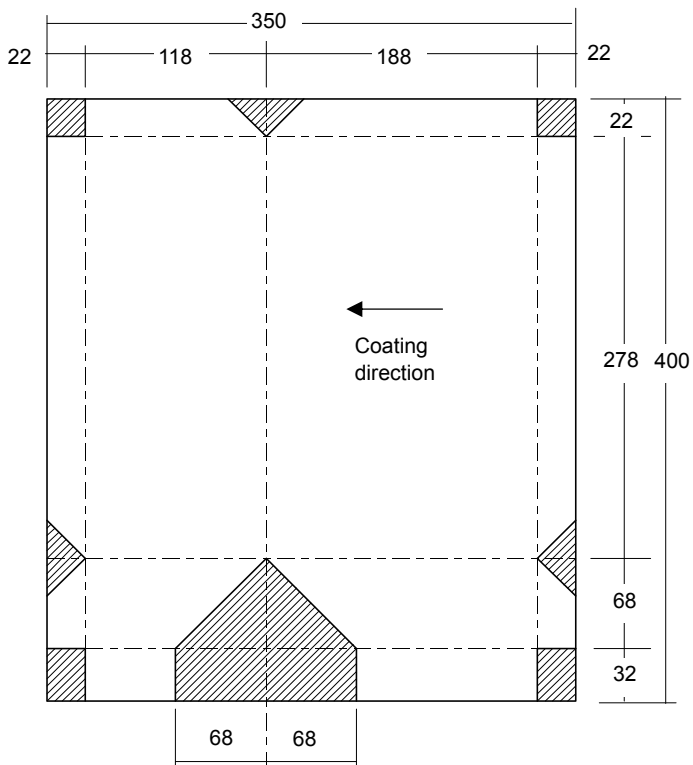
Section detail



A-A' detail

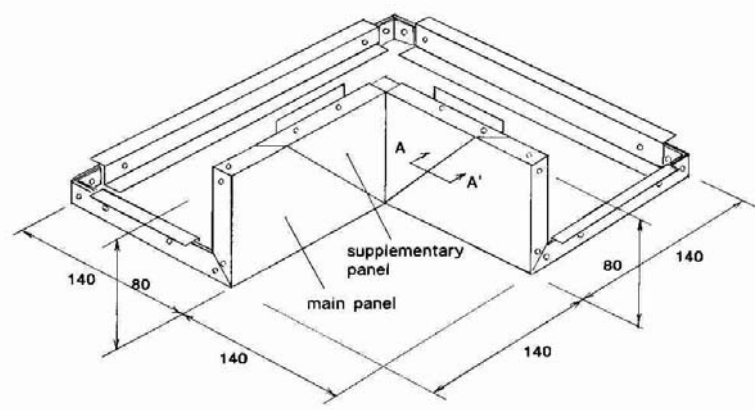


Cut & groove

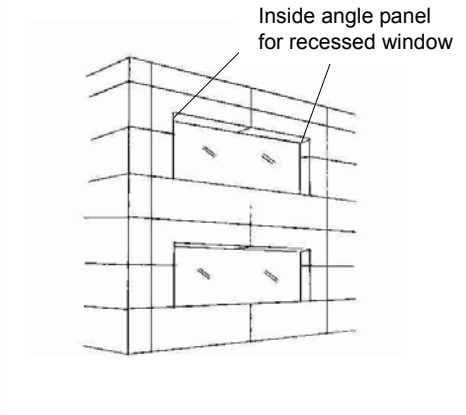


Example 4: Inside angle panel for recessed windows

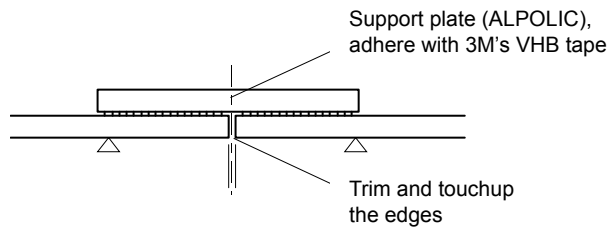
Completed panel



Application example

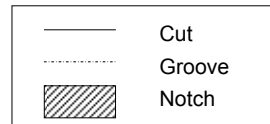
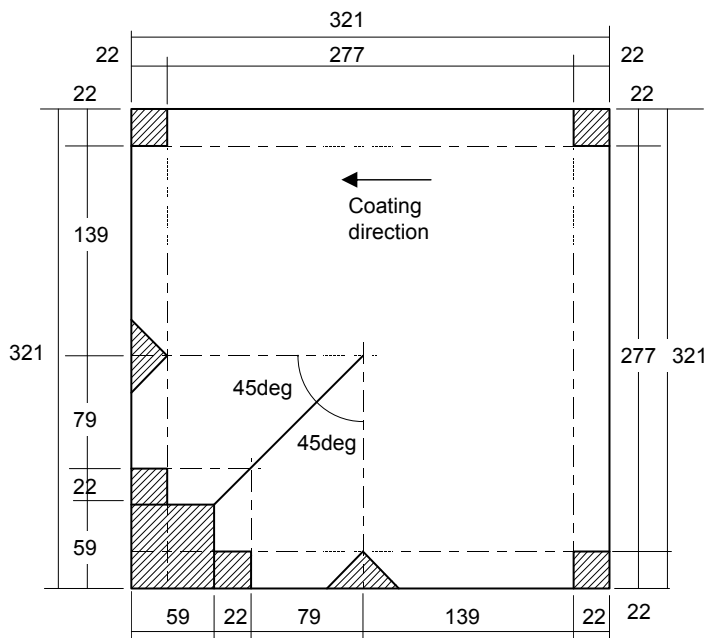


