TECHNICAL BULLETIN 154

Design Criteria for Outdoor Signs and Related Products

Introduction

This document will give some technical insight into the calculations and methods used to determine proper sheet sizes, hole opening sizes and edge engagement configurations for signs. The same information also applies to many skylight and glazing applications. The coefficient of thermal expansion and/or contraction for all grades (GPA, Acrysteel, S-300 and I-300) and colors of Aristech Surfaces acrylic sheet ranges from 0.000038 to 0.000042 in/in/°F (0.000068 to 0.000076 cm/cm/°C). For calculations, the average, 0.000040 in/in/°F (0.000072 cm/cm/°C) will be used throughout this bulletin.

Sheet Size Calculations

Example #1. An acrylic sign face 8' (2.44 m) long by 4' (1.22 m) wide by any thickness is assembled at room temperature of 75°F° (24°C). It is expected that this sign face will reach a maximum temperature of 150°F (65.6°C) in the summer and a minimum temperature of -20°F (-29°C) in the winter. How much will it expand in the summer (A) and how much will it contract in winter (B)? Also what is the total dimensional change (C)?

1. **Maximum Expansion (A).**
   Length:0.00004 x (150°F - 75°F) x 96" = 0.29".
   (0.00007 x (65.6°C - 24°C) x 244 cm =0.73 cm)

   Width: 0.00004 x (150°F - 75°F) x 48" = 0.14".
   (0.00007 x (65.6°C - 24°C) x 122 cm =0.36 cm)

2. **Maximum Contraction (B).**
   Length:0.00004 x [75°F - (-20°F)] x 96" = 0.36".
   (0.00007 x [24°C - (-29°C)] x 244 cm=0.91 cm)

   Width: 0.00004 x [75°F - (-20°F)] x 48" = 0.18".
   (0.00007 x [24°C - (-29°C)] x 122 cm =0.46 cm)

3. **Total Dimension Change (C).**
   Length:A + B = C or 0.29"(0.73 cm) + 0.36"(0.91 cm) = 0.65"(1.64 cm).

   Width: A + B = C or 0.14"(0.36 cm) + 0.18"(0.46 cm) = 0.32"(0.82 cm).

Often a simpler "rule of thumb" expression is used in lieu of the above calculations. It is: the combined expansion/contraction movement (C) is approximately 1/16" per foot (.52 cm per meter). Using this for the above example the results would be:

1. Total dimensional change (C) for the length.
   8' x 1/16" = 0.500" (2.44 m x .52 cm = 1.27 cm)

2. Total dimensional change (C) for the width.
   4' x 1/16" = 0.250" (1.22 m x .52 cm = .63 cm)

As can be seen, the "rule of thumb" technique which is an approximation yields slightly smaller numbers for this example.

Hole Size Calculations

For bolt sizes up to 1/2" (12.7 mm) in diameter, drill the hole 1/8" (3.2 mm) larger in diameter. (See Figure 1). It is equally important not to tighten down on a bolt to the point that expansion/contraction can not occur. Use rubber washers or grommet where possible, and only tighten the nuts finger tight.

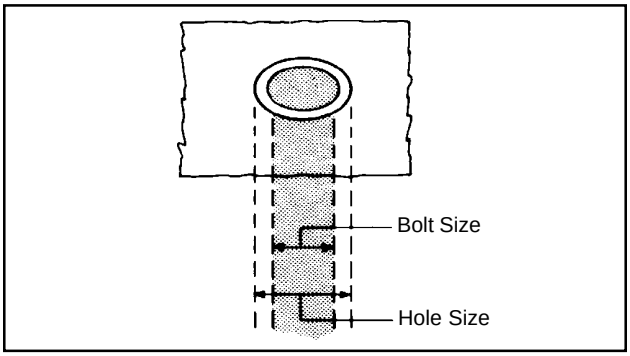

Figure 1

Edge Engagement

Figure 2 gives recommended Aristech Surfaces acrylic sheet thicknesses based on the long dimension of the sign and the specified maximum wind load in lbs/ft^2 (kg/m^2). Table 1 gives approximate wind velocities for a specified wind load in lbs/ft^2 (kg/m^2).

