



# Metal Composite Materials – Fire Performance Testing in the United States and Canada

## OVERVIEW

### Overview

Global fire events have heightened awareness regarding the use of metal composite material (MCM). Safeguards in place in North America help to ensure these types of fire incidents do not take place. By adhering to the performance criteria defined in the International Building Code (IBC) in the United States, the National Building Code (NBC), and the Provincial Building Codes in Canada and working with the experienced MCM Manufacturers and Certified Fabricators, MCM can be used safely and effectively on a variety of construction types.

### Discussion

Long before the IBC was first developed in 2000, the use of MCM was specifically regulated in construction. However, with the introduction of the 2000 Edition of the IBC, a specific section was developed defining, in detail, the required fire performance of the MCM and MCM systems. Section 1406 Metal Composite Materials (MCM) was developed to locate all fire performance criteria in one place in the code. Additional requirements for structural performance are found in Chapter 16 and certain specific applications are further developed elsewhere in Chapter 14, however the fire performance requirements are all contained in Section 1406.

The fire performance criteria for MCM begins with small scale laboratory tests to establish individual material characteristics and escalates to full scale testing of the MCM system to determine not only how the MCM burns, but how the overall MCM system performs in real world applications.

Following is a summary of the tests, procedures, results, and what performance is required for each test defined in IBC Section 1406.

## **MCM Performance Testing**

While generally smaller in scale, material testing provides specific values for the material such as material flame spread and smoke developed, ignition temperature, and several other flame spread values that have been used for other combustible materials for several years.

When MCM was first introduced to the code, the goal was to ensure that the material performed at least as well as other plastic materials already accepted and regulated by the code. Originally identified as the criteria used in the definition of Approved Plastics, MCM uses the following test standards to aid in defining performance:

### **ASTM D1929 - Standard Method for Determining Ignition Temperatures of Plastics**

This is a material test to show that the plastic component of the MCM will not ignite at low temperatures. A small material sample  $\sim 3/4 \text{ in}^2$  ( $20 \text{ mm}^2$ ) is subjected to a heat source to determine material ignition both with and without a pilot flame. The minimum self-ignition temperature of the plastic is  $650 \text{ }^\circ\text{F}$  ( $343 \text{ }^\circ\text{C}$ ).

MCM tested to this standard report ignition temperatures of  $700$  to  $750 \text{ }^\circ\text{F}$  ( $371$  to  $399 \text{ }^\circ\text{C}$ ).

### **ASTM D635 – Rate of Burning of Plastics**

Another small-scale material test associated to the use of light-transmitting plastics that measures how a sample,  $\sim 1/2" \times 5"$  ( $13\text{mm} \times 125\text{mm}$ ), burns once the ignition point is reached and the direct flame is removed. While not often used as an acceptance test for MCM, when subjected to this procedure, the material has a burning extent of  $1"$  or less which allows it to be classified as a CC1 plastic material.

These bench top tests define some interesting performance levels for the MCM; however, a larger scale material test is used to truly show performance in the areas of Flame Spread and Smoke Developed for the MCM.

### **ASTM E84 (UL 723) – Standard Method for Surface Burning Characteristics of Building Materials**

Designed to measure the flame spread and smoke developed of a larger material sample, the ASTM E84 test compares these product values to those obtained when burning Red Oak Flooring.

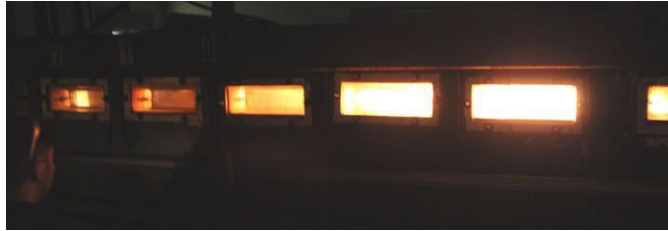
The ASTM E84 apparatus accommodates a sample 24 inches ( $610\text{mm}$ ) wide by 24 feet ( $7300\text{mm}$ ) in length. While there is some capability to measure thicker samples, it is not generally possible to measure the flame spread of MCM systems using this test. The sample is placed in a horizontal orientation with a gas flame introduced at one end. Flame progression and smoke generated are measured for 10 minutes. The results are compared with the red oak material used to calibrate the tunnel. The allowable flame spread for Class A material is  $\leq 25$  and the smoke developed is  $\leq 450$ .

The range of flame spread for MCM is typically 0 to 10 and the range of smoke developed is around 0 to 30. With these values, MCM would be recognized as a Class A material.

