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## Sectional Analysis of Pendentive Dome Mosques During Ottoman Era

### ANALYSE SECTIONNELLE DES MOSQUÉES À DÔME PENDENTIF PENDANT L'ÉPOQUE OTTOMANE

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**Abstract:** This study analyses types of pendentive dome mosques based on their variations from sectional view of documented drawings. The scope of this study is limited to the mosques constructed in Ottoman period which refers to the pendentive dome mosque architecture. The methodology applies descriptive analysis to classify its variation. This analysis takes into account that the main dome plays important role in classifying the variation. There are 51 mosques selected for the case studies. The study found that five types of the pendentive dome mosques can be identified accordingly. The number, position and organization of the dome design become the determining factors that influence the categories. The analysis also finds that all main domes share similar position located at the center of the prayer hall. The number of main domes comprises two and three units in the third category and it has more than three units in fourth category whereas the number of main dome is not more than one unit in other categories. The dome with higher rank of category show higher quality in terms of aesthetical value leading to visual feeling of domination in section view. In overall, the rank of the mosque's category besides corresponds to the level of its dome organization. The mosques in the higher ranked categories have more elaborated dome organization. This fits well with the logic of the hierarchy of importance to the corresponding category.

**Keyword:** pendentive dome; section; mosque; Ottoman era; architecture

**Résumé:** Cette étude analyse les types de mosquées à dôme pendentif en fonction de leurs variations à partir d'une vue sectionnelle des dessins documentés. La portée de cette étude est limitée aux mosquées construites dans la période ottomane qui se réfère à l'architecture de la mosquée à dôme pendentif. La méthode utilise l'analyse descriptive de classer sa variation. Cette analyse prend en compte que le dôme principal joue un rôle

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important dans la classification de la variation. Il y a 51 mosquées sélectionnées pour les études de cas. L'étude a révélé que par conséquent, cinq types de mosquées à dôme pendentif pouvaient être identifiés. Le nombre, la position et l'organisation de la conception du dôme deviennent les facteurs déterminants qui influent sur les catégories. L'analyse révèle également que tous les dômes principaux ont une position semblable qui est située au centre de la salle de prière. Dans la troisième catégorie, le dôme principal comporte deux et trois unités et il y a plus de trois unités dans la quatrième catégorie, alors que dans les autres catégories, le nombre de dôme principal ne dépasse pas un. Le dôme avec une catégorie plus élevée montre une meilleure qualité en termes de valeur esthétique, conduisant à une sensation visuelle de domination. Dans l'ensemble, la catégorie de la mosquée correspond au niveau de l'organisation de sa coupole. Les mosquées dans les catégories supérieures ont une organisation de coupole plus élaborée. Cela correspond bien à la logique de la hiérarchie d'importance de la catégorie correspondante.

**Mots-clés:** dôme pendentif; section; mosquée; époque ottoman; architecture

## **1. INTRODUCTION**

### **1.1 Ottomans and the mosque**

Establishment of a territory ruled under the Ottoman Kingdom yields development of the local architecture so called Ottoman architecture named after their empire. Many public buildings and edifices differing in size and form were built due to the needs arising from the growing number of the population who converted to Islam in its empire. Annexation of new territory into the empire had promoted the Ottoman's master builders to integrate their construction techniques with architecture in the new regions in its empire consists of Bosnian, Albanian, Croatian, Arabian and Kurdish territories. According to the Ottomans regulation, a throng of Turks who worked in the administration and military should be accommodated in new occupied regions. This in particular leads to construction of new mosques and administrative buildings. In case with the mosque design, the size and form of the mosques vary depending on the number of the Muslim community who live in the surrounding area. The increase in Muslim population leads to construction of many *Jami* Mosques, known as *Cami* in Turkish language Friday congregational prayers. In addition, the thriving economy of the towns and cities had elevated the importance of mosque construction. Hence thriving economy can be counted as the other determining factor to the size of mosque built in the area (Flon et. al, 1984).

