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The Proportional Relationship in The Three-Aisle Basilicas in Constantinople, Cilicia, Lycian, Lidia and Caria Regions (4th-6th Centuries)

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Abstract

With the emergence and spread of Christianity, many basilicas were built in Anatolia. The early period basilicas were generally designed in the same form by the masters of the period. There are no pastophorium cells in these basilicas. They usually appear as structures with a simple rectangular narthex. Our main problem is to evaluate these basilicas from a mathematical point of view. At the beginning of the questions to be asked about these basilicas, did every master apply the mathematical operation exactly? Did the masters build these structures by continuing the traditional method or did they do it with a good knowledge of mathematics? What kind of differences do basilicas built from region to region? This study, which we have discussed, asks the question of the effectiveness of traditional methods as well as mathematical methods when building basilicas. The question of whether architects adhere to mathematical methods and how important traditional methods can be for them is emphasized. Moreover, our study deals with how the early period basilicas are proportionally related. At this point, the churches were determined and the results were obtained.

Keywords: Basilica, church, ratio, $\sqrt{2}$, modulargrid.

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Konstantinopolis, Kilikya, Likya, Lidya ve Karia Bölgelerindeki Üç Nefli Bazilikalarda Oransal İlişki

Öz

Hristiyanlığın ortaya çıkması ve yayılmasıyla birlikte Anadolu'da birçok bazilika inşa edilmiştir. Yapılan erken dönem bazilikaları dönemin ustaları tarafından genel itibariyle aynı formda tasarlanmıştır. Bu bazilikalarda pastaforyum hücreleri bulunmamaktadır. Genellikle basit formda dikdörtgene yakın bir narteksi bulunan yapılar olarak karşımıza çıkmaktadırlar. Bizim temel problemimiz bu bazilikaları matematiksel yönden değerlendirmektir. Bu bazilikalar ile ilgili olarak sorulacak soruların başında her usta matematiksel işlemi tam anlamıyla uygulamış mıdır? Ustalar geleneksel yöntemi devam ettirerek mi bu yapıları inşa etmiş yoksa iyi bir matematik bilgisiyle mi yapmışlardır? Bölgeden bölgeye yapılan bazilikalar ne tür bir farklılık göstermektedir? Ele aldığımız bu çalışma da bazilikalar inşa edilirken matematiksel yöntemlerin yanı sıra geleneksel yöntemlerin de etkinliği sorusunu sormaktadır. Ustaların matematiksel yöntemlere bağlı kalıp kalmadıkları, geleneksel yöntemlerin onlar için ne kadar önemli olabileceği sorusu üzerinde durulmuştur. Ayrıca ortaya koyduğumuz bu çalışma erken dönem bazilikalarının oransal olarak nasıl bir ilişki içerisinde olduğu üzerinedir. Bu noktada tespit edilen kiliseler değerlendirilmiş ve bunun üzerine sonuçlar çıkarılmış ve yapılan ölçümler üzerinden değerlendirmeler açıklanmıştır.

Anahtar Kelimeler: Bazilika, kilise, oran, $\sqrt{2}$, modülergrid.

INTRODUCTION

The early Christians, instead of building new houses of worship, generally preferred to adapt Pagan houses of worship to their needs. Thus, in this context, we selected several examples of early (IV-VI centuries) Christian basilicas and by carefully examining and studying these examples, aimed at establishing a general picture about their common characteristics. As a part of our research, plans and measurements of the buildings selected were carefully examined and the results of the examination showed that there was no single systemic approach on the part of those, taking part in the planning and construction of the basilicas consisting the main topic of our research. At the same time, the results of our research indicate that quality of construction and skills of the stonemasons and other personal involved, increases according to the distance between the capital and location of any particular subject of our study, with the examples closer to the capital expressing better examples of craftsmanship. From this point of view, a question arises about the methods used by those builders and architects working in the early Christian era, what operations did they perform beyond mathematical calculations? Were the results of their mathematical calculations the main determinant behind the methods they used during construction process?

Another question we aim to answer is the eventual fate of the traditional construction methods. According to the data collected for and presented in this work, it can be determined that traditional methods were preferred, master builders generally relied on the experience and achievements of their predecessors and built their works interpreting existing professional knowledge in the context of their time and needs. Generally, architectural characteristics of particular buildings express characteristics that vary according to a particular region, this doesn't mean that those who built them had limited knowledge to execute mathematical calculations, but at the same time, it also doesn't mean that the calculations and mathematical methods used by them were very advanced or complicated, rather, mathematical methods used, were mostly based on empirical and practical methods that met everyday necessities. For example, during the early eras, building plans were drawn using stones, that were turned into more elaborate building schemes using ropes placed according to the plan. Land plot measurements were also made using ropes. Alongside ropes, plot measurement was also done using two units of measurement – *Orgye* (Fathom) and *Schoinion*. *Orgye* was, originally, either a stick or pole, approximately 2.1. meters long, that could be divided into nine *spithamoi* or 108 *daktyloi* (Fingers) (Ousterhout, 2016, p. 75-102). Generally, these traditional units of measurements were widely used by early master builders and the data, collected from the churches, studied as a part of this work, supports our ideas mentioned above. Our work lists plans and measurements of the churches in question in form of data tables and also, offers necessary evaluations.

Although our work is mostly centered around measurements and related data, there are also certain additional details that played important role during the construction processes of the buildings reviewed, like political conjuncture, religious motives, size and location of buildings, etc, but for academic reasons, we focused on measurements and technical data of the subjects of study.

Methods of Study

The data used in our work was collected by measuring basilicas using $\sqrt{2}$, modulargrid and Byzantine foot (Pous). The measurement of $\sqrt{2}$ ratio, was performed according to the main frames of the three-aisle basilicas, excepting apsis and narthex (Figure 1). To evaluate $\sqrt{2}$ ratios, measurements were performed by drawing a horizontal line from the upper corners of South-Eastern walls of basilicas spanning to the lower corners of North-Western walls. In the process, methods used by builders to construct narthexes were also closely evaluated and regional differences in applying architectural methods were also inspected and taken into consideration.

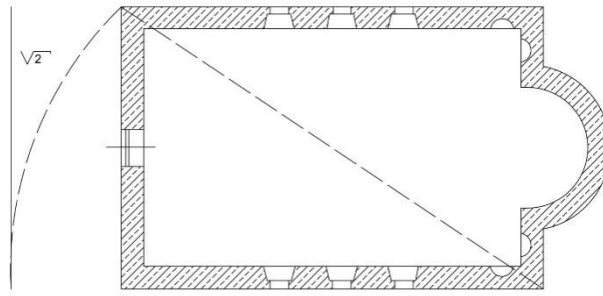


Figure 1: $\sqrt{2}$ rate applied to basilicas (Drawing: Tekin Doğan)

Another method – the modulargrid system, in architecture, describes a construction where certain parts face each other vertically according to “x-x” or “y-y” order, with equal interval between components (Alioğlu & Köroğlu, 2011, p. 331-340). During the application process of this method, the main detail taken into consideration was the width of narthex, more specifically, in context of basilicas, the details taken into particular consideration were outer walls of narthexes, middle of apsis and its outer walls (Figure 2).

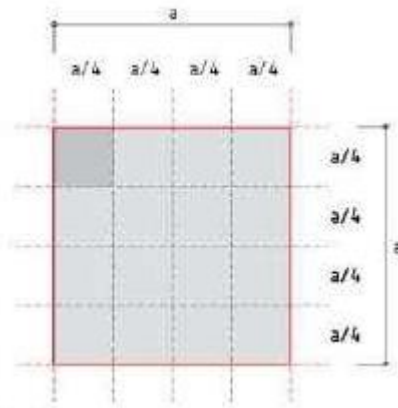


Figure 2: Modulargrid application (Alioğlu and Köroğlu, 2011, p. 333)

The objects of study were also measured according to the Byzantine Foot system, the resulting data is given according to their rounded measurements instead of fractional ones and are arranged into tables that also take regional characteristics into consideration.

Three-Aisle Basilicas of Early Period

The main focus of this work were the regions of Cilicia and Lycia; alongside basilicas located in these regions, examples located in Caria, Constantinople and Lydia (Sardis EA) are also present in limited numbers. During the classification process of the measured basilicas, the main factor taken into consideration was their full length (Excluding apsis and narthex) as specified in the table 1. Another factor we paid attention to was the fact that, in some cases, buildings show defined regional characteristics, for example, in Cilicia, outer walls of apsis were built so that they appear flat outside and rounded from inside of the church. During the evaluation of such examples, parameters of apsis were also taken into consideration.

Nineteen of evaluated basilicas have apses that appear semi-circular on outside facades, while fifteen basilicas contain apses that are semi-circular from inside. Four of the basilicas have three sections projecting outside and one basilica has three sections projected inside (Table 6).

We also grouped basilicas according to their location and examined their relations with regional specifications (Tables 2-3-4-5). The process of examination was completed according to its compatibility with $\sqrt{2}$ and modulargrid systems (Table 7).

The Basilicas from early era, generally possess rectangular plans close to cube, semi-circular apsis projecting outside, two aisles and a narthex. Also, these basilicas lack pastaphorial cells. In some cases, narthexes of basilicas were not established, so, they were measured excluding narthex. The shortest example, without narthex was Tapureli C width (Keil & Wilhelm, 1931, p. 96), while the longest was Ayatekla (Herzfeld & Guyer, 1930, p. 9), which, on its own right, is also the largest basilica compared to other examples. The basilica with smallest width is Batı Sandal (Hellenkemper & Hild 1986, p. 79). The basilica with shortest middle nave is Tapureli C, while the basilicas with the narrowest middle nave are Tapureli C and the Monastery of Kurşunlu (Ruggieri, 1995, p. 98). Tapureli C is also the basilica with narrowest northern and southern aisles. Generally, the average length of basilicas vary between 13 and 30 meters (Table 1).

