

# **The Architectural Characteristics of the Seljuk Domes in Isfahan's Mosques**

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## **Abstract**

Seljuk Iranian domes are among the most prominent structures in their heritage; this study is an attempt to examine and explore the underlying construction techniques, structural features, and concepts of the surviving examples of the Seljuk domes of the mosques in Isfahan. The construction techniques which have used for these domes have been based on precise information in terms of science and engineering. The aim of this research is also to track the architectural, structural and decorative development of Iranian domes and the possible factors affecting them, as well as technical methods that clearly contributed to the formation of rules and foundations for Seljuk domes. On the other hand, among the many factors that affected Seljuk architecture was the scientific renaissance that Iran witnessed during the Seljuk era, as it was an important factor in the remarkable architectural development of domes compared to the previous eras. Iran was not the only one that reaped the results of this architectural renaissance, but the influence of the Seljuk School of domed chambers extended to other Islamic countries such as Iraq, Syria, Egypt and Turkey.

The Seljuk in Isfahan developed the transition zones of their domes; the most important feature was the combination of the tri-lobed arch with a pointed frame. The tri-lobed squinches can, therefore, be regarded as the hallmark of the domes of the Mosques of Isfahan. The Seljuk mastered this technique and put it to good use, not only a solution to the problem of geometric transition but also addressed it in a high-level artistic manner. The Seljuk tri-lobed squinch consists of four niches.

## **Keywords:**

Dome, Transition Zone, Isfahan, Domed chamber, Seljuk, Tri-lobed squinch.

## **Research problems**

Many archaeologists discussed the Seljuk architecture like Creswell,<sup>1</sup> Godard,<sup>2</sup> Grabar,<sup>3</sup> Hillenbrand,<sup>4</sup> Schroeder,<sup>5</sup> Aslanapa,<sup>6</sup> Blair,<sup>7</sup> Jawadi,<sup>8</sup> and Anisi.<sup>9</sup> However, they did not highlight the architectural features of this architectural heritage. The main problem of this study is to revolve around the unavailability of a study on the architectural characteristics of the domes in Isfahan's mosques during the Seljuk period, as well as to unveiling the development of the Seljuk dome in the mosques of Isfahan during the 5<sup>th</sup> and 6<sup>th</sup> centuries AH (eleventh and twelfth centuries AD).

## Research objectives

- 1- To shed light on the characteristics and features of the architecture of the Seljuk domed chambers in Isfahan's Mosques.
- 2- To examine the underlying construction techniques, structural features, and concepts of the surviving examples of the Seljuk domes of the mosques in Isfahan.
- 3- To explore the architectural, structural and decorative development of Iranian domes and the possible factors affecting them, as well as technical methods that clearly contributed to the formation of rules and foundations for Seljuk domes.
- 4- To track the architectural, structural, and decorative development of Iranian domes and the possible factors affecting.

## Research methods

The research relies on several methods to achieve its objectives:

- 1- The historical approach, by exposing the studies that have dealt with the Seljuk domes in Iran.
- 2- The descriptive approach, by discovering the architectural features of the Seljuk domed chambers in Mosques of Isfahan.
- 3- The analytical study, through this approach, the study presents some hypotheses and ideas in order to achieve the goals and the objectives.

## 1. Introduction

### 1.1. The dome pre-Islamic Iran

It seems that the emergence of domes in pre-Islamic Iran was a legacy inherited by Persian architecture from Mesopotamia<sup>10</sup> and Central Asia.<sup>11</sup> Some attributes that the dome's acquisition as a traditional feature of Persian-Islamic architecture is probably due to the scarcity of wood in Persia, relying on cooked bricks and stones. The most important historical sign of Persian domes are the remains of Nyssa in Turkmenistan; The Parthian capital contains remains of a circular base with a diameter of 17 meters, with thick walls surrounding four columns in the center and statues niches on the walls.<sup>12</sup> The Palace of Ardashir (224-241 AD) in Fairuzabad had three domes;<sup>13</sup> each diameter is 45 feet.<sup>14</sup> Domes also appeared in the temples of fire in Chahar-Taqi,<sup>15</sup> the Zoroastrian temples in Kashan, and Chahar-Taqi. Its architectural plan is a square with four pillars of arches and covered with central oval domes.<sup>16</sup>

The construction of a dome over squinches was an impressive feature of Sassanid architecture; it became an inspiration for Muslim architects. André Goddard proposed the theory that the domed chamber in Chahar-Taqi was the reason for the appearance of small dome-covered mosques known as the Kiosk Mosques.<sup>17</sup> Many Chahartaqs were converted to mosques.<sup>18</sup> The Kiosk Mosque became popular in Iran in the Seljuk period. Only a few mosques remain according to the Chahar-taqi style in Iran during Seljuk period;<sup>19</sup> the Friday mosques at Qazvin, Barsian, Ardistan, Qurvah and Zawarah are good examples.<sup>20</sup>

On the other hand, significant proceed was made of the construction of domes in other Muslim territories, the Dome of the Rock in Palestine (72 AH / 691 AD) is the earliest example.<sup>21</sup> The importance of domes appeared as an important means of covering with the Approbation of the domed shrine; by building Al-Muntasir mausoleum (248 AH / 862 AD) at

Samarra, the oldest surviving one.<sup>22</sup> The Samanid mausoleum in Bukhara (296 AH / 908 AD),<sup>23</sup> the Imam Ali Mausoleum in Najaf (317 AH / 929 AD),<sup>24</sup> and the Mausoleum of Arab Ata in Tim (367 AH / 977-978 AD),<sup>25</sup> are good examples of this trend. The Seljuk period in Iran was a decisive turning point in the evolution of domes structure, whether erected inside or attached to mosques, as well as those above the shrines.

## 1.2. Seljuk domes in Isfahan's Mosques

The importance of the domed chamber became more important and common in the Seljuk period. The first Seljuk dome erected was the Dome of the Damascus Mosque (475 AH / 1082-1083 AD),<sup>26</sup> but the impressive start was with the southern dome of the Friday Mosque of Isfahan, Nizam al-Mulk dome (472 AH / 1080 AD,<sup>27</sup> 475 AH / 1082-1083,<sup>28</sup> 479 AH / 1086-1087,<sup>29</sup> 479 AH / 1087 AD)<sup>30</sup>, which was added by the vizier to the sanctuary of the hypostyle plan.<sup>31</sup> Blair believes that this dome was probably erected as a maqṣura, مقصورة, for Malik-Shah (465- 485 AH / 1073-1092), and was built in imitation of Damascus mosque's dome, that Malik-Shah had seen during his visit in the autumn of 1086.<sup>32</sup> However, the dome of the Nizam al-Mulk heralded a new style in the domed chamber and served as a prototype for similar structures built in many mosques,<sup>33</sup> it became a successful witness to inspiring architecture in other mosques during the 11<sup>th</sup> and 12<sup>th</sup> centuries.

