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INVESTIGATION ON TRADITIONAL RESTORATION TECHNIQUES OF TILING DECORATIONS IN THREE SAFAVID DOMES OF ISFAHAN

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Abstract
Safe preservation of the trailing ornamentations of the historical domes of Isfahan to these days is a well-known fact for the architects and artists of the field. A vast knowledge and mastery are required from the earliest phases of tile-baking up to the artistic executions of faience-mosaics as well as the supply and processing of gypsum, let alone a firm grasp of traditional geometry due to a complicated course of construction and restoration of faience-mosaics of the domes. Better conservation and maintenance of the architecture is demanded due to the historical, moral, and aesthetical significance of the tiled domes of Isfahan, i.e., their historical symbolism. One should firstly gain an acquaintance with the restoration methods of tiling from the earliest time to present. The study relied on the restoration process of three main historical domes of Isfahan, namely those of Jame-Abbasi and Sheikh Lotfollah mosques and of Madrese-ye chahar-Bagh.

Keywords: *Dome; Tiling; Traditional technology; Restoration; Isfahan*

Introduction

The art of ornamental tiling in Iranian architecture traces ultimately back to the ancient Elamite and Mesopotamian civilizations [1]. This art has been considered a prominent Islamic architectural element later introduced elsewhere, e.g., in Europe and Latin America [2]. The art of tiling is a cultural heritage of the past with a continuous existence over centuries [3, 4].

Tiled domes ornamented by faience mosaic are a significant element of Iranian-Islamic architecture with its own aesthetical value and popularity [5]. “Tiling crust” is a stability factor of the whole dome as well [6]. Tiling of the dome from its tip to the impost is not a mere aesthetical element and rather is an appropriate indigenous substitute for the usual western-metal-layer: it is consistent with the local Iranian climate with no conceivable alternate [7]. Tiling enjoys a protective role for the dome against rain and moisture as well [8].

Historical domes of Isfahan are composed of two main parts: the base (*Sagh*) and arc (Fig. 1). The outer crust of the dome is formed from a number of concentric intersecting domes. Each equally segmented vertical slice of the dome’s hemisphere bounded by two meridians, known as *Tark*, converges to the tip of the dome. Each dome is identified by its number of *Tarks*; e.g., the dome of *Jame-abbasi* has 16 (Fig. 1), *Lotfollah* has 8, and *Chaharbagh* has 12 Tarks. Nowadays the study of historical, artistic, and cultural monuments and their conservation are among the

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serious obsessions of the global cultural community. One of the important strategies in pathology and restoration of historical monuments and in decision-making for their endurance is to learn the underlying technical "science" or executive technics, or, loosely speaking, their "traditional technology." This holds for the material content and their processing for the optimization of the restoration process as well [9-11]. Historical monuments have always been considered as appropriate paradigms for the continuation of artistic traditions and "traditional technologies" according to indigenous and ecological resources, leaving their maintenance and restoration as of great importance [12]. The repair of the worn parts of the historical monuments is also considered as a strategy to endure "architectural spirit" [13] and as a treatment to promote the indigenous traditions [14].

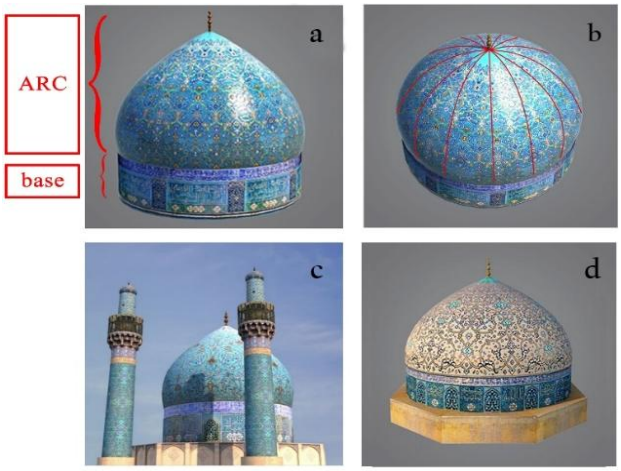


Fig. 1. Three-dimensional model: a. *Jame-abbasi, base* and arc; b. *Jame-abbasi*, *Tark*s; c. *Chaharbagh* school dome*;* d. *Sheikh Lotfollah* dome (M. Dadkhah)

