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"LESSONS FROM THE PAST: SOME GREEK BRONZE AGE RESPONSES TO NATURAL DISASTERS AND THEIR MODERN COUNTERPARTS"

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ABSTRACT

Earthquakes were so well known a phenomenon in antiquity as to inspire myths and require the creation of apotropaic cults. The stories linked to Poseidon, god of the sea, earthquakes and tsunami, had their origins during the Bronze Age, when Poseidon is the most frequently named god. In addition to literary traditions, we are able to recognize quite well in archaeological excavations traces of earthquakes and sometimes also of tsunami.

The question we here investigate is how Bronze Age people formulated a practical response to these events in terms of suitably resistant architecture. And what of these techniques still can be used in modern times.

In Aegean Bronze Age architecture, a series of anti–seismic practices were early developed during the more than two millennia. In Minoan palaces in particular, lighter walls were superimposed on stone ones built at basement or ground floor levels. Using vertical, horizontal and cross timbers they put up wooden frames into which stone and mudbrick elements were integrated and bonded, and over which clay and plaster were later applied. Recent research has improved our knowledge not only about the buildings and their basic structures, but also about more detailed aspects, such as the expertise of the Minoan masters in developing various types of plasters with different degrees of elasticity.

This contribution will investigate how extensively these techniques are spread in the Mediterranean basin and elsewhere, both in ancient and modern times. And how they can be applied to contemporary architecture in a more sustainable way.

1. INTRODUCTION: ORIGIN OF ANTI-SEISMIC CONCERN AS REFLECTED IN GREEK BRONZE AGE MYTHS, MONUMENTS AND SCHOLARSHIP

The great architect Le Corbusier was used to say: 'il n'y a pas d'homme primitif; il y a des moyens primitifs' (There are not prehistoric men; there are prehistoric tools). Unfortunately, as archaeologists, we can fall into the mistake of thinking that people living in the past were somehow inferior to us [*cit.* in Cornu 2007]. Whilst, of course, they had thinking processes, emotions and re–actions the equal of our own. They solved practical problems too – but with a different set of materials – but every bit as empirically as us.

One of these problems was the minimization of the effects of earthquakes in the most effective possible way. Earthquakes were so well known a phenomenon in antiquity as to inspire myths and require the creation of apotropaic cults. It is the case, in fact, that already

during the Greek Bronze Age, in the second half of the 2nd millennium BC, Poseidon was the most named god on the clay tablets written in Linear B, a form of proto–Greek [Palaima, 2010]. He was among the few divinities thereon, whose names continued into the Classical pe–riod [Rougemont, 2005]. Poseidon, in fact, before be–coming god of the sea, was responsible for earthquakes and tsunami and for the creation of islands [*DMic* 153–155. Palaima, 2004; Gulizio, 2011]. His name goes way back: he appears together with *A–ta–na* (Athena) in the oldest group of Linear B tablets found in the Room of the Chariot Tablets at Knossos, the greatest palace of Minoan Crete, in strata dated to the 14th century BC [Gulizio, Pluta and Palaima 2001; Rougemont, 2005, 331; Palaima, 2004; 2009]. In this, the earliest surviving record, he has the epithet of *e–ne–si–da–o–ne*, 'Earth–shaker' – just as in Classical and later times. This word appears in two very fragmentary tablets from Knossos [*DMic* 219. Rougemont, 2005, 335], even if it is not clear as to whether it was an adjective to go with the name Posei–don (whose actual name has now disappeared in a *la–cuna*) or indicating a divinity in itself [Gulizio, 2008]. Po–seidon is often related to horses [Palaima, 2009; Simon, 2014], an element probably connected with his Indo–Eu–ropean origin, but we should reflect that the noise of horses at the gallop recalls also the rumbling of an earthquake, and a major stampede will cause the ground to reverberate too [Nur and Cline, 2000].

It is a matter of fact that, despite the indications of–fered by ancient literature and by archaeological data, usually archaeologists prefer firstly and more often to speak about human agencies (revolutions, wars and the like) or the passage of time to explain their destruction strata, rather than considering earthquakes. See for ex–ample the first six annual reports of the Knossos palace excavations by Sir Arthur Evans at the beginning of the 20th century, in which the word 'earthquake' is not even mentioned as a possible reason of catastrophes; and even later Evans was often hesitant to connect earth–quakes with archaeological destructions [Jusseret and Sintubin, 2013; Driessen, 2017; Palyvou, 2018, 137]. Evans did however later change his view and in 1927 he refers to the anti–seismic devices of Minoan architecture [Evans, 1921–35, II, 286–325. Macdonald, 2017]. Even in 1948, when the great archaeologist Schaeffer interpreted numerous destruction layers in the Near East – datable between 1225 and 1175 BC and usually attributed to hu–man actions, as the result of earthquakes, he was highly criticized by his colleagues [Nur and Cline, 2000]. Today, there still remain very different and conflicting ap–proaches to interpreting destructions on archaeological sites: one person places a great emphasis on catas–trophic events, another underlines the human ability to respond in a positive way to the violence of nature [Nur and Burgess, 2008; Poursoulis, Dalongeville and Helly, 2000]. Much work has to be done to reconsider all the data from excavations to be able to better recognize traces of earthquakes and tsunami. It is interesting to ob–serve that the first interdisciplinary attempt in this di–rection for Aegean archaeology was achieved only at the very end of the 20th century [Stiros and Jones, 1996] and only very recently have others followed suit [Gerasimos, 2011; 2017; Jusseret and Sintubin, 2017]. As a result of this welcome integration between archaeological and seismological data, recently it has been possible to ar–gue for the existence in the Late Bronze Age not only of destructions caused by earthquakes, but of storms of earthquakes, possibly responsible for – or at least con–tributing to – destructions recorded over a 50–year–long period (ca. 1225–1175 BC) at the very time that politi–cal instability affected the Mediterranean in the 12th century BC [Nur and Cline, 2000]. A new term of inte–gration and fruitful collaboration between different dis–ciplines, both aiming for the same objective – that of a better historical reconstruction, seems now to have be–gun [Jusseret and Sintubin, 2017].