Another dome rises on the northern side of the same mosque, Taj al-Mulk (the northern dome).<sup>34</sup> Its construction started one year after the southern dome (481 AH/1088 AD),<sup>35</sup> it is the first example of double-shell domes in Seljuk mosques.<sup>36</sup> Although relatively small compared to the northern dome, it clearly outperforms them with regard to general proportions (symmetry) and their accuracy. The Northern Dome was presented as one of the best Seljuk domes ever.<sup>37</sup>

Both of the 6<sup>th</sup> and 7<sup>th</sup> centuries AH (12<sup>th</sup> and 13<sup>th</sup> AD) witnessed a tremendous cultural and scientific renaissance in Iran during the Seljuk period, accompanied by an architectural renaissance of the Seljuk state, the capital Isfahan was the center of this architectural activities; Five mosques were built: Gulpayegan (was built in 499-512 AH/1105-1118 AD,<sup>38</sup> , 507 AH/ 1114-1115 AD<sup>39</sup>, or 529 AH / 1135 AD<sup>40</sup>), Zawarah (530 AH / 1135-1136 AD<sup>41</sup>, or 546 AH / 1151,<sup>42</sup> 551 AH / 1156 AD<sup>43</sup>), Barsiyan (499 AH / 1105 AD<sup>44</sup>, or 529 AH / 1134 AD<sup>45</sup>), Ardistan (553 AH/1158 AD<sup>46</sup>, or 559 AH/ 1164 AD<sup>47</sup>), and Ardabil (6<sup>th</sup> AH/12<sup>th</sup> AD).<sup>48</sup>

## 2. Discussion

### 2.1. Evolution of The Seljuk domes in Isfahan

There are many factors that led to the evolution of the Seljuk domed chambers and contributed directly to their prevalence, that continued until the later centuries; It seems that the interest of the Seljuk court certainly on the manifestations of their civilization and their strength had a tangible and unlimited echo in their cultural and artistic production, which was clearly reflected in their architectural works. The Seljuk set these terms that the builders grabbed and constructed many architectural units that reflected Seljuk philosophy; such as mosques, schools, observatories, hospitals, and other facilities that served all walks of life. They also added substantial improvements to the architecture of the domes. They build domed chambers with relatively large diameters and dimensions compared to their predecessors; this

was a key factor in the evolution of its transition zones and its over-decoration, which is considered the basis for the subsequent developments of Iranian domes. Isfahan had the largest share of these architectural improvements more than other regions.

It is worth noting at this time that Isfahan was the capital of the Seljuks, and Nizām al-Mulk was trying to develop the city as the capital of the Muslim world. Not surprisingly, Nizām al-Mulk as an Iranian patriot revived the Chahar Taqi, the Sasanian form, to erect such a high dome chamber in Isfahan Jami Mosque,<sup>49</sup> quite possibly the largest one in the Islamic world at that time. In fact, it would assuredly have attracted a lot of attention - not only because of its size but because of its location; it was erected directly through the Sanctuary.<sup>50</sup> That combination of size and site said much about the power of the state. It made the dome an emblem of their authority, visible to all in the mosque.<sup>51</sup> This architectural addition was a prologue to signify the strength and independence of the new dynasty, the Seljuk. The concept of this new philosophy was shortly expanded into other mosques in Iran.<sup>52</sup>

In other hands, it seems that political rivalry within the Seljuk court has also had a significant impact on the architectural development; the rivalry between the two sturdiest viziers of Malik-shah court, Nizam al-Mulk (d 485 AH / 1092 AD) and Taj al-Mulk (d 485 AH / 1092 AD), spilled over into the field of architecture not only in Isfahan but also in Baghdad; The old vizier has added a huge dome chamber to the sanctuary of the Isfahan Jami Mosque, while the other vizier had constructed a magnificent dome on the northern side of the same mosque,<sup>53</sup> (figure No. 1). Isfahan was not only the one that witnessed this rivalry but also extended to Baghdad, the capital of the Abbasids; Nizam al-Mulk built Nezamiyya, his regular school, and Taj al-Mulk built Tajiyya.<sup>54</sup> It is also mentioned that Taj al-Mulk built a palace in Baghdad, following the example of Nizam al-Mulk, who had built a palace in the same city.<sup>55</sup>

Furthermore, we should take into account another important factor; the development of science in the Seljuk period served the architectural renaissance, the architecture of domed chambers was the first to be affected by this renaissance; According to Alpay Özdural, the relative relationships derived from the cross-sectional analysis of Taj al-Mulk dome appear to refer to the mathematician and astronomer Omar Khayyam (440- 525 AH / 1048- 1131 AD).<sup>56</sup> A cursory examination of the Seljuk domed chambers of mosques in Iran as a whole will suffice to show that, firstly, The Seljuks added domes to the sanctuary of the hypostyle plan of ancient mosques such as the south dome of Masjid Jami of Isfahan, also erected domes attached to mosques but isolated from the prayer area (i.e. not part of the prayer space), the northern of Masjid Jami of Isfahan is an example. The dome itself was a mosque (the Kiosk Mosque); the Friday mosques of Zawarah, Barsian, Gulpayagan, and Qurvah are examples. Secondly, except for the dome of Nizam al-Mulk which built on ancient piers; the architect tried to keep the four sides of the chamber as similar as possible. Third: The geometric proportions (diameter, dimensions, and height) of the domes are not the same. The drum of the domes relied on three forms of transition zones.

The Iranian Seljuks developed architectural techniques that reduced the mass of their domes, with geometrically defined schemes and interesting proportions. Using mathematical and engineering principles, these builders were able to achieve their goals. However, with regard to dimensions, there are noticeable disparities, while the dome of the Jami Mosque of Ardabil

was able to challenge the comparison with the dome of Nizam al-Mulk, with a diameter of 15 meters each<sup>57</sup> (Figures No. 2, 4).

As for the other domes didn't get this competition; Taj al-Mulk (9.5 meters),<sup>58</sup> fig. (2-b), Gulpayagan (10.6 meters)<sup>59</sup> (figure No. 5), and each of the Barsian (figure No. 6) and Ardistan domes (10 meters)<sup>60</sup> (figure No. 7), while the dome of Zawarah was the smallest one (8 meters)<sup>61</sup> (figure No. 8). Seljuk domes in Isfahan can be divided into two types: the first is the huge domes (figure No. 9), the type with a diameter of more than 10 meters, such as the domes of the Nizam al-Mulk and Ardabil, the second type, which have diameter of 10 meters; Gulpayagan, Barsian, Ardistan, are examples. While Taj al-Mulk, and Zawarah, were of the third type, less than 10 meters.

The domes of mosques in other Iranian provinces have also been unable to compete with the domes of the Seljuk capital; the dome of Qurvah is 5.5 meters, Sojas 9.2 meters<sup>62</sup> and Marand 7.4 meters,<sup>63</sup> except for the dome of the Mosque in Qazvin, which has a diameter of 15.20 meters.<sup>64</sup>

On the other hand, there has been significant architectural evolution, as Seljuk architects have been able to expand the diameter of the mausoleums domes; In 551 AH /1157 AD, Sultan Ahmad Singer built his mausoleum in Merv, covered by a huge dome (18 meters),<sup>65</sup> as well as the octagonal mausoleum, the Gunbad-i Jabaliyya (581-582 AH / 1186 AD), in Kerman, covered by a dome (11 meters).<sup>66</sup> There was also a differentiation in the heights; Nizam al-Mulk dome maintained the largest height (27 meters), compared to it; the other domes were smaller such as Gulpayagan, Ardistan, Barsiyan, Taj al-Mulk, and Zawarah, they measure 22, 21.6, 21, 20, 16 meters respectively.<sup>67</sup>

## **2.2. The characteristics of Seljuk domes in Isfahan Mosques**

### **2.2.1. The characteristics of the ground level**

The ground level is the first part of the domed chamber; it is a square area, located in the lower section of this structure,<sup>68</sup> this volume is completely enclosed by walls in the four sides, these walls with the transition zones provide the structural requirements for the dome. However, there are marked disparities. While the wall thickness of the Taj al-Mulk dome chamber (3 meters),<sup>69</sup> and it is of a size to challenge comparison with the Nizam al-Mulk dome (3.10 meters),<sup>70</sup> those of Gulpayagan, Ardabil, Ardistan, Barsian, and Zawarah are noticeably smaller, with walls which are 2.5, 2.4, 2, 1.7, and 1.6 meters thick respectively. On the other hand, the disparities in the heights of the domes necessitated a difference between each dome and the heights of the lower level, no dome can be compared to the dome of Nizam al-Mulk (10.6 meters); Ardistan 8.8 meters, Gulpayagan 7.3 meters, Taj al-Mulk 7.2 meters, Barsian 6.8 m, Ardabil 6.7 meters, and Zawarah 5.7 meters.

