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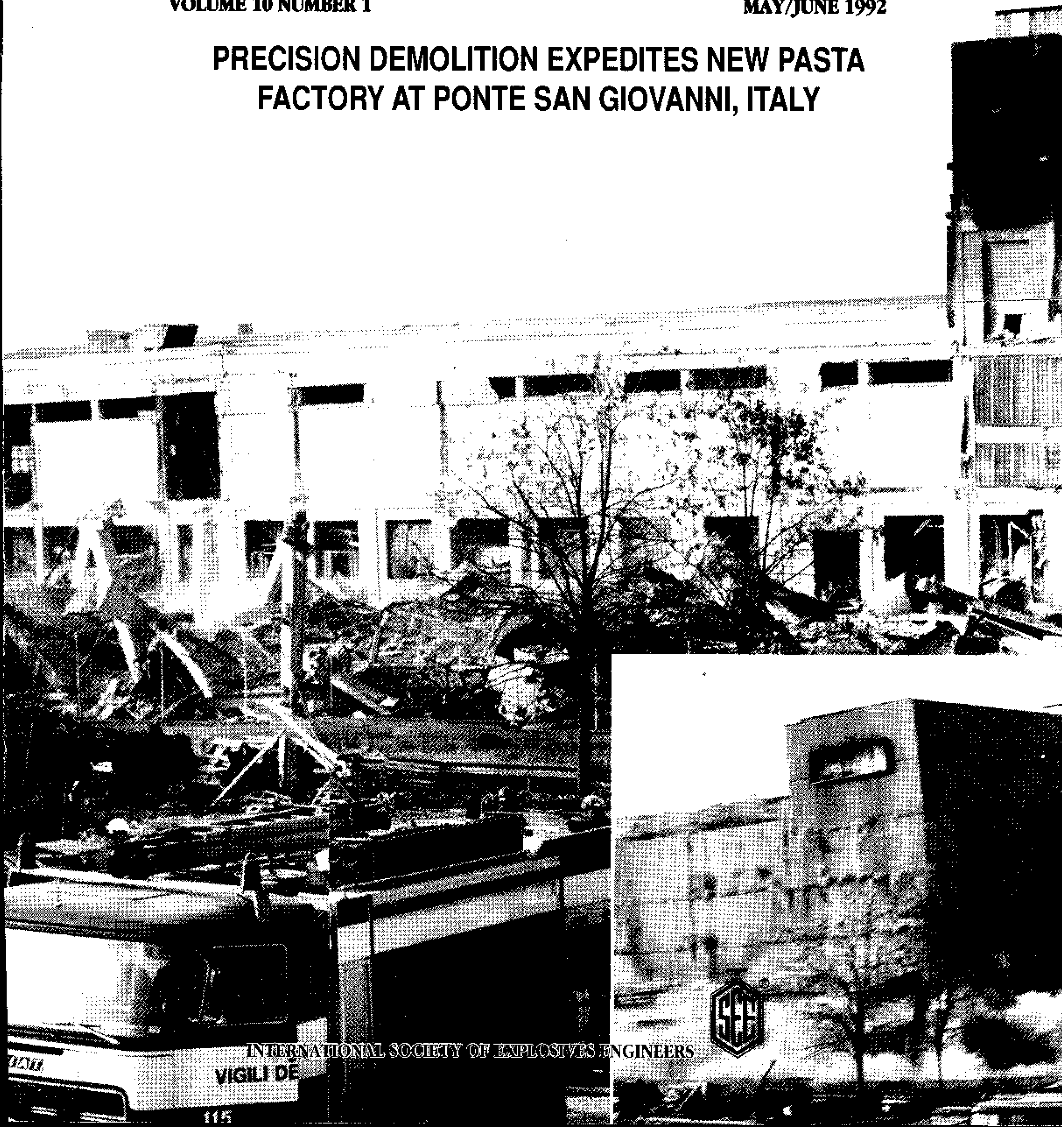
## PRECISION DEMOLITION EXPEDITES NEW PASTA FACTORY AT PONTE SAN GIOVANNI, ITALY




