By Michael Chusid, RA FCSI

Testing the Strength of CEILINGS

When selecting acoustic lay-in panels for a suspended grid ceiling (dropped ceiling), there are more properties to consider than just acoustical performance. The panels need to be robust enough to resist damage and deterioration, in order to maintain both their performance and appearance. If the ceiling panels are not strong enough to survive installation and normal use, they will need to be replaced frequently, hiking up the building owner's cost of the ceiling several fold.

Fortunately, the task of determining the strength and durability of ceiling panels has been figured out by a group of industry leaders working together under the auspices of ASTM International. This volunteer committee created a standard for testing the strength of ceiling panels – ASTM C367 *Standard Test Methods for Strength Properties of Prefabricated Architectural Acoustical Tile or Lay-In Ceiling Panels.*[1]

The standard stipulates methodologies for evaluating four different strength properties that provide a basis for comparing products. While ASTM points out that laboratory test results do not necessarily indicate performance under actual conditions of use, the test results do provide insight into how well panels will resist damage during handling, installation, maintenance and ordinary use. The four tests are:

Hardness: This test measures the force required to press a steel sphere into a panel. It has direct correlation to hardness and usually indicates impact and abuse resistance. This test is referenced in product literature for several ceiling panel products from major manufacturers and is especially important for ceilings that may be subject to abuse.

Friability: To measure the potential for a product to crumble or erode, small specimens are placed in a rotating tumbler, then taken out and weighed after 10 minutes and again after 20 minutes. If the specimens weigh less than when they started, it is because part of the material has been worn off by tumbling. Specimens that lose the most mass are more friable and prone to damage, especially at the corners and edges. It could be useful to compare the degree to which particular products may be damaged in handling, such as during shipping, unpacking, installing or later during above-ceiling maintenance. Friability is especially a concern with some types of ceiling panels that contain fibers such as silica fibers that may become airborne if they wear off, and can cause respiratory and other health problems.

Sag: Panels are exposed to elevated temperature and humidity, then returned to ambient room conditions, and then are measured for sag. Sag is a well-known problem, to such a degree that manufacturers specifically tout the sag resistance

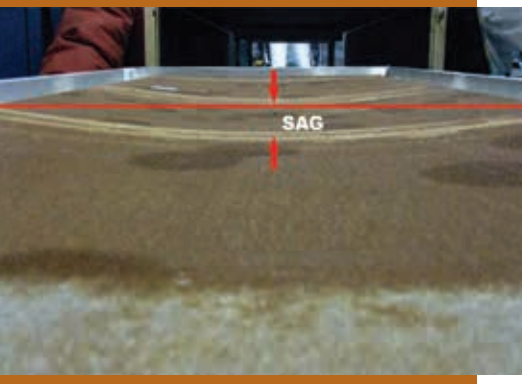
Friability test samples, (Left) mineral fiber panel specimens before testing; (Center) mineral fiber panel specimens after 20 minutes of testing; (Right) thermoformed panel specimens after 20 minutes testing (largely the same as before testing).

PHOTOS COURTESY OF CEILUME

Mount Holyoke College
Credit: Chun Y Lai Photography

Understanding the strength of ceiling panels makes it possible to combine several types of compatible panels on the same project.

Bavaria Downs
Credit: Brian Bossany



The sag test exposes ceiling panels to high humidity and heat, then returns them to normal levels, and measures how much the panel has permanently sagged. It gives a means to quantify the sag resistance that is claimed for some ceiling panels.

Transverse strength testing of a mineral fiber ceiling panel, a test with potential to reveal which products are more prone to breaking during handling.

of some products. Sag can occur due to high ambient humidity, failure or shutdown of building air conditioning systems, condensation and leaks.

Transverse Strength: Panels are tested in a hydraulic testing machine, supported on two edges and pressed down in the middle. The load at which the panels break (or are unable to resist more load) is recorded. The greater the modulus of rupture (flexural strength) the less likely the panel is to be damaged in the field. Panels that break during shipping and handling increase an installer's costs and may lead to inconvenient call-backs.