In contrast to the Seljuk domes in northern Iran, which avoided the use of many openings in the walls, such as the domes of Friday mosques in Qurvah, Qazvin and Urmia, the Seljuk domed chambers in Isfahan are very similar, with the bearing walls divided through relatively large openings, often the middle opening in each of the most spacious walls, in addition, there are many deep and shallow entrances, knotted entries, square piers blank niches and with engaged corner columns; so the lower walls of domed chambers in Isfahan are more articulated.<sup>71</sup> Generally, the interior space of the chamber is surrounded by a series of arches that visually lift the structure upwards, each side of the chamber is characterized by three

arches, wherein the middle arch has a wider span than the other two and visually dominates the space.<sup>72</sup>

### 2.2.2. The characteristics of the Transition zone

The Transition zone is the second (middle) part of the structure is a section that stands between the ground square level and the dome itself. This section is the result of a series of geometric transformations that start from a square base using squinches, arches and niches. In other hand; the dome rises from a sixteen-sided drum with alternating windows, resting on an octagonal transitional area formed by four squinches. These geometric transformations created the lower eight-sided prism, and by sixteen smaller arches alternatively cover the angles of the lower octagon in the form of a bridge and next to each other, form another floor in the form of a regular sixteen-sided prism on the lower eight-sided prism.<sup>73</sup> Structurally, the importance of these mini-arches is to partially transfer the localized forces in such a way that both horizontal and vertical forces are concentrated on small regions of the transition level. Architecturally, these mini-arches are a visual link between the body of the dome and the shell.<sup>74</sup>

The construction of a dome on the squinches was perhaps the most important architectural innovation of the Sassanid era, the period of establishing the squinch is uncertain, but it may have originated from eastern Iran.<sup>75</sup> The domes squinches of the Ardashir palace (224-241) in Firozabad were four conical squinches,<sup>76</sup> each having several oval-shaped arches.<sup>77</sup> The transition zone of the Chahartaqi was a simple squinch,<sup>78</sup> which was the basis for early Islamic domes in Iran, and the development of the transition zones in the 4<sup>th</sup> – 5<sup>th</sup> AH / 10<sup>th</sup> - 11<sup>th</sup> AD centuries, whether in Egypt or Iran.<sup>79</sup> By the 4<sup>th</sup>/10<sup>th</sup> century, two domed mausoleum in Transoxiana show the development of the transition zone; the Samanid mausoleum in Bukhara, the oldest surviving example of Islamic architecture (first half of the 4<sup>th</sup> AH/10<sup>th</sup> AD century),<sup>80</sup> and Arab Ata mausoleum (367 AH / 977-978 AD) at Tim, Which are the most prominent examples of early Islamic architecture.<sup>81</sup> The Samanid mausoleum shows great achievement in the structure of the transitional zone; with four pointed arches and squinches.<sup>82</sup> The transitional zone of Arab Ata is characterized by two elements; the tri-lobed squinches,<sup>83</sup> and muqarnas.<sup>84</sup> A further development of this feature shows at the Davazdah Imam mausoleum at Yazd (429 A.H / 1039 AD); the transition zone is a tri-lobed arch within pointed arches spanning the corners.<sup>85</sup> A similar form at Qunbad Qavos (397 A.H / 1006-1007 AD), a half dome above the pointed-arched entrance is based on two tri-lobed squinches.<sup>86</sup>

#### 2.2.2.1. The tri-lobed squinch

The Seljuk tri-lobed squinch consists of four niches (figures 10, 11). The axle acts as a piece of barrel vault supported by a plain squinch, while the lateral niches have a pointed concave shape. The Seljuk succeeded in breaking up each lobe by a series of sub-squinches, also lobbed. In most cases, each lobe is fragmented, resulting in the formation of three prominent beveled triangles, centered on compact cylindrical columns. The space between each lobe contains a small niche held by a pointed arch, while the angle contains two niches, which increase the apparent depth of the squinch, and it forms a variety of aspects defined from different angles. The more lobes that the transition zone consists of, the more stability the shouldered arch net guaranteed.

Structurally, the process of making squinches involves mechanical techniques, geometrical transformations and mathematical analysis. Seljuk by their very subtle observation, were able to bring these transformations together to achieve what might really be called "architectural alchemy".<sup>87</sup> This space visually provides other engineering features such as symmetry, structural balance, and harmony; the axial arches of the octagonal zone are filled by three lancet windows, the central one higher than the other two. This results in an echo of the tri-lobed shape.<sup>88</sup>

However, the Seljuk in Isfahan developed the transition zones of their domes; the most important feature was the combination of the tri-lobed arch with a pointed frame. The tri-lobed squinches can, therefore, be regarded as the hallmark of the domes of the Mosques of Isfahan. The Seljuk mastered this technique and put it to good use, not only a solution to the problem of geometric transition but also addressed it in a high-level artistic manner; this invention soon became the basis for one of the most important structural elements called muqarnas.

The tri-lobed squinch appeared as a framed transition zone within the Seljuk domed chambers, and can also be found inside of the ground level's pointed arches of the Seljuk domed chambers such as Taj al-Mulk dome, (figure No. 13, plate No. 2). However, in other Seljuk examples, it was defined as a separate part of the ground level, which we confirm was a common feature in Seljuk domes such as Nizam al-Mulk (figure No. 12, plate No. 1), Zawarah (figure No. 18, plate No. 3), Barsian (figure No. 16, plate No. 4), Ardistan (figure No. 17, plate No. 5). In contrast to the Seljuk domes in northern Iran, which applied the plain squinches; the tri-lobed squinch was the favorite transition zone of the Seljuks of Isfahan, as they used it in all domes in Isfahan, except for Gulpayagan (figure No. 15, plate No. 6), which relied on muqarnas niches as a single transition zone, and we can find the type of plain squinch in the transition zone of the dome of Ardabil (figure No. 14, plate No. 7).

#### **2.2.2.2. The plain squinches**

The plain squinches were common in other Seljuk Mosques Iranian provinces; The Friday mosques of Qazvin (500- 509 AH / 1106- 1115 AD),<sup>89</sup> Simnan (417- 466 AH / 1026- 1073),<sup>90</sup> Borujerd (533- 539 AH / 1139- 1145 AD),<sup>91</sup> Qurvah (570 AH / 1174 AD)<sup>92</sup>, Sojas (493 AH / 1100 AD),<sup>93</sup> and Marand (485 AH / 1092 AD, <sup>94</sup> 731 AH / 1331 AD)<sup>95</sup> are good examples of this trend. The tri-lobed squinche was also not preferred in Seljuk Mausoleums, such as the Mausoleum of Davazdah-Imam at Yazd (429 AH / 1039 AD), the Mausoleum of Sultan Sanjar (551 AH / 1157 AD), and the Gunbad Jabaliyya (582 AH / 1203 AD) which relied on plain squinches.

#### **2.2.3. The characteristics of the dome's shells**

The third part of the dome structure is the dome itself. The rim of the Seljuk's dome is constructed on a cylindrical drum; the drum is the cylindrical part of the dome on which the shell rests. Structurally; this vertical cylinder wall helps to neutralize the thrusts of the external shell according to the complex and specific static reactions.<sup>96</sup> The thickness of the brick courses of the cylinder wall decreases gradually from the bottom to the top. This construction method reduces the dome's weight structurally and makes the erection easier.<sup>97</sup> This style creates a gradient surface in the shape of an arched shape (shell).

### 2.2.3.1. The single-shell domes

This type is the most common type of domes in Islamic architecture. Nizam al-Mulk dome in the Masjidi Jami in Isfahan is the oldest Seljuk dome that was built according to this style (figure No. 12). With the dome of Nizam al-Mulk, no other Seljuk dome in Isfahan belonged to this type except for the dome of Gulpayegan (figure No. 15).

