

# **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") | Both top and back are effective sides.          |
|            | White-G30 / Champagne Metallic-G30    | N2   |                      |   |
|            | Light Beige-G30 / Silver Metallic-G30 | N3   | 1575×3099 (62"×122") |   |
|            | 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") |   |
|            | White Granite-G80                     | S2   |                      |   |
|            | Red Granite-G80                       | S3   |                      |   |
|            | Pink Granite-G80                      | S4   | 1575×3099 (62"×122") |   |
|            | 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<br>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-G75, 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<br>(Lumiflon-based) | Ultra-weather-ability<br>Coating warranty is available. | Outdoor (awnings, parapets,<br>signs)       |
| Conductive fluorocarbon<br>coating       | Electric-conductive<br>( $3 \times 10^{7-8}$ ohms)      | Interior walls and partitions in<br>factory |
| High cross-link polyester<br>coating     | High hardness (4H)<br>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<br>(Lumiflon-based) | Ultra-weather-ability<br>Coating warranty is available. | Outdoor (awnings, parapets,<br>signs)       |
| Conductive fluorocarbon<br>coating       | Electric-conductive<br>( $3 \times 10^{-8}$ ohms)       | Interior walls and partitions in<br>factory |
| High cross-link polyester<br>coating     | High hardness (4H)<br>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.

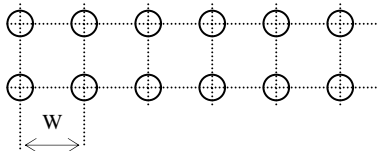
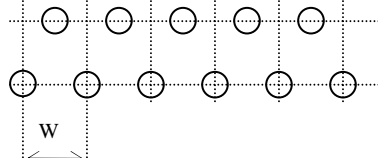
**1. Panel size**

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<br>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.

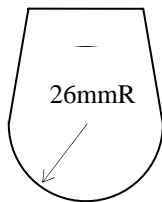
Impact Test with Steel Ball

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.

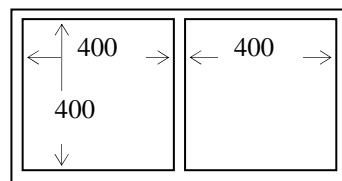
1. Testing method

- (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 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)

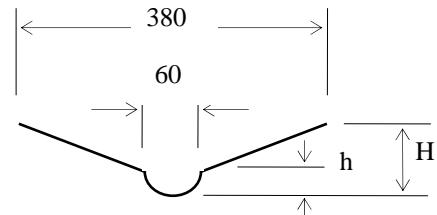
1 kg weight



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 column in the table, “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)

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

**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.

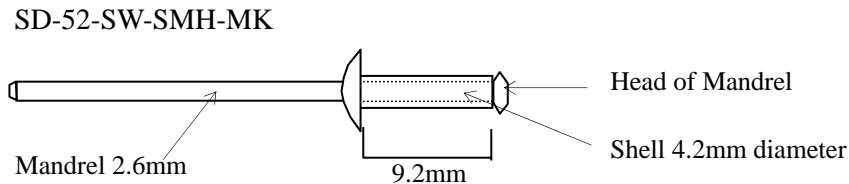
It is important that this method is not applicable to all ALPOLIC panels, but applicable only to the low-gloss finishes, because the trail of concealed rivet is visible from front if the surface is glossy. Especially on ALPOLIC/fr LT, this method is applicable only to **Matte Finish** products. Namely,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

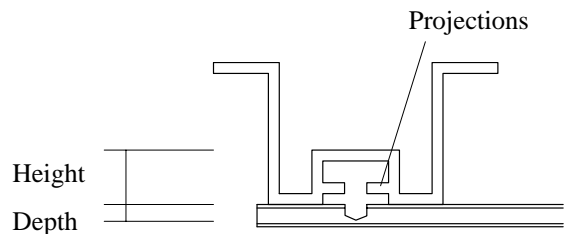


(2) Aluminum profile

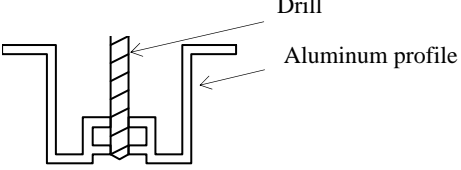
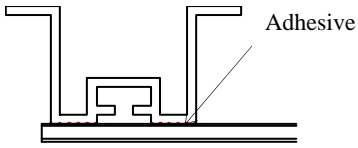
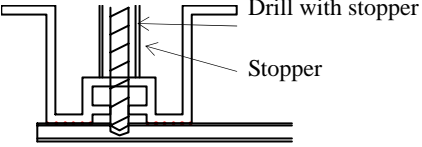
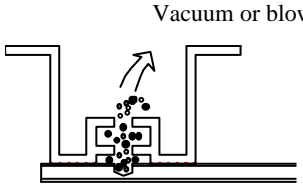
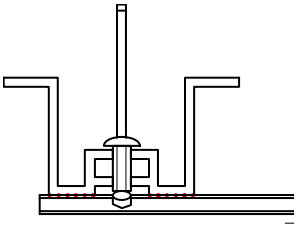
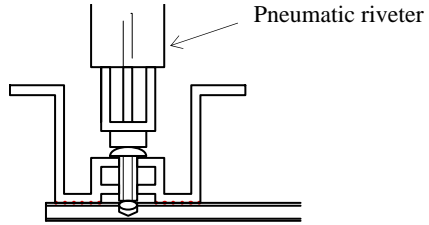
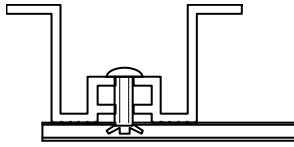
Any shapes of aluminum profiles are applicable, but the profile must allow the following fixing height, having projections to prevent lifting of aluminum skin.