2. THE ANTI-SEISMIC MINOAN TRICKS

The question we intend to investigate here is how Aegean Bronze Age peoples formulated a practical re–sponse to such catastrophic events in terms of suitably re–sistant architecture, with specific reference to Minoan palatial architecture. And what of these techniques still is and can be used in modern times (for a very general but updated view of the Aegean Bronze Age, see Cline [2010]).

For an archaeologist and generally speaking an his–torian too, earthquakes are great opportunities for the cre–ation of new phases, architectural, archaeological and historical alike. A 'destruction horizon' is a welcome dis–covery on every archaeological excavation, as something encapsulating a moment, and so more secure on which to ground hypotheses [Carandini, 1991; Driessen, 2013; 2013a]. In Aegean Bronze Age architecture in particular, a series of practices were developed during more than two

millennia, as a result of which monumental structures able to resist the earth's trembling were built. This was absolutely vital, in order to respond to the very frequent earthquakes affecting Greece and in particular the island of Crete. The significant and frequent seismic activity here is caused by its location above the Aegean subduction zone [Poursoulis, Dalongeville and Helly, 2000; Papadopoulos, 2011; 2017].

The case study now explored is the Minoan palaces of Crete, that is those monumental and asymmetrical buildings incorporating many open and closed spaces, constructed around a large rectangular open court [Figure 1. Evans, 1921–35; Graham, 1987; Driessen, Schoep and Laffineur 2002; Rethemiotakis, 2008]. The palaces contained large storage areas, very often administrative archives, alongside spaces dedicated to political and religious activities. The written documentation found in the archives is mostly of an administrative nature and does not allow us to make any historical deductions: the recovered documents, in fact, are mostly registrations of the material held in, going in and out from, and organized by the palace [see the contributions of Wiengarten, Tomas and Palaima in Cline, 2010].

The main palaces of Minoan Crete are traditionally Knossos, Phaestos, Mallia and Zakro. But in the last decades, other palaces, sometimes of inferior dimensions, have been found at Archanes, Galatas, Zominthos, Chania. Other sites, of lower importance still, such as the so–called 'villas', were widespread on the island, giving the image of a very well inhabited and exploited territory [Andreadaki–Vlazaki, Rethemiotakis and Dimopoulou–Rethemiotaki, 2008].

The First Minoan palaces were in use between 1900 and 1700 BC, when a series of destructions, very probably caused by earthquakes, laid them low [Evans, 1921–35, II, 287–288; La Rosa, 1995; Nur 2008]. The so–called New palaces followed and were occupied between 1600 and 1450 BC, when some catastrophic events signaled their end, whose causes are still under discussion. The fact that many of the palaces were excavated at the beginning of the last century, with techniques still in their infancy, makes it difficult to understand the details of these widespread destructions. It is a fact that, among the 'big' palaces, the only ones still functioning in the subsequent period were Knossos, at least for a few generations, and Chania. To explain these widespread destructions, that left extended traces of fire, we usually refer to human agency or at least to natural destructions followed by human agency disorders [Driessen and Macdonald, 1997; Macdonald, 2005; Alberti, 2014; Wiener, 2015].

One of the most intriguing aspects to do with the palatial architecture is its relationship with the territory in which it is located [Palyvou, 2018]. The Minoan palaces in fact are not delimitated by clear defensive structures (even if there were forms of controlling access), but are so embedded in the landscape that the in–