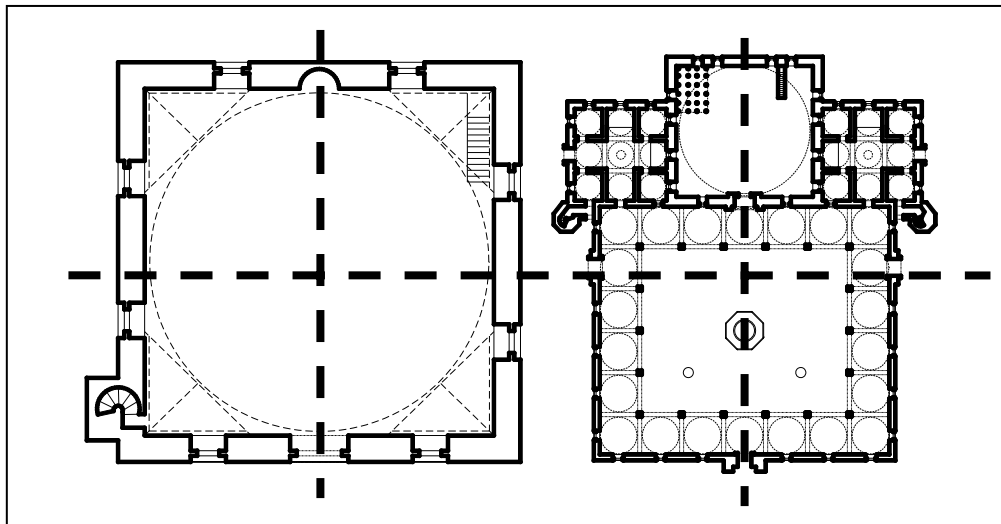
In addition, the Ottomans were aware of ability of architecture to immortalize their glory, wealth and grandeur of their kingdom. They contributed to construction of public buildings in which many of them are built with magnificent architecture in regards to this fact that mosques are among the important buildings in Ottoman architecture. The luster interior of these buildings with round arched façades topped by the pendentive dome reflects the multiple volume space design and grandeur of the building (Crane, 1993 and Saoud, 2004). Its beauty attracts every passerby inspired by their aesthetics. The tenet of this architectural style and construction became popular over the kingdom in parallel with expansion of the empire in Asia Minor and Balkan Region, Europe (Pasic, 2004).

### **1.2 Early Ottoman Mosque: architecture, construction and typology**

#### **1.2.1 Architecture**

The Ottoman mosque plan just like many other styles has a design with two main axes which are perpendicular to each other. The first one is the one horizontally divides the building plan into two parts (Figure 1). In many cases the divided parts are asymmetrical, especially if the mosque has a courtyard area. The second axis perpendicular to the horizontal axis is vertical. It halves the mosque plan into the same parts. In most Ottoman mosques, the vertical axis cuts the plan symmetrically while the horizontal axis has no certain place to cut through as it cuts the plan asymmetrically form of the mosque. The vertical axis links

the main porch to the *mihrab* which identifies the relationship of the spaces from the main entrance to the prayer halls and *mihrab*. Most single plan mosques have the entrance corridor (main porch) known as *riwaqs*. In other words, the vertical axis cuts through the main entrance and *mihrab*. This incorporates a special feature of cutting through the main dome symmetrically which might not be attainable by the horizontal axis. The disadvantage is that the axis poorly sheds light on the earring spaces particularly for the cases with relatively high level of interior enclosure. Thus the vertical axis is suitable for studying the dome(s) of the main hall and all the spaces along it.



**Figure 1: Horizontal and vertical axes of Orhan Gazi (left) and Sultan Bayezid mosque (right)**  
*Source: Drawn by Mohamad Nazri Radzi (assistance researcher), Universiti Sains Malaysia*

### 1.2.2 Construction

The method of construction was a blend of indigenous architecture in the region and the Ottomans cultural heritage including the architecture they brought along from their origin and the Islamic laws known as *shariah* laws. Climatic concerns and the used of building material besides had been being integrated by architecture of the place. This architecture was used as rudiments to the development of Ottoman mosque style. The Ottoman master builders transformed this fostered architecture in accordance to their culture and bylaws, and religious stances. The outcome of the process of adoption and translation symbolizes an architectural generation between 13 and 15 centuries AD. It forms the buildings which are considered and known as early Ottoman architecture today (Crane, 1993).

### 1.2.3 Typology

Typology of the mosque categories has been studied before. A study by Kuran (1968, pp. 24-28) classifies the Ottoman mosques into three major groups namely single unit mosque, eyvan mosque and multi-unit mosque. He generalized the concept of the single unit mosque by having a prayer hall surmounted by a dome, the eyvan mosque by having large interior space divided by compartments with flat roofs whereas having roofs covered by a series of domes in multi-unit mosque. He plausibly vindicated the use of 'unit' instead of 'dome' by justifying the fact that the 'dome' hardly refers to the upper structure while the 'unit' might be prevailed since it denotes the basic structural and spatial system of architecture. This demonstrates that he was aware of terminology of 'single dome' and 'multi dome' terms for the groups he named single unit and multi-unit mosques. The latter fashion of classification is amore accepted method in Turkish architecture.

