Dustfree construction sites are possible

Reinhold Rühl

Dust in the workplace is often viewed as a painful reality, whether it is the dust in the office, the dust in the quarry, in agriculture or at construction sites. Especially on construction sites many different and very dangerous dusts occur. Diseases caused by dust from asbestos, wood and quartz dust are testament to these dangers and the high exposure on construction sites. However, there are cost-effective techniques that can be used to perform with low dust, even dust-free.

Dust on construction sites

On construction sites, mixing dusts are mostly present. These can include numerous problematic, often carcinogenic substances (Figure 1). Crystalline silica dust is almost always present in construction materials (Fig. 2). In 2016 the Senior Labour Inspectors' Committee published a guidance for National Labour Inspectors, addressing risks to workers exposed to respirable crystalline silica (RCS) on construction sites: "Respirable crystalline silica (RCS) is one of the substances with the highest respiratory health risk to construction workers, together with asbestos" (EU Commission, 2016). This makes clear how dangerous silica dust is; alongside asbestos, it is one of the substances with the greatest health risk.

Asbestos	carcinogenic
Lead	teratogenic
Diesel engine emissions	carcinogenic
Hardwood (oak, beech)	carcinogenic
Other woods	suspected carcinogen
Ceramic fibres	carcinogenic
Old mineral wool insulation materials	suspected carcinogen
Silica	carcinogenic

Figure 1: Dust on construction sites

In the countries of the European Union, different limit values apply to silica dust at the workplace (between 0.05 and 0.15 mg/m³). There are also such ranges for the limit values for respirable dust (1.25 - 6 mg/m³). The limit value for silica dust has been in motion for decades, including the limit value for respirable dust. For silica dust, a reduction to 0.05 or 0.025 mg/m³ is currently being discussed in many countries.

In the USA, the workplace limit value for quartz dust was reduced from 0.1 mg/m³ to 0.05 mg/m³ (50 µg/m³) in 2016. In this context, the US Occupational Safety and Health Administration (OSHA) explained:

> "The Occupational Safety and Health Administration (OSHA) has issued a final rule to curb lung cancer, silicosis, chronic obstructive pulmonary disease and kidney disease in America's workers by limiting their exposure to respirable crystalline silica. The rule is comprised of two standards, one for Construction and one for General Industry and Maritime. OSHA estimates that the rule will save over 600 lives and prevent more than 900 new cases of silicosis each year, once its effects are fully realized. The final rule is projected to provide net benefits of about $7.7 billion, annually.
> About 2.3 million workers are exposed to respirable crystalline silica in their workplaces, including 2 million construction workers who drill, cut, crush, or grind silica-containing materials such as concrete and stone, and 300,000 workers in general industry operations such as brick manufacturing, foundries, and hydraulic fracturing, also known as fracking. Responsible employers have been protecting workers from harmful exposure to respirable crystalline silica for years, using widely-available equipment that controls dust with water or a vacuum system."

During work on construction sites the limit values for respirable dust and respirable silica dust are regularly exceeded, most drastically. BG BAU carried out many dust measurements during construction work. Table 1 shows some results of the evaluations of the measurement data of BG BAU (Rühl, 2018).

Table 1: Exposure against respirable dust and respirable silica dust on construction sites without protection measures (unless otherwise stated 95% values of the data pool)

	respirable dust	silica dust
highest OEL in europe	**6.0 mg/m³**	**0.15 mg/m³**
pavement, cut dry	19.2 mg/m³	up to 5.7 mg/m³
Drywall, grind	28.9 mg/m³	0.2 mg/m³
Dry sweeping	8.4 mg/m³	0.4 mg/m³
Drilling in concrete	7.0 mg/m³	2.2 mg/m³
plaster cut off	12.5 mg/m³	0.8 mg/m³
Chiselling	9.3 mg/m³	0.8 mg/m³
Drill bit for socket outlets	up to 8.0 mg/m³	
stonemasonry, grinding	up to 10.1 mg/m³	up to 2.2 mg/m³
stonemasonry, cutting	up to 8.8 mg/m³	up to 3.4 mg/m³

Therefore, dust control measures must always be used on construction sites. In the international literature there are many tables of construction materials and the corresponding silica content like Figure 2. The particular hazard posed by certain materials due to their high silica content is also reported. But with a low silica content, the same dust control measures must be taken as with a high silica content.

