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Evaluation of Asbestos in Terms of Occupational Safety in Urban Renewal

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Abstract: Today, urbanization needs to go beyond the need for shelter and meet the necessity for a livable environment. Urban transformation initiates with high disaster risk, environmental risk factors that should be examined in details. Urban transformation is a multi-faceted construction and demolition process. During this demolition period, organic and inorganic dusts emerge, and some chemicals in the debris and excavations react in the environment and cause toxic gases. Electricity, floor and ceiling coverings, water pipes, etc. used in old buildings are destroyed during urban transformation. The presence of asbestos puts employee and public health at risk. These risks are explained in extended amounts of studies in recent years. It has been declared by the World Health Organization that asbestos is a carcinogenic substance and it has been proven that it causes many lung deformations, cancer and other diseases when it enters the body. In this review, the particle size of dusts, what urban transformation means, what kind of construction and demolition process is, how to enter the structure of asbestos from here, handling and disposal of asbestos, which is exposed as a result of demolition in the urban transformation process, from all sides are examined.

Keywords: Asbestos, Urban Renewal, Occupational Health and Safety, Precaution in Asbestos Removal Operations.

Kentsel Dönüşümde Asbestin İş Güvenliği Açısından Değerlendirilmesi

Özet: Günümüzde kentleşmenin barınma ihtiyacının ötesine geçerek yaşanabilir bir çevre ihtiyacını karşılaması gerekmektedir. Kentsel dönüşüm, afet riski yüksek, çevresel risk faktörleri detaylıca incelenmesi gereken unsurları barındırmaktadır. Kentsel dönüşüm çok yönlü bir yapım ve yıkım sürecidir. Bu yıkım sürecinde organik ve inorganik tozlar ortaya çıkmakta, moloz ve hafriyat içerisindeki bazı kimyasallar çevrede reaksiyona girerek zehirli gazlara neden olmaktadır. Eski binalarda kullanılan elektrik, taban ve tavan kaplamaları, su boruları vb. kentsel dönüşüm sırasında yıkılmaktadır. Asbestin varlığı çalışan ve halk sağlığını riske atmaktadır. Bu riskler son yıllarda geniş çaplı çalışmalarda açıklanmaktadır. Asbestin kanserojen bir madde olduğu Dünya Sağlık Örgütü tarafından ilan edilmiş ve vücuda girdiğinde birçok akciğer deformasyonuna, kansere ve diğer hastalıklara neden olduğu kanıtlanmıştır. Bu derlemede, tozların partikül büyüklüğü, kentsel dönüşümün ne anlama geldiği, nasıl bir inşaat ve yıkım süreci olduğu, asbestin buradan yapıya nasıl gireceği, yıkım sonucu açığa çıkan asbestin taşınması ve bertarafı konularına değinilmiştir. Kentsel dönüşüm süreci, her yönüyle irdelenmektedir.

Anahtar Kelimeler: Asbest, Kentsel Dönüşüm, İş Sağlığı ve Güvenliği, Asbest Söküm İşlemlerinde Önlemler.

1. Introduction

Industrialization gradually gained speed in the world after industrial revolution. A wave of migration from rural settlements to the city began, and therefore the concept of unplanned urbanization

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emerged. Especially in Türkiye, after the 1990's, the unplanned urbanization that endangered the public health caused urban transformation. The acceleration of the industrialization and urban transformation process in recent years has necessitated the investigation of a large-scale dust problem within the framework of public and worker health. The spread of toxic dusts that harm the human body into the environment endanger human health in the long and short term and must be prevented. A serious legislative study has been carried out to eliminate the exposure of asbestos, which is one of the most important toxic dusts, in the world and in our country. Protection of industry and related worker health and safety is the top priority.

The use of asbestos has been banned in Türkiye since 2011. However, this could not prevent the existing asbestos hazard. In particular, the structural properties and cheap cost of asbestos have made its industrial use increasingly widespread. That's why asbestos, which is used in almost every field, especially in buildings, insulation, water pipes, electricity, roofing, etc. should be carefully managed. It is also used extensively in areas that endanger the health of workers and the environment during demolition.

The increase in urban transformation projects in recent years escalated the contact with asbestos. In this sense, the enacted legislation should be followed, asbestos exposure should be minimized and necessary studies should be carried out for the health of both employers, workers and civilians.