### 2.2.3.2. The double-shell dome

The main reasons for the appearance of the double-shell dome are to protect the inner shell of the dome, increasing the height of the building without significantly increasing the weight of the dome and providing a lower interior roof for decoration.<sup>98</sup> The thicknesses of the internal and external shells has been proportionally reduced from their bases to the top at either 25' or 30' angles, for the purpose of structurally reducing the overall weight of shells.<sup>99</sup>

The double-shell dome probably was emerged in the second half of the 4<sup>th</sup> /10<sup>th</sup> century. The earliest surviving double-shell dome can be seen in Qabus Tower (397 AH / 1006-1007 AD), the mausoleums of Abū'l Faḍl,<sup>100</sup> and Abū Sa'id. Both are attributed to the first quarter of the 5<sup>th</sup> AH /11<sup>th</sup> AD century.<sup>101</sup> Also we can find it in Seljuk tombs; Sheikh Shebeli Tomb at Damawand (5<sup>th</sup> AH /11<sup>th</sup> AD century), the Mausoleum of Sultan Sanjar (551 AH/ 1157 AD),<sup>102</sup> and Alaweyyan Tomb at Ghamadan (6<sup>th</sup> AH / 12<sup>th</sup> AD). However, the Seljuk of Iran applied the form of double shell dome in some domes such as Taj al-Mulk (figure No. 13), Zawarah (figure No. 18), Barsian (figure No. 16), and Ardistan (figure No. 17).

As for the shape of the Seljuk domes in Iran; the pointed shape was applied to all of them. The real renaissance of the domination of the pointed dome in Iran and Turkmenistan is attributed to the Seljuk. Although the pointed dome had appeared early in Islamic architecture, such as the Dome of the Rock in Palestine (72 AH / 691 AD) and the Dome of Al-Muntasir mausoleum at Samarra (248 AH / 862 AD), its spread centuries later was a logical result of a series of continuous development of architectural styles, innovations, and combination of different local experiments in which artistic and technical methods were improved through a long time. These development series started before the Seljuk era; the elliptical Sasanian arch was replaced by the pointed arch, which presents a profile struck from four centers.<sup>103</sup>

However, the pointed arch first appeared in undeveloped form in the Friday mosques of Fahraj (2<sup>th</sup> – 4<sup>th</sup> AH / 8<sup>th</sup> -10<sup>th</sup> AD).<sup>104</sup> The Seljuk admired the pointed form of the domes, applying it in most of their domes, both in mosques and in their shrines, but this does not necessarily mean the absence of half-spherical dome, it has appeared in one example: the dome of Zawarah (figure No. 18).

Rectangular windows are often opened on a single axis in the dome's shell, located on the upper edge of the dome's rim; the only exception is the dome of Nizam al-Mulk, which its shell is devoid of any windows. Seljuk architects seem to have developed lighting systems inside the domed chambers; all domes were erected after the dome of Nizam al-Mulk, its shells were characterized by windows. Each mosque displays some differences regarding this point; the shells of the domes of Taj al-Mulk, Barsian, and Zawarah have two windows, Qazvin Mosque also is a good example of this trend. While the Ardistan dome has four windows, the same feature can be seen in Sojas in northwest Iran.<sup>105</sup>



### 2.3. Decorations

Nizam al-Mulk dome is decorated with eight-rib vaults (figure No. 19), that intersect at the center of the intrados of the dome and ends at the edge of the rim; The Barsian dome (figure No. 20), was built as a model very similar to that of the Nizam al-Mulk, while the Zawarah dome was applied by 12 ribs vaults (figure No. 21). Also the Ardistan dome is decorated by 16 rib vaults (figure No. 22). The shell of Taj al-Mulk is decorated with five-rib vaults that are in fact the main components of the dome, which is in the form of a 5-sided star in the intrados (figure No. 23).

As an attempt to break the deadlock, to add greater breadth and depth to the visual dimension within their domes; The Seljuks did not neglect the spaces without decorations and worked to cover the spaces and surfaces with ornaments units. They used blank niches, also used deep and shallow niches in the decoration of the inner surfaces of walls of the domes, the same applies to blind arches. The technical method used in the decoration of domes was plain brick patterning fortified with carved stucco joints and plugs, these ornaments located at important points of chamber, their repetition alone makes an impressive effect.<sup>106</sup> The irregular pseudo-interlace basketwork pattern may well be found, in rather more carefully delineated examples, in the Barsian dome and Qurvah.<sup>107</sup> The five-pointed star and the eight-pointed star can be found at Gulpayagan dome. Innovating the use of bricks placed in intermittent geometric patterns and projections such as diagonal stripes, zigzags, herringbone and lozenges to decorate the internal facades, can be found in most Seljuk Domes.

Seljuk domes were an exhibition of Arabic calligraphy, where it was used with great skill in decoration by adapting it in specific strips and spaces with distinctive locations; The rim of the ground level is decorated with a band of Arabic inscriptions which can be found in rather carefully delineated examples, in the Zawarah and Ardistan, while the domes of Nizam al-Mulk, Taj al-Mulk, Barsian and Gulpayagan were good examples of the use of inscription band to decorate the drum.

However, The Seljuk domes in Isfahan witnessed a great renewal in the field of Arabic calligraphy types, as the circular, the Naskh and Thuluth calligraphies, were used in addition to the foliated Kufic calligraphy that was adorned with plant branches and letters connected to each other; it reached a large extent of beauty and decorative wealth. Several types of Arabic calligraphy have emerged; the foliated Kufic calligraphy, which appeared in the 4<sup>th</sup>/10<sup>th</sup> century,<sup>108</sup> was the most popular Arabic calligraphy in the Seljuk and was the most common for engraving at the time; it can be found in all the Seljuk domes of Isfahan, except for the Ardistan Dome, which has a unique other type: the Thuluth calligraphy.<sup>109</sup> The script of Ardistan is quite similar to the one used on the Na'in Mosque; both inscriptions use a similar punched rosette to decorate the empty ground of the upper zone, but the inscription of Ardistan is more attenuated.<sup>110</sup> In addition, the dome sometimes was decorated with Arabic inscriptions of Kufic style, the first of which was the dome of Nizam al-Mulk. The domes of Taj al-Mulk and Barsian, followed this approach, while the domes of Zawarah and Ardistan did not apply it.

### Conclusion

The Seljuk period in Iran was a decisive turning point in the evolution of domes structure, whether erected inside or attached to mosques, as well as those above the shrines. The

importance of the domed chamber became more important and common in the Seljuk period. The Iranian Seljuk developed architectural techniques that reduced the mass of their domes, with geometrically defined schemes and interesting proportions; using mathematical and engineering principles, these builders were able to achieve their goals. In addition, there are many deep and shallow entrances, knotted entries, square piers and blank niches with engaged corner columns; so the lower walls of domed chambers in Isfahan are more articulated.

The Seljuk in Isfahan developed the transition zones of their domes; the most important feature was the combination of the tri-lobed arch with a pointed frame. The tri-lobed squinches can therefore, be regarded as the hallmark of the domes of the Mosques of Isfahan. The Seljuk mastered this technique and put it to a good use, not only a solution to the problem of geometric transition but also addressed it in a high-level artistic manner. The Seljuk tri-lobed squinch consists of four niches. The axle acts as a piece of barrel vault supported by a plain squinch, while the lateral niches have a pointed concave shape. The Seljuk succeeded in breaking up each lobe by a series of sub-squinches, which are also lobbed. The space between each lobe contains a small niche held by a pointed arch, while the angle contains two niches, which increase the apparent depth of the squinch, and it forms a variety of aspects defined from different angles. The more lobes that the transition zone consists of, the more stability the shouldered arch net guaranteed.

