Historical towers and fortified houses in central Greece

A. Vagelakos & M. Karaveziroglou
Department of Civil Engineering, Aristotle University, Greece

Abstract

This paper refers to historical towers and fortified houses in central Greece, where there are many traditional villages. These historical buildings are presented with reference to their architectural style and their structural system. The pathology and analysis of the structures are also described in the paper. A brief, though detailed, description of the technical and geometrical characteristics of the buildings is given, together with a description of their present state, previous repair and alteration work undergone, historical data and photographic documentation. Three-dimensional simulation models are developed using finite element analysis, taking into account the materials used, the geometric data and the structural systems of the buildings. The results of the finite element analysis are then examined and conclusions drawn with regard to the masonry strength of the buildings.
Keywords: fortified houses, tower, central Greece.

1 Introduction

Quite a number of traditional Greek villages lie within the region of central Greece. The original nucleus of these villages would most likely have been a monastery, some isolated dwelling houses or settlements which had moved from the coast to the mountains seeking, in the main, a safe place to live. The locations of these villages were secure and almost inaccessible from the outside world, shielded from strong winds and far from pathways frequented by pirates and robbers. The land, however, would be fertile, with an abundant supply of water and rich in forest and pasture land in order to provide food for the settlers. In the wake of the first huts and simple dwelling houses came better finished and more substantial stone buildings which provided for the development of domestic skills and cottage industry (Leonidopoulou and Diamantopoulou [1]).

Figure 1: Amphitheatre-like layout of the fortified houses in the historic village of Fanari near Karditsa.

A common feature of these settlements is the terraced layout of the houses overlooking either a sheer hill or an expanse of more level ground, fig.1. The defensive appearance of these tower houses and mansions, the result of measures taken to fortify them against bandit raids and revolutionary events, is singularly impressive. Today, many of these historical buildings are being rescued. For the most part, they are scattered around the mountainsides and many of them are used mainly as holiday homes since, over the past fifty years, a large number of the inhabitants of the mountain villages have moved to the city (Travlos [2]).

2 Fortified houses

It is rather difficult to make an exact chronological classification of the historical buildings, as the peculiarities of each region have had an intense effect on their characteristics and design. Thus, the main factors which influenced the final choice of structure, shape, typology and structural system of the buildings, were the prevailing climatic conditions, the specific needs of the inhabitants as regards optimum use of space for the operation of cottage industries and other activities pertaining to each region, the provision for security and protection or fortification, the available building materials and the standard practice of the head workman and the artisans.

Nevertheless, we can say without doubt that the first significant buildings in these settlements were the high towers with their large roofed balconies, built towards the end of the 17th and at the beginning of the 18th century. The towers are mostly well proportioned, with an almost square ground plan of limited surface area and double or single stone masonry. The entrance is on the first

floor and access is gained by a movable wooden ladder. There are open or covered balconies on the top floor with several openings and a larger surface area which was useful for more comfortable summer living, for the carrying out of domestic skills and handicrafts and for the surveillance of the surrounding countryside.

The majority of these towers are now beyond saving. Apart from a few exceptions, they have either fallen into ruin or have undergone radical alterations and conversion work.

Figure 2: The high Kokoslis Tower at Ano Lechonia in the Mt.Pelion region.

2.1 Structural system – building materials

The number of floors and the height of the buildings vary. More commonly, they have two or three floors though some towers have as many as five floors, fig. 2. Intercommunication between one floor and another was by an internal wooden staircase.

Many mansions and towers were built by teams of skilled workers, mainly from Epirus, who went from place to place constructing buildings and bridges, not only in Greece but in the Balkan area and in Asia Minor (Karaveziroglou et al [3]). The building materials used were, for the most part, stone and wood. A common feature of these buildings is the stonework masonry with horizontal wooden lintels. The thickness of the masonry varies but it is usually between 0.6m. and 1.0m. though, in certain cases, it may be as thick as 2.0m. Sometimes the walls are covered in plaster, both inside and out, whereas at other times they are left bare. The mortar is made from clay with, in some cases, the addition lime and other reinforcing substances.