Conservation of European tileworks has nothing to do with their Iranian counterparts [15] due to basic differences between the two, which should be clarified so as to be respected on the basis of world heritage sites' management guidelines [16]. The traditional art of Iranian tiling enjoys some historical-cultural peculiarities, including the difficulty and complexity of production techniques and executions [17], the capability of being repaired [6], rendering a sort of identity to urban spaces [18], and enjoying an aesthetical significance [19]. Restoration of Iranian dome tiling is carried out by traditional methods and is classified as intangible heritage. Thus, any measure within those frameworks without respecting the architectural, artistic, and traditional technological bases would be accounted as infelicitous. As a result, any change imposed on the form of tiling crust requires changes applied to the shape and size of its designs [20].

During recent decades, the faience mosaic covering of a number of prominent mosques' and historical monuments' domes has suffered from serious damage to their tile ornamentations, leading to shrinkage of the crust, wrinkling of the different levels of the dome, separation of some parts of the tiles, the appearance of asymmetry, and variation of the colors and designs, all pointing to a considerably reduced effective lifetime of the domes' faience mosaic ornamentation restorations [11, 21].

Available evidence based on cultural heritage experts as well as faience mosaic masters' remarks shows the more recent the dome, the shorter becomes the lifetime of the tile-covered dome restorations; by now the effective lifetime of tiled layer restorations of the important domes of Isfahan has been reduced to just ten years, after which it enters the erosion phase [20], while in the more remote past of the Safavid era, substitution of tiling layers became necessary just two times within a century [22, 20]. It should be noted that the very destruction of tiles and

worn mortars for the sake of reinforcement and reconstruction of the dome's tiling layer can give rise to irretrievable damages due to the appearance of the main bricked surface of the dome followed by the leakage of water and penetration of moisture and due to the exerted hits for separating worn tiles and mortars from the surface of the dome.

Precedent of restorations of the main three domes

One finds the traces of tiling processes of the past 400 years within each monument of Isfahan as a result of permanent repairs then in progress [4]. Inscribed bricks point to repair and restorations of parts of the monuments and their domes in the Shah-Abbas period and that of his successors. The same has been evidenced after the fall of the Safavids, during the reigns of Fathalishah and Naseraddinshah in particular. Among these traces is the use of linseed oil and other natural products to leave the gypsum mortars as impermeable [21]. Some drawings of [23] during the reigns of Mohammad Shah and his son, Naseraddin Shah, show the unscathed condition of the domes' tiling at the time (Fig. 2). Frequent rebellions and abandonments of urban centers between the Safavid and Qajar periods badly damaged domes' tiling; many attempts were made by Isfahani artists [4] and philanthropists [8] for preservation and retention of those tiling-included monuments.

Fig. 2. *Jame-Abbasi* mosque dome, *Balenj*, or the impost of the dome: height determined by the arrow and the assumed horizontal line

