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THEORETICAL CONSIDERATIONS REGARDING THE CHOICE OF THE DEMOLITION TECHNOLOGY OF MINIMUM IMPACT BUILDINGS ON THE ENVIRONMENT

Abstract: *In the process of modernization, several new buildings are being constructed, necessitating the demolition of old structures to make room for them. However, with the increasing number of demolished buildings, there is a significant amount of waste generated, leading to considerable pollution. Environmental concerns have escalated due to the depletion of natural resources and the rapid deterioration of water, air, and soil quality. Consequently, a Community environmental policy has been established with the objective of preserving, protecting, and improving the quality of the environment while safeguarding human health. The protection of the environment is crucial for both present and future generations. In light of these considerations, this paper addresses the need to identify demolition technologies that meet the European Union's requirements for environmental protection and sustainable development, among the most commonly employed methods.*

Key words: *Demolition, technologies, impact, environment protection, sustainable development, waste.*

1. INTRODUCTION

In recent years, there has been a need to create new spaces for urban modernization, such as high-rise buildings, complex shopping centers, and intelligent leisure areas, in order to shape the image of a contemporary urban landscape, Figure 1. As a result, there has been an increase in the demolition of industrial areas with the intention of repurposing the land [4, 5].

Figure 1 Urban modernization first construction of new homes following the demolition of a factory [13, 14].

Simultaneously, the expansion of industrial capacity, urbanization, and socio-cultural changes have had an unprecedented impact on the planet. In light of climate change and the depletion of natural resources, it has become essential to prioritize sustainability and pollution reduction, requiring heightened attention [6].

Human activities have an unprecedented impact on the planet due to the expansion of industrial capacity, urbanization, and socio-cultural changes. Therefore, in the context of climate change and the depletion of natural resources, sustainability and pollution reduction have become urgent issues that demand immediate attention.

The principles and strategic elements governing this issue include the precautionary principle, which aims to prevent environmental risks and damage, and the prioritization of pollutants that directly and significantly endanger human health. In accordance with the principle of "the polluter pays," responsibility for waste management activities resulting from demolition works lies with their generators, or in some cases, with the manufacturers in accordance with the principle of "manufacturer's liability."

Sustainable development involves replacing existing technologies (Figure 2) with more efficient and cleaner ones (ecotechnologies) that minimize the consumption of natural resources and energy [12].

Figure 2 Demolition technologies and equipment [9].

Construction and demolition activities release waste, noise, smoke, greenhouse gases, and other hazardous elements into the environment, causing adverse effects on public health [1].

Demolition of buildings is the process of dismantling, destroying, or tearing down building structures using various technologies and equipment, figure 2. The demolition process produces ten times more waste than new construction projects, making sustainable waste management essential for such projects [4].

The demolition is carried out in the following order:

- Interruption of utilities: gas, water, electricity;
- Removal of doors and windows;
- Roofing;
- Dismantling the walls according to a plan that shows which walls must be torn down first and to what extent, in order to prevent accidents at work or degradation of neighborhoods;
- Sorting materials;
- Ensuring the capitalization of resources;
- Disposal of residues;
- Reception of the resulting works.

The application of the waste hierarchy aims to encourage action to prevent the generation and management of waste efficiently and effectively, thus reducing their negative effects on the environment, Figure 3 [11].

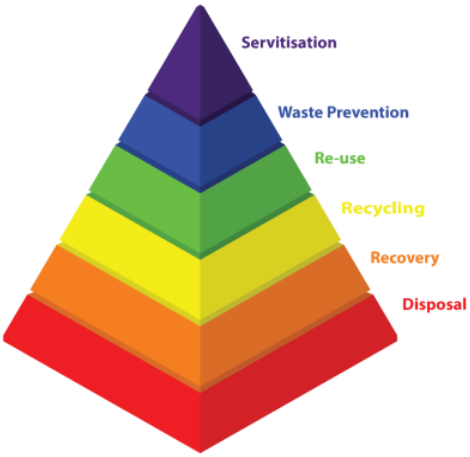

Figure 3 Waste hierarchy [10].

