Amid a Silicosis Surge, We Need to Rethink Countertops

Engineered stone countertops may be causing a spike in lung disease, with cases seemingly tied to the material's unique properties. Find out what design and construction teams should do—and why.

by Elizabeth Waters

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Compliance with silica safety standards within the construction industry has always been low, and we should never assume workers are wearing the required PPE. Many construction activities (such as that pictured above) expose workers to silica, but the dust from engineered stone seems to pose a heightened risk of silicosis.

Grinders' asthma. Stonecutters' consumption. Potters' rot. Silicosis.

Lung disease from breathing in dust is one of the oldest and most lethal occupational hazards for people working in the building trades. According to a "A Short History of Occupational Disease," an article published by the Ulster Medical Society in 2021, evidence of silicosis dates back to antiquity.

In the centuries since, silicosis has flared up in industries around the world. But a recent epidemic tied to engineered stone seems to suggest that this human-made material carries unique risks.

The disease began popping up within the last decade in people who fabricate (processes include cutting, grinding, drilling, and polishing) and install engineered stone countertops in countries includ-

ing Spain, Israel, Australia, and the United States. The incidence of cases—and deaths—among engineered stone workers in the U.S. has risen sharply, with the highest concentration occurring in California among young Latino men.

In response, the U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) launched an initiative in September 2023 to improve oversight of the material's fabrication and installation. Two months later, Australia voted to ban the use, supply, and manufacture of engineered stone (the law takes effect in July 2024), and the State of California approved an emergency temporary safety standard targeting the industry. Los Angeles County, which is experiencing the highest concentration of silicosis cases in California, is considering a ban on engineered stone.

So what's going on with silicosis and engineered stone? What do project teams and contractors need to know before specifying and installing it?

Should we be using engineered stone at all?

Silicosis is caused by a very common mineral

Silicosis—so named by Italian physician Achile Visconti in 1871—is a progressive, incurable, and sometimes fatal lung disease caused by breathing in respirable crystalline silica (RCS). Silica—or quartz—is one of the most common minerals on Earth, found in most rocks, sand, and mineral ore. When silica dust is inhaled, miniscule particles embed themselves deep in lung tissue and cause scarring. This scarring, which can worsen even after exposure ends, leads to suffocation over time.

According to "A Brief Review of Silicosis in the United States," published in *Environmental Health Insights*, there are three forms of silicosis:

- **Chronic**—the most common form; occurs after a decade or more of exposure to relatively low levels of silica
- **Accelerated**—develops after five to ten years of exposure to high concentrations of silica
- **Acute**—the rarest and most lethal form; results from short but extremely significant exposure

People have contracted silicosis—and described its symptoms and connection to dust inhalation—for as long as they've cut, sanded, polished, and built with stone.

But serious exposure and disease became much more widespread with the onset of the industrial revolution, when high-powered tools and processes started creating more and finer dust, and the mining industry boomed, ushering in a whole new scale of rock and mineral excavation. (Even so, medical science didn't officially define silicosis until 1930, at the International Labor Organization (ILO) Conference in Johannesburg.)

In the U.S., deaths from silicosis peaked in 1968 at more than 1,000 per year and have been in an overall decline since (to under 200 per year in the mid-2010s). Yet silicosis remains a significant occupational hazard in the U.S, with approximately 2.3 million workers—2 million of them in construction—exposed to silica in the workplace.

What is engineered stone?

Engineered stone (also called artificial stone or quartz agglomerate) was invented in Italy in the 1960s and is made with about 90% crushed quartz and various additives bound together by a polymer resin. Countertops made of engineered stone, which are marketed as more durable, stain resistant, cleanable, and affordable than those made of natural stone, took off in popularity beginning

in the 1990s. According to a 2019 study by the U.S. Centers for Disease Control and Prevention (CDC), U.S. imports of engineered stone countertops increased by about 800% between 2010 and 2018. And consumer demand is likely to keep growing, with Freedonia Group projecting a 9.3% annual rise through 2027.

