Part III

What is a Metal Composite Material (MCM)?—Skins

First and most obvious—in an MCM, the skins are made of metal. What started off as an aluminum skin business blossomed into a variety of metal surfaces—stainless steel, zinc, copper, and even titanium just to name a few. Variations in metal, metal thickness, and finish are now common. The real question is: what does the designer need to watch out for?

Skin Thickness

For as long as the product has been available in North America, typical aluminum thickness has been 0.019" (0.5mm). That thickness provides a good protection layer for the material that will resist normal exposure without significant visual damage due to impact. Understand that the material can be dented, but we'll see that the core material has a significant impact on performance. The main purpose for that skin is threefold:

1. To provide a substrate that can be painted or left in its natural state and provide a visually appealing product for a long period of time.
2. To transfer the wind loading from the surface of the panel to the anchorage system
3. To protect the core material directly from fire.

Finishes

Aluminum skins typically are painted with any one of a variety of finishes that meet the standard requirements of AAMA 2605. These finishes can be anything from earth tones with a low gloss finish to rich, vibrant colors with a high gloss finish, to metallic, to newer surfaces that imitate wood, marble, granite, etc. The aluminum skins provide a surface the finishes will adhere to and will not expand or contract excessively due to heat or moisture and cause the finish to fail.

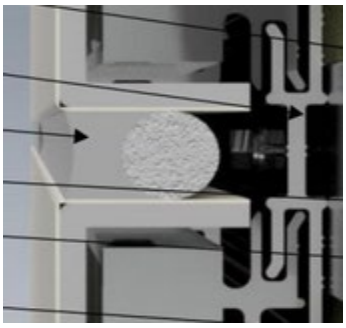
Nonaluminum metals are also very popular and can provide the appearance of that metal at a fraction of the weight and cost of a solid metal plate alternative.

Structural Performance

MCM panels typically have a very large area that lends itself to deflection during times of significant wind. The 0.019" aluminum skins have proven over many decades to be capable of taking high wind loads without creating excessive stress on the paint finish or yield the metal so the panel does not return to flat. In fact, that is one of the key advantages to MCM. The material is very forgiving and will remain flat over time.

The 0.019" thick aluminum skins also have shown the capability to be fabricated and folded so the wind load can be transferred back to the structure. In the following photos, the tight radius bend created when the panel is folded over, is dependent on the exterior skin. The back skin and

a portion of the core of the material are removed to allow space for this type of folding. This type of joint has been cycle tested in excess of 100,000 cycles to the maximum allowable deflection without failure of the aluminum skin.



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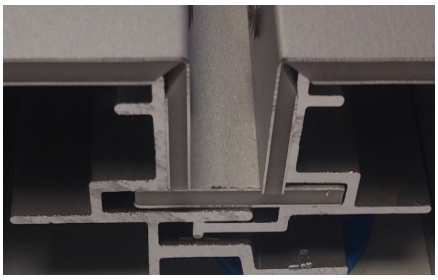

MillerClapperton

Quality

Fire Protection

One of the phrases that often heard in the field is “engineered to perform”. The only combustible element of MCM that really has any mass is the fire resistant core itself. While many of the fire resistant cores have been tested and meet the requirements of a Class A material, the metal skins serve as an additional protection for that core material. Fire will typically bounce off the metal skin for quite some time before that metal is compromised and the core is directly exposed to the fire

During the introduction of ACM to the marketplace, the only product available utilized 0.019” (0.5mm) skins on both sides of a solid extruded polyethylene core. As the product developed, the aluminum coil manufacturers developed skin thicknesses as thin as 0.010” (0.3mm) in the coil widths required.

While the final product may have the same visual appearance, fabrication of a panel with thin skin is more of a challenge using common installation systems. In addition, both the structural and fire performance of the panel are significantly reduced when a thinner skin is used. There even are instances where a different skin thickness is used on the inner and outer surface creating a panel that reacts differently under positive and negative wind loading. The codes will typically call out a minimum 0.019” thickness for the skins and most testing is done using this aluminum product.

Most important are that these skins perform the structural and fire performance required. The metals that are finished also must provide a smooth surface with good adhesion capability with the finished material.

