

# ALPOLIC®/fr LT

## Technical Manual

### Section 4 Appendices

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## Summary of Specification Data - ALPOLIC®/fr LT

### 1. General

ALPOLIC®/fr LT is an Aluminum Composite Material (ACM) with a sufficient fire safety, which is used on interior walls, columns, ceilings and partitions of shops, offices and factories. Its application is not only on interior field, but also on light outdoor field including soffits, awnings, parapets and signs. Besides, this material is applicable to such civil works as internal linings of tunnels.

ALPOLIC®/fr LT is manufactured by Mitsubishi Chemical Functional Products, Inc. and furnished by approved dealers or distributors of the manufacturer.

### 2. Product composition

ALPOLIC®/fr LT is composed of a non-combustible mineral core with a small amount of low-density polyethylene sandwiched between two skins of 0.3mm thick aluminium.

Composition	Skin material:	0.3mm thick aluminum (1100-H14)
	Core material:	Non-combustible mineral filled core with gray color.

The effective sides are finished with polyester coatings. “Reversible” has effective sides on both top and back. “Single, Stone and Timber” have an effective side on top and a wash coating on back. Refer to “6 Paint Finish” below. The effective sides are protected with a translucent self-adhesive / peel-off film.

### 3. Product dimension and tolerance

- (1) Panel thickness: 3 mm
- (2) Panel size in stock: The available panel size depends on the finishes as shown below.

Type	Finish	Code	Stock size, mm (in)	Remarks
Reversible	Pure White-G90 / Anodised Silver-G80	N1	1270×3099 (55"×122") 1575×3099 (62"×122")	Both top and back are effective sides.
	White-G30 / Champagne Metallic-G30	N2		
	Light Beige-G30 / Silver Metallic-G30	N3		
	Black-G30 / Gray-G30	N4		
Single	Off White-Matte	N5	1270×3099 (55"×122")	Top is effective side and back is wash coating.
	Gray Metallic-Matte	N6		
Stone	Black Granite-G80	S1	1270×3099 (55"×122") 1575×3099 (62"×122")	
	White Granite-G80	S2		
	Red Granite-G80	S3		
	Pink Granite-G80	S4		
	White Marble-G80	S5		
	Venetian Marble-G80	S6		
Timber	Sandstone-Matte	S7	1270×3099 (55"×122")	
	Maple-Matte	T1		
	Walnut-Matte	T2		

**Note:** Custom width is available between 914mm and the above width. Custom length less than 5000mm can be accepted. Please contact distributors or our sales office for the minimum quantity and the lead-time of the custom size products.

(3) Product tolerance

- Width: ±2.0mm
- Length: ±4.0mm
- Thickness: ±0.2mm
- Bow: Maximum 0.5% of the length and/or width
- Squareness: Maximum 5.0mm (diagonal difference)
- Surface defect: The surface shall not have irregularities such as roughness, buckling and other imperfections in accordance with our visual inspection rules.
- Panel edge: ALPOLIC/fr LT is supplied with a cut edge out of aluminum sheet displacement and core protrusion.

**4. Principal properties**

- (1) Panel weight: 5.5 kg/m<sup>2</sup> (1.13 psf)
- (2) Thermal expansion: 24×10<sup>-6</sup> m/m/°C (13×10<sup>-6</sup> in/in/°F)
- (3) Mechanical properties as a composite material, ALPOLIC®/fr LT

Tensile strength (ASTM E8)	30 MPa or N/mm <sup>2</sup> , 3.0 kg/mm <sup>2</sup> , 4300 psi
Yield strength (ASTM E8)	27 MPa or N/mm <sup>2</sup> , 2.7 kg/mm <sup>2</sup> , 3900 psi
Elongation (ASTM E8)	4 %
Flexural Elasticity (ASTM C393)	33 GPa or kN/mm <sup>2</sup> , 3400 kg/mm <sup>2</sup> , 4.8×10 <sup>6</sup> psi

(4) Mechanical properties of skin aluminum (1100-H14):

