BREATHE FREELY

Controlling Exposures to prevent occupational lung disease in the construction industry

BOHS British Occupational Hygiene Society

The Chartered Society for Worker Health Protection

Case Study

Crossrail

Silica dust control in sprayed concrete lining

Building the business case for prevention

Crossrail's Tunnel Boring Machines (TBMs) have constructed 42km of new tunnels for the trains to run through in 2018. In addition to this, 14kms of the new separate tunnels (cross-passages and platform tunnels) have been constructed using the Sprayed Concrete Lining (SCL) technique. Managing the health risks to workers in Europe's largest construction project clearly requires an overreaching occupational health programme. In the context of SCL, this has meant implementing dust exposure control measures, which, with 90% of the SCL tunnelling complete, have already demonstrated benefits beyond the worker health protection for which they were designed, including cost savings, employee satisfaction, and timescale efficiencies linked to a joined-up approach throughout a complex and multi-project health risk management task.

SCL health risks

SCL is applied to the surfaces of tunnels to provide reinforcement of the excavated area, using robotic spraying rigs. This continuing process of excavating, mucking out, spraying concrete, allowing to cure, breaking out and excavating further, generates a large quantity of hazardous airborne dust which, if inhaled, exposes workers to respiratory health risks. There is usually a particular risk of breathing in fine silica dust (respirable crystalline silica, or RCS) during the breaking out of the concrete and excavation of the soil, as well as during spraying operations. Any workers – nozzle men, pump operators, banksmen, surveyors, inspectors, engineers – who are in the tunnel during the various tunnelling stages are at risk.

Exposure control issues for Crossrail

The vast Crossrail project is split into many different sections of work operated by different contractors, and this is true of the SCL tunnelling operations. Each contractor is primarily responsible for selecting and implementing control measures for their SCL works, and the requirements vary depending on the scope and specifics of the different tunnels. Crossrail has the overriding responsibility to ensure the measures are implemented correctly and meet the requirements set out in BS6164 (the tunnelling standard) and the relevant health and safety legislation. There has to be a high level of cross-party cooperation and coordination between client, contractors, subcontractors and specialist consultants.

In some of these tunnel works, air monitoring showed that exposure to RCS during the sprayed application of the SCL was fairly low, but exposures were higher during the excavation phases. In other areas total inhalable dust presented a bigger exposure risk where levels could be in excess of five times the Workplace Exposure Limit (WEL) for sprayers. At the face of SCL works, other risks - for example the structural capability of newly sprayed SCL prior to curing, and noise – also have to be considered when thinking about dust control solutions.

The nature of tunnelling means that engineering controls can be difficult to implement. An additional issue specific to this project was that the established ventilation set up was to provide fresh air to the tunnels – many of which were originally constructed as launch or receptor caverns for tunnel boring machines (TBMs) – and not specifically to control the dusts from the SCL operations. This meant that although the ventilation had been designed to BS6164 requirements and had the de facto effect of removing airborne contaminants, it couldn't be assumed that it was doing so in the most effective way.

As with all large engineering and construction projects, the sheer number and range of workers requiring access and therefore protection was a consideration. Those at the sharp end – during excavation works and at the spraying face – would clearly be at most risk of dust exposure, but many other workers would also require access too.

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Crossrail control solutions

Material substitution and process modifications

With extraction and ventilation likely to be complex, the Crossrail team designed in process modifications and material substitutions from the start to minimise the use of silica and the risks of dust exposure, and a wet spray mixture with low silica concrete was specified wherever possible. SCL is applied in layers, with multiple coats consisting of primary lining, waterproofing and secondary lining. Wet application is preferred from a health perspective as it generates less dust, but secondary layers often have to be dry applied; however, here, pre-cast blocks have been specified for some of the secondary lining which has reduced the volume of spraying.

Engineering controls

A dedicated ventilation engineer, responsible for the design and balancing of the ventilation system, worked with the occupational hygiene team to ensure that there was not just an adequate supply of fresh air, but also a flexible and effective extraction system too. De-duster units, forced ventilation and spray misters to damp down the dust at the spraying face were utilised when and where necessary.

Administrative controls

Existing safety exclusion zones directly at the face (to eliminate the risk of operatives being hit by falling material) were integrated into the health risk reduction procedures, so secondary restriction zones were positioned behind the first as 'OH' zones, providing clear boundaries where respiratory and hearing protection was a requirement. Access to all restricted areas was strictly supervised, and exclusion zones strictly enforced.

RPE

Disposable dust masks were mandatory for all workers in the tunnel and general vicinity of SCL works. This was upped to powered respirators with positive pressure hoods and a higher APF protection rating of 40 for operatives working alongside the spraying rig in the restriction zones. All SCL crews utilising tight-fitting face pieces were face fit tested, all reusable RPE was subject to a formal daily check and a monthly in-depth 'MOT'.

Monitoring

A programme of personal and environmental monitoring was put in place to measure levels of dust, individual exposures and the effectiveness of the controls. This began with initial surveys to establish where and what the problems were, included checks of any improvement measures, and continued with regular monitoring to ascertain whether anything had changed. Additional ventilation systems (such as the de-dusters installed at the face) were introduced as a result, and the appropriate extent and positioning of the restriction zones was determined through real-time and personal exposure monitoring (typically at a distance of 25m from the face), undertaken by occupational hygienists and, as well, shift managers and engineers who were trained to use the monitoring equipment.

Health benefits

- Minimisation of risk of exposure to silica dust for all workers from the start through use of low silica concrete, wet mix application and pre-fabricated blocks for secondary linings.
- Reduced risk of dust exposure for all workers, including those in closest proximity to the spraying rigs and excavation works, through exclusion/restricted zones, additional ventilation, dust masks and powered respirators.
- Quick response, flexible and measurable health risk reductions in changeable conditions, through rigorous monitoring, ventilation adaptations and appropriate and adaptable restriction zones.

Business benefits

Financial

- Overall budget and timescale efficiencies from the ability of on-site occupational hygienists, working as part of the health and safety management team, to provide speedy and appropriate responses to unforeseen emerging risks leading to cost-effective control solutions.
- Cost savings from strict access controls which reduced the overall requirement for RPE, and from better reusable RPE rather than disposable.

Employee relations

- Improved working conditions for workers at the sharp end, who appreciated the comfort of powered RPE – for many, this was the first time it had been provided.
- Buy-in of better practices, such as clear access boundaries and use of correct RPE, which also made it easier to get sign up to other health and safety procedures.

Social responsibility

- Demonstration that Crossrail's comprehensive occupational health programme extends beyond compliance to best practice, by proactively eliminating preventable ill health and limiting exposures to health risks, through its integrated health strategy.

Crossrail

Park Health & Safety Partnership