Testing + Evaluation

Taking the Measure of Polished Concrete

A new standard may hold the key to uniformity in polished concrete floors.

By Christopher Bennett, Husqvarna

"Measure what is measurable, and make measurable what is not so."

That advice comes from Galileo, often noted as the father of modern science.

Unfortunately, this sound guidance has not always been heeded in the exposed concrete flooring industry.

Many products and systems claim to solve the persistent problem of varying, unpredictable results on polished concrete floors. There's little "concrete" evidence, however, to support one manufacturer's claim versus another's.

"Grit" is often used to rate gloss values of polished concrete floors. It's been the main method for communicating design intent for well over a decade. While the term "grit" is a common and even useful reference to describe gloss levels, it has not been able to precisely define the polish level on any proven, acceptable, repeatable scale.

This means that a specified 800-grit finish, for example, can vary widely in appearance from one floor to another, based on diamonds used, or even finish coats. Whether or not the contractor has actually delivered the 800-grit finish has sometimes been a matter of opinion and even legal dispute.

The Concrete Sawing and Drilling Association (CSDA) believes that gloss levels shouldn't be a matter of opinion, but should be based on measurable, quantifiable standards.

To that end, the organization published CSDA ST-115 in October 2013, a quantitative standard on measuring roughness averages (Ra). The idea is that such a standard can help design professionals specify by measurable numbers their expectations for concrete floor finishes, and not leave them at the mercy of

An installer uses a T-meter to take an Ra (roughness average) reading on a concrete floor following wet grinding. Photo courtesy of Adaptive Concrete Innovations.

This polished overlay measures at 32 µin (microinches), an ST-115 surface grade texture of B-2, or low polish, equivalent to an 800-grit finish. The difference is that the surface grade texture is measurable. Photo courtesy of CTS Cement | Rapid Set.

someone else's interpretation of their specifications.

To date, ST-115 is the only tool I know of that offers the design community quantifiable, scientific, and perhaps most importantly, repeatable results.

A Question of Reflectivity

I'm not saying light meters or distinction of image (DOI) meters are useless. On the contrary, they are important tools and I include their use in my specifications, but they have limitations. A light meter can tell you how much light a floor reflects, but it can't tell you why that light is being reflected. Is it reading a true diamond-polished concrete floor? Or is it reading a clear-coat epoxy or acrylic sealed floor?

A DOI meter can tell you how sharply an image is reflected in the floor, but again, it can't tell you if the floor is actually polished to spec.

An architect, for example, walks through a facility, conducting a punch-list inspection. She sees the concrete floor has a shine and the DOI or gloss meter numbers line up with the specification. She still has no way to verify that the concrete floor is polished to the level she specified and for which the client paid.

Is the floor glossy because it was polished as specified? Was the floor polished as specified, but the gloss is not what the architect expected? Was the floor not polished as specified, but a glossy coating was applied to hit the gloss or DOI meter numbers?

By measuring the roughness or smoothness of the finished floor as described in ST 115, the CSDA standard looks to answer these questions.

Sea of Diamonds

To understand why polishing with an 800-grit resin pad doesn't necessarily equate to a specific finish level, we need to look at how the flooring industry manufactures diamond tooling.

Diamond tools are composed of tiny industrial diamonds for an abrasive, and the matrix that holds those diamonds in place on the pad or puck, similar to sand on sandpaper. Matrixes can be made from resins, different types of metals and alloys, ceramic materials, and even combinations of metals and resins.

Diamond tools come in many different shapes, sizes, weights and diamond ratios. Each of these products leaves a different scratch pattern and affects the slab in its own way. Diamonds in softer metal matrixes wear differently against concrete than those in harder metals. The shape of the diamond segment also creates its own individual scratch pattern on the slab.

The way a circular segment affects the floor differs from a square- or diamond-shaped segment. Having more or fewer segments also affects the diamond tool's performance because of the increase or decrease of surface-area contact with the slab.

However, let's say that two manufacturers have identically shaped tools and the exact same metal alloy matrix. I'll go one step further and say that the industrial diamonds come from identical sources and that each pad's grit size is identical. Some manufacturers use various grit sizes of diamonds and average them to label their diamond tool "100 grit" or "200 grit," for instance. It doesn't necessarily mean that every diamond in that tool is actually the same size or grit.

Can these two identical tools still be different?

Yes. If one manufacturer has fewer diamonds in the matrix, it will create a different scratch pattern than its counterpart with more diamonds. It will probably take longer for grinding and polishing with that tool, as long as the matrix holds out.

The takeaway is that even two nearly identical diamond tools will have significant variations in performance. Add in the other variables — different shapes, sizes, matrix types and number of segments — and the performance variation increases again.

Measured for roughness average after every pass of grinder and polisher, this concrete floor in a high-end New Orleans grocery store shows an ST-115 A-2 finish, equivalent to 5,000 grit. Photo courtesy of Prep and Polish Consultants LLC Dallas, Texas.

All these diamond tools will affect their floors differently and create different results. Despite this, they can all have identical labels.

The point here is that there are no standards for manufacturing diamond tools. For years architects and designers have called for the same 800-grit finish floor and wondered why the results were different every time.

Contractors have wondered why one manufacturer's 400-grit diamonds produce higher gloss than another manufacturer's 800-grit diamonds. Those are legitimate questions, but they're the wrong questions for solving the problem of unstandardized results.

Why not simply measure the floor?

ST-115 turns the focus on what can be measured and quantified.

This concrete floor test panel in an under-construction Minneapolis-based corporate headquarters displays a roughness average of 2 µin (microinches), or an A-1 surface texture grade, the highest level of refinement on the ST 115 surface texture finishes chart. Photo courtesy of Ryan Companies of Minneapolis.