The aim of this study is to discuss how asbestos exposure caused by urban transformation can be prevented in terms of worker and public health. For this purpose, a review is presented where the concept of urban transformation has been explained, the chemical structure of asbestos has been examined, and where it is used in buildings. It has been specified in detail, and the precautions to be followed by the workers in terms of occupational safety in asbestos removal works have been stated. Furthermore, the legislation in Türkiye has been mentioned in this sense.

1.1. Urban Transformation Concept

The concept of urban transformation was first used in the early 20th century. After the industrial revolution, the idea of transformation was put forward in order to improve the inhumane environments in which the worker population in the cities had to live, and to make the existing one more livable (Şahin ve Bingöl, 2022).

The concept of urban transformation, has more than one definition in the literature. These are the policies put forward by the government in order to solve the disturbing urban difficulties of developed cities in the USA and England. Today, it is a concept that has been mentioned a lot, especially in terms of its application in Türkiye. Urban transformation is an action plan that tries to solve the economic, physical, infrastructural, social and environmental problems of the city (WHO and PAHO, 1997). In other words, it is the revival of the deteriorated economy in cities, the functioning of social functions that do not work, renewal in areas with social exclusion, and finally re-establishing this balance in areas where environmental pollution has increased (Roberts, 2000).

The Gölcük earthquake in 1999 and the Van earthquake in 2011 caused the urban transformation laws to be reconsidered. The existing laws were revised and it was decided to issue a new basic law. The purpose of Urban Transformation, is to increase the common spaces and social reinforcement areas in order to eliminate the housing and public deficiencies in the cities with the migration and population growth of the cities (Yasin, 2005). Enhancing the safety of old buildings and revitalizing their aesthetics is crucial. In addition, urban transformation projects aim to redevelop the infrastructural, environmental, economic and social needs of cities (Aydın and Turan, 2012; Ataöv et al., 2007). Due to these reasons, the Law No. 6306 on the Transformation of Areas Under Catastrophe Risk was enacted in 2012 (Üzmezoğlu and Ocaktan, 2017; Akkar, 2006).

Urban transformation projects gained momentum and demolition and conversion of approximately 7 million independent units covering a 20-year period was projected after the publication of the law (Demir, 2016). As part of urban transformation efforts, simultaneous demolition began in Türkiye on 3,169 buildings, 6,404 residential flats, and 34 service buildings, encompassing both public and private properties. Starting on October 5, 2012, the blasting method was extensively used in multiple cities across 35 provinces where simultaneous demolition was initiated (Demir, 2016).

During the destruction caused by the urban transformation projects, it was predicted that a large amount of waste would occur. The predicted waste would might come from rubble as 2.5 million tons and additionally a large amount of unpredicted excavation wastes could form. Many organic and inorganic dusts and fumes such as crystal glass fiber, wood dust, liquid petroleum products, lead, mold, fungus, which come out with the demolition processes, might appear. Among these pollutants, asbestos holds significant importance due to its association with diseases that have high mortality rates, morbidity, and disease burden (Üzmezoğlu and Ocaktan, 2017).

1.2. Asbestos

Dust according to the International Standards Organization (ISO4225-ISO1994) is being defined as, matter consisted of small solid particles smaller than 75 microns, which can hang in the air or precipitate under their own weight (World Health Organization (WHO), 1997). According to the risk of inhalation, particulate matter (PM10 and PM2.5) is one of the most dangerous types of pollutants. Due to all the negative effects, particulate matter pollution in the atmosphere must be constantly monitored. Particles less than 3 μm in diameter, greater than 5 μm in length and at least three times the width of the particles are classified as fibrous dust. Asbestos and similar minerals are also referred to as "fibrous minerals" due to these fibrous structural properties. (Zeydan, 2021).

