Asbestos release through degradation of fibercement

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Introduction

This work presents preliminary data on the effects of weathering on fibercement tiles, with emphasis on the release of asbestos due to degradation of the cement. Asbestos-reinforced fibercement is a low-cost building material widely used in Brazil and other developing countries. Besides its relatively low price, several technical properties contributed to make of this material a huge commercial success. Around 70% of the buildings in Brazil are covered with fibercement, and almost 90% of the Brazilian asbestos production is consumed in fibercement production. Asbestos-reinforced fibercement is composed by portland cement, asbestos (mostly chrysotile) and smaller amounts of cellulose. The asbestos content in the tiles is around 12.5 wt. %.

Although asbestos is widely recognized as hazardous to human health, fibercement is traditionally neglected as a potential source of asbestos contamination. It is usually handled as an inert material and asbestos release is considered only under such conditions as cutting, drilling or crushing fibercement pieces. Construction debris containing fibercement are considered in several countries as inert and no special care is taken concerning their disposal. Degradation of fibercement due to weathering is still relatively underestimated. As any concrete body, fibercement tiles are prone to undergo degradation when exposed to chemical, physical and biological weathering. Degradation of the cement matrix enhances porosity and may lead to detachment of the mineral fibers.

We studied a 25 years old fibercement roof in São Paulo City, Brazil. Tiles were analyzed under optical and scanning electron microscope, and their mineralogical composition was determined by X-ray diffraction. Samples of new, non-weathered tiles were analyzed for comparison. The mineralogical composition of the old tiles comprises chrysotile (asbestos), calcium hydrosilicates (cement), calcite and calcium sulfates. The latter two minerals are not present in new tiles and are formed by carbonic and sulfuric and acid attack during chemical weathering.

Surface analysis

Old fibercement tiles have rough surfaces, where loosen asbestos fibers can be easily seen with hand lenses or even with the naked eye. The fibers are also easily removable by touching. Weathering

features are more pronounced along the hinges of wave-like corrugated tiles, as these regions are more fractured, probably due to residual tensions from the manufacture process. There is a clear contrast between the upper and lower surfaces of the weathered tiles; the unexposed surface has much lower porosity and its fibers are quite fixed in the cement. The same contrast is observed where tiles overlap, whereas the underlying portions of the tiles remain unaltered, resembling new ones.

Under the scanning electron microscope, the upper surface of the tiles display an enhanced porosity, revealing huge amounts of asbestos fibers detached from the degraded cement (Figure 1). A weathered upper portion, about 2mm thick, is clearly seen, contrasting with the inner parts of the tile which are still well preserved. Biogenic structures resembling bacteria colonies were observed inside some of the pores.

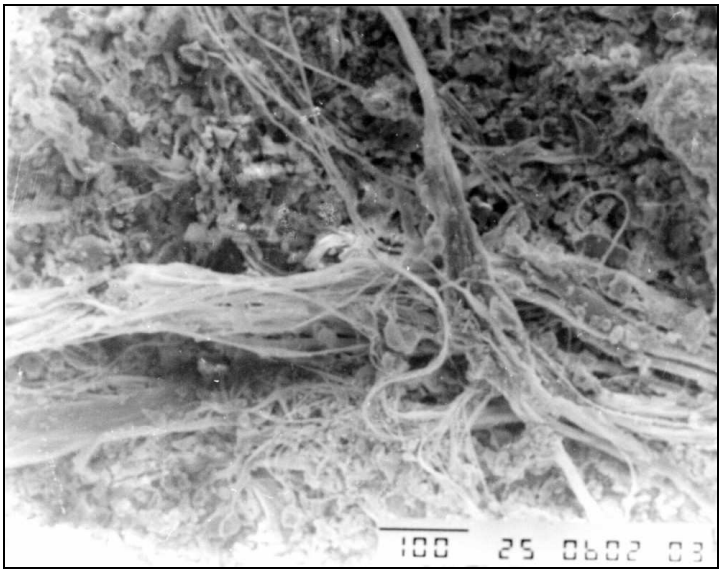

Figure 1. Scanning electron microscope image of loosen asbestos fibers in the upper, weathered surface of an old fibercement tile (scale bar = 0.1mm).

Asbestos release

Looking for detached asbestos particles in the environment around the tiles, two procedures were performed: (a) sampling of particulate solids in the atmosphere right above the tiles; and (b) analysis of particulate solids carried away by water impact and flow over the tile surface. The air sample corresponds to 330m^3, continuously sampled along 17 days in a pump apparatus placed 1 meter above the tile. While, for the other test, 20 liters of water were poured over the tiles and collected in its lower end. Solid fractions in air and water samples were collected in filters and analyzed under the electron scanning microscope.

Among the solids identified in the atmosphere and water samples, there is a large predominance of soot, as the sampling site is not far from major urban roads. Fibers are much lesser in volume,

comprising mostly cellulose and rare asbestos. Solid fraction carried by water also contains quartz and clay minerals.

Weathering simulation

An experiment of accelerated weathering was performed with fibercement samples immersed in distilled water at 60^{o}C in a glass Becker. The whole experiment took 56 days, corresponding to approximately 15 years of natural weathering. Four samples of new fibercement were cut under current water to avoid inhalation of asbestos, and carefully clean before being immersed in water. The samples were taken from the water, each at a time, after 14, 28, 42 and 56 days to measure their porosity. Using a non-weathered sample as a reference, a steady, non-linear increase in porosity was observed. Our preliminary data suggest that the longer the weathering, the higher the rate of cement degradation.

Solid residues were collected from the bottom of the Becker and analyzed under the electron scanning microscope, which confirmed the presence of asbestos fibers detached from the tile samples.

Conclusion

Fibercement tiles are potential sources for asbestos contamination. Progressive degradation of the cement in this material enhances porosity and loosens mineral fibers from the tiles. Fibercement cannot, therefore, be considered as an inert building material. Additionally, chemical weathering caused by acid attack of fibercement is stronger in industrial urban areas such as São Paulo, where rain water has a higher acidity than elsewhere.

Taking into account the vast areas covered by fibercement in Brazil and other countries, as well as the cumulative effects of progressive weathering of old roofs, the positive effects of a possible prohibition of asbestos-reinforced fibercement in civil construction would be only fully achieved if old fibercement roofs were replaced by safer materials. After removal, fibercement should to be disposed in controlled sites to avoid asbestos contamination of the surroundings.