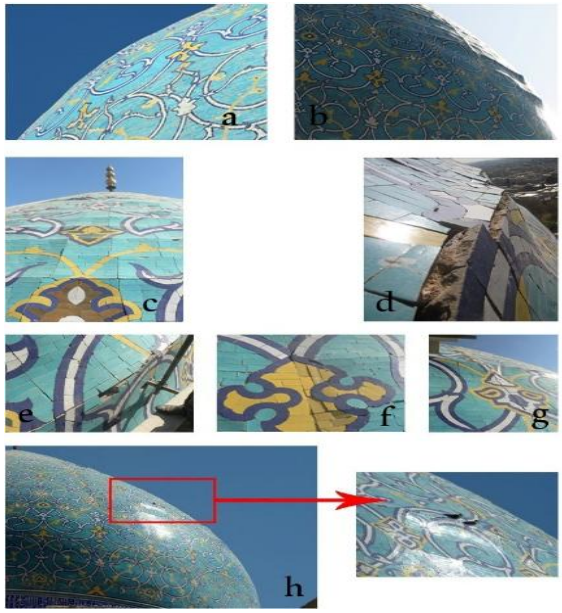


Fig. 3. *Jame-Abbasi* mosque dome: a. Inflamed tiles; b, h. Wrinkled tiles; c, d, e, g. Breaking and separation of tiles from the dome; f. Lack of adhesive mortar on the back of tiles after the 1980s and 1990s restorations

In the following, the history of the restoration of the researched domes is given in tables 1, 2, and 3. Some written sources have pointed out the restoration of the tiles of this monument.

Table 1. Precedent of Jame-Abbasi Mosque dome restorations

Time	The reason	Restoration Method	Master Craftsman	Restoration Problems	Source
The Qajar period	Collapsing part of Safavid tiles in the lower part of the dome	------	------	------	[24]
From 1931 to 1936	------	Replacing the Safavid tiles with modern ones	------	The difference in the design and color of the tiles, though they differed from the original ones as figured in the book by Holster [25].	[24]
1949	------	------	Abdul Ghaffar, Abdul Razzaq, Ali Moqzi, and Haji	------	[26, 27]
From 1980 to 1991	Inflaming of tiles resulted from earlier works of the 1970s	-Removing the separated tiles from the body of the dome and some renewals of the crust of the tiling - Cleaning a part of Safavid tiles and re-implementing them	------	------	------
From 1991 to 2001	------	The renewal of the dome's crust of the tiling except for its part known as b*alenj* (Fig.2)	Hosein Mosadeghzadeh	This restoration suffered from serious wrinkles and collapse of tiles in threeTarks in 2010 (Fig.3).	------
From 2011 to now	------	The whole of the dome's tiling crust, even at its *balenj*[1] and impost, was replaced and renewed.	Mehdi Pakdel	Changing the arch and form in the upper part of the tiling of the 15th and 16th parts of the dome (Fig. 4). Changing the color and design of the details of the tiles	------

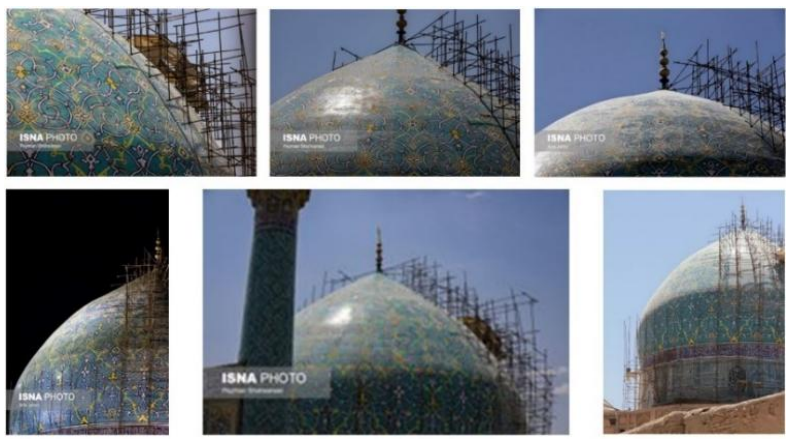


Fig. 4. *Jame-Abbasi* mosque dome, A deformed shape and arc of the upper part of the dome after the recent restoration [24]