Engineered stone has a higher proportion of silica content than most natural stone. Quartz dust—respirable crystalline silica—is the culprit in silicosis, so engineered stone countertops, made of at least 90% quartz, contain at least 90% silica. According to OSHA and the National Institute for Occupational Safety and Health (NIOSH), although this level of silica is comparable to the content of some natural stones—e.g., quartzite (95%) and quarzitic sandstone (90%)—it is significantly higher than the typical silica concentrations in most natural stone, including sandstone (60%), granite (10%–45%), and calcium-based stones (e.g., limestone and some marbles) that contain little or no silica.

Although engineered stone countertops do not put building occupants at risk of silicosis once installed, people who work in factories and shops that fabricate these products are at very high risk, as are people on jobsites where they're installed.

For those workers, RCS is an ever-present hazard—and it's serious enough that OSHA prioritized it immediately after the agency was created in 1971. Regulators initially required employers to reduce silicosis risk by limiting dust concentrations in the air. OSHA has since then significantly reduced allowable levels in the air and has also expanded compliance options to include prescriptive protocols, like wet-cutting methods and respiratory protection for workers (see sidebar).

Questions remain, however, about whether the controls that appear to work for natural stone adequately mitigate the risks of engineered stone.

Silicosis outbreaks among engineered stone workers

As the craze for engineered stone countertops heightened, a few countries began reporting increased silicosis cases among stone fabricators, most of whom worked with engineered stone. A screening begun in Queensland, Australia, in 2018 for instance, showed that 98 stone fabricators out of 799 tested had silicosis as of early 2019.

Also in 2019, as reported by the CDC, a cluster of 18 silicosis cases— including two deaths from the disease—appeared across California, Colorado, Texas, and Washington. Since then, cases in the U.S., many of them classified as "accelerated," have continued to increase.

Almost all diagnosed workers in the U.S. have been Latino immigrants—who, as the CDC describes, can be "especially vulnerable to workplace health hazards" because they may lack access to healthcare and employment options, and could face retaliation from employers for filing workers' compensation claims or reporting workplace violations. A 2023 *JAMA Internal Medicine* study, which analyzed cases in California of 52 patients with silicosis (51 of whom were Latino), reported that 45% of its subjects continued their work after their diagnosis. The authors warned that approximately 100,000 stone fabrication workers in the U.S. could be at risk of the disease and that exposure to high levels of silica dust can cause accelerated and acute silicosis.

"More than the national divide between countries," write the authors of a 2022 *Respirology* article, "workers' status on the job market has always been key to determining their exposures." They argue that stably employed, skilled workers tend to benefit from national prevention and compensation programs, whereas "workers with insecure jobs,

OSHA's long, slow march toward silica protection

OSHA was created in 1971, and, according to a brief history provided by the agency in a 2020 update to its instruction for the 2017 silica National Emphasis Program, almost immediately established a permissible exposure limit for respirable crystalline silica in the workplace—250 micrograms silica per cubic meter of air for construction, calculated as an eight-hour time-weighted average. To enforce the silica exposure limit, OSHA launched a Special Emphasis Program in 1996 and the first National Emphasis Program in 2008, the latter directing each region to focus 2% of total annual inspections on silica.

But compliance within the construction sector lagged, and in 2015, OSHA and NIOSH issued a joint hazard alert about silica in the stone fabrication industry.

The following year, OSHA published its final rule on silica—which had been on the agency's rulemaking priority list since the '90s. Composed of two separate standards (one for construction and one for general industry and maritime), it lowered the permissible exposure limit to 50 micrograms (so a lower concentration in the air) and established an action level of 25 micrograms of silica per cubic meter of air—one tenth of the original exposure limit.

The construction standard requires employers to mitigate their employees' exposure to silica by either implementing a prescribed combination of engineering controls (wet-cutting methods, dust collection systems, and ventilation), work practices, and respiratory protection for dust-generating tasks or by ensuring the silica exposure level of each at-risk employee remains at or below 50 micrograms.

often immigrants, working in small businesses in the 'informal sector,' are often subjected to more intense exposures as a result of limited regulatory protections."

BuildingGreen spoke with Eric Berg, deputy chief of health at the California Department of Industrial Relations about the issue. "We became aware in the last couple years there was a silicosis epidemic throughout the world and also in California," he reflected. The cases, he said, "really shot up in 2019," adding that since then, "there's been over a hundred cases that we know of." The increase in cases, he noted, "follows the market increase in use of artificial stone."

