Limiting the Use of Centering in Vaulted Construction:
The Early Byzantine Churches of West Asia Minor

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Introduction

The evolution of ecclesiastical architecture during the Early Byzantine period was marked by a major development in construction technology: the gradual transition from the building system of the "timber-roof basilica" to the one of the vaulted church. The early stages of this development seem to date back to the period between the late 5th and the 7th century AD and some of its earliest manifestations occur in the vaulted monuments of Constantinople and west Asia Minor. If the former are well-studied, the role of west Asia Minor in the development of vaulted church architecture is often underestimated, despite the publications of Auguste Choisy (1883), Hans Buchwald (1984), and others on this topic. Still, the published archaeological evidence from the cities of this area is clear: in Ephesos, Priene and Pythagorion, ambitious building programs were launched to replace timber-roof basilicas by magnificent domed churches.[1] By the end of the 6th century, major vaulted monuments had already made their appearance in the civic centers of Sardis, Hierapolis, and Philadelphia.[2] (Fig. 1) The plethora of Early Byzantine vaulted churches in the west coastal plains and river valleys of Asia Minor indicates that monumental architecture in this region was strongly influenced by the new architectural vocabulary. (Fig. 2)

This development changed radically the way in which churches were designed. The use of vaults, and, in particular, domes, called for load-bearing systems that were profoundly different from the ones of the timber-roof basilica. The continuity of the latter's rows of slender columns was disrupted by masonry piers of enormous dimensions; the church interiors were compartmentalized into a series of bays; the aisles were cut off visually from the nave.[3] On the other hand, the new towering spaces must have recaptured the scale and magnificence of the great vaulted caldaria of the Imperial Roman baths in the same region. The sixth-century masons built their vaults using fired bricks and mortar, exactly the same materials as the ones that Roman builders had used in the same region. This is indicative of the continuity that characterizes the development of building methods in the region. Although the use of brick and mortar to construct vaults was not a novelty, the vocabulary of Early Byzantine vaulted

[1] See Thiel 2005, 100-103 for Ephesos; Westphalen 2000, 275-80 for Priene; Tsakos 1979, 10-25 for Pythagorion.
[2] See Karydis 2012, forthcoming, for Sardis; Buchwald 1981, 301-302 for Philadelphia; De Bernardi Ferrero 1983, 87-92 for Hierapolis.
[3] Krautheimer 1986, 243-44.

architecture was renewed considerably. New vaulting patterns emerged, such as the one that comprises a series of domes on pendentives. (Fig. 3) The aesthetics of this "new style" have already been investigated.[4] However, in spite of major studies on Early and Middle Byzantine building methods, further research is required in the construction methods that marked the emergence of vaulted church architecture.[5] Indeed, until recently, the Early Byzantine manifestations of this development, and particularly the ones outside Constantinople, had not been sufficiently studied. This is a serious lacuna in our understanding of a development that was, after all, not only stylistic but also technological, and one that was not limited to Constantinople but also influenced architecture in the Aegean coastlands.

In a recent book, I sought to fill this lacuna, investigating the building methods and structural forms employed in the Early Byzantine vaulted churches of west Asia Minor.[6] As most of these churches are ruined, reconstruction was an essential part of my work. The methodology I used was based on the graphic survey and interpretation of vault fragments and construction details. This revealed new evidence for the original form of these churches and improved our understanding of their structure. (Fig. 4) Although this study focused on recapturing forms and construction methods that seemed lost to us forever, it overlooked the examination of the causes of this technological development. In particular, this book left a major question unanswered: one may ask whether the adoption of mortar and brick vaulting in Early Byzantine Asia Minor can be attributed to the tendency to avoid or, at least, minimize the use of timber in construction. Now, according to Cyril Mango, "one reason for the adoption of the masonry-roofed church [after the 6th century] may have been precisely the difficulty of obtaining suitable timber."[7] However, to consider this as the obvious answer is to overlook the fact that timber can play a major role in certain systems of vaulted construction as the material of the timber formwork, or centering on which the vault is constructed. Although Mango's hypothesis is plausible, the gradual move from timber-roof to vaulted forms, considered alone, is hardly sufficient to indicate the development of 'woodless' building methods. To answer the above question, it is necessary to determine the degree to which the construction of the region's Early Byzantine vaults required the use of centering.

[4] Buchwald 1982, 40-45.
[5] Deichmann 1956, 19-41, 84-95; Ward-Perkins 1958, 58f; MacDonald 1958, 2f; Ousterhout 1999, 216-33; Wright 2000.
[6] Karydis 2011.
[7] Mango 1978, 12.