The tests defined by the standard do not have pass/fail criteria. Instead, the standard simply provides test methods that produce numerical results that can be considered by specifiers and contractors. There is no overall number that encompasses all four tests. The results of any one test can be used to compare products, however, and gain some understanding of their relative robustness. Products that are more friable, for example, are more likely to be damaged during handling, and may have to be replaced. Products that are more prone to sag may be less desirable in hot and humid environments.

IF CEILING PANELS ARE NOT STRONG ENOUGH TO SURVIVE INSTALLATION AND NORMAL USE, THEY WILL NEED TO BE REPLACED FREQUENTLY, HIKING UP THE TRUE COST OF THE CEILING SEVERAL FOLD.

Of course, these tests are only useful for comparison if potential buyers can access the results. ASTM C367 is used by a number of the major manufacturers of ceiling panels. They have, apparently, performed some or all of these tests, because they refer to the results in sales literature for some products.

THE 4 STRENGTH PROPERTY TESTS:

1. Hardness
2. Friability
3. Sag
4. Transverse Strength

However, very few manufacturers publish the complete test results for their products. More often, product literature cites one specific test, such as a panel sold for abuse resistance that publishes the hardness test result, but none of the others. Some of the product verbiage just makes oblique reference to the standard, such as "... more impact resistance than typical fine-textured ceiling panels (ASTM C367) ..." which implies that the testing has been done for both the panel being promoted and the "typical fine-textured ceiling panels." Because numerical values for the tested products are not reported, we cannot assess whether the difference between the products is significant or only minimal.

"PERHAPS IF MORE PEOPLE REQUESTED STRENGTH TEST REPORTS, MORE COMPANIES WOULD MAKE THEM AVAILABLE."

From these references, we know that the testing has been done, but getting to see the results appears to be difficult. One product rep, when asked if he could forward the test report, replied that *even he* didn't have access to it and was unable to provide further information.

One manufacturer has published complete ASTM C367 results, apparently the only publicly available example of full results for all four tests. They are a maker of thermoformed acoustic panels. They also tested mineral fiber acoustic panels from a major manufacturer for comparison. Thermoformed panels are made of very different materials than mineral fiber panels, and the test results show the difference clearly.

The results show the products' relative performance, which could be useful in evaluating which is better for a given situation. To determine the best ceiling for a job, those aspects should be weighed along with the other major considerations, acoustic performance and aesthetic appearance. If more customers making product selections requested the ASTM C367 test reports for products they're evaluating, the data might become more readily available, and be put to good use.

PROPERTY	AVERAGE		NOTES
Hardness, lbf			
Thermoformed	8823		
Mineral Fiber	132		
Friability, % mass loss	10 minutes	20 minutes	
Thermoformed	0%	0%	
Mineral Fiber	8.7%	13.5%	
Sag, inch	Permanent Sag (After recovery)		
Thermoformed	0.096 inches		Not visible at normal ceiling height.
Mineral Fiber	0.764 inches		Sag would be visible at normal ceiling height.
Traverse Strength (Flexure)	Break Load, lbf	Modulus of Rupture, PSI	
Thermoformed	Didn't break	At yield 1298 psi	Panel didn't break but did bend.
Mineral Fiber	5.6 lbf	78 psi	

Tested by PRI Construction Materials Technologies LLC per ASTM C367 — Strength Properties of Prefabricated Architectural Acoustical Tile or Lay-in Ceiling Panels. *Courtesy, Ceilume*

Thermoformed panels, which are impervious to water and not absorbent, did well on the sag test.

Note:

1. *The full number of the standard is ASTM C367/C367M-16(2021), indicating that the current edition of was issued in 2016 and reaffirmed in 2021. Previous versions of the standard have been published since 1978. See www.astm.org/c0367_c0367m-16r21.html.*

PHOTOS COURTESY OF CEILUME