In principle, therefore, the silica content of construction materials should not be discussed. Work must always be carried out with low dust. Even if working with low-dust techniques must be standard, the artificial stones or working in artificial stone represent a special challenge (Horn, 2019; Cooper, 2015). Here the silica content is over 90%, the dust that occurs therefore consists almost entirely of silica dust. However, if artificial stone is used without protective measures, there is a high risk of developing silicosis after a very short time.

Therefore, there shouldn't be much discussion about the quartz content of building materials. Work must always be done with low dust.

Artificial stone	more than 90%
Sandstone, quartzite, flint	more than 70%
Concrete, mortar	25% to 70%
Shale	40% to 60%
China stone	up to 50%
Tile	30 to 45%
Slate	up to 40%
Granite	up to 30%
Brick	up to 30%
Basalt, dolerite	up to 5%

Figure 2: Crystalline silica concentrations in common construction materials

Dust - small and mean

The problematic dusts are those that are not seen. Dust particles are inhalable if they are smaller than about 10µm. Dust particles smaller than 1 µm can reach the alveoli (Fig. 3) and can cause chronic damage. Visible dust contains particles of this size, but alveolar dust is also present when nothing is visible.

This dust is only visible in direct sunlight. Everyone knows the experience that small dust particles can be seen where the sun shines into the room. Of course, these particles are everywhere in the room, not just where the sun's rays invade.

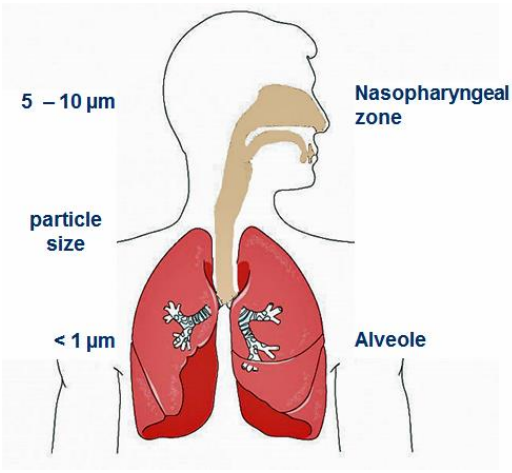

Figure 3: The smaller the dust particles, the deeper they enter the body

These very small dust particles are not only invisible, but they also sink very slowly to the ground. Dust particles of 1 µm need almost 7 hours to fall by 1 m (Fig. 4). When dust is whirled up (drilling holes, sweeping, etc.), the dangerous small dust particles have to be inhaled for hours.

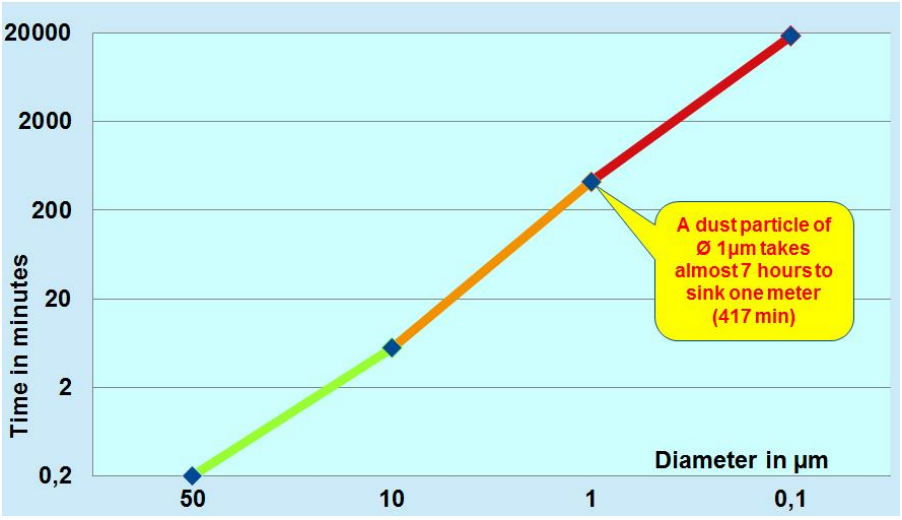

Figure 4: How fast do dust particles drop off?