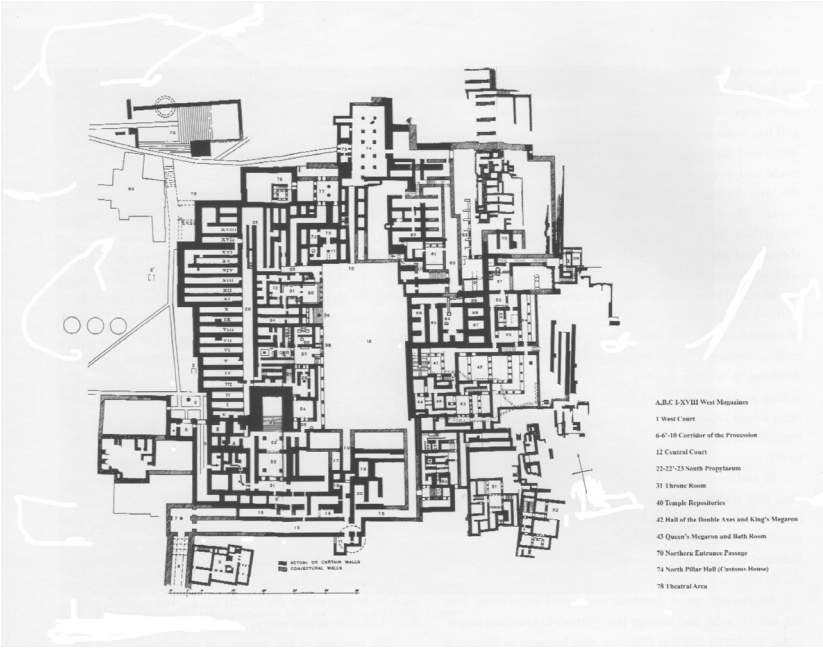


FIGURE 1. Plan of the Knossos palace (*after* Rethemiotakis 2008, fig. 2).

ner and the outer spaces form an integrated unity between the natural environment and the human. Also very clear is the application of a strictly rational approach in location of a settlement, with a view to exploitation of resources, production costs, transportations of raw and finished materials [Trigger, 1990; Shaw, 1971; 2003]. A Minoan palace looks truly modern, to apply current concepts sometimes taken from contemporary architecture, in its concern for sustainability, and in its thermodynamic and energetic principles [Chryssoulaki, 2013; Devolder, 2013; Palyvou, 2018].

The long life of the palaces, at least for 450 years (ca. 1900–1450 BC) and in the case of Knossos at least around six centuries (ca. 1900–1300 BC), yields evidence not only of destructions and decay generated by time's passing, but also the traces of very frequent earthquakes. These are detectable not only at the palaces, but also at other structures and sites of the Minoan civilization. Archaeology clearly testifies that the Minoans had a good experience and knowledge of earthquakes, were able to react and rebuild after them, and had systems in place to reduce their destructive effects.

The techniques used in the 2nd millennium BC palaces are numerous: exhibiting different degrees of effectiveness. Their traces can be found not only in archaeological excavation reports, but also in the very rich material culture, with ceramic models of dwellings and other structures discernible on items such as seals, sealings, frescoes, jewelry and pottery decorations (Figure 2).

The Minoan architectural discipline, as applied to palace construction, apparently experimented with a series of features, not merely aesthetic – as they often are considered to be – or simply practical, but also effective where earthquakes are concerned [Poursoulis, Dalongeville and Helly 2000; Tsakanika–Theohari, 2009; Palyvou, 2018]:

1. The placing of wall bases directly on the bedrock, or at different depths depending on the building type. This is a norm not only for monumental buildings as the palaces, but also for less impressive civil architectures. They dug down to the bedrock, if it did not outcrop, and sometimes cut into and regularized it in order to place the walls directly on it. In the case of more monumental buildings, there are traces of pits traversing the soil to join the bedrock on deep, as in the northern section of the Knossos palace.
2. Very frequent and evident, especially in palatial architecture, is the construction of a whole comprised of smaller free–standing blocks, separated by small open passages. This is one of the most widespread anti–seismic Minoan techniques, visible not only in all the palaces, but also in smaller edifices and units (Figure 3). It finds modern parallels.
3. The frequent use of wood in many parts of the buildings: in particular the wooden frames comprising vertical and horizontal posts, and cross beams, that are set on stone socles and infilled with mudbricks or stone (Figure 4).
4. The broken line of a façade, one of the most original features of palatial architecture in Crete, pre–

FIGURE 2. From left to right, architectural representations from the Neopalatial period: the so–called faience Town Mosaic from Knossos, ca. 16th century BC; the so–called Tricolumnar Shrine miniature frescoe from the palace of Knossos, ca. 16th century BC; clay architectural model of a two–storey Minoan house from Archanes, ca. 1600 BC (*after* Dimopoulou–Rethemiotaki 2005, figs respectively on pages 331, 12, 82)

sents very characteristic projections and indentations (Figure 5). For some scholars they are just decorative, a way to identify important public spaces [Palyvou, 2018]. But it has been also suggested that they could be crucial in the case of earthquakes because wall elements with different orientations can better resist shocks travelling in different directions [Driessen 1987]. It is of course possible that the type of indentation reflects different needs and choices: if shallow – decorative, or bigger – and so structural.