INTERNATIONAL SOCIETY OF EXPLOSIVES ENGINEERS

# DEMOLITION OF AN INDUSTRIAL BUILDING IN AN URBAN SITE

Case History: Panzani Ponte Liebig Spa Factory in Perugia, Italy

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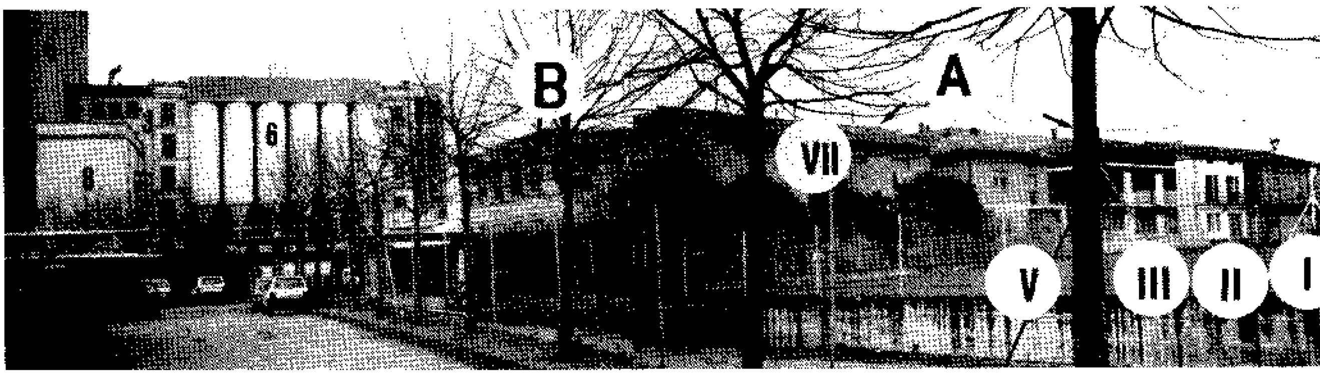



*Structure to be safeguarded in the neighborhood of the shed to be demolished (photo taken by spot "alpha," see fig. 1).*

**ABSTRACT**

This article deals with the demolition of an industrial structure at Panzani Ponte Liebig Spa pasta factory in Ponte San Giovanni, Perugia, Italy, using explosives.

The structure was built on top of a preexisting one and was surrounded by streets and civil and industrial buildings.

Demolition work was executed with controlled blasting techniques. Precautions had to be taken to safeguard people and the static integrity of neighboring structures and the sensitivity of technological systems in the factory. Particular care also had to be taken, both in projecting and executing the work, because the structure to be demolished had previously been damaged by fire and was in precarious condition.

**INTRODUCTION**

In order to modernize the Panzani Ponte Liebig Spa pasta factory at Ponte San Giovanni, Perugia, a plan was implemented to demolish some structures that were no longer functional.

Two buildings originally housing offices, pasta making and confectioning activities were scheduled for demolition. One was in precarious condition due to damage caused by a fire (structure A in fig. 1). The building's height, close proximity to other structures, streets and technological systems created the necessity of using controlled blasting techniques to execute demolition.

As a matter of fact, mechanical demolition was considered and excluded because of the high ricks of priming, demolition and unwanted kinematics in the frame. This could have caused big danger for the machine operators and could have left the frame in even more critical condition.

The other building (building B in fig.1) was lower and in better condition. It was later demolished with hydraulic hammers on backhoe excavators. The work was executed by Eco Cave SRL, a demolition contractor of Perugia, with your author acting as a consultant for the controlled blasting.

**STRUCTURE TO BE DEMOLISHED WITH EXPLOSIVES**

The structure to be demolished was a reinforced concrete industrial building. The building frame was made with precast pilasters and two (three in the eastern side) levels of resting beams (orthogonal to the longer side of the springing area). Curtain walls were made of reinforced concrete panels attached to the frame.

The springing area was about 1'700 $m^2$ and the height was 19 m (25M in the eastern side). The static condition of the structure appeared deeply compromised by the fire.

Several floors had caved in – no longer able to withstand the weight of machinery. Those floors left standing were severely bent and covered with wreckage.

