An Unusual Underpinning Operation

Un cas extraordinaire de reprise en sous-œuvre

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Summary

The author presents a case of ingenious underpinning of the foundations of an old building, when the underlying ground was partly scoured, the character and plans of underlying cellars were unknown and access under building was both dangerous and well nigh impossible.

Sommaire

Dans cet article l'auteur décrit un cas de reprise en sous-œuvre des fondations d'un vieux bâtiment, sous lequel le sol s'était en partie affouillé. L'accès aux caves était dangereux, pratiquement impossible. Une méthode ingénieuse a été appliquée.

The Old City of Lublin was built during the fifteenth to the seventeenth centuries and had been surrounded by defence walls during that period. It is situated on a hill. There is also a castle on a near-by hill. The town area within the walls was very limited and the buildings were very close together. Deep caves were made for various purposes, mainly for storing goods, but also for defence, and possibly as hiding-places for population against enemy attacks. Many of these caves were constructed with two-storey floors and sometimes even with three-storey floors; they reached to a depth of 10 metres below ground-level. These caves form generally a medley of corridors and halls, and in many places they are linked together by underground passages. The enclosed drawing shows a characteristic cave under the building and near-by.

The construction of caves was easy owing to the nature of the local soil consisting of thick layer of loess which is very stable and therefore suitable for tunnel driving. The ground water appears at a depth of 25 m below ground-level. Since they were built the cellars have sometimes been filled with earth, adapted or walled. Until recently the precise location, size and extent of them were unknown.

One night in 1958, a water main burst in the Market Place of the Old City and in a few hours the water scoured the ground and removed it to the subsoil. When the damage was observed early in the morning, there was a large crater in front of a house. The foundations of an adjacent building of historical value hung partly unsupported upon a cave. There were large cracks and fractures in the walls of brick and masonry, as well as in vaults and timber ceilings.

It seemed as if there was an immediate danger of the whole building collapsing in ruins. As the studies afterwards showed, a junction of cast-iron pipe of the 4 in. diameter water-main near the damaged house was not quite water-tight. It leaked and caused an increase in moisture content of the surrounding soil. The soil was weakened and could not safely bear the weight of the pipe.

As the pipe burst, the water escaping under pressure caused an enormous scour in the ground. The soil was thereby liquefied and flowed into the underlying labyrinth of caves.

When these threatening conditions arose, it was necessary to undertake rescue works at once. The crater in front of the house was immediately filled with 500 cub.m of sand.

The main problem was to underpin the foundations of the house, which were unsupported. No conventional method of underpinning was suitable in this case. There was no time for detailed study, in view of the threatened catastrophe. The foundation strata were unknown, and people living near-by did not know anything about the cellars and their construction. This was easy to understand, because during the last decades these cellars were not used by the inhabitants. The layout of the deeper cellars was therefore unknown and no plans existed.

It would have been very dangerous for workmen to enter the caves without previous support being given to the vaults and walls. The establishment of any provisional supports was impossible, because the layout of the basement was unknown. It was necessary to find a solution which would enable the base of the foundation to be rapidly strengthened, and the crater to be filled, without entering the cellars. In such conditions H. Zamorowski, the engineer employed at Lublin, introduced an ingenious method of underpinning. Concrete was poured into the open crater, using a wooden flume with its upper end at street level. The concrete spread easily by its own weight, without artificial pressure, creating a large flat bowl which gradually flowed upwards. In this way the concrete was poured without interruption until its upper surface reached the underside of the foundation. The volume of concrete used amounted to 300 cub. m.

It was then decided to introduce the filling material in this manner, assuming that it would spread around and fill the caverns, and in this way the foundations of the building were duly underpinned.

The use of 300 cub.m of concrete and of 500 cub. m of sand proved that enormous cavities existed in the subsoil, the filling of which would probably have been impossible in any other way. The success of the work, confirmed that this was the most suitable underpinning method. The same method was adopted under another near-by house, where the scour was on a very much smaller scale.

Later examination of the subsoil showed that the upper layer 5 metres thick consisted of a loose ground fill of varying composition and with a high percentage of organic materials. Below it, there is loess to a depth of 25 metres, a silt stratum with a certain amount of calcium carbonate. That layer rests upon the sand, where the ground water appears. The examination of loess from Lublin showed that its volume remains constant even when it is saturated. From this the author concludes that the subsidence was caused only by scour of the earth which was removed by water to the cavities existing at a lower level.

