Large Scale Building Techniques in Ilkhanid Iran

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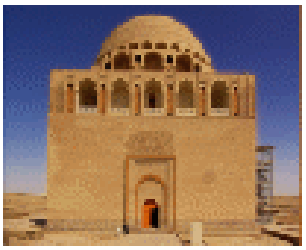
In his 1955 monograph, *The Architecture of Islamic Iran, The Il-Khanid Period*, Donald Wilber catalogued 119 monuments.[1] Of these, the first six were attributed to the early thirteenth century, before Hulagu (1218–1265) lead the Mongol invasion of Iran in 1256, and eventually established the Il-Khanid dynasty. The dynasty was relatively short lived—close to seventy-nine years. Wilber mentions only sixteen monuments during the first half of this period, but in his discussion of second half, beginning with the accession of Ghazan Khan (1271–1304) in 1295, he lists ninety-six structures. To be sure, the number does not come close to reflecting the vast number of secondary buildings that Ghazan and his brother, Oljeytu (1280–1316) commissioned in merely twenty-one years. This significant discrepancy in construction activity between the first and second phase comes as a result of Ghazan's rule. Indeed, this ruler planned, programmed, and implemented a revival in and an evolution of the construction industry as a part of his reforms to the entire structure of his state.

Prior to the Il-Khanid period, the Seljuk era builders of the eleventh and twelfth centuries had created magnificent buildings and introduced a series of technical and aesthetic solutions.[2]



The Mausoelum of Sultan Sanjar before and after its recent restoration

While Seljuk architecture continued to flourish in Anatolia well into the 13th century, the eastern provinces, Khwarazm and Khurasan, lacked any significant monumental construction after the middle of the twelfth century. Thus, between the building of the Mausoleum of Sultan Sanjar (1084/86H-1157CE) at Merv (in today's Turkmenistan), and the large-scale construction activities initiated by Ghazan Khan in 1295, the entire construction industry of greater Iran underwent a fallow period. Although some important monuments were built during the intervening 140-years, these few structures are located far apart and in the periphery of Iran's major centers.[3]

1 Wilber 1955, 100–104.

2 For an overview of Seljuk architecture, see Schroeder, 1964, "Islamic Architecture. F: Seljuq Period" in Pope and Ackerman, eds. *A Survey of Persian Art* vol. 3, 981–1045.

3 During this period of decreased architectural activity, the most significant structures were built in provincial centers such as Kirman (Jabal-i Sang, 581–82 H /1186 CE).

Although the waning of Seljuk power and the rapacious practices of the Khwarazmshahs during the decades of the late twelfth century had contributed to a disruption of building culture, the systematic Mongol incursions of the 1220s and 1230s were of a greater, and unprecedented, scale. They destroyed cities, confiscated valuables, and displaced the workforce, rounding up craftsmen and turning vast numbers of the population into slaves. Their incursion disrupted the social and economic structure of the entire Iranian region and left swaths of farmland abandoned.

This dire situation changed in 1253 when Mangu (1208–1259), the reigning Mongol Great Khan in Karakorum, dispatched his brother, Hulagu, west to annihilate the Isma'ilis (popularly known as the Assassins), to conquer Baghdad, and to subjugate western Iran's various 'bandit' tribes.[4] After this campaign Hulagu founded the new dynasty of the Il-Khanids. In an effort to cement the rule of this new dynasty, he launched campaigned of reconstruction, and initiated a new, monumental building campaign.

Hulagu and Doghuz Khatun

The very first indication of his permanent plans came in 1254, when, on his way to central Iran, he ordered the rebuilding of Quchan, a city razed by his Mongol predecessors a few years earlier.[5] A few years later, immediately after the fall of Baghdad in 1258, he ordered

4 Upon his accession to the throne of the Khan, Mangu followed the orders given by Chingiz Khan and began to organize the affairs of the empire—planning future wars and lands to be conquered, and the dividing the empire within the family. He sent his brother, Qubilai East to China and his other brother, Hulagu, west to Iran and Iraq. While Mangu instructed Hulagu on what to do in his new role, he emphasized that in all his decisions, he must consult with his Christian wife, Doghuz Khatun, and pay attention to her advice. The Mongols spent many years meticulously planning their military campaign. They gathered information about the area's mountain passes, river crossings, weather, grazing land and food and supplies for beast and man. Several groups of soldiers and engineers preceded Hulagu to prepare for the arrival of the massive army of 120,000 soldiers and his royal household and entourage. Roads were repaired, temporary bridges erected, and food supplies stored. Local nobility is required to pay their respects to the arriving Khan and contribute their share to the success of the enterprise (Rashīd al-Dīn, 685–687).

5 This may be the Mongol Empire's first military campaign during which cities were not savagely destroyed: some were rebuilt. The first example of this new approach occurred in Quchan, a city destroyed by the Mongols a few years earlier. Hulagu ordered the rebuilding of the city's houses and irrigation systems (Rashīd al-Dīn, 692).

the construction of a palace and a treasury on Shahi Island in western Iran.[6] A year afterward, Hulagu commissioned the construction of the observatory of Maraghe, a costly project where he spent 30,000 dinars on the instruments alone.[7]

Shahi Island / Lake Urumieh

By contrast, his immediate successors were comparatively less active. In the thirty years following his death in 1265, five relatively insignificant rulers became Il-khan, and exhibited only a cursory interest in new building. Among the few notable projects, Hulagu's son, Abaqa (1234–1282) restarted the construction of the impressive Iwan of Takht-e Suleiman.

Takht-e Suleiman

The Observatory of Maraghe, reconstruction

The next Il-Khan, Arghun (1258–1291) started a number of construction projects, including the initial foundation of the city of Sultaniyya, and a lofty tomb tower for himself.[8] Yet, very little of these buildings remains to today. Things changed dramatically when Ghazan, a recent

6 Hulagu is the first Il-Khan to be mentioned as *'imarat dust*, a "builder" who encouraged new development and construction (Rashīd al-Dīn, 734).