Yield strength (ASTM E8)	118 MPa or N/mm <sup>2</sup> , 12.0 kg/mm <sup>2</sup> , 17000 psi
Modules of elasticity (ASTM C393)	70 GPa or kN/mm <sup>2</sup> , 7000 kg/mm <sup>2</sup> , 10.2×10 <sup>6</sup> psi

**5. Summary of fire tests**

ALPOLIC®/fr LT comprising of 0.3 mm thick skin has passed the following fire tests:

Country	Test Standard	Specimen Thickness	Results & Classification
United Kingdom	BS476 Part 6	3 mm	Class 0
	BS476 Part 7		Class 1
USA	Tunnel Test (ASTM E-84)	3 mm	Class A / Class 1
	Interior Room Corner Test (UBC 26-3)	3 mm	Passed
Japan	Heat Release Test for Non-combustible Material (ISO5660-1) and Toxicity Gas Test	3 - 6 mm	Passed Certificate No. NM-0209

## 6. Paint finish

### (1) Finish type

The finishes can be classified into the following coating types:

Coating type	Finish
Solid Color	Pure White-G90, White-G30, Light Beige-G30, Black-G30, Gray-G30, Off White-Matte
Metallic Color	Anodized Silver-G80, Champagne Metallic-G30, Silver Metallic -G30, Gray Metallic-Matte
Stone	Black Granite-G80, White Granite-G80, Red Granite-G80, Pink Granite- G80, White Marble-G80, Venetian Marble -G80, Sandstone-Matte
Timber	Maple-Matte, Walnut-Matte

Custom colors and custom gloss are available, subject to minimum quantities and color match. Please contact distributors or our office for custom color request.

### (2) Coating system

Each finish type has the following coating system of polyester paint:

Solid and Metallic Colors: 2-coat / 2-bake system consisting of primer and top coating.

Stone and Wood Colors: Coated with a unique image transfer process. The coating consists of primer, image transfer layer and top coating.

Matte finish is produced with a unique coating in which microscopic wrinkles emerge over the entire coated surface during baking of the paint. Thus, Matte finishes have uniform and fine wrinkles over the surface.

All these coatings are produced in the manufacturer's continuous coil coating line.

### (3) Paint performance

The coating meets the following performance:

Test item	Test method	Performance
Paint thickness		17 microns min.
Gloss:	60° specular gloss (ASTM D523-89)	Matte to 90%
Pencil hardness:	(ASTM D522-88)	>= H
Adhesion (Cross-cut)	Adhesion (Cross-cut)	100/100 (Cross-cut)
Impact resistance:	Du-pont method, 0.5kg, 1/2 inch, 50cm, Backside impact test	No picking off
Water resistance:	50 °C, tap water, 24 hrs.	100/100 (Cross-cut)
Boiling water resistance	98-100°C, pure water, 4 hrs.	100/100 (Cross-cut)
Humidity resistance:	240 hrs, 98% RH, 50°C (ASTM D2247-87)	No blister, no pick off
Alkali resistance:	1% NaOH, 20°C, 24hrs.	No blister, no pick off
Acid resistance:	5% H <sub>2</sub> SO <sub>4</sub> , 20°C, 24hrs.	No blister, no pick off
Salt spray resistance:	1000 hrs, salt fog, 35°C	No blister, no pick off
Solvent resistance:	MEK, 20°C, 24hrs.	No blister, no pick off
Detergent resistance:	Detergent "Surf", 25g/30L, 20°C, 24hrs.	No blister, no pick off
Pollution resistance:	Lip stick, eye shadow, 24 hrs. After wiping off with IPA.	No blister, no pick off
Accelerated weathering test:	QUV, 500 hrs.	No blister, no pick off

#### (4) Optional coatings

Apart from the above polyester coatings, we can supply ALPOLIC/fr LT products coated with the following distinctive paints as option. Refer to Appendix 2.