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Part IV

What is a Metal Composite Material (MCM)?—Skin Performance

Part III discussed some facts on the basic aluminum skin that was used when aluminum composite material (ACM) was introduced back in the 1970s. At that time, 0.019" (0.5mm) stretched and leveled aluminum coil of this thickness was commonly available in both 3000 series (paint) and 5000 series (anodized) coil. The primary reason for this aluminum skin was to:

- Protect the core material from direct flame impingement for a certain period of time
- Provide a skin material that is structurally adequate to transfer wind loads from the panel after fabrication.
- Provide a visually flat surface that allows the bonding process and can be finished using the high quality architectural finishes

Aluminum Skins

Original testing investigated impact from a number of common everyday sources. Rocks, bottles, and a number of other objects were tossed against the ACM from a given distance and the visual damage was measured, or at least commented on. While these subjective results were interesting, there was no real way to translate the results to real life performance.

Panel penetration, commonly referred to as impact resistance, is a more measurable trait. The most common indicator of this performance is the TAS 201 (ASTM E1996) impact testing currently used for Miami Dade Product Approval. While the large missile typically penetrates the ACM panel, the small missile impact testing is generally successful due to a combination of the metal skin and composite action of the product.

Arguably, the most important performance of the aluminum skin is the transfer of load from the panel face to the "return leg" that is common in today's installation systems. While the loading is distributed along the entire perimeter of the panel, specific testing and actual field use have shown that the 0.019" skin does not yield due to the loading or to the repeated flexing of the panel under load.

Over the years, different manufacturers have introduced thinner skin ACM, down to 0.010". This material was initially introduced as a signage material, but companies are looking at architectural use to save costs. Questions raised by using this thinner aluminum skin material include:

- Resistance to puncture that would expose the core material (Fire and Strucutral concerns)
- Ability of the thinner skin to tranfer load without yielding (Structural)

- Anchor fastening of the fasteners pulling through the thinner skins (Bearing, Structural)
- Overall flatness of the thinner aluminum skin (Visual)

Different Metal Skins

There is no question that other metal skins have been successfully used in the manufacture of MCM material. So much so that the overall industry name Aluminum Composite Material (ACM) was changed to Metal Composite Material (MCM) over 15 years ago. Stainless steel, carbon steel, zinc, titanium, copper, and others have been used in the composite manufacturing process and construction with a great deal of success. There are 3 areas of concern when dealing with MCM:

1. **Natural Metals Age Naturally—**Most often, metals other than aluminum are used for visual impact and to obtain an "aged" look. Stainless steel, zinc, and copper are examples of materials that change appearance over time. The visual effect of the MCM should be very similar, but far less expensive, than use of a solid metal sheet. The weight of a solid metal sheet is another consideration that may make MCM an interesting option.

   Another concern is the interaction of the metal skins with any alternate metal material such as flashing and fasteners. Galvanic corrosion can be an issue in the presence of water and two dissimilar metals. Care should be taken throughout the design phase and during construction to avoid corrosion, which will lead to premature failure of the metal skins.

2. **Bond Strength with the Core—**As stated in previous segments of this document, one of the most critical elements in the production of MCM is the bond strength between the core and the metal skin material. Initial bond investigations have shown a value of 100 N-mm/mm is adequate to ensure the panel remains a composite during normal exterior applications. This bond is developed using a very precise chemistry which bonds the metal and the traditionally bond-resistant core material (typically a polyethylene based compound). To ensure the bond strength is within acceptable levels, manufacturers generally test the bond strength as manufactured, after 8 hours in boiling water, and after 21 days soaking in water at room temperature. These standard tests have worked well in the past and are recognized by the building code to provide a panel that will remain intact over time.

3. **Differential Expansion—**One variation used by companies around the world is to make an MCM with an alternate metal skin on the exterior side and an aluminum or non-metallic skin on the interior side. This is done solely for cost purposes as the interior skin is generally many times less expensive than the alternate metal skin used on the exterior side. The issue with this practice is in the difference in thermal expansion between the

two skin materials and the potential galvanic reaction of fasteners that pass through both materials.

Aluminum typically expands at a rate of 1/8" for 8' of length with a 100°F temperature change. Other materials, metallic and non-metallic can have quite different expansion rates, which could lead to an unbalanced panel. It only takes a slight amount of differential to have visual bow in the panel between stiffeners. This often is very apparent with high gloss finishes and would be even more apparent with highly reflective natural metals.