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Safe Removal of Underground Asbestos-Cement Water Pipes

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Abstract **-** Today, there are many countries around the world that have banned the asbestos for its carcinogenic nature of inhalable fibres. Italy was among the first European countries to ban asbestos, with Law 257/1992, and was among the first to issue technical sector regulations for the protection of workers and living environments. The technical characteristics of this substance, together with its low cost, led to the creation of different mixtures and the processing and production of over three thousand types of products containing asbestos with content varying from 10% to 99% in weight. These products included Asbestos Cement Pipes (ACPs), used for decades for civil and military purposes. ACP are not in themselves a primary source of danger to public health when underground, intact and still in place, insofar as the main asbestos-related health risk is inhalation. Cement asbestos pipes can however generate situations of risk when they are subject to removal or maintenance that involves their partial or total exposure to ambient air with the possible dispersion of fibres into the air.
The paper shows a systematic set of procedures and indications to be followed for the safe removal of underground pipes in ACM in order to ensure maximum protection of workers and the living environment surrounding the area of operations. These procedures may be subject to periodic updating on the base of feedback following their application. These procedures were developed because of the need to provide precise guidelines of national reference, due to a lack of specific sector regulations.

Keywords: Asbestos, Asbestos Cement Pipes, Safe removal, dig, no-dig.

1. Introduction

The generic term asbestos identifies certain naturally occurring fibrous silicate minerals that are exploited commercially (chrysotile, crocidolite, amosite, tremolite, anthophyllite, and actinolite).

Today, many countries around the world have banned this carcinogenic substance (International Ban Asbestos Secretariat (IBAS), October 23, 2018); Italy was among the first European countries to ban asbestos, with Law 257/1992, and was among the first to issue technical sector regulations for the protection of workers and living environments. Some countries are still extracting asbestos, mainly in Asia (transcontinental Russian Federation).

Commercial success, in particular for the minerals chrysotile, crocidolite and amosite was determined by their peculiar, “unbeatable” technical characteristics because they display the simultaneous resistance to fire and heat, chemical and biological agents, abrasion and wear [1][2].They are also sound-absorbing and insulating. They bind easily with other substances (lime, chalk, cement) and with certain polymers (rubber, PVC, etc.). The technical characteristics of this substance, together with its low cost, led to the creation of different mixtures and the processing and production of over three thousand types of products containing asbestos with content varying from 10% to 99% in weight. These products included ACP, used for decades for civil and military purposes. Until recently, these pipes were used not only in building industrial plants, but also to create utility networks (water, sewers, communications, gas, etc.).

ACP are made of a special cement mortar, to which asbestos was added (normally crocidolite or chrysotile, with amosite added in particular cases).

Such products are not in themselves a primary source of danger to public health when underground, intact and still in place, insofar as the main asbestos-related health risk is inhalation [4] [5]. However, they can generate situations of risk when they are subject to removal or maintenance that involves their partial or total exposure to ambient air with the possible dispersion of fibres into the air. This is especially in the case in which the outer surface of the product is degraded [3], even only partially, with the disintegration of the cement matrix and exposure of the fibres, or during cutting and/or handling of the pipes performed incorrectly. Therefore, situations of risk for operators or for the living environments surrounding the area of operations may arise unless specific prevention and safety measures are adopted.

Inail Dit has developed Operating Instructions in support of the operational management of the asbestos problem, available on the institutional website and of national and international reference.

The operational management include the Guidelines on the safe removal of underground cement asbestos water pipes. These instructions were developed on the base of vast experience matured during asbestos-cement pipe removal operations performed under specific experimental conditions. The authors have also collaborated in numerous expert opinions issued for the Ministries of Labour, Health and the Environment and dialogue in meetings of experts and (national and local) approvals and permits procedures with regional authorities, regional and local supervisory authorities, having consulted some of the leading Italian sector experts and trade associations.

2. Intervention techniques used

There are techniques in which excavation is required to reach the work area, while there are more recent techniques in which it is not necessary to excavate the entire line to be replaced, but only in some specific points.

These technologies undoubtedly offer the advantage of reducing operation time, being less costly and less invasive than traditional methods, but in the case in question, they are not always applicable to underground ACP.

2.1. Digging technique

The most used intervention techniques are those in which the pipe is exposed by digging along the network. These techniques are used both in the case of routine maintenance and in the case of urgent maintenance.

After digging, the operator will check the type of material, on the base of the pipe diameter and the type of break.

The first action to be performed on pipes suspected to be made of ACM is to lay a seal with stainless steel repair clamp around the outer surface of the pipe, to make it water tight and stop the leak.

This primary maintenance intervention, which does not require any cutting, can be followed some time later by the replacement of the damaged section of pipe, subject to prior characterisation to be performed according to the specific procedures outlined in this document. Once the presence of asbestos is confirmed, actions must be taken to remove the pipe in compliance with the general principles of prevention and precaution established by the regulations in force.