Another detail we paid special attention was determining the compatibility of basilicas with $\sqrt{2}$ and to achieve this, we drew straight lines from one wall corner of narthex to the corner of the opposite wall, excluding apses in process. In the case of 28 basilicas, the compatibility was observed, while in eleven cases, the resulting data was outside of $\sqrt{2}$ ratio (Table 8).

The modulargrid system failed to yield a specific result in regards of the basilicas and was applied with taking the narthex width into consideration. In examined cases, a modular grid system cutting basilicas into northern and southern parts starting from entrance, was observed. In some cases, this system also applies to the outside of apsis. But the main point here is the presence of a line that cuts apsis from the middle. The result of our calculation performed using this system is also noteworthy and shows measurement differences between basilicas and proves that during the process of designing these basilicas, modular system was generally applied in theory and had very limited practical application.

It was also important to evaluate basilicas using the Byzantine Foot system and as mentioned above, data obtained using this system was listed using rounded results instead of partial ones (Table 10). In this system, one Byzantine Foot equals 31.23 cm. According to Erich Schilbach, the Byzantine Foot system was first systematized during the reign of Justinian I (525-548) (Schilbach, 1970, p. 13-36).

Evaluation According to General and Regions

Evaluating basilicas according to their location greatly improves our understanding of the collected data and helps with their interpretation, thus, we'll also try to make regional evaluation using the data obtained by evaluating and measuring the basilicas. The main question we concentrated on during the examination of the basilicas concerns the architectural methods, traditions and systems and their influences on final design and these questions will also show possible details used during the designing process of the basilicas.

Generally, early era basilicas in Anatolia are either dual or three aisle and possess a narthex and generally have a simpler outlook. Some of them have several floors and generally, their naves are divided by colons. General proportions of basilicas are close with each other and generally, combined length of left and right aisles equals to the one of the middle nave. Distance between colons in some buildings is 2.50 meters. Generally the width of the middle nave is 1/3 of general building width and combined with other aisles, it's 3/5 of total width (Buchwald, 1999, p. 20-26). In this regards, Aeneas Oikonomou, in his work gives a detailed characteristic of Byzantine measuring units and their metric equivalents (Oikonomou, 2012, p. 407-582).

When evaluating characteristics of the basilicas, the first thing that draws our attention are regional differences. Sizes of the basilicas evaluated in this paper generally varies between 20 and 30

meters and the longest ones with both, narthex and excluding it are located in the Cilicia region, while the smallest ones are from Caria (Tables 2-4). The largest basilica of Cilicia is Ayatekla and its counterpart in Caria is the basilica of Knidos E (Love, 1974b, p. 101-109). In regards of general width, the regions of Cilicia, Constantinople and Lycia are close to each other, while the Caria group contains the smallest examples evaluated. Examples with the highest middle nave are generally located in Lycia, while the ones with smallest examples are generally found in Caria. The evaluated basilicas of Constantinople generally have middle naves that, in size are close to each other (Tables 2-3-4-5).

Among the basilicas evaluated, those with largest and widest proportions are generally located in Constantinople. For example, in Cilicia, the length of naves generally varies between 8 and 55 meters. These numbers in the examples located in Lycia are 13-36 meters, in Caria and Constantinople they are respectively 13-20 and 20-29 meters (Tables 2-3-4-5).

Of the evaluated basilicas, twenty-eight was compatible with $\sqrt{2}$ ratio, while in eleven cases such detail wasn't observed. Also, the measurements taken from the corner rooms of Tapureli A (Keil & Wilhelm, 1931, p. 95) and Yanıkhane Kuzey (Hellenkemper & Hild, 1986, p. 84) and Alacami basilicas of Kadirli (Bayliss, 1997, p. 57-87) revealed their compatibility with $\sqrt{2}$ (Table 8).

The distribution of basilicas compatible with $\sqrt{2}$ per region, is almost even. In Cilicia, four basilicas out of fifteen, in Lycia three out of ten, in Caria one of the four basilicas is outside of $\sqrt{2}$ range. In Constantinople, all basilicas are within $\sqrt{2}$ norms (Table 9).

When using the modulargrid system, differences between basilicas located in different regions and some cases, among those located in same regions can clearly be observed. In this work, we applied modulargrid system focusing on narthex and apsis, more specifically, outer walls of narthex and middle of apsis and outer wall of apsis. And while using this method, we observed that in the basilicas of Hasanlıler (Hellenkemper & Hild, 1986, p. 65), Korasion Mezarlık (Keil & Wilhelm, 1931, p. 107), Anamur Nekropolis (Russell, 1987, Figure 14), Alacami of Kadirli, Korykos (Herzfeld & Guyer, 1930, p. 94), Ayatekla, Tapureli A and the Holy Apostles of Anamur (Russell, 1987, Figure 9), the finishing line of modulargrid coincided with the middle of apsis. In Tapureli C, Church of Cambazlı Büyük (Keil & Wilhelm, 1931, p. 37), Korykos, Çatiören (Hellenkemper & Hild, 1986, p. 77) and Yanıkhane Kuzey the line goes outside of apsis. In the basilicas located in Lycia, in Xanthos Doğu (Hellenkemper and Hild, 1986, p. 77), Andriake A (Tekinalp, 2000, plate 19), Demre Ala Church (Grossmann, 1993, p. 1-6), Andriake D (Tekinalp, 2000, plate. 56), Kök Burunu (Harrison, 1963, p. 139), Andriake C (Tekinalp, 2000, plate. 50), the line falls inside basilica, while in Kydna (Ousterhout, 2016, p. 107), Güceymen Tepesi (Grossmann & Severin, 1981, p. xciii) and Andriake E it falls outside (Tekinalp, 2000, plate 63). In Caria, in every example, the line ends inside basilicas. Thus, it shows that this region had its own general standard. Same general standards can be observed in basilicas evaluated in Constantinople, where, the basilica of Constantinople Studios Monastery and Theotokos Chalkoprateria the last point of the line takes place outside of apsis, while in the basilicas of Beyazit A and Topkapı Sarayı the line goes through the middle of apsis, but what is the most important is that in every case, the system fits with general characteristics of basilicas.

Using Byzantine Foot system also helps us to understand how measurement systems were used at the time of the construction of the basilicas studied. The length of basilicas measured, varies between 43 and 179 feet (Table 10). With Tapureli C being the smallest with the length of 43 feet and Ayatekla being the largest with 179 feet. Per regional basis, length of the basilicas evaluated in Cilicia, range from 43 to 179 feet, in Lycia, 50 to 128 feet, in Caria 45 to 74 and in Constantinople between 54 and 79.

CONCLUSION

The final result of our research shows that there was no real standardization in basilicas evaluated, although it doesn't mean that construction plans were executed without any scientific architectural foundations, while regional differences are present, general characteristics of basilicas also show that there is a certain level of interconnection between regions, expressing itself in architecture of basilicas and as we approach the capital, the level of standardization increases, with those involved in construction process preferring to follow certain guidelines closely than in the peripheries. While in Cilicia and Lycia regions there is no standardized system to mention, in Caria and Constantinople certain basic standards followed during construction processes can be observed. For example, compatibility with $\sqrt{2}$ was a part of design in every region but wasn't always followed. Module grid system wasn't observed in Lycia and Cilicia, but in Caria and Constantinople they seem to be a sort of standard. Thus, we can conclude that builders working in Constantinople were more skilled and had better understanding of construction theories and as a result of the education they had received, they were more receptive to the tendency of standardization. Decrease of standardization with the increase of distance from the capital indicates that with the decrease of formal architectural education, the role of traditional practices increased. Thus, we can conclude that regional architects generally preferred to synthesize experience of previous generations with their own architectural preferences, also, we can't rule out that they also bore motivation of improving general architecture of their home regions.

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Table 1: Early Three-Aisle Basilicas in Constantinople, Cilicia, Lycia, Lydia and Ca

	Total Length Including Narthex (TLN)	Total Length Excluding Narthex (TEN)	Total Width (TW)	Middle Aisle Length (MAL)	Middle Aisle Width (MAW)	North Aisle Length (NAL)
Tapureli C	20m	13.50m	12.20m	9.70m	4m	8m
Kök Burunu	20.40m	14.20m	11.50m	13m	5m	13m
Yanıkhan Kuzey	18.80m	14.90m	13.60m	13.70m	6m	13.70m
Kurşunlu Monastery	18m	14m	12.80m	13m	4m	13m
Tapureli A	18.50m	14m	13m	13.50m		
Korasion Mezarlık	21m	14m	13.90m	12.50m	5.50m	12.50m
Anamur Nekropolis	18m	15.50m	13m	19.60m	5.80m	14.10m
Demre Güceymen		15.50m	11m	14m	4m	14m
Korykos Kuzey Kilise	20m	15.60m	11.70m	15.10m	5.10m	12.20m
Uşak-Selçukler 1. Church	19.90m	16.50m	14.30m	14.50m	6m	10.60m
Sura Valey	21m	16.60m	13.50m	15m	5.50m	15m
Batı Sandal		16m	10.90m	10.90m	5.10m	10.90m
Pisidian Melli		16m	13.20m	14.50m	6m	14.50m
Beyazıt A Basilica	22m	17m	20.90m	20.20	8m	15m
Hasanaliler Early Period Church	21.30m	17.50m	15.50m	16.20m	6m	14.10m