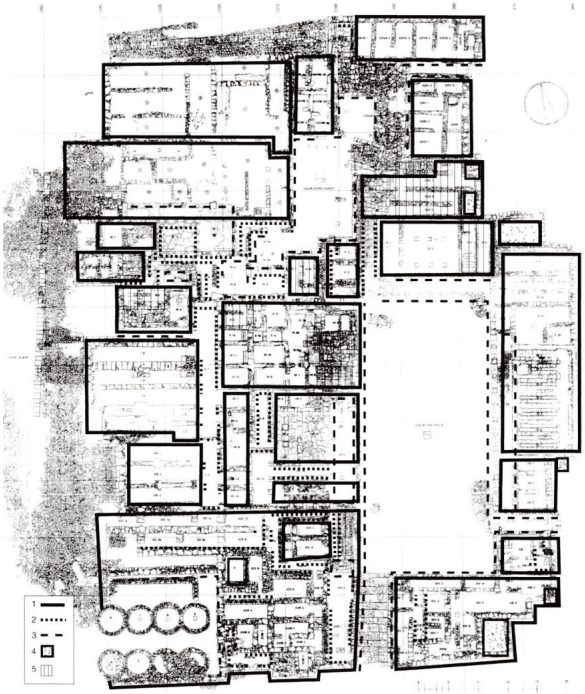


FIGURE 3. Plan of the Malia palace, with the system of different construction blocks. 1: boundary of blocks; 2: corridors and other separating spaces; 3: open spaces; 4: closed outbuildings; 5: staircases (*after* Poursoulis, Dalongeville and Helly, 2000, fig. 4).

5. The use of external friezes, projecting slightly, and of horizontal timbers to border or contain walls. These features are visible not only in other media, such as house models and frescoes, but also in the very Santorini buildings, preserved for several floors and whose architecture shows undeniable links with Crete [Figures 6–7, Palyvou, 1999; 2018].
6. The extensive use of wooden elements inside walls made both of stones and mudbrick [Figure 8. Palyvou, 1999, 112–118. Tsakanika–Theohari, 2009].
7. The use of lighter upper floors, in which pillars and walls are thinner and superimposed on stronger ground floor elements; with a large use of wooden features.
8. The extensive use of supportive pillars at the center of rooms, especially in basements and ground floors.
9. The wide use of internal partition walls, dividing the bigger spaces into smaller unities, and in particular the use of pier–and–door partitions to divide big rooms: this is a very specific feature of Minoan architecture, allowing a big room to be divided into more and separate spaces, if desired (Figure 9).

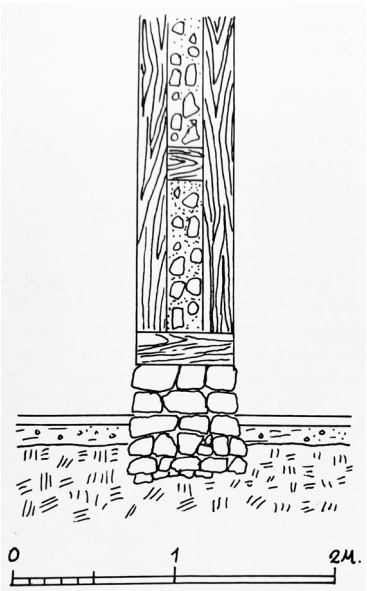


FIGURE 4. Reconstruction of a wall in Tylissos with stone socle, timber frame and rubble–filled interior (*after* Shaw, 1971, fig. 177); Timber traces in the Hagia Triada villa, in which the stone walls are covered with gypsum slabs, whereas the timber was left visible and able to remain dry, in order to not be affected by the humidity absorbed by the gypsum (*after* Tsakanika–Theohari, 2009, fig. 4).

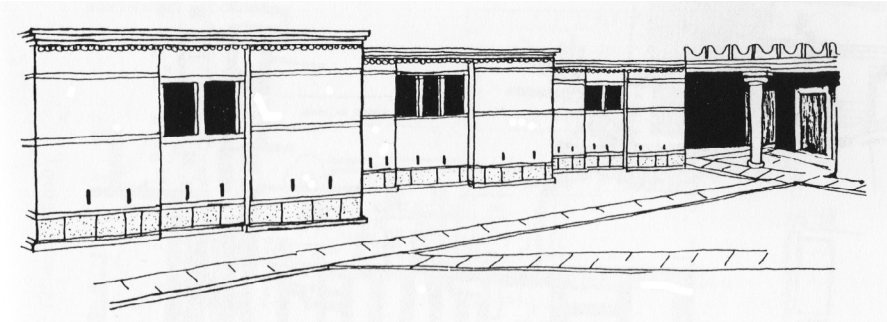


FIGURE 5. West façade and west entrance of the Knossos palace (*after* Graham, 1987, fig. 155).

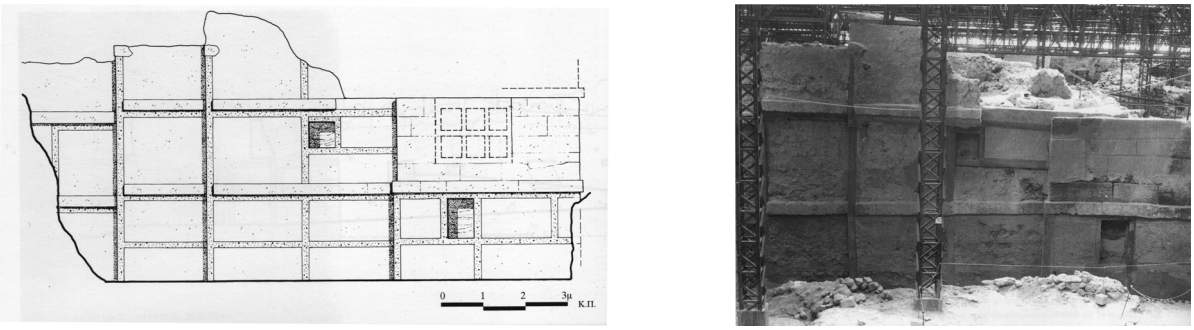


FIGURE 6 - 7. Grid of horizontal and vertical timber frames on the façade of Xestè 2, Santorini, Akrotiri, ca. 17th–16th centuries BC (*after* Palyvou, 1999, figs 22–23).