<b>Optional coating</b>	<b>Characteristics</b>	<b>Suitable application</b>
Fluorocarbon coating (Lumiflon-based)	Ultra-weather-ability Coating warranty is available .	Outdoor (awnings, parapets, signs)
Conductive fluorocarbon coating	Electric -conductive ( $3 \times 10^{7-8}$ ohms)	Interior walls and partitions in factory
High cross-link polyester coating	High hardness (4H) High reflectivity (80%)	Internal lining of tunnels

#### **7. Perforated panel**

ALPOLIC/fr LT Perforated Panel has a pattern of holes at regular intervals. This provides ventilation and permits vision through the panel, making it suitable for balconies, staircases and partitions. Refer to Appendix 3.

## Optional Coatings

ALPOLIC/fr LT is coated with polyester paints in standard, but we can supply ALPOLIC/fr LT products coated with the following distinctive paints as an option.

Optional coating	Characteristics	Suitable application
Fluorocarbon coating (Lumiflon-based)	Ultra-weather-ability Coating warranty is available.	Outdoor (awnings, parapets, signs)
Conductive fluorocarbon coating	Electric-conductive ( $3 \times 10^{-8}$ ohms)	Interior walls and partitions in factory
High cross-link polyester coating	High hardness (4H) High reflectivity (80%)	Internal lining of tunnels

### 1. Lumiflon-based fluorocarbon coating

Lumiflon-based fluorocarbon coating can realize the ultra-weatherability. The coating resists a long-term exposure to outdoor conditions and complies with AAMA 2605-98 issued by the AAMA (American Architectural Manufacturers Association).

Four types of finishes are available: Solid Colors, Metallic, Sparkling Colors and Stone Series. The gloss can be adjusted between 20 and 80%. In these finishes, the paints are applied in the manufacturer's coil coating lines. The coating system of each finish is:

- A. "Solid Colors" are a 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.
- B. "Metallic Colors" and "Sparkling Colors" are a three-coat three-bake system.  
The thickness is 32 microns (1.26 mils) minimum and consists of a conversion coating, an inhibitive primer, a Lumiflon-based metallic coating and a clear coating.
- C. "Stone 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.

Refer to the Color Chart of Lumiflon-based fluorocarbon coating.

Lumiflon-based fluorocarbon coating has a coating warranty of 10 years in standard.

### 2. Conductive fluorocarbon coating

ALPOLIC/fr LT coated with conductive fluorocarbon paint is used on interior walls, partitions and ceilings of clean rooms and warehouses. With an electric-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                |

### **3. 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 the area where the panel might be scratched during maintenance work, such as an internal lining of tunnels. The paint is applied in 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 $\mu$ minimum |
| (2) Pencil hardness:      | 4H with ASTM D522-88   |
| (3) Surface reflectivity: | 80% in diffuse reflection (white color)                                |

**ALPOLIC/fr LT Perforated Panel**

ALPOLIC/fr LT Perforated Panel has 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.

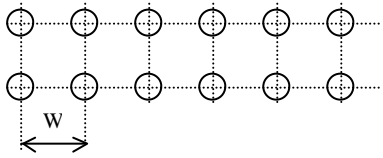
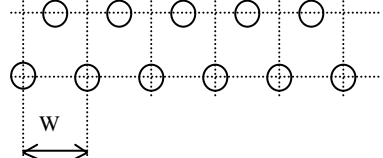
**1. Panel size**

Maximum width: 1270mm (55")

Maximum length: Approx. 3000mm (118")

Practical examples of sizes: 1000×300mm, 1000×500mm, 1000×700mm, 1000×1000mm

**2. Examples of perforation pattern**

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%

**3. Panel strength:**

Panel strength is lessened after perforation. Namely, the permissible load of ALPOLIC/fr LT becomes smaller dependent on the perforation ratio. The following table shows the maximum limit of uniformly-distributed load, like a wind load, without causing permanent deformation.

