Dust in the Construction Industry

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Abstract

The sources of dusts both external and as created by work processes. The diseases caused by dust. The importance of “dose” in terms of health outcomes, and diseases. "Dose" determination. Critical analysis of available information (data) as well as relevant case studies, reports, investigations to identify the important health and safety issues. Intervention programmes.

Keywords: Construction dust; lung diseases; particle size; case studies; reports; investigations; intervention

Dust in the construction industry

Sources of dusts both external and as created by work processes

Mineral dust.

Crystalline silica Sawing, drilling or sanding and sweeping fibre-cement products used as internal/external wall and ceiling cladding, flooring, roofing or fencing.

Cutting or drilling any non-standard GIB® wallboard product, these contain fibreglass. (Aqualine™, Braceline™, Fireline™, Ultraline™, Noiseline™)

Other Silica

Synthetic Mineral fibre (SMF): cutting fibre optic cables and reinforcing tapes.

Continuous Glass Filaments: Cutting or handling of textiles in reinforced plastics and concrete or electrical insulation, fibre-optics and plumbing materials.

Fibreglass, glass fibre or glasswool: handling or cutting pink, blue, green and white insulation batts.

Rockwool: handling or cutting brown insulation batts, formed insulation, or limpet materials, such as acoustic insulation and fire-rating materials.

Asbestos Demolition or transporting of old houses: "... the hazard remains in many buildings and homes that were constructed during the periods of heavy asbestos use." (RSoNZ 2015)

Serpentines, e.g., chrysotile grey fibreboard, which is usually found in cladding and roofing materials: workers are exposed when the material is sandblasted, sanded, shattered or sawn in any way.

Amphiboles, e.g., crocidolite (blue asbestos) which is used in lagging pipes. Plumbers and Electricians often have to handle or cut away old lagging.

Diesel smoke from heavy machinery, generators and combustion heaters. Workers close to exhausts will inhale the fine particles, but people can also absorb the superfine particles at a distance.

Fly-ash is used as a concrete additive for marine cement, and is also created when construction materials are burnt. Generally, concrete with flyash additive will be delivered wet, however.

Slaked Gypsum (uncured plaster), Plasterers are exposed when mixing plaster from powder. Painters will sand cured plaster and are exposed to cured dust.

Natural dust: Includes naturally occurring volcanic ash, soil and sand stirred up due to excavation in new subdivisions, in dry conditions.

Ceramic fibres, Cutting or handling insulation and fire-proofing blankets, electrical insulator fixtures and fireproofing panels. The fibres fly when the material is handled, but especially when it is cut.

Aramid, Bulletproofing cloths and high-end reinforcing tapes

Nylon, Washers, construction films and ventilating moisture barrier building wraps. Flying particles are inhaled during installation of building wrap.

Carbon, Composite carbon-fibre materials and robotic-fabrication products which are offered as an alternative to steel reinforcing "… could mean that Carbon fibre will replace steel." (Alderton 2017). The cutting, sanding and grinding of carbon fibre is not common on construction sites currently, but will be in the future.

Silicon carbide. Use of abrasives and cutting tools and the grinding or cutting of heat spreaders in LED's.

Heavy metals

Chromium, nickel, zinc, lead, titanium, cadmium and arsenic are present in cement dust.

Cadmium dust from grinding, scraping of blasting red, orange and yellow industrial paints. It occurs in site-specific high concentrations in hazardous waste dumps and around battery manufacture.

Lead. Old paint and ceramic glazes (renovation, especially chipping or sanding old finishes); solder Metal treatment paints; galvanising; the application of timber treatment; exposure to nano-materials printed via 3-d printing. Inhalation of lead particles generated by: burning of materials containing lead; stripping of lead paint and inhaling airborne contaminated soil or dust resulting from battery recycling.

Vanadium. HVAC manufacturers and possibly roofers are exposed when cutting and welding sheet metal.

Nickel stainless steels (frequently 8-12% nickel); Nickel metal is used to provide hard-wearing decorative, shiny engineering coatings known as 'nickel-plating' or 'electroless nickel coating' or 'electroforming'. Dust occurs when grinding or cutting bathroom or kitchen fittings and door furniture. (not common)

Beryllium. Beryllium is found in waste sites containing computer hardware, disposed cell phones, aerospace junk, dental laboratory waste and telecommunications industry waste.

