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Review Paper

REQUIREMENTS AND MANNER OF DISPOSAL OF CONSTRUCTION WASTE CONTAINING ASBESTOS

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Abstract. *According to the categorization and classification of waste materials, asbestos is classified as hazardous waste owing to the presence of asbestos fibers and potential presence of other minerals or metals, such as cadmium or chromium. The waste generated during building construction and demolition mixed with asbestos is considered hazardous. Exposure to asbestos dust is often accompanied by chronic non-specific respiratory conditions. Building demolition waste containing asbestos is often deposited in non-sanitary landfills and dumping sites. The issues concerning the environment and the surrounding population due to non-sanitary disposal of asbestos waste are associated with the hazardous properties of airborne asbestos fibers. This paper discusses asbestos-containing construction waste, its generation, and the conditions for its treatment and disposal.*

Key words: *construction waste, asbestos, asbestos waste*

1. INTRODUCTION

Extensive construction work has resulted in large amounts of construction waste generated through various construction activities, such as building demolition, construction, reconstruction, adaptation, and numerous forms of technical maintenance. Unfortunately, the increase in the scope of construction activities has not been accompanied by the necessary infrastructure for reception and disposal of construction waste, which led to problems in managing this type of waste, often resulting in illegal disposal at inadequate locations. Handling this type of waste requires a special approach.

First of all, the practice of uncontrolled construction and demolition waste disposal needs to be stopped as soon as possible, including permanent disposal at the source, at locations that do not meet the legal requirements. The owner of construction waste needs to be responsible for the cost of construction and demolition waste management and to be obligated to arrange separate collection and temporary storage. In current practice, waste collection is not separated

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from construction and demolition activities. Even though there is a general legal requirement that the waste producer has to collect generated waste separately and to sort it according to subsequent treatment (Art. 26, Law on Waste Management) [1], the requirement is not implemented for construction and demolition waste owing to a lack of subordinate legislation. It is usually the waste with high economic value, such as metal, that is recycled, while other potentially recyclable materials are deposited in landfills or, more often, at unsecured local dumping sites.

Construction waste includes waste generated during the construction of buildings or public infrastructure, reconstruction, maintenance, or demolition of existing structures, and waste from excavated material, which is unusable without previous processing. According to the Waste Catalog, construction waste is categorized as waste group 17, which includes the following:

- Non-hazardous construction and demolition waste including concrete, earth, brick, glass, rock, plastics, tiles and ceramics, copper, bronze, brass, iron, steel, insulation materials, and plaster.
- Hazardous construction and demolition waste including construction and insulation materials containing lead and asbestos, gypsum panels, paint thinners, mercury, fluorescent light bulbs, etc.

The waste generated during construction and demolition is fully recyclable, but there are numerous obstacles to its recycling, as listed below:

- Legal uncertainty of the legal status of reused construction and demolition waste (the end of a material's waste status is still legally unregulated, except for glass, iron, steel, copper, and aluminum);
- There is no proper registry of sources, quantities, and flows of construction waste, although there is a legal framework in place for such a registry, but it is not implemented in practice;
- Construction waste quantities are enormous;
- Large quantities of construction waste are disposed of without proper control;
- There is no system of construction waste source separation;
- Hazardous waste is not separated from construction waste;
- Use of recycled construction materials is not incentivized;
- There is no legal obligation for the waste producer to recycle this type of waste (even though the Law on Waste Management defines construction and demolition waste as a priority waste flow for recycling);
- There is no economic incentive, because mineral waste from construction and demolition may be deposited at a relatively low cost;
- There are no quality standards for reused construction and demolition waste (especially in terms of environmental performance), which leads to liability issues;
- In the building design stage, the issue of construction waste is often neglected and insufficiently regulated through subordinate legislation;
- There is no high-quality construction waste exchange market in place;
- There is no proper communication between all participants in construction waste management [2, 3].

2. ASBESTOS-CONTAINING CONSTRUCTION WASTE

It is well-known that all types of asbestos belong in the first class of carcinogenic materials, because the microscopic fibers lodge inside the lungs and remain there for years, potentially causing various diseases, usually up to decades after exposure. The following are the most common diseases caused by asbestos: asbestosis (scars on lung tissue), lung cancer, and mesothelioma (most often in the pleura and in the peritoneum) [4].

Jobs with high risk of asbestos exposure include construction worker, asbestos excavation operators, asbestos production factory workers, firefighters, insulation workers, industry workers, power plant workers, steel mill workers, etc.