Maximum uniformly-distributed load (kPa):

Supporting condition		4-side simply supported					4-side fixed				
Perforation ratio		0%	10%	20%	30%	40%	0%	10%	20%	30%	40%
Panel size mm×mm	1000×300	8.1	6.5	4.0	2.4	1.6	11.5	9.2	5.8	3.5	2.3
	1000×500	2.9	2.3	1.5	0.9	0.6	4.2	3.3	2.1	1.3	0.8
	1000×700	2.3	1.9	1.2	0.7	0.5	2.4	1.9	1.2	0.7	0.5
	1000×1000	1.8	1.4	0.9	0.5	0.4	1.7	1.3	0.8	0.5	0.3

**Notes on fabrication and installation**

- (1) Effective surfaces are protected with protective films. Remove protective film immediately after installation. With Reversible Panels, peel off the film from both sides.
- (2) Align the coating direction in case of Metallic Colors, Stone and Timber Finishes, to avoid slight color difference due to coating direction.
- (3) Use aluminum or stainless steel rivet or screw for junction. If aluminum skin has a contact with other metals under humid atmosphere, the corrosion of the aluminum might be accelerated with galvanic corrosion.
- (4) On re-coating on ALPOLIC/fr LT Perforated Panel, use air-curing type paint and dry it at 90°C or lower, to prevent the core material from overheating.

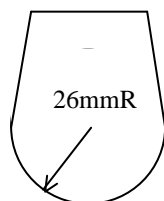
**Impact Test with Steel Ball**

We held this test to check the impact resistance of ALPOLIC/fr LT. As the test result shows, ALPOLIC/fr LT never shows crack, break and fracture by the impact of steel ball.

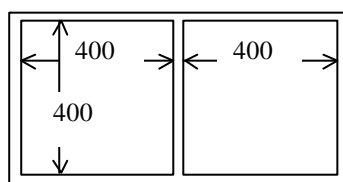
1. Testing method

- (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) Steel ball: 1 kg weight shown below
- (4) Procedures: Steel ball is dropped onto a specimen from 1 to 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)

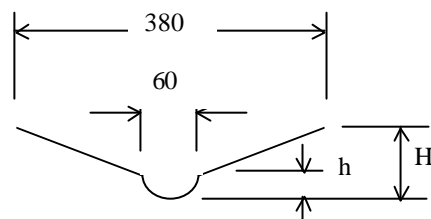
1 kg weight



Specimen holder



Evaluation of deformation




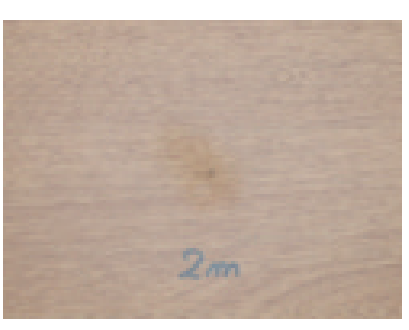
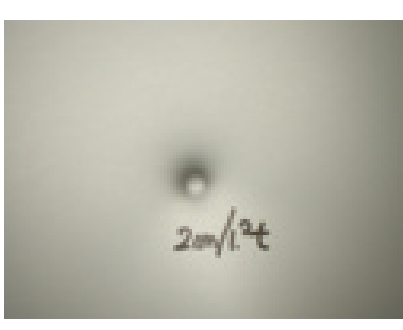
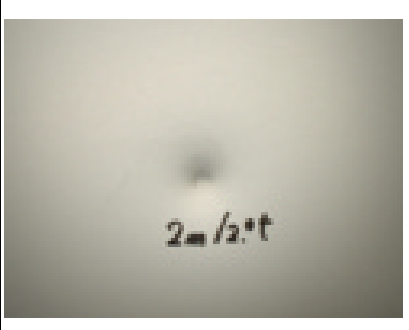


2. Test result

Material	Thickness (mm)	Weight (kg/m <sup>2</sup> )	Fracture	Deformation (mm)			
				2	4	6	8
ALPOLIC/fr LT	3	5.5	No		○	○	△
Aluminum sheet, anodized	1.2	3.2	No	○	○		△
	2	5.4	No	○	○	△	
Steel sheet, vinyl coated	0.8	4.8	No	○	○	△	
	1.0	7.9	No	○	○	△	
Veneer	6	3.0	Yes/Back (1m)	○	△		
	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 fracture, “Back” indicates that the specimen fractured in the back. “Both” indicates that fracture was found both in back and front. “Not available” means that it is impossible to measure the deformation value due to fracture.