Chemical dust.

Arsenic: Arsenic dust can occur when grinding or sanding some dried glues (weather or water-resistant) and drilling or sawing H3.2, H4 and H5 CCA treated timber.

Organic or Vegetable dust. Wooden products: sawing; cutting; routing; sanding; dry sweeping and bagging dust from extraction systems.(WorkSafe 2016)

Persistent Organic Pollutants.

Persistent organic pollutants are those which remain in the environment and are amplified through the food chain. They include pesticides, dioxins, furans and PCBs, these are formed during incomplete combustion and whenever materials containing chlorine (e.g. plastics) are burned.

Biohazards.

Building or renovating on farms, medical facilities, veterinary facilities, butchers, tanners, old septic tanks, restaurants, food preparation industries and demolition of rotting buildings creates a biohazard risk.

Moulds, Spores. The demolition of old buildings and the digging of foundations can release mould spores.

Bacteria and Viruses, Sneezing, sick co-workers, compost heaps, digging in top-soil, the demolition of animal sheds and medical facilities, the removal of old septic tanks and work in dump areas with mixed refuse.

Dust mite, The demolition of dirty buildings.

Diseases caused by dust

Mineral dust

Crystalline silica. Crystalline silica causes wheezing upon the inhalation of dust, followed by asthma, emphysema. acute silicosis, cancer (in lungs or stomach), kidney disease; scleroderma (skin thickening), and rheumatoid arthritis (joints). (Rutecki 2014)

Asbestos. Asbestos exposure causes asbestosis and mesothelioma (cancer in the lining of the lungs, abdomen, or heart)

Diesel smoke. Diesel smoke can temporarily irritate the eyes, skin or respiratory tract and/or cause dizziness, headaches or nausea. Longer-term exposure may lead to lung cancer, kidney damage, and increased risk of heart attack. (Truck news 2016)

Fly-ash (also contains silica). Fly ash causes acute lung disease, silicosis; and pulmonary fibrosis (thickening of lung and heart tissue). (Shrivastava 1994)

Cement. Cement exposure can lead to lung function impairment, chronic obstructive lung disease, restrictive lung disease, cancer of the throat, lungs, stomach and colon. Workers can present with burns on their legs, hands and arms. "Cement dust may enter into systemic circulation and thereby reach the essentially all the organs of body and affects the heart, liver, spleen, bone, muscles and hair and ultimately affects tissue micro-structures and their physiological performance". (Meo 2004) (Dietz et al. 2003)

Plaster. Gypsum is slaked, thus it reacts with water inside the lungs causing irritation to the respiratory system and occupational asthma. Long term plaster-lung is likely to include chronic obstructive pulmonary disease (lungs, heart), chronic bronchitis and emphysema (lungs), which is irreversible. (Breathefreely.org n.d.)

Naturally occurring volcanic ash, soil and sand. Chronic exposure poses a risk of silicosis and trauma to the eyes. The type and location in the body of symptoms is related to the size and shape of the particles. (Horwell Baxter 2006) Volcanic ash, soil and sand is stirred up during excavation in new subdivisions and roadworks, and can be radio-active.

Synthetic Mineral Fibre (SMF) materials

Ceramic fibres (also aramid, nylon, carbon silicon carbide).

These coarse mineral fibres irritate the eyes and skin. Inhalation of airborne SMF dust can irritate the upper respiratory tract: "… may involve reddening, burning, itching, prickling, scaling, thickening and inflammation around the fingernails" (IHRF 2016). Mesothelioma (cancer) (WHO n.d.)

Heavy Metals. These tend to bioaccumulate, thus the symptoms increase over time. Symptoms are tachycardia (heart palpitations), increased blood pressure due to vasoconstriction (the blood vessels constrict) and anaemia due to haematopoiesis (specifically mercury, nickel and arsenic) (Huang and Ghio, 2006)

Lead, Mercury, Arsenic. These are neurotoxins which affect multiple body systems and the nervous system. They are distributed to the brain, liver, kidneys and bones. Nuerotoxins are stored in the teeth and bones, where they accumulate over time. Anger, fatigue, hand tremors, blurred vision, and slurred speech, memory disturbances and sleep disorders, have been observed after arsenic, lead and mercury exposure. At high levels of exposure, lead attacks the brain and central nervous system to cause coma, convulsions and death. (WHO 2018).