Another study is by Yektin (1959) who stated the origin of Ottoman architecture can be divided into two groups. The first one begins from 1300 and lasts almost two centuries. The second one covers the rest until 1700 A.D. The first period is chronologically important while the second one is the time that the Ottoman architecture had reached its maturity. Despite the fact that he mainly dealt with the second period, he

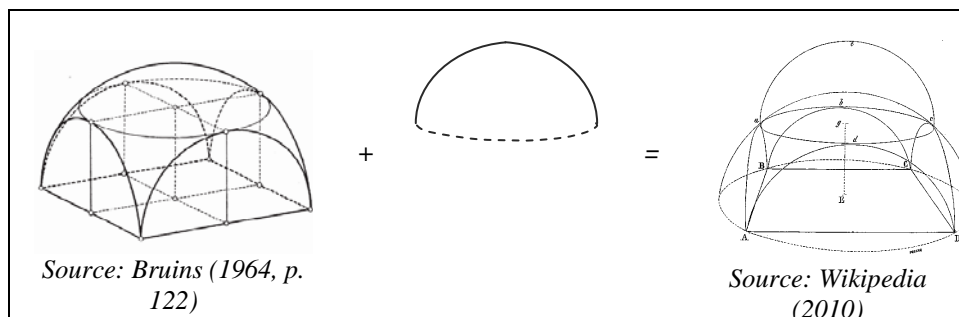
accentuated that the first group must be given priority since it is the time that the Ottoman Kingdom were gaining power in Asia Minor coinciding with the decline of Seljuks Kingdom and Eastern Roman Empire. Another fold of importance of the 13<sup>th</sup> century is the knowledge development of science and mathematics, which was applied in architectural design and construction. At this time the building design conceptually had made a breakthrough with application of mathematics (Wilford, 2007). Therefore it is the reason that the period between 13<sup>th</sup> and 15<sup>th</sup> century is selected for this study.

With an advance of science and mathematics, the typology of the Ottoman mosque is translated differently in three dimensional construction rather than plan view in two dimensional construction. A study conducted by Erzen (2004) indicated the mosque's main feature which has a design with the 'dome's roof cover' system and she noted that its attribute of 'centrality' deserves to be given a special attention. In a review of Erzen's book, Margolis (2004) agreed that this roof cover denotes the dome and the roofing system of the mosque. He argued that according to this book, the dome and all the roofing system can be figured as a 'distinctly' separate part of the Ottoman mosque before 1540 AD, which evolves later when Ottoman architecture reached its maturity era.

### 1.3 Pendentive Dome in Ottoman mosque

The meaning of pendentive dome is a dome surmounted on another dome. Its design origin can be traced backs to building construction in Persia (Creswell, 1914). Tracing the origin of Ottoman architecture requires studying the origin of Ottomans' ancestors. Seljuks as the intermediate ancestors of Ottomans who had ruled Persia before the presence of the Ottomans and Ottomans were in contact with Iran since the first time this tribe left Mongolia from Genghis Khan's threat seeking refuge to the Asia Minor known as Turkey today (Shaw, 1997, pp. 1-8). This connotes that the pendentive dome's construction has an influence from architecture Persia and Asia Minor, and popularly developed it throughout the whole empire as a symbol of Ottoman architecture when the Ottomans ruled Asia Minor and Balkan Region. The idea that pendentive dome's construction is originated from Hagia Sophia cannot be true as the Constantinople defied the expansion of Ottoman Empire until 1453 when Sultan Mehmed lastly conquered the city. Hence the Hagia Sophia was not available to the master builders of the Ottomans. Even if the credit was given to Hagia Sophia's influence in many textbooks' history, it must be acknowledged that the methods were also used by master builders in Persia and Armenia (Hammond, 2005).

The main attribute of pendentive dome's construction is that it does not require column and beam construction. The upper dome is supported in either ways, by round arches or a dome-base structure. The upper dome can be constructed on the arches instead of being directly constructed on the ground (Pasic & Siravo, 2004 and Unsal, 1973). The pendentive dome has sphere form with the space beneath it a square, circular or octagon plan shape. If the space is asymmetry along one of the X-X or Y-Y axis in a cartesian coordinate system, then the dome has an elliptical form. Corbelling, squinches and slab of triangles are conventional methods to fill the space between the upper dome and the supporting arches. The other method of constructing pendentive dome is using dome-base structure. This means that the upper dome locates on top of the base dome. The head of the base dome is cut and the upper dome is replaced as the lid (Figure 2).



**Figure 2: The pendentive dome and its basic formula of construction**

Svenshon (2009) found that mathematical models had been extensively employed and there are meaningful relationships between each square and circular component of such constructions. Each part is proportionate to the other part. The height of the dome and supporting vaults in addition to the radius of dome and the square space beneath it can be revealed and expressed by numbers and their relation can be explained through formulas. Moreover, the domes are also studied in terms of their structural features (El-Sheikh, 2000). This includes the material and the cost of construction. This study assumes that the mosques in early Ottoman period can be classified into categories in which certain characteristics are in common. Therefore, this study aims to offers a novel typology of classification of Ottoman mosques in reference to the dome from sectional analysis. It gives credits to the dome design as the main criterion of classification and seeks the influence of the dome on the whole design from the section view.