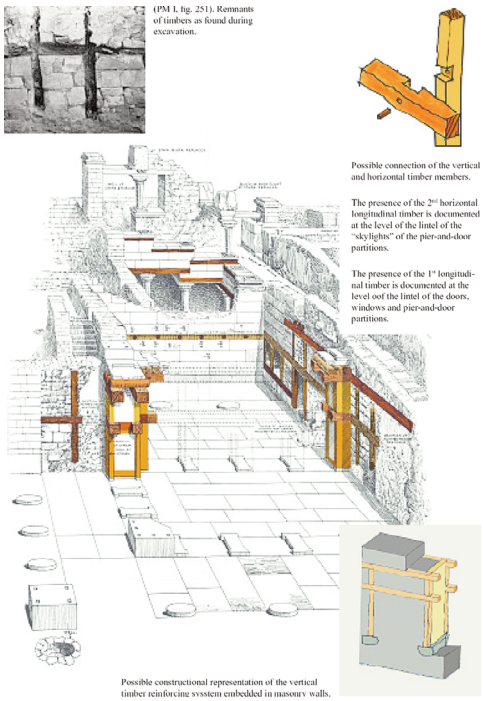


FIGURE 8. A reconstruction of the use of timber elements in masonry walls of the Hall of the Double Axes in the palace of Knossos (*after* Tsakanika–Theohari, 2009, fig. 3, modified from a T. Fyfe axonometric drawing published in Evans, 1921–35, III, plate G).

We must draw attention here to the fact that we are dealing with an architecture some 3500 years old, that was not only anti–seismic, but also ecological and sus–tainable, because it was using locally available materi–als, such as wood, mudbrick, stone and a sort of calces–truzzo. Even if the passage of time has left destruction and decay, the Minoan palaces remains still testify to the re–silience of such an architecture.

3. SOME PAST AND MODERN COUNTERPARTS: THE 'MUDBRICK IN TIMBERED-FRAMES' TECH-NIQUE IN ANCIENT AND MODERN ARCHITEC-TURE

After this very quick overview, we will concentrate on one specific technique and practice that has escaped the bounds of time and space: the use of mudbrick walls on the top of stone basement ones, better known to contemporary architects as *adobe*. This construction technique has two different expressions: one in which the mudbricks are simply superimposed on the stone basement and a second one employing a wooden

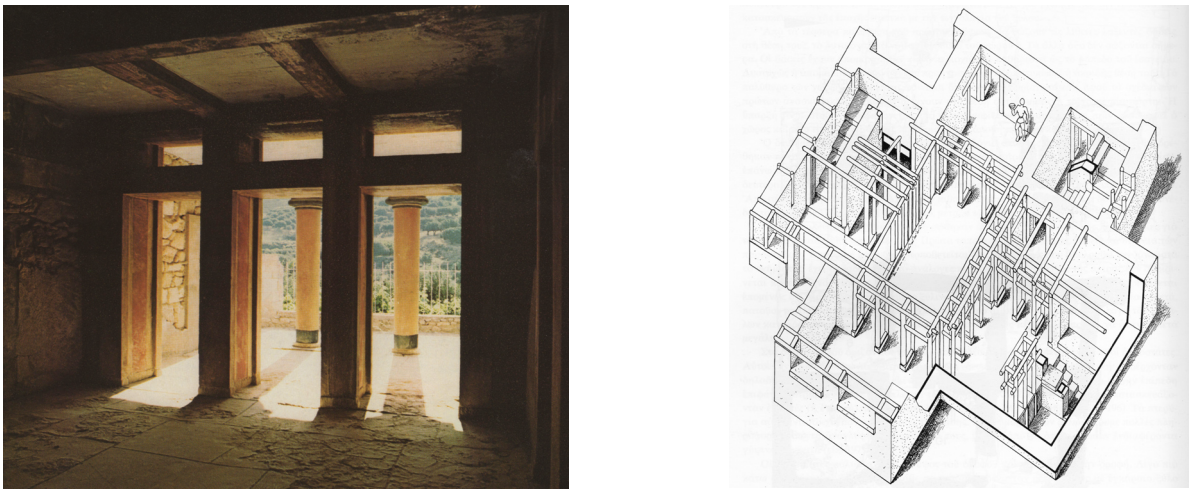


FIGURE 9. On the left, a 'pier–and–door' partition from the Royal Villa at Knossos (*after* Michailidou, 2001, fig. 60); on the right axonometric drawing of Xestè 3 at Santorini with pier–and–door partitions (*after* Palyvou, 1999, fig. 192).

framework integral to the stone basement and filled in by mudbrick or stone debris. I will concentrate especially on this second type, given its presence in Minoan palatial and civil architecture [Shaw, 1971; Devolder, 2005, 2006; Tsakanika–Theohari, 2009].

