Bending Strength & Stiffness

ALPOLIC Aluminum Composite Material Panels

ALPOLIC aluminum composite material (ACM) is typically used in applications such as exterior wall panels. While non-load bearing (they do NOT carry the dead load of other building components or floor live loads), they are required to transfer wind pressures to the supporting structures without bending failure of the aluminum or excessive deformation. To ensure specific panels meet the loading and deflection requirements, both the aluminum stresses and panel deformations need to be calculated and compared to allowable values. These calculations can be very complicated and if precision is required are best left to your design professional.

ACM Mechanical Properties

In order to perform structural calculations the basic mechanical properties of the ACM panel must be determined. This is done by physical tests or calculations, possibly both. These properties include the Flexural Modulus (Young's Modulus or E) of both the ACM and the aluminum alloy skins; the Moment of Inertia (I) of the ACM panel and the aluminum skins, as well as, the Equivalent Thickness of an aluminum sheet producing the same stress levels under load as the corresponding ACM sheet.

E_{ACM} is the Flexural Modulus of the ACM and has been determined by testing samples of ALPOLIC ACM. Because different sizes of ACM have a uniform amount of aluminum content, but, a varying amount of core content (thicker panel, same aluminum, more core) by volume, E_{ACM} decreases as the ACM size increases (6mm is smaller than 4mm is smaller than 3mm).

E_{Skin} is a well-documented aluminum property and is usually considered as a constant for most alloys. 3105H14 is the most commonly used aluminum alloy for ACM skins.

E is generally used (along with I) to determine panel deflections (movement) under load.

T_{ACM} is the total thickness of the ACM panel.

T_{Equal} is the Equivalent Thickness of a solid aluminum panel having the same stresses at the outer face as the corresponding ACM panel. This is found by solving the stress equation $M(T_{ACM}/2)/I_{ACM} = M(T_{Equal}/2)/I_{Equal}$. At a given load, the Bending Moment (M) is the same for both sides of the equation and so reduces to $(T_{ACM}/2)/I_{ACM} = (T_{Equal}/2)/I_{Alum}$.

T is generally used to determine maximum stresses on the aluminum skins.

I_{ACM} is the Moment of Inertia of the ACM panel.

I_{Skin} is the Moment of Inertia of the aluminum skins assuming the core material does not contribute to the panel stiffness.

I is generally used (along with E) to determine panel deflections (movement) under load. Since panel widths vary, I is usually given in units of width, (typically I per inch of width). I times E is a very useful measurement of stiffness, but the appropriate E must be used with the appropriate I. In our case, always multiply E_{ACM} by I_{ACM} and E_{Skin} by I_{Skin} . If you check, you'll find the result is very close to the same number which is a confirmation of the tested value for E_{ACM} .

Basic Properties ALPOLIC PE and fr Cores

	3mm	4mm	6mm
T_{ACM}	0.118 in	0.157 in	0.236 in
T_{Equal}	0.099 in	0.120 in	0.153 in
I_{ACM}	$1.37x10^{-3}$ in^{4} /in	$3.25x10^{-3}$ in^{4} /in	$10.98x10^{-3}$ in^{4} /in
I_{Skin}	$0.94x10^{-4}$ in^{4} /in	$1.83x10^{-4}$ in^{4} /in	$4.49x10^{-4}$ in^{4} /in
E_{ACM}	$7110x10^{3}$ psi	$5770x10^{3}$ psi	$4220x10^{3}$ psi
E_{Skin}	$10000x10^{3}$ psi	$10000x10^{3}$ psi	$10000x10^{3}$ psi

Using these basic mechanical properties, 3105H14 yield and tensile values and rectangular flat plate bending equations, a close (somewhat conservative) approximation of panel stress and deflection for a given panel size can be calculated.*

Otherwise use the following charts.

*If you don't know where to find the aluminum yield and tensile values or the rectangular flat plate bending equations, you maybe should move on to the charts. For those who still want to know more, find a copy of the latest Aluminum Design Manual and any version of Roark's Formulas for Stress and Strain.