## **2. MATERIAL AND METHODS**

### **2.1 Approach**

This study uses qualitative research. It uses documentaries for classification of the mosques. This method is usually regarded as the method of analysis of documents and materials (Marshall & Rossman, 1998). This study investigates evolution of Ottoman mosque in reference to pendentive dome from sectional analysis. It narrows down its scope to solely mosques which were constructed. Hence, those of which has been altered to a mosque from a church or temple origin are excluded. This study undertakes conformability test as all descriptive analysis requires validity test and conformability is among the tests to validate any analysis (Guba & Lincoln, 2005). To describe a group norm, it investigates and exemplifies more than 51 mosques aged for more than 250 years between 13<sup>th</sup> and 15<sup>th</sup> centuries as the testimonial to support the concept of classification for each category. All of the selected mosques are from the same region known as modern Turkey today. The dates refer back to the establishment of Ottoman Empire in early thirteenth century until the late of second half of fifteenth century. Then Ottomans started a new era called golden ages when construction of buildings was more luxurious and grandeur. Although this era has good example and more well-known buildings, but the early period must be acknowledged for studies dealing with the origins of Ottoman architecture. Thus, the proper period for this study which concerns the roots and forming ideas of what called Ottoman architecture is the first period.

### **2.2 Data collection**

The data is gathered from the available documentaries of mosques including plans, sections, photos and published manuscripts. The other method for ensuring all important and key buildings given attention is using some scholarly works about mosques in the same period e.g. Kuran's book (1968) titled 'The Mosque in Early Ottoman Architecture'. The classification of mosques is elicited based on the main dome of mosques in section view. The collected data could be classified in five categories in line with the classification from the plan analysis. The section analysis refers to the section made by the vertical axis of the mosque. If the section view is the mere source of classification, it could cause incorrect understanding of the whole classification system. This is because a nuclear mosque and an earring mosque have almost same characteristics in the section by the vertical axis while they are different in plan and 3 dimension construction. This prompts bearing in mind that the classification from the sectional analysis should follow the classification from the plan view. Nonetheless, if though the classification does not follow the plan view the actual result will not be changed. The only change is the integration of the some categories yielding three categories e.g. the first two categories will be combined into one. This occurs for the consecutive categories, the third and fourth categories will be combined into a new one so does the fifth category. To prevent further confusion, we here follow the method already used by in plan view in the earlier analysis in this study.

### **2.3 Methodology**

Each category has independent characteristics that form the category. The variations are possible by adding or removing parts that do not affect the main concept which is originally constructed on. The important factors in classification of the categories are the number, their location and the aesthetical impression of the

dome. Riwaqs, semi-domes, other methods of roofing system on the surrounding spaces of the main dome are considered the factors that make variations within these categories. The date of construction is intentionally not taken into account since construction of a mosque and its architecture accordingly is a result of many factors such as budget, number of prayers, importance of the mosque, the taste of founder and sponsor, the emergency of construction and many others.

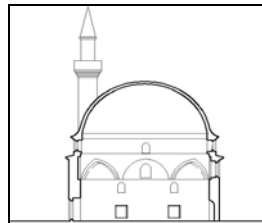
For instance, a nuclear dome mosque is a timeless and placeless concept and has been constructed in Asia Minor and Balkan Region during the Ottoman era and does not belong to certain period. Therefore, the concept of mosque is the one given the credit for study rather than the chronology of construction. The name for each category inherits the character of the pedentive dome mosques' design which indicates the main idea supporting the category that precedes the development. The other point worth to mention is that simple and small mosques have higher number of frequency in construction than those with large area and full of ornaments. This is simply due to the attribute of being less costly.

### 3. ANALYSIS

With reference to a study of the dome plan and form of mosque design in early Ottomans from plan view, the sectional analysis classifies the pedentive dome mosques into five categories as follows:

#### 3.1 Single dome design

In this category, this single dome (Figure 3) becomes a dominant element when viewed in section. The dome is surmounted above the prayer hall. Expression of pedentive dome's domination in the mosque design would be stronger for the mosques without porches (*riwaqs*) since it affects the symmetrical form of the section. No matter the dome covers the whole area or only some parts of the prayer hall, the dome is positioned at the center above the payer hall. The dome rests on four arches covered as part of the building walls. Hence the thickness of the supporting arches beneath the dome is considerably grand in size. The wall corners are extensively covered with masonry built to hide the joint between its wall (cubical geometry) and dome corners (spherical geometry) which envelope the prayer hall. The dome corners functioned as a joint support to the pedentive arches which have their bases on the each corner of the prayer hall. Squinches and triangular planes are frequently used to joint the circular form of the dome to its square supporting walls. Glass windows on the walls under the dome allow sunlight's penetration.