Mudbrick is a very economical material that can be found virtually everywhere, it does not require a particular expertise either in fabrication or in building. It is also fire resistant and really suitable in a hot climate because it absorbs and releases heat gradually. Capped with layers of plaster, it becomes well insulated also against water that constitutes its one true enemy. As stated by Leick in [2003]: 'The thermic qualities of thick brick walls make them particularly suited to the predominantly hot climate as they absorb and release heat very gradually. Coated with several layers of plaster they are draught or wind–proof and not easily damaged by fire'.

Looking at how a wall in a Minoan palace was constructed, we see that the internal part could be filled with stone debris or mudbricks and later covered with a double coating of plaster, the first coarser and more akin to mud–plaster and the second one more refined and of lime. The composition of mudbricks usually depends upon the earth found near the settlement, to which a series of minerals, shells, sand and other organic inclusions could be added to increase the plasticity and/or strength of the brick. It must be underlined that until the Classical period bricks were not fired, but only sun–dried. The recovery of 'fired'= burnt bricks in Minoan sites signifies that they got that way by a conflagration accompanying a destruction. Evans refers to the huge quantity of decayed 'sun–dried bricks' coming from upper floors in the Domestic Quarter that he found during the Knossos palace excavations [Evans, 1921–35, I, 327]. Concerning the composition of the mudbrick, we are able today to affirm the Minoans were able to choose between different recipes in order to achieve different results. Also to the two plaster layers the first tends to be coarser and the second finer: each therefore had a different plasticity and were so produced to give different outcomes [Guest–Papamanoli, 1978; Devolder, 2005, 2006].

The existence of the wooden framework was very rapidly recognized at the beginning of excavations in Knossos, in the very early 20th century: in many walls of the palace, such were easily identified by the spaces left by the decayed vertical and/or horizontal timbers (Figure 10). This Bronze Age technique is not exclusive

FIGURE 10. Hall of the Double Axes, south wall, in the palace of Knossos, with traces of the vanished vertical and horizontal timbers (*after* Evans. 1921–35, I, fig. 251)

to Crete: vertical and horizontal timbered–frames walls – both with rubble stones and in mudbricks – appear also in some buildings in Santorini, where it has been considered a Minoan legacy [Palyvou, 1999].

Looking more widely still, this type of technique is very well known and used in all the Mediterranean area from antiquity until today, not only for private houses, but also for monumental civic buildings and temples. It is not necessary here to attempt a complete catalogue, but we will briefly refer to few examples from antiquity. In Palestine, mudbrick walls on stone basements (with roofs of timber and reeds) for houses were used from the Early Neolithic until the present. The Bible refers frequently to mudbrick manufacture. Exodus 5, 6–7: 'That very day, Pharaoh gave the order to the people's taskmasters and their scribes 'Do not go on providing the people with straw for brickmaking as before; let them go and gather straw for themselves''. Job 4, 19: 'What then of those who live in houses of clay, who are founded on dust'. Ezekiel 13, 10–14: 'This is because they have misled my people by saying Peace! when there is no peace. When my people were repairing a wall, these men came and plastered it over! Tell these plasterers: It will rain hard, it will hail, it will blow a gale, and down will come the wall! Will not people ask you: What has become of the plaster you slapped on it? Well then, the Lord Yahweh says this: I am going to unleash a stormy wind in my fury, torrential rain in my anger, hailstones in my destructive fury, and I shall shatter the wall you plastered and knock it down and lay its foundations bare. It will fall and you will perish under it; then you will know that I am Yahweh'.

In an Iron Age building from Hazor, in Palestine, the widespread traces left by decayed timbers in walls showed that they used there too a wooden framework with mudbrick filling [Nauman, 1971, *cit.* in Reick and Kempinki, 1992, n. 48]. The same is so in Egypt, where they are still used today [Reick and Kempinki, 1992]. I personally excavated in Tuscany on an Etruscan site of the 6th century BC, built with the same technique. In the East Mediterranean in antiquity, it is very commonly encountered from the Neolithic and Bronze Age onwards, not only in Greece but also in Anatolia, where exists the same wooden framework structure, filled with mudbrick [Leick and Kirk, 2003]. It is possible to trace the presence of the technique down until today, being present in private houses of few decades ago, with or without the wooden frame, for example in Phocis, Argolid and Messenia (Figure 11) [Guest–Papamanoli, 1978].

Actually this building technique with earth is widespread across the whole globe, in more historical and recent times alike, well beyond the Mediterranean basin, in Russia, Iran, even Central and South America. Similar techniques are used for example both in Pakistan and Portugal [see Rafi et al., 2012]. If we compare the location of earth–based architecture of today with that of seismic danger, one may note some considerable overlapping of the two, especially in the Mediterranean basin, in Asia and in the western Americas [Figure 12. Bollini, 2012].

Recently, the advantages of building with earth and wood have been much emphasized. There is a sort of

FIGURE 11. On the left, house in mudbrick with wooden horizontal elements in Galaxidi (*after* Guest–Papamanoli, 1978, fig. 7); on the right, house in Kalamata, Peloponnese, with stone socle, wooden frame and mudbricks (photo taken in 2014).