3. Appearance of specimen (examples)

		
<p>ALPOLIC/fr LT 3 mm N1 Pure White-G90 Impact: 1kg × 2 m</p>	<p>ALPOLIC/fr LT 3 mm T2 Walnut-Matte Impact: 1kg × 2 m</p>	<p>Aluminum sheet 1.2 mm Anodized Impact: 1kg × 2 m</p>
		
<p>Aluminum sheet 2.0 mm Anodized Impact: 1kg × 2 m</p>	<p>Veneer 15 mm Impact: 1kg × 2 m</p>	<p>Acrylic sheet 3 mm Impact: 1kg × 1 m</p>

**Modified Non-Penetrating Rivet**

1. General

The non-penetrating rivet method permits a fixing aluminum profiles to ALPOLIC panels as an alternative method of those by adhesives and double-sided tapes. This rivet, unlike adhesives or double-sided tapes, fulfills a mechanical fixing. Therefore, it is suitable for the area where a reliable fixing is required even in the event of fire or other accidents.

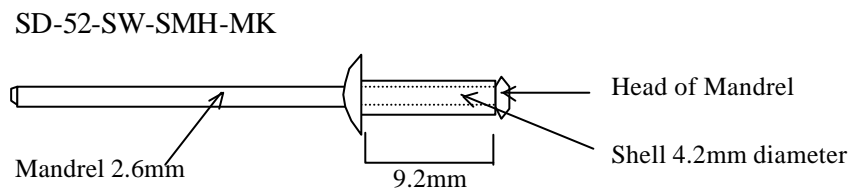
It is important that this method is not applicable to all ALPOLIC panels, but applicable only to the low-gloss finishes, because the trail of concealed rivet is visible from front if the surface is glossy. Especially on ALPOLIC/fr LT, this method is applicable only to **Matte Finish** products. Namely, we can apply this method to the following gloss levels:

ALPOLIC type	Applicable gloss level
ALPOLIC/fr LT 3mm	Matte Finish only
ALPOLIC/fr 4mm, 6mm	30% gloss or less

2. Installation method

(1) Rivet

Use the rivet, SD-52-SW-SMH-MK, as shown in the diagram.

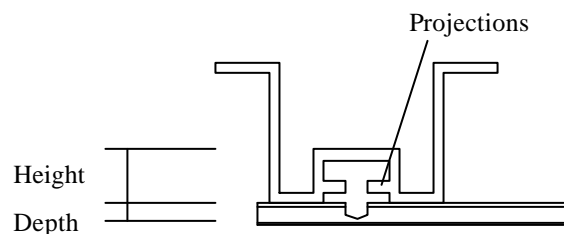


(2) Aluminum profile

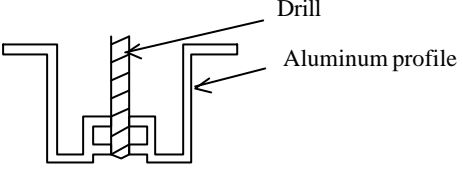
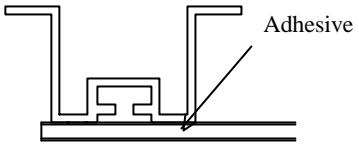
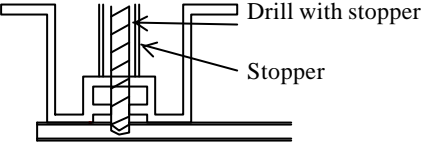
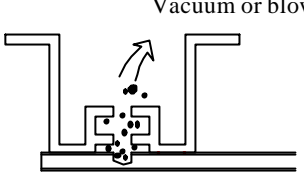
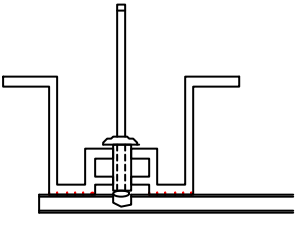
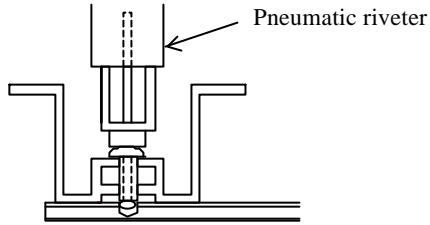
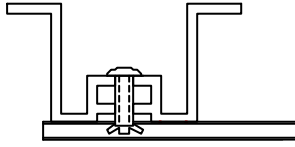
Any shapes of aluminum profiles are applicable, but the profile must allow the following fixing height, having projections to prevent lifting of aluminum skin.