After preliminary preservation of the building against further damage, and after saving this historic house, a systematic examination was made of the subsoil and cellars to ensure its subsequent safety.

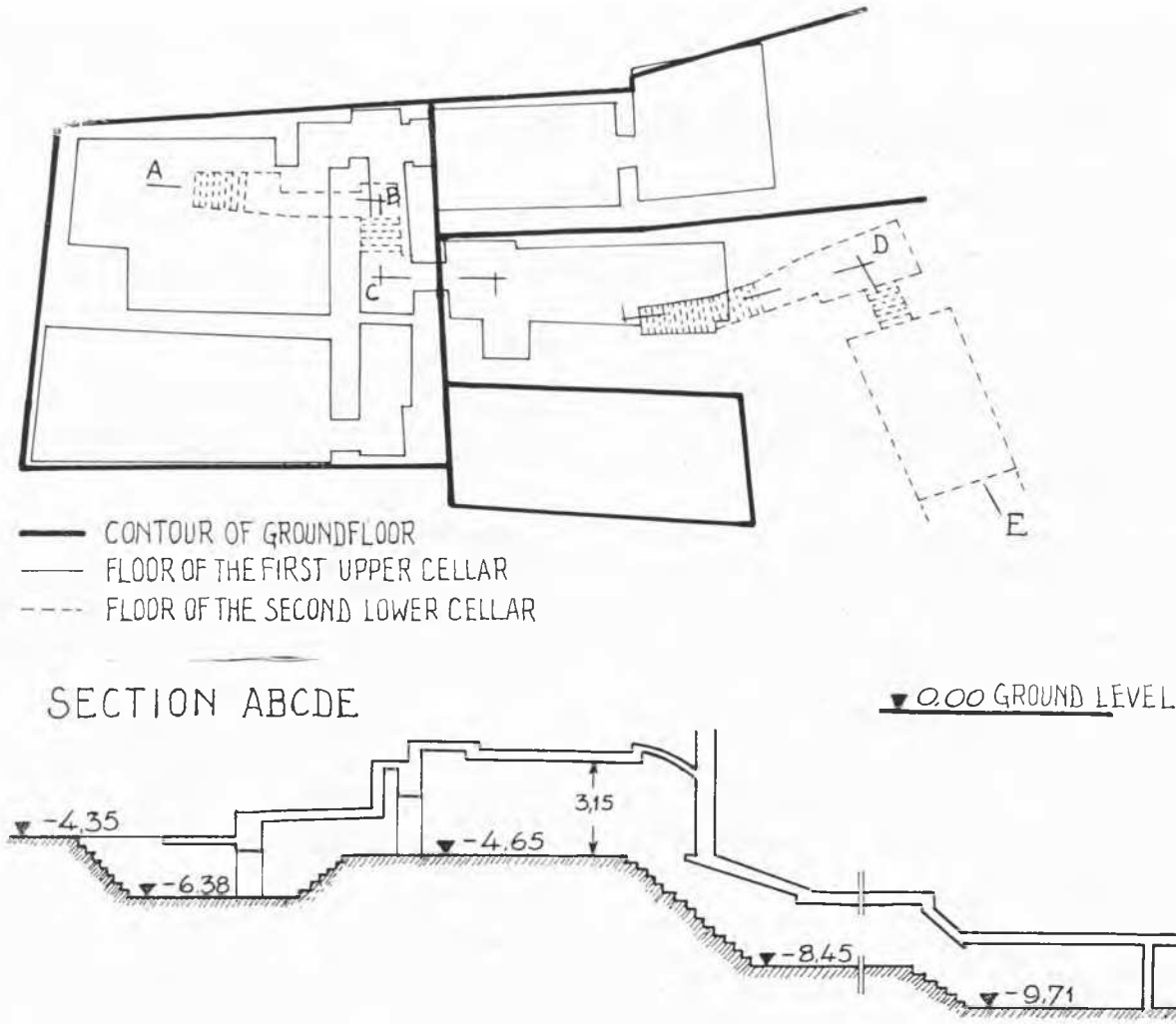
A
B
C
D
E
CONTOUR OF GROUNDFLOOR
FLOOR OF THE FIRST UPPER CELLAR
FLOOR OF THE SECOND LOWER CELLAR
SECTION ABCDE
0.00 GROUND LEVEL
-4.35
-6.38
-4.65
3,15
-8.45
-9.71

Fig. 1