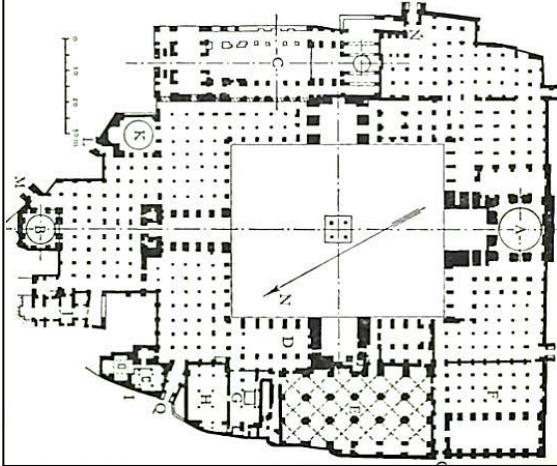
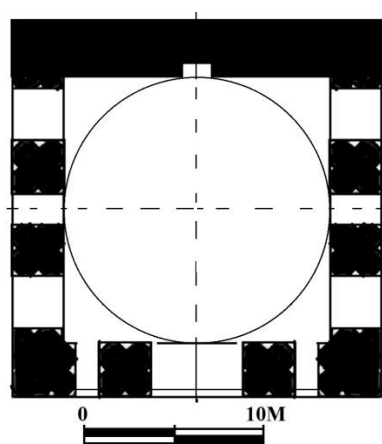
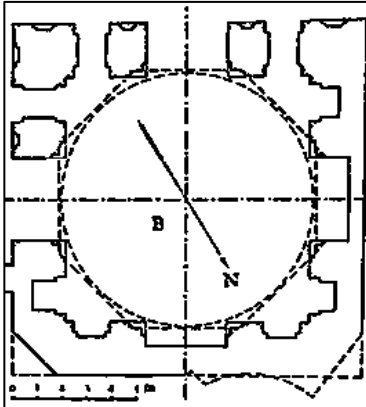
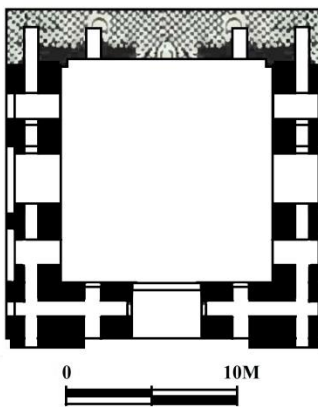
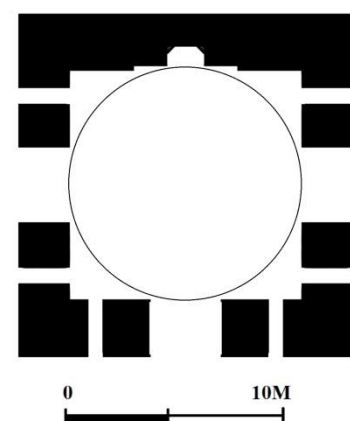
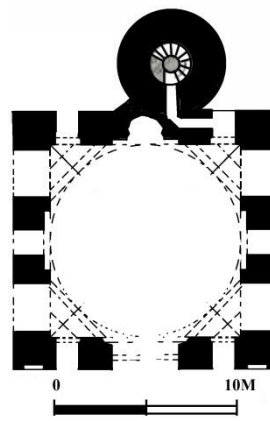
In contrast to the Seljuk domes in northern Iran, which applied the plain squinches; The tri-lobed squinch was the favorite transition zone of the Seljuk of Isfahan, as they used it in all domes in Isfahan, except for Gulpayagan which relied on muqarnas niches, and we can find the type of plain squinch in the transition zone of the dome of Ardabil. Rectangular windows are often opened on a single axis in the dome's shell, located on the upper edge of the dome's rim; the only exception is the dome of Nizam al-Mulk, which its shell devoid of any windows. Seljuk architects seem to have developed lighting systems inside the domed chambers; all domes erected after the dome of Nizam al-Mulk, its shells are characterized by windows.

Many Seljuk domes were built by the technique of rib-vaults,; Nizam al-Mulk dome has four-rib vaults divided to eight rib-vaults, the Barsian dome was built as a model very similar to that of Nizam al-Mulk, while the Zawarah dome applied the internal surface of the shell of Barsian using 12 ribs vaults. Also the Ardistan dome is decorated by 16 rib vaults. The shell of Taj al-Mulk is decorated with five-rib vaults that are in fact the main components of the dome, which is in the form of a 5-sided star in the intrados,

The Seljuk did not neglect the inner spaces of the domes without decorations; they covered the spaces and surfaces with ornaments units and Arabic inscriptions quoted from Quranic texts. They used blank niches, also used deep and shallow niches in the decoration of the inner surfaces of walls of the domes, the same applies to blind arches. The technical method used in the decoration of domes was plain brick patterning fortified with carved stucco joints and plugs, these ornaments located at important points of chamber, their repetition alone makes an impressive effect. The irregular pseudo-interlace basketwork pattern may well be found, in rather more carefully delineated examples, in the Barsian dome. The five-pointed star and the eight-pointed star can be found at Gulpayagan dome. Innovating the use of bricks placed in intermittent geometric patterns and projections such as diagonal stripes, zigzags, herringbone and lozenges to decorate the internal facades, can be found in most Seljuk domes.

The Seljuk domes in Isfahan witnessed a great renewal in the field of Arabic calligraphy types, as the circular script, the Naskh and Thuluth scripts, was used in addition to the foliated Kufic that were adorned with plant branches and letters connected to each other; it reached a large extent of beauty and decorative content.

### Figures and plates

	
<p>Figure (1) shows plan of the Friday Mosque of Isfahan (Godard, The art of Iran, 280)</p>	<p>Figure (2) shows plan of Nizam al-Mulk dome (Hillenbrand, 'Architecture and Politics', 148-173)</p>
	
<p>Figure (3) shows plan of Taj al-Mulk dome. (Hillenbrand, 'Architecture and Politics', 148-173)</p>	<p>Figure (4) shows plan of Ardabil Mosque (Godard, The Art of Iran, 276)</p>
	
<p>Figure (5) Shows plan of Gulpayagan Mosque (Godard, The Art of Iran, 279)</p>	<p>Figure (6) Shows plan of Barsian Jami' Mosque (Godard, The Art of Iran, 279)</p>

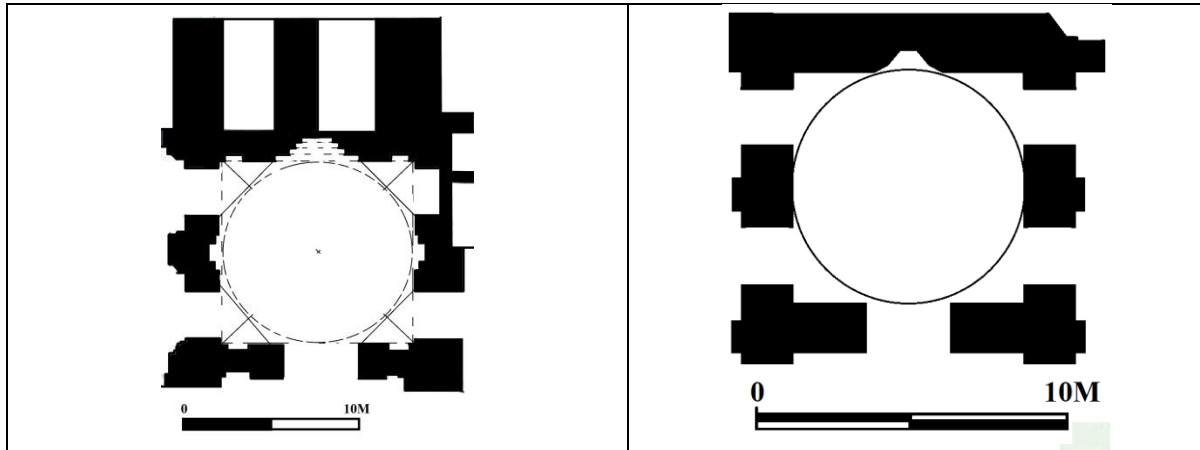


Figure (7) Shows plan of Ardistan Jami' Mosque (Godard, The Art of Iran, 278)

Figure (8) Shows plan of Zawarah Jami' Mosque Godard, The Art of Iran, 293)