The asbestos-containing waste includes raw asbestos waste and any other material or artifact containing asbestos or asbestos fibers, as well as asbestos dust due to asbestos emission in the air during the processing of asbestos or materials and products containing asbestos [5].

The construction waste containing asbestos includes the following:

- Firmly-bound asbestos waste, containing asbestos and mostly inorganic matter, includes asbestos cement products (flat or corrugated large-format panels, small-format façade and roof sheets), asbestos cement planters etc., pipes for building and civil engineering construction, pipes for irrigation and drainage;
- Asbestos-containing waste is processed using solidification methods, such as processed light construction panels, fireproof and fire-resistant panels, processed asbestos paper and cardboard, etc.;
- Firmly-bound asbestos waste containing mostly organic matter, generated during asbestos processing, includes materials contaminated with asbestos fibers (construction elements and devices used for removing materials that contain loosely-bound asbestos, floor coverings, textile, curtains, foil, insulation materials, protective work clothing), construction chemicals containing asbestos (joint caulks, surface application caulks, fillers and sealing compounds, sealants, plastics and adhesives, paints), other asbestos-containing waste with mostly organic matter (floorings, acid resistant vessels), and waste asbestos solidified with inorganic binders;
- Loosely-bound asbestos waste includes asbestos-containing waste generated during reconstruction or maintenance of parts of structures or devices, asbestos-containing dust, asbestos dust and asbestos sludge (dust particles from filtering devices, raw asbestos generated during asbestos processing, loosely-bound materials containing asbestos from devices and construction elements, asbestos sludge originating from wastewater treatment or demolition of buildings or devices containing loosely-bound asbestos), light panels containing asbestos (light construction panels, fireproof panels, and fire resistant panels).

Figure 1 shows the use of asbestos in materials used in construction.

In the late 1970s, researchers determined potential causes of increased fiber concentrations inside buildings in which asbestos was used for wall surface treatment. According to more recent studies, asbestos-containing materials built into structures do not pose a hazard in terms of fibers floating freely through the air. If asbestos materials are used and maintained properly, it is highly unlikely that asbestos fibers will be released spontaneously. Only when product autonomy has been disturbed can fibers be distributed into the air. Asbestos-containing materials, especially asbestos cement roof sheets, tend to degrade, mostly due to the effects of precipitation and other atmospheric influences, which results in the release of fibers [7].

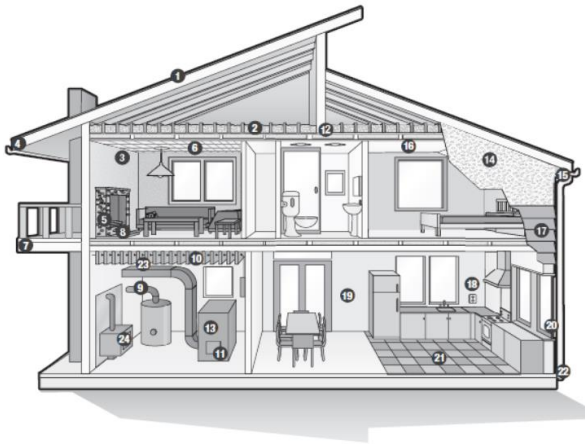

Fig. 1 Use of asbestos in materials used in construction. 1. Roof felt and shingles, 2. Loose, blown-in insulation, such as vermiculite, 3. Incandescent light fixture backing, 4. Roof gutters can be made of asbestos cement, 5. Artificial fireplace logs and ashes, 6. Acoustic tiles, 7. Deck under-sheeting, 8. Asbestos pad under the fireplace hearth, 9. Pipe insulation, 10. Main panel and fuse box; each fuse wire has an individual asbestos flash guard, 11. Door and gasket covers, 12. Backing behind recessed lighting, 13. Boiler and furnace insulation, 14. Asbestos can be found in stucco, 15. Soffit boards can be made of asbestos cement or asbestos insulating board, 16. Textured or stipple-coated walls and ceilings, 17. Asbestos cement (transite) board siding and under-sheeting, 18. Outlets and switches, 19. Gypsum board filling compound, and patching and joint compound for walls and ceilings, 20. Window putty, 21. Flooring: vinyl tiles and linoleum sheet flooring; flooring adhesive, 22. Downpipes can be made of asbestos cement, 23. Insulation on electrical wires, 24. Heat reflector for wood stove [6].

Asbestos-containing construction materials pose low risk to residents' health if the materials are properly maintained so as to prevent asbestos fibers from being released into the indoor environment [7]. Thus, it is necessary to provide professional supervision and regular inspections of the state of such buildings in keeping with the recommendations. Proper monitoring of the buildings' state by the inspectorate and regular building maintenance will prevent the release of asbestos fibers and protect the health of all occupants.