While the ASTM E84 test gives some information on how flames spread over the surface of the material, this test is oriented horizontally so the amount of information provided to predict vertical flame spread is limited. The primary uses of these test results are to determine flame spread/smoke developed classification based on the requirements of the code and to provide a means to compare the performance of

one product to another.

To fully understand the performance of the MCM when used as an exterior cladding system, an additional, much larger test must be completed.



ASTM E84 Tunnel Test Apparatus

### **MCM System Performance Testing**

#### **NFPA 285 – Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components**

Since the 1980's, the building codes in the United States have recognized the need for wall assembly testing. Beginning with the Exterior Insulation Finish Systems (EIFS), the code has been concerned with flame spread over, within, and behind cladding systems. Therefore, wall assemblies containing combustibles at any location in the assembly are required to meet the performance requirements of NFPA 285.

The NFPA 285 is a full-scale test method exposing a wall assembly sample measuring a minimum of 13 feet 4 inches (4.06m) in width by 18 feet (5.48m) in height to a flame source equivalent in intensity to a fire breaking out of a window of a fully involved room. This test procedure, with a total exposure time of 30 minutes, measures both the visual flame spread both vertically and horizontally along the wall as well as temperature readings throughout the sample. The criteria for NFPA 285 are very specific and include:

- A maximum temperature of 1000 °F (538 °C) at a height of 10 feet (3.05m) above the window opening.
- No flames shall emit from the surface of the exterior face of the cladding that reach a height of 10 feet (3.05m) or greater above the window opening.
- No flames shall emit from the surface of the exterior face of the cladding that reach a horizontal distance of 5 feet (1.52m) or greater from the vertical centerline of the window opening.

Because each wall assembly consists of several different materials in a unique orientation to each other, the IBC requires that each different assembly be tested to NFPA 285. If the assembly, or even a component of the assembly is changed from a wall evaluated using NFPA 285, the assembly must be either tested or an equivalency analysis developed for submittal to the local building official.



NFPA 285 Test Apparatus

### **Canadian Testing**

Testing required by the National Building Code of Canada (NBC) and the provincial codes is based on standards developed in Canada. As with testing in the United States, material performance is critical; however, the Canadian test standards are slightly different than their US counterparts.

### **CAN/ULC S102 – Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies**

Like the ASTM E84 test, the S102 measures the flame spread and smoke developed of a material sample. The test apparatus is oriented differently than the ASTM E84, however the results still indicate flame spread of a horizontal sample. Each material type must provide Flame Spread and Smoke Developed values that meet the performance requirements of the NBC or governing provincial code.



CAN/ULC S102 Test Apparatus

### **CAN/ULC S134 – Fire Test of Exterior Wall Assemblies**

This full-scale wall test is very similar to the NFPA 285 however the test wall assembly sample is 6 meters (19 feet 8 inches) wide and 9.8 meters (32 feet 2 inches) tall. The test measures flame spread and material temperatures using thermocouples and radiometers throughout the sample; however, the assembly is constructed over a block wall, so the fire insult is only seen from the exterior of the sample. Like the NFPA 285, the main concern with this test is vertical flame spread and the temperature of the sample during the test exposure. Also, as with the NFPA 285, any change in material or orientation in this test assembly requires either a new test or an engineering analysis to show compliance with the requirements of the

applicable code.



CAN/ULC S134 Test Apparatus

*(Pictures Courtesy Intertek Building and Construction)*

## Summary

The test results are provided to the building official as support for an evaluation report written by an independent third party, which identifies the performance of the MCM and the allowable uses of that material based on the testing results.

There are several evaluation services and labs that can test the MCM and MCM systems. While the IBC does not require an evaluation, it is highly recommended to obtain an evaluation report for the MCM that identifies performance and limitations of use in accordance with the code.

It should be noted that since the development of IBC Section 1406, the MCA is not aware of a wall built in accordance with the NFPA 285 test assembly that has not performed to limit the flame spread on

high rise construction.

With the testing required under IBC Section 1406 and the number of assemblies tested and passing the NFPA 285 and ULC S134 performance requirements, it could be said that wall performance in the United States and Canada is equal to or better than the performance of tested wall assemblies throughout the world.

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MCA's marketing and technical activities create awareness of metal, its applications, and its benefits. MCA also works to eliminate barriers to metal's use in construction by supporting product performance testing, initiating research, and monitoring and responding to codes and regulations that affect metal.

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