A-A' detail

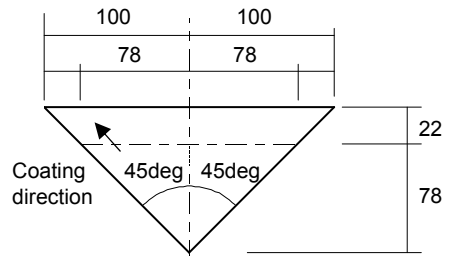


Cut & groove

Main panel



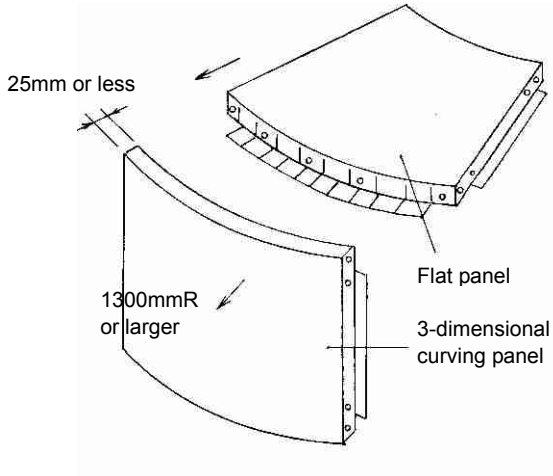
Supplementary panel



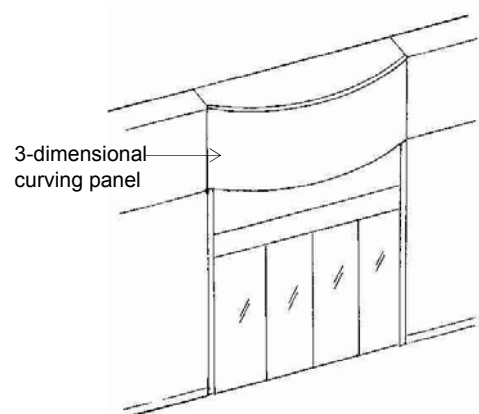
Example 5: Three-dimensional curving panel

This panel is applicable when the curving radius is larger than 1300mmR in 4mm thick ALPOLIC. We use a regular 3-roll bending machine.