(3) Fixing height and suitable depth

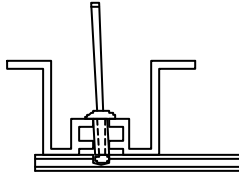
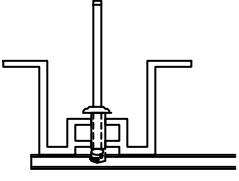
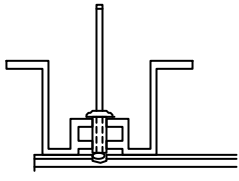
	Height, mm	Depth, mm
ALPOLIC/fr LT 3mm	7.5	2.5
ALPOLIC/fr 4mm	7.5	3.0
ALPOLIC/fr 6mm	6.0	3.5



(4) Procedures

<p>Step 1: Make 4.5mm hole in the aluminum profile.</p> 	<p>Step 2: Adhere the profile on ALPOLIC with adhesive. Use Cemedine Super X or equivalent.</p> 
<p>Step 3: Make 4.3mm hole in ALPOLIC. Use a drill with a stopper to give the specified depth.</p> 	<p>Step 4: Remove scraps and chips around the hole.</p> 
<p>Step 5-1: Set the rivet</p> 	<p>Step 5-2: Pull the mandrel to fasten.</p> 
<p>Step 5-3: Finish</p> 	

(4) Improper works

<p>Inclined setting</p> 	<p>Scraps remain.</p> 	<p>Hole is shallow.</p> 
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3. 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.

ALPOLIC type	Design strength/piece
ALPOLIC/fr LT 3mm	160 N
ALPOLIC/fr 4mm, 6mm	330 N

**Note:** Keep the distance from the rivet center to the edge at least 20mm to ensure the above strength.

## Panel Strength of ALPOLIC/fr LT

### 1. General calculation method

#### (1) Calculation of permanent deformation

In order to examine the possibility of permanent deformation, we calculate the maximum stress that may arise in aluminium skins of ALPOLIC/fr LT when a wind load works on it. We can use the following equation for this purpose:

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

Where,      Stress:    in MPa or N/mm<sup>2</sup> (or psi)  
               b:            Panel width or height, whichever the shorter side, in mm (or inch).  
               B:            Coefficient dependent on a/b ratio (panel width/height) and supporting condition, as shown in Table 1.  
               w:            Wind pressure in MPa or N/mm<sup>2</sup> (or psi)  
               t<sup>2</sup>:        Square of apparent thickness of ALPOLIC/fr LT in mm<sup>2</sup> (or in<sup>2</sup>), given in the following table:

	t <sup>2</sup> (mm <sup>2</sup> )	t <sup>2</sup> (in <sup>2</sup> )
ALPOLIC/fr LT	4.39	0.68×10 <sup>-2</sup>

When the maximum stress calculated from the above equation is lower than 0.2% proof stress (117 MPa or N/mm<sup>2</sup> (or 170×10<sup>2</sup> psi)), aluminium skins are still within elastic range and permanent deformation will not occur. A suitable safety factor is herein taken into account.