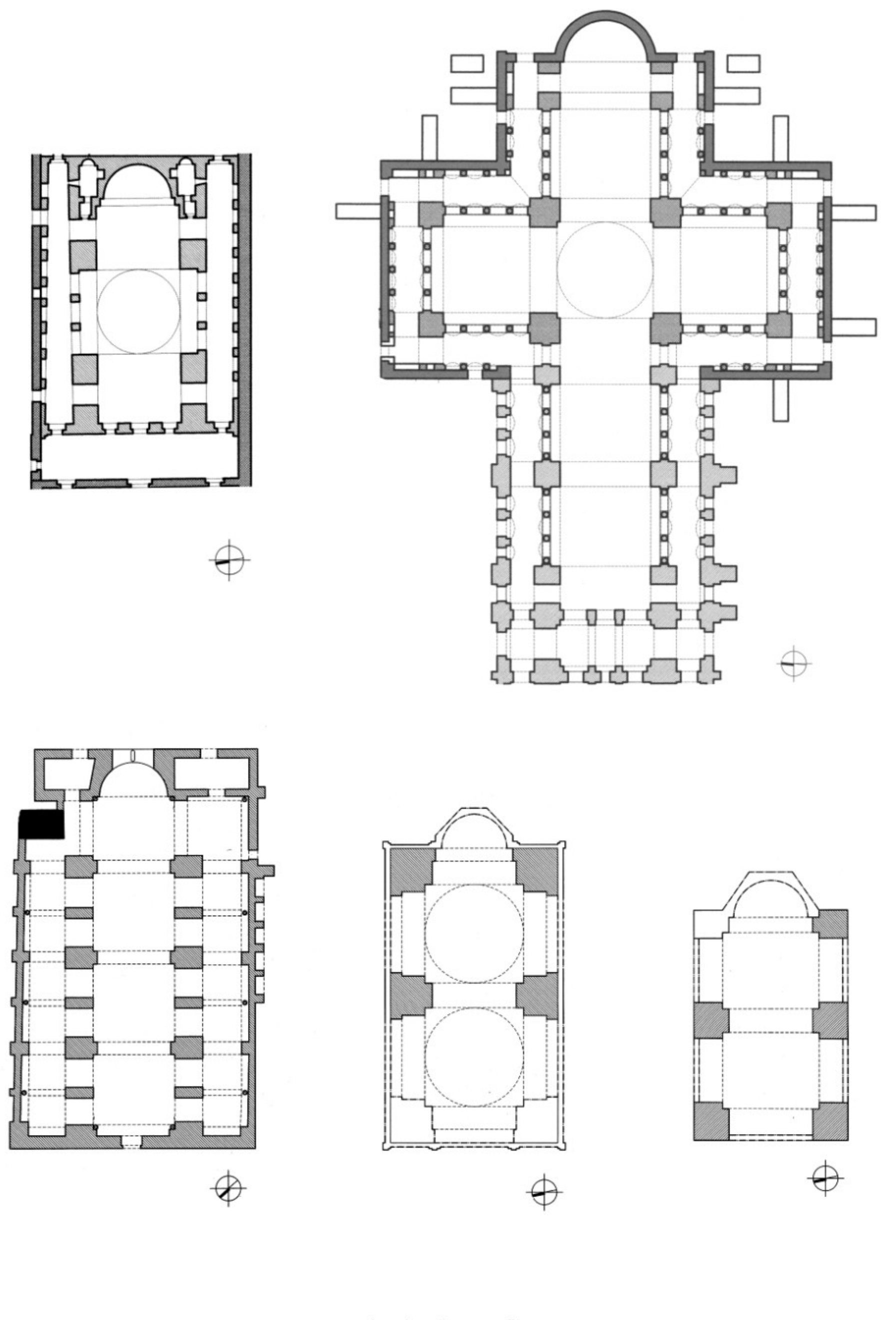

Fig. 1: The Early Byzantine Vaulted Churches of West Asia Minor, Table of Plans. Upper row, left to right: St. Mary at Ephesos and St. John at Ayasoluk. Bottom row, left to right: “Urban Basilica” at Hierapolis, St. John at Philadelphia and Building D at Sardis (CAD drawings by Carolina Vasilikou, 2009).

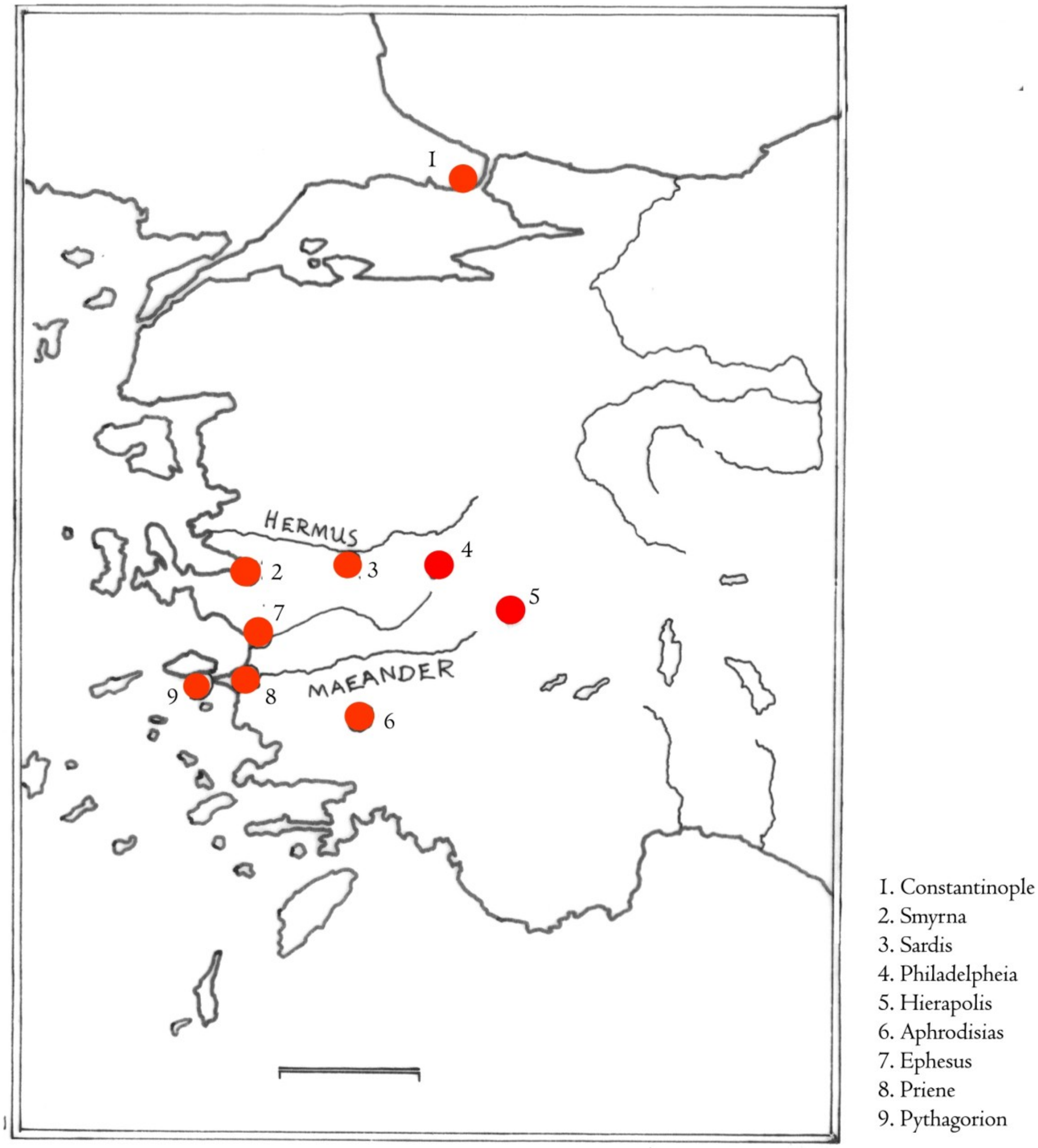

Fig. 2: Map of West Asia Minor, showing the sites associated with the development of vaulted church architecture (ink on tracing paper, Nikolaos Karydis, 2009).

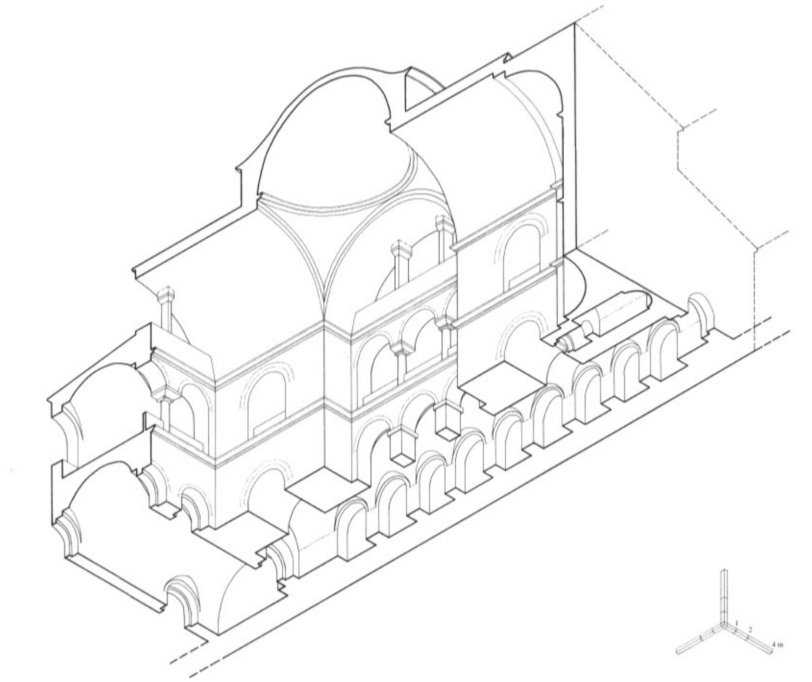

Fig. 3: Ephesos, St. Mary, Cross-domed church, Reconstructed Axonometric (ink on tracing paper, Nikolaos Karydis and Carolina Vasilikou, 2009).