Arsenic: Inactivates up to 200 enzymes and disrupts DNA formation and repair: "Acute arsenic poisoning is associated with nausea, vomiting, abdominal pain, and severe diarrhoea. It can cause encephalopathy (brain impairment) and peripheral neuropathy (reduced function in nerve endings)" (Ratnaike 2003)

Cadmium. Cadmium can cause respiratory tract and kidney problems. Damage is irreversible and includes renal (kidney) failure. It is carcinogenic and can cause osteomalacia (bones going soft); osteoporosis (bones hollow out); pain in the back and risk of fractures. At a cellular level cadmium attacks the DNA through oxidative stress[1].

Vanadium. Vanadium dust has a particularly swift effect of vasoconstriction (reducing diameter of blood vessels) due to its ultrafine particle size, which crosses the alveoli/cell membrane in the lungs. This leads to vascular (blood vessels) disease. (Huang Ghio 2006)

Nickel. Nickel exposure causes oxidative stress and is toxic to the blood, immune system, brain, DNA, heart, lungs, nerves, and liver. It is also a carcinogenic agent. (Das 2008)

Beryllium. Even infrequent exposure to beryllium can have negative health effects. Some people will develop illness shortly after exposure, while others may develop these many years after exposure. Once exposed, people have a lifelong risk of developing disease with respiratory symptoms leading to lung cancer, and skin diseases. (ATSDR 2008)

Chemical dust

Round-up contains glyphosate and adjuvants. In 2006 a study on embryonic cells revealed that the adjuvants increase the potency of glyphosate and that Roundup exposure "… may affect human reproduction and fetal development in case of contamination." Workers who are exposed can pass on fetal abnormalities to their offspring. (Benachour et al. 2006)

Organic or Vegetable dust

Wood. Wood dust can cause respiratory problems and occupational asthma. Woodworkers face complicating allergic reactions to some varieties of wood dust, typically those which are high in oil, such as Cedar or Sandalwood; or if the wood has been treated or glued.

Biohazards. Pathogens **(**Bacteria and Viruses) such as Hepatitis; and decomposition bacteria associated with dead organisms, can cause flu-like symptoms, ill health and possible liver damage.

Moulds, Spores. Some moulds are toxic. Asthma symptoms are associated with black mould.

Dust mite, Cat allergens. Allergic individuals will present with respiratory symptoms and skin irritation.

The importance of "dose" in terms of health outcomes, and diseases.

The term 'dose' refers to the quantity ingested, by mass. Where dust is concerned, the current state of affairs is that risk levels are equated with atmospheric concentration by mass. Atmospheric concentration, however, has no correlation to dosage, unless the length of exposure time is taken into account.

Furthermore, the danger presented by irritant dusts (e.g. silica) has less to do with the mass of dust present in a volume of air, or of the total mass ingested, than it does to the number of particles in the body. Given that the most dangerous particles are at the lower end of the size range where their mass is thousands of times less than that of the largest particles, the so-called safe exposure levels published, by companies such as Hardies, in their safety data sheets is not only meaningless, but is also dangerously misleading.

In addition, even if dose were to be measured in terms of number of small particles ingested rather than by mass, there is no known safe dose. Even small doses can cause the worst health issues associated with the dust. This is also true for toxic dusts *e.g.* heavy metals.

This misinformation is endemic, and is even found in the nuclear industry. It is now well known that the usual method of testing for radiation exposure via Geiger counters, fails to register extremely dangerous beta or ‘hot’ particles. These have a very small range, but even a single particle lodged in the body can cause cancer, by mutation of the cells immediately adjacent to it. (Busby 2018)

"Dose" determination

Blood levels. Some determinations are made post-exposure, for soluble particles absorbed, which migrate throughout the body by measuring blood levels in individuals: "Even blood lead concentrations as low as 5 µg/dL, once thought to be a “safe level”, may be associated with decreased intelligence in children, behavioural difficulties, and learning problems" (WHO 2018)

Percentage. The median lethal dose of Roundup to embryonic cells is 0.3% within one hour, "… at 0.06% , after 72 h, the embryonic cells appear to be 2-4 times more sensitive than placental ones." The percentages refer to the amount of Roundup in the medium (*i.e.* the spray). (Benachour 2006). Some sprays such as Glyphosate 360, have 360g/l which converts to 36%.