Cambazlı	22.60m	18.50m	14m	18m	6m	15m
Milet H. Mikhael Basilicas	21.70m	18m	12.30m	17m	6m	17m
Çatören	23m	19.30m	16.10m	18m	7.30m	18m
Andriake E	24m	19.50m	14.50m	18m	6.50m	18m
Kydna		19.50m	14.50m	18m	6m	18m
Arneai C		19.80m	13.30m	19m	5.50m	19m
Kuzey Nekropolis Basilicas	21.50m	19m	12.50m	17.50m	5m	17.50m
Demre Ala Kilise	24m	20m	14.50m	18m	7m	18.80m
Anamur Holy Apostles Church	24.50m	21m	16.70m	19.50m	6.30m	19m
Knidos C	26.90m	23m	15m	21.50	7m	21m
Knidos E	27.50m	23m	17.70m	20m	7m	19.50m
Arnea B		23m	14m	21.70m	7m	21.70m
Topkapı Sarayı Basilica	28m	23m	20m	28m	9m	21m
Andriake D	27m	24m	17m	22m	8.50m	22m
Andriake C	29m	24m	16m	22m	7m	22m
Alacami in Kadirli	29m	24m	14.50m	23m	9m	23m
Andriake A	31m	25m	17m	23m	8m	23m
Andriake B		25m	19m	23m	8m	
Amorium Aşağı Şehir Church	32m	26m	22m	24m	10m	24m

Constantinople Studios Monastery Church	34m	27.50	25.90m	25.50m	12m	25.50m
Sardis EA	36m	29m	21m	29m	9m	29m
Assos Gymnasium	35m	30m	22m	29m	11m	29m
Constantinople Theotokos Chalkoprateia Church	40m	31m	31m	29m	21m	29m
Korykos	38m	33m	20m	32m	9m	32m
Xanthos Doğu	44m	40m	28m	36m	13m	
Ayatekla (Meryemlik)	66m	56m	33m	55m	15m	55m
Note: Apse is not included in the measurements.						

Table 2: Three-Aisle Basilicas Cilicia Region

	Total Length Including Narthex (TLN)	Total Length Excluding Narthex (TEN)	Total Width (TW)	Middle Aisle Length (MAL)	Middle Aisle Width (MAW)	North Aisle Length (NAL)	North Aisle Width (NAW)
Tapureli C	20m	13.50m	12.20m	9.70m	4m	8m	2m
Yanıkhan Kuzey	18.80m	14.90m	13.60m	13.70m	6m	13.70m	2.9m
Tapureli A	18.50m	14m	13m	13.50m			
Korasion Mezarlık	21m	14m	13.90m	12.50m	5.50m	12.50m	2.5m
Anamur Nekropolis	18m	15.50m	13m	19.60m	5.80m	14.10m	2.5m

Korykos Kuzey	20m	15.60m	11.70m	15.10m	5.10m	12.20m	2.2
Batı Sandal		16m	10.90m	10.90m	5.10m	10.90m	3m
Hasanaliler Early Period Church	21.30m	17.50m	15.50m	16.20m	6m	14.10m	2.3
Cambazlı Great Church	22.60m	18.50m	14m	18m	6m	15m	3m
Çatiören Early Period Church	23m	19.30m	16.10m	18m	7.30m	18m	3.3
Anamur Holy Apostles Church	24.50m	21m	16.70m	19.50m	6.30m	19m	3.9
Alacami in Kadirli	29m	24m	14.50m	23m	9m	23m	3.9
Ayatekla (Meryemlik)	66m	56m	33m	55m	15m	55m	7m

Table 3: Three-Aisle Basilicas Lycia Region

	Total Length Including Narthex (TLN)	Total Length Excluding Narthex (TEN)	Total Width (TW)	Middle Aisle Length (MAL)	Middle Aisle Width (MAW)	North Aisle Length (NAL)	Northern Aisle Width (NAW)
Kök Burunu	20.40m	14.20m	11.50m	13m	5m	13m	2m
Demre Güceymen		15.50m	11m	14m	4m	14m	2.50m
Andriake E	24m	19.50m	14.50m	18m	6.50m	18m	3m
Kydna		19.50m	14.50m	18m	6m	18m	2.80m
Arneai C		19.80m	13.30m	19m	5.50m	19m	2.70m

Demre Ala Church	24m	20m	14.50m	18m	7m	18.80m	3m
Arneai B		23m	14m	21.70m	7m	21.70m	2.50m
Andriake D	27m	24m	17m	22m	8.50m	22m	3m
Andriake C	29m	24m	16m	22m	7m	22m	3m
Andriake A	31m	25m	17m	23m	8m	23m	3m
Andriake B		25m	19m	23m	8m		4m
Xanthos East	44m	40m	28m	36m	13m		5m

Table 4: Three-Aisle Basilicas Caria Region

	Total Length Including Narthex (TLN)	Total Length Excluding Narthex (TEN)	Total Width (TW)	Middle Aisle Length (MAL)	Middle Aisle Width (MAW)	North Aisle Length (NAL)
Kuşunlu Monastrey	18m	14m	12.80m	13m	4m	13m
Milet H. Mikhael Basilica	21.70m	18m	12.30m	17m	6m	17m
Knidos C	26.90m	23m	15m	21.50	7m	21m
Knidos E	27.50m	23m	17.70m	20m	7m	19.50m

Table 5: Three-Aisle Basilicas Constantinople Region

	Total Length	Total Length Excluding Narthex	Total Width (TW)	Middle Aisle Length (MAL)	Middle Aisle Width (MAW)	North Aisle Length
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	Including Narthex (TLN)	(TEN)				(NAL)
Beyazıt A Basilica	22m	17m	20.90m	20.20	8m	15m
Topkapı Sarayı Basilica	28m	23m	20m	28m	9m	21m
Constantinople Studios Monastery Church	34m	27.50	25.90m	25.50m	12m	25.50m
Constantinople Theotokos Chalkoprateia Church	40m	31m	31m	29m	21m	29m

Table 6: Apses

Outside	Internal	Fronts
Andriake A	Arnea C	Kurşunlu Manastırı
Andriake B	Batı Sandal	Kydna
Andriake C	Cambazlı Great Church	Demre Ala Church
Andriake D	Alacami in Kadirli	Constantinople Studios Monastery Church
Andriake E	Kök Burunu	Constantinople Theotokos Chalkoprateia Church
Demre Güceymen Tepesi	Yanıkhan Kuzey	
Arnea B	Çatiören Early Period Basilica	
Psidian Melli	Hasanaliler Early Period Basilica	
Anamur Holy Apostles Church	Anamur Nekropolis Church	
Kuzey Nekropolis Kilisesi	Korasion Mezarlık Church	

Korykos	Tapureli A	
Knidos E	Tapureli C	
Knidos C	Korykos Kuzey Church	
Sura Valey	Ayatekla (Meryemlik)	
Uşak Selçikler	Milet H. Mikhael Church	
Assos Gymnasium		
Sardis EA		
Xanthos Doğu		
Kurşunlu Monastery		

Tablo 7: Apses Distribution According to Regions

Cilicia Region Externally Apsed Buildings	Lycia Region Buildings with External Apses	Caria Region Buildings with External Apses
Korykos	Andriake A	Knidos C
Anamur Holy Apostles Church	Andriake B	Knidos E
	Andriake C	Kurşunlu Monastery
	Andriake D	
	Andriake E	
	Arnea B	
	Xanthos Doğu	

Cilicia Region Internally Apsed Buildings	Lycian Region Internally Apsed Buildings	Caria Region Internally Apsed Buildings
Batı Sandal Erken Dönem Kilisesi	Kök Burunu	Milet H. Mikhael Church
Tapureli A	Arneai C	
Tapureli C		
Korasion Mezarlık		
Yanıkhan Kuzey		
Anamur Nekropolis Church		
Korykos Kuzey Church		
Hasanaliler Early Period Church		
Cambazlı Büyük Church		
Çatıören Early Period Church		
Alacami in Kadirli		
Ayatekla (Meryemlik)		

Table 8: $\sqrt{2}$ Proportional Distribution

Comply $\sqrt{2}$ ratio	Comply not $\sqrt{2}$ ratio
Korasion Mezarlık	Tapureli A
Batı Sandal	Korykos Kuzey Church
Yanıkhan Kuzey Church	Cambazlı Büyük Church
Anamur Nekropolis Church	Alacami in Kadirli

Tapureli C	Arneai C
Hasanaliler Early Period Church	Demre Ala Church
Çatiören Early Period Church	Kök Burunu
Anamur Holy Apostles Church	Milet H. Mikhael Basilica
Ayatekla (Meryemlik)	Sardis EA
Xanthos Doğu	Sura Valey
Kydna	Kuzey Nekropolis Church
Demre Güceymen Tepesi	
Arneai B	
Andriake A	
Andriake B	
Andriake C	
Andriake D	
Andriake E	
Kurşunlu Monastery	
Knidos C	
Knidos E	
Beyazıt A Basilica	
Topkapı Sarayı Basilica	
Constantinople Studios Monastery Church	

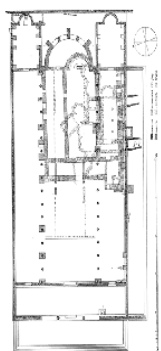
Constantinople Theotokos Chalkoprateia Church	
Amorium Aşağı Şehir Church	
Korykos	
Assos Gymnasium	
Corner-Room comply to $\sqrt{2}$ Ratio	
Tapureli A	
Kadirli'deki Alacami	
Yanıkhan Kuzey Church	

Table 9: $\sqrt{2}$ Proportional Distribution According to Regions

Comply $\sqrt{2}$ ratio Cilicia Region	Comply $\sqrt{2}$ ratio Lycia Region	Comply $\sqrt{2}$ ratio Caria Region
Korasion Mezarlık	Xanthos Doğu	Kuşunlu Monastery
Batı Sandal	Kydna	Knidos C
Tapureli C	Demre Güceymen Tepesi	Knidos E
Yanıkhan Kuzey Church	Arneai B	
Anamur Nekropolis Church	Andriake A	
Hasanaliler Early Period Church	Andriake B	
Anamur Holy Apostles Church	Andriake C	
Ayatekla (Meryemlik)	Andriake D	

Korykos		
Comply not $\sqrt{2}$ ratio Cilicia Region	Comply not $\sqrt{2}$ ratio Lycia Region	Comply not $\sqrt{2}$ ratio Caria Region
Tapureli A	Arneai C	Milet H. Mikhael Basilica
Korykos Kuzey Church	Demre Ala Church	
Cambazlı Büyük Church	Kök Burunu	
Alacami in Kadirli		
Note: Korasion Mezarlık Church is the only structure that fits $\sqrt{2}$ with its additional structure.		

