House in stone, wood and earth in Delchevo, Bulgaria. (photo: Saverio Mecca)

Earthen architecture in Southestern Europe:
Italy, Bulgaria, Greece, Cyprus and Malta

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State of the Art

The region of the Eastern Mediterranean, Italy, Malta, Greece, Cyprus and Bulgaria, reveals a richness of two main forms of earthen architecture. Both are related to the ancient building culture of the Middle East, the masonry (mud brick and rammed earth) and the half-timber and masonry (earthen, stone and brick) traditions. Earth was one of the main building materials used from ancient up until recent times in order to solve the main architectural problems and to produce mortars, pavements, coatings and so on.

Knowledge of the earthen architectural heritage of the region is not homogenous, besides the sub-region of Sardinia, Italy, where we can find the highest levels of identification and characterization of earthen architecture as a living heritage, or Cyprus where groups of architects are providing care to the traditional building culture, in other regions such as Bulgaria and Greece the process of rediscovery and revaluation has only started in recent years.

History

Earthen architecture in the Aegean area dates back to the Neolithic era. Its more ancient traces are well known from Cyprus (since 9000 BC) to Macedonia and Crete, and later in Italy with the colonization from the eastern Mediterranean. While in Bulgaria, picket-knit structures, coated with clay, can be traced to the Neolithic Age (6000-4000 BC), revealing the influence of a northern earthen construction culture.

During the Roman Empire period the prevalent construction technique adopted in the region was adobe masonry, save for the half-timber and earth

Adobe and wooden timber, house in the region of Gotse Delchev. (photo: Saverio Mecca)

Fortified greek walls in Gela, Sicily, Italy. (photo: Letizia Dipasquale)

tradition mostly in Macedonia and the mid-mountain regions of Greece and Bulgaria.

During the period of Ottoman rule (the end of the 14th – the second half of the 18th century) and the "National Revival" period (the end of the 18th-19th century) the traditional building techniques were consolidated and improved. This is the case of the half-timber and earthen techniques of Macedonia and South Bulgaria, especially developed for improved seismic resistance.

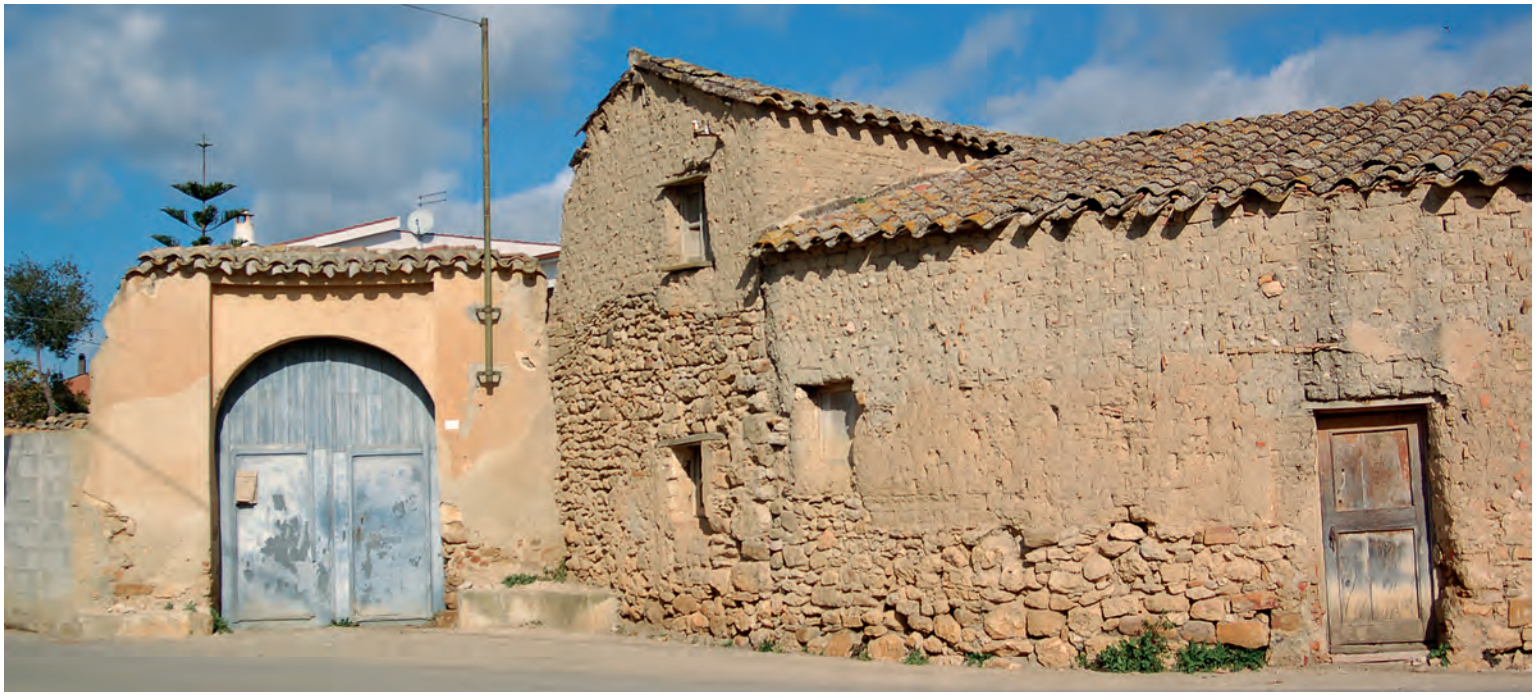
The need for seismically resistant structures has been an interesting factor of technical innovation and improvement of traditional building techniques in this region: in relation to the earthquakes, as in Macedonia and in south Bulgaria, and as in Calabria (Italy) at the end of the 18th century, local master masons under the Ottoman Empire or scientists after the 1793 earthquake (Calabria) developed and consolidated interesting building cultures, based on an effective interaction between timber structure and masonry (earthen bricks, fired bricks and stones) or wattle and daub.