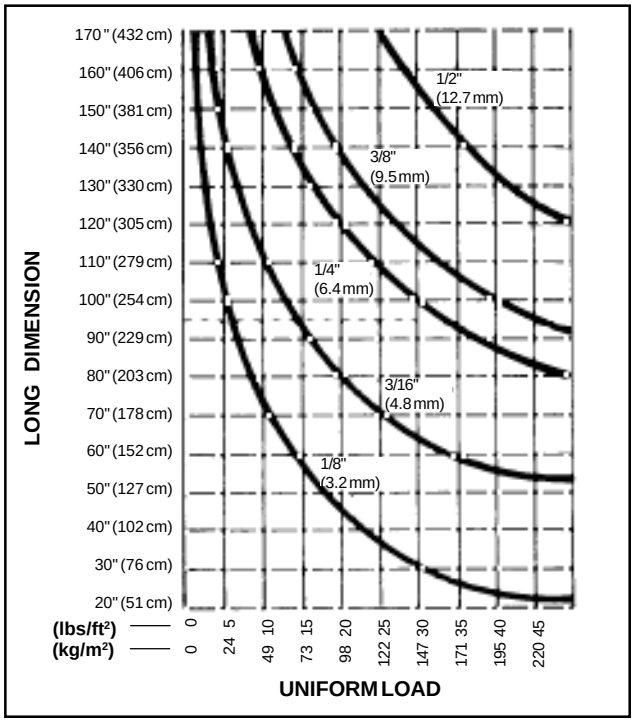

Figure 2

Table 1

Approximate Wind Velocity (MPH)	Uniform Load (lbs/ft²)
75 (121 km/hr)	20 (98 kg/m²)
90 (145 km/hr)	30 (147 kg/m²)
100 (161 km/hr)	40 (195 kg/m²)
130 (209 km/hr)	50 (244 kg/m²)

Example 2. The sign face in Example 1 must withstand 30 lbs/ft² (147 kg/m²) wind load. Determine the proper sheet thickness, the expansion/contraction clearances and the recommended edge engagement dimension using Table 2 and Figures 2 and 3.

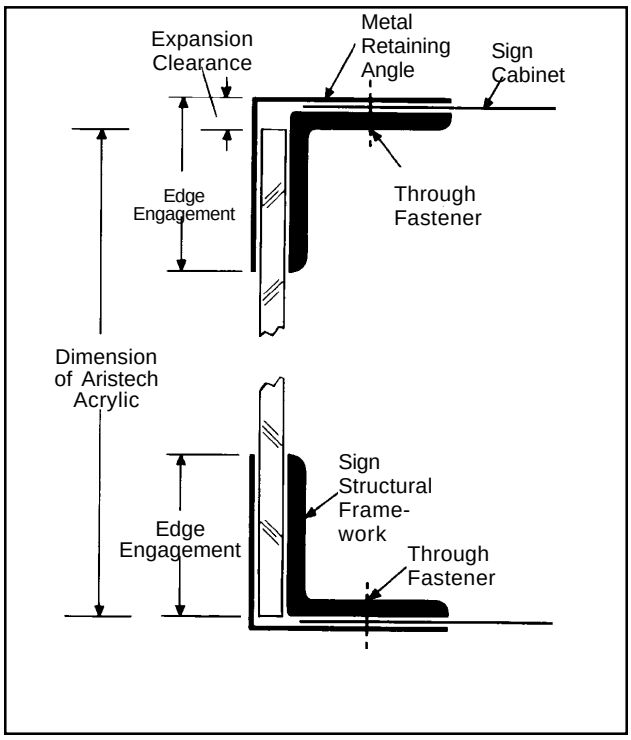

Figure 3

Table 2

Short Dimension	Expansion Clearance	Edge Engagement (Includes Expansion Clearance)
Up to 42" (Up to 107 cm)	1/8" (3.2 mm)	1.250" (31.8 mm)
42" to 72" (107 to 183 cm)	1/4" (6.4 mm)	1.250" (31.8 mm)
72" to 96" (183 to 244 cm)	1/4" (6.4 mm)	1.500" (38.1 mm)
Over 96" (Over 244 cm)	0.3% of short dimension	1.6% of short dimension

Note: These values are approximate.

1. From Figure 2 the recommended thickness is 0.250" (6.4 mm).
2. From Table 2 the expansion clearance is 0.250"(6.4 mm). This compares to the total width calculation (C) from example #1 of 0.32" (0.82 cm).
3. From Table 2 the edge engagement dimension is 1.250" (31.8 mm).

Note: If no expansion clearance is allowed, excessive bowing, twisting, warpage and/or stress cracking can occur. Also, with proper edge engagement, acrylic sheet sizing, and sign housing design, blow-out or loss of the sign face under severe environmental conditions is much less likely to occur.

Other Design Considerations

1. Thermal coefficients of expansion/contraction for other materials.

Table 3 gives some coefficients for other materials in cluding metals used in sign housings. These numbers can be used in a calculation such as Example #1 if the sign housing composition is known. The movement of the housing will be in the same direction as the acrylic and therefore should be subtracted from the acrylic ex pansion/contraction dimension.

Table 3

Comparison of Coefficients of Thermal Expansion of Acrylic and Other Building Materials

Material	In/In/°F (cm/cm/°C)
Acrylic	.0000410 (.000074)
Aluminum	.0000129 (.000023)
Copper	.0000091 (.000016)
Steel	.0000063 (.000011)
Plate Glass	.0000050 (.000009)

Figure 4 illustrates some typical edge engagement configurations.