**STRUCTURES AND TECHNOLOGICAL SYSTEMS TO BE SAFEGUARDED**

The elevated building B consisted of a three level, reinforced concrete framed structure. It was also damaged by the fire and was later demolished.

Other structures that needed safeguarding in the factory area were: silos (some of them were very thin and up to 40 m high); mills; machines for making, drawing and confectioning pasta; transformers and power cages; medium voltage iron frameworks; warehouses; and civil buildings (fig. 1, photos 1, 2, and 4).

The nearest residential buildings outside the factory were two level houses on the west side (fig. 1, photos 1 and 4). About 80 m west was a busy street.

## THE CONTROLLED BLASTING PROJECT

### General

In the blasting project, particular care was taken to keep seismic transient (the blasting and falling masses induced upon ground impact), air overpressures and flying concrete fragments within safety limits.

The project objectives were:

- preliminary works to facilitate the razing of the structure and to make the explosives charging easier and quicker;
- pulling down kinematics;
- safety limits to be achieved and estimated values of induced ground vibration, air overpressure and thrown concrete fragments;
- blast rounds (explosives types and amounts, detonating cord, detonators and charge ignition sequence).

## SEISMIC WAVES INDUCED BY MASS IMPACT AND EXPLOSIVES

Expected ground peak particle velocity "$V_{MAX}$", versus distance from impacting mass barycenter "R," was established referring to the following decay law (power regression of values induced by the impact of a 14 levels building axially falling):

$V_{MAX} = 1673 \bullet R^{-1.41}$ ($V_{MAX}$ [mm/s]; R [m]).

Predominant frequency of the seismic transient was expected to be between 7 and 7 Hz in the 30 meters range.

Expected ground peak particle velocity, induced by explosive blasting, versus scaled distance "SD", was established referring to the following decay law:

$V_{MAX} = 240 \bullet (SD)^{-2.2}$ ($V_{MAX}$ [mm/s]; SD [m/kg$^{0.5}$])

Predominant frequency of the seismic transient was expected to be higher than that induced, at the same distance, by mass impact; it was considered to be between 50 and 100 Hz (propagation media was a conglomerate).

## SAFETY LIMITS FOR PEAK GROUND VELOCITY

Because of the lack of specific national regulations and standards, the safety limits for ground particle velocity induced were adopted by DIN 4150, 1983, Germany (table 1). The difficult predominant frequencies of seismic transient induced by blast and mass impact triggered adoption of two different safety limits both for residential and industrial buildings (table 2).

**Table 1**
DIN 4150, 1983 (GERMANY)
Safety Velocity (mm/s) for Different Constructions

| Construction | Seismic Transient Predominant Frequency <10 Hz | 10 ÷ 50 Hz | 50 ÷ 100 (*) Hz |
|---|---|---|---|
| Industrial | 20 | 20 ÷ 40 | 40 ÷ 50 |
| Residential | 5 | 5 ÷ 15 | 15 ÷ 20 |
| Particularly Delicate | 3 | 3 ÷ 8 | 8 ÷ 10 |

(*) For Frequencies Higher Than 100 HZ Safety Limits of 100 HZ Can Be Adopted

**Table 2**
Safety Limits Adopted For Peak Ground Velocity $V_{MAX}$ (mm/s)

| Building | Mass Impact | Explosives |
|---|---|---|
| Residential | 10 | 20 |
| Industrial | 30 | 50 |

A peak velocity of 20 mm/s was expected at a scaled distance "SD" (R/Q$^{0.5}$) lower than 3 m/Kg$^{0.5}$; a peak velocity of 50 mm/s was expected at a scaled distance lower than 2 m/Kg$^{0.5}$. Maximum charge "Q" allowed to be blasted per time delay at various distances "R" from the shot was, therefore, not to exceed $Q = (R/3)^{1/2}$ kg for residential buildings and $Q = (R/2)^{1/2}$ kg for industrial buildings.