The word asbestos means "indestructible, incorruptible, very durable". The most important asbestos mineral deposits in the world are located in China, Russia, Kazakhstan, Canada, Brazil and Zimbabwe. In Türkiye, Eskişehir, Kütahya, Bilecik, Yozgat, Sivas and Diyarbakır are the provinces where contact with asbestos is most intense. The total country reserve is around 1.5-2 million tons (Akboğa et al., 2017). Asbestos mineralogically is divided into two groups as serpentine and amphobic. The amphibole group is a harmful type of asbestos and has a hard, needle-like structure. Serpentine group asbestos is less dangerous than asbestos in the amphibole group. Chrysotile (white asbestos), crocidolite (blue asbestos), amosite (brown asbestos) are the most used asbestos types (Akboğa, et al., 2017). Asbestos is a fibrous, soft, mineral material that does not change in fire, has poor thermal and electrical conductivity, and resistance to microorganisms. The structure of asbestos in a construction material is illustrated in Figure 1. The structure of different types of asbestos as mineral and fiber is shown in Figure 2. These natural properties of asbestos make it an ideal insulating material. In addition, it is highly resistant to heat, abrasion and corrosion, its melting point is above 1200°C. It is resistant to acids and bases. It has the feature of mixing with cement and similar materials. Different asbestos types were used in construction materials to enhance resistance to tensile compression, alkalinity, heat, chemical effects, bending, and electricity in the past. They had high performance against corrosion, abrasion or burning. They had high fluidity, low thermal conductivity, high flexibility. In the past, its favorable attributes included easy application procedures and low cost. In the industry; it started to be used towards the end of the 19th century, and especially at the beginning of the 20th century (1930-1970), the use of asbestos spread all over the world with the production of asbestos cement by mixing asbestos fibers into the cement (Demir, et al., 2018). It has been used in up to 3000 commercial products, especially in the industrial sense, from construction to ships, automobiles, and the textile sector (Yeşilyurt, 2016). Asbestos use in buildings, ceilings, exteriors, floors, pipes, sewer lines, walls, floors, beams, columns and other building elements, in

short, asbestos has been used in almost every part of industrial materials. (Akbel and Özdemir, 2020). The usage areas of asbestos are demonstrated in Figure 3.

Figure 1. Asbestos in a Construction Material (Çember, 2022).

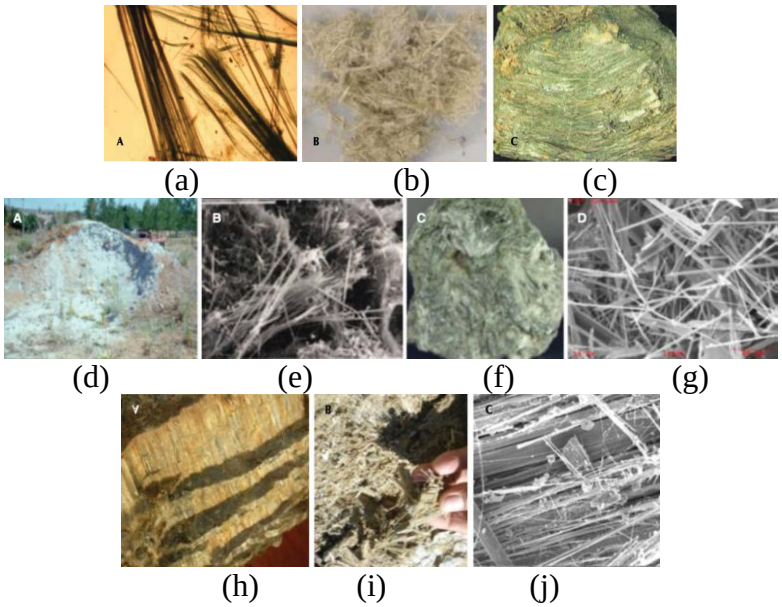

Figure 2. Different perspectives of asbestos types (a) Crocidolite mineral*, (b) Amosite mineral fibers microscopic view*, (c) Anthophyllite mineral rock appearance*, (d) Tremolite asbestos pile**, (e) Tremolite fibers SEM image** (f) Actinolite mineral appearance**, (g) Actinolite fibers SEM image** (h) Banded view of chrysotile asbestos fibers (white parts)**, (i) Fibers**, (j) Scanning electron microscope (SEM) image of chrysotile asbestos fibers** (*Atabey, 2009,**Atabey, 2015)

After the first quarter of the 20th century, it was declared as a “Group 1A” carcinogen in the "Carcinogenic Substances" list by the World Health Organization (WHO) and the International Cancer Research Center (Akboğa et al., 2017). Asbestos enters the human body through respiration, digestion or skin contact, creating a carcinogenic effect and causing various diseases. Ingestion of asbestos fibers is relatively less dangerous than inhalation. While asbestos fibers taken by digestion can be removed from the human body, when inhaled, they remain in the lungs due to the chemical effects and resistance of asbestos to microorganisms, causing incurable diseases (Arseven et al., 2005). Asbestos entering the body through respiration causes fluid accumulation between the lung membranes, calcification, thickening of the lung membrane and diseases that form connective tissue in the lung tissue (Akboğa and Baradan, 2011).