3. GENERATION OF ASBESTOS-CONTAINING CONSTRUCTION WASTE

Asbestos waste in construction is generated during the following operations [3,4,8]:

1. **Earthworks** during construction of roads, canals, reservoirs, etc. The excavated material usually contains partially broken rocks, earth debris, sand, and grit. A portion of this waste may be used at the excavation site (different road construction techniques, as a filling for cavities, building of embankments, etc.). The probability of asbestos emerging during earthworks is low. Asbestos can be deposited in the excavated material

from braking systems of transport vehicles and machinery and thus potentially pose a hazard to workers.

2. **Construction work**: Processing of materials such as tin, paneling, and wood to desired specifications prior to use generates certain quantities of waste. In addition, the quality of materials delivered to construction sites could differ from the quality specified in the order, which results in discarded material and additional waste generation. Negligent handling can generate significant quantities of broken and unusable materials, which usually become waste. Substantial quantities of waste are generated from temporary structures, which are disassembled after the main construction has been completed (auxiliary buildings for workers, machinery, and the like). In general, construction site clearance generates specific amounts of mixed waste. The quantity and type of generated waste primarily depends on the type of building being constructed and the efficiency of control of a given construction company. The main type of waste materials generated during construction work include wood debris, surplus concrete, and broken bricks, blocks and panels. Considering that production of asbestos-containing artifacts is banned, no asbestos waste should be generated from the construction of new buildings.
3. **Building renovation:** Building renovation usually involves the removal (disassembly) of interior construction materials, whereby only the interior load-bearing walls are left standing. In some instances, parts of the roof are partially or completely removed and wooden beams are repaired or replaced if needed. Commercial and other non-residential buildings more often change their owners/users or their purpose. Every new owner/user adapts the building to their own needs, in which case a partial reconstruction is warranted. The main types of waste generated during renovation include gypsum products and mortar, wood, broken panels, concrete, masonry and various other materials, such as flooring, wallpapers, bathroom and sanitation equipment, etc. Renovation may also include the removal of asbestos materials, e.g., in roofs or air conditioners. These procedures require special attention in terms of occupational safety owing to the amount of waste they generate.
4. **Building maintenance**: The quantity of waste generated during regular building maintenance is not large, but it includes light bulbs, electrical switches, sanitation pipes, pipe coatings, and the like, all of which may contain asbestos.
5. **Building demolition:** When parts of residential areas are reconstructed or when areas are prepared for new construction, the existing structures and buildings need to be demolished. The waste generated during such work varies depending on the type and age of the building being demolished. It also contains waste materials produced during building renovation. As with renovation, demolition is also expected to generate asbestos waste, especially for buildings built during and before 1980s, when asbestos was commonly used in construction. Building demolition generates the largest quantities of asbestos waste. When asbestos is mixed with other materials during demolition, all waste thus generated is considered hazardous, which further increases the amount of hazardous waste.
6. **Recovery after catastrophic events:** Natural and other catastrophic events, such as wars, industrial accidents, natural disasters (earthquakes, hurricanes, and floods), and fires can damage asbestos-containing materials and thus expose all persons present (rescue personnel, paramedics, cleaning crews, afflicted population, etc.) to harmful asbestos fibers.

4. MANAGEMENT OF ASBESTOS WASTE FROM CONSTRUCTION SITES

Building demolition waste containing asbestos is often deposited in non-sanitary landfills and dumping sites. The issues concerning the environment and the surrounding population due to non-sanitary disposal of asbestos waste are associated with the hazardous properties of airborne asbestos fibers. When a material such as asbestos is deposited in such landfills, the risk of fibers being released into the environment increases if its structure is compromised (breaking or crushing) [4].

After the correlation had been established between asbestos and serious diseases in humans, many countries first began to control its use and then banned it altogether. Currently, there are more than 50 countries in the world that have completely banned the use of asbestos, including the EU countries (asbestos production and use banned since 2005) [9,10].

Management of construction asbestos waste involves collection, transport, temporary storage, handling, and processing or disposal. [8].

Before transport, asbestos waste from construction sites is enclosed so as to prevent the dispersal of asbestos fibers and dust into the environment. [4].Construction asbestos waste is transported to the disposal site without any reloading. Construction asbestos waste is enclosed in containers or other visibly marked vessels, according to the rules regulating the transport of hazardous materials. Loosely-bound asbestos waste is packed inside bags made of cloth or an artificial material, or in polyethylene foil at least 0.4 mm thick or layers of stretchable foil with total thickness of at least 0.6 mm.