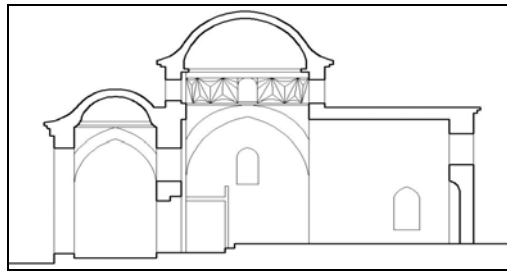
**Figure 3. Section of Orhan Gazi mosque**

*Source: Drawn by Mohamad Nazri Radzi (assistance researcher), Universiti Sains Malaysia*

#### 3.2 Pedentive dome design

On grounds of covering the prayer hall as the largest area in plan, the dome in this category (Figure 4) is significant in importance that impresses the viewers from its façade's elevation. This is due to relatively large form of dome comparing to the other design elements in the section. All the pedentive dome mosques have domes above the prayer hall although its position can be slightly different in the design. The dome normally is at central position in section view (square type's prayer hall) surmounted on a part of the wall perimeter but in cases with oblong type's prayer hall, its location is closed to the porch (*riwaqs*). The flanking domes are constructed lower in comparison with the main dome in order to emphasize their less importance compared to the central dome above the main prayer hall. The main dome in these mosques is supported by a semi-dome to bear the thrust of the dome otherwise the dome rests on grand arches covered by walls. Belt of triangular connect the dome to its quadrangle supporting space. Windows are on the walls

of the main hall in with several types of the openings (single, double or triple rows) to allow as much sunlight penetrated into the interior.

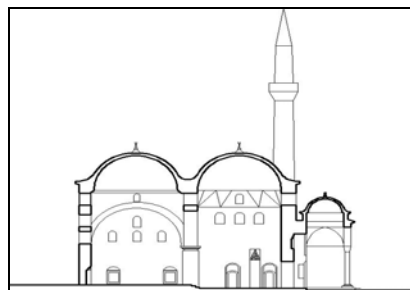


**Figure 4: Section of the Mosque of Ebu Ishak**

*Source: Drawn by Mohamad Nazri Radzi (assistance researcher), Universiti Sains Malaysia*

### **3.3 Multi-dome design**

As we analyze the third category onwards (Figure 5) of mosque architecture in early Ottomans, the feeling of domination of single dome design in the section view starts to shrink. This is due to multiple in number of pendentive domes in the mosque design. The domes surmounted above the main prayer hall are constructed higher than other design elements to compensate their importance. This design also helps these domes constructed higher to be seen from outside. Pendentive domes are widely used because the adjacent domes cannot have their interior arches covered as a part of the walls so that they do not cause separation to the prayer halls. The pendentive system allows height increment to prevent gloominess of small space under the domes. Corbels at the corner and triangular planes or belts are among the methods used to cover the wall and arched corners. A series of lower and upper windows on domes (sky lights) walls are built to allow sunlight's penetration inside of the building, thus the crown and window areas receives brighter than other areas. Most mosques have sky lights on the dome perimeter. The possible areas for these dome's windows are under the supporting arches.



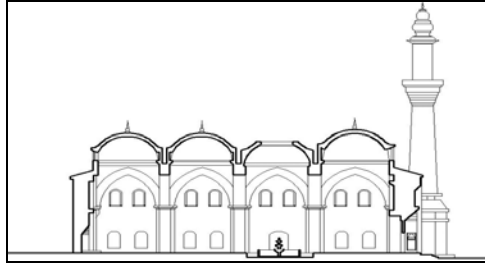
**Figure 5: Section of Murad Pasa Mosque**

*Source: Drawn by Mohamad Nazri Radzi (assistance researcher), Universiti Sains Malaysia*

### **3.4 Rectangular multi-dome design**

In this category (Figure 6) the dominant feeling of the single dome mosque's expression is not expressed in the design as the number of small domes with the same size in the design is utilized. Instead, the variety of decoration and connection between the dome and the walls or columns is emphasized. This variety ranges from simple squinches to corner stalactites and triangular planes. All the domes usually are built with the same height except the main row of domes functioned as the entrance of the mosque which is often built by the master builders with slightly elevated. The common character of this rectangular multi-dome is having the same diameter and regular in size and design. The pendentive system which relies on arched columns is the major method supporting the domes. The slight elevated domes allow sunlit fenestration to light up the indoor area. The natural light illuminates the interior areas from the roof window under the dome's

perimeter and from windows of the walls under the supporting arches. In case with Ulcami mosque, one of the pedentive dome has an open skylight (known as oculus in Pantheon built during Roman era). This skylight from a truncated dome functions as inner courtyard inside the prayer hall provided with a pond for ablution.