Table 2. Precedent of restorations of the dome of *Chahar-bagh* school

Time	The reason	Restoration method	Master craftsman	Restoration problems	Source
1855	Loss of its original beauty and the necessity of repair (some 50 years before those of his own)	------	-----	-----	[22]
The Pahlavi period	-----	-----	Abdul Ghaffar and Haji Ali Moqzi	-----	[26, 27]
1994	Damages have been described as the collapse of tiles from the body of the dome due to climate issues	Installing and replacing a buttress, carving of tiles[2], and laying tiles on the main frame over the two Tarks.	Ali Moqzi, Hosein Taheri, Hasan & Hosein Zareei	-----	[28]
From 2011 to 2013	-----	-----	Hosein Mosadeghzadeh, Mohammad Poorhamedani	Creating the asymmetric shape of the dome, the step-like shape of the arrangement of the tiles, height differences between two adjacent Tarks, and variation of design and colors of this dome (Fig. 5).	-----
From 2012	-----	Restoring 3 tareks out of 12 tareks	Panjehpoor	Figure 6	-----

Fig. 5. Dome of *Chahar-bagh* school: a, d. variation of colors and design; b. level difference of two adjacent *Tark*s; c. the general façade of the dome; e, f. inflamed tiling crust; g, h. asymmetric shape and step-like layout of tiles due to failed restorations; l. Collapse of part of the tiling

Fig. 6. Dome of *Chahar-bagh* school, recent restoration of tiling

Table 3. Precedent of Lotfollah Mosque's dome restoration

Time	The reason	Restoration method	Master craftsman	Restoration problems	Source
The first Pahlavi period	partial collapse of tiles in the base of the dome and in the entrance gate.	------	Abdul Ghaffar	-----	[26]
recent decades	-----	-----	Hosein Mosadeghzadeh	-----	[27]
The last few years	Worn plaster mortar sticking the tiles to the dome body.	Using historical tiles along with new tiles.	Rahmat-allah Rezayat & Mehdi Rezayat	Figure 7	-----

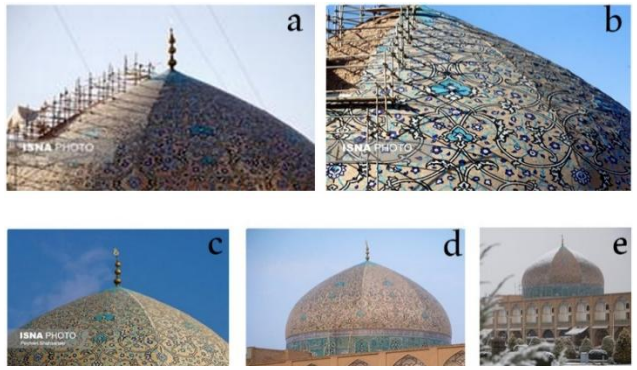


Fig. 7. *Lotfollah* Mosque dome: a, b. dome during restoration (2019); c, d. color variation of the restored *Tark* with respect to old *Tark*s (2019); e. as the tark was not being snowed, contrary to the rest of the tarks (January 2020). sources a, b, c [24]; d, e [29]

As is already noted, conservation and maintenance of the domes' tiling is a very complicated and precise process, including documentation of the plan and dimensions of the dome, making a fermented mold, implementation of the plan and design over the mold, removal and transferring of worn tiles and mortars from the dome's crust, reinforcing and returning them to their original location, and making appropriate new tiles while respecting the dimensions, designs, and colors so as to substitute the tiles' crust. These render the restoration projects of the domes as the biggest, most expensive, and most time-consuming ones. The process is carried out with such materials as gypsum mortar, metals, wood, and palm rope, all being sensitive to moisture; thus, the process requires being done with specific time interval lapses. The destruction of the domes is rather different from that of other architectural elements covered by a tiling crust due mainly to their high altitude and vast surface as well as their curved shape. For example, the tiles are not easily accessible compared with those of other structures and

elements. Meanwhile, the damages do not immediately become exposed to direct observation of the visitors and become so only after the whole structure undergoes damages and thereby enters a critical condition. This causes the restoration process to be intrinsically a critical one. Employing modern technology for parts of the program contributes to the problems from another side [30]. Their relatively awkward position within a monument leaves the domes as potential targets for further damage during the restoration process [1].