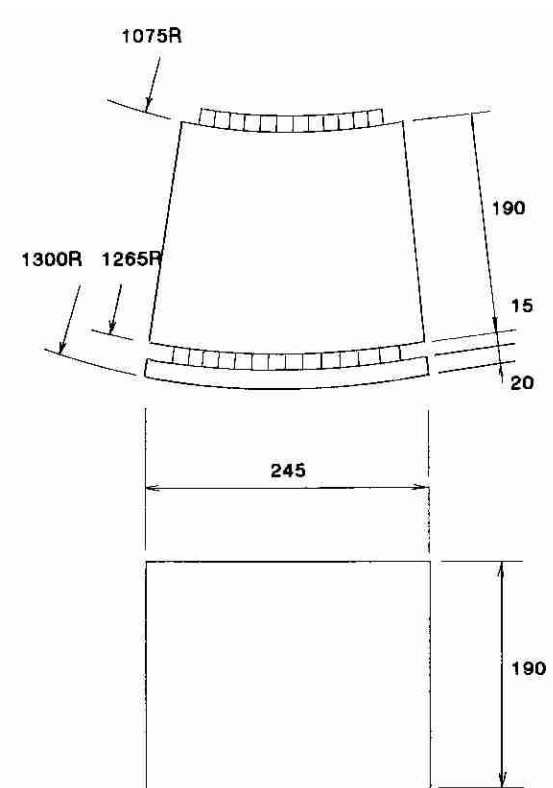
Front view



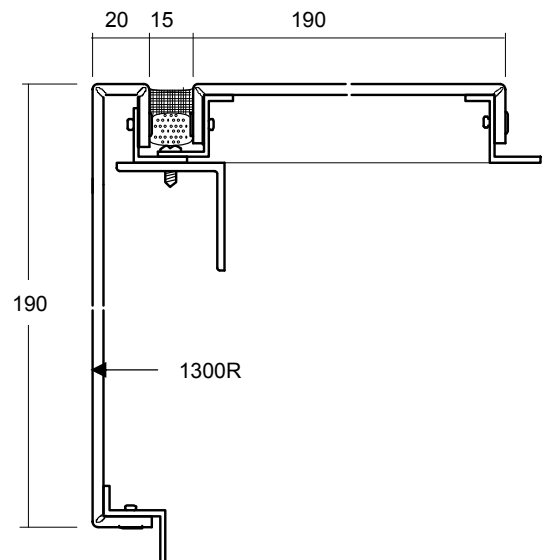
Application example



Elevation and plan

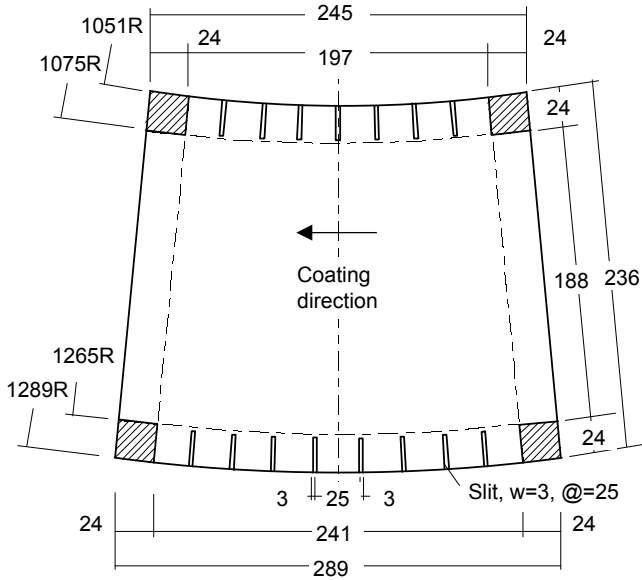


Section

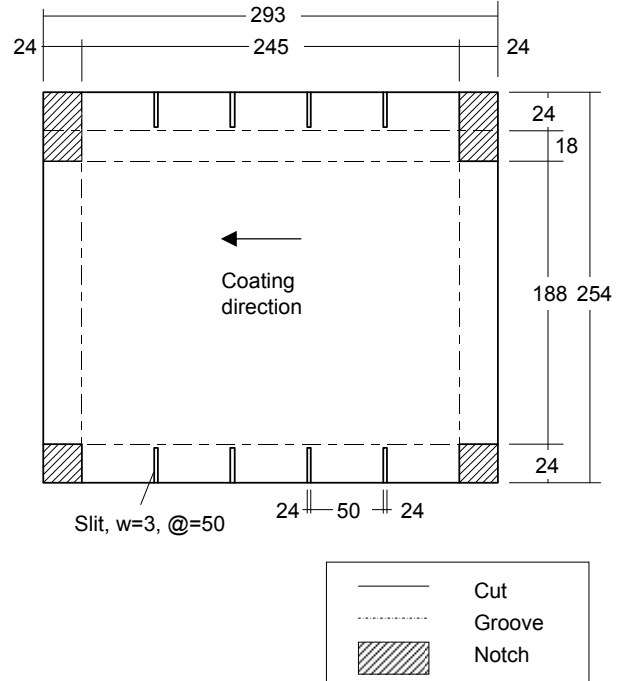


Cut & groove

Flat panel

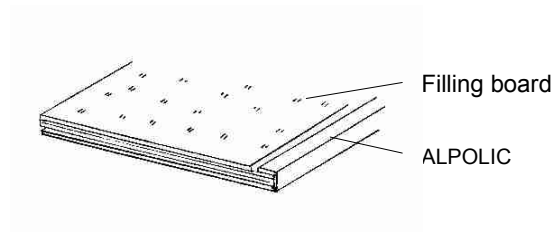
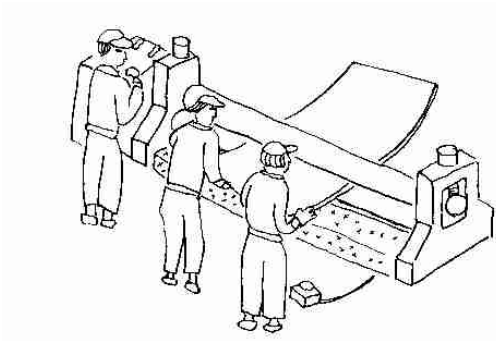


3-dimensional curving panel



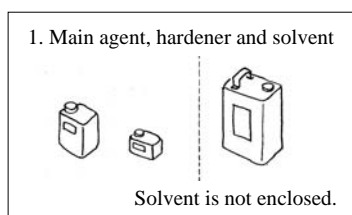
Bending work

Bend ALPOLIC panel and filling board together



Appendix 9: Touch-up coating method

It is one of the advantages of Lumiflon paint that the coated surface can be re-coated at room temperature. This manual refers to a typical touch-up (repair) coating method of ALPOLIC panels coated with Lumiflon-based fluorocarbon paint. An air-cured type of Lumiflon-based fluorocarbon paint, called “Bonflon #5000” is used as touch-up paint.