Prior to the engineered stone countertop boom, Berg continued, silicosis cases in the stone fabrication industry were "pretty rare … maybe one or two a year, or up to five, max." That said, he acknowledged that many cases had likely gone undiagnosed or had developed later in workers' lives and weren't linked to workplace exposure. "Now," he said, "it's hitting people in their 20s."

Berg explained that California had copied OSHA's 2016 final rule, but "silicosis continued to be a problem even after the new regulations, and it was difficult to enforce. Things could be manipulated, so we couldn't enforce it."

In response, he said, California's Division of Occupational Safety and Health (Cal/OSHA) rolled out a Special Emphasis Program in 2019 and 2020, the state's first systematic evaluation of RCS exposure, to evaluate and enforce compliance with safety regulations in the stone fabrication industry. According to the program report, Cal/OSHA conducted personal air sampling, done by attaching a sampling device to workers within their breathing zone, to measure the silica exposure of 152 workers in 47 shops.

The agency found that a quarter of total air samples taken—across half of the shops inspected—exceeded the silica PEL, with the highest concentration found to be 13 times above the limit. Further, almost three-quarters of the employers whose sites were tested were out of compliance with the state's silica standards (by not conducting exposure assessments, communicating silica hazards to employees, or providing medical screenings), and more than half were not complying with its respiratory protection standard (which requires employers to develop a respiratory protection program that includes procedures for proper respirator use).

According to Cal/OSHA, the state silica standard is best suited to large companies because it relies on employers to perform technically sound exposure assessments to determine required exposure controls. Small businesses (which make up most of the stone fabrication industry) often lack the capacity or willingness to do this. Plus, the standard includes loopholes that enable companies to exempt themselves from complying.

In discussing the findings of its Special Emphasis Program, Cal/OSHA emphasized that improved compliance with existing safety standards, employee education, and research would be necessary to reduce the risks from engineered stone. Regulators also cautioned that, given the high exposure levels and the widespread lack of compliance with safety standards, relying on "engineering, administrative, and PPE controls to adequately protect workers" may not be sufficient.

Dust from engineered stone might also be uniquely hazardous. As Berg explains, airborne particles of engineered stone "tend to be smaller" than those of natural stone, which makes them more respirable, and also "angular, which makes them more dangerous." Furthermore, because these particles are embedded in polymer resin, Berg noted, when the engineered stone is cut or ground, the particles get "grouped to-

The rule offers employers two options for assessing exposure: performance and schedule monitoring. For the former, employers may use any combination of "objective" data (industry surveys or calculations) and monitoring data to demonstrate individual employee exposure levels, while the latter requires monitoring of each employee (which must be repeated if initial exposure levels are above the 25-microgram action level). However, if an employer's initial monitoring shows levels to be below the action level, they are exempt from any further testing.

OSHA also set parameters for housekeeping practices, requiring employers not to dry sweep, dry brush, or use compressed air to clean when doing so would kick up dust—unless safer methods (e.g. wet sweeping or HEPA-filtered vacuuming) are not feasible.

Finally, employers must develop, implement, and train employees on a silica-exposure control plan; provide at-risk employees with medical screenings every three years; and keep records of measurements, exposures, and screenings.

To enforce the rule, OSHA initiated a replacement National Emphasis Program in 2017, requiring that states comply or develop their own equally stringent program.

Still, close to 20% of air samples taken by OSHA in 2017 and 2018 exceeded the PEL, the agency noted in the emphasis program's instruction document.

gether with chemicals that can be lung irritants." Combined, these factors likely make the effects of engineered stone dust worse than the dust of natural stone.

Berg insists that engineered stone can be fabricated and installed safely—but, he says, it's an exceptional product that "requires additional measures. There are shops doing the work, but they're in the minority and were going above and beyond" the standard.

So, what's being done?

The U.S. federal government, the state of California, and Australia have each taken steps to address what Berg called "the silicosis epidemic."

In September 2023, OSHA began an initiative, supplemental to its current emphasis program, targeting enforcement of existing silica safety regulations and assistance with compliance. "The highest silica levels are associated with manufactured countertops, where crystalline silica is mixed with resins, adhesives, and pigments," said an OSHA memo. The initiative targets two sectors (brick, stone, and related construction material merchant wholesalers; and cut stone and stone product manufacturing), within which OSHA area offices must inspect at least five engineered stone shops in the next year.

