Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering. Vol. XV, 2026
Print ISSN 2285-6064, CD-ROM ISSN 2285-6072, Online ISSN 2393-5138, ISSN-L 2285-6064

CASE STUDY ON THE ASSESSMENT OF THE EFFECTS OF CONTROLLED BLASTING DEMOLITION ON NEARBY BUILDINGS

Adrian SIMION

National Institute for Building Research, Town Planning and Sustainable Territorial Development "URBAN - INCERC", 266 Pantelimon Road, District 2, Bucharest, Romania

Corresponding author email: simion_i_adrian@yahoo.com

Abstract

Some of the civil and industrial buildings in Romania have exceeded or will exceed, in the coming period, their expected operating lifespan. This fact requires the establishment of a strategy for their replacement and one of the methods that responds to a high degree to these requirements is the demolition of buildings using explosives. This paper presents a theoretical study assessing the impact of the explosive demolition of an industrial building on an adjacent 10-story residential structure. The evaluated effects included the aerial shock wave, seismic impact, thrown fragments, and environmental pollution. To this end, both pyrotechnic parameters and calculation formulas derived from specific legislation were utilized. The demolition impact assessment was carried out during the design stage, providing the necessary documentation to obtain the demolition permit for the industrial building.

Key words*: blast effects, buildings, explosives, explosive demolition, impact assessment.*

INTRODUCTION

Each structure is designed for a specific service life. After this service life, its existence becomes very dangerous for its occupants and surrounding buildings (Popa et al., 2024).
The demand for demolishing old buildings has increased recently, especially in major cities worldwide, where numerous structures were built during past periods of high economic growth (Silva et al., 2022).
A significant portion of these buildings are demolished using techniques that utilize explosive energy, which are often applied in the USA, Europe, and China (Isobe & Jiang, 2022).
In Romania, urban modernization in recent years has generally provided the pretext for the demolition of numerous old buildings.
In some situations, the demolition of these structures was only possible by applying new methods of controlled demolition using explosives (Laszlo et al., 2022).
Implementing the technique of demolishing structures using explosives aims to achieve the desired results by applying optimal constructive and economic solutions, without disrupting ongoing activities, and ensuring safety for both the personnel involved and the environment (Thomsen et al., 2011). Demolishing structures using explosives poses a series of risks to the environment and to people within the range of the explosion's effects. These works are carried out based on technical projects starting from the hypothesis of minimizing and/or removing these risks. In reality, this state of affairs is not always possible.
Sometimes, it is not possible to determine by calculation the optimal explosive charges to achieve the desired effect while maintaining a satisfactory level of protection. At other times, charges calculated as safe from a protection standpoint cannot achieve the desired blasting effect. For these reasons, implementing a demolition project using explosives - especially in an urban environment - requires a compromise between the amount and placement of explosives used to achieve the desired goal and the actual level of protection for the surrounding environment and individuals within range of the explosion's effects.
Practice in the field has shown that a way to achieve this compromise is to use the explosive charges resulting from the calculation as necessary to achieve the desired effects, while using measures to protect the environment and individuals, by means of means of protection adequately sized to achieve the required level of safety.

MATERIALS AND METHODS

The study presented below consists of assessment of the effects that the demolition of an industrial structure had on buildings located in the nearby of this demolition area.
These effects consisted of the air shockwave effects, the seismic effect, the effect of thrown fragments and the effect of environmental pollution (Fourney, 1983). The structure demolished through controlled blasting (hereinafter referred to as OD12) was an industrial building located on the premises of the former Titan Factory - Bucharest (Figure 1).

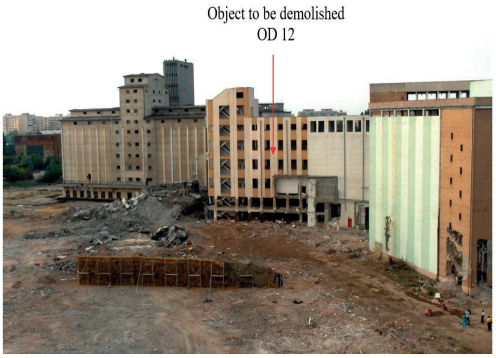


Figure 1. Overview of OD 12 before demolition, taken from the 10th floor of the protected building

Outside the TITAN Bread Factory, to the south, several residential complexes were built approximately 130 m away from the demolished structure (Figure 2).