2.2. No-dig techniques

There are no-dig technologies that preserve the existing pipes, even if damaged or simply to be preserved, by rebuilding the inner surface with products and/or materials compatible with use in contact with drinking water. These technologies include both internal lining with cement mortar or resin (if the existing pipe still has the necessary static resistance) and inserting a structural liner into the pipe capable itself of withstanding the functional stresses, leaving the old pipe solely as a guide.

It must be noted that one of the no-dig techniques sometimes used to replace existing ACP, especially in urban environments, and not compliant with the provisions of current legislation on asbestos, is “pipe bursting”, which involves demolition of the existing pipe without removal and the simultaneous insertion of a new, even larger diameter, pipe. This technique, despite having the undeniable advantage of ease of execution and reduced operation time, causes the deliberate break-up of the ACP, increasing the dispersion of fibres into the ground and leaving in place fragments of ACM, with the possible future risks this entails.

One further technology that is based on the pipe bursting principle, in combination with the micro-tunnelling technique, is the pipe replacer. This involves broking up the pipe by an expansion cone and sucking up the debris with the the removed earth as the digging head advances.

Another techniques is to lay new pipes, leaving the old section in place, connecting the new pipe with by-pass valves. This by-pass solution allows the old pipe in ACM to be used in the event of emergency problems with the new section, ensuring minimal disruption to services. The new pipe can follow the same course as the existing pipe or, due to varying constraints, it may be necessary to identify a different route even at a considerable distance. These constraints can include restrictions above ground, such as changes to road systems or overlying buildings, or the existence of underground utilities. These situations are more frequent when operations are in an urban environment.

3. Technical Operating Instructions

The guidelines elaborated by Inail Dit concern the partial or total removal of ACP, performed using traditional open-air digging methods, irrespective of the restoration of network function.

Two experimental campaigns were also carried out aimed to verify the exposure of workers to asbestos fibers during pipes maintenance operations.

The first experimental campaign was carried out by simulating the cutting of pipes with different cutting equipment (show at point 7, chapter 3) to verify which instrument guaranteed the least production of dust. In the second campaign was assessed the degree of exposure to asbestos workers during a real case (Fig.1).

The results obtained from the experimental campaign made it possible to correctly assess the risks for workers and for living environments.

Fig. 1: Experimental campaign.

These procedures refer to "programmable" and "emergency" activities. An activity is "programmable" when its execution is not of urgent nature and can be fitted into an established time span. Such activities include conservation and redevelopment for the renewal, renovation, improvement and functional adaptation of existing networks and systems, in implementation of local area planning and existing planning and programming instruments.

"Emergency" operations instead require the execution of emergency measures due to structural collapse, leaks or dispersion in the network that cause irregularities or interruptions to service or danger to third parties. These operations must be performed as soon as possible, twenty-four hours a day, all year round.

The majority of "emergency" activities are performed in urban areas and require small roadwork sites to be opened for limited periods, with the aim of avoiding disruption town/city traffic. They require smooth organisation, with the rapid set-up and disassembly of worksites and the initiation and completion of work in as short a time as possible for the service to be restored.

This study produced 96 instructions: 52 instructions refer to programmable operations and 44 instructions to emergencies.

The most important technical operating instructions to be adopted in the programmable maintenance operations are shown below:

1. A fence suitable to prevent unauthorized access must surround the working site area, in relation to the type of work performed; we recommend using a mobile fence of at least two meters in height. All the safety measures in terms of signage must also be adopted (access prohibited to unauthorized persons, asbestos hazard warning, etc.) and daytime/night-time work site notices must be exposed. In the case of operations in which the work site areas are immediately adjacent to highly populated areas, the work site area must be fenced off with a blackout net. The net must lay over the fence with closed mesh (dustproof) in such a way to limit dust dispersion as much as possible. It must be resistant to mechanical stress, tearing and ageing from exposure to atmospheric agents.
2. Once the asphalt layer has been removed, the position and depth of the pipe channel can be identified using a suitable probe. The subsequent dig must reach 15 cm above the upper surface of the pipe, even by means of lateral deepening of the trench. During this stage, to wet the ground with water is recommended, even using spray irrigation systems, avoiding the formation of pools or streams, in order to limit dust emission during excavation (Fig.2).
3. The parts of pipe affected by separation/breakage/cutting must be completely uncovered using hand tools (shovels, spades, trowels, etc.), taking care not to scrape the outer surface of the ACP. Soil must be removed from an area of approximately 15 cm of depth, near the separated/broken/cut parts of pipe (and not along the whole section uncovered).