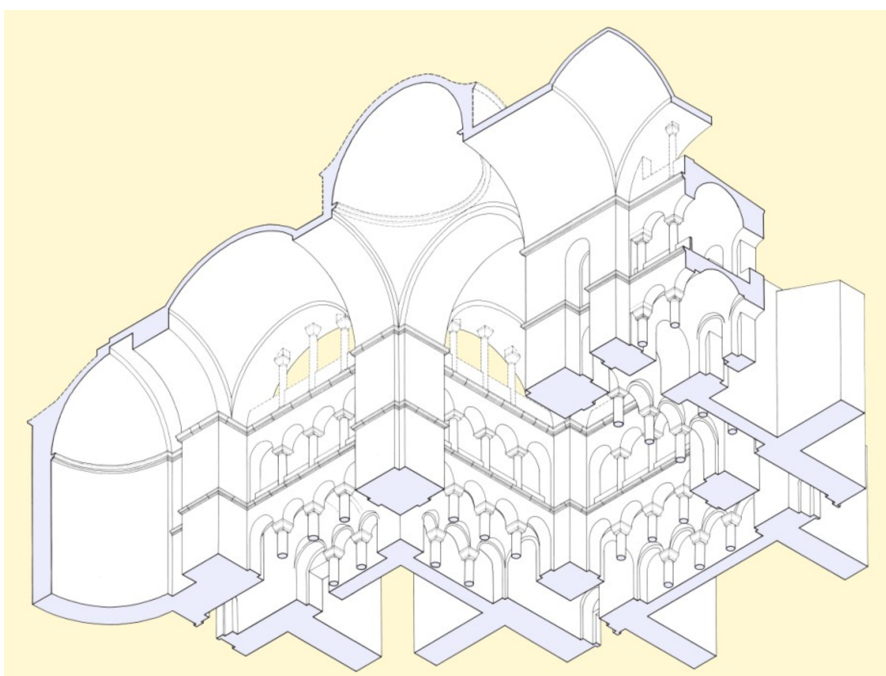

Fig. 4: Ayasoluk (near Ephesos), St. John the Theologian, Reconstructed Axonometric (mixed media, Nikolaos Karydis and Carolina Vasilikou, 2012).

Tracing the exact manner in which brick vaults were formed fifteen centuries ago has obvious difficulties. However, the scanty evidence available is, in some cases, sufficient to determine the shape and brick pattern of the original vaults. These can sometimes indicate whether a vault was constructed on centering, or whether the need for temporary support was drastically reduced. The present article reexamines the vault structures of Asia Minor from this point of view. This study sheds new light on the building methods employed in the region during the Early Byzantine period. Most importantly, it reveals that the development of vaulted construction was based on the use of brick patterns characterized by the setting of bricks in corbelled, 'pitched' or 'arched' brick courses. These specific vault patterns have been considered by various authors as indications of building without centering.[8] However, before taking these patterns as evidence for the development of a 'woodless' building technology, it is necessary to establish the degree to which they were used in our churches as well as to reevaluate the extent to which they would have made it possible to dispense with timber formwork.

Before we move on to further analyse this topic, a few preliminary words are necessary for the monuments on the survey of which the present work is based. Of the eight vaulted churches of the area that can be plausibly dated to the Early Byzantine period, three are particularly relevant here because they preserve significant fragments of their vaults. The most well-known of these monuments is the church of St. John at Ayasoluk, near Ephesos. This domed, cruciform basilica, considered in the 6th century A.D. as the Ephesian counterpart to the church of the Holy Apostles in Constantinople, resulted from the modification, during the time of Justinian, of an earlier vaulted church.[9] (See Figs. 1, 4) Additional information can be drawn from the complex of St. Mary at Ephesos. At the heart of this complex lie the remains of a cross domed basilica. (See Figs. 1, 3) If the latter's date remains uncertain, we know that it was built on the west part of the nave of an earlier basilica, whose secondary spaces and adjoining Baptistery seem to have been covered by vaults.[10] Our third source of information is the so-called "church of St. John" at Philadelphia (Alaşehir). The remains of this aisleless, twin-domed basilica preserve significant portions of the original vaults, undisturbed in their original context.[11] (Fig. 5) The reexamination of the above monuments is made possible by the recent graphic reconstructions published by the author in 2011.[12] Helping to determine the building methods followed, these detailed drawings constitute a useful tool in the exploration of vaulted church architecture in the region.

[8] Choisy 1883, 31-58, 99-105; Ward-Perkins 1958, 61; Khachaturian 1971, 18; Sanpaolesi 1971, 19; Ousterhout 1999, 219; Huerta 2009, 292.
[9] See Procopius V. i. 4-7 for the attribution of the church to Justinian and its formal comparison to the Holy Apostles; Hörmann 1951, 205, and A. Thiel 2005, 100, for detailed descriptions of the remains and an analysis of the building phases; Karydis 2012 (forthcoming) for a graphic reconstruction of the vaults.
[10] Knoll 1932, Karwiese 1989.
[11] Buchwald 1981, 315.
[12] Karydis 2011, 145, 174, 176.

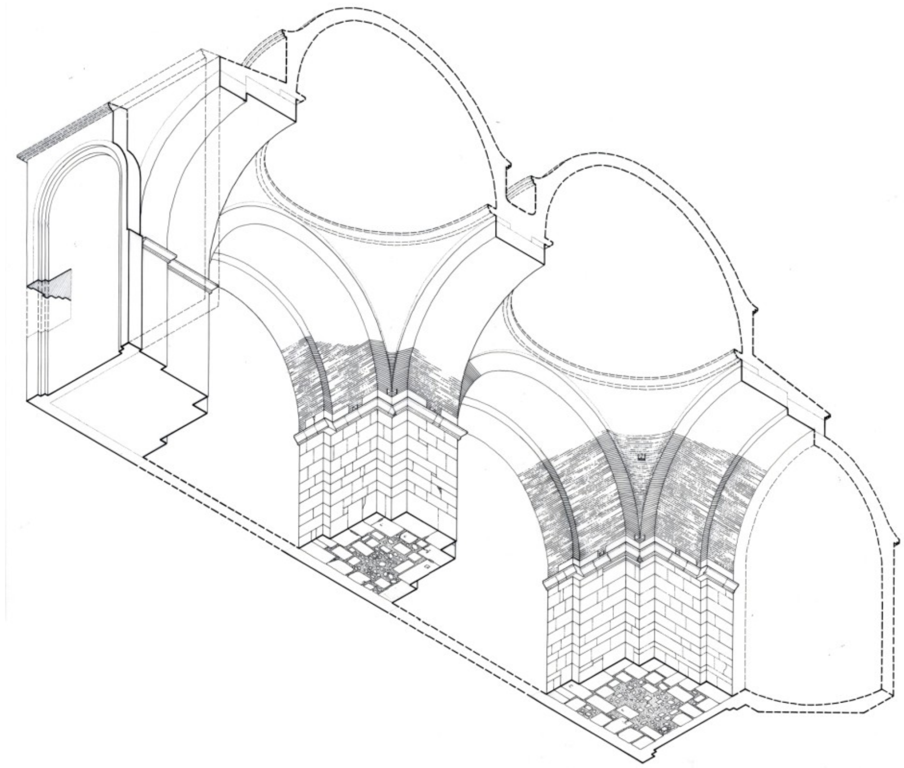

Fig. 5: Philadelphia (Alaşehir), St. John, Reconstructed Axonometric (ink on tracing paper, Nikolaos Karydis, 2009).