7 The famous scientist and astrologer Nasīr al-Dīn Tūsī (1201–1274) was meant to leave for the court of Qubilai Khan to build an observatory for him. However, Hulagu decided to keep Tūsī, his scholarly assistants, and major scientific library in his own realm, and to finance the very costly and ambitious construction of the Observatory of Maraghe—another indication of his slow disassociation from the Great Khan in Central Asia.

8 For an overview of the construction activities by Hulagu and his successors prior to Ghazan Khan, see *Survey*, vol. 3, 1047 ff.

Muslim convert, rose to Il-Khan in 1295.

During Hulagu's reign, finances were of little concern, thanks to an influx of plundered riches after the 1258 fall of Baghdad. However, by time Ghazan became Il-Khan, a series of unqualified predecessors had run the country into bankruptcy. As reported by Rashīd al-Dīn in his *History of Ghazan Khan*, Ghazan stated "I inherited a bankrupt empire… my fathers did not leave anything for me." During the first two years of his reign, his treasury lacked funds to the point where he could not afford to give gifts to nobility or to visiting dignitaries. Ghazan refers at length to his empty coffers, the beautiful wooden trunks he kept solely to appreciate their woodwork.[9] To remedy the situation he took control of the administration and initiated a series of far-reaching and significant reforms that addressed almost every aspect of life. Their success rapidly refilled the royal treasury. Just two years later he was giving lavish gifts and funding several projects from the treasury or his own resources. [10]

Rashīd al-Dīn and other chroniclers often mentioned that, prior to Ghazan, some of the Mongol nobility had attempted building new structures but that their efforts were of poor quality, and would collapse soon after their erection. Furthermore, they struggled to control the cost of construction and the project timeline. Often the efforts needed to organize and build outweighed the benefits that resulted from the new building. [11]

Ghazan's reforms were part of his efforts to rebuild the country. Rashīd al-Dīn outlines these accomplishments and some of his specific reforms in 40 chapters or *hikayat*.[12] As Ghazan's reforms are quite well known, I will concentrate on those directly impacting the building industry. While these reforms led to improved economic and social conditions, the transformation of the construction industry surpasses them all.[13] In order for the industry to flourish, one first had to create a secure business climate and encourage private sector investments. Ghazan completely overhauled the judicial system to eliminate the rampant corruption, theft and abuse of power by local warlords. This reformed judicial system protected the farmers, the working class, and the merchants. It encouraged them to expand their businesses, ultimately increasing the revenues paid to the treasury.

The reforms created a standard of purity for the coinage throughout the empire and established a currency system facilitating the monetary exchange for all business transactions. Weights and measurements were also standardized and regulated by law to foster confidence and ensure fair trade. The restructuring of the construction industry led to new regu-

9 Rashīd al-Dīn details the treasury's complete depletion of funds during the reign of Arghun and Geikhatu. He also talks about the precious trunks of the treasury that were elaborately handcrafted, but essentially empty (Jahn 1903, 182–183).

10 On the wealth accumulated by Ghazan, see Jahn 1903, 205–206.

11 Rashīd al-Dīn details the construction industry's deficiencies (Jahn 1903, 201–202).

12 In over 200 pages, Rashīd al-Dīn describes Ghazan Khan's reforms. Although there may be some exaggeration in Rashīd al-Dīn's portrayal of Ghazan Khan as an all-knowing, renaissance man, there is no doubt that Ghazan was a talented individual of many interests, who saved the empire and implemented considerable reforms. His large scale changes resulted in the Il Khanid Empire's resurrection (Jahn 1903, 169–374).

13 Hekayat #12 specifies the details of the construction industry's reorganization and the creation of a system that succeeded both in erecting major monuments and in improving construction quality throughout the empire. Every city and village benefited from these reforms in one form or the other (Jahn 1903, 201–207).

lation of building materials. A system of quality control was established, prohibiting the use of inferior materials. A method was established to identify the cost of construction, to monitor its progress and to document even its smallest details. The organization and oversight of a construction site was entrusted to local trustworthy individuals. They were responsible for the quality of the completed building, its timely completion and its adherence to the budgeted cost of construction.

The reforms created a system of guidelines that encouraged farming and development of vacant and abandoned lands. Every such land parcel was categorized into three groups spanning from the easiest to develop to the most difficult. Accordingly, each developer received tax breaks and incentives in proportion to the degree of difficulty of developing his land parcel. The new edicts mandated the construction of a village bath and a mosque in every town, with the revenue from the bath covering the expenses of the mosque and its activities.

Ghazan also focused on the improvement of infrastructure. Water channels were installed throughout empire to promote farming and even to provide much needed water for wild animals. There are several Nahr-i Ghazani (canals of Ghazan) mentioned in the contemporary chronicles, the largest located in the vicinity of Baghdad.[14] He also mandated the construction of defensive walls in major cities, including in the capital of Tabriz, and focused on urban planning.

The perimeter of Tabriz after the expansions of Ghazan Khan

In his plans to build a new wall around the city of Tabriz, he discussed the necessity of enclosing the gardens, farmland, and houses that fell outside the original city boundaries. He went

14 Previous Mongol military campaigns destroyed many cities and left many irrigation systems either ruined or ill-maintained. It was critical to re-build the water supply system to support agriculture, an industry not only necessary for the daily supply of food but also a revenue generating trade. Ghazan is repeatedly credited with either the repair of or the new installation of canals and irrigation systems (Jahn 1903, 144–145).

on to say that one must plan for the expansion of cities; thus including these properties within the city walls would increase property values. But he also considered the repercussions of urban overcrowding, concluding that limited space leads to a congested development, with houses of 2–3 stories, narrow streets and no sanitary facilities. This affects the quality of life in an urban area and the city deteriorates.[15] One must say—quite far-reaching planning, and a vision for the future.