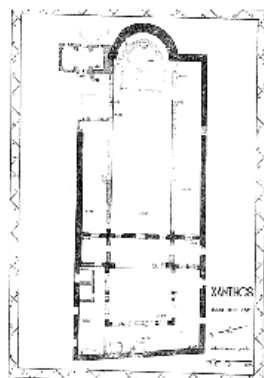
Plans



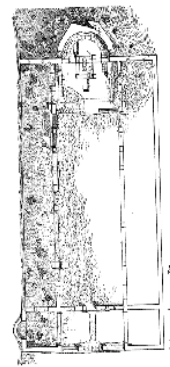
Ayatekla (Meryemlik)
(Herzfeld, F. Guyer S. 1930: 9).



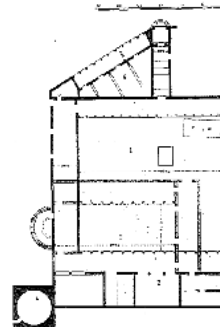
Sardis Kilise EA
(McClanan, A. 2015: 174)



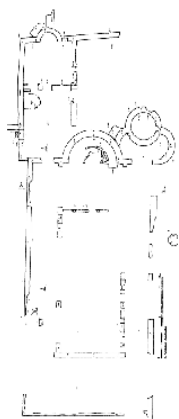
Xanthos Doğu Basilica
(Metzger, H. 1977: 67)



Korykos
(Herzfeld, F. Guyer S. 1930: 94)



Assos G
(Serdaroğlu, Ü.)



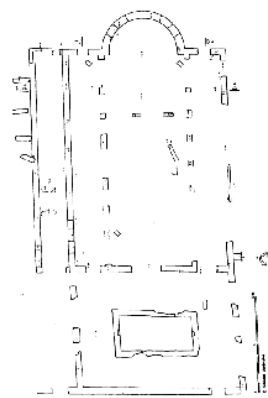
Andriake A
(Tekinalp, V. M. 2000: levha. 19)



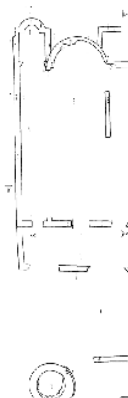
Andriake B
(Tekinalp, V. M. 2000: levha. 28)



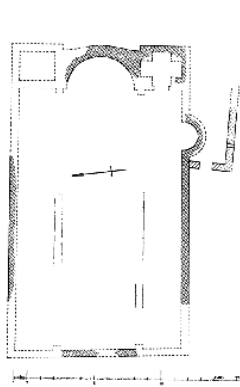
Andriake C
(Tekinalp, V. M. 2000: levha. 50)



Andriake D
(Tekinalp, V. M. 2000: levha. 56)



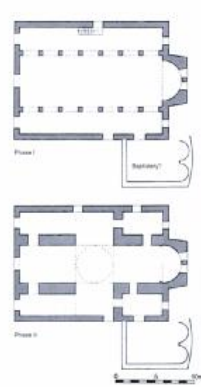
Andriake E
(Tekinalp, V. M. 2000: levha. 57)



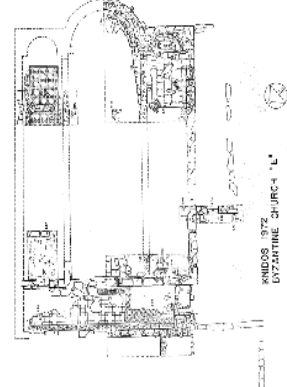
Arneai C (Abb 4)
(Grossmann, P. und S,
Hans-Georg 1981: XCIII)



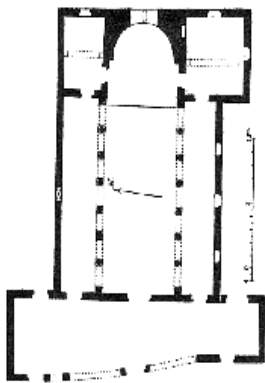
Güceymen Tepesi (Abb. 3)
(Grossmann, P. und
Severin 1981: XCIII)



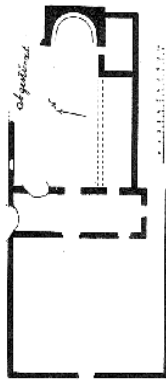
Kydna
(plan Adam, J. P. 1977),
(Ousterhout, R. 2016: 107)



Knidos E
(plan David Peck)
(Love, I. C. 1974: 105) (Figure



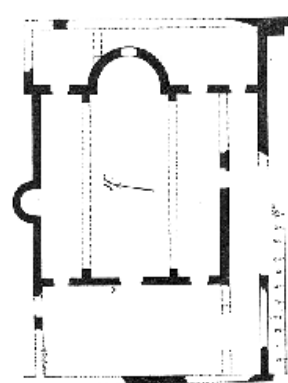
Cambazlı Büyük Church
(Keil, J. und Wilhelm, A. 1931: 37)



Tapureli A (Erdemli-Mersin)
(Keil, J. und Wilhelm, A. 1931: 95)



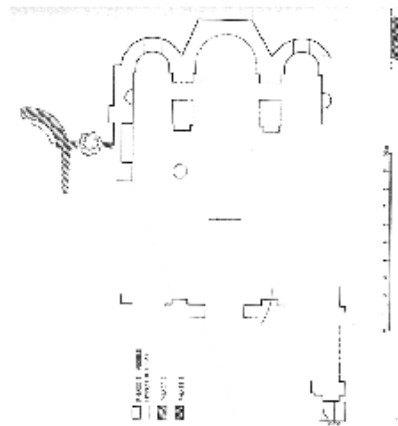
Tapureli C (Erdemli-Mersin)
(Keil, J. und Wilhelm, A. 1931: 96)



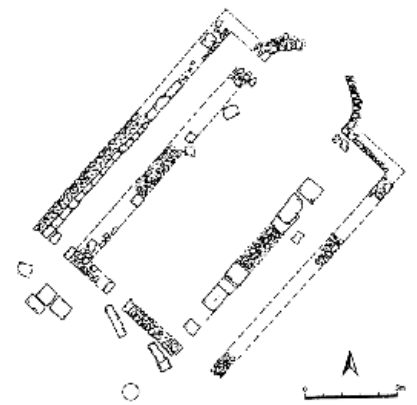
Korasion Mezarlık Church
(Keil, J. und Wilhelm 1931)



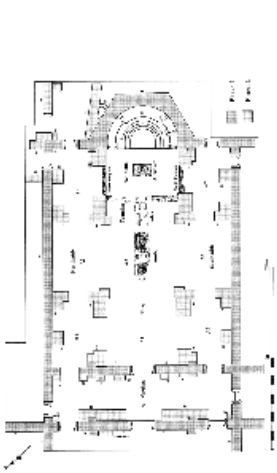
Milet H. Mikhael Basilica
(Wiener, W. M. 1982: Abb. 4)
149)



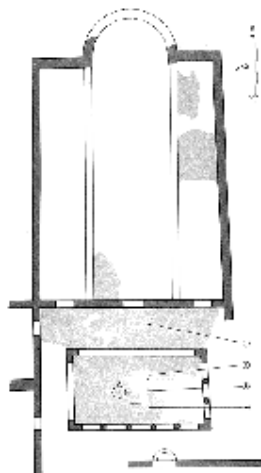
Kurşunlu Monastery
(Mango-Sevcenko 1973) (Ruggieri, V. 1995: 98)



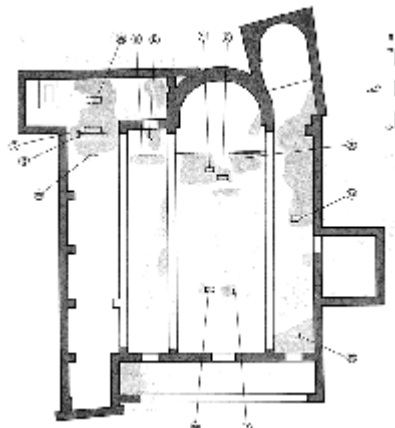
Pisidian-Melli Early Period Agora Basilica
(Vandeput, L. and Köse, V. 2002: 148)



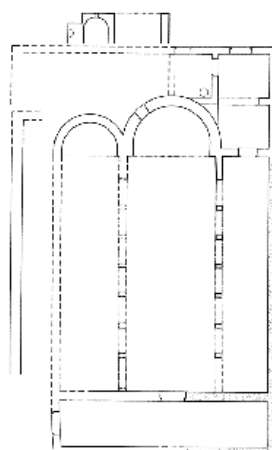
Amorium Aşağı Şehir Church
(Ivision, E. A. 2003: 127)
F.1986: 77)



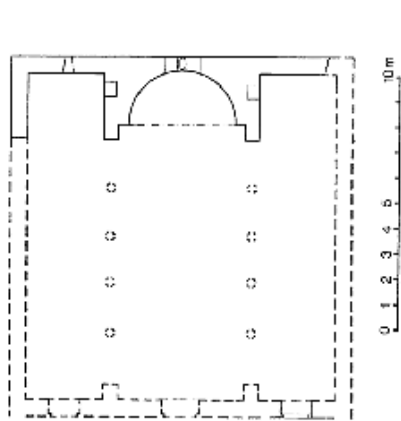
Anamur Holy Aposles Church
(Russell, J. 1987: Figure 9)