Throughout this region the earthen building culture was extensively and continuously diffused until the middle of the 20th century, the beginning of the urbanization processes, mainly because of the local availability of raw materials and the ease of its production and application. Also in this region, the diffusion of industrialized building materials encouraged the abandonment, demolition or replacement of earthen buildings. Additionally, the adoption of national building codes and seismic regulations imposed new design procedures and limits to further uncodified traditional earthen construction techniques.

According to the main rule of distributing building techniques, earthen architecture is strongly influenced by geographical and geological and natural features respectively, the climate and the ready availability of building materials. In the regions where stone or/and wood are also widely available the simplest earth masonry technique is more easily combined with stone masonry and variably complex timber structures of earthen architecture can be found mainly in the construction of the upper floor(s), built with the wattle and daub technique.

Adobe masonry

Adobe had been the most diffused building technique in the region since an-



Traditional house in adobe (domu) in Samatzai, Sardinia, Italy. (photo: Silvia Onnis)
Adobe houses in Sambiase, Calabria. (photo: Ettore Pelaia)

cient times in Cyprus, the Aegean Islands and continental Greece, in South and Central Italy, Sardinia and to a lesser extent in Sicily.

In Cyprus, adobe was mostly used in the lowland regions (Mesaoria Plain) where the easiest construction material is clay soil. Adobe masonry was used in urban centres, villages and coastal areas, while in the hilly, mountainous areas or in villages along rivers, where stones were available, the use of adobe was predominantly limited to the upper parts of structures, supported on a stone wall, low or high, up to the first floor.

The dimensions of the earthen brick in Cyprus are 5 x 45 x 30 cm (height x length x width), while the thickness of the walls was 30-50 cm. Adobe masonry was in most cases finished with earth, gypsum or lime-based renders. The large part of adobe structures, still existing, date from the first half of the 20th century, while a few of them are from the 19th and late 18th centuries.

In almost every region of Greece adobe masonry is seismically improved by a typical "Ottoman" technique of confining with horizontal timber ties or truss, vertically spaced at 0.70 -1.00m, coordinated with the floor and the openings.

