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Nanotechnology– balancing accident reduction with potential health risks in construction

Topic - Emerging/new technologies, materials and practices

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Nanotechnology involves working at a sub microscopic level with particles or structures which are 1-100 nm in size – one nanometre being a billionth of a metre. Nanotechnology has the potential to reduce certain health and safety risks in the construction industry. It also offers improved material functionality and performance. However, there are unresolved concerns regarding the health risk from some nanomaterials. It is important that the adoption of these new materials does not increase the risk of occupational ill-health, described by Gibb et al (2006) as a 'slow accident'. The IOSH-funded research on which this paper is based is assessing the use and benefits of nanomaterials in construction through literature review and interviews with industry stakeholders. The research is also exploring the potential for harm, particularly during demolition and recycling at end of life, by testing nano-enabled construction products in a laboratory environment.

The benefits of nanotechnology – reducing worker risk

European Directives put requirements on designers to consider the health and safety of those who construct, maintain and demolish our buildings and infrastructure, and nano-enabled products can be a part of this. For example, self-cleaning glass (containing nanotitanium dioxide) reduces accident risk by negating the need for workers to access difficult high-level areas in order to clean windows – the rain does the work for them. Self-compacting concrete (containing silica fume, which is a nano-form of silicon dioxide) removes the need to vibrate wet concrete and to powerfloat the surface to make it flat and smooth: both of these operations being ones which are significant contributors to hand-arm vibration and other musculoskeletal disorders. An example from outside construction is the use of nanosilver. This is incorporated into paints and coatings where its antimicrobial properties help reduce the risk of infection spread in healthcare environments, protecting both staff and patients.

The risks of nanotechnology

However, nanotechnology also brings potential risks. For example, some of the desirable functional properties arise from the increased reactivity of the constituent particles, a consequence of their very high surface area-to-mass ratio; but this increased reactivity might also increase their potential for harm. This has led NIOSH in the USA to set a recommended airborne exposure limit for nanotitanium dioxide of 0.3 mg/m^3 (NIOSH 2011). This compares to the limit for non-nano titanium, which is 2.4 mg/m^3. However, the likely health risk also varies substantially between different nanomaterials. One which has caused particular concern is Carbon Nanotubes (CNTs) which can have asbestos-like effects due to their needle like shape and bio persistence. NIOSH has set an airborne limit here of 0.001g/m^3 (NIOSH 2013), although it is important to note that not all CNTs appear to be similarly toxic. The risks arising from nano-enabled materials are clearly important for those working in production but are also of concern for those in the construction industry who are using the products and those who demolish buildings at end-of-life.

Finding a balance

One way of minimising the risk from nanomaterials is to only develop applications for those which are less toxic. For example, silica seems to be one of the most widely used nanomaterials in the construction industry, being included in many surface coatings and some insulation materials as well as concrete. The risk from nanosilica is generally considered to be low to medium compared to other nanomaterials (Napierska et al 2010, Som et al 2014). Selecting safer forms of particular materials is also important –for example short, tangled CNT are recognised as being less hazardous than longer ones (Donaldson et al. 2013). An additional control mechanism is to stabilise nanomaterials such as CNTs within a matrix to ensure that free particle are not released during use or disposal. However, it is important that such a matrix remains stable over time in the face of challenges such as weathering and maintenance; and ultimately at demolition, recycling and disposal

There is still insufficient data regarding the hazard potential of nanomaterials to support good decision making on their use. A particular risk is that as materials become cheaper and more widely available, their usage may increase outside their original scope, so that any risk becomes disproportionate to the benefits. This is illustrated by an increase in the use of nanosilver outside of healthcare environments – it is added, for example, to socks, washing machines and hairdryers. Whilst there is no strong evidence for its toxicity to humans, concerns have been raised regarding adverse environmental consequences and the development of microbial resistance (SCENIHR 2014). CNTs are only just beginning to be used in construction, with their inclusion in some specialist coatings as well as pre-commercial trials for use in concrete. It is difficult to predict which forms may be used in the buildings of the future, or even which ones may be in use currently; and whether their potential to cause harm is taken into account when selecting them, and whether it outweighs the benefits they might bring. Nanotechnology offers substantial societal benefits, and can contribute to improved health and safety in many arenas. It is essential however, that this is balanced by an accurate understanding of any additional risks which may arise from its application.

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