*Setting the Standard*

September 2021

# MOCA Informational articles

## How to tell you have well-made boards.

It is unfortunate that too many magnesium-oxide cement boards have issues around consistency and quality. This issue has been resolved by some manufacturers, however, a recent accelerated aging study, published August 2021, conducted at the University of Belfast School of Natural and Built Environments found that only 2 of 6 MOC boards maintained sufficient material properties to be useful. Four samples failed in under 57 days (11, 11, 28 and 57 days), while 2 samples did not fail after 840 days of cyclic accelerated weathering. While subjecting boards to this method of testing is the best way to determine that they will perform as expected it is not really practical. This paper, “Exposure of Magnesium Oxide Boards to Various Conditions for Extended Durations” can be accessed here.[1]

Here are a few ways that you can easily determine if your boards should perform adequately over time, of course, following best practices is a given for achieving desired outcomes with all building materials.

### Water content / Density.

It is critical that the manufacturing process uses the correct molar-ratio of water, magnesium oxide and magnesium chloride or sulfate. One easy way to get an indication of this is to conduct an oven-dry test to measure the amount of “free” water in the boards after curing. Free water is not chemically bound in the cement matrix and will easily evaporate if the sample is kept in a warm and dry environment until its weight does not change.

To conduct this test cut samples of your board, measure them accurately to 1mm or less to determine their volume, width x length x thickness, knowing this will allow you to determine the boards density and to compare it to other coupons being tested.

Weigh the sample to the nearest gram or less, obviously the more accurate your measurements the closer the result will be to its actual free-water content.

Place the samples in an oven set to 60 to 70 degrees C or around 150 degrees F. This temperature must not approach the boiling point of water, so if you are at altitude adjust the temperature to ensure that water will not reach the boiling point as this will cause the chemically bound water to also evaporate.

Keep the samples in the oven until the weight does not change, this may take hours, or overnight. Take the samples out of the oven and allow them to cool in a desiccator or well- sealed container so they won’t absorb moisture from the environment. Weigh the dry samples and deduct this weight from the original wet weight. This will determine the weight of the water that evaporated and its dry conditioned density. Divide the weight of the water by

[1] https://www.sciencedirect.com/science/article/abs/pii/S0950061821021875?via%3Dihub

the weight of the dry board and multiply the result by 100, this is the percentage of water in the wet board.

Weight of water / weight of dry board X 100 = water content %.

Well-made boards that have been properly cured should have a free-water content under 8%. If the boards have been stored in an area of high humidity they will absorb extra moisture, and this should be considered when evaluating your result. The newer the boards the more relevant this test will be.

If the boards have excessive moisture, and we have tested boards with greater than 25%, they will have greater hygro-thermal movement (shrinkage and swelling) and are more likely to have issues with excess free chloride or sulfate ions, cracking or splitting and cement decomposition. Adding water to chloride ions will create acids, which can also degrade the reinforcing mesh.

## Density

Determine the volume of the dry coupon in cubic cm and divide into its dry weight in grams, the result should be between 0.9 and 1.2 gr/cc for most boards, the density of each sample should vary by no more than 0.5%.

Weight / volume = density (gr/cc, kg/cm)

## Shrinkage

Using the samples from the water content test measure the length/width of dry conditioned samples and compare to the original wet dimensions to determine the change in dimension/shrinkage and divide the amount of shrinkage by the dry dimension and multiply by 100 to obtain the shrinkage percentage, which should be less than 0.3%

Wet dimension – dry dimension / dry length x 100 = shrinkage %

## Simple flexural breakage test

This is an easy and fast test to conduct. Well-made boards will not break when “bounced”. Have two workers hold a full-size board flat at the 4-foot ends. Bounce the boards causing the middle to bow up and down a few times.

Well-made boards will pass this stress test while poorly made boards will break. If you have boards that break discard them, do not use them for any structural purpose. It has been shown that it is possible for some boards in a lift to be non-compliant while others in the same lift are acceptable. We believe that this could be caused by poor mixing or curing.

OEM users who use the boards to make insulated panels or cladding need to handle every board and this process is in itself a rudimentary quality test. If you find boards that break easily it would be best to conduct additional tests on boards in the same batch that pass this stress test.