#### (2) Maximum deflection

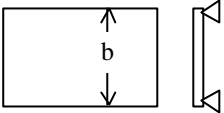
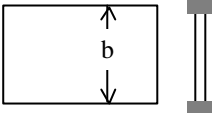
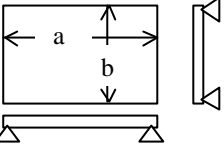
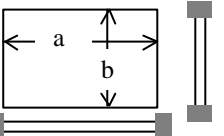
The maximum deflection of ALPOLIC/fr LT panel can be calculated with the following equation:

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

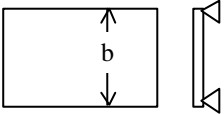
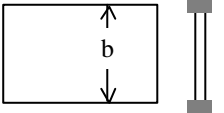
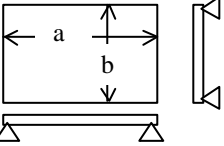
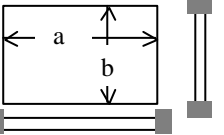
Where,      Deflection:    in mm (or inch)  
               b:            Panel width or height, whichever shorter side  
               A:            Coefficient dependent on a/b ratio (panel width/height) and supporting condition, as shown in Table 2.  
               w:            Wind pressure in MPa or N/mm<sup>2</sup> (or psi)  
               E<sub>AP</sub>:        Flexural elastic modulus of ALPOLIC/fr LT  
               t<sub>AP</sub>:        Thickness of ALPOLIC/fr LT  
               E<sub>AP</sub>t<sub>AP</sub><sup>3</sup> values are given as follows:

	E <sub>AP</sub> t <sub>AP</sub> <sup>3</sup> (N mm)	E <sub>AP</sub> t <sub>AP</sub> <sup>3</sup> (lbs inch)
ALPOLIC/fr LT	906×10 <sup>3</sup>	7.99×10 <sup>3</sup>

**Table 1 Coefficient B for calculation of stress**

Support condition		Equation and B value							
2-side simply supported and 2-side free		$\text{Stress}_M = 0.75 w b^2 / t^2$							
2-side fixed and 2-side free		$\text{Stress}_M = 0.5 w b^2 / t^2$							
4-side simply supported		$\text{Stress}_M = B w b^2 / t^2$							
		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		$\text{Stress}_M = B w b^2 / t^2$							
		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 2 Coefficient A for calculation of deflection**

Support condition		Equation and A value								
2-side simply supported and 2-side free		$\text{Deflection} = 0.156 w b^4 / (E_{AP} t_{AP}^3)$								
2-side fixed and 2-side free		$\text{Deflection} = 0.0313 w b^4 / (E_{AP} t_{AP}^3)$								
4-side simply supported		$\text{Deflection} = A w b^4 / (E_{AP} t_{AP}^3)$								
		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		$\text{Deflection} = A w b^4 / (E_{AP} t_{AP}^3)$								
		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 typical cases

The following tables are calculation results of typical cases with the above calculation equation.

**Table 3 Maximum Stress, 4-Side Simply Supported**

Material: ALPOLIC/fr LT 3mm (Stress: N/mm<sup>2</sup>)

w, kPa (kg/m <sup>2</sup> )	b, Panel width (mm)	a, Panel length (mm)								
		900	1200	1500	1800	2100	2400	2700	3000	>3000
0.5 (51)	600	19	25	27	29	31	31	31	31	31
	900	27	39	49	57	59	63	66	69	69
	1200	39	47	65	75	91	100	104	109	109
	1500	49	65	74	96	116	133 *	146 *	156 *	156 *
1.0 (102)	600	38	50	54	59	62	62	62	62	62
	900	53	79	99	114	119 *	125 *	132 *	138 *	138 *
	1200	79	94	130 *	150 *	182 *	200 *	209 *	217 *	217 *
	1500	99	130 *	147 *	193 *	232 *	265 *	292 *	313 *	313 *
1.5 (153)	600	56	75	81	88	92	92	92	92	92
	900	80	118 *	148 *	171 *	178 *	188 *	197 *	208 *	208 *
	1200	118 *	141 *	195 *	225 *	274 *	300 *	313 *	326 *	326 *
	1500	148 *	195 *	221 *	289 *	348 *	398 *	437 *	469 *	469 *

