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Current Problems Involving the Dismantle of Asbestos-Cement Sheets in Buildings. The Case of Central Market in Alicante

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ABSTRACT

The project and the works described in this article mainly deal with the removal of the current asbestos-cement covering of the roof of the Central Market in Alicante and its replacement with zinc diamond-shaped scales, similar to the originals which were implemented in 1921 when the building was put into service.

These upgrades were necessary to avoid the causes (and consequences) of rainwater infiltration, as described in an earlier report in 2006, also drafted by the author of this article.

The article illustrates the difficulties involving the practical application of spanish Code RD 396/2006 (minimum safety and health requirements for work with risk of exposure to asbestos) in a complex case such as this, especially with regard to aspects such as economic (increasing costs), technical (increased difficulty of implementation), and the total duration of the work (total increase in duration due to interference with other trades).

KEYWORDS

Asbestos-cement, chrysotile, roof deconstruction, zinc.

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1 INTRODUCTION

Since its opening in 1921, the Alicante Central Market building (Fig. 1) has undergone two significant changes: first, in 1938, when it was badly damaged as a result of the bombings during the Spanish Civil War (May 25, 1938) [Perez 2007], and second, in 1987, when it underwent significant reforms, affecting almost all of its functional elements [Navarro 1987]. Since then, the building had presented a clinical picture that included, among other problems, a series of leaks that presented themselves whenever it rained.

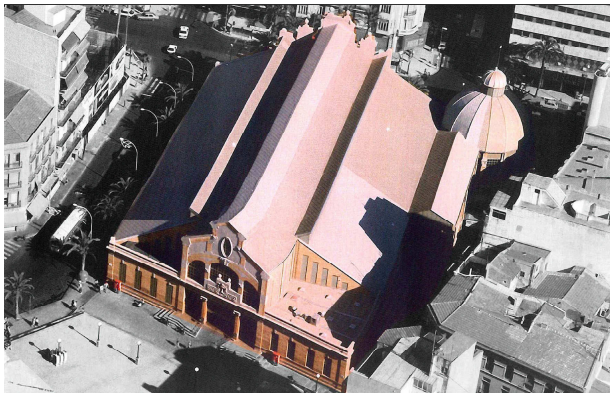

Figure 1. Central Market (Alicante).

2 BACKGROUND

2.1 Description Of The Cover System

The roof is supported by a combination of metal pillars (interior), small brick pillars (east and west facades), and load-bearing walls (north and south facades) which support long-span steel trusses, in two orthogonal directions. The substructure of the roof, which consists of large and small slats of wood, is supported by metal profiles. The outermost layer of the roof cover consists of asbestos-cement plates that are nailed over the little slats(Fig. 2).

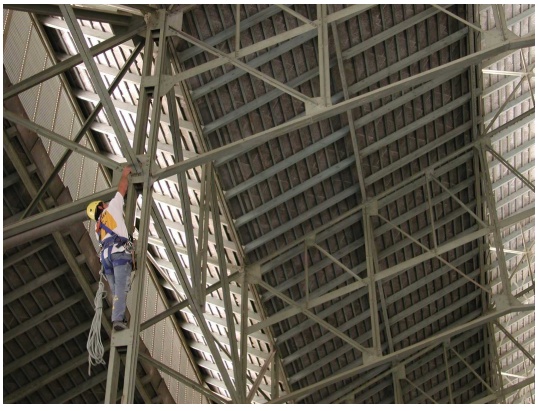

Figure 2. Partial view of the inside of the cover (photos taken during the inspection work "in situ" for drafting the injury report, 2006).

To each specific function we can assign a main material; in this way we have:

- Steel, which is used for the main load-bearing structure (brackets, trusses, and support straps)
- Wood, which is mainly used for the substructure (small slats and supports)
- Asbestos-cement, which, together with zinc, is the finishing material

The outer layer of the roof is composed of plates of different shapes and materials, depending on their location:

- Inclines: asbestos-cement squares 6 mm
- Top: asbestos-cement squares 3 mm
- Lantern of the dome: diamond-shaped zinc scales

2.2 Damage To The Items Covered

A technical study in 2006 identified the following risks associated with and deficiencies in each of these materials [Sirvent 2006]:

The steel, although relatively acceptable, had at various points begun to corrode, which manifested itself in the form of surface pitting (the profiles had not lost structural integrity).

Many of the wooden items remained undamaged, but we found some specific elements that had become unusable due to them having broken, or because they had begunto show symptoms of decay.

Finally, the main problem that we found with the topcoat was that it contained leaks in various locations. Before the renovation, a large surface of asbestos-cement square plates had received several additional layers of waterproofing paint with a base of chlorinated rubber and fiberglass mesh.

As a result of this study, we concluded that the most technically viable solution would involve the deconstruction of the existing roof, finished in asbestos-cement boards to proceed with the implementation of a new deck that guarantees a certain level of durability and waterproofing.