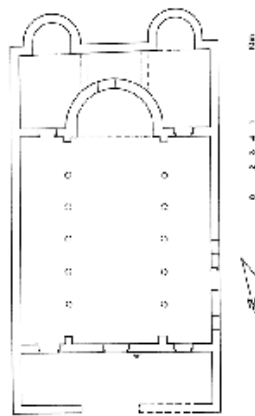
Anamur Nekropolis Church
(Russell, James 1987: Figure 14)



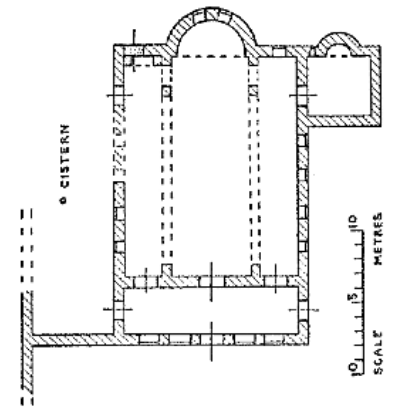
Hasanaliler Early Period Church
(Hellenkemper, H. und Hild, F.1986: 77)



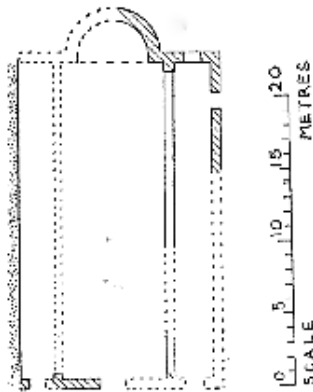
Batsandal Early Period Church
(Hellenkemper, H. und Hild, F.1986: 79) (Figure 12)



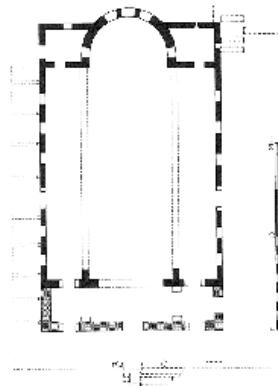
Yanikhan Kuzey Church
(Hellenkemper, H. und Hild, F.1986: 84) (Figure 14)



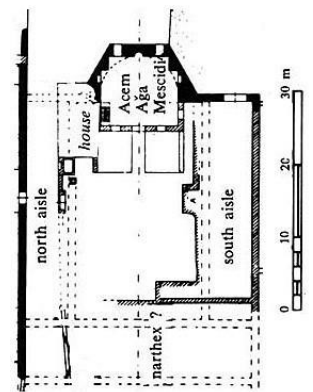
Sura Valley
(plan: Rott) (Harrison, R. M. 1963: 14)



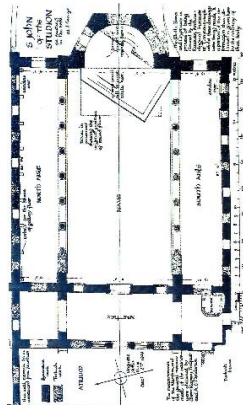
Arneai B
(plan: Rott, XLVb)
(Harrison, R. M. 1963:141)



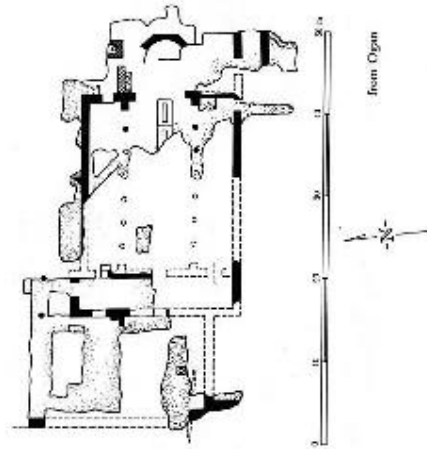
Alacami in Kadirli
(plan Michael and Gough, Mary)
(Bayliss, Richard 1997: 62)



Constantinople Theotokos Chalkoprateia Church
(Kleiss, W. 1965: 129-167).

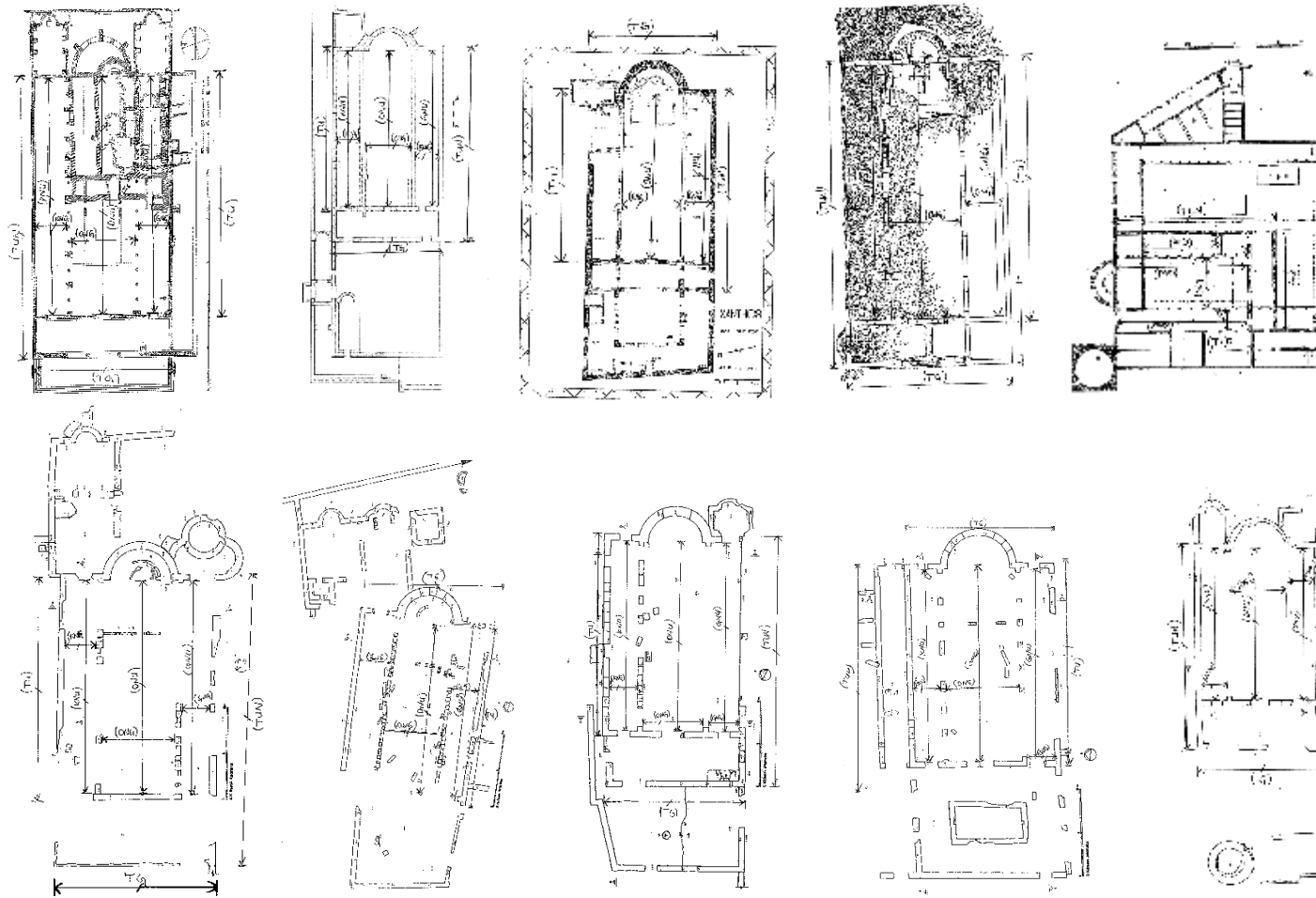


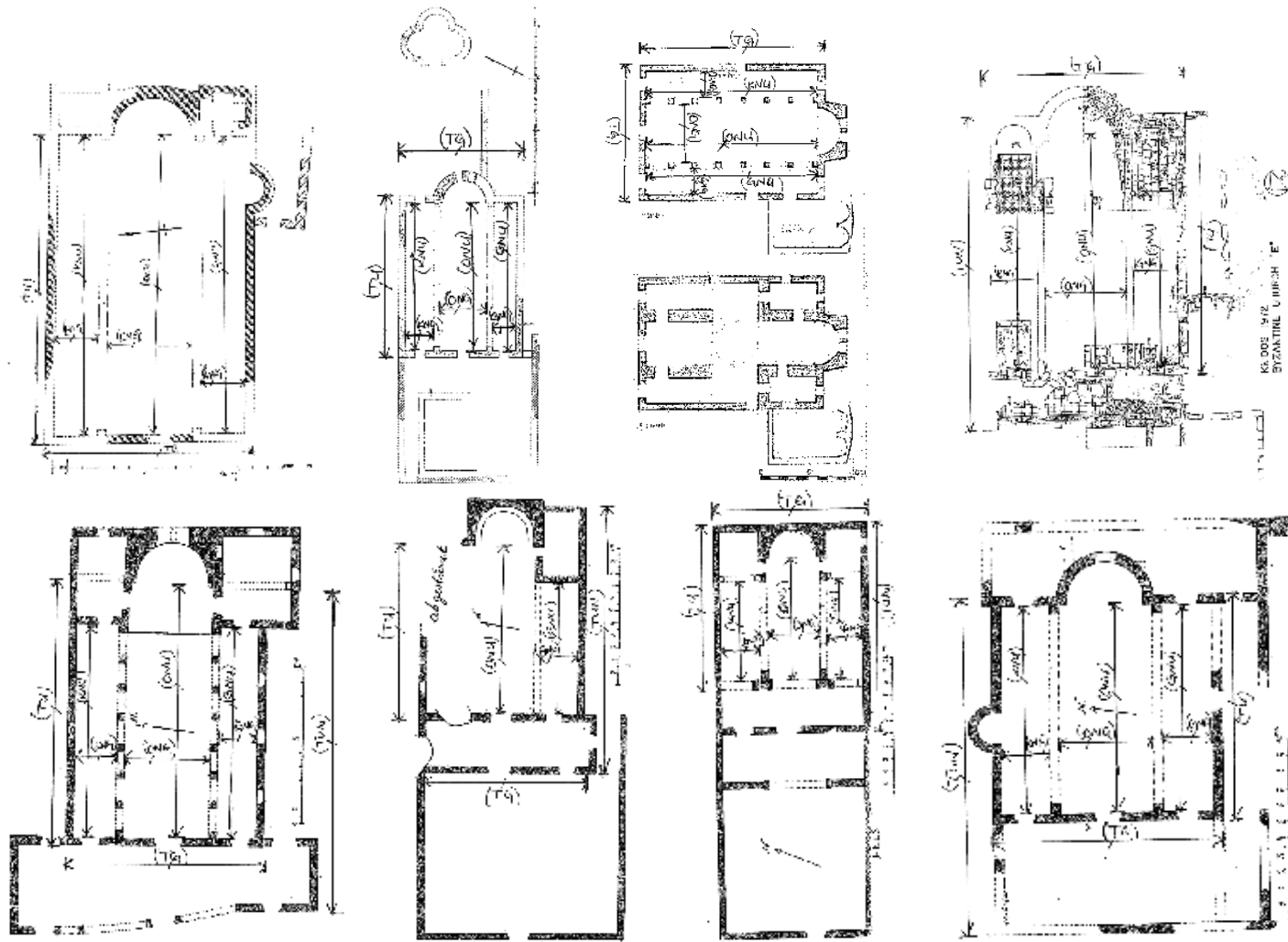
Constantinople Studios Monastery Church
(A. van Millingen, 1912).