When setting the limit value of 1.25 mg / m³ for respirable dust, the German AGS (Ausschuss für Gefahrstoffe – Committee on dangerous substances that advises the government and authorities) stated, that this OEL avoided of chronic, particle-induced inflammatory processes in the lung, which also prevents the development of lung tumors observed in animal experiments with rats. Together with environmental-medical data, the information obtained in occupational medicine studies shows that even very low dust loads can cause not negligible effects (AGS, 2014).

Occupational diseases caused by dust

Table 1 show that very high concentrations of silica dust and respirable dust are present on construction sites. It is therefore not surprising that a declining trend in silica-related diseases is not apparent in construction companies insured with BG BAU (Berufsgenossenschaft der Bauwirtschaft - statutory accident insurance for the construction industry). Almost 100 new cases of silicosis, silico tuberculosis and lung cancer caused by silica dust (Figure 5), as well as about 30 deaths per year are recorded.

The majority of construction companies are members of BG BAU. But construction activities are also insured with other accident insurers: the electricians, half of the heating, plumbing and air

conditioning companies, half of the stonemasons, half of the demolition companies, many temporary workers, the municipal authorities. With regard to all construction jobs, the number of cases reported in Fig. 5 is about 130 new cases and about 40 deaths per year due to quartz-related diseases.

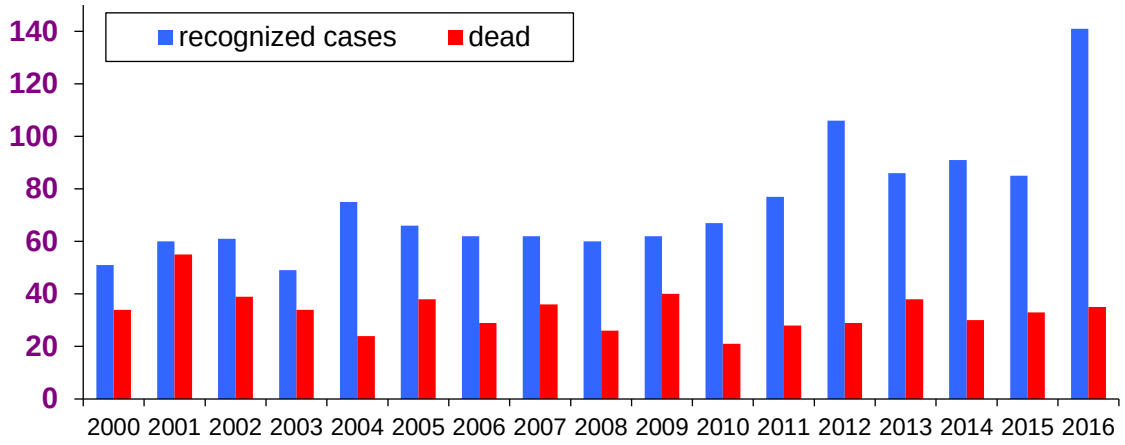

Figure 5: Crystalline silica-related occupational diseases at BG BAU (silicosis, silico-tuberculosis, lung cancer; BK-DOK)

In the case of asbestos-related occupational diseases (Fig. 6), a declining trend is expected in the coming years. The cause for the many diseases are not current exposures, but because of the long latencies of up to 40 years attributable to very high exposure until about 1985. However, in Germany and Switzerland, high current asbestos exposures are known. In the case of unprotected use of asbestos-containing plasters, tiles and fillers, up to 4 million asbestos fibers/m³ have been measured, above 1 mg/m³ silica dust and respirable dust above 9 mg/m³ (Scherer, 2016).