Figure 2. View from the terrace of the industrial building to be demolished, with the residential blocks which the construction to be protected is part

The demolished building featured a reinforced concrete frame system, with a resistance structure consisting of columns and beams stiffened by floor slabs.
Before demolition, the building had a rectangular footprint measuring 28.20 x 9.25 m and a height of GF+5 floors+2 recessed floors (total height of 31.90 m).
It consisted of two sections without an expansion joint between them: the first section measured 12.20 x 9.25 m (GF+5F+2R), and the second section measured 16.00 x 9.25 m (GF+5F).
The building's structural frame consisted of reinforced concrete frames, with columns (measuring 0.75 x 0.75 m at the ground floor and 1st floor, and 0.65 x 0.65 m at the 2nd floor), beams (0.35 x 1.00 m and 0.45 x 0.70 m at the ground floor, 0.60 x 1.00 m and 0.45 x 1.00 m at the 1st floor), and ribs (0.25 x 0.40 m and 0.20 x 0.30 m). The layout and dimensions of the columns within the industrial building structure are shown in Figure 3.

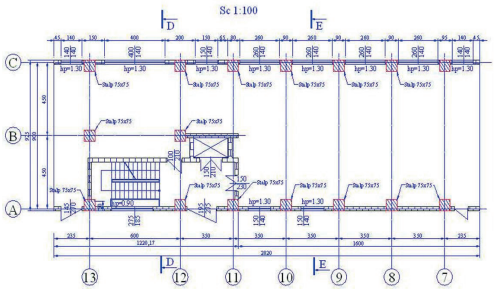


Figure 3. Ground floor plan of the demolished structure

The building's roof consisted of a reinforced concrete coffered slab (waffle slab) for the 5-story section (GF+5) and a reinforced concrete flat slab for the section with a height of GF+5+2R (receded floors), both equipped with thermal and water insulation. Access to the upper floors was provided via stairs.
The building envelope was made of non-load-bearing brick masonry walls and glazed surfaces, which were destroyed once the factory was abandoned (Figure 4). The reinforced concrete technological floors were positioned at the following levels: +3.50 m, +7.00 m, +11.50 m, +16.00 m, +20.50 m, +25.00 m, and +28.70 m.

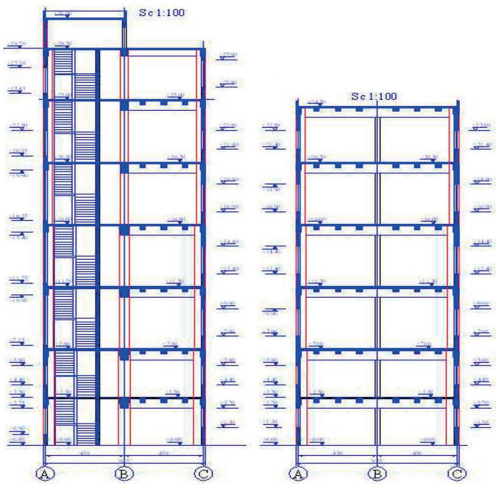


Figure 4. Cross sections of the demolished structure

During the demolition of the industrial building, measures were taken to protect neighboring structures from the effects of the process.
One of the protected buildings was a 10-story residential block consisting of a rigid core and reinforced concrete frames.
The centrally located core, made of shear walls surrounding the elevator, was designed to handle most of the lateral loads, while the reinforced concrete columns were responsible for supporting the gravity loads (Figure 5).

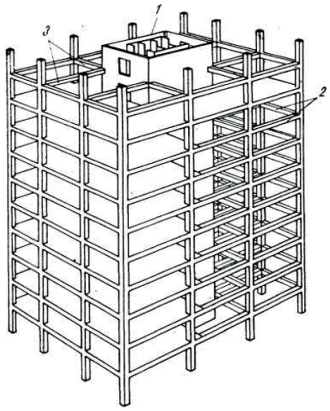


Figure 5. Combined structure made with central core and reinforced concrete frames: 1- central core made of reinforced concrete diaphragms; 2 - marginal reinforced concrete frames; 3 - intermediate reinforced concrete frames

