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CASALE MONFERRATO REMEDIATION: ASBESTOS POLLUTION AND SAFETY MEASURES TO PROTECT WORKERS AND ENVIRONMENT

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Abstract

Asbestos is considered one of the most harmful occupational carcinogens causing more than 100,000 deaths per year and exposure to airborne asbestos fibers is held responsible for half of the deaths from occupational cancer (caused by mesothelioma, asbestos-related cancer and asbestosis). Because of this, this substance is now banned in 52 Countries, including Italy, which prohibited the extraction, and marketing of asbestos in 1992. Many areas have therefore been identified in this European Country as highly contaminated by asbestos. Among them also the area of Monferrato, which includes the Municipality of Casale Monferrato and 46 neighboring municipalities. The Eternit asbestos cement plant, located in the municipality of Casale, caused the contamination. The aim of this paper is to describe the complex remediation activities conducted in this wide area, located in northern Italy, highlighting the main phases and the most important issues during the remediation execution; moreover the purpose is to recall the appropriate prevention and protection measures to adopt to prevent new asbestos exposures and to emphasize their importance. This study can serve as an important reference for the academic participants involved in this field at European or international level.

Keywords

Asbestos, Remediation, Pollution, Safety Measures

1. Introduction

In recent years, the media has brought to the forefront worldwide the issue of asbestos, highlighting various health and environmental concerns. The term "asbestos" refers to a group of minerals (Chrysotile, Crocidolite, Amosite, Tremolite, Anthophyllite, and Actinolite) whose commercial success has been determined by their unique technical characteristics, which are considered "unparalleled." These minerals are capable of withstanding fire, heat, chemical and biological agents, abrasion, and wear. They are also easily woven, possess sound-absorbing and thermal insulating properties, and readily bond with other substances such as lime, plaster, cement, and certain polymers like rubber and PVC. Due to their technical characteristics and low cost, various mixtures incorporating asbestos, primarily with cement, plastics, bitumen, and paints, were developed, leading to the production of over three thousand types of asbestos-containing products (ACPs), with asbestos content ranging from 10% to 99% by weight.

These materials were mainly used in sectors such as shipbuilding, railway rolling stock, metallurgy, steelmaking, metalworking, automotive industry, military industry, asbestos-cement industry, construction, sugar refineries, agriculture, oil refineries, textiles, and the glass industry. The Industrial activity had a notable boost in the post-war era, during which asbestos was considered a strategic material (WHO, 2019).

Estimated global consumption of asbestos minerals is currently around 1 million tonnes, mainly for asbestos-cement products. Chrysotile accounted in the past for more than 85% of all asbestos extracted and is at present mined and used predominantly in Asia and Eastern Europe. In recent years, the world leaders in the production of asbestos have been Russia, China, Brazil, Kazakhstan and India, while China is the first world consumer, with 570,000 tons used in 2015. The asbestos extraction by these countries has been declining sharply, although the natural reserves remain enormous (Ro-Ting, L. et al., 2007).

The extraction of the mineral by these mentioned countries has been sharply declining, while the natural reserves of the mineral remain enormous.

Table 1: *Global Production and Mineral Reserves in Tons*

World Mine production and Reserves:			
	Mine production		
	2020	**2021**	**Reserves**
United States	no data	no data	Small
Brazil	71.200	110.000	11.000.000
China	120.000	120.000	95.000.000
Kazakhstan	227000	250.000	Large
Russia	720.000	700.000	110.000.000
Zimbabwe	8.000	10.000	Large
World total (rounded)	**1,100.000**	**1.200.000**	**Large**

(Source: U.S. Geological Survey, Mineral Commodity Summaries, January 2022)

Many epidemiological studies have demonstrated the carcinogenicity of these fibers, and as a result, it has been classified by European legislation (Regulation EC 1272/2008 concerning the "Classification, Labeling, and Packaging of Substances and Mixtures" - Table 1) into:

- Hazard Category 1A - known to be carcinogenic to humans, classification largely supported by human evidence;
- Hazard Category STOT RE 1 - specific target organ toxicity, upon repeated exposure.

The hazard statements are:

- H350: may cause cancer;
- H372: causes damage to organs through prolonged or repeated exposure.