Due to much less rainfall in Isfahan in recent years, the corresponding damages have been reduced; otherwise, the lifetime of tiling crusts would have become much lower than what is currently observed. Thus, one should always consider choosing suitable and durable restoration/reconstruction materials so as to provide more efficiency and functionality of the monument itself [31] as well as to secure a more economical and financial-saving restoration process [32]. Tiling restoration is a multidisciplinary job requiring professions other than that of tile workers as well, such as tile carvers[2], tile bakers[3], designers, carpenters, and painters [19]. One of the main issues is the shortage of master workers: the remaining ones are mostly old-aged and unable to work efficiently due to the height of domes. This sort of exclusion of work within a limited circle of local-traditional masters leaves not so much space for modern-scientific interventions, inclusion of critics and advisory notes, and also training young masters [20]. Thus, a detailed recognizance of Isfahan's dome restoration programs can give rise to the development of sophisticated methods with much fewer expenses, enabling at the same time the appropriate offices to obviate many of the up-to-now "intrinsic" problems.

In this paper the usual contemporary methods of supplying, making, and restoring methods of tiling of three main historical domes of Isfahan, from production to execution, and their associated problems and obstacles have been investigated. Our conclusions are immediately generalizable to other domes so as to modify the current methods in use elsewhere for other tiled domes and even for every sort of tile-covered monument.

Experimental part

The study has followed a combination of library, field, and interview methods. A vast domain of written sources of every sort, from historical-artistic to restoration reports and archived files in the Isfahan Cultural Heritage Organization, has been studied due to a lack or shortage of sources directly specified for the domes and their tiling. Among these are reports of some prominent scholars such as Homai, Goddar, and Pope, who have documented the historical experiences related to the conservation of the tiling heritage of the domes, and the Isfahan "university of art" dissertations and treatises on the issue of domes and their tiling. Moreover, we have attempted some field studies through interviews with the traditional masters of the past and present generations, attending continuously at some active tile-restoration workshops of the three main domes of Isfahan, and gathering photos of both past and present to provide material for the present article.

Usual methods used in the restoration of domes' tiling ornamentation

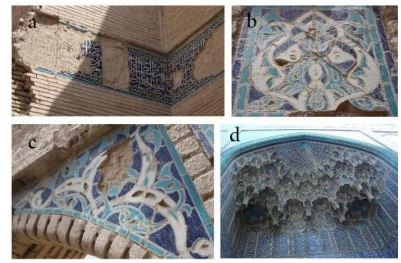
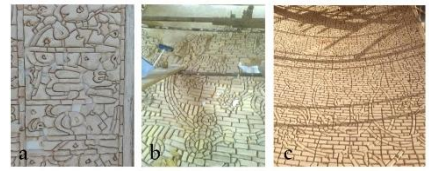
The traditional methods of repair/restoration of domes' tiling, through replacement or substitution of historical materials with new products in particular, are in gross contradiction with the modern principles that emerged from the so-called "universal conservation movement" [33]. It is for this reason that the current general method of repair and restoration of tiles and tiling in Iran and in adjacent countries has always been under critical assessment [34], as was the case in Isfahan itself from when the board of experts of restoration was founded in the city's university of art.

Tile-making and carving techniques in the restoration of domes' tiling ornamentation

The repair and restoration of the domes' tiling are influenced by their corresponding executive methods. In this section we first introduce a kind of traditional tile known as Narreh

in Persian (Table 4) and then deal with the making technology and carving of faience mosaics in the tiling of historical domes of Isfahan.