## AIR OVERPRESSURE

Expected air overpressure peak value "AOP" induced by explosives blasting, versus scaled distance, was established referring to the following decay law:

$AOP = 2.5 \bullet SD^{-1.07}$ (AOP [lb/in$^2$]; SD [ft/lb$^{0.5}$])

The overpressure limit value was established below 151 dB at a distance of 20 meters from the structure to be demolished.

## CONCRETE FRAGMENTS THROWN

The safety distance for fragment throw was established to be greater than 100 meters. In any case, the boundary pilasters were covered with pieces of thick rubber belt (the one employed in the rock belt conveyors).

## IMPOSED KINEMATICS

Since there was a large yard in front of the building, it was decided to direct the falling debris into this area. Blast rounds were planned so as to create a load redistribution in the building frame so that on explosion, the building would rotate toward that yard. Because there were structures in close proximity to both the east and west sides (a power station and a medium voltage iron framework 13 meters from the east side which was 25 m high and a warehouse 6 meters from the west side which as 19 m high), the east and west sides of the structure to be razed were forced to slightly rotate toward the structure center.

## BLAST ROUNDS

Explosives charges were placed in preexisting passing holes in the pilasters (hole diameter "Ø" was of 60 mm, photo 5). Drilling new holes was much too dangerous because of the structures critical stability.

Leaned charges were employed to fracture those sections of pilasters without preexisting holes.

Explosives employed were:

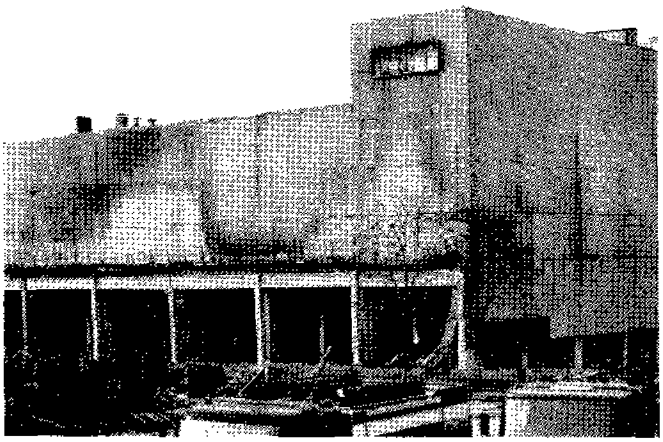
- high nitroglycerin content dynamite "GELATINA 1" tubular charges Ø 50 mm and "GOMMA A" rectangularly shaped 0.5 Kg (by ITALESPLOSIVI, Italy);
- detonating cord (12 grams of pentrite per meter, by ITALESPLOSIVI);

*continued page 30*

**Demolition** *continued from page 28*

- electric 30 ms delayed detonators (by DYNAMIT NOBEL, Germany).

In-hole charges were made of about 0.15 Kg of dynamite stemmed with clay. To reduce charging time, the charges were preconfectioned in a cartridge made of a PVC pipe with 60 mm explosive at the center of the pipe and tamping clay at both ends. The explosive charge was primed by detoning cord (fig. 3). This explosive cartridge could quickly be placed in the holes.

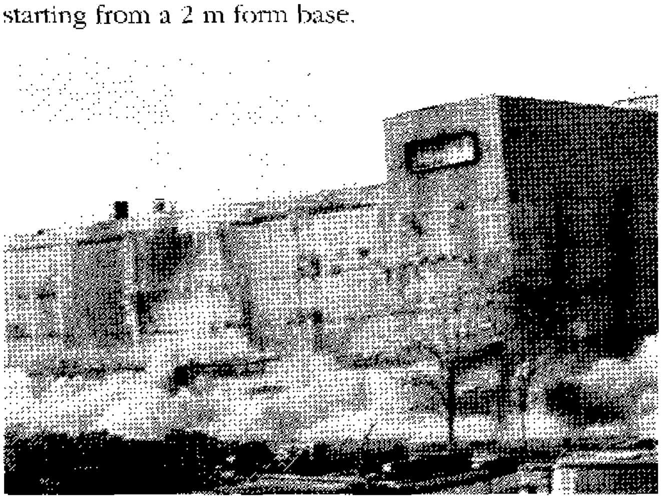


*The building "A" to be demolished (photo taken by spot "beta," see fig. 1)*

The leaned charge, about 2/3 (0.33 Kg) of the original "GOMMA A" charge, was also primed by detonating cord. The charge was tamped with a thick strata of clay and a sack of sand (the sacks were hung on the pilasters before charging). In this way, it was possible to improve confinement and reduce both explosive specific charge and air overpressure.