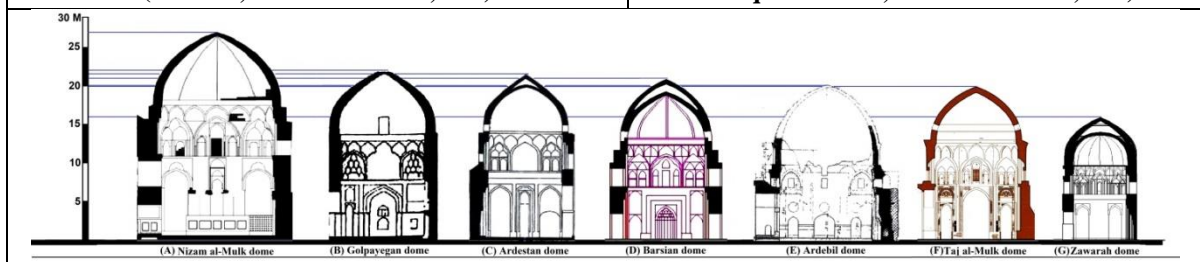


Figure (9) shows the dimensions of Seljuk's Mosques domes in Isfahan: a. Nizam al-Mulk, b. Gulpayegan, c. Ardistan, d. Barsian, e. Ardabil, f. Taj al-Mulk, g. Zawarah (by the author)

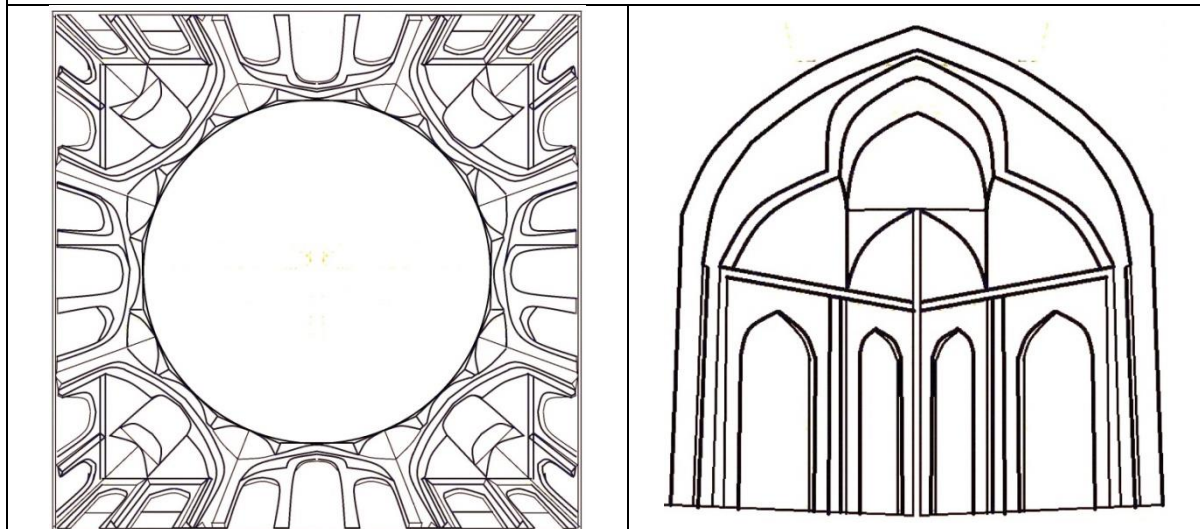


Figure (10) shows the transition zones of Seljuk domed chamber. (by the author)

Figure (11) shows the structure of Seljuk tri-lobed squinch. (by the author)

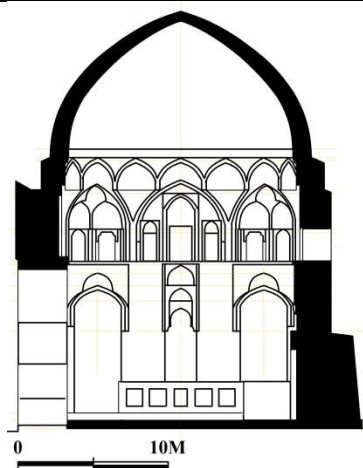


Figure (12) shows the interior elevation of Nizam al-Mulk dome. (by the author)

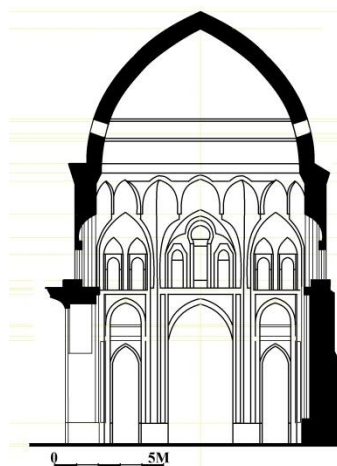


Figure (13) shows the interior elevation of Taj al-Mulk dome. (by the author)

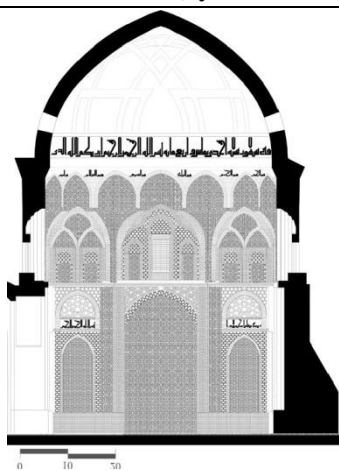


Figure (13-a) shows the interior decorations of Taj al-Mulk dome. (Kakhki, "Recognition of architectural features")<sup>111</sup>

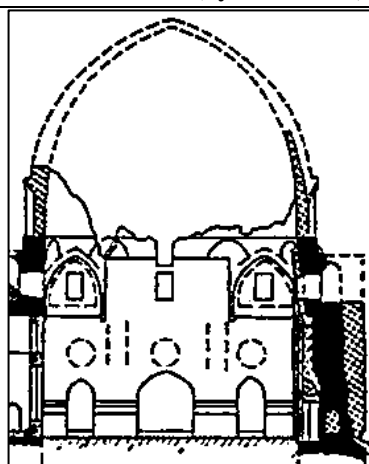


Figure (14) shows the interior elevation of Ardabil dome. (Golchin, "Explanation of Geometrical System")

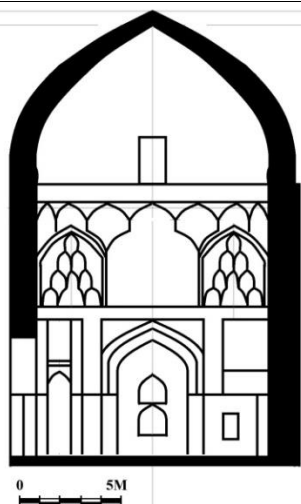


Figure (15) shows the interior elevation of Gulpayagan dome. (by the author)

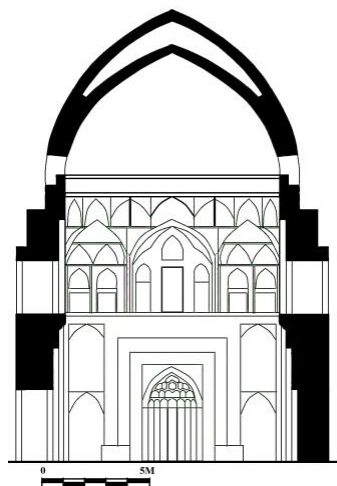


Figure (16) shows the interior elevation of Barsian dome. (by the author)

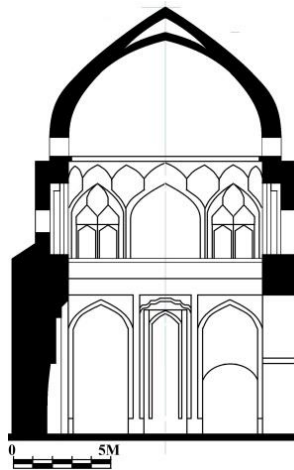


Figure (17) shows the interior elevation of Ardestan dome. (by the author)