Table 4. Tile-making and carving techniques

Types of Tiles	Attributes	Construction technologies	Pictures
4-1-1-**Narreh**	*Narreh* has had the most application in the tiling ornaments of the domes (Fig. 8) from the earliest eras of their history due to their specific shape and size compatibility with the curved surface of the dome. pp. 42-44 [5].	It is produced within the tile and terracotta baking kilns (Fig. 9) by traditional tile "artists" familiar with the tile's body and its traditional glaze, mineral materials and their extractions, and material content. The body, or biscuit[4], of the tile is built from clay and stone paste[5] (Fig. 10). This paste takes the form of the mold and becomes baked within the kiln. In prescriptions remaining from the Qajar period, the use of tin and lead in making its glaze and color, which existed in the Safavid period, has been mentioned [35]. Colors needed for the glaze were supplied from the nearby mines. Unfortunately, due to the high costs of producing traditional materials, today glazes are being made principally with industrial materials [30].	 **Fig. 8.** *Narreh* tile, its obverse and reverse, and some colors of its glaze  **Fig. 9.** a. Closing of kiln door while it is baking; b. Kiln with laid tiles after baking of tiles[3]  **Fig. 10.** Crude body of tile without glaze, known as biscuit
4-1-2-faience mosaic	This means inlaying small pieces together of tile each carved with different design and color like a single large piece to be erected on the wall (Fig. 11) as an ornamental element of the monument or the mosaic-tiled dome. In this method thousands of pieces of tiles are put together to form a single design, p.50 [5]. The advantage of mosaic tile is its capability to be laid over a curved surface as that of a dome or of a minaret (Fig. 11-D). Thus, if	For this, monochrome tiles are provided with specific known designs and colors, to be carved in accordance with the color and dimension of the general design in mind, each with their own size (Fig. 12). Then the pieces are put inversely, i.e. from their glazed side, on the general design's surface, while their glazed-free side facing outward (Fig. 13). Then the pieces are fixed together using gypsum mortar (Fig. 14) [8]. **Patterns of tile designs:** A type of design with specific combination of spiral or helix pattern were used in Safavid period ornamentations of domes, locally known as *eslimy, khataii, and Toranj*. Their design's detail required a good knowledge of geometry due to the arced surface of the dome. Thus, the arced surface of the dome was divided from its tip to the base (*Pakar*) to several equal slices known as *Tark* (Fig. 11-B). Then the designing was carried out repeatedly over each slice/*Tark* up to the coverage of the whole	 **Fig. 11.** A. Faience mosaics of the Safavid portico of the *Jameh* mosque of Barsian[6]; b, c. Faience mosaics of the Mozaffari-period[7] shrine of Shah-karam; d. Stalactite of the *Chaharbagh* school gate  **Fig. 12.** a. Sticking of a paper design on a monochrome tile glaze; b. Carving of tile according to the paper design; c. After carving. (sources: a, c. CHO; b. Enayati) 

it is to be restored, it doesn't become disharmonious with the rest of intact tiles.

dome and forming of its design. some complicated geometrical calculations are required in dome cases due to their arced surface and the way tiles should be accommodated together in such situation. The calculations include finding the "arc" of dome, making a mold known as *Takhmin* or *Takhmir*[8] Fig. 17 left).

Fig. 13. Pieces of mosaic tiles of *Narreh* type and their inverse lay out over the mold, a: base of the *Lotfollah* mosque dome; b: Dome of *Jame-Abbasi*; c: dome of *Chaharbagh* school. (sources: a, b. CHO; c. Panjehpoor)

Fig. 14. *Chaharbagh* school dome, Gypsum mortar being poured on the back of *Narreh* tiles. (source: Panjehpoor)

Traditional methods of faience mosaic execution over the dome

Two methods are used for the replacement of worn tiles with the new ones or, in fact, a reconstruction of the dome's design:

Complete dismantling of the tiles of one Tark of the dome and its replacement

In which the whole of the old or worn tiles of a *Tark* are separated from the dome's surface with a double-headed chisel, and the worn mortar is also carved up to the dome's rough surface known as *Zebreh*[9] (Fig. 15). Then new tiles are inserted during several consecutive steps. It should be noted that within restoration projects the removal of tiles is not included in the *balenj* part of the dome, whose tiles are usually best preserved due to its less arced shape compared with the upper parts of the dome, as stated earlier (Fig. 15).

