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Research Article

Destruction of Construction Structures with Explosion Technique

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ABSTRACT

Large buildings, tall chimneys, smokestacks, bridges, and increasingly some smaller structures may be destroyed using explosives. Imploding a structure is very fast and an expert can ensure that the structure falls into its own footprint, so as not to damage neighboring structures. This is essential for tall structures in dense urban areas. The use of explosives has been widely preferred in recent years because the destruction of concrete structures has been safer, faster, and more economical than traditional methods of demolition of old structures. In our country, it has been implemented in recent years under urban transformation. The study examined the destruction by explosives of structures that had completed their lifetime or had been damaged for other reasons.

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1. Introduction

The idea of dismantling explosives and structures as part of urban transformation was introduced in Europe after World War II [1]. After the method's success, it was successfully applied in the United States to destroy high-rise structures. In Turkey, housing has also been one of the preferred methods in recent years due to the narrow habitats and damage caused by devastating earthquakes.

The explosion technology has many advantages, including the rapid decommissioning of concrete structures, low economic costs, occupational safety, and the ability to control environmental impacts, which are the biggest problems with explosive activities (Table 1).

In the case of explosives and destruction, the structural and material characteristics of the structure need to be determined and planned in detail. Minor errors in the design phase will harm explosion-related environmental impacts and performance.

There are many studies in the literature on explosions and destruction. Kasai et al. (1993) pointed out that a seismic-designed six-story concrete building was successfully demolished by explosion as planned and that explosive destruction methods need to be improved in the future and further improved based on the experience gained from this experiment [2].

Table 1. Concrete demolition techniques [1].

Method	Cost	Environmental Impacts	Risk
Steel ball	High	High	Low
Wrecking ball	Medium	Very low	Very low
Hydraulic breaker	Very high	Low	Very low
Blasting	Low	High	High

Kurokawa et al. (1993) obtained data that could be used to predict the collapse method. They also measured the rock's vibration, noise, and rotation, making predictions for the actual collapse experiment and obtaining the data needed to plan the protection methods and shelter procedures [3]. Sawada et al. (1993) pointed out that the explosive destruction of a building did not break up entirely into small pieces and that this occurred because of the low amount of explosives. However, the study will be an example for other studies in terms of the environmental impacts of the explosion and the building's robustness, they said [4]. Görgün (2002) identified the factors affecting buildings, the methods used for destruction, and the types of explosives used in explosive destruction. The author presented explosion designs for some structural elements and modeling that he did with the program-supported software [5]. Griffin (2008) modeled phased crash scenarios with computer-supported software. The author noted that the software enabled the realistic creation of the models and was influential in predicting local and global collapse behaviors [6]. Lupoae and Bucur (2009) combined the finite element method and the applied element method with the discrete element method. The authors pointed out that there was a good correlation between numerical modeling and the actual destruction of the structure [7]. Doğan et al. (2009) pointed out that the destruction of a water tower using explosives had the desired level of one-dimensional distribution and that the water towers had been successfully destroyed [8]. Sikiwat et al. (2009) conducted a study considering the uncertainties of moderately complex and complex structures in simulation. In addition, the authors have improved the simulation model for the simulation of large-scale complex structures [9]. Özyurt et al. (2016) compared the destruction process using explosives and machinery. The authors concluded that machinery destruction was more cost-effective [10]. Ünal (2016), in urban transformation projects, has assessed the availability of explosive building demolition and methods of infrastructure and infrastructure excavation, as well as the advantages and disadvantages of exploding and mechanical methods, in comparison [11]. Türker et al. (2020) have developed a simulation program to predict the mechanism of structural demolition. The authors used this simulation to design the explosive destruction of a standard concrete structure [12].

2. Destruction by Blasting

The explosives vary according to the physical characteristics of the destruction structure. The aim here is to move the center of gravity by disrupting the static balance of the structure. In other words, the explosive weakens the structure's sub-carrier elements, and the remaining carrier elements become deformed under the momentum load.

Determining the amount of explosive material to be used on a structure to be destroyed is a critical process when designing an explosion. In this context, it is necessary to gather a set of data that could directly affect the technique to be applied. Work and environmental safety must be ensured in the area where the explosion occurred. If the building is destroyed, electrical, water, gas, etc., connections must be closed, and no flammable or explosive substances must be present in the building. The necessary planning in terms of time and cost in such studies is important for the efficiency of the studies.