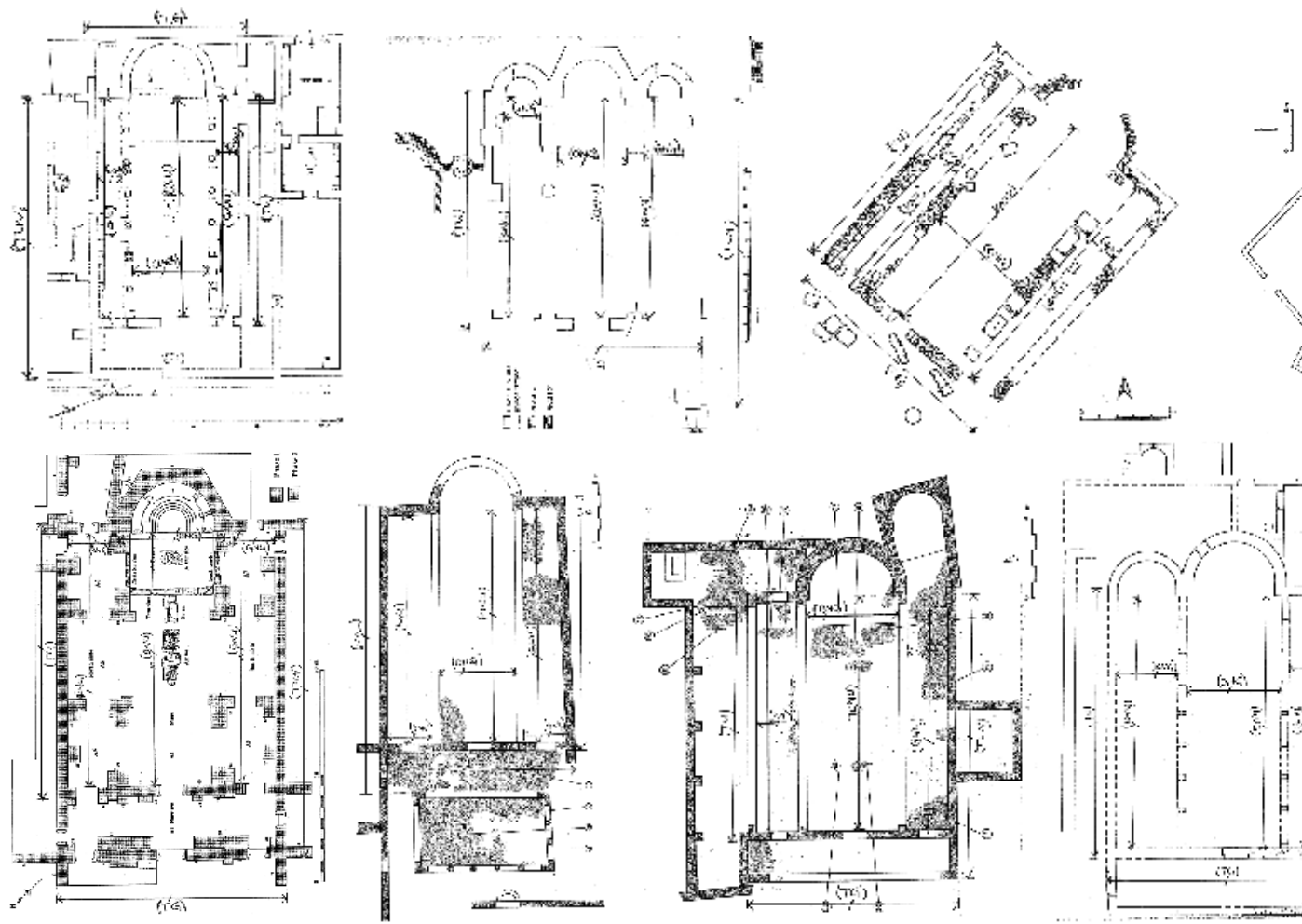


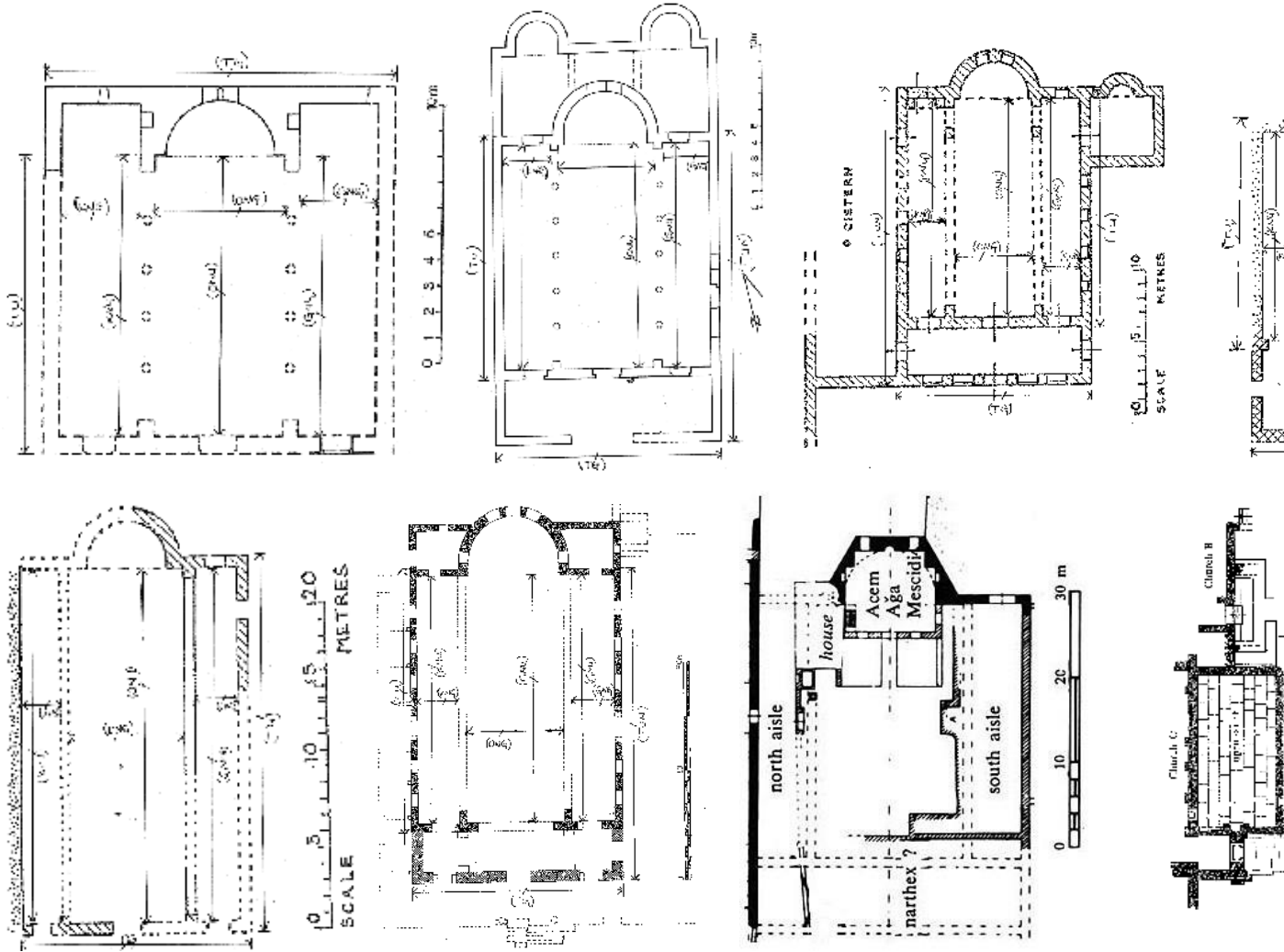
Topkapı Sarayı Basilica
(Thomas F. Mathews, 1971) (plan Ogan)