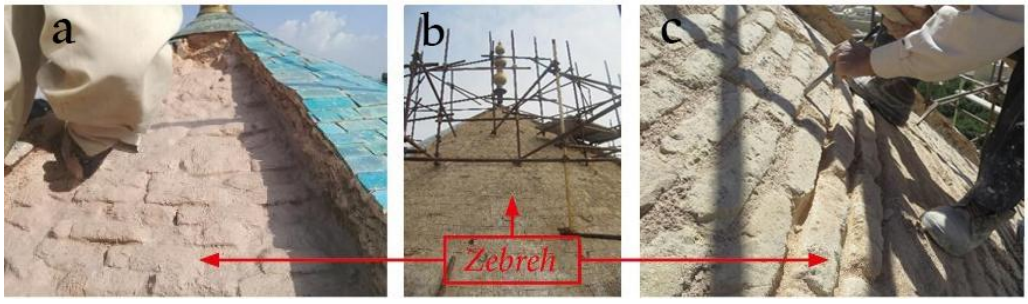


Fig. 15. The main bricked (*zebreh*) body of the dome after dismantling of old tiles and before laying of new ones: a: tip-shaped head of the dome of *Lotfollah* mosque; b, c: dome of the Jame-Abbasi school. (source: CHO)

The steps of tile restoration projects are as follows:

a. Installing of the buttress, today mostly of metal, replacing the wooden counterparts of the past. It is put on the two *Tarks* of the dome in a step-like manner and rarely covers the whole of the dome's area (Fig. 16).

b. Finding the arc of the dome, known as *Chafd*, for making the curved mold; it is one of the most important steps of the restoration program (Fig. 17: left), the successful implementation of which counts as half of the whole plan. The distance between the back of the tiles and the dome's rough surface (the location of grouting, Fig. 17: right) should be everywhere even and at its least possible ordinate to provide the space for grouting. Two methods exist for the calculation of the dome's arc, with the first one being more practical.

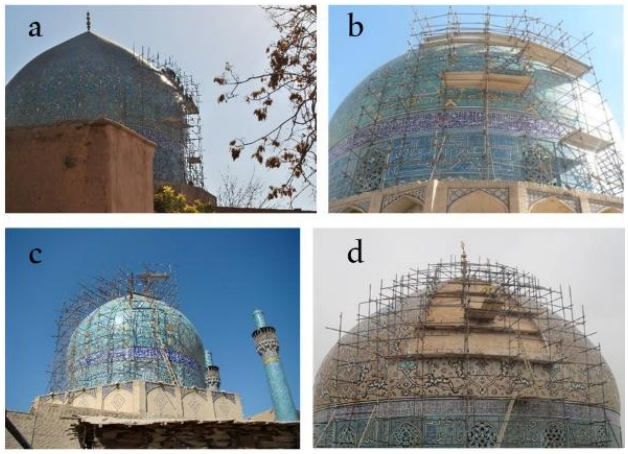


Fig. 16. Buttresses over historical domes of Isfahan: a, b: *Jame-Abbasi Mosque,* 2010; c: *Chaharbagh* school, 2010; d: *Lotfollah Mosque,* 2022 (sources: a, b, c: Motalebi; d: CHO)

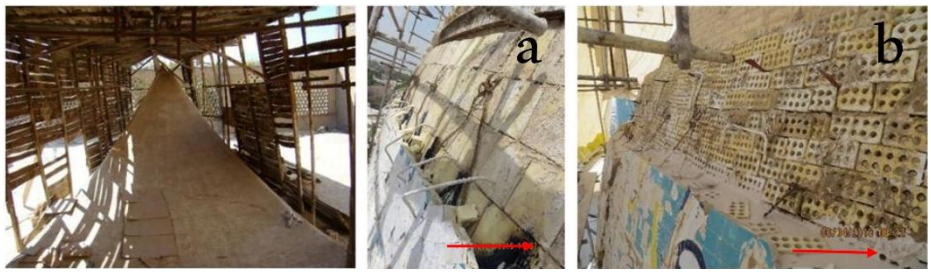


Fig. 17. (left): Curved mold of the dome of *Chaharbagh* school before laying of tiles (source: Motalebi) **(right):** Grouting part of the *Abbasi Jame Mosque:* a. before grouting, 2015; b. after grouting, 2018 (source: CHO)