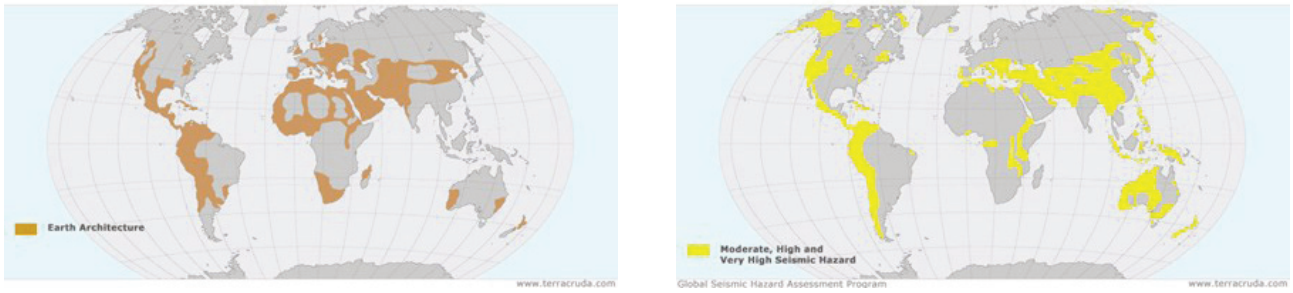


FIGURE 12. A comparison between the existence of earth–based architecture and seismic danger (*after* Bollini, 2012, fig. 1).

resurgence in its use, probably because mudbrick is also a very ecological material: it is available more or less everywhere, so there less pollution consequences in its transport, it is reusable, it stores heat, it protects the timbers in contact with it, it helps regulate the air humidity in interior spaces, with positive impacts on the health of the inhabitants [Minke, 2006; Vavili–Tsinika and Karantaki, 2012; Servadio, 2018]. A contemporary example located in Switzerland apparently uses the same principles seen in Minoan palatial architecture: a timber structure into which earth or mudbrick are integrated (Figure 13).

In the case of the Minoan palaces, there are apparently other reasons in play, related to its anti–seismic proprieties, as some very recent experiences demonstrate not only in the Mediterranean, but all over the world.

After the earthquake that affected Turkey in 2007, a series of analyses were conducted especially on *adobe* houses in rural areas that suffered great damage. The results showed that a greater degree of harm was suffered by houses in *adobe* that lacked any structure able to contain walls and to properly connect walls to basements and roofs. In order to lessen any catastrophe in the future, an anti–seismic Code was promulgated in which great emphasis is given both to the quality of materials and to the use of confining elements as bonding beams and tie features [Figure 14. Ural et al., 2012].

An interesting experiment has been carried out in Peru, after the catastrophic earthquakes of 2007, when hundreds of people died and thousands of houses, most of them in mudbrick or *adobe*, were destroyed [for the reaction of *adobe* houses in earthquakes see Tarque et al., 2014]. Due to the economic impossibility for the inhabitants to reconstruct their houses with different materials, they were trained to build again with *adobe*. And to improve the stability of the structure in case of quakes, all the mudbrick walls were enclosed within a plastic grid built into the foundation of the house, connected to the wooden roof and plastered with mud to protect the surface. The results have proved very effective in terms of creating a resistant architecture and also an economical one [Figure 15. Blondet et al., 2008].

FIGURE 13. Mudbrick and wooden elements in a house from Switzerland (*after* Minke, 2006).

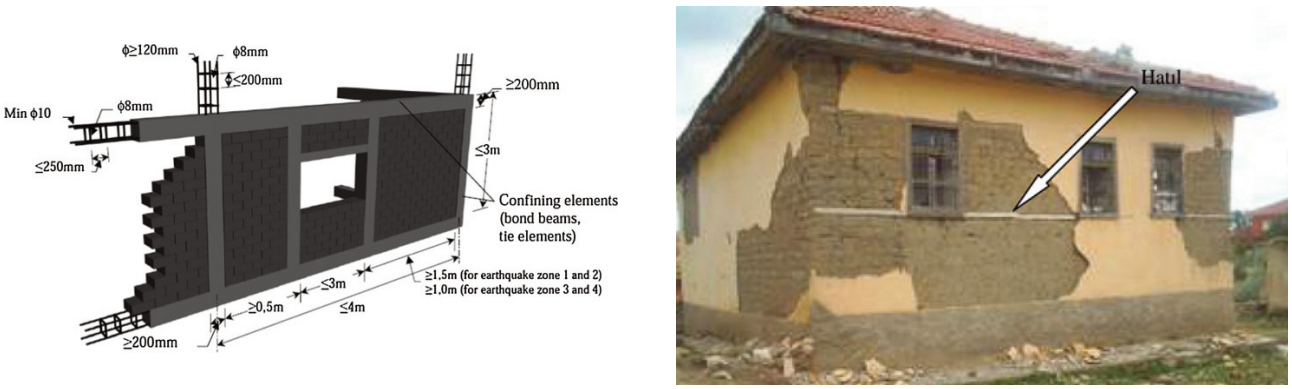


FIGURE 14. On the left a building constructed with the 2012 new anti–seismic Turkish Code; on the right a standing Turkish house after the 2007 earthquake (*after* Ural et al., 2012, figs. 12 and 6).