As a consequence, asbestos has left behind numerous problems related not only to health aspects but also concerning the remediation activities and disposal of Asbestos-Containing Waste (ACW).

2. Context

2.1. International Legislation

Many countries have already banned (Opinion of the European Economic and Social Committee, 2014) the extraction and commercialization of asbestos (European Union, Japan, etc.) and are now engaged in remediation actions and management of Asbestos-Containing Waste (ACW).

Historically, Europe has heavily utilized this substance, to the extent that between 1920 and 2000, it used over 50% of the asbestos commercially traded worldwide. Currently, it bears the largest global burden of asbestos-related diseases as a consequence of its extensive use and asbestos is the major cause of work-related cancer, with as much as 78 % of occupational cancers recognised in the Member States.

Within the European Union (IARC, 2012 – 1; IARC, 2012 - 2), which represents only 13% of the world population, the most asbestos-related deaths have been recorded, accounting for approximately 56% of global mesothelioma deaths and 41% of asbestosis deaths.

In this context, the European Commission has banned the commercialization and use of products or substances containing asbestos since 2005. Currently, the final discussion is taking place in Brussels (Resolution EU - P7_TA 0093, 2013) regarding the future Directive of the European Parliament and of the Council amending Directive 2009/148/EC on the protection of workers from the risks related to exposure to asbestos at work.

At present, it is still being optimized. The current text briefly states that, after a two-year implementation period, the new Occupational Exposure Limit (OEL) of 0.01 asbestos fibers per cm^3 will come into effect. After a transition period of six years, Member States will be required to use only electron microscopy, excluding phase-contrast optical microscopy, which is currently allowed. Later this six years, two options will be possible:

- reducing the asbestos limit value in air to 0.002 f/cm³, excluding the counting of thin fibers (<0.2 μm),
- setting it at 0.01 f/cm³ counting thin fibers (<0.2 μm).

The regulation always emphasizes the importance of risk assessment, considering removal as the preferred option.

2.2. Italian legislation

In regards to Italy, it is important to note that in the past, approximately 3.7 million tonnes of raw asbestos produced between 1945 and 1992 were used, along with around 1.9 million tonnes of imported raw asbestos during the same period, considering it as a strategic material. However, exports declined due to competition from Canada, and production levels gradually decreased, ultimately ceasing in 1992 with the ban on the substance. Most of Italy's raw asbestos fibers were extracted from the Balangero site in Turin, which was the largest asbestos mine in Europe, and the Emarese site in the Aosta Valley.

Today, many asbestos-contaminated sites still remain, requiring significant remediation and disposal of ACW. Many facilities that produced asbestos were left highly contaminated by companies, and the Italian government had to undertake their remediation to protect the surrounding urban residential areas (Paglietti, F. et al., 2010; Bellagamba, S. et al., 2018).

Among them, the most emblematic and internationally renowned case is the Casale Monferrato production plant in Piedmont. The safe management of this remediation involved the collaboration of multiple public administrations (Ministry of Environment, Region, Municipalities, Local Health Authorities, Regional Environmental Protection Agencies, etc.) with the technical and scientific support of national scientific institutions. It represents a significant case study that has led to the redevelopment of the territory, including land use recovery, resulting in positive health, environmental, and economic outcomes.

2.3. Casale Monferrato case of study

In 1998, the Casale Monferrato site was declared a Superfund Site (SS) to remediate, encompassing the territory of 48 municipalities (Comba, P. et al., 2018; Marsili D. et al., 2019) with a total area of 739 km².

It housed the Eternit and Fibronit plants, which accounted for over 40% of the national production of asbestos-cement products. This led to both occupational and environmental

exposure: workers were exposed to pollution within the production facilities or from the dispersion of fibers from the open-air storage of production waste materials.

Further dispersion of fibers occurred during the transportation of raw asbestos from the station to the plant or finished products from the plant to general warehouses located on the other side of the city, using uncovered vehicles. Reuse of jute sacks, originally containing crocidolite, for mail or agricultural purposes also contributed to additional airborne exposure. Further improper exposures were generated by the transportation and laundering of work overalls at home, the cultivation of gardens or other recreational activities along the contaminated riverbank, the reuse of non-intact and unsellable waste materials, and the use of "polverino" (a waste powder derived from asbestos processing) received for free from the plant and reused as insulating material for attics or paving courtyards.