While Ghazan often sponsored his construction activities from his own incomes, he encouraged courtiers, nobility and greater urban population to participate in these rebuilding activities, and often expected their compliance.

All of the above initiatives increased construction activity throughout the empire, but two aspects of late Il-Khanid architecture are of particular interest for the purposes of this initial study:

The first is the planned initiative to test the limits of structural technology and building possibilities with the intent to build unprecedented mega-structures.

The second is the regimented organization of the work force and the construction site—a system that could be the envy of any modern construction management company.

Three individuals were directly responsible for the first initiative. Ghazan Khan, his brother Oljeytu, and their ambitious vizier, Taj al-Dīn ʻAli Shah. Ghazan focused on building the first mega-structure, Oljeytu the second, and the vizier, Taj al-Dīn ʻAli Shah the third.[16]

Their intention was not only to repair the destruction of the first waves of Mongol invasions, or to rebuild necessary public and private infrastructures. No, they built to achieve immortal glory. Two great buildings remaining in the landscape of their realms caught their attention: the great vault of the Taq-i Kisra at the Sasanian site of Ctesiphon, built in 540 CE, and the giant dome of the Mausoleum of Sultan Sanjar in Merv. Both Ghazan and Oljeytu refer to the latter building with admiration, awe and ambitious jealousy.[17]

The three new building projects did not evolve in a linear fashion where the first structure would have been used to experiment with construction techniques, the second to improve

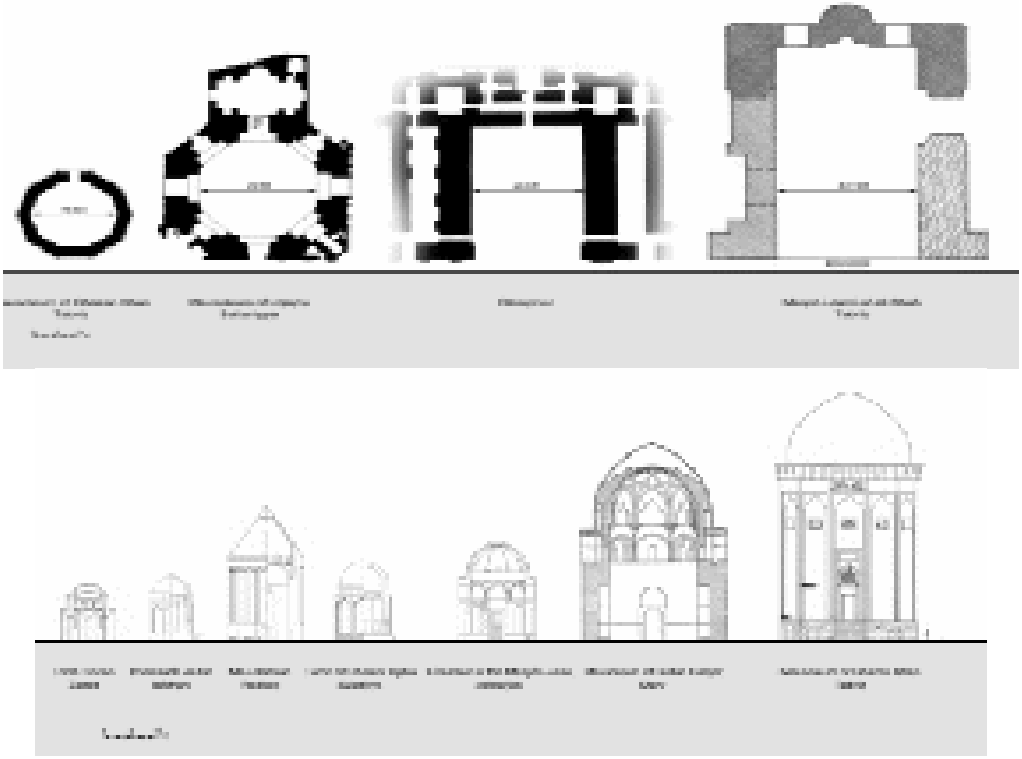
15 When planning the expansion of Tabriz, Ghazan Khan casts his focus to the future and thinks of urban planning on a larger scale. He considers the outcomes of overcrowding—high buildings that jam the streets and cut off light and air to the populace and a lack of sanitation that causes sickness. He promotes gardens and imports various species from other places to provide for a large variety of trees, fruits and vegetables. To encourage a better quality of life within the urban structure, Ghazan is willing to pay for a large portion of the public improvements out of the treasury (Jahn 1903, 203).

16 It has been often speculated that Taj al-Dīn ʻAli Shah was the actual builder of Ghazan's tomb tower. He certainly played a role in the construction of Oljeytu's mausoleum. However, it is not clear whether he was just the construction administrator or whether he had direct influence upon its architectural concept. It is intriguing that his other building, the mosque of Tabriz, is totally different in concept and vision from Sultaniyya.

17 Upon visiting this mausoleum and several holy Islamic shrines, Ghazan Khan was extremely impressed and comments that those blessed with such a legacy cannot be considered dead and even in death they are worthier than those alive. He specifically states that he will follow this example and build a mausoleum for himself. One assumes that he planned it himself and when completed, it was bigger than the mausoleum of Sultan Sanjar (Rashīd al-Dīn, 997).