At the state level, California passed an emergency temporary standard for RCS in December 2023 to immediately improve silica protection in the stone fabrication industry by making the existing standard simpler for small shops to implement and for Cal/OSHA to enforce. "The emergency [rule] lasts a year," Berg noted, saying Cal/OSHA was striving to make it permanent before it expires in December 2024.

The temporary standard applies to "high-exposure trigger tasks," defined as any work with artificial stone containing at least 0.1% silica or natural stone containing at least 10%. It prohibits employers from dry-cutting, dry sweeping, cleaning with compressed air, walking

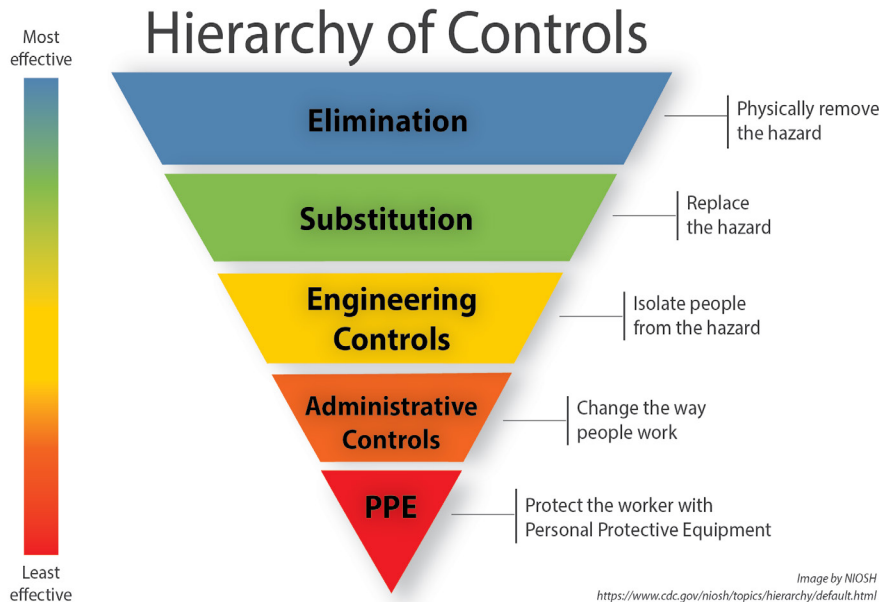

Chart: National Institute for Occupational Safety and Health (NIOSH). License: Public domain.

Existing silica safety standards rely on engineering and administrative controls and PPE, but many are questioning whether these controls are sufficient to mitigate the silicosis risk from engineered stone.

through dry dust, or using employee rotation to meet exposure limits.

The temporary standard attempts to close loopholes in the current standard by denying employers the ability to use objective data, monitoring data, or feasibility objections to avoid complying with engineering and workplace controls and with respiratory protection requirements. Employers must conduct monitoring every 12 months if high-exposure tasks are performed, regardless of any previous monitoring results or whether they expect exposure levels to be below the allowable limit. And, no matter what safety precautions are in place, all high-exposure tasks must be performed in a "regulated area."

Berg explained that shops must use prescribed "wet methods, and, on top of that, they have to use a powered air-purifying respirator, a higher order of magnitude" than a typical respirator. He described it as "something that you'd see with asbestos." The temporary standard also requires employers to provide employees who have a silicosis diagnosis (or even a "likely silicosis" diagnosis) with respirators fed with a supply of clean air.

Companies must expand written exposure-control plans (including monitoring and recording silica exposure levels to demonstrate controls are working) and display all safety signage in English and Spanish.

The temporary standard is significant, Berg explained, because it enables Cal/OSHA to take immediate action if it sees a violation. Before it was in place, he continued, "we had to do air sampling if the employer was out of compliance, regardless of [whether] they were dry cutting. Now, if we see they're dry cutting or don't have the PPE on, we can stop the work in a matter of minutes, whereas before it was weeks or months."