Figure 3: The Tower of Skoteiniotis at Makrinitsa on Mt. Pelion.

The floors are of wood, as is the roof, which is covered with slates or ceramic tiles. The balconies are usually supported by the interior wooden beams which jut out under the balcony and are reinforced by double and triple cantilevers, fig. 3. In the past, the beams were supported by wooden oblique braces.

Over the years, many wooden beams have been replaced either by similar wooden or metal ones. The ceilings of the interior on each floor are usually covered with lath and plaster. On account of the fortified nature of the dwelling, the number of openings on the lower floors is limited, and more numerous and larger on the top floor. A typical feature of this type of building are the battlements with slit-like loop-holes on the towers, built for defence against enemies and bandits, fig. 4.

2.2 Pathology – common damages

The main reasons for the fortified houses falling into ruin was that, over the years, they had been abandoned and left to neglect. Consequently, the harsh climatic conditions prevailing in these mountainous areas, with their heavy rains and snowfalls, caused damage to the roofs of the buildings, resulting in the

Figure 4: The Tower of Mamjios in Tsaritsani, with its battlements and loop-holes, on the outskirts of Larissa.

subsequent erosion and deterioration of the masonry. Moreover, centuries of earthquake activity and lack of adequate foundations on stable ground has had the direct result of causing cracks to appear on the walls of the buildings.

The brunt of the damage to the buildings has been borne by the masonry on the top floor, where small or large, roofed or enclosed balconies or jettied storeys jut out in order to increase the room space of the building. The timber frame of the jettied storeys and the projecting wooden beams have suffered the greatest damage and distortion.

2.3 Structural analysis

Three dimensional simulation models using finite element analysis (shell and frame elements) are used for the static analysis of the buildings, taking into consideration the geometric data, the materials, the structural system and the pathology of the buildings (Wilson and Habiboulach [4]). The structural analysis of the building is examined for combinations of vertical loads and horizontal seismic actions, taking into account the geographical position of the structures and drawing conclusions with regard to the masonry strength of the buildings.

It would appear from the results of the structural analysis that the earthquakes which have occurred over the last few centuries in the area did not result in high levels of stress and the fact that the buildings are still standing obviously proves their resistance to earthquake activity. In most cases, once the buildings have been repaired, the structures are found to have acquired a satisfactory level of safety, providing no drastic alterations or conversions have been made.

The restoration work normally required on these buildings is the repair of the masonry, which involves the grouting of cracks, joint-filling with mortar and the replacement of parts which have suffered serious damage, especially wooden items such as the roof, the balconies, and windows and door frames. The basic principles behind these repair and maintenance works is the preservation of the original initial bearing system of the structure and the matching of the materials used for the restoration work with the original ones, as regards their natural and mechanical characteristics (Karaveziroglou [5]).

Two static models representing the initial phase in the building of the Tower of Kokoslis at Ano Lechonia on Mt. Pelion and its final or present day state are presented within the framework of this project, fig. 5. The tower was built around the end of the 17th century. Its ground plan is almost square, measuring 7.3m x 8.3m. and consists of the ground floor and four storeys. The total height is about 17m. In 1870, or thereabouts, a Frenchman who had come to the Koskolis silk works, added the north-facing staircase, had windows installed and a new room arrangement made, possibly after damage had been caused by fire. The stone masonry on the top floor was rebuilt together with a new roof, the cantilevers and the balconies were sawn off, and new balconies and jetties were installed. The double stone masonry has a total thickness of 2m and concealed wooden horizontal lintels (Kizis [6]).