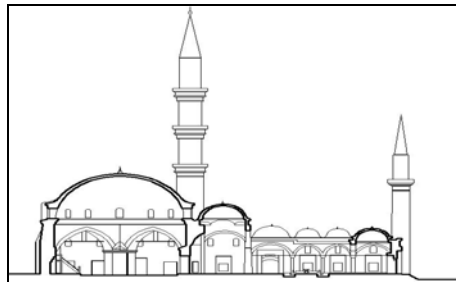


**Figure 6: Section of Ulcami mosque**

*Source: Drawn by Mohamad Nazri Radzi (assistance researcher), Universiti Sains Malaysia*

### **3.5 Hierarchical domes courtyard design**

In this category (Figure 7), the importance of the single dome's expression in the mosque design revives by using hierarchical order of the dome design (primary, secondary and tertiary domes' sizes). Not only because the main dome on prayer hall covers a wide area but as a virtue of its height, the primary dome is designed as the most dominant element in the section. The dome surmounted on the main hall is dominant and the highest element in section if the minaret is not accounted. The height of the domes' design in the section decreases towards the courtyard and entrance with having its summit at the main dome. Even in arcade courtyard, the height of the closer domes (secondary domes) is more than those (tertiary domes) being far to the main dome. The main dome is supported by the arched piers enclosed by the walls. The joints between pedentive arched walls and domes are covered by squinches. A drum or polygonal form encircles its exterior with window design on its walls around for sunlight's penetration. The pedentive system of dome contributes sunlit concept by having elevated dome concept to allow sunlit fenestration to light up the indoor area. Windows' design at its round rim and walls is used for sunlight's illumination. The domes at the arcade area around the courtyard are constructed in lower in height to give prominence to the sense of entrance place of the porch (*riwaqs*) area.



**Figure 7: Section of the Mosque of Sultan Bayezid**

*Source: Drawn by Mohamad Nazri Radzi (assistance researcher), Universiti Sains Malaysia*

## **4. DISCUSSION**

Given the special attention to the pedentive dome by sectional analysis, this part is grouped into four sections. It discusses the dome in terms of its height, number, position and construction as follows:



#### 4.1 The main dome's height

In all cases, the main dome surmounted the prayer hall typifies the largest and highest element in the section. It gives the feeling of focal point in the mosque design creating as a sense of landmark in section. The height of the main dome varies from case to case. The dome indicates the location of the main prayer hall. The height is proportioned to the size of prayer hall. The larger is the prayer hall, the larger and higher is the dome. The study finds that although any increase in number of the main hall's domes results in decrease of the dome's height but bigger mosques have larger domes. In cases with mosques with additional parts like courtyard, the height of the mosque in the section gradually reduces from the main dome as the highest element and the entrance as the lowest element.

#### 4.2 The number of the main domes

The study concludes that all the mosques have only one main dome from the section view except the third and fourth category (Multi-dome and Rectangular multi-dome design). In the first and second category, the pendentive dome design is the only visible element in the section. The third and fourth categories have more than one dome on the prayer hall and one can find a row of the domes with the same size from the section. The number of the main dome in third and fourth category used in the Ottoman mosque design has at least two domes. These domes have multiple in number due to cover the vastness of the prayer hall particularly in the fourth category as its design does not apply primary dome expression. In the fifth category, the dome of the prayer hall is treated as the dominant element thereby the most eye-catching part land marking the design. This category has secondary and minor domes built around the main dome.

#### 4.3 The position of the main dome

The main dome is always surmounted above the prayer hall. In the first and second category, it covers the whole prayer hall. Due to the increase in number of the main domes in the third and fourth category, the attribute of centrality is retained by the developed into a row of domes. In other words, the main dome is on central part of the prayer hall, but the total area for the prayer hall comprises the roof cover under several secondary domes for overcoming the structural constraints. From top view, this denotes the feature in which the jointing point of two diagonals of the prayer hall would act as the center of the dome. The fifth category dome is located on the center. The adjacent prayer halls around the dome are covered by different secondary smaller unit domes, and the main dome is centralized.

#### 4.4 Construction of the main dome

Method of dome construction is pendentive system which typifies the essence of Ottoman mosque architecture. There are other methods of construction. Using squinches, and integration of mentioned methods with triangles are among the other popular methods. In first and second category use of squinches and triangles are usual provided that the dome recedes internally. Therefore, the supporting walls are thick built from masonry. In these two categories, arched columns supporting the dome are commonly utilized and the same condition is in third and fourth categories. In these categories due to the oblong space that the dome supposed to cover, the designer employed double or triple arched columns. The surrounding walls are thick but not as much as the first two categories. In third category the walls are built thinner because of the flanking spaces that stand against the thrust of the main dome and in fourth category this is due to the extensive employment of the columns wherever necessary. The use of semi-dome is another method to tackle the dome's thrust issue that can be seen in the fifth category. In this category, the hybrid application of all mentioned techniques is available. Giant arches embedded in the surrounding walls support the domes. Table 1 shows the pendentive dome types of the studied mosques.