Calculations

Maximum Panel Stress: $\sigma_{max} = \beta * w * b^2 / T^2_{Equal}$

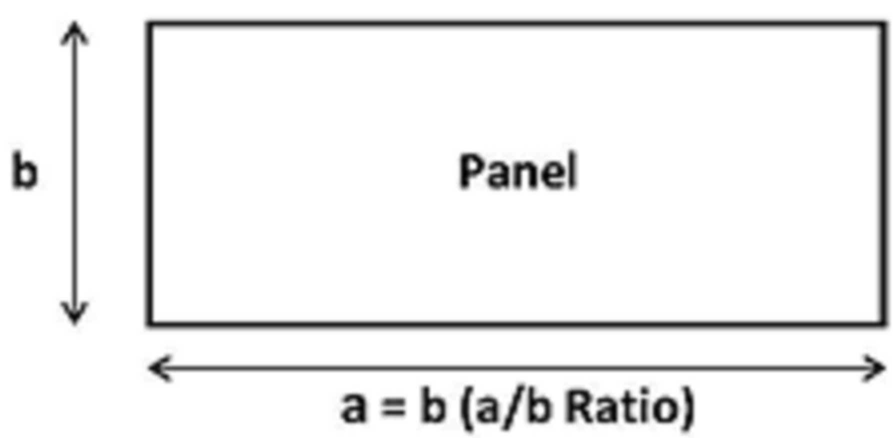
Maximum Panel Deflection: $y_{max} = (-\alpha * w * b^4) / (E_{ACM} * T^3_{ACM})$

W = Uniform Load (psi)

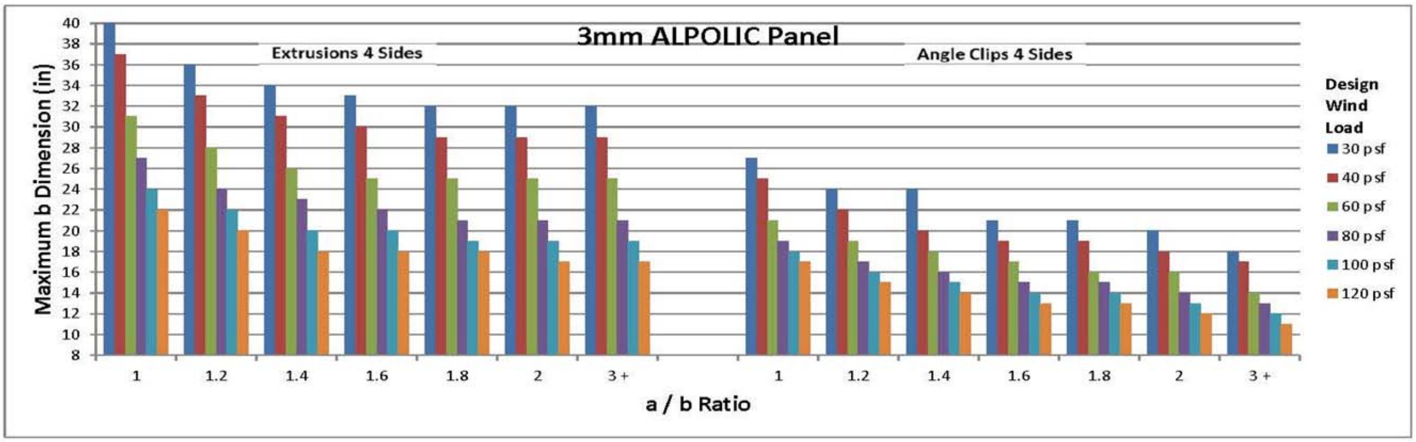
b = Smallest Panel Dimension (in.)