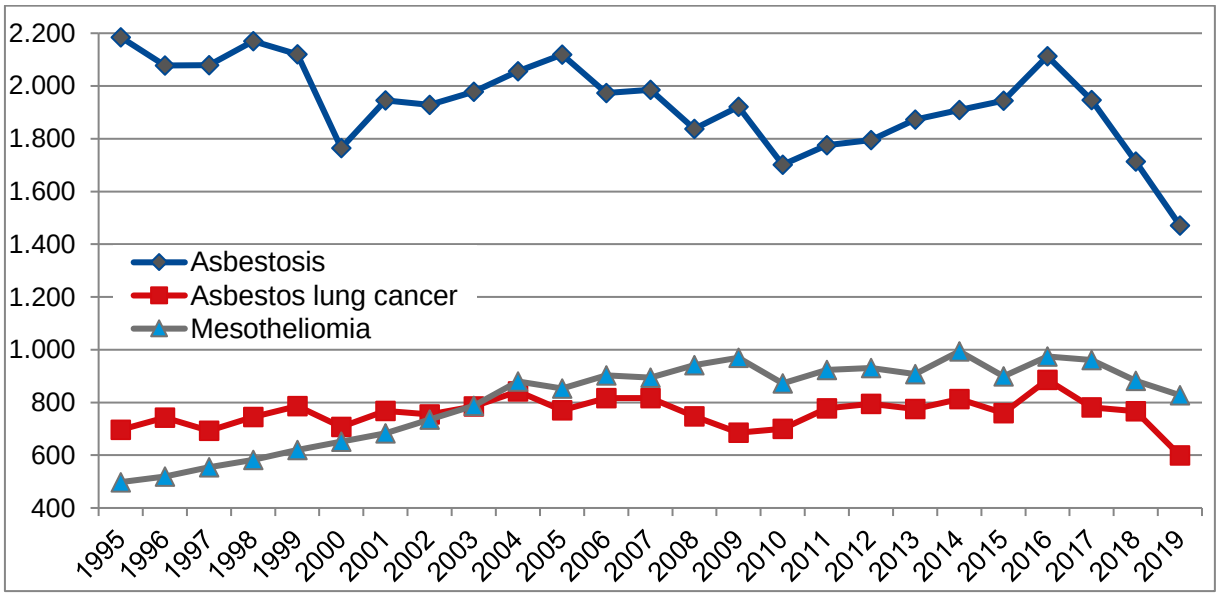

Figure 6: Asbestos-related occupational diseases in Germany (BK-DOK)

The number of adenocarcinomas, the cancer of hardwood dusts, has been increasing for years (Fig. 7). This is probably less a sign of rising exposure, than a reference to increasing sensitivity to this illness on the part of physicians. The latencies for the adenocarcinomas as well as for the quartz-related diseases are over 30 years.

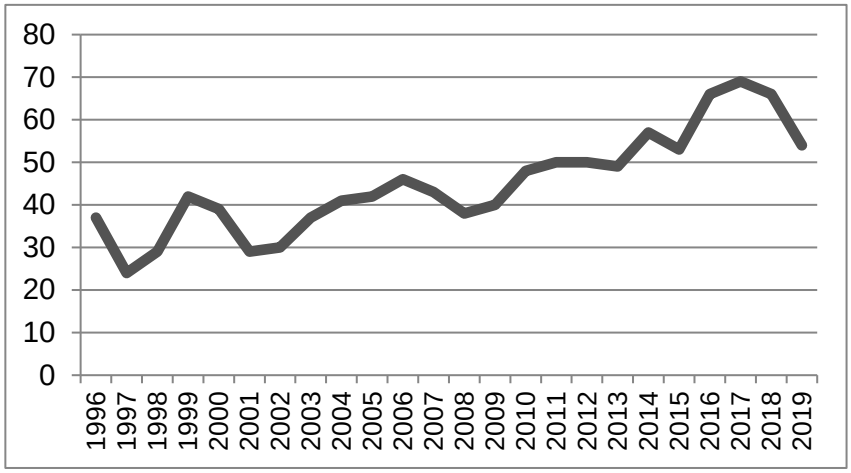

Figure 7: Occupational adenocarcinomas in Germany (BK-DOK)

Solutions for practice

Dust-free work on construction sites is possible or at least low-dust working. The techniques for drilling without dust, for grinding and cutting with little dust and even for almost dust-free demolition of plaster exist. There are a multitude of low-dust techniques for construction sites (Table 2). The "basic equipment" - Sucked off hand-held hand tools, construction vacuum cleaner, air cleaner (fig. 8) - is already available for below 3,000 euros and allows dust-free working on many construction sites. Almost all hand-held machines (demolition hammer, milling, etc.) can be equipped with a suction device (www.bgbau.de/themen/sicherheit-und-gesundheit/staub/staubarme-bearbeitungssysteme/ or www.dustfreeworking.tno.nl/tools). When connected to a construction dust extractor, work is virtually dust-free.