Adobe traditional houses in Pera, Cyprus. (photo: Saverio Mecca)

This building technique, diffused in all the "Ottoman" region from Albania to Azerbaijan, and finalized to reduce the propagation of a diagonal crack in the wall and the risk of collapse during seismic action (Bei, 2007), combines two different and low strength materials in an effective system to resist catastrophic damage from frequent earthquakes.

In Italy, adobe masonry or cob are more diffused in the regions such as Sardinia, Calabria and Marche where the easiest construction material is clay soil (lowlands and hills where agriculture was more diffused). Adobe masonry was used in urban centres, villages or isolated dwellings, while in the hilly, mountainous areas or in villages along rivers, stones were integrated for foundation or as in Lamezia for finishing and protecting large earthen adobe walls (civatura). Also in Italy, most adobe structures still existing, date from the first half of the 20th century, while a few of them are from the 19th and late 18th centuries.

In the central region of Bulgaria adobe masonry for houses was still popular and built until the 1960s. Normally adobe houses are plastered and cannot be easily distinguished from other masonry architecture. Although rare, adobe houses are sometimes built with two floors. In order to strengthen the construction in the masonry, wooden beams (called kushatsi) are embedded in the way they are applied in stonework.

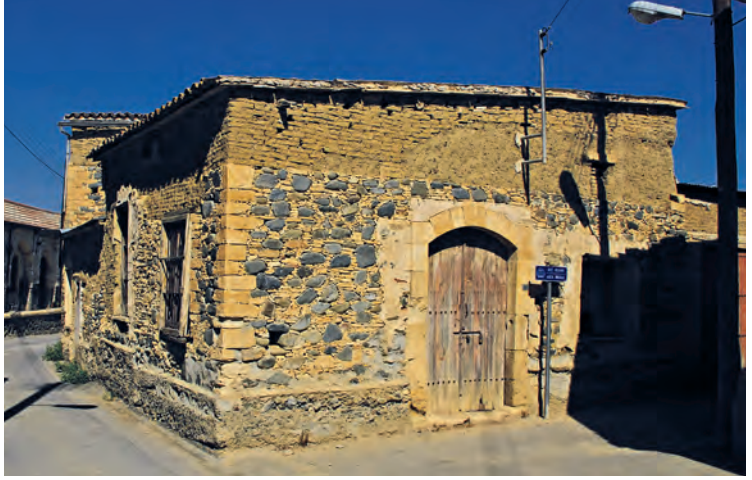
Half timber with earth

The half-timbered building technique consisting of a wooden framework and filling (brick, adobe, wattle and clay daub or, rarely, stone) characterizes some areas of this region, such as Bulgaria and Macedonia, with high-quality architectural form and construction, revealing the influence of the Ottoman building culture. In other areas, such as Calabria, after the earthquake of 1793 scientists and architects designed with regards to seismic criteria an effective model of half-timbered houses, which were built for several years. These houses are usually rendered and white-washed and it is difficult to identify the exact filling material, except in the case of degraded plasters.

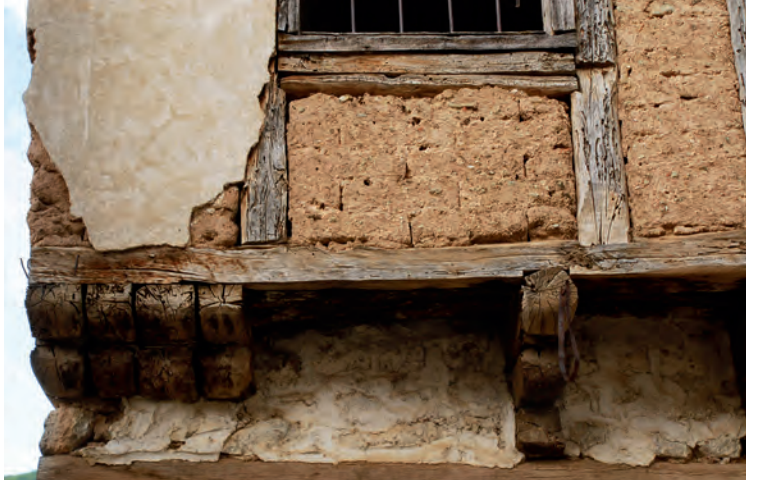
In Bulgaria (North-West and Central, Rhodope mountains, Gotse Delchev and Ivaylovgrad region), a high quality wooden framework consisting of two kinds of timber elements: main timber frame having a bearing and horizontal resistance function and secondary timber frame for supporting the in fill (adobe (called kirpich or dolma), brick or stone), or the wattle and daub system (called pletarka), or wooden laths plastered with clay and chaff (called baskii). The secondary timber frame can vary according to the in fill system, which can play a complementary structural role.