All the charges in a pilaster were connected to each other with detonating cord which was ignited with a detonator.

Pilasters were fractured for various section heights, starting from a 2 m form base.



*Charge ignition (photo taken by spot "beta").*

*Pilaster of the first and second rows. It is possible to see the preexisting passing holes that were charged with explosive cartridges. It is also possible to see a floor all covered with wreckage and machinery destroyed by the fire (photo taken by spot "gamma," see fig. 1).*

Pilasters of the first row (from Z1 to Z9) and of the third at the boundary (X1 and X9), were fractured for a height of about 4 m with 16 in-hole and 4 leaned charges (fig. 4).

Pilasters of the second row (from Y1 to Y9) and of the fourth at the boundary (W1 and W9) were fractured for a height of about 4 m with 8 in-hole charges.

Pilasters of the third row (from C2 to C8) were fractured for a height of about 2 m with 8 in-hole and 2 facing charges.

Pilasters of the fourth row (from W2 to W8) were fractured for a height of about 2 m with 4 in-hole charges.

Pilasters of the fifth and last row (from V1 to V9) were fractured with 3 in-hole and 1 facing charge, to make hinges.

About 80 kg of explosive were distributed in about 370 in-hole and 60 leaned charges.

Charges were sequentially ignited starting from the central pilasters of the first row. Time delay increased from the first to the last row and from the center to the side pilasters (fig. 4.)

## DEMOLITION WORK

The demolition was carried out through the following phases:

**Demolition** *continued from page 30*

*continued page 35*

- preliminary cuts of pipes and steel supports which were adjoining the structure to be demolished "A" to the elevated one "B";
- mechanical demolition of the curtain walls (made of bricks) at ground level, making passages and wooden foot bridges for easy and quick access to all pilasters;
- preparing explosive cartridges, charging holes and placing leaned charges, blasting (with consequent structure collapse);
- hewing the structure disjointed on the ground (by rods cutting);
- fragmentation of the hewn material with a portable jaw crusher and separation of concrete from the steel rods;
- charging concrete wreckage and steel, transportation to a stocking point (wreckage was recycled as roadway embankments).

Cartridge confectioning, setting in place and blasting was performed in one day by three pairs of blasters (your author among them plus directing the work).

**ACKNOWLEDGEMENTS**

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*Structure collapsed on ground.*

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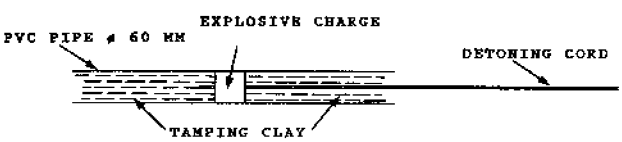


*Fig. 3 – Preconfectioned explosives cartridges for in-hole charging.*

**STRUCTURES TO BE SAFEGUARDED**
1 warehouse
2 methane gas cage
3 mills, pasta making and confectioning
4 silos
5 power station
6 medium voltage iron frameworks
7 fuel tanks
8 offices
9 street
10 Tiber River
form I to VIII: closest residential constructions outside the factory

**STRUCTURES TO BE DEMOLISHED**
"A" (pasta making and confectioning)
"B" (offices)

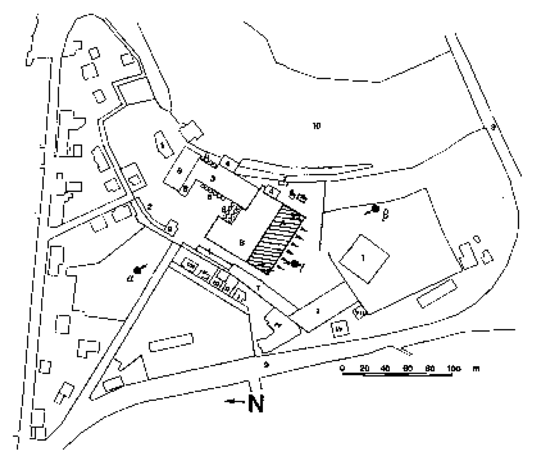


*Fig. 1. – Planimetry of the PANZANI PONTE LIEBIG SPA factory at Ponte S. Giovanni and surrounding areas. Structure to be demolished and structures to be safeguarded.*