**Table 1: List of pendentive dome mosques and types of the dome's category**

| No. | Name of the mosque | Year                                     | City  | Number of main dome(s) in meter [usually to cover the prayer hall] | Type of main dome | Category of plan |
|-----|--------------------|--|-------|--|-------------------|------------------|
| 1   | Orhan Gazi         | early fourteenth century (repaired 1775) | Gebze | 1 (D=12.3, H=15.70)  | On squinches      | Single dome      |

To be continued

Continued

| No. | Name of the mosque   | Year  | City                                     | Number of main dome(s) in meter [usually to cover the prayer hall] | Type of main dome                                | Category of plan |
|-----|----------------------|---|--|--|--|------------------|
| 2   | Hoca Yadigar         | 1374  | Inonu                                    | 1 (D=9.5)  | Pendentive                                       | Single dome      |
| 3   | Orhan Gazi           | first half of fourteenth century              | Bilecik                                  | 1 (D=9.5)  | pendentive                                       | Single dome      |
| 4   | Kasim Pasa           | 1478 (restored 1964)                          | Edirne                                   | 1 (D=11)   | On squinches fairly on the wall                  | Single dome      |
| 5   | Hudavendig ar        | Mid fourteenth century (no inscription plate) | Behramka le(northern slope of Acropolis) | 1 (D≈9)  | On walls by belt of triangulars                  | Single dome      |
| 6   | Yildirim Bayezid     | 1382  | Mudurnu                                  | 1 (D=19.65)  | On four large squinches                          | Single dome      |
| 7   | Alaeddin Bey         | 1335  | Bursa                                    | 1 (D≈ 6.10)  | On transitional triangulars                      | Single dome      |
| 8   | Firuz Aga            | 1490  | Istanbul                                 | 1 (D=10.5)   | Pendentive                                       | Single dome      |
| 9   | Haci Sahabeddin Pasa | 1436  | Edirne                                   | 1 (D=8)  | Pendentive                                       | Single dome      |
| 10  | Sehf Vafa            | unknown                                       | Istanbul                                 | 1  | Pendentive                                       | Single dome      |
| 11  | Agalar               | unknown                                       | Istanbul                                 | 1  | On walls and supportive columns                  | Single dome      |
| 12  | Hatuniye mosque      | 1485  | Tokat                                    | 1  | Pendentive                                       | Pendentive dome  |
| 13  | Yukari Cami          | End of fourteenth century                     | Krsunlu                                  | 1  | Pendentive                                       | Pendentive dome  |
| 14  | Sultan Orhan         | 1334  | Iznik                                    | 1  | Pendentive                                       | Pendentive dome  |
| 15  | Timurtas             | Late fourteenth century                       | Bursa                                    | 1  | On squinches                                     | Pendentive dome  |
| 16  | Ebu Ishak            | Late fourteenth century                       | Bursa                                    | 1  | On belt of triangulars                           | Pendentive dome  |
| 17  | Yahsi Bey            | 1441  | Tire                                     | 1  | Pendentive                                       | Pendentive dome  |
| 18  | Gazi mihal           | 1421  | Edirne                                   | 1  | Pendentive                                       | Pendentive dome  |
| 19  | Sultan Bayezid       | inaugurated in 1486                           | Amasya                                   | 2 (D=14x13.15, D=15.15 square)                                     | On squinches                                     | Multi dome       |
| 20  | Murad Pasa           | 1469  | Istanbul                                 | 2 (D≈ 10.5, H=21)  | the 1st on the triangulars and the 2nd on a belt | Multi dome       |
| 21  | Yorguc Pasa          | 1428  | Amasya                                   | 2  | Pendentive                                       | Multi dome       |
| 22  | Gedik Ahmed Pasa     | 1474-77                                       | Afyon                                    | 2 (D=11.5)   | Pendentive                                       | Multi dome       |
| 23  | Orhan Gazi           | 1339  | Bursa                                    | 2 (D= 8.45, H=16)  | Pendentive                                       | Multi dome       |
| 25  | Murad II             | between 1424-1426                             | Bursa                                    | 2 (D=10.60, H=10.60)   | Pendentive                                       | Multi dome       |