From an ecological standpoint, reusing demolition waste reduces the need for authorized landfills. From an economic perspective, using recycled materials instead of natural resources is an advantageous solution [3].

In this case, in order to protect the environment, there is an increasing concern to identify a technology with minimal impact on the environment.

The choice of demolition method must take into account the technical aspects of the work, the possibilities for recycling materials resulting from demolition, and the environmental consequences. Demolition materials are even more valuable when separated. More selective demolition involves obtaining higher-value by-products.

2. DEMOLATION METHODS

The aim of the study is to identify optimal construction demolition technology that has minimal impact on the environment and for this the most used technologies were compared: mechanical demolition by controlled explosions and deconstruction or disassembly.

Mechanical demolition by controlled explosions is frequently employed due to its obvious advantages, Figure 4.

Figure 4 Demolition by explosions [8].

Among the major advantages of demolishing buildings with the help of explosives we can mention:

- low consumption of time and labor;
- reduced expenses (approximately 5% of the cost of demolition by classical methods);
- better capitalization of materials resulting from demolition;
- high degree of security.

In the case of applying this demolition method, there are also some problems that can be solved. These include the seismic protection of neighboring buildings, continuity of traffic immediately after the demolition, and keeping the production process in operation during demolition.

The general concept underlying demolition through controlled explosions is established following the analysis of factors related to the cost price, ensuring the protection of neighboring buildings, reduced working time, and achieving an imposed fragmentation. The chosen method must be compatible with the location of the building, the nature of the soil, the outer and inner shape of the building, the load-bearing capacity, and the explosive materials used [3].

The deconstruction known as „dismantling of buildings", focuses on minimizing the destruction and wastage of materials. Dismantling, a relatively new term, encompasses the selective extraction of building materials (Figure 5) prior to their demolition [13-19].

Figure 5 Waste storage and sorting platform [8].

This method involves removing materials by category and sorting them for reuse or recycling, figure 5. With rigorous planning, this approach may, in some cases, result in a reduction of discarded materials by up to 90% and substantially reduce CO2 emissions [20]. Additionally, there is equipment available that can work on-site to convert concrete residues into aggregates for soil stabilization or cement mixtures, Figure 6.

Figure 6 Mobile demolition materials processing plants [8].

Disassembly not only saves the most useful components but also extracts additional materials such as parquet, wooden stairs, railings, support pillars, cables, bricks, etc. [17]. Once disassembled, these materials have a higher value due to their improved condition.

Their price increases, making them more valuable in the scrap market, while the cost of the dismantling process significantly decreases [18]. Furthermore, since certain components have been carefully removed, they can be reused in the construction of another building.

Controlled demolition involves:

- removal and disposal of hazardous materials and components (ex: asbestos-containing materials, PCB-containing switches, etc.) according to the provisions of the specific rules. This ensures the protection of workers on-site by avoiding improper handling of hazardous components and prevents environmental pollution;
- selection and disassembly of reusable components (for example, bricks, tiles, beams, ferrous elements, door and window frames, doors and windows, etc.). If they are undamaged, they can be reused as they are; otherwise, they can undergo remediation and treatment processes (cleaning, operational checks, repairs, painting) to adapt to new uses;
- recovery of recyclable materials (for example, brick and concrete rubble, wood, drywall, etc). These materials can be recycled after proper preliminary treatment and are used to produce new materials, which may serve different functions and purposes from the original ones;
- disposal of non-recyclable waste (a set of materials that remain after selection and can no longer be used). These materials will be sent for proper disposal [9].

Hat Down method – Japanese company Kajima Construction has developed a new demolition method that involves the use of computer-controlled hydraulic jacks to support the lower levels when the resistance pillars are removed. The floor then descends onto the jacks, and the operation is repeated for each level, Figure 7.