During the demolition works of OD 12 using controlled explosions, the following effects occurred: the air shockwave effect; the seismic effect; the effect of thrown fragments; and the effect of environmental pollution.
Assessment of the effect of the air shock wave:
According to the legislation in force in Romania, in HG 536/2002 the value of the overpressure in the shock wave front is determined with the relation:

$$\Delta p_f = 0.84\lambda + 2.7\lambda^2 + 7\lambda^3 \quad [\text{kgf/cm}^2]$$

where λ is the scaled distance and is calculated with the relationship:

$$\lambda = \frac{\sqrt[3]{Q}}{R} \qquad [\text{kg/m}]$$

where Q is the amount of explosive material, expressed in TNT equivalent [kg], that detonates instantaneously and R [m], is the distance measured from the site of the explosion to the protected building.
Compared to OD 12, the nearest building is a residential apartment building located at a distance of approximately 130 m.
The maximum charge per delay interval is 3.3 kg of dynamite. Since a nitroglycerin-based explosive mixture is used for the demolition, which has an equivalence coefficient of 1.3 TNT equivalent and there are 3.3 kg of dynamite per detonation stage, it follows that (HG 536, 2002):

$$Q = 3{,}3 \times 1{,}3 = 4{,}29 \text{ [kg TNT equivalent].}$$

The 4.29 kg of dynamite results from adding the amount of explosive in the holes to the amount of PETN in the detonating cord used to initiate the explosives (10 g/m).
Under these conditions, the value of parameter λ is:

$$\lambda = \frac{\sqrt[3]{Q}}{R} = \frac{\sqrt[3]{4{,}29}}{130} = 0{,}0125 \text{ [kg/m].}$$

The resulting value is negligible; for this reason, the shock wave front overpressure was determined via the direct method, resulting in:

$$\Delta p_f = 0.84x0{,}0125 + 2.7(0{,}0125)^2 + 7(0{,}0125)^3 = 0{,}0111 \text{ [kg/cm}^2\text{]}.$$

This calculation did not account for the fact that the total mass of explosive used in the previous calculation is distributed into small charges placed in blast holes (Olsson & Bergqvist, 1993).

For this reason, specialized literature, such as works by experts from the Swedish Detonic Research Foundation (Persson et al., 1981), considers that the overpressure value in the shock wave is:

$$\Delta p_f^* = 0.2\Delta p_f \text{ [kg/cm²]}.$$

In this case $\Delta p_f^* = 0.00222\,kg/cm^2$ and this value is well below the limit that could cause any damage to the building being protected.

From the analysis of this data, it appears that, to protect the neighboring property during demolition, it is sufficient to install protective measures consisting of used rubber mats or to create screens from straw bales, tarpaulins, etc.

Assessment of the seismic effect induced by detonation of explosives:

The seismic effect caused by oscillations produced by the detonation of explosives charges during blasting works subjects nearby structures to spatial movement, which places dynamic stress on their constructive elements.

Depending on the intensity of the oscillations and the condition of the structures, stresses can cause damage over time.

This occurs when the generated oscillations lead to dynamic stresses that exceed the tensile, shear, or bending strength of the structural elements.

To assess the seismic effect of elastic oscillations transmitted through the ground to building foundations, the velocity criterion has been chosen globally in most cases, as it is the only reproducible parameter for the entire range of frequencies characteristic of seismicity produced by blasting works (Persson et al., 1970).

The seismic waves affecting the structure to be protected are generated by the detonation of explosive charges in the blast holes within the structural elements of OD 12 and by the ground impact resulting from the building's collapse (Lupoae, 2016).

Assessment of the seismic effect induced by explosions inside structural elements:

When designing blasting works, the size of the concentrated explosive charge that can be detonated instantaneously is determined by the formula:

$$Q_{inst} = \left(\frac{R}{\alpha k}\right)^3 \text{ [kg TNT equivalent)]},$$

where R is the distance between the blast site and the target (m); k is a coefficient based on the properties of the medium being blasted, and α is a coefficient depending on the blast effect index. The quantity of explosive that can be detonated per delay stage is determined by the relation:

$$Q_{tr.itr} = \frac{2}{3} Q_{inst} f(n) K_1 \text{ [kg TNT equivalent)]},$$

where $f(n)$ is a reduction coefficient based on the delay time of the initiation system, and $K1$ is a reduction coefficient based on the number of blasts carried out during a year.

Using the calculation formulas presented above, for objective OD 12, the following is obtained: R = 128 m (the distance between OD 12 and the building to be protected); K = 9 for clay rocks; α = 1 (for an explosion index n = 1); Q_{inst} = 1139 kg TNT equivalent = 876.5 kg dynamite; $f(n)$ = 0.917 for the NONEL-MS system; K_1 = 1 (for one blast); $Q_{tr\ itr}$ = 696.5 kg TNT equivalent = 535.8 kg dynamite.

It can be observed that the values obtained from the calculation are very high compared to the maximum explosive charge per delay stage of 3.3 kg dynamite.

Even if the explosive charges were to detonate in boreholes drilled into the ground, the oscillation velocity generated by the explosion shock is below the level established as admissible.