From the results of the examination of the structural analysis of the Tower of Kokoslis, the following conclusions can be been drawn: Throughout the initial phase of the tower's existence, as a consequence of the symmetrical design of the ground plan in combination with its sound structure, the building stood for many years without suffering any damage. The damage most likely to be incurred at that time would be to the large balconies and the masonry on the top floor, where later on, repairs and alterations were carried out. The addition of the spiral staircase and the demolition of the northern interior wall altered the symmetrical design of the ground plan and, due to the more recent masonry being badly attached to the original masonry, the tower possibly suffered a great deal of damage in the area where the old and the new masonry had been joined. The wooden floors with their floor planks and the plaster-covered timber ceilings, together with the wooden roof, gave a substantial amount of support against horizontal loads. fig. 6.

At the present day, the tower is in a satisfactory state. It is inhabited periodically, when mainly the first two floors are put in use. The top floor has incurred the most damage, particularly the internal timber frame walls and the jettied stories where repair work should be carried out immediately.

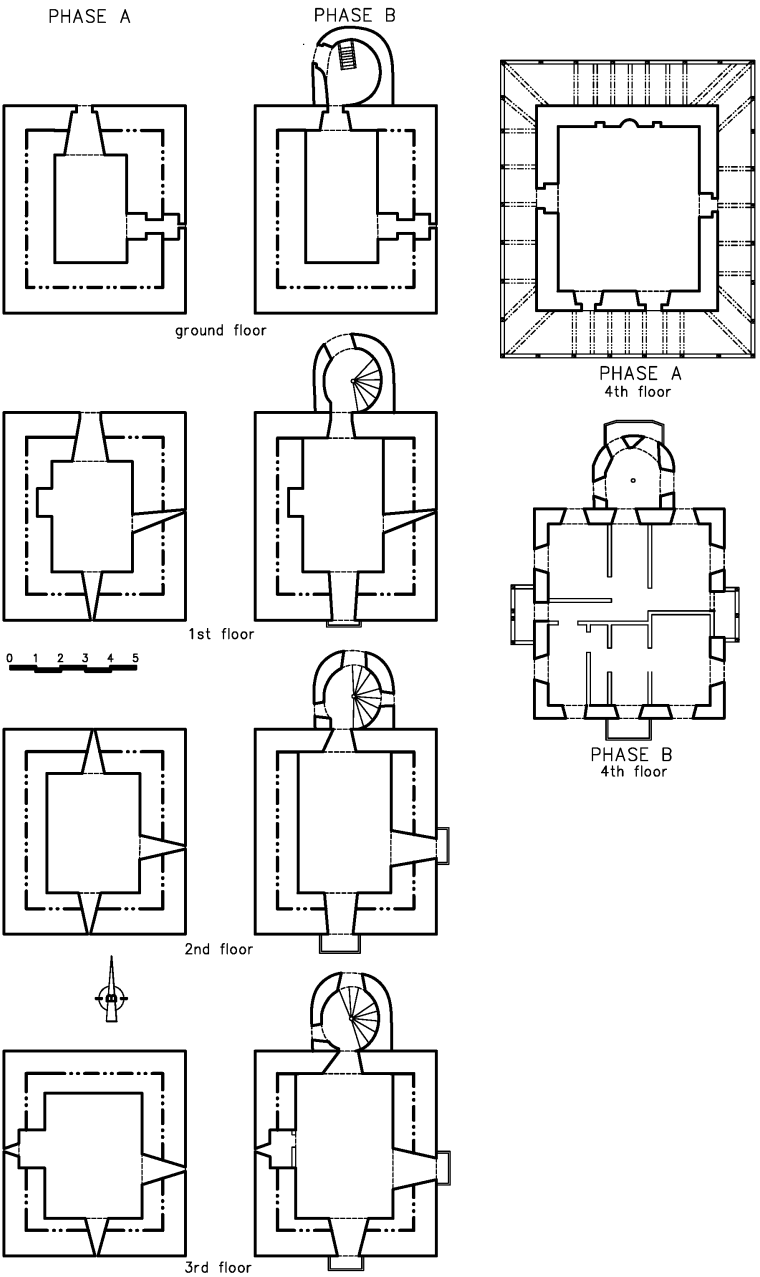

Figure 5: Plans of the ground floor, 1st floor, 2nd floor, 3rd floor and 4th floor of the initial (Phase A) and final (Phase B) of the Tower of Kokoslis.