In northern Greece (regions of west Macedonia), in mid-mountain areas, usually upon the stone bearing walls, the second level is made with adobe walls and/or timber framed walls, known as tsatma, similar to wattle and daub. This second floor structure, as it is lighter than the traditional masonry type, is more effective during earthquakes. Most buildings as in Bulgaria have an architectural projection on the upper floor known as sahnissi mostly built with the tsatma technique.

The tsatma is a wooden frame of straight horizontal timber laths with the



Traditional house in Pera, Cyprus. (photo: Saverio Mecca)



Abobe with wooden timbers, Antartiko, Cyprus. (photo: Saverio Mecca)

empty spaces in between filled with different earth and masonry techniques.
In Italy the wattle and daub technique was widely used by the Villanovians and Etruscans to build elliptic or oval huts, and by the Romans who built "graticcio" walls (in Vitruvius opus graticium). The buildings were composed of a structure in wood, filled in with an earth plaster with vegetal materials, usually straw.
Today, a few examples of wattle and daub rural buildings, with a straw roof, can be found in the north of Italy (the Alpine zone, Veneto, Friuli Venezia Giulia), in rural fields. In Lazio, the "fraticci" consists of vertical posts and horizontal poles tied together with wickers, on a stone foundation, filled with tree branches of chestnut, oak or elm and interlaced canes (Beranger, 1995).
In Calabria, after the earthquake of 1783, "case baraccate" were built with a wooden frame, with vertical, horizontal and oblique chestnut or oak beams placed with a distance of roughly 1.20m to create a cross structure. A weave of wickers and reeds is bonded to the main structure with thin chestnut laths and is covered with an earth mortar. In some cases adobe fills the structure. For the interior walls the "incannicciato" technique is frequently used, a mesh of interwoven canes or branches covered by a clay plaster.
In Veneto, the traditional rural buildings, called "casoni" are composed of a wooden structure with adobe filling and a high spire roof, covered by straw and ditch reed (Bertagnin 1999). Today only three examples of these buildings, now in museums, survive.

Rammed earth

Rammed earth is consistently present in Italy: Piemonte, around Turin and above all Alessandria. Whereas Piedmontese housing made with rammed earth is usually grouped in villages, that of Tuscany is generally more disseminated. Fired bricks were used only for those building elements more susceptible to degradation, like foundations and corners, or subject to greater stress, such as arches and vaults.
In Tuscany (in the area of Val di Chiana, Val d'Elsa, San Miniato and in other inland parts of Pisa) we find rural and rustic dwellings dating back to the 13th century or 18th century (Val di Chiana). In this region rammed earth buildings are enhanced with detailed architectural elements, including buttresses in adobe, framed walls, cornices, or even ventilation openings in barns. The rammed earth enclosure wall is thick and for better reinforcement it is intercalated by pillars in adobe. Usually these rural constructions have plaster on the interior of the dwellings.

Stone and earth

In the area of Sicily and Malta we can find cases of walling where earth has been used as a complementary element, integrating the stone elements, more or less regularly, which are disposed in double leaves (walls of "pietra e tayo" and "a sacco"). These techniques were widely used in traditional Sicilian and Maltese architecture in both urban and rural contexts, because of the low cost due to the ease of building and the availability of local materials. These techniques were used continuously from the Middle Ages until the end of the 19th century.
In Malta, in traditional farmhouses and in urban buildings of Valletta and Gozo, the building technique consists of double leaves of masonry with a "mazzkan", a traditional type of in fill that was used to fill thick walls, usually made of crushed stone and soil.