Methodology

In order to establish whether the building system used in west Asia Minor required centering or not, it is necessary to consider the reasons that make centering necessary and the special cases where its use is limited. First, we should note that timber centering plays an essential role in some systems of vault construction that use fired bricks and mortar. It prevents the unfinished parts of the vaults from falling before the structure is locked into position. Centering also helps to control the emerging vault shape and to maintain the voussoirs true to the curvature of the vaulted shell.

On the other hand, not all vaults require centering. Take, for instance, the construction of a hemispherical dome with conical brick courses forming horizontal rings. According to Rowland Mainstone, because of the double curvature of this shell, "each completed horizontal ring will itself function as a circular arch and prevent the inward collapse of the incomplete vertical arches."[13] This implies that, theoretically at least, it is possible to limit temporary support to a moveable timber template that holds the bricks of each circumferential ring while the ring

[13]Mainstone 1988, 165.

remains incomplete. Another key for limiting the use of centering seems to lie in the way the bricks are set. For instance, according to Auguste Choisy, a barrel vault made of pitched bricks can be constructed without centering.[14] (Fig. 6) Piero Sanpaolesi mentions examples of Late Antique, Early Christian and Islamic domes where the arched shape of the courses, and the division of the vault shell in interlocking and seemingly self-supportive units would have made it possible to dispense entirely with the use of centering.[15] Robert Ousterhout describes many Middle and Late Byzantine examples of pitched-brick vaulting as well as vaults featuring peculiar zigzag and chevron brick patterns, showing that vault construction without the use of centering was common in Byzantium from the tenth century onwards.[16] These examples indicate that certain methods of setting the bricks to construct a vault shell make limited use of timber formwork.

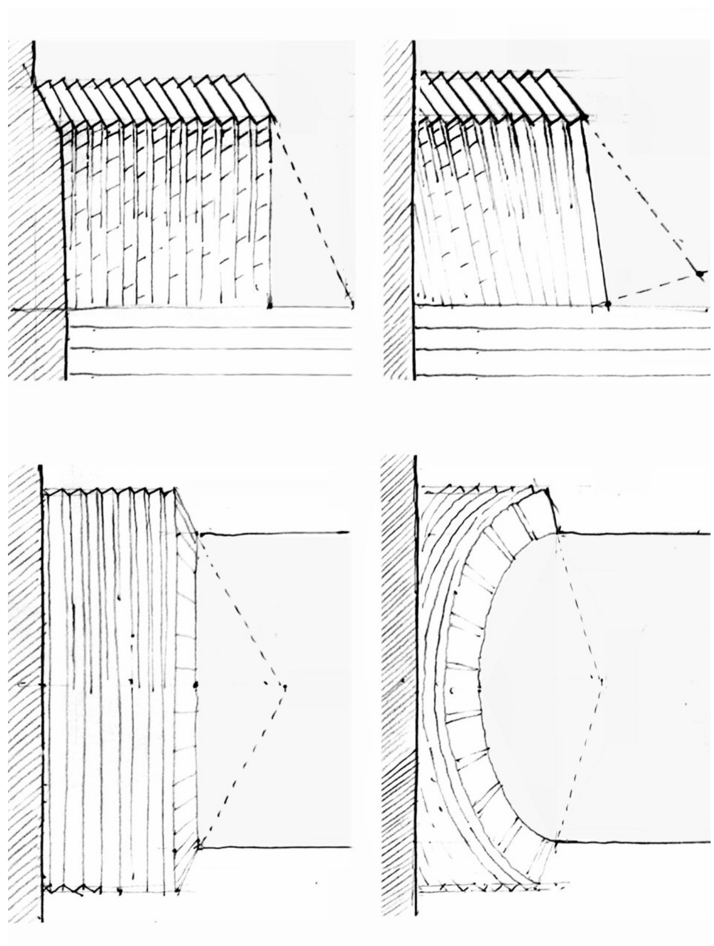

Fig. 6: Two Types of Barrel Vaults Made of Pitched Bricks, interpretive plans and sections (pencil on paper, Nikolaos Karydis 2003, after Auguste Choisy 1883).

[14]Choisy 1883, 21-48.
[15]Sanpaolesi 1971, 11.
[16]Ousterhout 1999, 221.

We now return to our initial question regarding the role of timber in the early development of vaulted construction in west Asia Minor. The examples of brick vaults cited above illustrate that, depending on the vaulting system employed, the degree to which timber is used varies. At the same time, the work of Choisy (1883), Sanpaolesi (1971), Mainstone (1988), and Ousterhout (1999) suggests that the examination of the structure and form of the vaults can offer valuable indications concerning the construction process. Therefore, to answer the central question of the present article, it is necessary to reexamine the structures of the churches, paying particular attention to the brick setting, the shape of the vaults, and the existence of putlog holes. Although these details are insufficient to reconstruct the building process in detail, they at least indicate the degree to which the construction of these vaults required the use of centering.

Understanding the Building Process

If western Asia Minor constitutes an ideal region to study the vaulting methods of the Early Byzantine period, this is not only because of the sheer number of vaulted churches there, but also because of their ruined form. Indeed, their dilapidated structure exposes their inner layers of construction and reveals details that in other, better preserved examples remain concealed. A detailed examination of these details can be found in what follows. My approach to this examination is analytical. It involves the separate investigation of the constituent elements of the vaulted ceilings. First, we will examine the elements of the primary vault structure: the broad arches, and the major spherical vaults covering the naves and transepts of our churches. Afterwards, we will turn our attention to smaller secondary vaults: the groin and barrel vaults found in aisles, galleries and side chambers.

Constructing the Primary Vaults

The central space of most churches in west Asia Minor is divided in rectangular bays. The piers in the corners of these bays carry broad arches of considerable span that can reach 14 m and a soffit width that ranges from 3 to 5 m. These arches are usually surmounted by pendentive domes (spherical vaults in which the pendentive and the crown are parts of the same spherical surface) or full hemispherical domes on pendentives. The vaulted unit combining a spherical vault with four broad arches seems to have been one of the main characteristics of this architectural vocabulary. (See Figs. 3, 5) In many cases, this unit was used in a modular way so as to create a rhythmically articulated, vaulted canopy.