Air Sampling. Measuring how much dust is in the air is a way of establishing that there is indeed dust in the air sampled, however the dangerous fine particles are orders of magnitude lighter than the course particles, so air sampling is not a safe way to determine whether one is below the 'legal' limit. Literature aimed at test-sampling officers describes how to set standards for scientific equipment, how to collect the dust, which filters to use, and the climatic conditions of the sealed room in which the sample is to be burned to establish the silica (and oxidised heavy metal) content which is left in the ash. (NIOSH 1994)

Exposure Limits. New Zealand is lagging behind the EU and the USA, when it comes to Silica dust exposure limits, possibly due to the difficulties associated with establishing the size of the particles which are collected: Hardies still states that "A workplace exposure standard (WES) has not been established by WorkSafe NZ … a general limit of 3mg/m^3 for respirable particulates and 10mg/m^3 for inhalable particulates when limits have not otherwise been established. [table 1] " (Hardies 2017). WorkSafe, however, had actually reduced the limit for generic airborne dust to 2 mg/m^3 in 2012. (WorkSafe 2017 b). When comparing with overseas limits, Hardies' proposed limit figures are three orders of magnitude too high (x 1000).

The EU has decided to be more stringent, rather than taking the wholistic approach of the NZ government (vacuuming and disposing all construction dust): "The legal limit for silica dust is set at 0.075 mg/m^3" (75 µg/m3). This point has been determined as safe (can work for 40 years, 40 hours a week, 8 hours a day), but determines that all sawing, milling and drilling operations, as well as cleaning up, are unsafe. [figure 1] (Inspectie SZW 2015)

OSHA in the USA is proposing to set an even lower exposure limit at 50 micrograms of RCS per cubic meter of air (50 µg/m3), averaged over an 8-hour day. (OSHA 2013)

As a general rule, if dust is visible, the limits are being surpassed.

Critical analysis of available information identifying OHS issues

Relevant case studies. A study was published in the American Journal of Industrial Medicine, cited 192 times, regarding a terminal case of stomach cancer caused by asbestos dust from sweeping factory floors, which showed that Chrysotile Asbestos was indeed causing cancer, contrary to industries stating that it did not. (Egilman Menéndez 2010). This highlighted the way industry manipulated lawmakers for over 70 years, by arguing that one type of asbestos was safe to use.

A case study published by WorkSafe about Placemakers® truss factories, demonstrates how the reduced WorkSafe exposure limits in 2012 ($2mg/m^3$), led to making five specialised plywood hoods for the drop-saws used, as the machines were not efficient in extracting enough dust with existing vacuum devices. The dust levels were measured via air monitoring. The new hoods reduced the dust to $0.5\ mg/m^3$. (WorkSafe 2017 b). Large enterprises are generally quicker to respond to new legislation.

Reports. The MBIE Publication *Asbestos background information* describes how asbestosis is a latent disease which affects the wider community. National death statistics reveal that New Zealanders appear to have a cavalier attitude to construction dust and pay for it 20 to 40 years later. The document lists the Australian and New Zealand asbestos legislations side by side (MBIE pg13). Future research could include the investigation and analysis into how Australians are better prepared than New Zealanders via their legislations towards asbestos.

Asbestosis is similar to Silicosis: this was recognised as early as 1936, (Glass et al. 2017). Although silicosis is one of the most common occupational diseases (Poinen-Rughooputh *et al*. 2016), silica has far less restrictions imposed, than asbestos. Two mistakes are made in assumptions by legislators: One is that Asbestos is the more dangerous, when Silica is nearly as bad, (see Section 6.3 *Problems with Substitution*, WHO, n.d.); the other is that current and historical asbestosis statistics could well be falsely including silicosis sufferers, because the initial symptoms are similar.

