Dust masks for Indian quarry workers: A comparative analysis of the filtering efficiency of fabrics

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ABSTRACT: *This paper was designed to suggest a method to help prevent workers from breathing in dust at stone quarries found in Pune, India. This was done by researching and testing various respiratory protective devices (RPD). For this study, dust masks were tested in laboratories by copying the conditions found in various stone quarries found in India. The results of these tests were then compared against the allowable standards seen in Australia and Internationally. It was found that four layers of loosely woven fabrics performed best; however it was noted that even these masks would not be suitable for use in some of the most hazardous stone quarries sites found in Pune, India.*

INTRODUCTION: Since the industrial revolution, there has been a greater awareness of the health effects of breathing in dust particles. In Australia, there are laws and standards that have been put in place to protect workers from dust-related illnesses.

STANDARDS AND LEGISLATION: Unlike Australia, in India there are few standards and laws put in place for workers. In addition to this, these standards and laws are rarely enforced or controlled, resulting in dangerous working conditions for those exposed to high levels of fine dust. Workers in mines and stone quarries are particularly at risk, with many dying from *silicosis* – an illness caused by breathing in dust.

HEALTH RISKS: The health risks that are related to breathing in dust particles depend on both the type of dust and its concentration.

Phenumoconiosis is a disease that causes chest tightness, shortness of breath and coughing. This disease is caused by breathing in dust.

Silicosis is a form of *pneumoconiosis* that affects mine and quarry workers. *Silicosis* is caused by breathing in silica dust in its pure form. As a result, crushing or blasting rocks that contain silica is likely to leave nearby workers at high risk of contracting this disease.

Fibrosis (scarring in the lungs) is most common in an advance version of silicosis. Once you contract this, it cannot be cured, it can only be treated. It has been suggested that clay dust can also cause fibrosis, but usually requires long-term exposure in order for it to have serious effects.

Kaolin, or *china clay*, has been studied for a long time. It was found that *pneumoconiosis* only occurred with workers who were around the highest levels of kaolin dust. Only long-term exposure (~42 years) would cause severe fibrosis.

THE SITUATION IN INDIA:

Due to the lack of enforcement and education about the dangers of breathing in dust, many

people work or live near highly dangerous conditions. The families of these workers are also affected when exposed to high levels of potentially dangerous airborne dust.

The most cost effective way to deal with this situation is to create engineering controls that trap and collect dust at its source. To stop dust from becoming airborne, harming workers' lungs, Australian and International standards state that face masks should be used. Most workers in India do not wear face masks, while others use silk or cotton scarves to reduce irritation. These have poor facial seals and allow air to flow around the scarf, which carry dust with it. Since 1987 studies have showed that the levels of silica in stone crushing workplaces were so high that only six months of working in these conditions would be enough to cause silicosis.

Often patients with signs of silicosis are sent home from Hospitals due to doctors incorrectly diagnosing them. This often makes their illness worse, potentially leading to death. From this it is clear that controlling the levels of dust and using filtration technology is needed.

A study from Kristen Wood from Engineers Without Borders Australia, aimed to address the lack of *RPDs* at these sites. The results of these tests were limiting, leading to potentially a high percentage of errors. Multiple measurements were taken to minimise this error where possible.

METHODOLOGY: Different versions of *RPD* were tested that matched conditions in Indian quarries. A vacuum pump was used to pull air from a dusty environment through varies fabrics that were tested. These tests measured the performance and the rate of flow through each of these fabrics. These results were than compared to three masks that can be bought in Australia. Both the dust and test fabrics were taken from stone quarries that were available in the region. In addition to fabric testing, the dust samples were also analysed by x-ray diffraction.

EVALUATION: Tests showed that some fabrics would not be good for RPDs, but further studies may be required to find the right fabrics for shop-purchased quality masks. While the tightly woven fabrics filtered the dust well, their flow rate drop was still very high. This indicated that they were quick to become blocked with dust, and if used as a mask, it would become very difficult to breathe through.

Based on its low flow drop value, the loosely woven fabrics were tested again, with four layers in each test. This had a much lower penetration value, while maintaining reasonable flow rates during the tests. The masks that can be bought in shops were mostly made of a thick, loosely woven material. While the penetration value for this combination was good, the drop in flow was too high to be used.

An understanding of the dust sample showed that there was no crystalline silica present, and that the material was likely to be a form of clay. This is likely to be harmless to humans if controlled at a reasonable concentration.

CONCLUSIONS: This work has shown that some fabrics would not be suitable for use in designing sample dust masks, while others may be appropriate after additional testing.

Fabrics with tight weaves were too hard to breathe through when dirty, as dust filled small spaces between the fibres and thus stopped the air flow. Also many layers of loosely woven fabrics may allow for less resistance. This is because many paths through the material will be available as others fill with dusts. Loose fibres will also help bridge the gap between threads and improve the filter.

Natural fibres like cotton may make for better filters: the random curl of natural fibres may contribute to threads which are less dense; also they will bridge the gaps between each other, providing a good filtration of dust with little prevention of air flow.

Simple water spraying or dust extraction systems may be enough for use at the stone quarry sites, with masks using the four-layer loose weave fabrics as another option. For use at sites with crystalline silica present in the dust, better performing masks would need to be discovered.

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