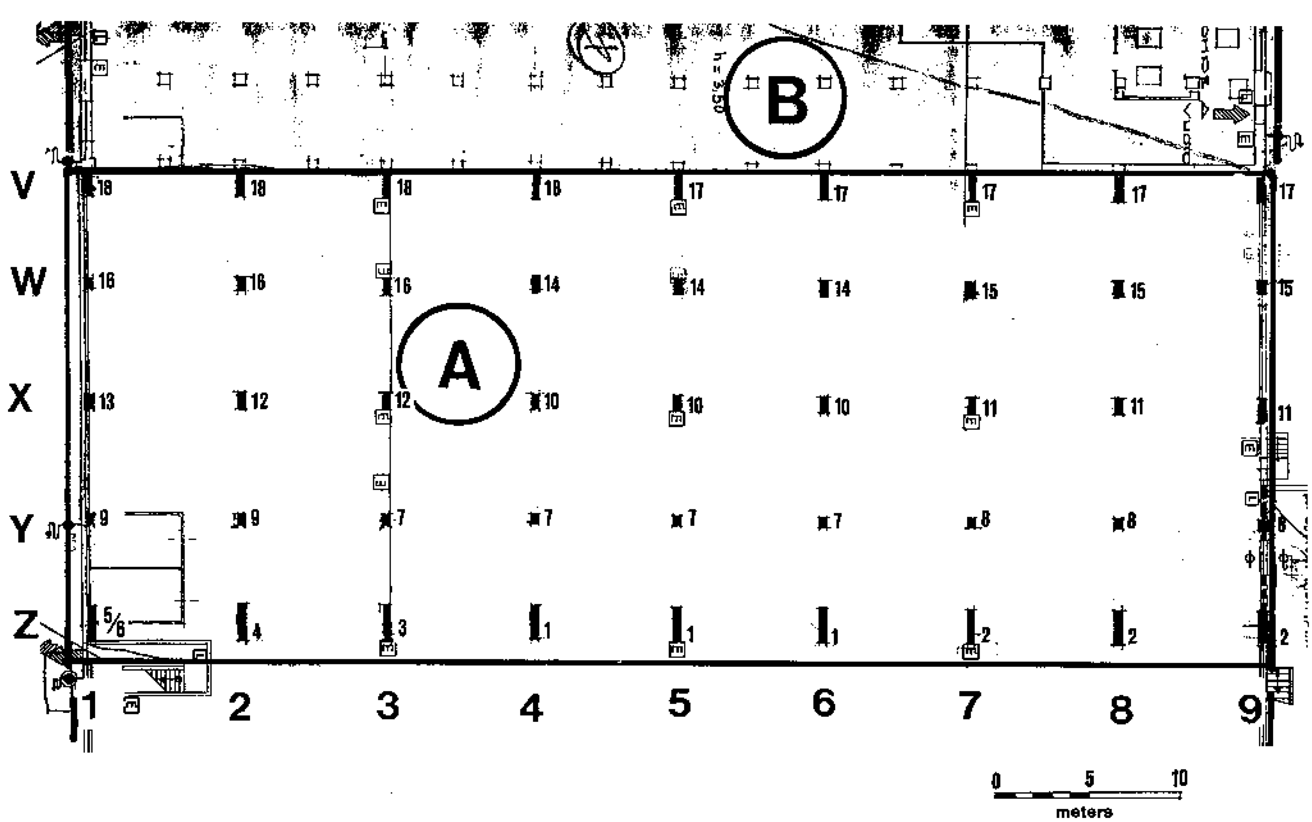


*Fig. 2. – Transversal section of the structures to be demolished. Scheme of the induced collapse kinematics in the building "A."*