Moreover, the degradation of asbestos-cement roofs, which were widely spread across the area, also posed an additional risk.

3. Research Aim: Casale Monferrato Remediation

The remediation of the SS site involved the removal of both friable and compact asbestos-containing materials. The main activities carried out were:

1. The remediation of the Eternit plant and surrounding areas;
2. The remediation of the "Polverino" (asbestos waste powder);
3. The remediation of the asbestos-cement roofing in public and private buildings.

4. Methodology: Inail scientific consultancy activity

INAIL, together with the Local Health Agency and Local Environmental Agency, has conducted several inspections in the Casale National Superfund Site, which have identified the main risk situations and also developed "unusual" remediation procedures specific to the environmental context; in fact the wide area extension and high level contamination required site specific evaluation and remediation actions not defined by law. INAIL has also produced technical-scientific advices following applied for this site and then endorsed by the Ministry of the Environment as general Guidelines for all asbestos Superfund remediations. Inail produced more than 20 specific advices, realized more than 20 on-site surveys and participate more than 50

administrative meeting with regional, local and Ministerial administration to define the best strategy to renovate the entire area (Paglietti et al., 2012).

Considering the high amount of indication prescribed, here are reported synthetically only the main precautionary and safety indications provided for the remediation of Ex Piemontese area and to identify and quantify the "polverino" still in place.

4.1. Ex Piemontese Data Collection and Analysis Procedures:

The remediation concerned an area of approximately 16,000 square meters with the presence of residential and school urban settlements frequented by young people. The asbestos-containing material was found both in friable matrix and in highly fragmented compact matrix, at depths of up to 1.40 meters, with a quantity of approximately 14,000 cubic meters. Below are the main prescribed measures:

- Operate with static and dynamic enclosures, not exceeding 10,000 cubic meters, in order to allow sufficient air exchange.
- Access to the entire "Ex Piemontese" area must only be through the Personnel Decontamination Unit (PDU) located at the site entrance, following the correct entry/exit procedures.
- Appropriate PDUs and Material Decontamination Units (MDUs) must also be set up at the entrance of each individual confined area (work lot).
- After the remediation of each lot, the concentration of asbestos in the soil must always be verified to be < 1000 mg/kg through sampling and analysis at the bottom and walls of the excavation.
- In confined areas, a certification of reusability of the areas must be carried out if the asbestos concentration in the air does not exceed 0,002 f/cm3. Ambient air sampling should be performed using high-flow pumps at a rate of 8-10 liters per minute, with a minimum of 3000 liters sampled, using polycarbonate or mixed cellulose ester filters and analysis using a Scanning Electron Microscope (SEM).
- The ACW (asbestos-containing waste), properly packaged in big bags, must be deposited, categorized and separated by E.E.R. codes, in a statically and dynamically confined temporary storage area.

- After the removal of contaminated material and certification of reusability of the remediated area, the excavation must be covered with a layer of clean soil of at least 20 cm before any potential reuse of the area.
- Wastewater from the PDU must undergo purification using filtering systems capable of retaining particles equal to or larger than 3 microns. Regarding wastewater discharge into the sewer system, the limit to be adopted is 100 f/cm3.
- Workers must wear personal protective equipment (PPE) during their entire stay within the work area and during all work phases, ensuring that the PPE is kept in full working condition or promptly replaced, even during visual inspections or preliminary activities.
- A specific vehicle washing platform must be provided and installed in the immediate vicinity of the site entrance. For the aforementioned platform, if water reuse is intended, a treatment unit must be included that, at the final stage, retains fibers larger than 3 microns. It is necessary to conduct periodic sampling to monitor the clogging state of these filters, followed by SEM analysis on a bi-weekly or monthly basis.
- Before leaving the "Ex Piemontese" area, all vehicles, especially those used for the handling of excavated soil, must undergo thorough cabin vacuuming using a vacuum cleaner with HEPA absolute filters and complete washing (not just the wheels) at the designated platform at the entrance.
- Proper decontamination procedures must be followed for all PPE, equipment, and vehicles that will be used outside the work area after completion of the work.