The construction of this canopy must have started from the broad arches. These elements played an essential role in the overall structure. As we saw, they had to bridge major spans. At the same time they carried the loads of the spherical vaults and counteracted their lateral thrusts. The desire to make these elements particularly robust is reflected in their considerable thickness which ranges from 70 to 90 cm. These arches were invariably made of bricks laid radially. Now, this specific technique normally involves the use of centering.[17] Indeed, a look at the remains of St. John at Philadelphia seems to reveal potential traces of the use of such a formwork. (Fig. 7) The feet of the broad arches preserve a series of putlog holes. Their position, just over the pier cornice, at the springing of the vaults would have made these cavities ideal means of attachment of the horizontal timbers of a 'flying' centering. The outward projection of the stone cornice may have served the same purpose. On the other hand, one may see these same putlogs as traces of the use of tie-beams, such as the ones frequently employed in Middle Byzantine monuments.[18]

At first sight, it is difficult to imagine these broad arches being constructed without some kind of temporary support. Indeed, the radial setting of bricks and their steep inclination over a certain height would have made it necessary to support a major part of the vault during construction, until it is locked into position. However, a closer look at the form and structure of the broad arches of St. John at Philadelphia indicates that the use of centering was limited to a small part of the arches. Indeed, up to a level of almost +1.00 m over the springing, the arch was built with over-sailing (corbelling) brick courses on roughly horizontal beds. From this level, and up to +3.65 m over the springing, the brick courses, having assumed an inclination of 13°, are kept almost parallel and somewhat less than normal to the curve of the arch. (Fig. 8) This inclination is gentle enough for the bricks not to require temporary support during construction. That the latter was not used for the entire vault structure is also reflected in the irregularity of the profile of the part of the vault that corresponds to the corbelling courses. This profile deviates from the usual semi-circular outline. Its irregularity may be attributed to the insufficient control of the shape of the emerging vault, caused by the lack of sufficient centering.[19] All these details are indicative of an economic and free-hand method of construction, which limits the use of centering to the crown of the vault.

In Philadelphia, the only part of the broad arch for which the use of centering could not be avoided must have been the part that corresponds to the upper one third of the height. The size of the corresponding timber formwork would have been drastically reduced, compared to the one necessary for the stabilization of the entire broad arch. In the broad arches of Philadelphia, the builder managed to limit the use of centering, by making the lower part of the arch structure self-supportive, and thereby, reducing the area of the arch that required temporary support. Examples of similar broad arches in Ephesos illustrate a different, but equally ingenious way of economizing on timber scaffolding.

[17]Mainstone 1988, 170; Ousterhout 1999, 216-18, fig. 179, 180.
[18]See Ousterhout 1999, 211-13 for a general discussion, and Touliatos 2009, 61-63 for the use of timber reinforcement in the *Katholikon* of the Monastery of Docheiarion in Mount Athos.
[19]See George 1913, 39 for a similar interpretation of the "non-geometrical" form of some of the vaults of St. Eirene. For an alternative interpretation based on the broad arches of Hagia Sophia, see Mainstone 1988, 203, fig. 232.

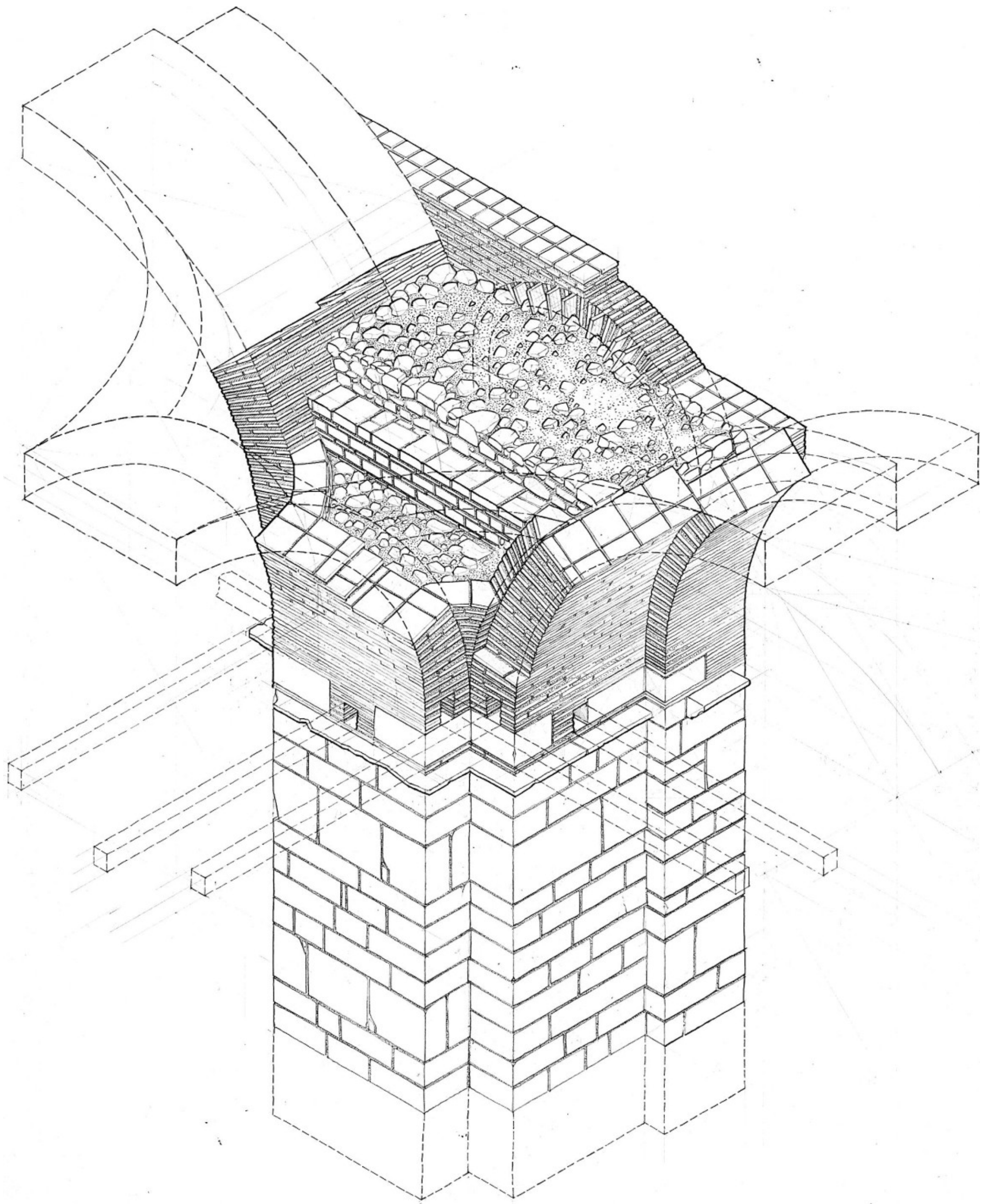

Fig. 7: Philadelphia (Alaşehir), St. John, Northwest Pier, Interpretive Axonometric (pencil on paper, Nikolaos Karydis 2009).