Roughing It

The CSDA standard is a first step in measuring concrete surface texture values. The standard describes a floor's level of mechanical refinement with an Ra or "roughness average" number. It examines the real value of small-scale features on concrete surfaces to create benchmarks for various gloss levels.

If we can measure and analyze the surface texture of a floor, we can begin to understand how the finishing process influences the texture. That provides a tool for architect and contractor alike to communicate specific design intent clearly and concisely.

A concrete slab begins its journey from rough to refined. The Concrete Sawing and Drilling Association hopes to bring uniformity to grinding and polishing with a new standard that focuses on measuring surface roughness. Photo courtesy of Husqvarna.

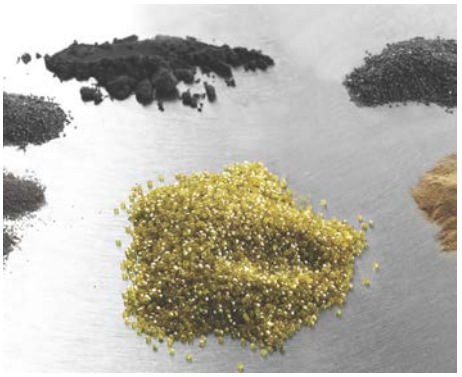
Everyone has seen the specification that reads "polish to a 400-grit finish."

You could interpret that as an acrylic topcoated floor burnished, rather than ground and polished, with a 400-grit diamond-impregnated pad.

You could also understand it to be a multistep bonded abrasive polished concrete (BAPC) floor as described by the Concrete Polishing Association of America, which is likely more in keeping with the spec's intent.

Legally, both floors match the specification. Both will likely exhibit similar glossmeter numbers, at least while new. However, the BAPC is the sustainable, low-maintenance, energy-saving polished concrete floor that the designer and owner seek, or at least close to it.

It is also the floor that validates the claims of many manufacturers' reps about polished concrete. However, the first approach has a lower installation cost. Come bid-time, the contractor who bids the less expensive, less durable floor type, often wins.



These industrial diamonds, in sizes from sand to pebbles, are used in many applications, including as abrasives on concrete grinding and polishing pads. Photo courtesy of Husqvarna.

Then the architect and client are left scratching their heads when the gloss is prematurely gone. The client is less inclined to trust the architect, and the architect is less inclined to trust diamond-polished concrete floors.

This isn't to say that acrylic floors are bad, but rather to point out the difficulty in precisely matching a specification to a finish in the current environment. Sometimes you need a glossy clear coat on the floor,

but that shouldn't be a low-cost substitute for a specified and paid-for level of polish.

What's Good Enough for Steel

The measurement basis of ST-115 is Ra (roughness average). It's measured with contact stylus instruments. This is not new technology.

Surface-finish height parameters have been in use for many years with other surface materials. In the steel industry, for instance, steel surfaces often get abrasive cleaning before being coated with protective treatments. The surface profile resulting from the cleaning has to be accurately assessed to ensure compliance with specifications.

On concrete, these surface profile measurements can tell how the surface was processed as well as how it was finished. Waviness, lay and process direction are all part of the aggregate measurements that determine the Ra numbers. Quantifying the geometric irregularities of a mechanically refined floor at various levels provides a way to describe the exact means and methods to produce the floor the architect or owner asked for in the first place.

This view of the undercarriage of a half-ton planetary grinder shows the main disc, which rotates in one direction, and the three smaller discs attached to it, which rotate in either the opposite or the same direction. This configuration helps avoid swirl marks on concrete. Diamond abrasive pucks for smoothing concrete floors attach to the smaller discs. Photo courtesy of Husqvarna.

Handheld profile meters, available from many manufacturers, are easy to use, says Andy Bowman, Adaptive Concrete Innovations, Rose Bud, Ark. Bowman led the 17-member committee of industry professionals that drafted ST-115 beginning in 2011.

He explains that you simply meter the floor behind each pass of the grinder or polisher to see what your Ra is in microinches (µin).

ST-115 includes a "surface texture finishes chart" comparing Ra microinch measurements to surface-grades. An Ra measurement of 8 µin, classified as an A-3 surface texture, for instance, equates to a high polish, while a 125 µin is honed, and a 250 is ground.

The standard's Comparative Analysis Chart matches surface texture grades to gloss and DOI meter readings and grit

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A surface roughness tester measures the texture of a polished concrete floor at 8 µin (microinches), an A-3 on the ST-115 Surface Texture Finishes Chart, equivalent to a 3,000-grit finish. Photo courtesy of Ardor Solutions.

finishes. That high-polish A-3 surface texture equates to a gloss meter reading of 75-80, a DOI meter reading of 80-plus, and a grit-finish of 3,000.

Though fairly simple, Bowman says the CSDA offers a four-hour class on the non-proprietary system for measuring the Ra of concrete floors, usually folded into manufacturer certification courses.

CSDA offers the 11-page standard free as part of the organization's 2014-2015 Resource Guide.

Diamond tooling manufacturers can get in on the standards conversation as well. A third-party audit of pads can certify them as being able to produce a specified surface texture. Certified accurately and independently by ST-115 standards, designers and installers can then depend on the pad to deliver the specified results every time.

When designers, installers and manufacturers speak the same numeric language, and clients can depend on them to deliver verifiably uniform results every time, the industry can only benefit.

About the Author

Christopher Bennett is a former U.S. Navy Chinese linguist enjoying his new life in the construction industry. He's in his fourth year as a specifications consultant at Husqvarna Construction Products, and in his second year as a member of Husqvarna's rock and blues band. Bennett is an active member of the Portland, Ore., CSI chapter and a Concrete Polishing Association of America board member. He and his wife recently celebrated the birth of their first child, a daughter. D+D