Safety Data Sheets. Hardies upgraded their Safety Data Sheet to state that the silica is toxic (Hardies 2017) and that repeated, occupational exposure must be mitigated via imported air protection and vacuum assisted operation. For small builders this means buying new tools and safety equipment, or better still, a refusal to handle Hardies (elimination).

Investigations. A team of investigative academics conducted a literature review of previously secret corporate documents, depositions and trial testimony produced in litigation; as well as published literature. It concluded that there is evidence showing industry manipulation of science, leading to a long lag-time before asbestos was linked to asbestosis in mainstream legislation, specifically it stated that industry stalled for nearly forty years on asbestos regulation, due to a spurious debate over which asbestos form was more toxic. It warns of other materials which face a similar lag-time, as law-makers are pressured by industry to delay passing legislation. (Egilman *et al.* 2014).

Formulation of intervention programmes or strategies to reduce the incidence and severity of health and injury issues

Evaluative analysis: Intervention Design for Hardies silica-based products

Asbestos and Silicosis must be medically differentiated with definitive diagnosis[2], because manufacturers have substituted materials, from using asbestos to using 'sand' or 'fibreglass'. Precautions by Hardies have stated for some time that the product contains crystalline silica (Hardies 2012). However, the builders, with warnings of silicosis, do not heed them.

1. **Prevention through Design (PtD)**. Eliminate hazards to workers, and clients, at the source. Investigate NZGBC's Greenstar (commercial) and Homestar (residential) or NABERNZ (services) initiatives, and/or encourage architects to follow LEED or Passive House principles, to reduce the use of dangerous or toxic materials. (NZGBC 2015)
2. **Substitution.** Change the materials to reduce the risk. For example: Encourage customers to specify wooden weatherboards instead of cement-fibre weatherboards.
3. **Engineering Control.** Use of machines which create bigger particles, which fall to the ground. (Airborne particles are more dangerous: If dust is seen floating in the air, the dust can be inhaled). The benefits of this tactic are limited, however, as fine particles are still present albeit in lower numbers.

   Hardies recommends the use of snapper shears or fibre shears (as opposed to disc grinders) (Hardies 2017). The solution to replace the tools used, is an adaptive challenge. Consult the employees on the purchase of snapper shears.

- Resistance will come from financial managers because the tool is expensive.
- Resistance to use of the tool is based on the erroneous idea that shears are slower.

- Training sessions will need to include on-the-job tool handling.
- Resistance will come from workers on-site, who are already using disc grinders and other methods prohibited by the Hardies SDS. This should be overcome by education and enforcement of company policy.

4. **Administrative control.**
    - ***Communication training*** within toolbox meetings:
    - ***Annual Medical Diagnosis*** for workers routinely exposed to wood, cement, natural or silica dusts. This is recommended by Hardies is in their current SDS (Hardies 2017).
    - Introduce regular ***health monitoring***, including the scheduling of doctor's visits if coughing is an issue. Use a consultative process over a series of toolbox meetings to gain the trust of employees to self-report any respiratory illness, fatigue, aches and pains.
    - Investigate the reasons for sick days.

    Administrative control via measurement.

    - Meet documentation guidelines with increased tracked communication. (KPI tracking software).
    - Create a questionnaire for foremen installing Silicate products, which has a percentage score.
    - Use mobile app (*e.g.* SiteApp n.d.) checklists.
    - Aim to improve the KPI percentage.
    - Schedule a series of meetings with workers to train for, and achieve, improved measuring behaviour and an enhanced level of communication.

5. **Better PPE.** Invest in higher grade PPE. This will require research and consultation with workers *e.g.* any types of masks have advantages and disadvantages:

    ***Disposable paper masks*.** These are convenient, disposable and cheap. However, they use negative pressure *i.e.* the worker has to pull the air through the filter, which can be very uncomfortable in the summer, or when working hard, and can also draw particles in through the sides if it does not fit properly or if the worker has facial hair.

    Cartridge dust masks are convenient, fairly light and only the filters need replacing, however they need maintaining and also rely on negative pressure. Communication is difficult, and heavier models can cause neck strain, as the head is off-balance.