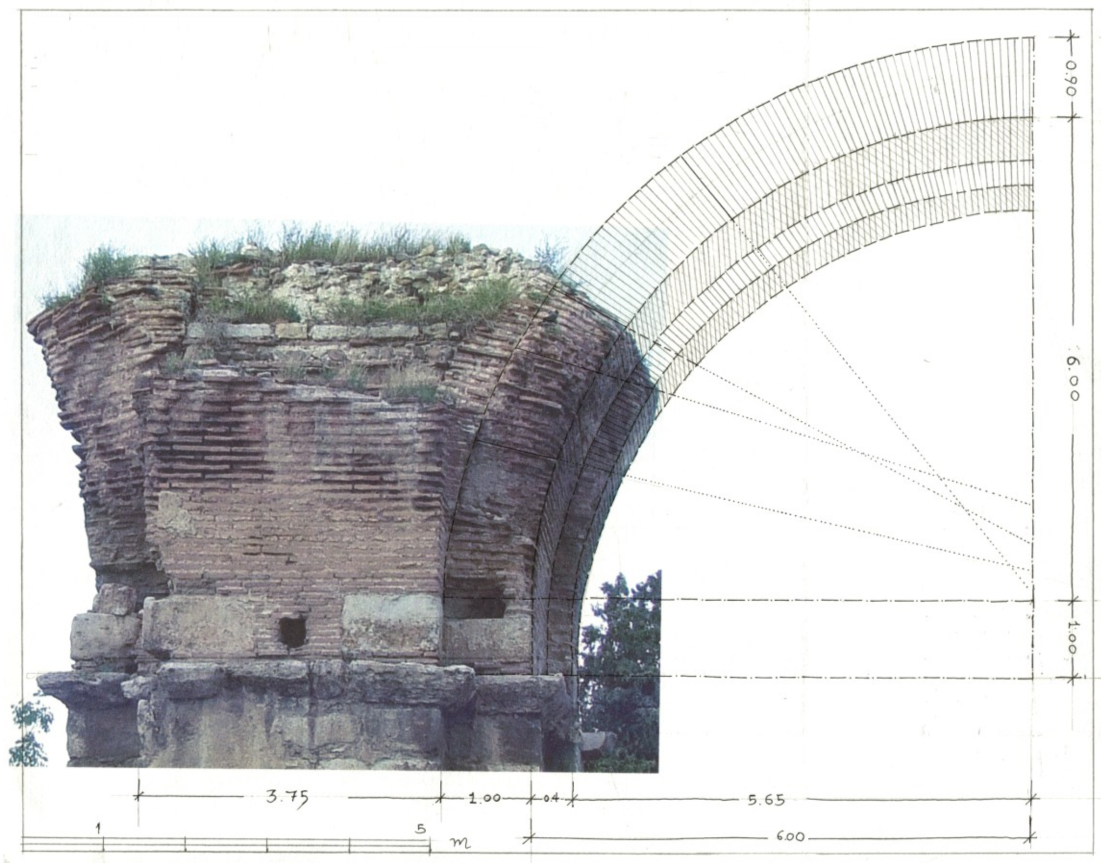

Fig. 8: Philadelphia, St. John, Detail of Vault Fragment on top of the Northwest Pier. The diagram superimposed on the photograph highlights the feeble inclination of the bricks and reconstructs the missing crown of the arch (mixed media, Nikolaos Karydis, 2008).

The broad arches in St. John at Ayasoluk, and the barrel vaults in the piers of the cross-domed church of St. Mary at Ephesos were subdivided into two superimposed arch rings made of radial bricks. (Fig. 9) This made it possible to construct the broad arches in two stages. Once the lower arch-ring was built, the timber formwork could be removed. The complete ring could now provide support for the upper ring. This method reduced significantly the weight of the structure that required timber centering. This must have also reduced the number and size of the beams of the formwork.

Unfortunately, the remains in Ephesos and Ayasoluk are not sufficient to establish whether the subdivision of the broad arches in two arch rings went together with the setting of the lower brick courses at a flat inclination, as in St. John at Philadelphia. However, if the two techniques were combined, they would have limited considerably the timber centering required for the construction of the broad arches. In addition to this, the uniformity of the broad arch sizes meant that their formwork could be reused for multiple broad arches. These considerations indicate a conscious attempt to reduce the use of centering in a type of structure that usually requires temporary support during construction.

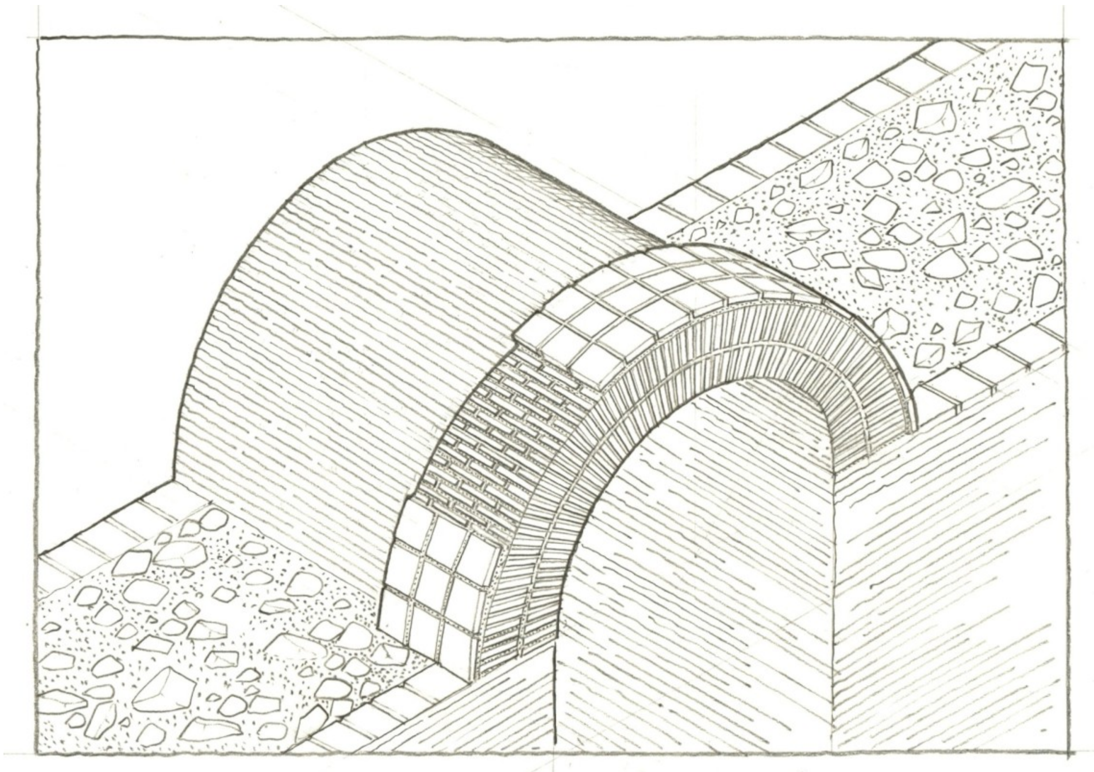

Fig. 9: Ephesos, St. Mary, Cross-domed Church, detail of barrel vault connecting the two parts of the northwest pier (pencil on paper, Nikolaos Karydis, 2009).