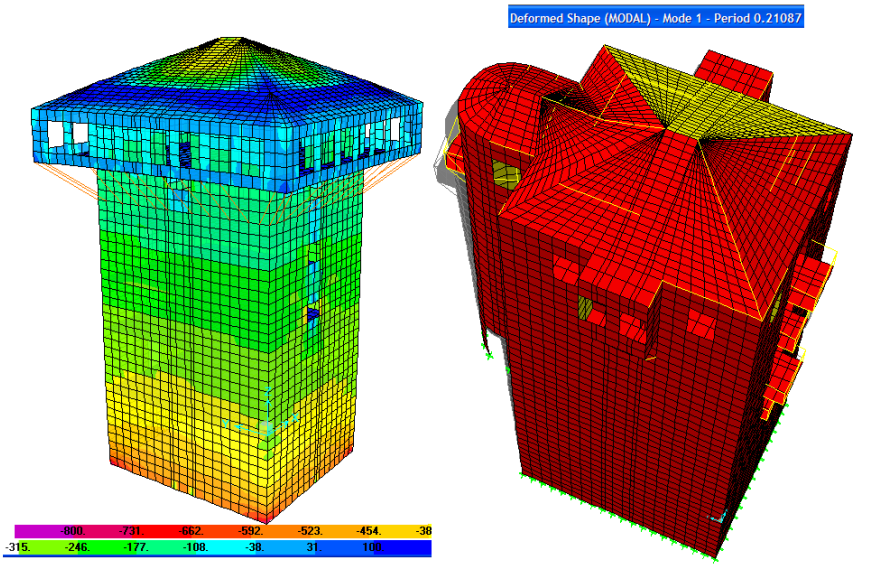

Figure 6: The Tower of Kokoslis, left: Results of the vertical stress in the first phase of the tower, in combination with the vertical loads. Right: The first mode for the present state of the tower.

3 Conclusions

There are a fairly large number of fortified houses and mansions in the region of central Greece displaying a large variety in architectural style and structural system. From the results of the structural analysis and the study of the pathology of the buildings, it can be concluded that the damage incurred by them is due mainly to neglect following abandonment by the owners and to the severe weather conditions prevailing in the surrounding mountainous areas which have caused the buildings to deteriorate.

The preservation and maintenance of these historical fortified buildings is deemed to be an urgent necessity, representing as they do an outstanding example of the country's architectural heritage.

References

[1] Leonidopoulou, P., & Diamantopoulou A., *Traditional Greek Architecture*, Melissa, Athens, pp. 11-30, 1995.
[2] Travlos, T., *Fanari*, Savalas, Athens, pp. 12-25, 2002.
[3] Karaveziroglou, M., Karayianni, E., Stavrakakis, E., Vaggelakos, A., A small valley in Greece and its bridges throughout the centuries, *Proc. of the 8th International Conference on Structural Studies, Repairs and Maintenance of Heritage Architecture*, Halkidiki, 2003

[4] Wilson, E., Habiboulach, A., *SAP2000 Computers and Structures Inc,* 2002.
[5] Karaveziroglou, M., Research on strength and deformation of mortars for intervention in historical buildings of Northern Greece, *Proc. of the 1st Scientific Meeting on the Act of Restoration of Historical Buildings in Northern Greece,* Thessaloniki, pp. 226-233, 1995.
[6] Kizis, G., *Domestic Architecture in Pelion Region*, ETBA, Athens, pp. 325-343, 1994.