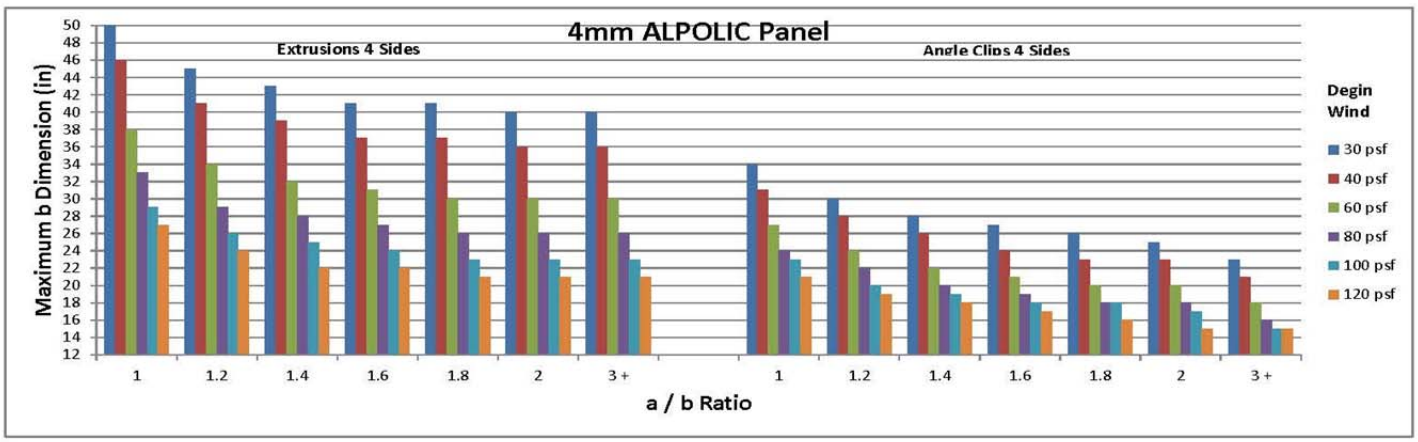
a/b = Ratio of Largest Panel Dimension to Smallest Panel Dimension (Always >=1)

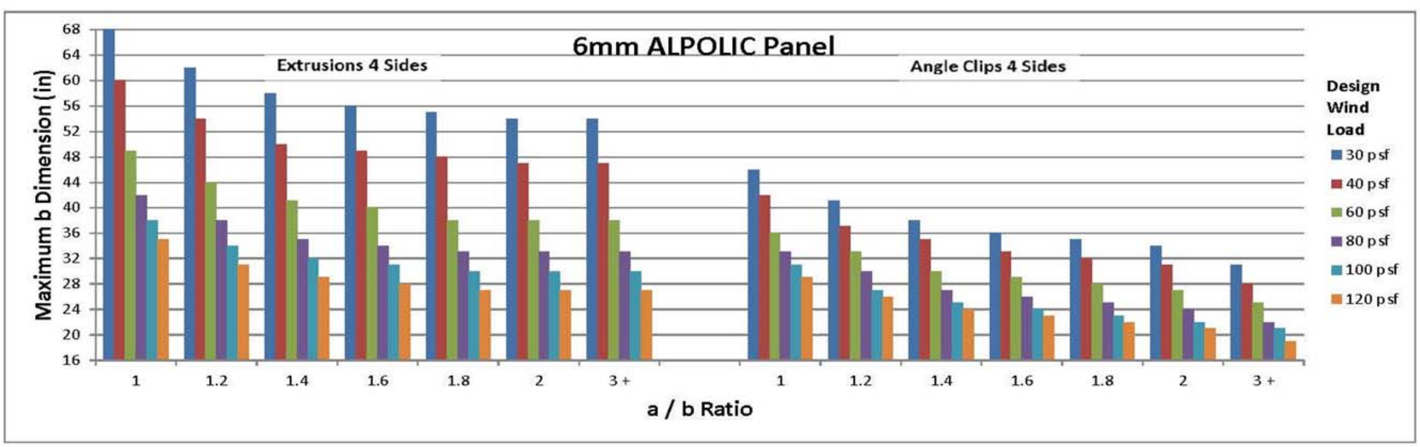
	a/b	1	1.2	1.4	1.6	1.8	2	∞
Simple Supports	β	0.2874	0.3762	0.4530	0.5172	0.5688	0.6102	0.7500
All Four Sides	α	0.0444	0.0616	0.0770	0.0906	0.1017	0.111	0.1421
Simple Supports a sides	β	0.4182	0.5208	0.5988	0.6540	0.6912	0.7146	0.7500
Fixed Supports b sides	α	0.0210	0.0349	0.0502	0.0658	0.0800	0.0922	0.0922
Fixed Supports a sides	β	0.4182	0.4646	0.4860	0.4968	0.4971	0.4973	0.5000
Simple Supports b sides	α	0.0210	0.0243	0.0262	0.0273	0.0280	0.0283	0.0285
Fixed Supports	β	0.3078	0.3834	0.4356	0.4680	0.4872	0.4974	0.5000
All Four Sides	α	0.0138	0.0188	0.0226	0.0251	0.0267	0.0277	0.0284



Charts







* Controlled by maximum allowable bending stress (13,200psi)
or maximum panel deflection (b/60) as applicable.

**Extrusions 4 sides represent fixed bending supports
Angle Clips 4 sides represent simple bending supports