**Table 4 Maximum Stress, 4-Side Fixed**

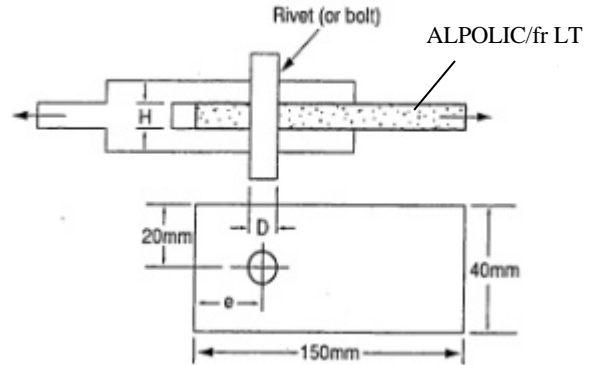
Material: ALPOLIC/fr LT 3mm (Stress: N/mm<sup>2</sup>)

w, kPa (kg/m <sup>2</sup> )	b, Panel width (mm)	a, Panel length (mm)								
		900	1200	1500	1800	2100	2400	2700	3000	>3000
0.5 (51)	600	19	20	21	21	21	21	21	21	21
	900	28	38	44	46	46	46	46	46	46
	1200	38	50	65	74	79	82	82	82	82
	1500	44	65	79	98	112	120 *	125 *	127 *	128 *
1.0 (102)	600	37	41	41	41	41	41	41	41	41
	900	57	77	88	92	92	92	92	92	92
	1200	77	101	130 *	148 *	158 *	163 *	164 *	164 *	164 *
	1500	88	130 *	158 *	197 *	223 *	240 *	250 *	255 *	256 *
1.5 (153)	600	56	61	62	62	62	62	62	62	62
	900	85	115	131 *	138 *	138 *	138 *	138 *	138 *	138 *
	1200	115	151 *	195 *	222 *	237 *	245 *	246 *	246 *	246 *
	1500	131 *	195 *	237 *	295 *	335 *	360 *	375 *	382 *	384 *

**How to read the table:** \* indicates that the maximum stress becomes larger than 0.2% proof stress (yield stress) of aluminum skin 1100 H-14 (117 N/mm<sup>2</sup>). Stiffener will be required in this range. In other range where the calculated stress is lower than 117 N/mm<sup>2</sup>, the panel will withstand without stiffener.

**Strength of Junction Holes**

Rivet, bolt/nut and tapping screw are quite often used for junction between ALPOLIC/fr LT panels and aluminum profiles. When tensile force loads on the junction point, stress will arise in the junction hole of ALPOLIC/fr LT panel. In order to evaluate the maximum elastic limit of junction hole, we held the following tensile test.



**1. Test method:**

Do tensile tests with 5mm hole s (D) that locates different distance from edge (e). Determine the maximum elastic limits by means of stress-strain curve.

**2. Test result:**

Hole diameter, D, mm (in)	From hole center to edge, e, mm (in)	e/D	Max. elastic stress, S, in MPa (psi)	Max. tensile force, F, in N (lbs)
5 (.197")	5 (.197")	1	17 (3000)	320 ( 72)
	10 (.394")	2	29 (7000)	720 (162)
	15 (.591")	3	33 (8000)	820 (184)

**3. How to use the above data:**

To utilize the above data, we convert the stress to tensile force with the following equation:

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

- Where, S: Maximum elastic stress in Mpa (psi)
- F: Maximum tensile force in N (lbs)
- t: Thickness of ALPOLIC® in mm (in)
- D: Diameter of hole in mm (in)

Calculation example:

Premise: ALPOLIC®/fr 3mm (.118"), D = 3mm (.118"), e = 6mm (.236"),

Result:  $F = S \times t \times D = 29 \times 3 \times 3 = 261$  N per junction point

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

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