In conclusion, given that these charges detonate above the ground, a potential seismic effect induced through the soil cannot be considered regarding the blasting works performed for the demolition of OD 12.

Assessment of the seismic effect induced by ground impact during the collapse of OD 12:

Assessment the seismic effect produced by the collapse of OD 12 on the ground, it must be

noted that the resistance structure consists of reinforced concrete frames.

For these structures, when the chosen demolition method is overturning in a specific direction, the reduction of the main portion of the falling energy is achieved through the large interior spaces of the structure.

These spaces ensure that, at any given moment, only a small fraction of the building's elements are in contact with the ground, while other elements reach their breaking point and subsequently collapse completely (Figure 6; Figure 7; Figure 8).



Figure 6. Space inside the demolished building from a lower floor



Figure 7. Space inside the demolished building from a higher floor



Figure 8. The structural elements of OD 12 collapsed on the ground

Assessment of the effect of thrown fragments:

The main consequences of this effect consist of: local destruction resulting from the impact between the thrown fragments and the protected objective; the occurrence of local fires where the thrown fragments land, if they are heated to an appropriate temperature; to minimize these effects, a series of protective measures have been taken, as follows: installing wire mesh with a 0.03 × 0.03 m mesh size on the building to be demolished, directly over the explosive-filled boreholes, to slow down and retain large concrete fragments detached during the explosion (Figure 9);



Figure 9. Wire mesh used in the manufacture of protective screens

installing various types of screens on the construction pillars, adjacent to the boreholes loaded with explosives, to slow down and

contain small fragments detached during explosions (Figure 10); installing protective panels on or near the structures to be protected and identifying any potential fire outbreaks immediately after demolition and extinguishing them.

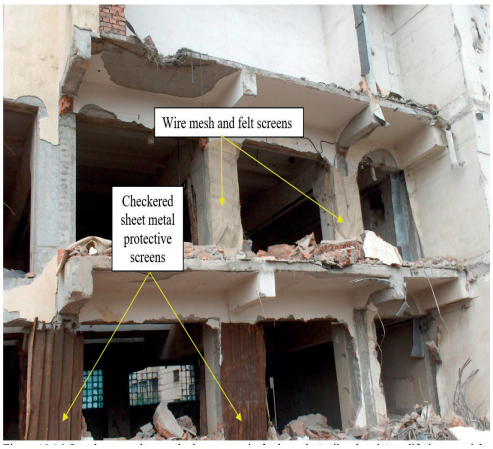


Figure 10. Installation in front of mine holes, the various type of screens for slowing down and retaining large fragments detached from the explosion

Assessment of the environmental pollution effect:

This effect is limited in both time and space of action; it is caused by blasting gases and dust resulting from the crushing of the reinforced concrete structure, as well as the interaction of structural elements with each other and upon contact with the ground (Figure 11).



Figure 11. Dust and explosion gas pollution during demolition of OD 12

To reduce dust pollution, the area where the structure collapsed was sprayed with water, both before and immediately after its fall (Figure 12).



Figure 12. Water spraying of the demolition area to limit dust pollution

RESULTS AND DISCUSSIONS

The results obtained from this study primarily serve a justificatory role. This study can be provided by the demolition contractor to the relevant authorities in the event of complaints from residents of protected properties regarding inconveniences or damage caused by the demolition activity (Simion, 2014).

Thus, to prevent potentiality litigation during the demolition of the industrial structure presented in this paper, monitoring actions were carried out. Monitoring refers to post-event verification methods of the effects generated by this type of demolition. These consisted of filming and photographing the preparatory work performed on the structure to be demolished, filming and photographing the condition of protected buildings before and after the demolition, and measuring blast effects regarding airblast and seismic wave levels, as well as the level of dust dispersed in the air and deposited in the environment.

The non-hazardous level of oscillations caused by explosions during the industrial building demolition is established based on the degree of damage to structures located in the nearby of the demolition area (Singh & Roy, 2010). This threshold varies from country to country and is generally adopted based on the quality of the

constructions and even the manner in which minor repairs are executed for buildings near the blasting area.

It was assessed that the collapse process of the industrial building did not generate ground oscillation intensities capable of damaging neighboring buildings in any way.

During the demolition of the industrial structure, no shrapnel projections or fragments of building materials were observed and recorded, and the overpressure in the shock wave front due to explosions was of short duration and low intensity, and did not cause inconvenience to residents of nearby buildings.

