GARLAND
Concepts Realised

Tackling silica dust exposure head-on… *At the Design Stage*

Protecting construction workers from exposure to silica dust has traditionally been considered the responsibility solely of the contractor and an issue that only requires consideration at the site level. Such a perspective usually only affords the worker a low level of protection from this, the most prevalent hazard on many construction sites. With enhanced responsibilities on the PSDP to support risks being designed out by taking into account the General Principals of Prevention, eliminating worker exposure to silica dust poses new challenges for an old industry.

What is the hazard?

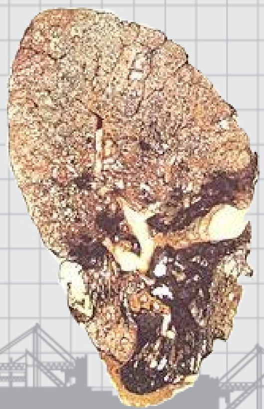
Silica, or crystalline silicon dioxide (SiO_2) is the most common compound on Earth (>42% by weight). It is the basic component in sand and rock. Silica is contained in many common construction products such as concrete, cement, masonry, tiles, plasterboard, brick, granite, sand, topsoil, rock, gravel, gypsum products... The list goes on.

What is the risk?

Exposure to silica isn't a significant issue for construction workers, until the product is pulverised down to respirable-sized particulate dust. Respirable crystalline silica dust is produced when cutting, grinding, chipping, hammering, drilling, chasing, crushing, loading, hauling or demolishing any silica-containing products.

Exposure to respirable crystalline silica dust is probably the most common hazard on many construction sites. Inhaling the dust can cause silicosis - a serious, progressive, irreversible lung disease. Once inhaled, very fine silica particles travel deep into the lungs and cause scar tissue to form. The scarring thickens and stiffens lung tissue, thus reducing the ability to breath. If exposure is not stopped, silicosis can be lethal. Inhaling silica dust also causes lung cancer, chronic obstructive pulmonary disease (COPD), heart failure, autoimmune disease and can dramatically increase the risk of life-threatening conditions such as pulmonary hypertension, arthritis, kidney disease, emphysema, bronchitis and tuberculosis.

Due to the wide range of illnesses relating to respirable silica exposure, it's difficult to obtain figures for attributed fatalities. In the UK the HSE estimated approximately 4618 fatalities from exposure to respirable silica in 2014 (combination of silicosis, COPD and lung cancers related to silica exposure)[i]. As a comparison, fatalities from asbestos-related exposures were estimated at approximately 5461[ii]. Legislation for the control of occupational exposure to asbestos, however, has been in place in the UK since 1969, and occupational exposures to the general working population has been declining in the 48-years since. The contrast is; when compared with asbestos, the control of occupational exposure to respirable crystalline silica is only in it's infancy. The magnitude and extent of the problem is so vast, in the Health & Safety Industry, respirable silica dust is becoming known as *"the new asbestos".*

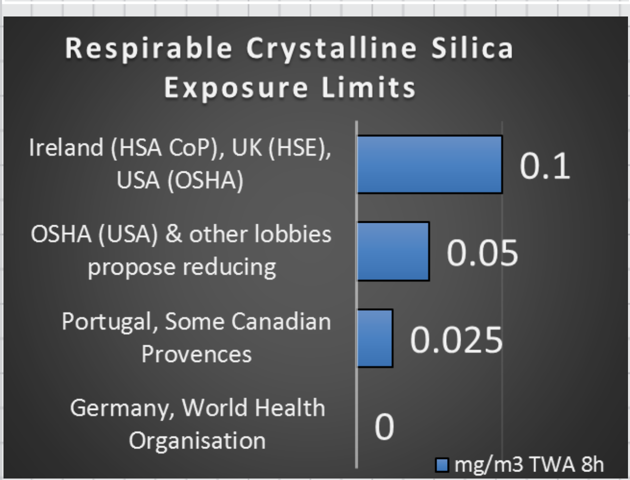


A lung affected by silicosis

How much is too much?