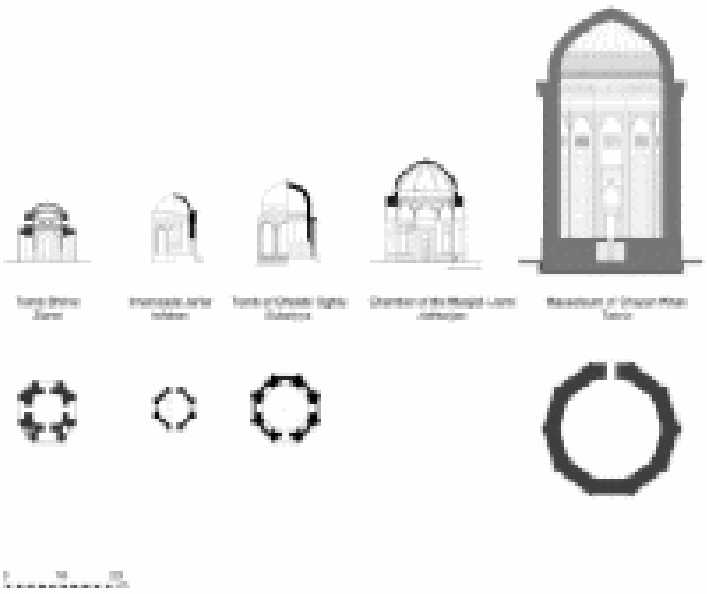
the previous methods, and the third to synthesize both experiences. They were planned and completed concurrently: three large-scale experiments, each one pushing the structural envelope within a different construction typology.

Taq-e Kasra or the Palace of Ctesiphon



The first in this trio, Ghazan's tomb tower, was inspired by Seljuk design but manifested on a geometrically increased scale. He used this 45-meter high mega-structure topped by a dome as the keystone for an entire suburb of public and private buildings.[18] Interested in the construction process of his mausoleum, Ghazan intervened directly in its design and inspected

18 For the first time a funerary structure is not just a tomb tower but a massive suburban development. While the tomb of Ghazan is the complex's most imposing and important structure, there are several other buildings—houses, hospitals, madrasas, khangahs, baths, caravanserais, an observatory, and mosque—form an integral part of this development. The maintenance costs are guaranteed by various incomes and a proper administration is in place to safeguard its operations (Jahn 1903, 207–216).



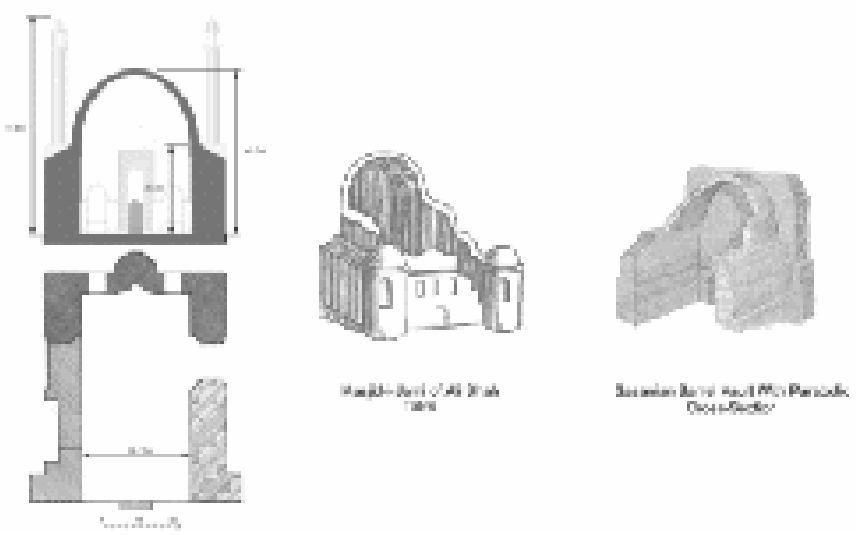
the construction site whenever possible.[19] Described in great detail by a contemporary historian, the tomb was dodecagonal, featuring a frieze of the twelve zodiac signs on the walls. Included also was a crypt. For the purpose of this paper, I am using Donald Wilber's reconstruction of the tomb tower, and have provided a possible section.[20] This, however, is a very empirical reconstruction with unresolved issues pertaining to the details of its height and its span. Following the advice of Renata Holod, I have applied the Kashani geometric proportions to this building.[21] In my exploration, I discovered that Wilber's reconstruction does not seem to adhere to the dimensions given by Vassaf. Even allowing for three different equivalents for the standard measure called the *gaz*, it appears that Wilber had applied it to the overall height, but not to its floor plan. I cannot address the problem of commensuration here, and will address that on another occasion. What is critical though is that from a structural point of view the building is described as a typical tomb tower known from Seljuk architecture—a dome that rests upon massive supporting walls—here rendered in gigantic scale.

The general technique of supporting the dome is to absorb its lateral trusts through the use of massive thick walls. There is no major new technical advancement in Ghazan's tower because a continuous ring of thick walls supports the relatively shallow dome. The builder capitalized on the known techniques of tomb tower construction by balancing the proportions of the tower with its floor plan and its total height. Although Ghazan succeeded in building a mausoleum larger than that of Sultan Sanjar, whether its diameter was larger than the span of Taq-i Kisra still cannot be established conclusively.

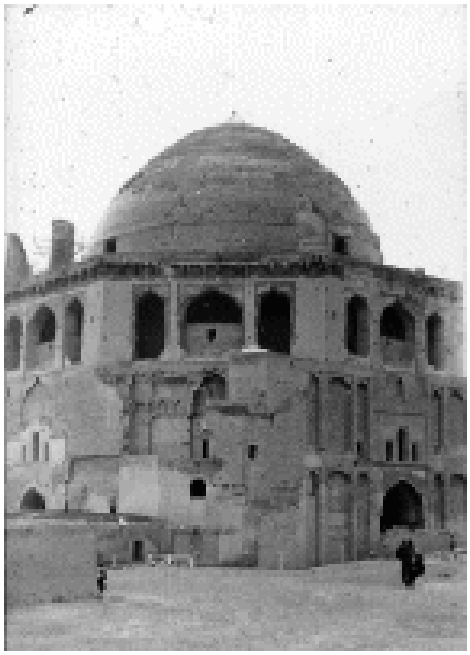
19 Rashīd al-Dīn tells the story of the Ghazan Khan visiting the construction of his tomb tower and being asked by the "muhandis" how many windows he wanted in the tower. His response exemplifies his pragmatism in affairs of state. He says, "None, where I will be buried, I will not need any light" (933).