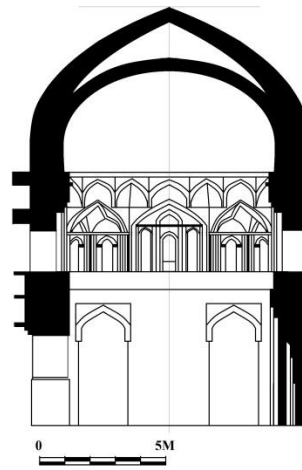


Figure (18) shows the interior elevation of Zawarah dome. (by the author)

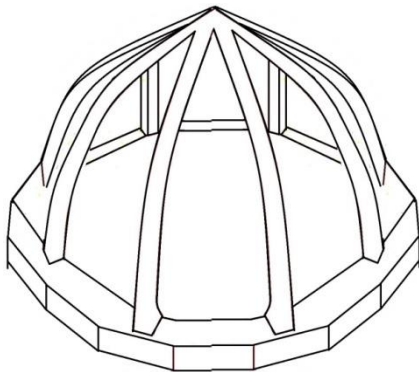


Figure (19) shows the rib-vaults and decoration of Nizam al-Mulk dome. (by the author)

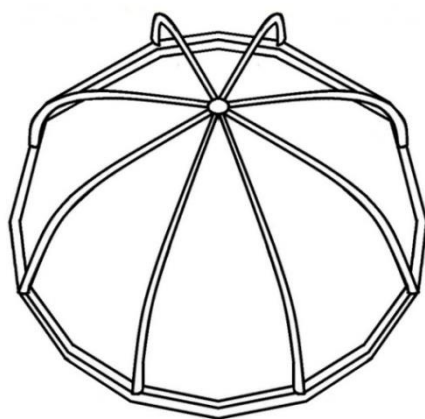
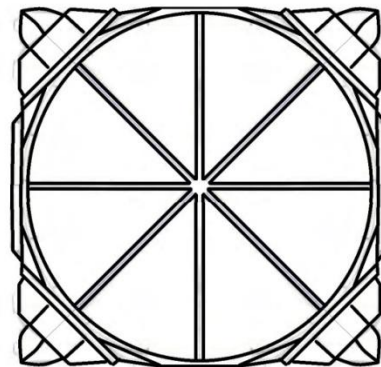
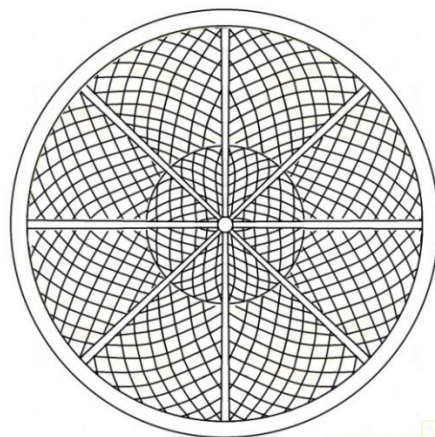


Figure (20) shows the rib-vaults and decoration of Barsian dome. (by the author)





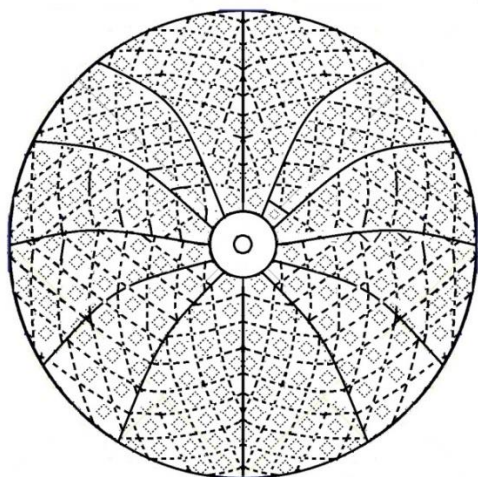


Figure (21) shows the rib-vaults and decoration of Zawarah dome. (by the author)

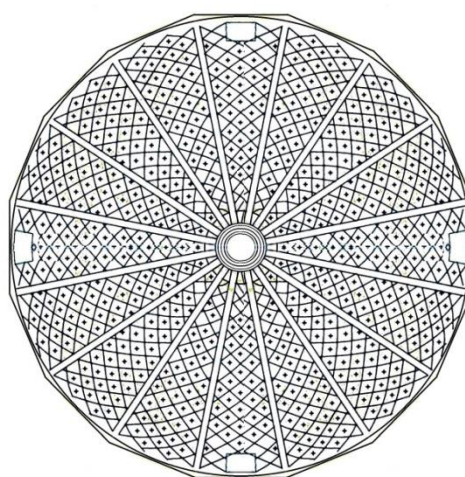


Figure (22) shows the rib-vaults and decoration of Ardistan dome. (by the author)

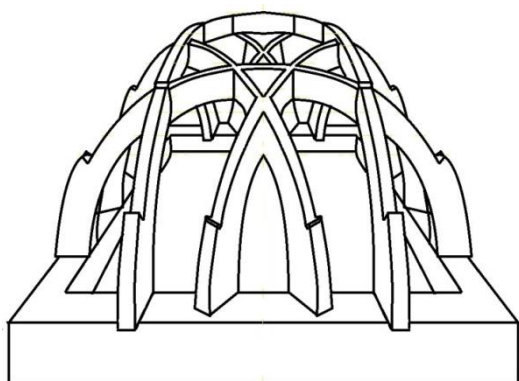


Figure (٢٣) shows the rib-vaults and decoration of Taj al-Mulk dome (by the author)

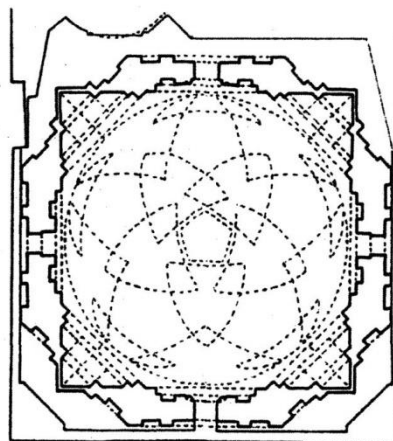


Figure (٢٣-a) shows the internal decoration of Taj al-Mulk dome. (Ghannad, a Study on the North Dome)

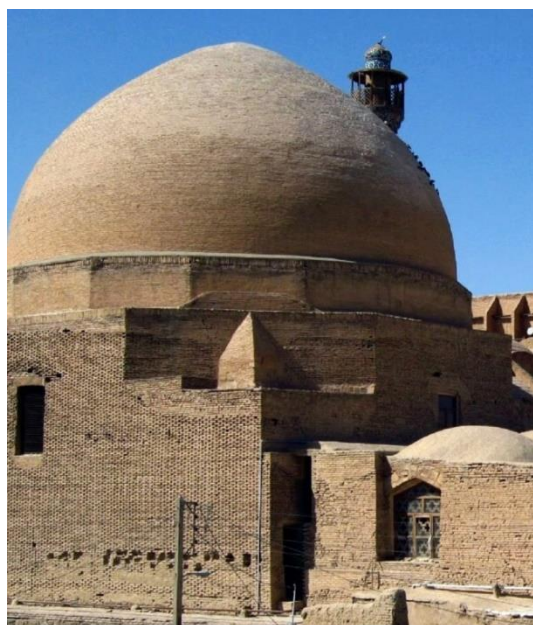


Plate (1) shows the exterior and interior views of Nizam al-Mulk dome. (Archnet)<sup>112</sup>