In 2011 the HSA issued a Code of Practice for the Health, Safety and Welfare at Work (Chemical Agents) Regulations 2001. The Code of Practice outlines the maximum exposure limit for a range of chemicals including respirable crystalline silica. A maximum exposure limit of 0.1mg/m³ over an eight hour weighted average is specified – i.e. a worker must not be exposed to an average of 0.1mg of dust per unit volume air over a standard eight hour workday. For these exposure limit values, the general rule-of-thumb is; *if dust containing silica is visible in the air, it is almost always over the permissible level.*

In 1996, the World Health Organization International Agency on Cancer Research (IARC) first classified silica as “a known human carcinogen”. IARC reaffirmed its position in 2009 noting an “increased risk of lung cancer [from silica exposure] was observed across various industries and processes.” So the question must pondered, how much of this carcinogen is safe to inhale? ... It’s a bit like asking how long is it safe to smoke cigarettes before you get cancer!



How is the risk controlled? *The traditional case:*

Worker exposure to silica dust was traditionally seen as an unavoidable risk. Most of us can remember seeing construction workers on their way home from work covered head-to-toe in white dust. As occupational safety requirements percolated down to contractors, simple dust masks may have been provided to workers exposed to the hazard. As further advancements in safety Regulation and education were made, so too the levels of protection advanced. As well as administrative controls, Personal Protective Equipment (PPE) in the form of fit-tested HEPA filters, full-length disposable overalls and gloves are all now part of the standard requirements. PPE however, is the last line of defense, intended only to be used when all other options have been exhausted. But it is not predominantly the case that other options have been exhausted… Greater levels of protection are almost always available for the worker.

Raising the bar on worker protection – *at the Design Stage:*

There are many ways to deal with the hazard. The common approach is to mitigate the hazards associated with worker exposure to silica dust by minimising exposure to the hazard. The best practice approach, however, is for the PSDP to advocate the elimination of the hazard from the outset - at the Design Stage. By ensuring the effective application of the General Principals of Prevention, conventional design strategies can be blended together with contemporary design innovations to ultimately eradicate most of the cutting, chipping and grinding that would otherwise produce harmful respirable silica dust.

Implementing Design Strategies: *(Principal 1: Avoid risks; Principal 3: Combat risks at source…)*

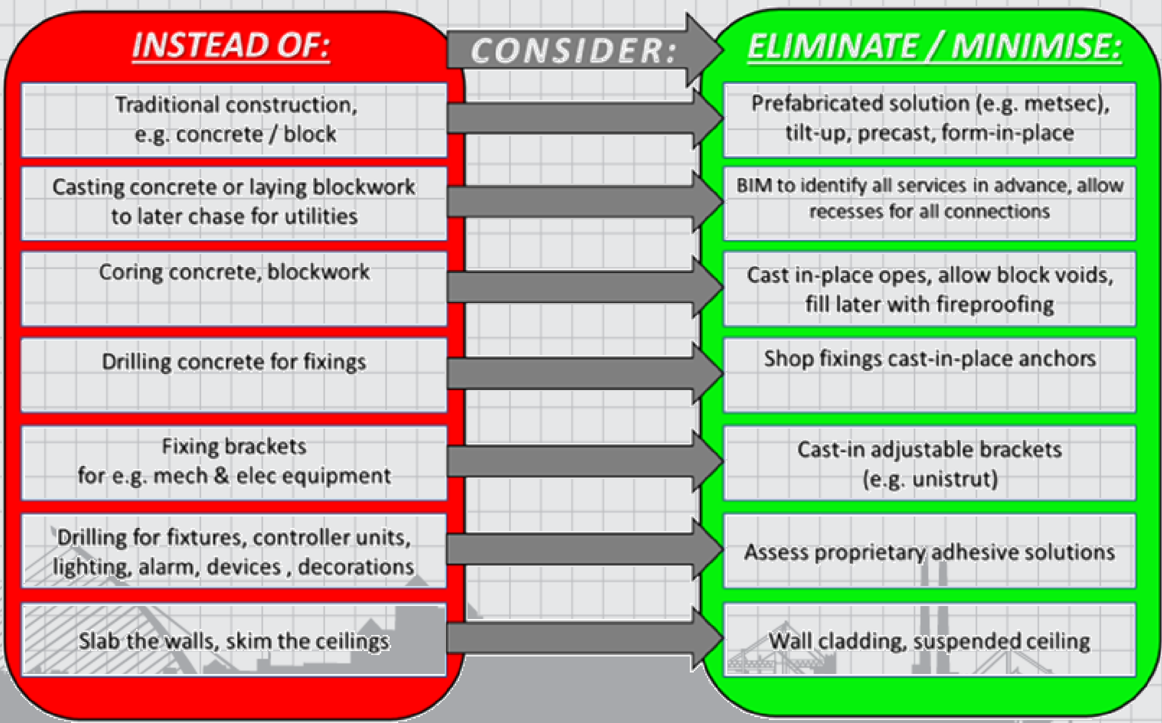
Simple design strategies can prevent the necessity to produce the dust in the first place. For example, instead of chasing utility channels into a concrete wall, we encourage Designers to consider constructing a partition wall over pre-laid utilities. A similar philosophy can be employed for sub-floor utilities and/or above on the ceiling.