To be continued

Continued

| No. | Name of the mosque   | Year                                 | City               | Number of main dome(s) in meter [usually to cover the prayer hall] | Type of main dome | Category of plan             |
|-----|----------------------|--------------------------------------|--------------------|--|-------------------|------------------------------|
| 26  | Yesil Cami           | between 1412-1419                    | Bursa              | 2  | On triangulars    | Multi dome                   |
| 27  | Yildirim             | started in 1390, completed in 1395   | Bursa              | 2  | On squinches      | Multi dome                   |
| 28  | Muradiye Mosque      | 1435                                 | Edirne             | 2  | On triangulars    | Multi dome                   |
| 29  | Mezid Bey            | 1441                                 | Edirne             | 2  | Pendentive        | Multi dome                   |
| 30  | Rum Mehmed Pasa      | 1471                                 | Uskudar , Istanbul | 1 (D=11.15)  | Pendentive        | Multi dome                   |
| 31  | Atik Ali Pasa        | 1496                                 | Istanbul           | 1  | Pendentive        | Multi dome                   |
| 32  | Davud Pasa           | _                                    | Istanbul           | 1  | On squinches      | Multi dome                   |
| 33  | Lala Sinan Pasa      | 1524                                 | Sincanli           | 2  | Pendentive        | Multi dome                   |
| 34  | Ulcami               | 1396                                 | Bursa              | 20   | Pendentive        | Rectangular multi-dome       |
| 35  | Eski Cami            | 1402                                 | Edirne             | 9  | Pendentive        | Rectangular multi-dome       |
| 36  | Zincirlikuyu         | end of fifteenth century             | Istanbul           | 6 (D=5.6)  | Pendentive        | Rectangular multi-dome       |
| 37  | Cebeli Sultan Mehmed | 1421                                 | Dimetok a, Greece  | 1  | Pendentive        | Rectangular multi-dome       |
| 38  | Bulbul Hatun         | 1509                                 | Amasya             | 2  | Pendentive        | Rectangular multi-dome       |
| 39  | Sarchane             | 1393                                 | Amasya             | 2 (D=8.5)  | On squinches      | Rectangular multi-dome       |
| 40  | Abdal Mehmed         | second half of the fifteenth century | Bursa              | 2  | Pendentive        | Rectangular multi-dome       |
| 41  | Sehadet              | 1337 or 1365                         | Bursa              | 2  | Pendentive        | Rectangular multi-dome       |
| 42  | Aksemseddin          | 1455                                 | Kure               | 3  | Pendentive        | Rectangular multi-dome       |
| 43  | Guzelce              | 1406                                 | Hayrabolu          | 1  | Pendentive        | Hierarchical domes courtyard |
| 44  | Uc Serefli Cami      | 1437                                 | Edirne             | 1  | Pendentive        | Hierarchical domes courtyard |
| 45  | Ulcami               | 1376                                 | Manisa             | 1 (D=10.8)   | Pendentive        | Hierarchical domes courtyard |
| 46  | Isa Bey              | 1375                                 | Selcuk             | 2  | Pendentive        | Hierarchical domes courtyard |
| 47  | Ulcami               | _                                    | Sivas              | No main dome   | On squinches      | Hierarchical domes courtyard |
| 48  | Fatih                | 1436-71                              | Istanbul           | 1  | Pendentive        | Hierarchical domes courtyard |
| 49  | Sehzade              | _                                    | Istanbul           | 1 (D=19 elevated finally at 38m above the ground)                  | Pendentive        | Hierarchical domes courtyard |

To be continued

Continued

| No. | Name of the mosque | Year    | City     | Number of main dome(s) in meter [usually to cover the prayer hall] | Type of main dome       | Category of plan             |
|-----|--------------------|---------|----------|--|-------------------------|------------------------------|
| 50  | Sultan Bayezid     | 1484-88 | Edirne   | 1  | On four large squinches | Hierarchical domes courtyard |
| 51  | Bayezid            | 1505    | Istanbul | 1 (D=18)   | Pendentive              | Hierarchical domes courtyard |

## 5. CONCLUSION

In conclusion, sectional analysis provides the cut-through mosque sectional viewpoint, thereby making possible studying pendentive dome and its influence on mosque architecture. The sectional analysis enabled us to study the dome influence on the mosque architecture because this analysis provides design data for studying the number, position, height and construction of the dome. The study shows that pendentive dome plays important role in the Ottoman mosque architecture. There are five categories of the mosque architecture in section view. However, the first and the second category can be grouped in one division since they share many in common characteristics from the section view. The differences can be identified only if the researcher takes into account on the plan view. The other categories which can also be grouped subsequently is third and fourth categories. The study finds that the dome's size is interrelated to the size of prayer hall. The slightly rectangular prayer hall result with an oval dome roof cover. This is because the dome is always surmounted on the center of the prayer hall. If we exclude the minaret, the dome becomes the highest element in the drawing section and therefore has the most impression to the observer. The master builders accentuated this feature by designing the rest of the mosque's dome elements declining toward the main entrance. This emphasizes on the primary dome as the focal point of the design. The master builders strived to keep this feature but for the cases that the prayer hall are stretched rectangular, this left them no choice but to increase the number of the domes (multiple dome concept) that can reach to four in a row like in the fourth category. The increase in number of the main domes decreases the difficulties that master builders had to cope with the dome's span, and gives the opportunity to exhibit their level of expertise in terms of interior space design. The domes in fifth category demonstrate the highest level of sophistication. Notably, the pendentive dome design reaches its maturity and complexity. Aesthetical impression is bestowed on the mosque in this last category by employment of higher level of knowledge in construction. Importance notwithstanding, the first and second categories have the credit of fundamental and generating the forms of pendentive dome design. All categories are derived from them even though the first and second categories acquire the simplest possible forms. In other words, they embed the fundamental form of pendentive dome design necessary to elaborate with complexity of multi-dome design in the other categories as well as essential for making variations.

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