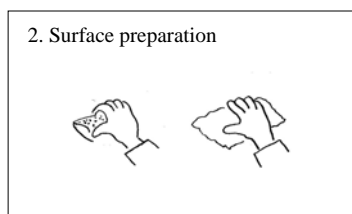


1. Touch-up paint (1 kg set) consists of:

Main agent: 0.93 kg

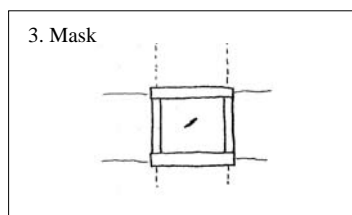
Hardener: 0.07 kg

Solvent is not enclosed in the package. If you need solvent to dilute and adjust the viscosity of the paint, procure it locally. Refer to the bottom note for suitable solvents.



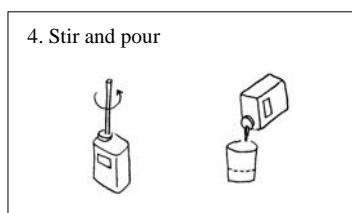
2. Wipe off dust and stains with a soft rag. Polish the relevant area with sandpaper #320-400 mildly. Remove oils and fats with IPA (isopropyl alcohol), ethyl alcohol or N-hexane diluted to 50% with water.

Note: Do not use solvents for surface preparation.



3. Cover the surrounding area, if necessary.

Note: Do not use PVC tapes. Gloss increase may occur.