(3) Fixing height and suitable depth

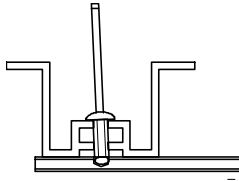
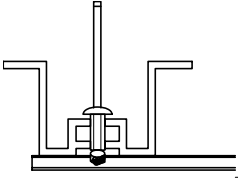
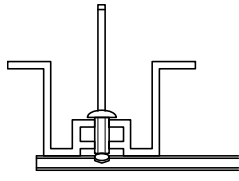
|                   | Height, mm | Depth, mm |
|-------------------|------------|-----------|
| ALPOLIC/fr LT 3mm | 7.5        | 2.5       |
| ALPOLIC/fr 4mm    | 7.5        | 3.0       |
| ALPOLIC/fr 6mm    | 6.0        | 3.5       |



(4) Procedures

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

#### (4) Improper works

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

### 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:

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

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

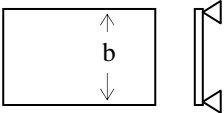
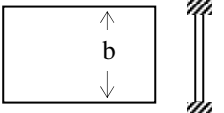
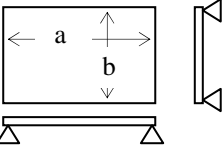
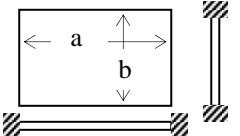
The maximum deflection of ALPOLIC/fr LT panel can be calculated with the following equation:

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

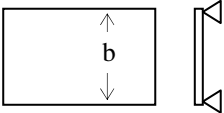
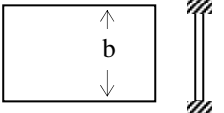
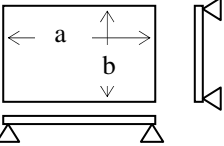
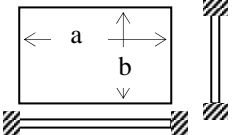
Where,      Deflection:    in mm (or inch)  
               b:            Panel width or height, whichever shorter side  
               A:            Coefficient dependent on a/b ratio (panel width/height) and supporting condition, as shown in Table 2.  
               w:            Wind pressure in 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 |   | $\text{Stress}_M = 0.75 \cdot w \cdot b^2 / t^2$ |        |        |        |        |        |        |        |
| 2-side fixed and 2-side free            |   | $\text{Stress}_M = 0.5 \cdot w \cdot b^2 / t^2$  |        |        |        |        |        |        |        |
| 4-side simply supported                 |   | $\text{Stress}_M = B \cdot w \cdot b^2 / t^2$    |        |        |        |        |        |        |        |
|   |  | 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                            |  | $\text{Stress}_M = B \cdot w \cdot b^2 / t^2$    |        |        |        |        |        |        |        |
|   |  | 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 2 Coefficient A for calculation of deflection**

| Support condition                       |   | Equation and A value   |        |        |        |        |        |        |        |        |
|---|---|--|--------|--------|--------|--------|--------|--------|--------|--------|
| 2-side simply supported and 2-side free |  | $\text{Deflection} = 0.156 \cdot w \cdot b^4 / (E_{AP} \cdot t_{AP}^3)$  |        |        |        |        |        |        |        |        |
| 2-side fixed and 2-side free            |  | $\text{Deflection} = 0.0313 \cdot w \cdot b^4 / (E_{AP} \cdot t_{AP}^3)$ |        |        |        |        |        |        |        |        |
| 4-side simply supported                 |  | $\text{Deflection} = A \cdot w \cdot b^4 / (E_{AP} \cdot t_{AP}^3)$      |        |        |        |        |        |        |        |        |
|   |   | 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                            |  | $\text{Deflection} = A \cdot w \cdot b^4 / (E_{AP} \cdot t_{AP}^3)$      |        |        |        |        |        |        |        |        |
|   |   | 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 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<br>(kg/m <sup>2</sup> ) | b, Panel<br>width<br>(mm) | a, Panel length (mm) |       |       |       |       |       |       |       |       |
|--------------------------------|---------------------------|----------------------|-------|-------|-------|-------|-------|-------|-------|-------|
|                                |                           | 900                  | 1200  | 1500  | 1800  | 2100  | 2400  | 2700  | 3000  | >3000 |
| 0.5<br>(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<br>(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<br>(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**

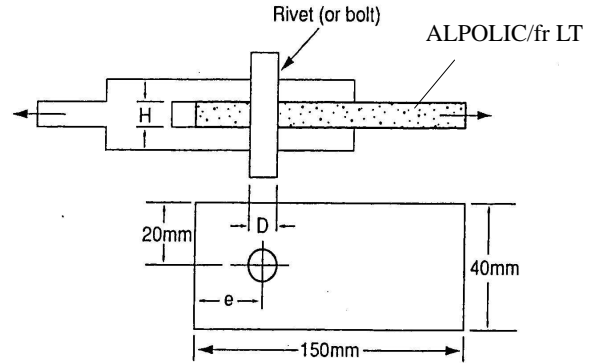
Material: ALPOLIC/fr LT 3mm (Stress: N/mm<sup>2</sup>)

| w, kPa<br>(kg/m <sup>2</sup> ) | b, Panel<br>width<br>(mm) | a, Panel length (mm) |       |       |       |       |       |       |       |       |
|--------------------------------|---------------------------|----------------------|-------|-------|-------|-------|-------|-------|-------|-------|
|                                |                           | 900                  | 1200  | 1500  | 1800  | 2100  | 2400  | 2700  | 3000  | >3000 |
| 0.5<br>(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<br>(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<br>(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 holes (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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