According to the WHO, approximately 125 million people in the world are exposed to asbestos in the workplace. According to the calculations of WHO, 107,000 people die of lung cancer every year as

a result of mesothelioma disease due to asbestos use. According to these calculations, it is estimated that about half of occupational cancer-related deaths are caused by asbestos. It is also estimated that thousands of deaths from cancer each year are attributed to exposure to asbestos in the home (WHO, 2018).

The global data on asbestos has provided insights into the harmful effects of asbestos on humans, including its impact on mortality and morbidity rates. Occupational asbestos exposure is unknown in our country because adequate records are not kept. Since respiratory failure or other respiratory diseases are recorded in death records in Türkiye, it can be said that there is almost no data on asbestos exposure (Üzülmezoğlu et al., 2017).

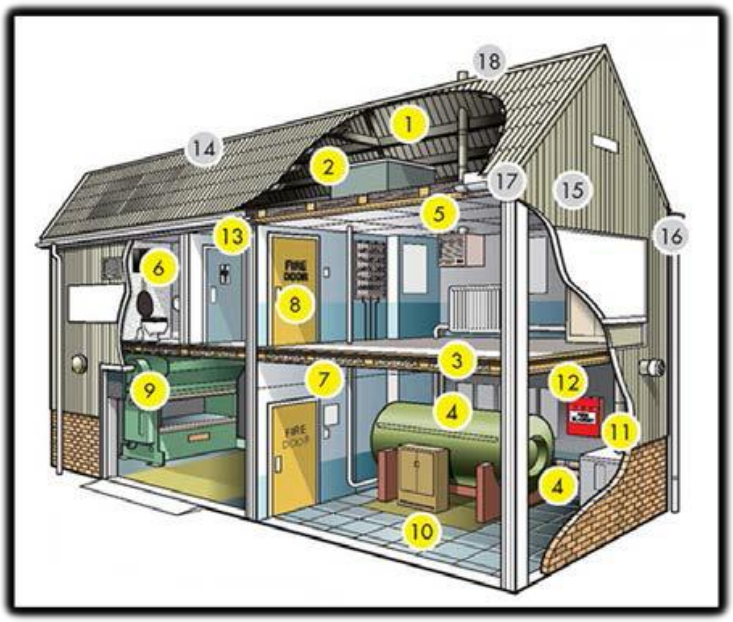

Figure 3. The usage areas of asbestos in Buildings (Ministry of Labor and Social Security, 2022; 1) Spraying asbestos on ceilings, walls, beams and columns, 2) Asbestos Cement Water Tank, 3) Loose Fill Insulation, 4) Coating in Boilers and Pipes, 5) Ceiling Covering, 6) Toilet bowl, 7) Partition Wall, 8) Fire Door, 9) Asbestos Ropes and Gaskets, 10) Marleys, 11) Asbestos Panels Around the Boiler, 12) Fire Blanket, 13) Decorative Coatings on Walls and Ceilings, 14)Eternite, 15) Asbestos Cement Panels, 16) Asbestos Cement Chutes and Pipes, 17) Upper Threshold, 18) Asbestos Cement Chimney, 19) Others: In Fuse box, Ventilation System)

The asbestos types that come out in the demolition of the building are mostly chrysotile. The reason is that the structure of the materials used in the buildings is usually chrysotile. Chrysotile asbestos extracted from buildings are classified in 7 different groups according to fiber length and fiber length is grouped between 0.1 and 1.9 cm. Especially, 4th and 5th group chrysotile asbestos with fiber lengths of 0.6 - 0.4 and 0.4 - 0.2 are used in pressure resistant asbestos cement pipes and in the production of cement boards. This type of asbestos, which is quite fine for the particle size, causes serious health problems in case of long-term exposure (Atabey, 2009). In demolition sites, especially roof covering (Figure 4a), floor covering (Figure 4b) and pipes (Figure 4c) are the main asbestos sources. Examples of them are demonstrated in Figure 4.

(a) (b) (c)

Figure 4. (a) Asbestos roofing, (b) Asbestos floor covering, (c) Asbestos pipe (Şahin ve Bingöl, 2022; Tezcan, 2007, T.C. Ministry of Labor and Social Security, 2023)

The level of asbestos fibers in the ambient air was between 0.0004 and 0.0005 fibers/cm3 while asbestos was used (Ontario Ministry of Government Services Publications Service Branch. 1984). Asbestos fibers also may occur naturally in water, and therefore in foodstuffs. 0.2 to 2 million asbestos fibers per liter up to several hundred million asbestos fibers per liter were measured in natural waters (Commins, 1987).