## Visual Appearance

### Pinholes

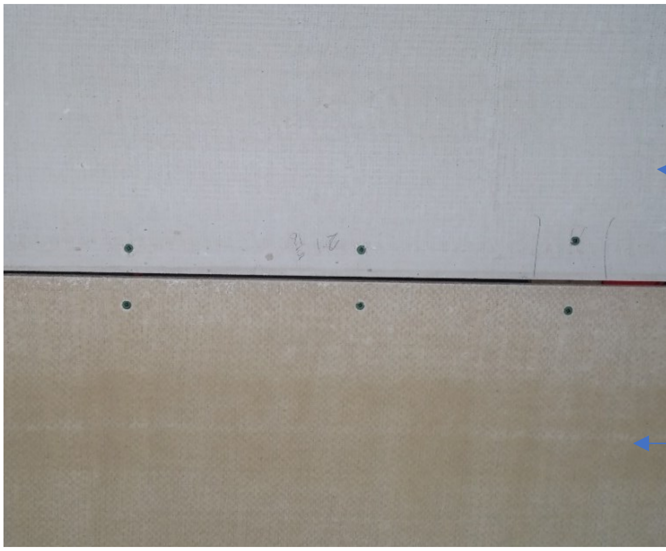
Well-made boards will have a uniform appearance with few, if any, surface pinholes and / or voids. The pinholes are an indicator of manufacturing problems as they have been found in the smooth surface on boards that perform poorly in other tests. A few scattered holes is not likely to be a large issue but if you find groups of them and more than a few per board be careful how you use these boards.

We have found it extremely difficult to fill these holes, they seem to be larger below the surface and re-appear after several coats of paint and have failed to fill even when an appropriate filler is applied.

*Figure 1 Too many pinholes*

## Color

The color of the boards should be uniform with no blotchiness, boards without colorants added should be a uniform off-white color. Boards that have fly-ash added to enhance water resistance would be a light gray color.



Two boards from the same shipment, this is the correct color.

Boards with this tan color are more brittle, generally not a high-quality board.

**Figure 2 Board color variance**

Failed boards removed after 2 months service, notice the brown color and blotchy appearance. Excess chlorides turn boards brown as they react.

**Figure 3 Failed boards.**

## Reinforcing Mesh

The mesh used in the boards manufacture provides tensile strength, improves impact resistance and is critical to the board's performance. The warp and weft of the woven fiberglass mesh should be aligned parallel to the edges of the boards. Although the cement may be well formulated and cured if the mesh is miss-aligned the boards will exhibit lower tensile strength and this is an indication that the manufacturing process quality control is lacking.

General use boards may have a non-woven fabric under the smooth slurry coat and a woven structural mesh on the rolled back surface or embedded between the third layer of stucco on sanded-back boards. Structural use boards should have woven mesh on both surfaces and in some cases also in the middle of the boards. Increasing the number of layers and gauge of the mesh will increase its bending strength. We have found that boards with good bending strength that have poorly formulated cement and rely almost entirely on the mesh. This is not a good board overall.

In addition, we know that poorly formulated boards with excess water content and / or leachable ions can cause the mesh to become brittle and in some cases dissolve, obviously these boards will not perform as desired over time.

The mesh in this failed board is obviously poorly laid. Boards were removed from the project resulting in a lawsuit.

*Figure 4 Wavy mesh*

## Voids and fish mouths

Looking at the edges of the boards while stacked in the lift you should see few to no large voids in the board core cement matrix. Some well-made boards use aeration to reduce the weight and these “bubbles” should be regularly spaced throughout the boards. Large voids indicate poor manufacturing processes and would result in non-predictable strength and fire-resistance. Obviously more porous boards will absorb more moisture and should be used primarily for low strength interior applications.

If you see gaps greater than 1mm between the edges of the boards as they are stacked in the lift it is an indication that the boards are not as stable or “balanced” as they may otherwise be and may be more susceptible to creep or warping. We have seen these gaps greater than 2 or even 3 mm in the bottom of lifts with other lifts stacked on top. As each lift would weigh 3,000 lbs. or more It is clear that no amount of easily applied pressure will cause these boards to flatten.

If you require boards that are perfectly flat it is best to add this requirement to the order specifications and to consider using sanded back boards.