4.2. “Polverino”: Detection Procedure in Attics

The peculiarity of the Casale Monferrato Superfund Site lies precisely in the use of asbestos dust as residual of factory production in out-door area paving or as insulation in the attics of private residences. This latter case has led to the contamination of high amount of buildings included in the mentioned 48 municipalities. Most of the “polverino” used in in-door areas has already been removed using static and dynamic confined area or permanently secured (where it was too much complicated to remove). However, numerous situations still remain to be verified if still contaminated or not; so, they pose a potential source of environmental contamination and risks for the local health agency surveyors involved in the controls. To this end, a safety procedure has

been agreed upon for inspecting the attics of residential buildings by technicians from the regulatory authorities, aimed at detecting any remaining asbestos dust in place.

The procedure includes, among other things:

- Using personal protective equipment (PPE) such as a category III coverall (with a non-woven fabric of class 3 o 4 o 5), gloves, and a full-face mask with a P3 filter.
- Using a portable vacuum cleaner with absolute filters to vacuum the specific coverall.
- Spraying water on the outside of the coverall when exiting the contaminated area.
- Operators wearing a double coverall that should be removed at the end of the sampling process, ensuring that it is rolled down and outwards to contain the contaminated part inside. The used coverall should be immediately packaged in a dedicated sealed bag for disposal on the ground as asbestos-contaminated waste. All exhausted PPE must be classified with the EER code 15.02.02* - Absorbents, filter materials, rags, and protective clothing contaminated with hazardous substances.
- Removing the plastic sheet protecting the platform at the end of the inspection and packaging it in a double bag and subsequent big bags as soon as it reaches the ground.
- Closing and sealing the access point used for sampling to prevent the dispersion of friable materials in outdoor environments after completion of the operations. All materials used to seal the opening must be brought at the working height before the opening procedure.
- Managing and classifying the waste materials separately from the exhausted PPE.

This procedure has been adopted by all local advisors assuring an higher safety level.

5. Findings

The remediation activities that involved both the Eternit and Fibronit plants and the surrounding areas, as well as various municipalities in the district, resulted in the remediation of a large part of the area. Specifically, the following asbestos-related materials were removed from the former industrial plants:

- Approximately 1,500 cubic meters of friable asbestos piles within the plants.
- 54,000 square meters of asbestos-cement roof, including 15,000 cubic meters of sheets that were disposed of in underground production and decantation basins, later buried and secured.

- 160,000 square meters of demolished surfaces.
- 12,000 cubic meters of friable asbestos from the right bank of the Po River, where an actual "asbestos beach" had formed due to the discharge channel of water from the nearby former industrial plants.
- 700,000 square meters of asbestos-cement roof coverings in public and private buildings.

Furthermore, the remediation of the SS included approximately 25,000 square meters of insulated courtyards and attics containing "polverino," a material that contained about 10-15% asbestos. This material was present in more than 150 spots spread across all 48 municipalities.

For the remediation activities at this site, approximately 47 million euros have been allocated to date, with funding provided by the Ministry of Environment and the Piedmont Region.

Figure 1: *Eternit Factory in Casale Monferrato before and Later Remediation (Source: Authors Composition from Web Images)*

6. Conclusion

This Paper describes the complexity of the Environmental Remediation and Restoration activities carried out at the Superfund site of Casale Monferrato where the former asbestos cement factories Eternit and Fibronit were located. This so complex remediation started in the early ’90, is still in progress, but the major source of fibres dispersion are eliminated and the asbestos concentration level in the town is now much lower than the European threshold limit value. This result has been achieved thanks to the cooperation among the Environmental Ministry which funded the remediation, and the regional and local agencies, coordinated by Inail-Dit to guaranty a maximum level of workers safety.

This paper also show some technical procedures that could be reused in similar situations often encountered in other Countries, like the removal of “polverino” from buildings or how to prevent exposition of health local agencies workers, uncharged to check if asbestos is still present in the buildings.

These procedures, applied in hundreds situations, can be considered strongly accurate and feasibly reproducible in other places. They could be considered useful not only for friable asbestos but also for the safe asbestos cement removal, guarantying the respect of the higher prevention and protection measures established by the new European Directive.

This Directive will be soon approved and will require immediately lower asbestos threshold limits and new analytical technics for asbestos sampling and analysis using after the next six years only the electron microscopy.

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