Once the broad arches were complete, they formed the basis for the erection of a more complex and challenging vault shell: the spherical vaults that covered the rectangular bays of our churches. These were either pendentive domes or full, hemispherical domes on pendentives. The remains of the northeast pier of St. John at Philadelphia offer the opportunity to examine the structure of a pendentive that must have been surmounted by a full hemispherical dome. This pendentive is made of a series of circumferential brick courses which lie on top of the extrados of the broad arches. (Fig. 10) Its structure has at least one point in common with the one of the broad arches in the same monument: the bricks are not laid radially in relation to the centers of curvature, but at a slightly "flatter" inclination. Provided that the mortar used was sufficiently fast-setting, the inclination of the bricks, intentionally gentle, was not enough to make the bricks slip from the mortar-beds below them. Therefore, this particular part of the structure did not require formwork.

The pendentives ensured the transition from the rectangular shape of the plan to the circular circumference of the dome. Domes did not only have various shapes (shallow or hemispherical), but various structures as well. Paradoxically, the structure that appears more frequently in the remains of our churches is not the typical Byzantine one, consisting of bricks laid radially in circumferential courses and forming horizontal rings. Instead, a more sophisticated method seems to have been used. The spherical vaults of the nave of St. John at Ayasoluk and the baptistery of St. Mary at Ephesos seem to have been made of bricks set in “arched” courses of limited length. (Fig. 11; see Fig. 4) These courses were curved in two directions: they followed both the curvature of the vault as well as the curvature of an independent pattern of smaller arches within the vault. Each complete course, because of its double curvature, must have functioned as a circular arch, and would not have collapsed, even if the circumference of the dome was incomplete.

Fig. 10: Philadelphia, St. John, Detail of Vault Fragment on top of the Northeast Pier, displaying remains of a pendentive (photo by Nikolaos Karydis, 2007).

At this point, we should note that the same characteristic, the double curvature of the courses, is also encountered in standard domes made of circumferential courses. In both building systems, once the courses are complete, they constitute arches locked into position. The only support required is the timber template necessary to hold the bricks in place until they form a complete course. It is here that the differences between the two vault structures begin. Although both systems divide the spherical vault into self-supporting units, the one encountered in our region reduces drastically the size of these units. Indeed, the arched courses are much shorter than the average circumferential course in a dome of an equivalent size. This means that the template required to form each course would also have been smaller. This is a major advantage in domes as large as the ones of Ephesos and Ayasoluk, whose diameter can reach 14 m. Thanks to this ingenious technique, these enormous shells were divided in a large number of small arches, which could be stabilized during construction with small templates and were self-supportive when complete. Another difference between the two systems lies in the degree of variation

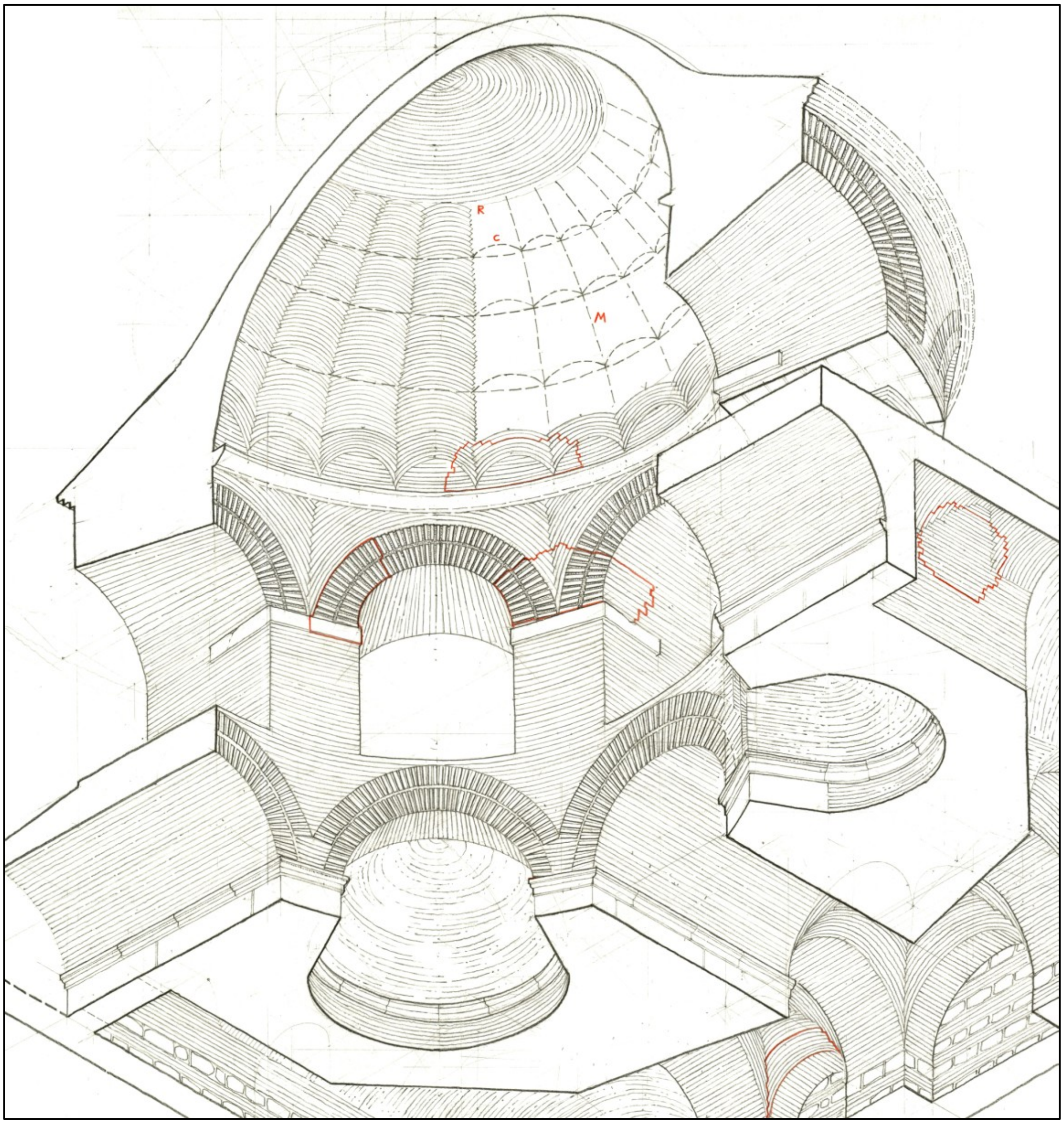

Fig. 11: Ephesos, St. Mary, Baptistery, Reconstructed Axonometric, detail showing dome made of arched brick courses. The existing fragments on which the reconstruction was based are shown with a red outline. According to this reconstruction, published in Karydis 2011, the dome was made of small arched brick courses (C), interlocking along the meridians of the vault (M). Over a certain level (R), the standard system of circumferential brick courses must have been the most practical to use (pencil on paper, Nikolaos Karydis, 2009).

between the lengths of the courses. The domes in Ephesos and Ayasoluk formed patterns that did not allow the courses to exceed a certain length. This means that the same, small timber template could be used repeatedly, with minor adjustments. The above observations seem to indicate that the division of the vault in small, relatively uniform and self-supportive units made it possible to construct sizeable spherical vaults without extensive systems of temporary support. Considering that other ingenious methods reduced the formwork necessary to build the broad arches and pendentives, we realize that the construction of the entire primary vaults of our churches must have made limited use of centering.