CONCLUSIONS

The demolition of vast portions of the existing urban structure has been a continuous feature of urban renewal in Romania since the 1990s (Simion & Dragomir, 2014). In this process, many buildings that could have been renovated or otherwise utilized were lost. A large part of these constructions were industrial structures was demolished using one of the most efficient techniques: demolition with explosives. This technique is based on the destructive action of explosions within holes drilled into structural elements to cause the collapse of the building.

This method is particularly effective for large industrial facilities where rapid demolition is required.

However, despite its efficiency, the demolition with explosives requires rigorous engineering analysis and expert supervision to prevent unintended damage to nearby buildings (Yuzbasi, 2025).

Studying the destructive phenomena and actions that occur during explosions requires evaluating, with a certain probability, the scale of destruction and the effects produced on people and various urban buildings.

The destructive effect of explosions on structural elements manifests in a particular way, as the explosive charges detonate in the holes where they are placed, and the transfer of a certain amount of energy from the explosion to the construction material and the environment generates the destructive action and the effects of the explosion.

Controlled demolition projects differ from one construction to another and generate undesirable effects, such as acoustic, seismic, and dust impacts, which must be continuously understood and measured.

To ensure the impartiality and credibility of these effect measurements, they must be carried out by specialists other than those performing the demolition works. These specialists must be accredited for such tasks (possessing proven qualifications and competence) and must use specialized equipment for recording dynamic parameters that has been metrologically verified.

REFERENCES

Isobe, D. & Jiang, R. (2022), Explosive demolition planning of building structures using key element index, *Journal of Building Engineering*, Volume 59, 104935.

Decision No. 536 of 30 May 2002 (2002), on the approval of the Technical Norms regarding the possession, preparation, experimentation, destruction, transport, storage, handling and use of explosives used in any other specific operations in the activities of the holders, as well as the authorization of fireworks makers and pyrotechnicians**), Bucharest, RO: Official Gazette, No. 479 of July 4, 2002.

Fourney, W.L. (1983). *Fracture Control Blasting*, In Rossmanith, H.P. (eds), Rock Fracture Mechanics. International Centre for Mechanical Sciences, 275, Springer, Vienna.

Laszlo, R., Jitea, C., Garaliu, B., Nicola, A. & Miklos, L. (2022), Design and execution of demolition work by blasting of industrial constructions – technical and safety aspects, *Bulletin of the Polytechnic Institute of Iaşi Machine constructions Section*, 68 (2), 119-131.

Lupoae, M. (2016). Numerical solution to estimate the seismic effect on controlled explosive demolition, *16th International Multidisciplinary Scientific GeoConference SGEM2016,* 10.5593/SGEM2016/B12/S03.081.

Olsson, M. & Bergqvist, I. (1993). Crack lengths from explosives in multiple hole blasting, In Mohanty B. (Ed), *Rock Fragmentation by Blasting*, 187-191, CRC Press, London, doi.org/10.1201/9781003078104-25.

Persson, P.A., Holmberg, R., Lande, G. & Larsson, B. (1981). Underground blasting in a city, M. Bergman (Ed.), Subsurface Space - Environmental Protection · Low Cost Storage Energy Savings, Pergamon, 1, 199-206.

Persson, A., Lundborg, N. & Jonsson C. H. (1970). The Basic Mechanisms in Rock Blasting, Paper presented at the 2nd ISRM Congress, Belgrade, Yugoslavia, .

Popa, I., Petcu, C., Stoica, D. & Dima, A. (2024), Rice husks and their potential for use in construction. *Scientific Papers. Series E. Land Reclamation, Earth Observation & Surveying, Environmental Engineering*, XIII.

Silva, A., de Brito, J., Thomsen, A., Straub, A., Prieto, A.J. & Lacasse, M.A. (2022), Causal Effects between Criteria That Establish the End of Service Life of Buildings and Components. *Buildings* 2022, 12, 88.

Simion, A. (2014), Evaluation of seismic effects of blasting demolitions, *UTCB Scientific Bulletin*, 4.

Simion, A. & Dragomir, C.S. (2014), Reliability of demolition by controlled implosions, *Constructions: Journal of Civil Engineering Research*, 15(2), 56 – 59.

Singh, P.K. & Roy, M.P. (2010), Damage to surface structures due to blast vibration, *International Journal of Rock Mechanics and Mining Sciences*, 47(6), 949-961.

Thomsen, A., Schultmann, F., & Kohler, N. (2011), Deconstruction, demolition and destruction, *Building Research & Information* 39(4), 327-332.

Yuzbasi, J. (2025), Fundamentals of Controlled Demolition in Structures: Real-Life Applications, Discrete Element Methods, Monitoring, and Artificial Intelligence Based Research Directions. *Buildings*, 15, 3501.