    ***PAPR masks*.** Workers will feel more comfortable with imported air blowing past their face, and the masks are designed to be balanced on the head. The workers will consequently comply more willing with PPE rules. The masks also provide eye protection, and some models come with hearing protection and helmets. They can be easier to communicate through, if other workers can see the mouth, or if fitted with blue-tooth. However, PAPR masks require maintenance and are very expensive. (SafetyInfo 2016)

Comment:

Construction managers and supervisors find that making workers wear masks is a nearly impossible task, potentially involving apparently tyrannical transactional leadership. Showing graphic videos of the dire health consequences of non-compliance might help. The distribution of information has not worked to date. Workers become irritated by masks, especially if they also have to wear hearing protection, safety glasses and helmets. Talking means having to take off the mask (inhaling the dust temporarily stuck on the outside). Hot days become claustrophobic and laborious.

The best solutions are a) elimination of the product and b) the use of PAPR masks, in conjunction with the recommended cutting tools, combined with education and the strict enforcement of policy in order to change entrenched habits.

References

Alderton, M., (2017), *Could Carbon Fiber Be the Superhero of Building Materials?*, Retrieved from https://www.autodesk.com/redshift/carbon-fiber-building/

Agency of Toxic Substances and Disease Registry, (ATSDR) (2008), *Beryllium Toxicity Patient Education Care Instruction Sheet*, Environmental Health and Medicine Education [website] Retrieved from https://www.atsdr.cdc.gov/csem/csem.asp?csem=5&po=15

Breathefreely.org, (n.d.) *Plasterer*, Retrieved from http://www.breathefreely.org.uk/assets/plasterer_fact_sheet.pdf

Busby, C., (2018) *Depleted Uranium DU Hot Particle In A Lung, Inhaling Radioactive Xenon Gas As Root Cause of Lung Cancer, Calculation Of Irradiation And Damage Caused Internally; Equivalent To Eating A Hot Coal From A Fire,* [Blog], Retrieved from https://www.agreenroadjournal.com/2014/08/du-hot-particle-in-lung-depleted.html

Das, K.K., Das, S.N., Dhundasi, S.A., (2008), *Nickel, its adverse health effects & oxidative stress.* Retrieved from https://www.researchgate.net/profile/ProfKusal_Das/publication/23688113_Nickel_its_adverse_h ealth_effects_oxidative_stress/links/5877068b08aebf17d3b9a748/Nickel-its-adverse-health-effects-oxidative-stress.pdf

Dietz, A., Ramroth, H., Urban, T., Ahrens, W., Becher, H., (2003), *Exposure to cement dust, related Occupational Groups and Laryngeal cancer: results of a population-based case-control study*, Retrieved from https://www.inhance.utah.edu/downloads/Publications/Germany-Heidelberg.pdf

Egilman, D., Bird, T., & Lee, C., (2014), *Dust diseases and the legacy of corporate manipulation of science and law*, International Journal of Occupational and Environmental Health, 20:2, 115-125, DOI: 10.1179/1077352514Z.000000000104

Egilman, D., Menendez, L.M., (2010), *A Case of Occupational Peritoneal Mesothelioma from Exposure to Tremolite-Free Chrysotile in Quebec, Canada: A Black Swan Case*, Retrieved from https://pdfs.semanticscholar.org/3b8f/891347b28d1327efa1e47dd47f32077734be.pdf

Glass, W.I., Armstrong, R., Chen, G., (2017), *Banning Asbestos in New Zealand, 1936–2016, an 80-Year Long Saga*, Retrieved from https://drive.google.com/file/d/1chovISCiTypE3FGxqFNsCaRVrSO47F0e/view?usp=sharing

Gazette, (2017), *Hazardous Substances (Disposal) Notice 2017*, Retrieved from https://gazette.govt.nz/notice/id/2017-au5639#_Toc487538467

Hardies, (2012), J*ames Hardie Fibre Cement Sheet Products, Safety Data Sheet*, Issue 2, July 2012 Retrieved from http://www.jameshardie.co.nz/assets/Uploads/resources/James-Hardie-MSDS-Cement-board-July-2012.pdf