Cal/OSHA has warned that if the stone fabrication industry can't demonstrate that it can safely handle engineered stone, the agency will consider following Australia's lead by calling for a total ban. But Berg appeared optimistic about the efficacy of the temporary standard, mentioning that just the day before his interview with BuildingGreen, a team of Cal/OSHA inspectors had issued 12 work-stoppage orders in one day (one for every shop they inspected).

Shops can start work back up as soon as they demonstrate compliance.

Will these measures be effective?

Reactions to these measures are mixed. Some (including members of the medical community and workers' rights advocates) want more regulation or even a ban on engineered stone. Others (including some industry associations) are concerned that California's emergency regulations are too onerous and will penalize already-compliant companies.

The question underlying this dissonance seems to be what the World-wide Agglomerated Stone Manufacturers Association (AStA) has characterized as a disagreement about whether this is a product safety issue (i.e., that engineered stone is inherently more dangerous than alternative countertop materials) or a workplace safety issue (i.e., a risk employers can manage with engineering controls, new safety protocols, and PPE).

Berg, for his part, says it's both a product and a workplace safety issue because engineered stone is "a product that is more dangerous and [is] not being used safely."

In an email to BuildingGreen, AStA director Beatrice Barbiero emphasized the company's strong support for enforcement and compliance assistance but noted that "it remains to be seen" whether California's temporary standard will improve compliance among

noncompliant fabricators or just impose "additional requirements on fabricators who were already compliant and keeping their workers safe."

Jim Hieb, CAE, CEO of Natural Stone Institute (NSI), expounded upon AStA's concern in an email to BuildingGreen. "These fabricators must now use respirators and meet other requirements … despite the fact that they were already in compliance and utilizing industry best practices."

AStA's and NSI's skepticism taps into widespread concern, according to a 2022 article in *LAist* by Jim Morris and Leslie Berestein Rojas, that OSHA and state agencies like Cal/OSHA, don't have the resources to effectively enforce silica standards. Stone fabrication shops, the authors explain, are numerous, often so small that they can move locations to avoid citations and can employ workers who are unlikely to report violations—a combination that makes enforcement difficult.

California's temporary standard "will only be effective if it can be enforced," Hieb continued. "Cal/OSHA has limited resources and is facing historic employee vacancy rates. We are concerned about their ability to provide enforcement to non-compliant fabricators, especially those who are utilizing dry cutting, grinding, [and] polishing practices."

Both Barbiero and Hieb voiced support for a bill, introduced in February by Assembly member Luz Rivas from the San Fernando Valley, that seeks to protect engineered stone workers in California. If passed, the legislation would create a licensing program for compliant shops and would require the California Department of Industrial Relations to maintain a public database to track shop compliance with safety standards. "At question," Hieb considered, "is whether or not enforcement of a license program would prove more effective than the current enforcement of CAL/OSHA requirements."

Still, some are calling on regulators to invoke the precautionary principle by banning engineered stone altogether—although the enforcement feasibility question would remain.

When asked about AStA's perspective on a possible engineered stone ban, Barbiero replied, "This is a workplace health-and-safety issue—not a product safety issue. Without addressing compliance with the safety regulations and requirements, the risk of silicosis remains because silica is present in other types of products." Barbiero also claimed that "noncompliant fabricators are exposing their workers to hazardous dust generally," arguing that "banning engineered stone will not eliminate this issue."

Recent research (and the sudden increase in silicosis cases among stone workers) indicates that this may not be true—that exposure to silica dust from engineered stone is more hazardous and can lead to accelerated development of silicosis. Although Cal/OSHA notes that there is evidence suggesting accelerated silicosis cases can occur from natural stone under certain circumstances as well, there's currently a case to be made that engineered stone comes with unique hazards.

It appears that the rise in silicosis cases among U.S. engineered stone workers is the result of a complex—and not yet fully understood—mix of product hazards, workplace exposure risks, and workforce equity issues.

- The dust from engineered stone is likely more hazardous than that from natural stone.
- Industry compliance with silica safety regulations is low, regardless of the material being processed.
- Many fabricators and installers are Latino immigrants, many of whom lack access to insurance, health-

care, workers' compensation, and whistle-blower protections.

Any real solution will require an equally complex, nuanced approach—one that's also enforceable.

How should AEC practitioners proceed?