The legal entity or entrepreneur responsible for the transport or disposal of waste containing asbestos fibers or dust has to ensure that during loading, unloading, transport, and disposal there will be no release of asbestos fibers or dust in the air or discharge of liquids containing asbestos fibers, all according to the rules regulating the transport of hazardous materials.

Storage of construction asbestos waste is conducted in such a manner as to prevent the dispersal of asbestos fibers and dust into the environment.

Before removal, asbestos-containing waste is processed using the procedures of surface processing or solidification, or destruction of asbestos fibers, in order to prevent the dispersal of asbestos fibers and dust into the environment.

If asbestos waste does not contain any other hazardous materials except for firmly-bound asbestos and if it includes construction waste containing firmly-bound asbestos, then it is deposited in a landfill without a previous eluate analysis, in accordance with the Law on Waste Management.

If a landfill does not possess a specially designed compartment for asbestos waste disposal, it is stored in a specifically designated area of the landfill until final disposal so as to prevent the dispersal of asbestos fibers into the environment.

Asbestos-containing waste is deposited at a landfill inside special compartments designed for safe disposal of asbestos waste. These compartments are visibly marked and separated from other waste at the landfill. Such waste needs to be covered on a daily basis to prevent the release of asbestos fibers into the environment. The compartments in which asbestos-containing waste is deposited may not be opened. Likewise, the compartments may not be dug or drilled, so as not to release asbestos fibers and dust into the environment. The lining of the compartments is made of PVC and geotextile and then covered. After the compartments have been sealed, a layout plan of the landfill site is created, indicating the exact locations where asbestos waste is deposited. These locations are specially marked [3].

The main issues regarding asbestos and asbestos waste management in Serbia are the following: no data about the precise quantities of generated construction waste containing asbestos; inadequate handling of generated waste and its disposal in non-sanitary landfills; and insufficient capacities of the landfills that possess a license to receive such waste.

5. CONCLUSION

Construction waste comprises waste generated during the construction of buildings or public infrastructure, maintenance or demolition of existing structures, as well as waste from excavated material, which cannot be used without additional processing.

To successfully resolve the issue of construction waste, especially if it contains asbestos, it needs to be managed properly. With the help of current technologies, most construction waste can easily be used as secondary raw materials. This type of waste constitutes around 75% of the total quantity of waste in Serbia. Through recycling, construction waste can be reused, which in turn helps preserve and conserve resources and also protects the environment. Unfortunately, less than 5% of construction waste in Serbia is reused.

Construction waste has a considerable recycling and reuse potential. Around 80% of generated construction waste can be reused, most of it can be used as a secondary raw material, while the remaining portion has to be managed properly.

Recycling produces secondary raw materials, which can then be reused in construction. In order to maintain control of waste disposal, it is crucial to adhere to prescribed waste management measures. The most important measure is the prevention of waste generation, which involves precise and expert planning, while management or disposal of such waste is recommended only as a last resort.

Materials containing asbestos built into structures do not pose any hazard concerning the airborne asbestos fibers. If asbestos-containing materials are properly used and maintained, there is low probability that asbestos fibers will spontaneously become airborne. This is, however, more likely to occur when physical structure of the material has been compromised. Asbestos-containing materials, especially asbestos cement roof sheets, tend to degrade over time, usually due to precipitation or other elements, which results in the release of asbestos fibers.

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USLOVI I NAČIN ODLAGANJA GRAĐEVINSKOG OTPADA KOJI SADRŽI AZBEST

Azbest je prema kategorizaciji i klasifikaciji otpadnog materijala svrstan u opasan otpad zbog prisustva azbestnih vlakana i mogućeg prisustva drugih minerala ili metala poput kadmijuma i hroma. Otpad nastao prilikom građenja i rušenja objekata, koji je pomešan sa azbestom, smatra se opasnim otpadom. Izloženost azbestnoj prašini često je praćena i učestalim hroničnim nespecifičnim oboljenjima disajnog sistema. Građevinski otpad koji sadrži azbest često se odlaže na nesanitarne deponije i smetlišta.. Problemi koji se tiču životne sredine i okolnog stanovništva zbog nesanitarnog odlaganja azbestnog otpada su povezani sa opasnim svojstvima azbestnih vlakana. U radu je prikazan građevinski otpad koji sadrži azbest, njegov nastanak i uslovi pod kojima treba da se tretira i odlaže.

Ključne reči: *građevinski otpad, azbest, azbestni otpad*