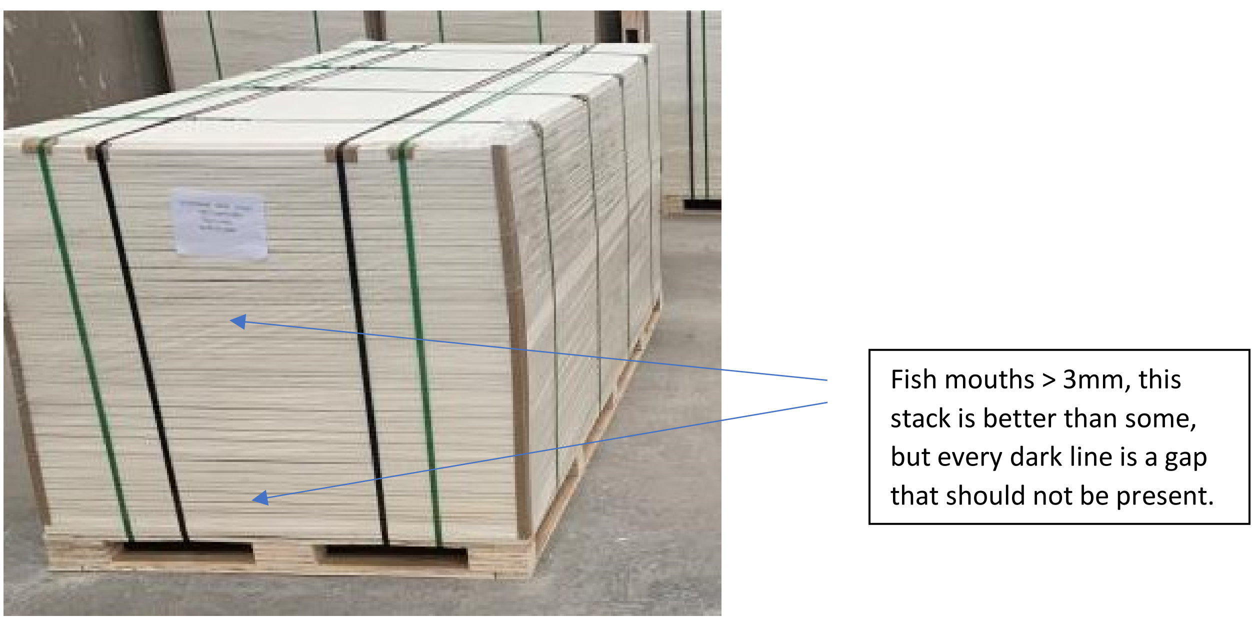



**Figure 5 Fish mouths**

## Wet and dry bending tests

One of the QA tests MOCA uses is the comparison between saturated and conditioned bending strength tests. These 2 results should be within 20%, i.e. saturated boards should be at least 80% of the strength of conditioned boards. As the name suggests take 2 samples from the same board, preferably not from an edge, saturate one set by submersing in water for a day and the other set in the oven to dry being careful to keep the temperature well below the boiling point.

Using a 3-point press assembly or simply by adding weights to samples mounted over 2 supports, load the samples until the sample breaks and compare the loads. If the saturated boards carry less than 80% of the dry boards loads, they should be considered suspect and subjected to additional tests.

## Halogenation

This is a common test conducted at all reputable factories and with a bit of effort it can be performed anywhere. It will indicate higher than acceptable levels of chlorides without the need for extensive laboratory testing. The process is to place coupon of boards flat into a controlled environment kept at 30 to 35 °C with 90 to 95% humidity for 72 hours. If the boards develop "salty tears" on the bottom surface, you have a problem as your boards are not suitable for most uses.

## Conclusion

Magnesium oxide cement boards can provide solutions for common construction issues that other materials cannot. They should become part of many assemblies that require resistance to stresses from water, fire, lateral and transverse loading, mold and to limit sound transmission. Always purchase boards from reputable suppliers who can provide current test reports for leachable ion content and that have passed the appropriate material property tests. MOCA subjects every batch to a series of 8 tests conducted at an ILAC certified lab, a process that costs less than $1,000.00. Money well spent in our opinion. These tests include.

Water content, chloride ion content, wet and dry bending strength, screw pull-out, halogenation, shrinkage, and density.

If you encounter issues feel free to contact MOCA, as it is one of our objectives to limit the use of non-compliant boards, thereby protecting the market and increasing the use of regulated boards in construction. We invite you to join MOCA and to assist us in these endeavors.