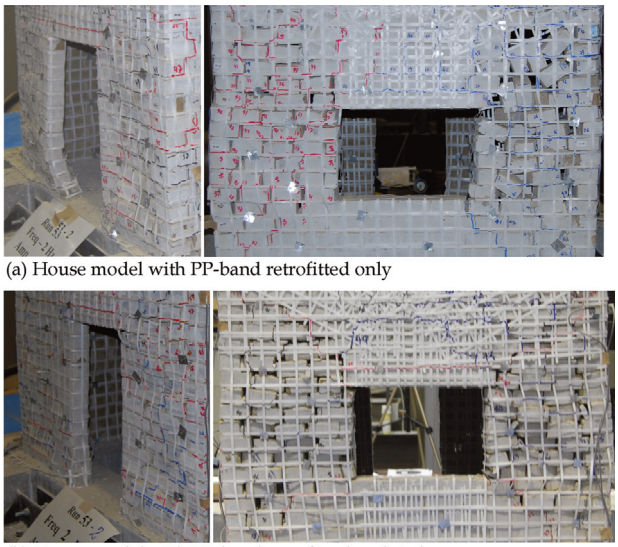
FIGURE 15. New construction in mudbrick and PP–net in Peru with the involvement of the local population (*after* Blondet et al., 2008, figs. 5a, 8a, 2a).

Experiments were conducted on two *adobe*–house models, one without any reinforcement and one with an applied grid, interconnected inside the walls and with floors and basement. The model with applied grid resisted earthquakes very well [Bossio, Blondet and Rihal, 2013].

In 2015, in order to reinforce existing *adobe* houses and to ameliorate future constructions, a series of experiments have been conducted, applying to *adobe* houses of different structures external steel bars or plastic grids. One of them involved the application to the walls of a PP–band, i.e. a polypropylene–polymer resin fibre in grid form, a cheap material and readily available world–wide. The walls were likewise enclosed by the PP–band, connected to the basement and the roof: the results with earthquakes were significantly impressive, showing that many of the simple mudbrick structural defects could be resolved by the application of grids. The results were still better when PP–band and tie–bars were used together [Figure 16. Sathiparan and Meguro, 2015].

In very general terms, these modern experiments with applied grids to *adobe* walls, connected with concrete basements and roofs, can be compared with the timbered frames of the Minoan palaces, a technology almost four thousands of years old.

Therefore, one can deduce that the wooden frames in Minoan palaces were adopted not just for aesthetic reasons or as a building technique or even just by chance (as some archaeologists believe), but because, after the experiences of centuries, it was observed that they helped the stability and elasticity of walls in case of earthquakes. The use of this mixed technique – wooden framework plus mudbrick on stone socles – in Crete appeared at the very beginning of Neolithic and was used all through the Bronze Age. It is very reasonable therefore to think that it was chosen, at least in part, for its undeniable anti–seismic proprieties, especially in monumental buildings. Chance cannot be considered as responsible for its development, but on the contrary all was deliberately produced and used in order to minimize damage and improve stability, always with an eye being kept on the aesthetics of Minoan architecture, an aspect very important for this Bronze Age population.



(a) House model with PP-band retrofitted only

(b) House model with PP-band retrofitted and tie-bars

FIGURE 16. A still standing experimental house model in mudbrick and PP applied grid: (a) without, and (b) with tie–bars (*after* Sathiparan and Meguro, 2015, fig. 14).

4. CONCLUSIONS

In few sentences, Le Corbusier summarizes the meaning of many lessons from the past: 'It is necessary to understand history, and he who understands history knows how to find continuity between that which was, that which is, and that which will be'. In planning a place in which we want to live not only safely and healthily, but also surrounded by beauty and harmony – as probably was the desire of the Minoans during the 2nd millennium BC, it can be useful to identify and underline any continuity between a still visible past made of monuments and memories and the future we want to build.

Certainly we need to reconsider the materials used in restoring and repairing not only archaeological sites, but also historical cities and centers, and to re–think the use of traditional materials (even if modernized through new technological developments). Wood, stone, *adobe* were used down the centuries and millennia for creating a healthy and safely built space, not only perfectly harmonized with the natural environment, but also sustainable in economic terms. Further, when we are dealing with historical places and landscapes, the experience of the many traditional Mediterranean architectures and of the Minoan palaces, with their open and closed spaces modulated as a unity and effectively located in the natural landscape, can be a useful inspiration for promoting a more 'natural' approach in contemporary architecture. The positive psychological effects of the older approaches on the individual are now widely acknowledged.

Memories of and emotional bonds with the ancestors and the past can help support and encourage the introduction of good practices in building and renovating, bolstered by the common links detected in different architectural approaches, even if separated by millennia and many miles. An in–depth knowledge of our common and long history can help us indeed to think positively about our Mediterranean background. Thus, we may reconcile the unity between environment and buildings and unquestionably that between nature and man.

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