It's not yet completely clear what this means for project teams.

As with everything, seek transparency in the supply chain. AStA advises end users, designers, and other professionals to find out if fabricators have a contractor or business license, and whether they offer workers' compensation insurance. Another question the trade association suggests "is to ask your fabricators if they comply with OSHA's regulations and requirements." As we've established, however, compliance with the current federal OSHA standard does not guarantee worker safety.

But as Morris and Berestein Rojas highlight in their article, many people feel that the practices—safe or not—of stone fabricators and installers are not at the core of the issue. Rather, responsibility lies with the manufacturers of engineered stone countertops, they argue. The authors interviewed a lawyer in California who has filed dozens of product liability lawsuits against manufacturers—including Caesarstone, Cosentino, and Cambria—who he claims knowingly neglect the safety of workers downstream. They also spoke with physicians in the state who are encouraging consumers to purchase granite, marble, wood, porcelain, or concrete countertops instead of engineered stone.

Given what we know about the underdeveloped and underenforced safety regulations, and given what we don't yet fully understand about the risks of engineered stone, it seems prudent for the AEC industry to put a pause on selecting and installing the material.

Harkening back to NIOSH's hierarchy of controls, the most responsible measure we can take is to eliminate the need or find substitutes for engineered stone countertops—at least until employers can more effectively control the hazard they pose. See the table below, and our product guide, for a spectrum of alternatives to choose from.

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BuildingGreen's Roundup of Countertop Materials

All countertop materials come with potential environmental, health, and social justice concerns. Select the surface that fits the application, fulfills the design objectives, meets health and environmental criteria, and has the greatest durability.

For our full guidance, see buildinggreen.com/product-guide/countertops.

MATERIAL	POSITIVES	CAUTIONS	TIPS
Materials appropriate for heavy use			
Natural stone	Inherently non-emitting Can be chemical resistant without sealants Durable	Risk of forced labor (primarily with imports) Quarrying impacts Transportation carbon Silicosis risk with high quartz content (e.g., quartzite) to fabricators and installers if safety protocols are not in force Vulnerability with low quartz content (e.g., marble) to water, stains, acid rain, chemicals	Default to local sourcing for best environmental and social outcomes. Prefer certified materials ANSI/NSC 373 and/or Cradle to Cradle Silver.
Sintered stone	Durable (more durable than tile) Stain resistant Heat resistant Doesn't require sealants or synthetic binders Available in different thicknesses	Energy-intensive manufacturing Installation difficulties	–
Porcelain tile	Durable Stain resistant Doesn't require sealants or synthetic binders	Energy-intensive manufacturing Rare possibility of heavy metals in recycled content or glazing	
Glass composites	Contain pre- or post-consumer recycled glass	Impacts from BPA-containing epoxy High embodied carbon from cement Sealer sometimes needed for cementitious products	Avoid products that use epoxy binders.
Materials appropriate for lighter use			
Wood	Repairable if damaged Natural material Availability of sustainably sourced wood Low embodied carbon (depending on source)	Vulnerability to moisture, staining, and chemicals Protective coatings needed; may include epoxy	Look for reclaimed wood or FSC-certified materials, including rapidly renewable options like bamboo, cork, or hemp. Select products with low-emitting binders.
Plastic laminate	Inexpensive Multiple design options Some contain FSC-certified paper	Not durable Made with formaldehyde-based resins	Look for FSC-certified paper. Use ULEF or NAF substrate. Use only in low-traffic applications.
Materials not receommended at this time			
Engineered stone or quartz	Durable Mimics real stone Numerous color options Stain-resistant	Silicosis risk to fabricators and installers if safety protocols are not in force Some contain antimicrobials Vulnerable to heat Difficult to repair if damaged	May be impossible to identify fabricators that monitor working conditions and provide effective dust controls. Prefer certified materials: CDHP Standard Method emissions requirement, NSD/ANSI 51 food contact safety certification. Prefer products made with post-consumer recycled content.
Acrylic and polyester solid surfaces	Many conform to ANSI-approved performance standards Non-porous Homogenous Can be sanded and repaired if damaged and can be installed without seams	Impacts from mostly virgin plastic	Difficult to differentiate preferable products.

Source: BuildingGreen, Inc.