20 Wilber, plate 17.

21 Ghiyath al-Din Jamshid Kashani, *Miftah al- Hisab*, translated by Saied Ali Reza Jazabi, Tehran, 1366. Kashani provides a complete series of formulae both for mathematical as well as geometrical calculation of numbers, spaces and forms. Of particular interest is his description of the design of various arches and domes.



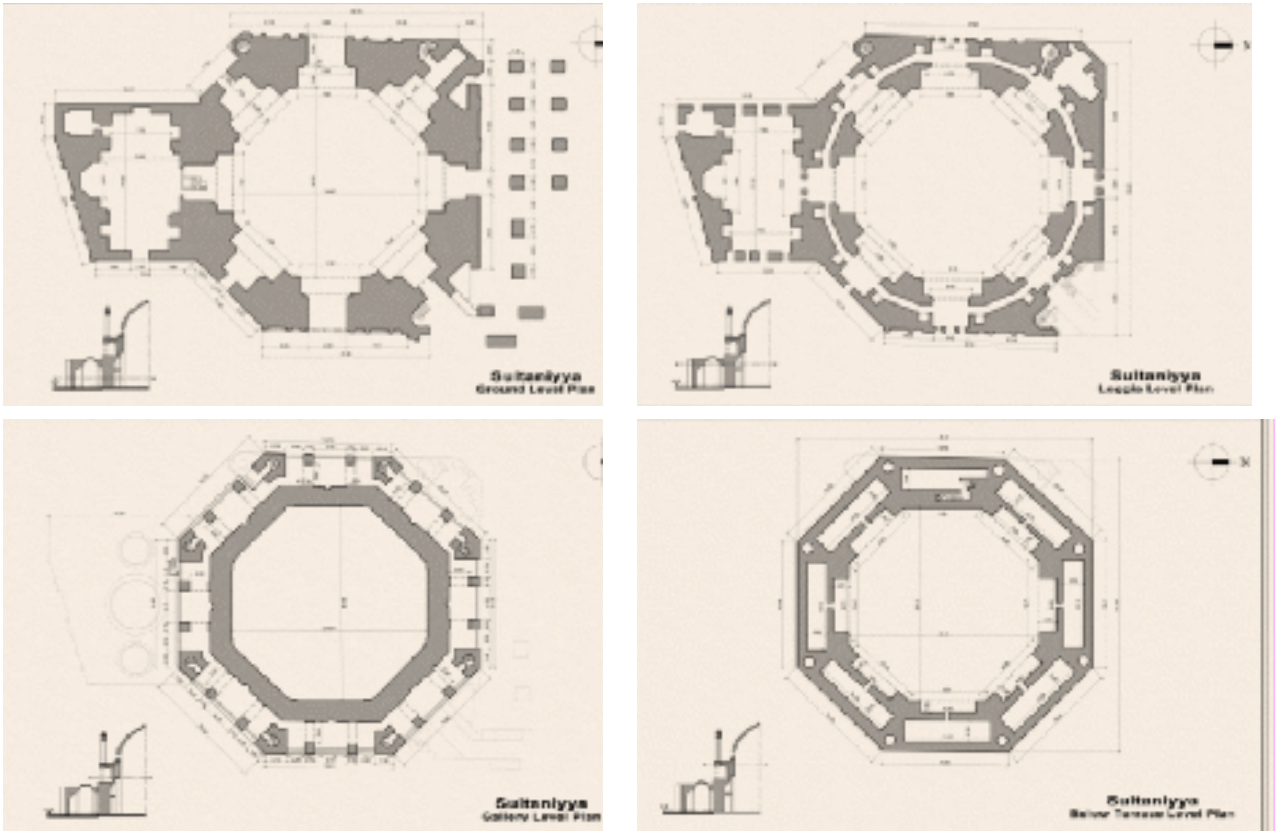
For the purpose of this presentation, I will discuss the Arg of ‘Ali Shah before dealing with the Mausoleum of Oljeytu, simply because it is a less structurally complex building. Its initial purpose and the specific goal were to surpass the arch of Taq- i Kisra. Despite its size and depth, the new structure is simply a barrel vault, one arch repeated *ad infinitum*. The issue that bears further exploration is its span, and the manner in which the arch’s lateral forces were contained. Thick lateral walls at the base, acting in a typical manner as lateral buttresses, seem to accomplish this. Again, the structure exhibits an escalation of scale but lacks technical innovation. The vizier ‘Ali Shah was commissioning the ultimate spanned space by testing the limits of known technologies. This construction technique had developed in smaller structures and could not be empirically multiplied to increase volume and scale. There is a finite point at which the structure is stressed past an acceptable limit and its building materials collapse under their own weight. Traditional construction techniques of the era failed



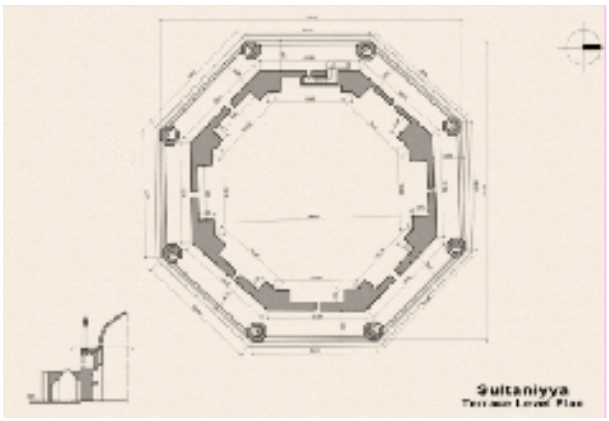
The Mausoleum of Uljaiytu prior to its restoration

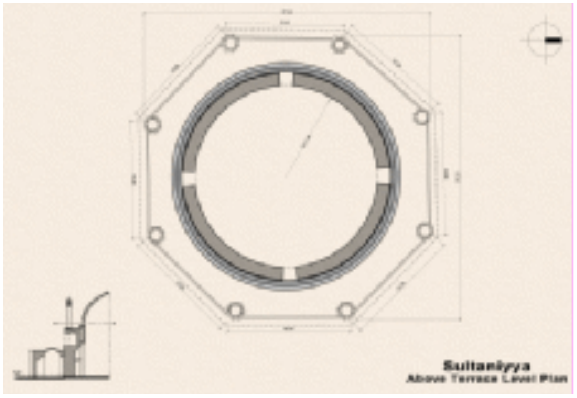
to consider this repercussion. Accordingly, Ghazan's tomb tower and the Arg of 'Ali Shah both collapsed soon after their construction for unknown reasons. Still, the collapses were not directly attributed to deliberate human action in the sources; thus, they could have been due to earthquakes, material fatigue or a combination of the two.