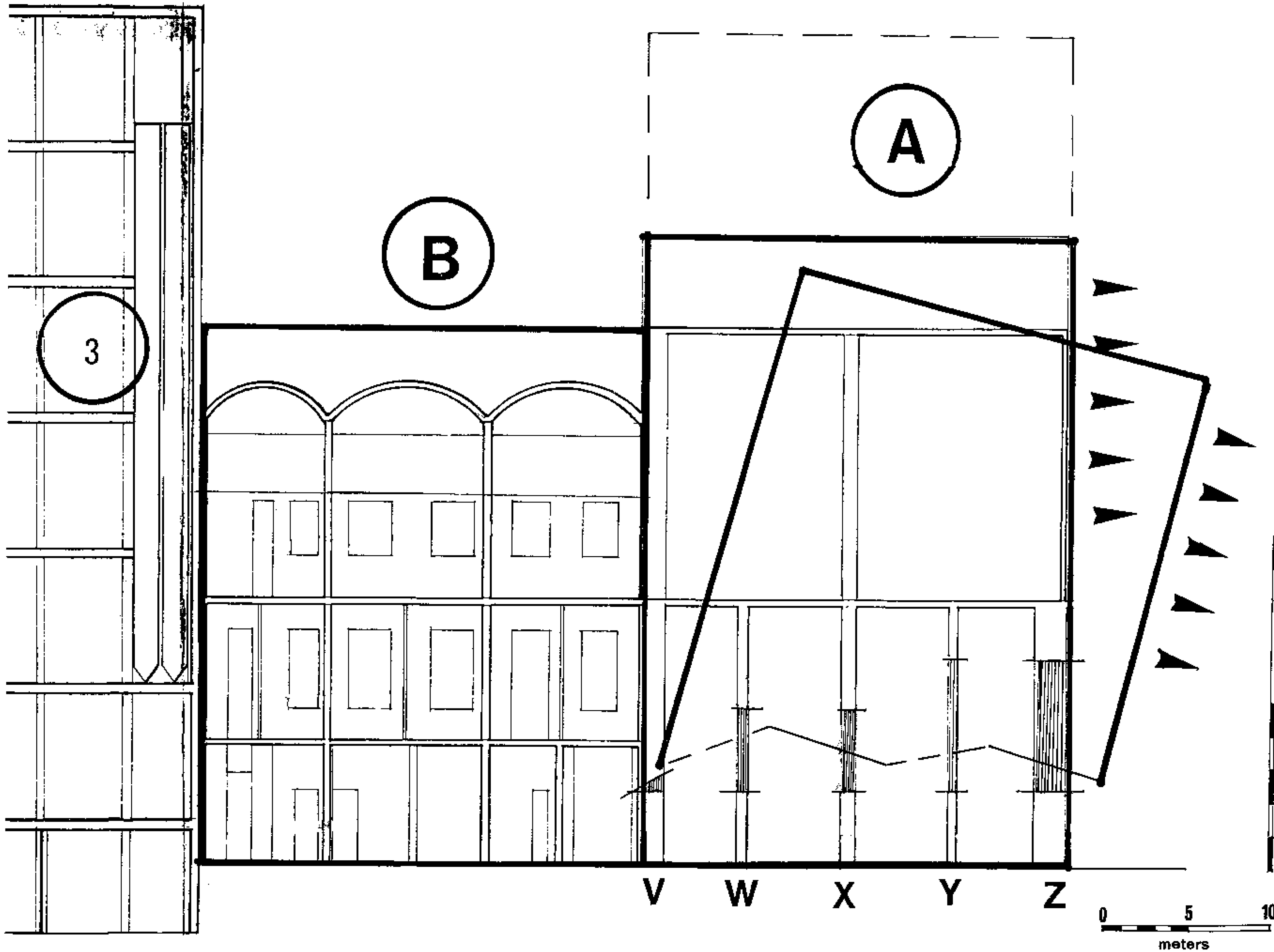


*Fig. 4 – Sequence of explosives charges ignition*