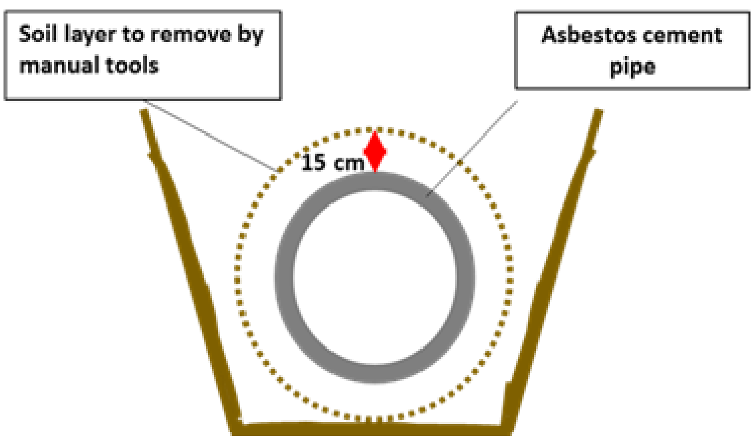

Fig. 2: Diagram of the procedure for excavating asbestos cement pipes.

4. When the pipe is uncovered from soil and partially suspended, it is recommended to put a lay at high-density polyethylene sheet at least 0.15 mm thick, between the pipe and the underlying ground. This must be placed at least under every area of separation/breakage/cutting and extended according to the specific operating conditions. In the case of the presence of water in the dig, the specific operating methods are to be evaluated to guarantee its effectiveness.
5. In the case of water in the bottom of the dig, to drain naturally or flow into the sewer using a suitable channel can be allowed. To disperse water on impermeable paving (e.g. asphalt, cement, etc.) must be forbidden, as it could dry off and lead to the dispersion of fibers into the atmosphere.
6. The outer surface of the pipe must then be cleaned thoroughly, in particular the area/s affected by the separation/cutting. Then the exposed outer surface must be sprayed continuously with water or biodegradable encapsulating product.

7. The pipe cutting operations must be performed using suitable instruments, including:
    a) hand saw (dry sawing) for small diameter pipes, to be used only when operating under forced suction using HEPA H13 absolute filters or continuous spraying of the cutting area using encapsulation coating. At the end of the operation, the saw must be encapsulated, sealed in a bag and sent for disposal at the end of the working day (considering its rapid wear and low cost);
    b) low-speed petrol jigsaw only if fitted with integrated systems for continuously spraying the cutting area with water or impregnating encapsulating solution, to be used preferably for pipes with diameter and thickness compatible with the length and characteristics of the saw blade; at the end of operations, the blade and the saw must be wet cleaned as far as possible and stored in a dedicated sealed container;
    c) hand chain pipe cutters (dry cutting), to be used only when operating under forced suction using HEPA H13 absolute filters or continuous spraying of the cutting area using encapsulation coating. At the end of operations, the tool must be wet cleaned and stored in a dedicated sealed container.
8. The work equipment must be chosen according to the specific work conditions, with the aim of reducing dust to a minimum. Any visible swarf produced during cutting must be collected, whether in powder or mud form. The use of angle grinders (Flex grinders), which generate high fibres dispersion and significant risks for operators and surrounding living environments, is always forbidden. Additional medium/high speed, dry-use electric tools, such as the electric jigsaw, do not comply with the provisions of the aforementioned decree.
9. The separated piece/s of pipe must be harnessed and lifted to be sprayed again with (preferably biodegradable) encapsulating liquid, focusing particularly on the outer surface, breakage points, cutting faces of pipes or sections and spraying inside the pipe too, where possible.
10. The removed pipes can be laid on the ground, on suitable sheets, to be wrapped in sealed packages and labelled with the name of the producer of the waste, an asbestos warning and the code R (hazardous waste). It recommend using the EWC 17.06.05* - "Construction materials containing asbestos" [6].
11. After packaging properly and cleaning the outside of the packages, all the waste produced, e.g. soils, pipes, Personnel Protective Equipment (PPE), must be removed from the work site area on suitable vehicles, preferably on the same day or upon reaching a first payload and, in any case, within the deadline indicated for temporary storage.
12. All the worker must use and wear Category III PPE (protect from the risk of death or serious and permanent injury). The worker must also receive adequate practical training. In particular, attention must be given to the correct use of specific asbestos PPE (disposable masks must not be reused; masks must not be worn around the neck or on the head and used only during one-off actions; the hood of the bodysuit must not cover the eyes during operations; etc.) (Fig.3).


Fig. 3: Some examples of real cases some examples of real cases of interventions on asbestos cement pipes

4. Conclusion

The paper shows a systematic set of procedures and indications to be followed for the safe removal of underground pipes in ACM in order to ensure maximum protection of workers and the living environment surrounding the area of operations. These procedures may be subject to periodic updating on the base of feedback following their application.

These procedures were developed because of the need to provide precise guidelines of national reference, due to a lack of specific sector regulations that has led, in some cases, to uncertainty over the authorisation, operational and supervisory procedures for operations to remove underground ACP, to the extent that these procedures have been applied differently in the different regions of Italy.

Additional goals is to encouraging the collection of data on underground ACP and their remediation, with subsequent notification of national authorities to implement the mapping of national areas affected by the presence of asbestos and knowledge of specific data on the diffusion of underground utility networks in asbestos-cement to be enable the medium and long-term planning of pipe removal operation.

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