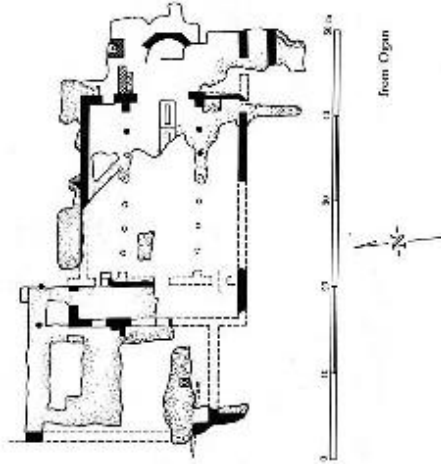
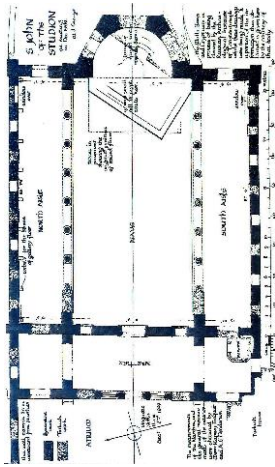
Drawings: Drawings indicating the length and width of the plans (the churches we discussed above are given in the sa



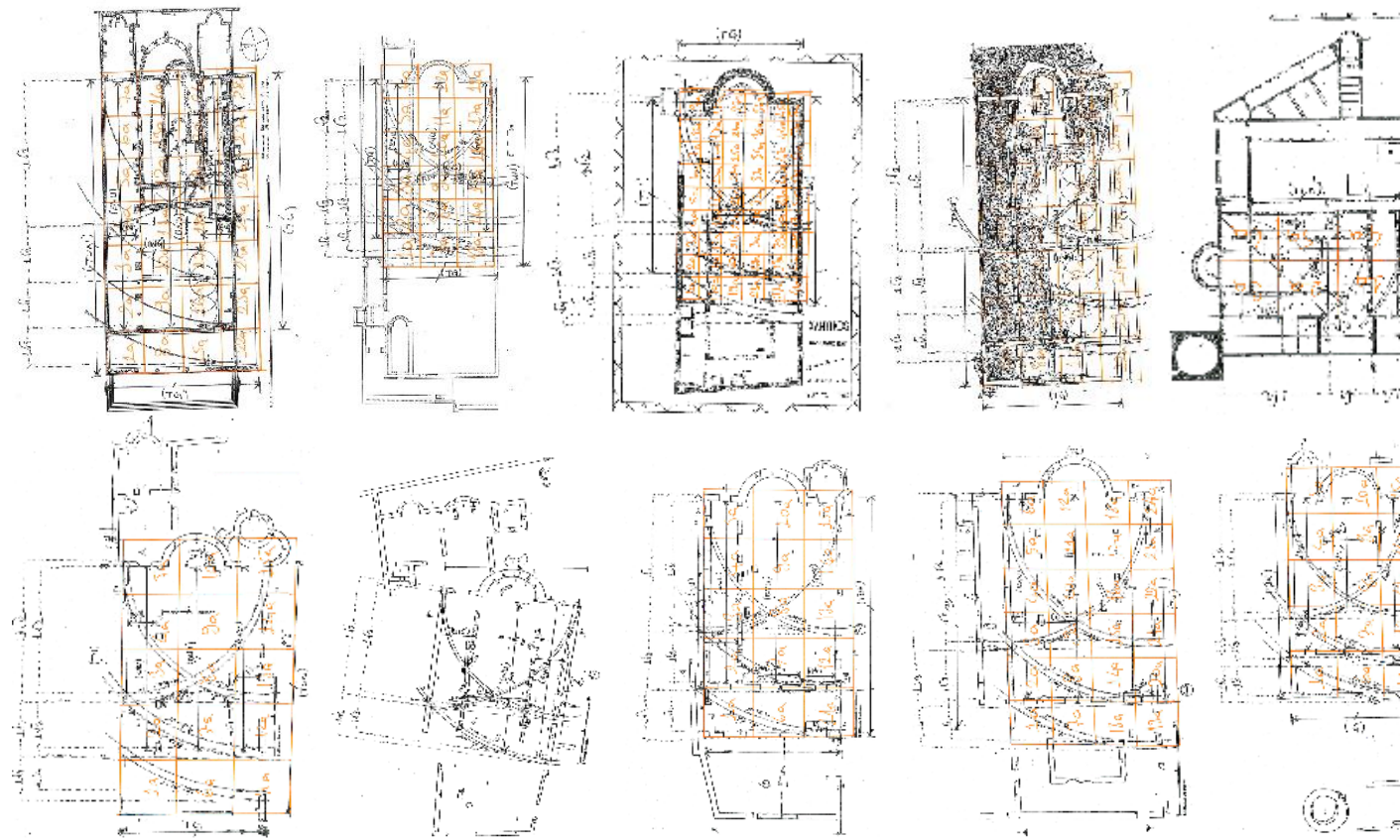


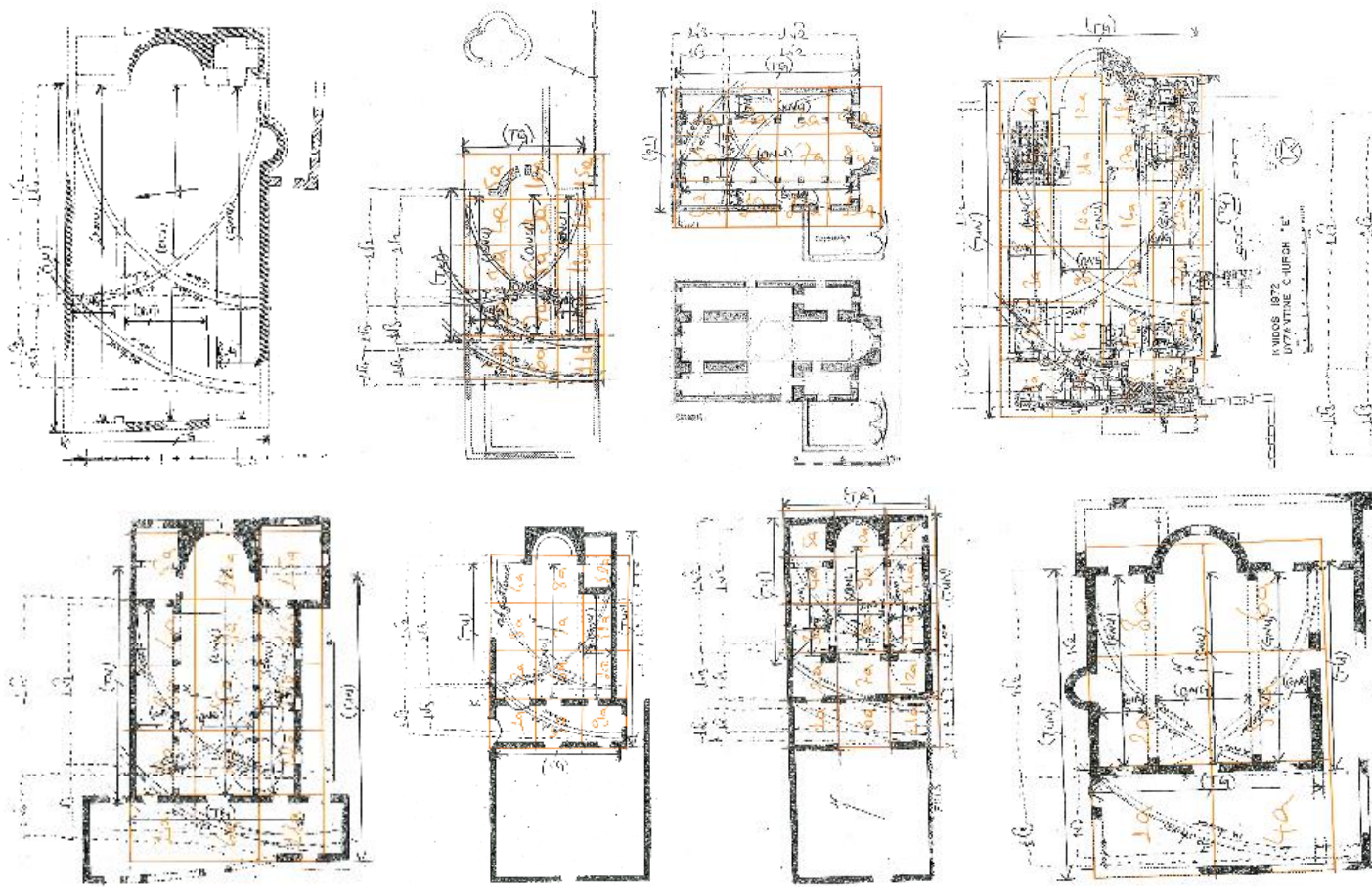


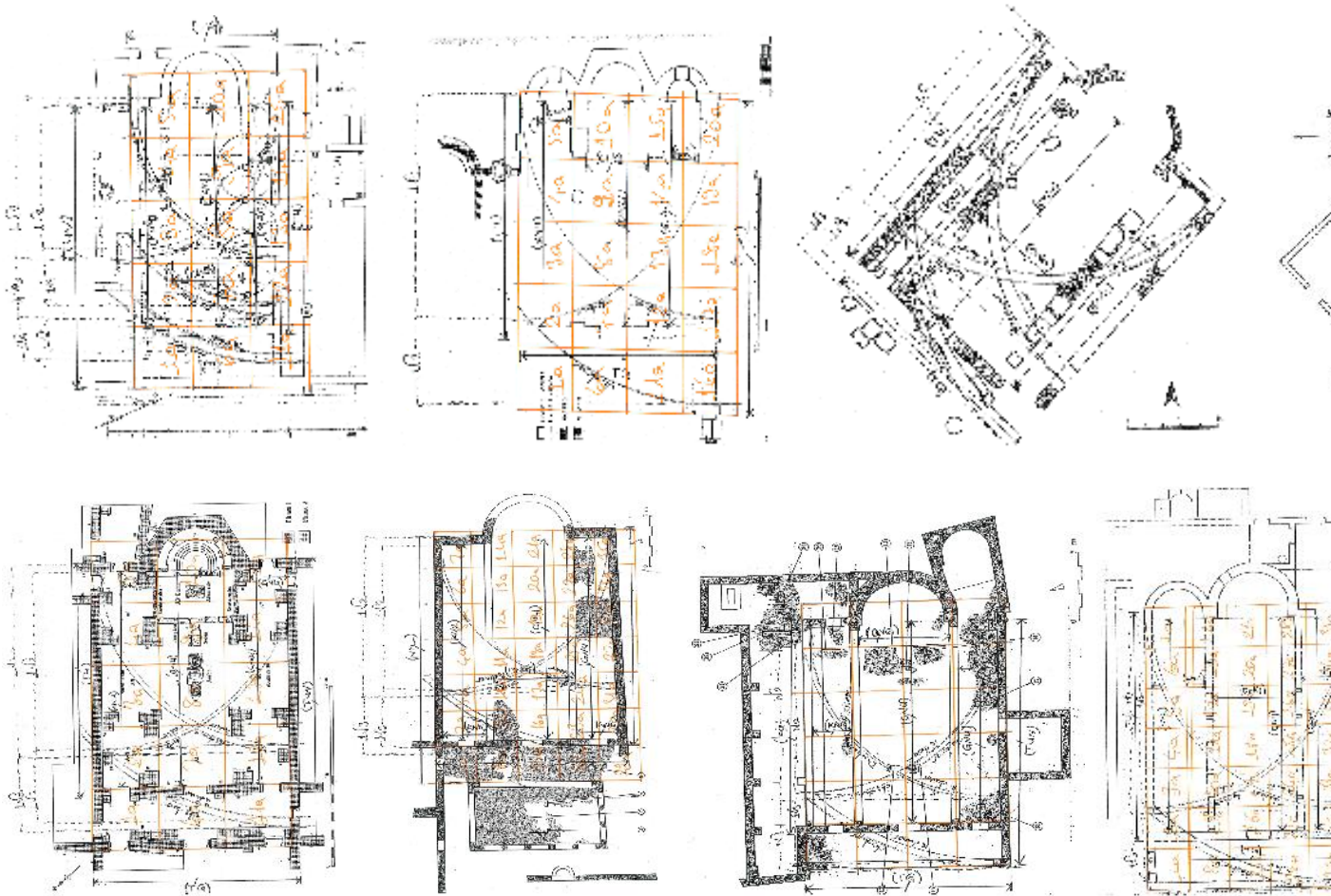


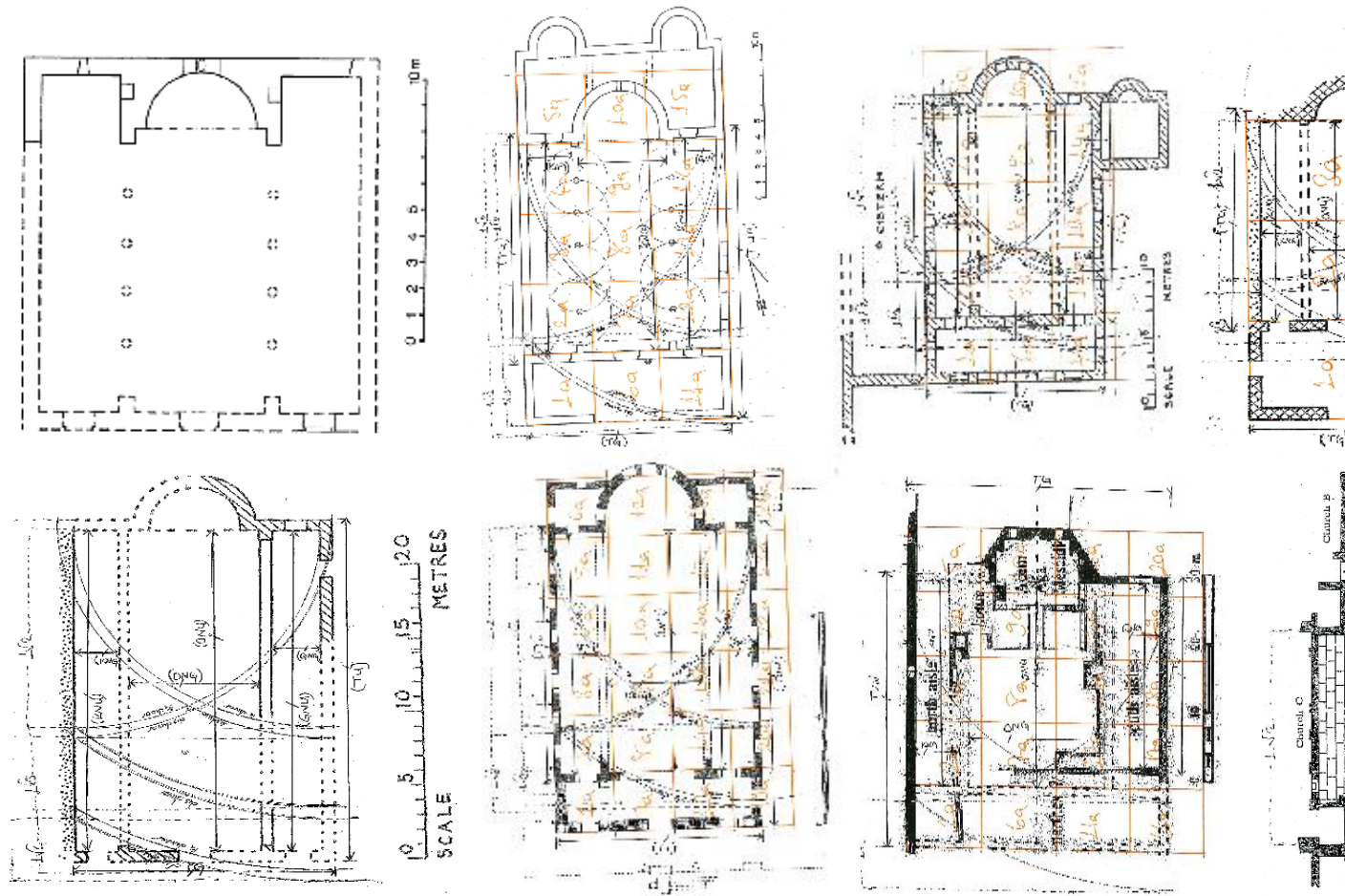


Drawings: Evaluation of plans in the modular grid system and at the rate of $\sqrt{2}$ (the churches we discussed above are given here)









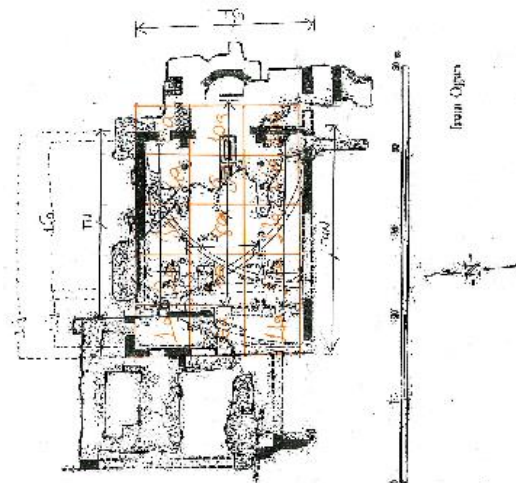
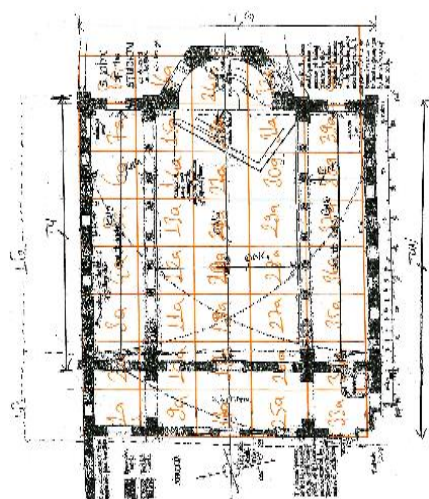


Table 10: Byzantine Foot

	Byzantine Foot
Tapureli C	43 foot
Kök Burunu	45 foot
Korasion Mezarlık Church	45 foot
Kurşunlu Monastery	45 foot
Tapureli A	45 foot
Yanıkhan Kuzey Church	48 foot
Anamur Nekropolis Church	50 foot
Demre Güceymen Tepesi	50 foot
Korykos Kuzey Church	50 foot
Batı Sandal	51 foot
Pisidian Melli	51 foot
Uşak Selçukler	53 foot
Sura Valey	53 foot
Beyazıt A Basilica	54 foot
Hasanaliler Early Period Church	56 foot
Milet H. Mikhael Basilica	57 foot
Cambazlı Büyük Church	59 foot
Kuzey Nekropolis Basilica	61 foot
Çatıören Early Period Church	62 foot
Andriake E	62 foot
Kydna	62 foot
Arneai C	63 foot
Demre Ala Church	64 foot
Anamur Holy Aposles Church	67 foot
Knidos C	74 foot
Knidos E	74 foot
Arnea B	74 foot
Topkapı Sarayı Basilica	74 foot
Andriake D	77 foot
Andriake C	77 foot
Alacami in Kadirli	77 foot
Andriake A	80 foot
Andriake B	80 foot
Amorium Aşağı Şehir Church	83 foot
Constantinople Studios Monastery Church	88 foot
Sardis EA	92 foot
Assos Gymnasium	96 foot
Konstantinopolis Theotokos Chalkoprateia Church	99 foot
Korykos	106 foot
Xanthos Doğu	128 foot
Ayatekla (Meryemlik)	179 foot