2.3 Restoration Concept: Historical Research

As a preliminary to the drafting of the project for replacement of the deck, we reviewed the original project report (written in 1914 by the City Architect, sr. Fajardo, along with Engineer, sr. Lafarga), in order to better understand the materials and systems that were used in the original building. Various sections of the report [Fajardo & Lafarga 1914] described different parts of the roof structure as follows: "*The main spaces [...]. Knives are placed on the belt and above them the galvanized sheet metal and galvanized which serves as the cover. The roof of the dome and lantern are coated with zinc diamond pieces*."

The second part of the report, “Calculation of the Elements of the Market”, states: "*We propose the use of corrugated and galvanized sheet metal for the covers, and zinc pieces for the remaining areas*."

Using this data, with the fundamental criterion being to restore the original image of the building, we proposed the use of diamond-shaped pieces of zinc, using current materials and techniques that ensure adequate waterproofing and durability, while respecting the original image.

3 THEORETICAL DATA (Investigations Prior to Commencement of the Renovation)

3.1 Asbestos

The term "asbestos" designates a series of fibrous minerals composed of silicates of iron, aluminum, magnesium and calcium among others, according to the internationally accepted registration of chemicals provided by the Chemical Abstract Service (CAS). There are two main types of asbestos: chrysotile and amphibole.

Chrysotile (white asbestos, CAS No. 12001-29-5) is a hydrated magnesium silicate (40% Si, 38% Mg, 2% Fe), white or greenish, with fibers in multiple vertical streaks.

The main health risk associated with asbestos is the airway inhalation of microscopic fibers, which requires special caution in activities that involve the release of fibrous particles into the environment. The two main illneses that one can develop by exposure to asbestos are malignant mesothelioma (pleural or peritoneal), and asbestosis (pulmonary fibrosis).

The spanish national legislation regarding minimum safety and protection of workers from health risks arising from asbestos exposure at work is the RD 396/2006 of March 31, 2006. The current European standard is the Directive 2009/148/EC of the European Parliament and the Council, November 30, 2009, on the protection of workers from risks related to asbestos exposure at work.

3.2 Asbestos Identification Tests Performed in Alicante Central Market

In order to unequivocally characterize the material composure of the sheets of Alicante Central Market roof, we obtained a sample from each type (thicknesses of 3 mm and 6 mm). They were transported to the laboratory at the Department of Building Materials at the University of Alicante, where they underwent analysis by optical microscopy. The presence of chrysotile (white asbestos) was discovered in each sample (Fig. 3).

Figure 3. Chrysotile (micrograph of a sample of the roof of the Central Market, corresponding to a square plate of thickness 3 mm).

3.3 Description of the Works

The renovation of the Central Market building [Sirvent, 2007] included the work leading to the removal of the current coat of asbestos-cement, restoration of the steel structure and substructure of wood, and the installation of a new layer of zinc plates.

It also included the placement of various types of interior and exterior scaffolds, lifelines, and temporary protection to ensure safe work practices. The most significant project items were:

- Fall protection safety net (2,850 m2).
- Double protective plastic membrane (3,010 m2).
- Removal of asbestos cement plates (3,475 m2).
- Cleaning and treating steel structure (1,515 m2).
- Replacement and painting of the wooden substructure (2,780 m2).
- New roof finished with diamond scales of zinc (3,475 m2).

4 EXPERIMENTAL (Execution of the Works)

4.1 Requirements of the Asbestos Spanish Law RD 396/2006 and Its Application

The demands arising from the implementation of the RD 396/2006, together with the need to protect the interior of the market from weather elements, required a carefully planned intervention. Following are some of the requirements of the RD 396/2006, which helped determine the project planning:

Section 8: Personal Protective Equipment. "*The use of personal respiratory protective equipment shall not be continuous, and its usage time for each worker, [...]shall in no case exceed 4 hours a day.*" This article is quite limiting on the speed of the renovation, since the process of replacing the deck must begin with the removal of the existing asbestos-cement plaques.

Section 7: Organizational Measures. Paragraph d) -2 º indicates that "*the places where such activities are conducted [...] shall not be accessible to persons not pertaining to the asbestos removal job.*" This section requires us to create different shifts so that the removal of the asbestos cement sheets does not coincide with work in other trades.

Section 6: Preventive Measures. Paragraph a) states that "*the working procedures must be designed so as not to produce asbestos fibers, if that proves impossible, the release of asbestos fibers into the air must be avoided.*" This requirement necessitates the use of measures that complicate the project´s execution, as will be apparent in later sections.

4.2 Initial Work-Planning & Organization

The project plan [Sirvent 2007] was developed as a result of combining the above basic premises. City authorities added a final condition: the market must be kept open to the public during the renovation.

The first phase involved installing guards on the exterior of the building (a perimeter of tubular scaffolding) and on the interior a system of multidirectional scaffolding that created a platform for ongoing security and lifeline nets anchored to the trusses (Fig. 4).