Table 2: Low-dust techniques for construction sites

- Construction vacuum cleaner, dust class M
- Air cleaner
- pre-separator
- Sucked off hand-held hand tools (like demolition hammer, sander, grinding machine)
- Driller with integrated exhausting systems
- Abraded fox-cut saws
- One way container

Figure 8: Sucked off hand-held tools (here a demolition hammer), construction dust collector and air cleaner. These minimum equipment with low-dust techniques does not even cost 3,000 euro

Construction vacuum cleaner can be used to suck up dust and to suck off hand-held hand tools. Construction vacuum cleaner are not normal dust collectors, but have features that are particularly required on the construction site, among others
- approved for dust class M (EN 60335-2-69, Annex AA);
- Cables in H 07 RN-F - Equipment (up to 4 m cable also H 05 RN-F);

- washable filters (PES filters);
- moisture-resistant fleece removal bag or plastic disposal bag;
- fully automated filter cleaning;
- robust chassis.

Dust cannot always be avoided, despite extraction on the handheld tools. Thus, even with a sucked-off demolition hammer, some dust will still be released during the removal of tiles or plaster. Here air cleaners are used. Air cleaners are basically nothing else but transportable suction systems, a filter makes the air "dust-free".

With an air cleaner, breathing protection can also be dispensed with as a backup measure. And finally, an air cleaner prevents other trades and residents from being exposed to dust. Numerous tilers use these air cleaners already and can advertise with the slogan "we sanitize your bath dust free".

Advertising of a bathroom studio for dust-free work (Staubfreies Arbeiten) with "Air-Clean technology"

In the case of a higher dust concentration, higher efficiency dust collectors should be used. They are more powerful than the normal construction dust collectors, both in terms of the suction force, as well as in terms of the maximum quantity which fits into the dust collector.

Finally, more pre-separators come to the construction sites, primarily for large amounts of dust. They are used for instance during parquet grinding between the suction nozzle and the construction dust collector. The bulk of the dust collects in this pre-separator. The advantage is that the construction dust collector and its filter are less stressed. The dust collected can be removed from the pre-separator and a new collecting bag can be inserted again.

Suction drills are a symbol of dust-free working. Conventional drills have a drilling helix for the extraction of drilling dust from the hole. In contrast, suction drills have a largely smooth cylinder shaft and openings at the tip, through which the dust is sucked off via a coupling attached to the rear part of the drill and the construction dust collector connected to it (Fig. 9). The dust of drill holes, for example for dowels, is thus removed at the point of origin and blow-out of the borehole is not necessary.

Figure 9: Suction drills

References

1. AGS, 2014: Begründung zum Allgemeinen Staubgrenzwert (2014/2001) in TRGS 900. www.baua.de/DE/Angebote/Rechtstexte-und-Technische-Regeln/Regelwerk/TRGS/pdf/900/900-allgemeiner-staubgrenzwert.pdf?__blob=publicationFile&v=2
2. BK-DOK: Berufskrankheiten-Dokumentation der Unfallversicherungsträger - Occupational diseases documentation of the accident insurance institutions. www.dguv.de/en/facts-figures/ods/index.jsp
3. Cooper, Jared H.; Johnson, David L and Phillips, Margaret L.: Respirable Silica Dust Suppression During Artificial Stone Countertop Cutting. Ann. Occup. Hyg., 2015, Vol. 59, No. 1, 122 - 126
4. EU Commission: Guidance for National Labour Inspectors on addressing risks from worker exposure to respirable crystalline silica (RCS) on construction sites. Senior Labour Inspectors' Committee (SLIC); October 2016; https://osha.europa.eu/en/highlights/respirable-crystalline-silica-construction-sites-new-european-guidance-labour-inspectors
5. Horn, Allyson: Silicosis death dust audit reveals 'major epidemic worse than asbestos'. 20th February2019; updated 21th February 2019; https://www.abc.net.au/news/2019-02-21/silicosis-death-dust-audit-reveals-major-epidemic-worse-asbestos/10830452;
6. OSHA, 2016: Federal Register / Vol. 81, No. 58 / Friday, March 25, 2016 / Rules and Regulations; DEPARTMENT OF LABOR, Occupational Safety and Health, Administration
7. Rühl, Reinhold: Staub auf Baustellen. Fraunhofer – IRB Verlag, 2018, ISBN-13: 9783738801255
8. Scherer, Stefan: Erfahrungsbericht Schweiz: Staubende Arbeiten an asbesthaltigen Fliesenklebern. SUVA, Bereich Chemie; 3. Erfahrungsaustausch „Asbest“, 15. Juni 2016, BAuA, Dortmund