Hardies, (2017), *James Hardie Fibre Cement Sheet Products, Safety Data Sheet*, Issue 4, December 2017, Retrieved from http://www.jameshardie.co.nz/assets/Uploads/resources/James-Hardie-SDS-Cement-board-Dec-2017.pdf

Horwell C.J., Baxter, P.J., (2006), *The respiratory health hazards of volcanic ash: a review for volcanic risk mitigation*, [Bibliography rewiew] Retrieved from https://www.paho.org/disasters/index.php?option=com_docman&view=download&alias=1826-

respiratory-health-hazards-of-volcanic-ash&category_slug=majorvolcanoes&Itemid=1179&lang=es

Huang Y.C., Ghio A.J., (2006), *Vascular effects of ambient pollutant particles and metals*. Medpub, [Abstract] Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/16842137

Industrial Health and Research Foundation (IHRF), (2016), *Synthetic Mineral Fibres*, Health and Safety Fact Sheet, Retrieved from http://www.workershealth.com.au/wp-content/uploads/2016/12/Synthetic-Mineral-Fibres-SMF-Factsheet-2016.pdf

Inspectie SZW, (2015) *The dangers of silica dust*, [youtube] Retrieved from https://www.youtube.com/watch?v=HzV0Bp7sJRs

Lee JS., Mahendra, S., Alvarez P.J.J., (2010), *Nanomaterials in the Construction Industry: A Review of Their Applications and Environmental Health and Safety Considerations*, [Abstract], Retrieved from https://pubs.acs.org/doi/abs/10.1021/nn100866w

Meo, S.A. (2004), *Health hazards of cement dust*. Saudi Med J. 2004 Sep;25(9):1153-9 [Abstract] Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/15448758

MBIE, (n.d.), *Asbestos background information* http://www.mbie.govt.nz/info-services/employment-skills/workplace-health-and-safety-reform/document-and-image-library/background-information-for-asbestos-chapter-discussion-document.pdfLast Name, F. M. (Year). *Book Title*. City Name: Publisher Name

Ministry for the Environment (MFE), (n.d.), *5. How to tell if a material is a waste*, Retrieved from http://www.mfe.govt.nz/publications/waste/module-1-hazardous-waste-guidelines-identification-and-record-keeping/5-how-tell

NIOSH, (1994), *Particulates not otherwise regulated, total 0500 definition*, NIOSH Manual of Analytical Methods, 4th Edition, Retrieved from https://www.cdc.gov/niosh/docs/2003-154/pdfs/0500.pdf

OSHA, (2013), *OSHA Fact Sheet, OSHA's Proposed Crystalline Silica Rule: Overview*, Retrieved from https://www.osha.gov/silica/factsheets/OSHA_FS-3683_Silica_Overview.pdf

Poinen-Rughooputh, S., Rughooputh, M.S., Guo, Y.J., Rong,Y., Chen, W.H., (2016), *Occupational exposure to silica dust and risk of lung cancer: an updated meta-analysis of epidemiological studies*, Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5095988/

Ratnaike, R.N., (2003), *Acute and chronic arsenic toxicity*. Postgrad. Med. J. 79, 391.[Abstract] https://www.ncbi.nlm.nih.gov/pubmed/12897217

Royal Society of New Zealand, (2015), *Asbestos exposure in New Zealand: Review of the scientific evidence of non-occupational risks*, Royal Society of New Zealand Office of the Prime Minister's Chief Science Advisor, Retrieved from http://www.royalsociety.org.nz/expert-advice/papers/yr2015/risks-from-asbestos-exposure-in-the-non-occupational-environment/

SiteSafe, (n.d. 2015-ish?), *Dust Protocol Canterbury Safety Rebuild Forum*, Retrieved from https://www.sitesafe.org.nz/globalassets/guides-and-resources/best-practice-guides/dust-protocol-v2.pdf

Shrivastava, D.K., Kapre, S.S., Cho, K., Cho, Y.J., (1994), *Acute lung disease after exposure to fly ash.* Published in PubMed/Chest, [abstract]. Retrieved from https://www.ncbi.nlm.nih.gov/pubmed/8020301