The main risk to human with asbestos lie on exposure time. The earthquake that affected 10 provinces centered in Kahramanmaraş at 2023 reminded the asbestos exposure risks of demolition sites. Thousands of buildings destroyed by the earthquake raised the inhaling risk of asbestos causing serious health problems. Figure 5 gives an example of the earthquake-affected area having high asbestos exposure risk. During this period, various occupational groups made statements that countermeasures against asbestos exposure should be taken urgently. These groups suggested short term precautions as, spreading water on the earthquake debris, using dust masks and goggles at the earthquake debris site, avoided not to meet nutritional needs within this area, using protective disposable overalls and boots to prevent asbestos contact with the body and skin. They also warned workers to change and wash their protective equipment and clothes after use. Furthermore, they warned workers to work with shift working hours to lessen the exposure time to asbestos (Palabıyık-Anatolia Agency, 2023). Precautions that needs to be taken under the regulations are explained in occupational safety section.

Figure 5. Destroyed area affected by the Kahramanmaraş-centered earthquake at 2023 (Palabıyık-Anadolu Agency, 2023)

2. Occupational Safety

According to Demir (2016), in Türkiye it is predicted that at least 6,500,000 independent units will be demolished in the next 20 years with the urban transformation. As a result of these demolitions, it is expected that 500,000,000 tons of demolition waste will be generated. In case of conversion of 6,500,000 independent units in 20 years, approximately 50,000 buildings are demolished per year on average.

In our country, in the "Regulation on Health and Safety Precautions in Working with Asbestos" (Official Gazette, January 25, 2013, number:28539) for all asbestos types, the eight-hour time-weighted average value (ZAOD-TWA) of the asbestos concentration in the air that workers are exposed should not exceed 0.1 fiber/cm^3. This 1 liter of air corresponds to 100 fibers (Yeşilyurt, 2016). In the aforementioned regulation, the precautions to be taken before working with asbestos, while working with asbestos, in case of exceeding the limit value and the general precautions to be taken in terms of occupational health and safety are explained in detail.

The Employer, taking into account the type and physical properties of asbestos and the degree of exposure of the workers in the works where there is a risk of exposure to asbestos dust before working with asbestos is obliged to make a risk assessment. In the work plan, the measures to be taken at the workplace included in the risk assessment should be determined. These measures include; the type and estimated duration of the work, the place where the work will be carried out, the method to be used to remove asbestos and asbestos-containing materials, the characteristics of the equipment to be used in asbestos removal, the protection of those who perform the work, the protection of other people in or near the environment during the process, and before starting the destruction of asbestos materials.

If the employer suspects that there is asbestos or asbestos-containing material in any building or environment where the employer works, the employer ensures that the dismantling, demolition, repair, maintenance and removal of materials that may contain asbestos are carried out by experts or employees authorized by the Ministry of Labor and Social Security. In cases where the amount of asbestos may exceed the exposure limit, despite the implementation of technical precautions, it is the employer's responsibility to ensure the use of personal protective equipment by determining appropriate working hours for workers, including respiratory system protection and other necessary gear. Furthermore, it is crucial to place adequate warning signs in areas where the limit value is likely to be surpassed. Measures should be taken to prevent the dispersion of asbestos or asbestos-containing materials' dust into the environment. These precautions encompass limiting the number of workers handling asbestos to the minimum possible, preventing dust release from asbestos, implementing effective and continuous cleaning and maintenance procedures in areas and equipment at risk of asbestos exposure, appropriately labeling water-containing materials in sealed packages for transportation and storage, and disposing of them in compliance with legislation. Figure 5 illustrates the coverage of workers in asbestos-contaminated construction zones.

If the limit value is exceeded, appropriate actions are implemented to reduce the asbestos level below the limit, and employees are prohibited from working in the asbestos area until necessary precautions are taken. Subsequent asbestos measurements are conducted to assess the effectiveness of the implemented measures. In work environments where it is not feasible to reduce exposure and meet the limit value solely through the use of respiratory system protection, it is unreasonable to expect employees to continuously rely on respiratory protection. The duration of work for employees is predetermined, and this maximum period must not be exceeded.