The implementation of a high standard of Quality Assurance at the formwork assembly stage ensures effective and efficient concrete pours, negates the tendency to overpour, and hence, can eliminate cutting and chipping concrete later down the line.

Comprehensive Building Information Management (BIM) techniques can be used on larger new-builds to identify all required utilities in advance. All service routes can then be confirmed and plotted within the model, long before any construction begins. This permits planning appropriate recesses and openings to be incorporated into the formwork, again eliminating the later requirement to produce the harmful dust.

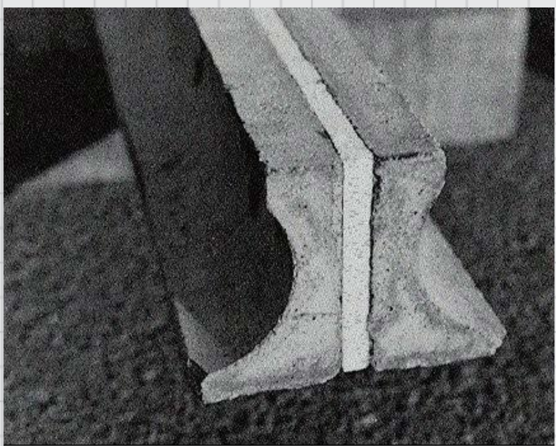
Implementing Design Innovations: *(Principal 5: Adapt to technical progress; Principal 6: Replace dangerous with less dangerous)*

The human advancement of technology has dramatically impacted every facet of mankind's activities on this earth, and construction is no exception. Development of polymer, adhesive, alloy, chemical and composite technologies has led to a potentially limitless range of materials available to address existing construction problems and issues. One only has to stroll around a local DIY store to see new innovative construction technologies and novel solutions to old problems. Designers have a statutory obligation to maintain awareness of technical progress within the industry, and apply that knowledge to improve collective protection. For any Designers wishing to maintain familiarity with the rapidly changing construction tools, technologies, materials and innovations, the National Construction Summit in the RDS is the annual opportunity for construction suppliers to exhibit their latest products.