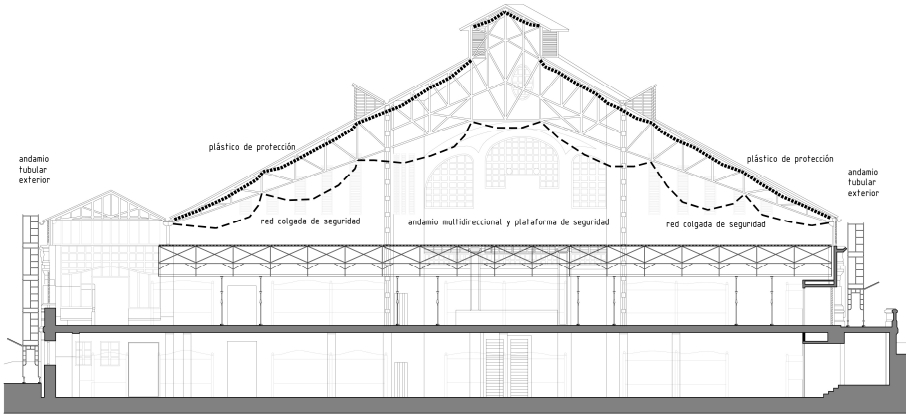

Figure 4. Section Deconstruction Project (2007).

The second phase involved placement of two plastic protective membranes under the roof and above the net (the lower membrane was impermeable, and was used as protection in case of rain, and the higher, thinner membrane was used to collect and encapsulate the asbestos dust; *section 6 RD 396/2006*).

The third phase involved the removal of the asbestos-cement plates, performed by specialists in handling asbestos [Sanjuán 2007]. Their work was coordinated with three other teams (steel, wood, zinc) so as not to coincide in the use of space and/or time, since their activity is harmful to the other workers (*section 7 RD 396/2006*).

4.3 Changes: The Difficulty of Implementation of Some Requirements

The first problem that arose during the execution of the works concerned *Section 7: Organization*. It was impossible to coordinate the performance of three teams of different trades, so that all could work simultaneously on a small portion of the roof (during different hours of the day) in order to avoid exposure of large areas of the roof to rain.

From a technical standpoint, an ideal situation would involve each team working only the hours required to perform their tasks in a small area of the roof (*Section 8*). In reality, this conflicts with economic considerations of both the owner of the building (longer duration of the project) and of the companies (limiting hours each working day is less profitable).

Another change to the plans was the elimination of the dual plastic membrane system under the current cover (*Section 6*) due to the difficulty of removal of asbestos collected in the plastic. It was replaced by a different extraction system (allowed by law). However, practice showed that this new system would not allow the removal of small and medium asbestos pieces, which were deposited on plastic or metal sections of the trusses (Fig. 5). We subsequently needed to measure fiber concentration in accordance with regulations.

Figure 5. Chunks of asbestos is not removed by exhaust systems deposited on the metal structure.

5 CONCLUSIONS

The RD 396/2006 has clear requirements for workers at risk of exposure to asbestos, so we assumed that specialists in these tasks would understand and apply these rules.

However, the problem arises in renovations in which other trades outside of asbestos handling share the same space and/or schedule. In these cases, we must try to avoid this simultaneity because of the health risks to these other workers, who usually have neither the adequate training nor equipment to protect themselves from these risks. Article 7 d) -2 º explicitly prohibits this simultaneity.

In any case, before granting access to other workers not specialized in asbestos to areas where there has been manipulation of asbestos (simultaneity in space but not in time), the work environment must be assessed and controlled according to the prescriptions made in Article 5 of the code, to ensure that the thresholds set out in Article 4.1 are not exceeded.

The same procedure should be applied in cases where there is simultaneity in time but not in space, for example, in the case where several trades agree on the same shift schedule but in different areas of the jobsite. We should indicate that this scenario is worse than the previous one, because handling asbestos may cause ruptures that generate a substantial amount of airbore fibers that are easily carried by the wind (when working outdoors), affecting other non-specialized workers.

Finally, we should say that the capture of fibers in the vicinity of the emitting source with extraction systems is suitable only for very tiny particulates, but does not remove pieces of small and medium size. Thus, deconstruction by breaking of pieces should be avoided, or, at the very least, an additional means of collecting these pieces (eg, encapsulated by plastic) should be provided to prevent fibre deposition in other parts of the jobsite.

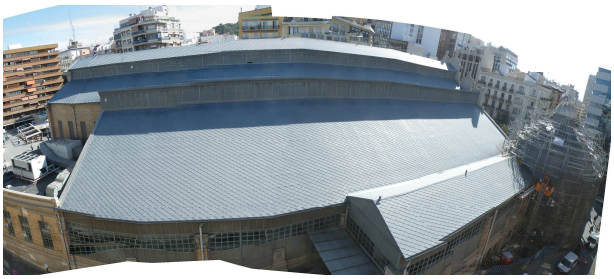

Figure 6. Final appearance of the new cover of zinc pieces (March 2010).

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