Maximum reach of machines used for demolition with explosives is advantageous in buildings with a height of >32 m and usually with a number of storeys of 8. Also making a classification according to the construction material of the building possible. Demolition with explosives, industrial chimneys, water towers, warehouses, and bridges can be used effectively in such structures (Figures 1, 2, 3 and 4).

Figure 1. Demolition of a chimney [13].

Figure 2. Demolition of the cooling towers [13].

Figure 3. Demolition of a steel bridge [14].

Figure 4. Demolition of a water tower [15].

The required amount of explosive material shall be determined after determining the structural parts and delays to be exploded at the design stage. Large amounts of explosives need to be used in steel structures, which are more difficult to break down than concrete structures. Therefore, the risk of debris and air shock is very high. In the explosive destruction process, the explosion hole design is made by the geometry and location specified on the elements that make up the structure (Figure 5).

Delays of 0.25–0.50–0.75 milliseconds are commonly used in the use of explosives for destruction. The delay periods need to be adjusted appropriately to avoid similar environmental impacts caused by explosions in mining.

This will prevent explosion-induced earthquakes, air shocks, and the spread of structural components into the environment (Figures 6, 7).

Figure 5. Opening of explosive holes and placing explosives [16].

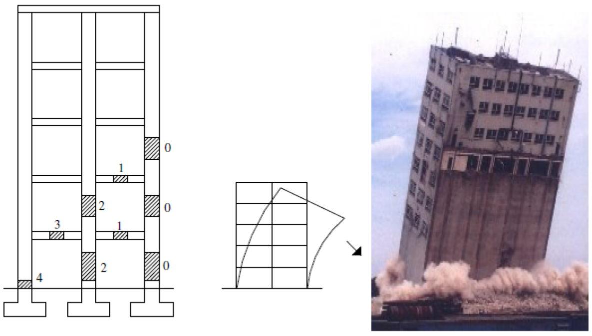

Figure 6. Schematic representation of the columns to be blasted in a building to be demolished [16].

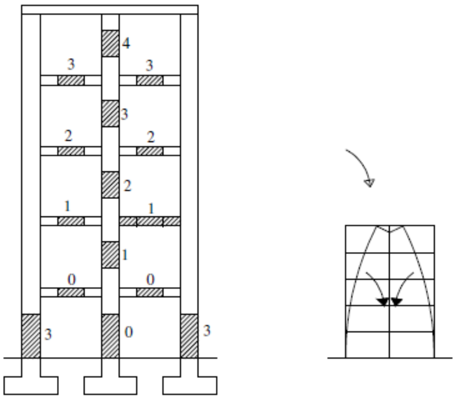

Figure 7. Layout of the delay system in a building intended to collapse into itself [16].

Protective materials such as sandbags, geotextiles, scraps, cane fabrics, and wire fencing can prevent the dispersion of particles that may arise after the explosion and prevent air shocks. Similarly, external coating materials can reduce the environmental impact (Figure 8).

Figure 8. Covering of structural elements [16].

After all procedures are completed, the demolition process is carried out. In demolitions in the form of side tipping, it is beneficial to create a cushion with rubble or old tires in the area where the building will be tipped over to prevent shaking due to environmental effects caused by blasting (Figure 9).

Figure 9. Demolition phase.

Waste materials and construction waste left behind from buildings demolished due to urban transformation, end-of-life, and earthquakes can be utilized in various ways. In this context, it can be used as recycled aggregate and paste backfill additive material for filling in underground mines [17, 18, 19, 20, 21].

Conclusions

The structures in settlements where urban transformation is inevitable today must be demolished. Destruction has made considerable progress in recent years with explosives, which are economically and technically advantageous. Destruction can be done more efficiently and safely, especially when destroying high-rise structures. The use of explosion and destruction techniques in structures that have ended their economic life or are severely damaged due to natural disasters and are at risk for safety is inevitable. The static properties of the structures to be destroyed using explosives should be determined, and parameters such as the amount of explosive to be used, the time of delay, the total number of holes, and the ignition scheme should be determined according to the durability properties. A safe destruction process should be carried out with the necessary precautions to minimize the environmental impacts of explosions.

Ethics committee approval and conflict of interest statement

"There is no need to obtain permission from the ethics committee for the article prepared"

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Authors' Contributions

-Study conception and design: Dilmaç

-Drafting of manuscript: Dilmaç

-Critical revision: Dilmaç

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