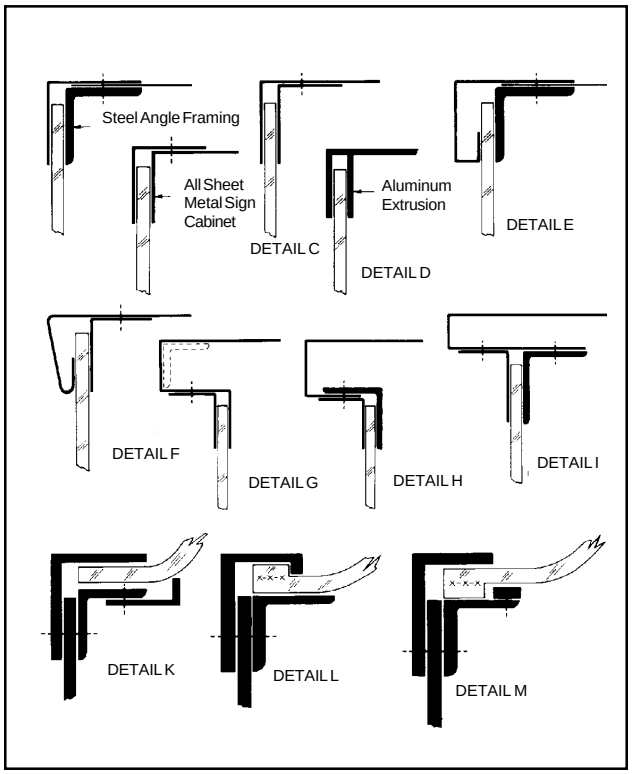

Figure 4

2. Hanger Bars.

Certain sizes, shapes and thicknesses will tend to sag or bow due to their weight. Hanging the Aristech Surfaces acrylic sign face from the top edge will overcome this tendency. (See Figure 5) for some typical hanger bar configurations.

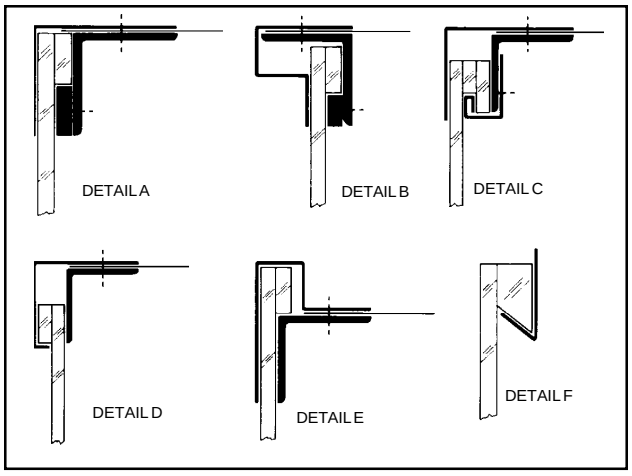

Figure 5

3. Tie Bars

For extremely large signs or if other design or environmental problems cause “blow-out” problems, internal tie-back braces are a solution. See Figure 6 for a typical tie-back bar. This is a fairly complicated area and will not be covered in this bulletin in great detail. For further information contact the Aristech Surfaces acrylic sheet unit’s technical service department at Florence, Kentucky.

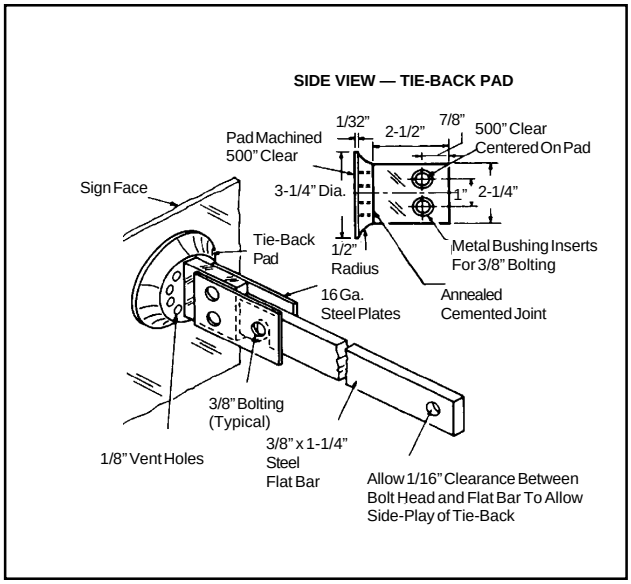

Figure 6

4. Testing For Wind Load Or Resistance.

This is covered in detail in Aristech’s Technical Information Sheet #2 which is available upon request.

For cautions and other information relating to handling of an exposure to this product, please see the applicable material safety data sheet published by Aristech Surfaces.

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