Constructing the Secondary Vaults

Next to the major vaults covering the naves of St. John at Ayasoluk and St. Mary at Ephesos, there was an additional network of secondary vaults. These were often barrel vaults, but there are also a few cases where cross vaults were used. In all cases, the span of the vaults is quite limited, rarely exceeding 3.5 m. The building techniques employed here are different from the ones used in the primary vaults. In the secondary vaults, construction did not start from a horizontal plane but from the vertical faces of major walls, supports, and arches of the primary structural system. These elements formed the points of departure of successive vertical or steeply inclined rings of bricks laid pitched on their edge. Several authors have claimed that, provided that the mortar used was sufficiently adhesive and fast-setting, the building of such vaults did not require substantial temporary support. However, we must consider the possibility that the masons, to facilitate their task, used small moveable templates, in order to keep individual bricks in place until the mortar set and each arched ring was complete.

Barrel vaults made of pitched bricks are found in the aisles of St. John, the side chambers of the domed phase St. Mary, as well as the corridors of the Baptistery of the same church. (Fig. 12) Although the main body of these vaults consisted of bricks set in pitched courses, their lower portions, as well as their middle parts, were made of horizontal brick courses. This composite structure reflects the tendency to reduce the need for centering without, however, entirely abandoning the conventional technique of setting bricks radially. This combination of techniques can be explained by taking into account the construction sequence followed in one the barrel vaults covering the chambers flanking the west apse of the St. Mary. (Fig. 12) Having completed the lower portion of this vault, which consisted of horizontal, radial courses, the workmen must have started laying pitched courses simultaneously from the two narrow ends of the space to be covered. Setting the bricks so as to form vertical slices, each one lying against the previous one, construction gradually moved towards the center of the vault. There, construction changed, with the bricks set radially to form a portion that tapers upwards. None of these building stages necessitated centering. The radial setting of bricks in the feet of the vaults was possible without temporary support as the inclination of the bricks was not steep enough to cause the bricks to slip. In the central portion of the vault, the steeper the inclination of horizontal courses became the more their length decreased, limiting the need for temporary framework to the minimum. The rest of the construction, based on a repetition of self-supportive vertical slices and relying on the immediate adhesion between bricks and mortar, must have only required a limited use of formwork. Indeed, thanks to the horizontal courses at the feet of the vault, the length of the vertical rings was reduced, facilitating their temporary support with the aid of small, moveable templates. We therefore realize that the introduction of radial courses, seemingly paradoxical in a structure that does not require centering, is in fact meant to facilitate building without timber formwork.

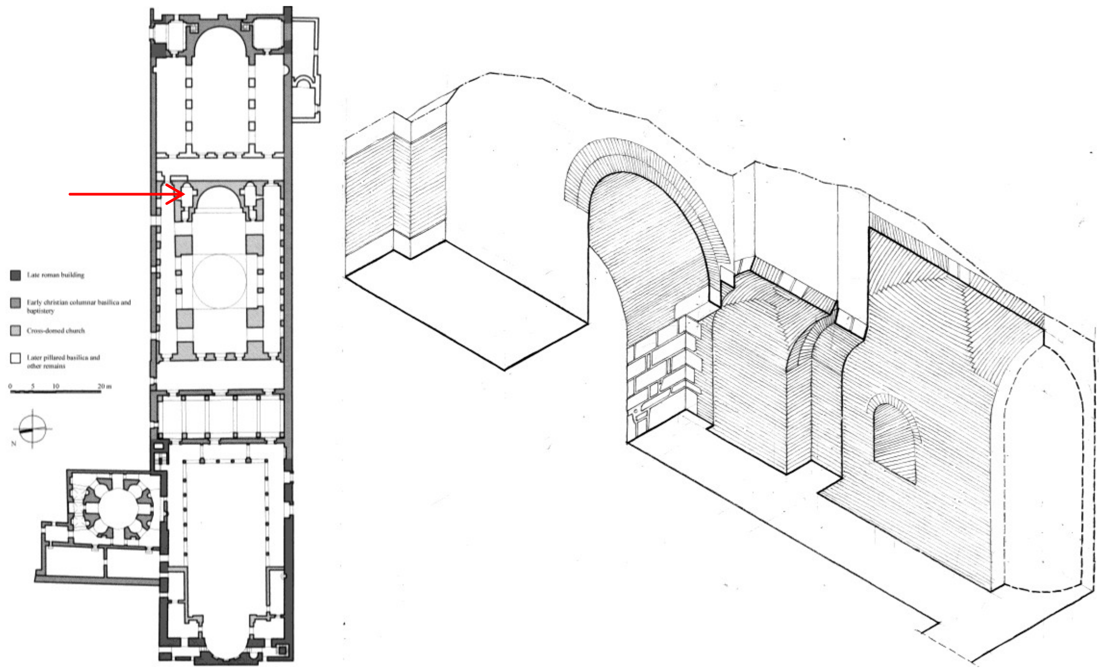

Fig. 12: Ephesos, St. Mary, Cross-domed Church, axonometric drawing of the secondary vaults covering the north side-chamber (pencil on paper, Nikolaos Karydis, 2009).

Conclusion

The vaults analyzed in the previous paragraphs indicate that the emergence of the masonry-roofed church in west Asia Minor was based on building methods that limited the centering required in vault construction.Given the massive size and span of some of these vaults, this was a remarkable feat of structural engineering. This achievement was based in the use of two construction strategies. The first strategy involved the division of the vault shell in self-supporting units and the reduction of the area that requires temporary support during construction. In major barrel vaults, this was achieved by setting the lower bricks in almost horizontal, over-sailing courses. In smaller barrel vaults, the bricks were set pitched on their edge. In spherical vaults, the use of self-supportive arched courses served the same purpose. The second strategy consisted in limiting the size and increasing the uniformity of the self-supportive units. This helped to reduce proportionately the size of the temporary support needed to stabilize each of the courses before all of their bricks were in their place and the structure was locked into position, becoming self-supportive.

If the above methods tend to be associated with the need to limit centering, what is frequently overlooked is that the division of the vaults in small units must have also reduced the number of builders required to build sizeable spherical vaults. This realization indicates that the use of the above methods may also have had another motive besides the reduction of centering. Made of small, self-supportive units that were easy to build and control, sizeable spherical vaults could now be constructed in an additive, cumulative manner by a modest workforce. This shows that the methods examined above do not only represent an attempt to limit centering but should be inscribed in an overall tendency to adapt monumental constructionto the economic realities of a period of limited resources. Indeed, the sixth century seems to have been an era in which climatic conditions, epidemiological events and a catastrophic taxation policy caused a major decline in the revenues of the cities of the region.[20] The development of "free-hand" methods such as the ones revealed in the present study can be interpreted as an attempt to recapture the grand scale, spatial complexity and magnificent vaults of Roman Imperial architecture adapting them to the declining economic conditions of sixth century Asia Minor.

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[20]Foss 1976, 54-62; for an interesting sixth-century testimony, see John Lydus, *De Magistratibus Reipublicae Romanae*: 3.58 and 61.

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