Figure 5. Examples of asbestos removal operations at the construction site (Keleş, 2022; TekMerkez OSGB 2022; EMC, 2022)

In workplaces working with asbestos; Employees are provided with appropriate personal protective equipment such as protective clothing and respirators. Personal protective equipment cannot be taken out of the workplace. Protective clothing is cleaned in the workplace or where cleaning work is carried out and is only removed from the workplace in closed containers. After each use, protective equipment is checked, cleaned, repaired and maintained. Although the measures to be taken by the employer and the worker are determined. The most important method of protection is to inform and train the employees. Asbestos materials removed after demolition are transported in suitable sealed packages and should be stored separately from other materials. In addition, asbestos wastes are labeled in a way to show that there is asbestos in them using the markings in the relevant legislation of the Ministry, and removed from the workplace as soon as possible in sealed packages and should be destroyed in accordance with the relevant legislation. On the packages of asbestos and asbestos-containing products, appropriate danger signs and symbols should be prepared as a clean, legible and indelible label in accordance with the regulation, affixed, printed or tied on the package. In addition, any packaging material that has come into contact with asbestos cannot be used for any other purpose. These packaging materials should be collected and disposed of in accordance with the rules regarding the disposal of asbestos waste (T.C. Ministry of Labor and Social Security Labor Inspection Board, 2005).

Asbestos fibers are stored separately from other dangerous chemicals and materials by taking precautions to prevent dust and fiber scattering in the environment where asbestos fibers are stored. (of the “Dangerous Chemicals Regulation” (Guideline 40, Official Gazette No. 21634). According to the "Regulation on Landfilling of Wastes" (Official Gazette, No. 27533), wastes containing asbestos can be stored in II class storage facilities without being tested. In storage facilities that will accept asbestos-containing construction wastes and other asbestos wastes; asbestos waste is stored in a separate cell from other wastes and these cells are kept under control. If the waste is not packaged, it should be wetted regularly. In order to prevent the spread of asbestos fibers in the facility, the top of the storage facility should be covered with the last top cover. No drilling or similar work should be carried out in the storage facility that will cause asbestos fibers to spread around.

Since it is not possible to incinerate or recycle asbestos wastes, it should be ensured that disposal is made by means of a separately isolated and covered cellular storage disposal method in the sanitary landfill described in the "Waste Management Regulation". It is ensured that the wastes are buried in the soil in appropriate areas, unused containers, bags, etc. are buried in protective materials as soon as they are reused. After removing the wastes from the environment, it should be ensured whether there is asbestos dust (less than 0.01 fiber/cm3;) in the work area and its surroundings, and inspection are carried out. Stored materials should not prevent passages without narrowing the movement areas, It should not prevent the use and operation of fire extinguishing equipment and should not be overturned. After the asbestos warehouses are closed, a plan including the coordinates showing the exact location of the storage facility and the cell where the asbestos fibers are stored should be

prepared and necessary measures should be taken to prevent the contact of asbestos with people in the possible use of the land after the storage facility is closed.

3. Results and Conclusions

It has been observed that the dust generated in industrial areas has increased gradually, and if precautions are not taken, serious damage to human health is observed. When we go more specifically, it has been determined that asbestos dust, which is especially toxic, is one of the most dangerous dust types for the society in terms of mortality and morbidity. With the housing policies of Türkiye, the problem of urbanization has emerged in many cities today. It is a fact that people no longer only have the right to shelter, but to live in a healthy, beautiful, livable environment, as well as in social and physical environments with developed infrastructure and transportation networks. In order to achieve this, the concept of urban transformation becomes important that includes a multi-faceted construction and demolition process. Asbestos, which was used in buildings and many areas in the past, comes out in these demolition works. People working in maintenance, repair and demolition works to be carried out during any kind of transformation, their families and residents are in serious danger without even realizing it. The damage caused by asbestos puts human life at significant risk, causes cancer in the long run, and causes lung diseases.

In this sense, in order to prevent possible dangers, awareness of employers, workers and society should be raised, asbestos removal specialists should enter the buildings with asbestos and necessary evacuations should be made with the training provided by the government. In addition, if there is any suspicion of asbestos, an application should be made to the necessary institutions and help should be sought by experts in this regard. In recent years in our country, it should be aimed to raise awareness, although to some extent, for occupational safety and awareness raising activities should be aimed.

Author(s) Contributions

The contribution of the authors to the article is equal and is around fifty percent.

Conflict of Interest

The authors declare that there is no conflict of interest.

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