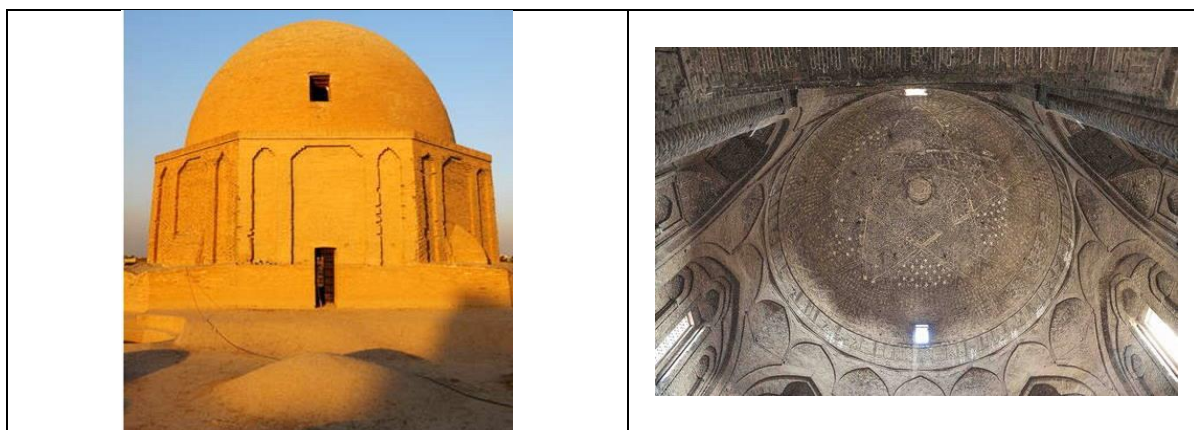


Plate (2) shows the exterior and the interior views of Taj al-Mulk dome. (UNISCO)<sup>113</sup>

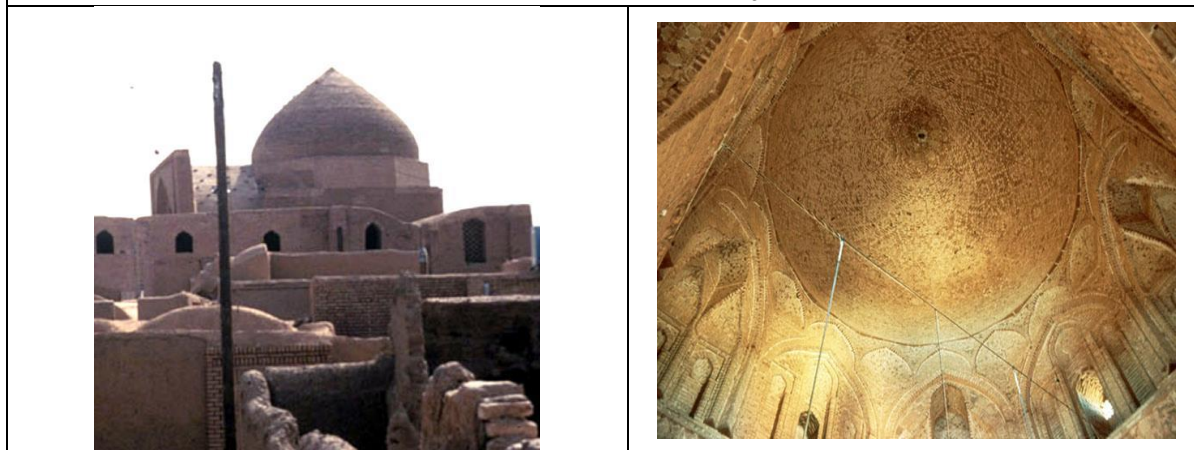


Plate (3) shows the exterior and interior views of Zawarah dome. (Archnet)<sup>114</sup>



Plate (4) shows the exterior and interior views of Barsian dome (Encyclopedia Iranica)<sup>115</sup>



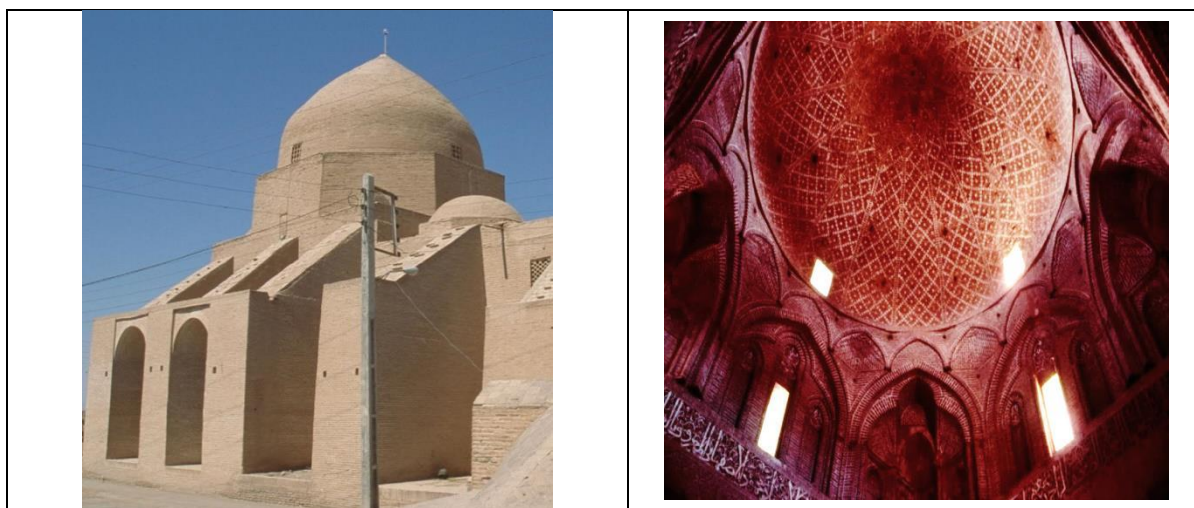


Plate (5) shows the exterior and interior view of Ardistan dome (Archnet)<sup>116</sup>

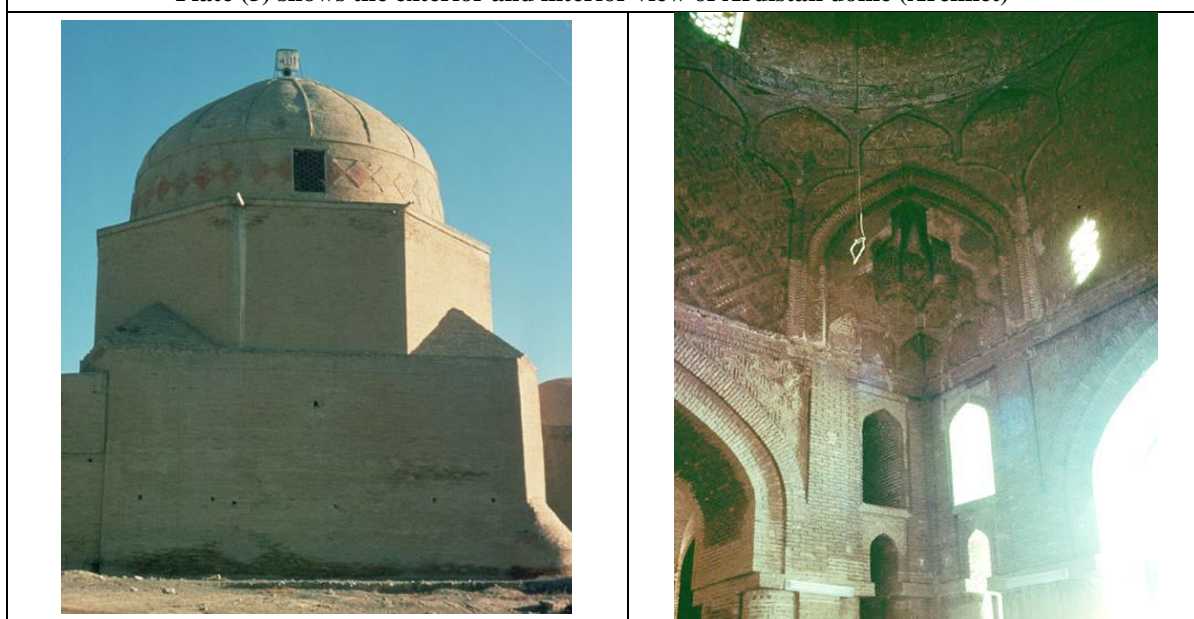


Plate (6) shows the exterior and interior view of Gulpayagan dome. (Archnet)<sup>117</sup>



Plate (7) shows the exterior and interior of Ardabil dome (Archnet)<sup>118</sup>

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