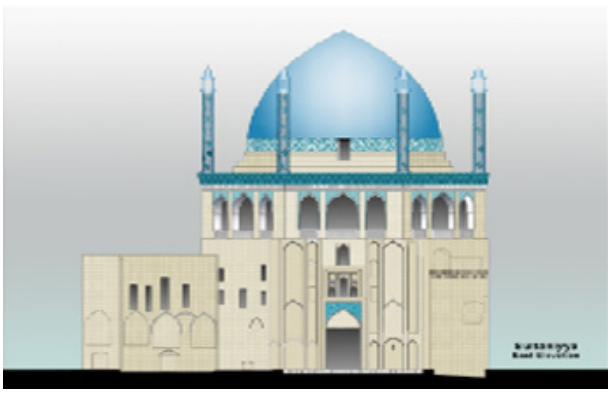
The Mausoleum of Oljeytu is the only mega-structure of the three that survived.[22] This mausoleum exhibits a completely different structural approach from its peers. Here, the experience of Seljuk builders culminated in a very sophisticated structure, one where the thickness of the walls was almost irrelevant to the stability of the building. The ovoid profile of the dome is this structure's first architectural breakthrough. This design minimized the lateral forces of the dome and was almost self -supporting. Loads generated by the dome were easily transferred to its supporting structure that rested upon a simple foundation system. While the floor plan of Oljeytu's mausoleum appears to be an octagon, in reality it must be considered a domed square structure. In a polygonal domed structure, the dome is supported by the continuous mass of its walls. However, in a domed square, the dome is supported by a zone of transition where the square meets the base of the dome. Here, in fact, the dome rests upon the apex of 8 arches, a solution that is much closer to the structure of the typical square space. A key aspect of this structure is how it becomes lighter as it increases in height. On the first floor, the massive corner piers connect with huge arched vaults or iwans. At the log-



22 A survey and study program of the mausoleum was directed by the author, between 1977–1979. Ernst Grube and Eleanor Sims studied the decorative elements of the mausoleum, and Sheila Blair read and evaluated the interior calligraphic inscriptions. See Blair, 43–96 and Sims, 139–76.



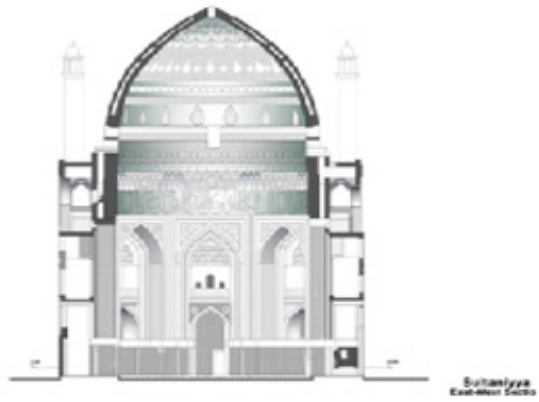


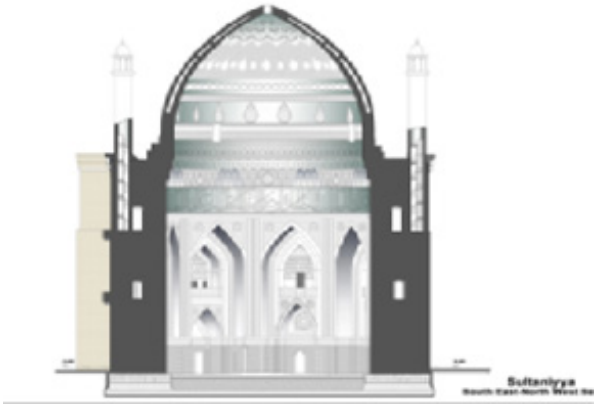


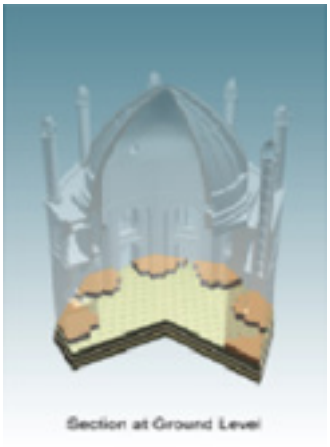
gia level, the piers are already thinned, and excavated to the maximum, thereby making the structure lighter. Little remains from the massive structural base at the gallery level, as it is now further reduced to the essential supporting elements. And finally, comes the dome level. During the every moment of construction almost each level of the building was self-supporting, resulting in a safe and efficient construction process.

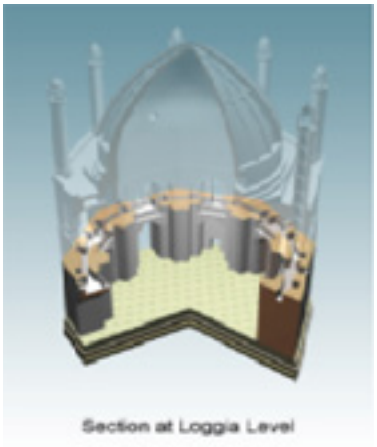
A second remarkable structural innovation is the transition from massive walls to a series of intricate arches that seemingly float within a thin layer of enclosure. This system can be called architecture of the void. The entire weight of the dome is transferred through a successive, interconnected system of arches, and then finally anchored into the foundations. The survival of this monument over seven centuries in an extremely active seismic zone bears testimony to its structural integrity.