Don't cut the concrete! *(Principal 8: Develop an adequate prevention policy…)*

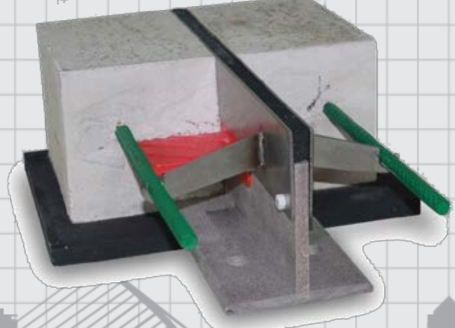
It has always been tricky to eliminate the requirement to cut when using concrete for certain applications. One particular example is large concrete floors that require shrinkage/expansion/contraction joints. With traditional construction methods, the floor is laid either by continuous pour, long strip, wide bay or two-layer slab construction. When the floor is finished, it is subdivided into a grid of specific predefined intervals, and a road saw is used to cut channels along the grid. These sawn cuts act as restraint-movement joints that relieve shrinkage-induced stresses within the slab. Road saws typically incorporate dust suppression systems that wet the disk as the saw advances, thus dramatically reducing silica dust exposure levels during the cutting. But water dries and the dust returns, and so does the potential for the next worker to be exposed to the hazard. Not to mention, road saw cutting is a specialised and relatively expensive process.

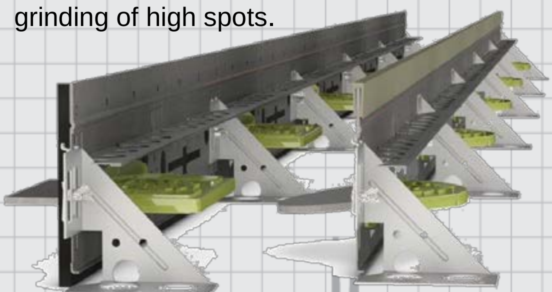


Expanded polystyrene is sandwiched within specially constructed expansion joint rails. The top inch of expanded polystyrene can be removed and the cavity filled with a suitable joint sealant.

Contemporary concrete development is seeing the increased use of ground and pile supported 'jointless' concrete floors. Large area construction methods are used with a steel fibre concrete mix, although reinforcing steel alone can be used, or a combination of both. Fibres within the mix help control the width and distribution of cracks caused by shrinkage, contraction and expansion. Despite the jointless name, free movement joints are required at the perimeter of each bay poured, typically up to 35m intervals. These free movement joints can be formed, as opposed to cut, and can be planned to provide for breaks in construction schedules. Where the necessity for even larger bays arises, post-tensioning can be used to construct jointless floors of up to 100m x 100m. Tendons cast within the concrete maintains the slab in compression, and there is a low risk of cracks opening within the bay.

The formwork industry is also rising to the challenge. A range of products are available that compensate for slab movement on the macro scale. Fabricated steel leave-in-place screed rails have been available for some time and help improve slab finishes to tighter tolerances. The new generation of these products incorporate a strip of polymer foam along the length of the rail. Once the concrete is laid, the foam acts as a true expansion joint, permitting larger slabs to be poured without the requirement to saw cut at a later stage. These precision-cut rails provide for excellent tolerances across the slab, reduce any tendency to over/under pour, and hence reduce the likelihood for rework, additional pours and eliminates any potential for later grinding of high spots.





Commercially available leave-in-place screed rails that allow for slab movement.

The GARLAND PSDP Approach

New technology can be expensive. Quality Assurance isn't cheap. BIM takes time, time is money. Innovative proprietary materials cost more than standard materials. Adding fibres to a mix is a supplementary step in the process, causes additional abrasion and wear on batch plant equipment, and ultimately leads to costlier end product…
Sure, to implement more expensive processes and use more expensive materials may cost more in the early stages of the project. But savings will be realised with less steps in the build process, fewer resources required at the fit-out stage, resulting in quicker total build-times. Not to mention the savings incurred by reduction of incidence rates of occupationally-induced silicosis, autoimmune disease, lung cancer and other debilitating illnesses born by Construction Industry workers, which ultimately impacts social care resources and the wider community. At GARLAND, our PSDP Teams actively encourage Designers to effectively apply all resources available to eliminate these risks and capitalise on these savings, from the outset.

Further Queries?

If you have any further queries please contact one of the **GARLAND Safety Management** Team.

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Further information is also available on our website: **www.garlandconsultancy.com**

[i] HSE Statistics 2014/2015 – *Respirable crystalline silica*
[ii] HSE Statistics 2014/2015 – *Asbestos related diseases*