Truck News, (2016), *Breathing dangerous diesel fumes*, [website] Retrieved from https://www.trucknews.com/features/breathing-dangerous-diesel-fumes/

WorkSafe, (2017), *Silica dust in construction (fact sheet)* Retrieved from https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=4&ved=0ahUKEwikmqeRpJrcAhVEv7wKHbmrB2gQFghFMAM&url=https%3A%2F%2Fworksafe.govt.nz%2Fdmsdocument%2F2692-silica-dust-in-construction&usg=AOvVaw2oPbAsW9QY-ROnpXDOP8WI

WorkSafe, (2017 b), *Working with experts to find innovative solution to airborne dust*, [website] Retrieved from https://worksafe.govt.nz/the-toolshed/case-studies/work-related-health-case-studies/working-with-experts-to-find-innovative-solution-to-airborne-dust/

WorkSafe, (2016), *Wood dust: controlling the risks*, Retrieved from https://worksafe.govt.nz/topic-and-industry/dust-and-fumes/dust/wood-dust-controlling-the-risks/

World Health Organisation, (WHO), (n.d.), *Hazard Prevention and Control in the Work Environment: Airborne Dust*, Retrieved from http://www.who.int/occupational_health/publications/en/oehairbornedust3.pdf

World Health Organisation, (WHO), (2018), *Lead Poisoning and Health,* Retrieved from http://www.who.int/news-room/fact-sheets/detail/lead-poisoning-and-health

Footnotes

[1] ****Oxidative stress =*** An added complication caused by the metals oxidising (reacting) with moisture and gases in the body. (Lee *et al*. 2010). The body is starved of oxygen at a cellular level.

[2] To differentiate when diagnosing between asbestosis and silicosis, location of the diseased tissues plays a role:

> "For a diagnosis of asbestosis, pulmonary parenchymal scarring must be present. Pleural disease alone is *not* enough. Furthermore, patients with any exposure to asbestos are at increased risk for mesothelioma (cancer in the lining of the lungs, abdomen, or heart)—even in the absence of pulmonary or pleural disease. Silicosis is upper lobe predominant … keep in mind that tuberculosis incidence is increased in persons with silicosis. All patients with silicosis should undergo purified protein derivative testing (kidneys) and tests for an increased incidence of scleroderma (skin) and rheumatoid arthritis. (joints)" (Rutecki 2014)

Tables

Engineering controls	**WES-TWA**
Calcium Silicate	10mg/m3 (as inspirable dust)
Crystalline silica:	10 mg/m3 (as respirable dust)
Quartz (Silicon Dioxide)	0.1 mg/m3 (as respirable dust)
Cristobalite	0.1 mg/m3 (as respirable dust)
Cellulose (Paper)	10mg/m3 (as inspirable dust)

Table 1: from (Hardies 2017): Hardies recommends exposure monitoring and sets admissible levels in their safety data sheets. Compare these with the WorkSafe limits for all airborne dusts, set at 2 mg/m^3 for all dust, in 2012.

Figures


BEWERKINGEN AAN STEENACHTIG MATERIAAL

ACTIVITEIT	KWARTSSTOF IN DE LUCHT (MG/M3)	
- ZAGEN	TOT CA. 15	(= 200 X TEVEEL!)
- FREZEN (SLEUVEN)	TOT CA. 15	(= 200 X TEVEEL!)
- FREZEN (VLAKKEN)	TOT CA. 15	(= 200 X TEVEEL!)
- BOREN	TOT CA. 2,5	(= 33 X TEVEEL!)
- SCHUREN/SLIJPEN VAN VLAKKEN	TOT CA. 15	(= 200 X TEVEEL!)
- VEGEN	TOT CA. 1	(= 13 X TEVEEL!)

Figure 1: Screenshot from Dutch video report (Inspectie 2015) of Silica dust exposures, shows sawing (zagen) and sanding (schuren) creating 200 times the recommended EU 'dose'; milling, grooving and chipping (frezen, sleuven, & vlakken) has 200 times the recommended exposure; drilling (boren) will give 33 times; while sweeping (vegen) can be 13 times the exposure rate deemed to be safe. (Kwartsstof = crystalline silica dust, teveel = too much)