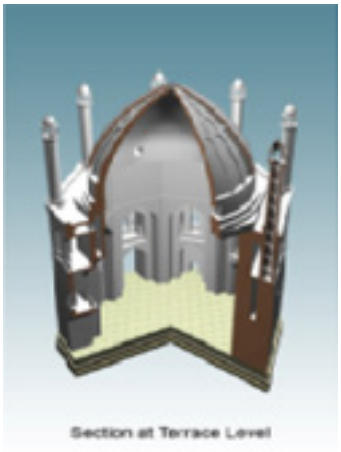
Two additional aspects of the construction bear mentioning. The entire structure is built without centering, and there was no a wooden or metal chain around the base of the dome. At the bottom of the dome, where its circular base rests upon the 8 centers of the 8 arches, the structure is continuous.





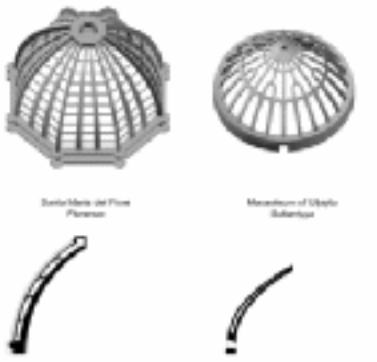






This base, acts as a bond beam, creating continuity and controlling dome's outward forces: a function similar to that of the chain at the base of domes in Europe's major cathedrals.[23]

The dome is also a double shell construction. Not to be confused with a two- or three-shell dome construction, where the two domes act separately within the structure, this unified double shell features arches on the inner shell, which support the outer shell. As a result, the dome itself is lighter in construction, with a larger base and a thinner profile as it progresses towards its apex.



Although one might argue that double shell construction was known prior to this mausoleum in greater Iran, these previous iterations featured a second shell of wood or an independent second dome configuration.[24] From a structural point of view, both types of double domes are immaterial to the present discussion of structure. However, several decades ago, San Paolesi proposed that the dome of Santa Maria Del Fiore in Florence was built by Brunelleschi with

23 When André Godard first visited Sultaniyya in the early 1930s, he noticed traces of wood in the dome area. As he could not access the higher levels of the dome, he assumed that similar to the European tradition, there would have been a wooden chain around the dome. This is proven not to be the case. The wooden beams seen in the dome are, in fact, part of the original scaffolding system. Wooden beams would be installed perpendicular to the body of the dome, within the brick structure, and used as scaffolding. When the dome was completed, these beams would be cut from the higher to the lowest levels of the dome as the workers stuccoed and decorated its the interior. A piece of the wood remained buried in the body of the dome and its outer surfaces would be plastered and painted, thus making it invisible.

24 Most notable among these examples are the Dome of the Rock, the twin towers of Kharagan tombs, and last but not least the double shell construction of the mausoleum of Sultan Sanjar in Marv.

the same technique of construction as found in Oljeytu's mausoleum—specifically the system of layering bricks called "spina di pesce" (fish spine).[25] Yet, although a localized knowledge of Brunelleschi's structure appears extremely likely, to date no direct evidence has been identified linking the two buildings together. Each structure capitalizes on the respective experience of the other—almost out of context from the local traditions.[26]

While similarities tie the two buildings together, there are also differences. Unlike Santa Maria Del Fiore, this mausoleum was never a freestanding structure. It was surrounded by a large number of other buildings, and its octagonal shape would only have been visible from a distance. The mausoleum's band of exterior galleries is also unique. Originally, such a system, as seen in the Mausoleum of Sultan Sanjar, would have been built simply to cover the ugly exterior view of the transition zone from the square to the circular base of the dome. Here, however, the galleries are located below the transition zone, and create an accessible, richly decorated, gorgeous space. And for the first time, the architecture projects with a view to the landscape.

A few words about the minarets: of the eight original minarets, only one survived into the twentieth century by the time the restoration process of the monument began. Its height thus could be clearly measured only to the point where the cylindrical shaft transformed into a larger base. To visualize the structure better, I have tried to represent the mausoleum as if all of the minarets exist, although there is no clear knowledge as to their finished height or detail.

The famous 16th century Nasuh Matrakçi painting showing a view of Sultaniyya represents the minarets as too high, surpassing the height of the dome.[27] I believe that this representation follows the Ottoman tradition of building of his time, where similar minarets, tall and slender, would have been more common than in Iran. In a number of later sketches and renderings by Western travelers, the minarets are shown at a lower height than the dome itself.[28] Once again at the suggestion of Renata Holod, I have explored three different scenarios presented here. If nothing else, I hope this will trigger further research in the future.

Current discussions of these mega-structures continue to ignore the great achievements in construction management, organization and logistics necessary for the concurrent construction of several mega-structures and their completion in record time. Writing in the fourteenth century, Rashīd al-Dīn admiringly mentioned that more people were involved in the construction industry during that time than in any other historical period. He specifically

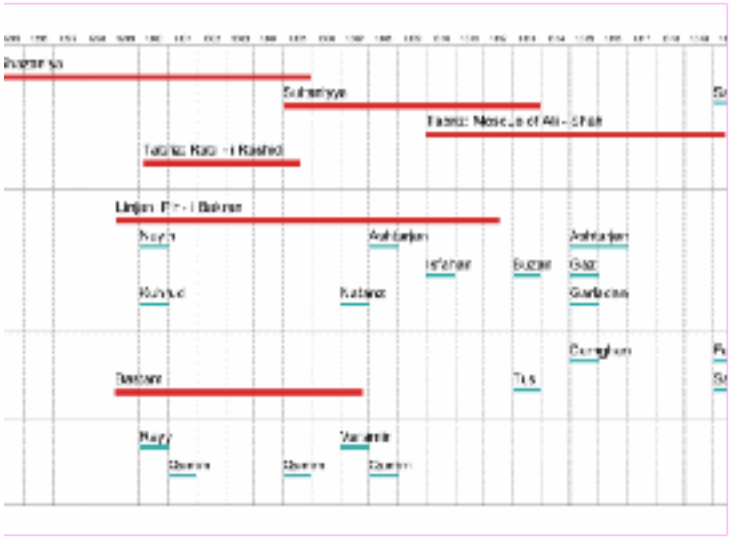
25 San Paolesi 1972, 221–260.