To reduce the danger caused by explosions, constructions are gradually dismantled from the inside, a method known as "grounding." This approach is not only safer but also more environmentally friendly, making it particularly useful in densely populated urban areas [2].

The traditional method of demolishing a building involves explosives, resulting in noise, dirt, and significant risks. In response, the residents of the Land of the Rising Sun have come up with an alternative that minimizes these inconveniences. Their proposed system involves a gradual internal collapse of tower constructions.

The process is particularly impressive when observed from within. The buildings seem to shrink before your eyes, with each floor descending slowly with the assistance of giant jacks. However, since the operation takes time, most people on street level don't even notice any changes. It's only when their attention is drawn to it that passers-by realize the tower constructions have actually become smaller.

The company that developed the system claims that it offers a cleaner, safer, and greener method. In Japan and major cities like Hong Kong, Singapore, and various metropolises in the United States, there is a significant number of buildings exceeding 100 meters that require demolition. With the implementation of this new system, demolitions can be carried out in a cleaner and safer manner.

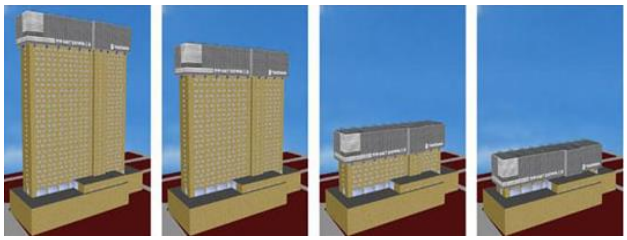

Figure 7 Hot Down method.

An incredibly ingenious solution to the problem was developed by the Takenaka Corporation, drawing inspiration from self-climbing formwork, to create the Hat Down method for demolishing super tall buildings. In this method, the uppermost floors are enclosed within a sealed metal structure, essentially functioning as a vertically movable scaffolding [19]. Within this structure, three cranes are suspended from the ceiling, with each crane responsible for demolishing one-third of the space.

3. RESULTS

In order for demolition to have minimal impact on the environment, it must comply with the objectives of the European Union's environmental policy. In the case of controlled explosion demolition, the toxic effects of the gases released during the explosion occur.

Gases released upon contact with precipitation in the atmosphere produce changes in the composition of water and soil, thereby increasing their toxic capacity.

The contribution of air pollution to the to the physicochemical modification of water occurs through

dry and wet deposition. With wet deposition (precipitation), pollutants present in the atmosphere are deposited on the water's surface. This results in an increase in pH, conductivity, sulfate loading, nitrates, chlorides, and heavy metals. These effects are particularly evident in surface waters, impacting flora and fauna. Airborne particles contribute to increased water opacity and the presence of toxic substances.

The following changes occur through dry or wet deposition of toxic substances on the ground:

- soil acidity increases;
- soil regeneration processes and composition are altered.

To reduce pollution on construction sites, it is crucial to implement effective measures for dust and emission control. These measures should be applied to every activity that generates dust on-site. Ensuring the health of the population and the safety of workers on-site is also of utmost importance.

Environmental standards are increasingly viewed as incentives to promote the use of less hazardous alternatives and environmentally friendly materials during the product design phase. These standards also aim to encourage recycling and minimize waste disposal.

4. CONCLUSIONS

From an environmental perspective, the success of the demolition activity is achieved when:

- products dismantled from demolition are stored separately for recycling;
- any impact on the environment is minimized;
- the movement of equipment and vehicles is carried out with great care to avoid any damage to the environment [3].

In the case of demolition technology involving explosive materials, it certainly has a negative impact on the environment. The damage caused to ecosystems by this method is often irreversible.

On the other hand, deconstruction places emphasis on waste recycling. The Hat Down method is a technique that has a minimal impact on the environment. Compared to technology involving explosive materials, it eliminates pollution and also prioritizes recycling, similar to the deconstruction method.

In conclusion, among the three techniques discussed, the Hat Down method best aligns with the objectives of the European Union's environmental policy.

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