4. Stir the main agent to homogenize the pigments. Pour an appropriate quantity of the main agent into a beaker.

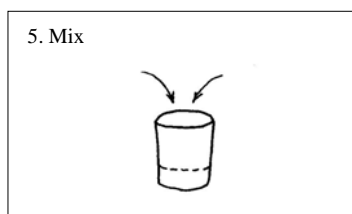
5. Add an appropriate quantity of hardener and solvent. Mix them well and maintain for 30 min before use. The mixing ratio is as follows:

Main agent : Hardener = 93 : 7 (=13 : 1)

Solvent: 20-40% to adjust the viscosity

6. Apply the paint with brush or spray. Approximately 1 hr will be required for the surface to dry at 20°C.

Note: Use the mixture within 6hrs (at 20°C). Do not apply below 10°C.



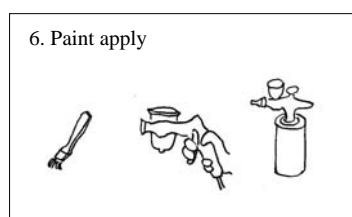
General Notes:

1. Re-coated surface shows a slightly different appearance, especially in metallic colors, due to the coating method difference.

2. Do not expose paint to direct sunshine for extended periods.

3. Store the paints away from direct flame and excessive heat. Keep airtight and away from moisture.

4. Suitable solvents: xylene, butyl acetate, MIBK (methyl iso-butyl ketone), and thinners for urethane/acrylic-urethane paints are suitable. As these are strong organic solvents that are inflammable and intoxicating, follow the manufacturer's instructions. Most commercially popular paint thinners are not suitable.



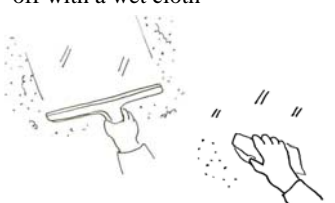


Appendix 10: Example of practical cleaning method

Cleaners and detergents are normally local products. A cleaner or a detergent widely available in one country may not be available in another country. This method is an example of practical cleaning method suitable for Lumiflon-based fluorocarbon coating. The cleaner called “Magiclean” is a household cleaner from Kao Corp and widely available in East and Southeast Asian countries. “Sharpshooter” is a versatile cleaner from 3M and available worldwide.

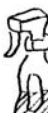
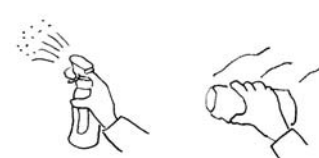

1. Light surface soiling

Firstly, try a water rinse using a soft sponge with modest pressure to remove the soiling (stain). If the soiling remains after drying, then use dilute Magiclean.

<p>1. Add cleaner to water</p> <p>Water 5 liters Magiclean 50-250 ml</p> 	<p>2. Apply the solution and spread</p> <p>Hold for 1 min</p> 	<p>3. Dry with a squeegee and wipe off with a wet cloth</p> 
<p>Dilute Magiclean to 1-5% (50-250ml Magiclean to 5 liters water). Magiclean is a household cleaner with pH 8 from Kao Corp.</p>	<p>Spread the solution around ALPOLIC surface. Use soft towel or sponge. Wait for about 1 minute, the foam will be blackened.</p>	<p>Dry with squeegee and finally wipe the surface with wet towel containing clean water.</p>

2. Medium to heavy surface soiling

Use undiluted Sharpshooter or 50% Magiclean. As Sharpshooter is an alkali (pH12) and Magiclean is a weak alkali (pH8), we require a water rinse after using these cleaners. Also, eye protection is necessary to handle these solutions. Follow the manufacturer’s safety instructions.

<p>1. Use undiluted Sharpshooter or 50% Magiclean</p> 	<p>2. Apply undiluted Sharpshooter or 50% Magiclean with sprayer, soft cloth or sponge.</p> 	<p>3. Rinse with a wet cloth containing clean water.</p> 
<p>Use undiluted Sharpshooter, or dilute Magiclean by 50% (100ml Magiclean to 100ml water).</p>	<p>Apply the solution on ALPOLIC with sprayer, towel, or sponge. Slight rubbing is required to remove heavy surface soiling. Use a soft towel.</p>	<p>Rinse with a wet cloth soaked in clean water.</p>