26 There has been considerable discussion regarding this issue, especially among Italian scholars. During a 2012 conference in Florence, several architectural historians discussed aspects of this subject; see International Scientific Congress Florence, "Domes in World," 19–23 March 2012, http://www.domesintheworld.com/

27 Matrakci Nasuh is the author of a series of important volumes of miniatures. In particular there is one describing Suleiman I's first Iran-Iraq campaign in 1534–35, the well known Fetihname-i Karabuğdan. Besides illustrating the important cities of Istanbul, Baghdad and Tabriz, he also includes many cities on the war path. The Library of Istanbul University hosts the only copy of this work.

28 See, for example, detailed drawings by Pascal Xavier Coste, in *Monuments Moderns De La Perse Measures, Dessines et Decrits*, Paris 1867.

details that (tens of) thousands individuals work on public projects, while even more are building for themselves. He also writes about the resulting ten-fold increases of property values and the incredible speed of construction.



Timeline of construction activity from 1295 through 1320

As mentioned above, there had been a century and a half of relative inactivity in new construction, since the erection of the mausoleum of Sultan Sanjar. Nonetheless, beginning about 1296, a generation of master builders emerges from Iranian soil to fulfill the demand of the new programs and requirements of their masters. The Mongol policy of sparing the lives of artists and artisans after conquest continued to foster such advances. Credit must also be ascribed to "foreign" master builders. There is clear evidence that Armenian and Georgian builders were heavily involved in the construction of the Mausoleum of Ghazan Khan. For example, evidence that Armenians were working and living in the new Ilkhanid capital, Sultaniyye was discovered by this author in a large scale Armenian cemetery on the nearby plain.[29]

Fourteen thousand laborers are mentioned in the annals of construction relating to Ghazan Khan's mausoleum in Tabriz. This construction site also included other significant buildings: schools, hospitals, hospices, caravanserais, an observatory, guest quarters and accessory buildings. While construction continued on Shamb-e Ghazani (Ghazan's suburb), his vizier, Rashīd al-Dīn mirrored the same process on the other side of the town. He built his own mausoleum, of smaller dimensions but with a similar surround of other buildings in his special quarter of Rab-i Rashidi. How many workers would have been involved in this construction?

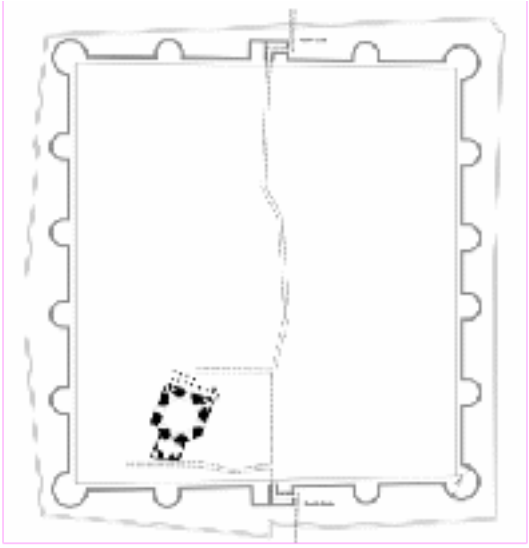
A few years later, in 1304, Oljeytu starts his own mega-structures in Sultaniyya. His mausoleum would have employed more people than that of his brother. He also built an entire city with a palace for himself, a mosque, and public buildings such as bazaars, caravanserais, hospitals, hospices, houses, infrastructure, water-providing qanats, and a magnificent, cut stone defensive wall around the citadel. Simultaneously, others are building churches, housing and secondary structure. It is amazing to imagine the new capital as a construction site.

29 Brambilla Marco, *La communita ed il cimitero Armeno di Sultaniya, Studi e Restauri di Architettura, Italia-Iran*, Roma 1980, 87–93.

Concomitant with Oljeytu's projects, Taj al-Din 'Ali Shah starts his own mega-structure in Tabriz. How many people were working on this project? One can estimate that between Tabriz and Sultaniyye over one hundred thousand workers were engaged in construction. An incredible number! Perhaps, as a result of this massive flow of human capital, these monuments were built in record time. Ghazan, who died in 1304, was buried in his own mausoleum. In this best case scenario, the building was ready in nine years. The first phase of the mausoleum of Oljeytu was completed in ten years. Consider these time frames in comparison with those of Europe's major palaces and cathedrals, which required at least a century before completion.

How did the Il-Khans accomplish this? I only know half the answer: perfect planning, an expertise of master builders of different origin and experience, and prefabrication. The actual construction and decorative work proceeded concurrently; proof of a sophisticated and elaborate, mature and advanced construction industry.

There are still many open questions concerning the Sultaniyya mausoleum. The thirty years' excavation and architectural research have revealed many details, but a clear image of the urban planning and layout of the citadel has yet to emerge. For example, why is the most important building of Sultaniyya oddly positioned next to the service gate of the surrounding wall?



The citadel of Sultaniyya with the location of the mausoleum

Sultaniyya, East Elevation after recent restoration

In this short presentation there is only so much that can be touched upon, but I hope I was able to communicate the incredible accomplishments of three individuals of Il-Khanid Iran who influenced the world architecture from the Taj Mahal to Florence, and set the course for the development of Islamic architecture in Timurid and Safavid Iran and Mughal India.

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