The first method: For finding the latitude and longitude of the arc of the dome, first wooden slabs of 1.5 to 2 meters long and 7cm wide are used as a template to show a part of the dome's arc. It is put over the dome's surface on the separation of one *Tark* from the adjacent one and then shredding it from the ordinate up to the point when the slab's curvature becomes tangent to the curvature of the dome is started. Then the surface of the dome at the start and the end of the slab is marked, and the next slab is put at the endpoint of the previous one over the dome's surface, and the previous step of shredding of this one is repeated to find the longitude of the arc. Now a copy is taken from every shredded slab to be attached to each other in a dovetail (consequential) manner (Fig. 18, left). Now two lines of separation of one *Tark* from two adjacent counterparts are obtained. It is necessary to find the arc latitudes (orbits) of the *Tark* to fix the slabs on the ground, showing two boundaries of the *Tark*. Now the slabs are held perpendicular to the meridians of the dome, and their shredding is repeated in the same manner to find the latitude curvature of one *Tark* of the dome (Fig. 18: between, right). From the tip of the dome to the impost of the arc, slabs are put on the latitude arc for every 5 meters to complete finding the arc.

The second method: Here practical steps of mold making are the same as before, with the difference that the plumb-line height of each point of the dome is used to find its arc: from one-point tangent to the dome, a line is provided perpendicular to the surface of the roof; then by measuring the distance between each point up to this line, slabs are being cut with these lengths to find the chassis of the concave/negative mold. This method is usually used to correct the first one [36].

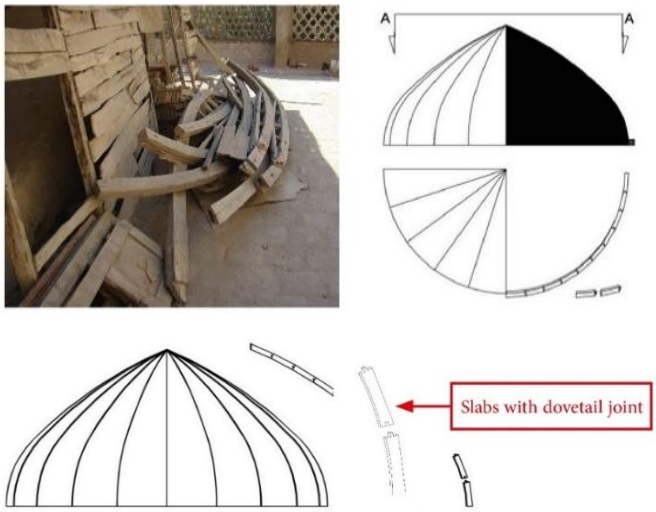


Fig. 18. (top left): Dovetailed slabs of the restorations of the past; *Chaharbagh* school dome; **(top right):** Schematic plan of finding the latitude of the arc of the dome, by slabs and their dovetail attachments; **(bottom):** Schematic plan of finding the longitude of the dome's arc using slabs and their dovetail attachment

c. To make the curved mold of 1/1 scale on the ground. Now we turn to the executive phase and making of the mold on the ground, usually to be done by traditional carpenters and tile workers. One of the templates of meridians (dovetailed slabs of longitudinal arc) is put on the ground with at least a 1m separation from its surface at the closest point. Now the template of the similar "meridian" is put precisely at the same height as the previous one with the aid of "level-stride" and fixed there. Then orbits become installed at their place after fixing of the templates. In this way, both the distance of the meridians and the curvature of the mortar supposed to fill this part are determined. The skeleton of a *Tark* is fixed on the ground using a mortar of gypsum and brick, and the floor of the mold is formed by some slabs. Then the whole of its surface becomes flat using gypsum mortar to evoke for us precisely the curvature of *Tark*. Now the negative/concave mold is prepared, which is referred to as an arced mold or "curve *Takhmiri*" (Fig. 19).

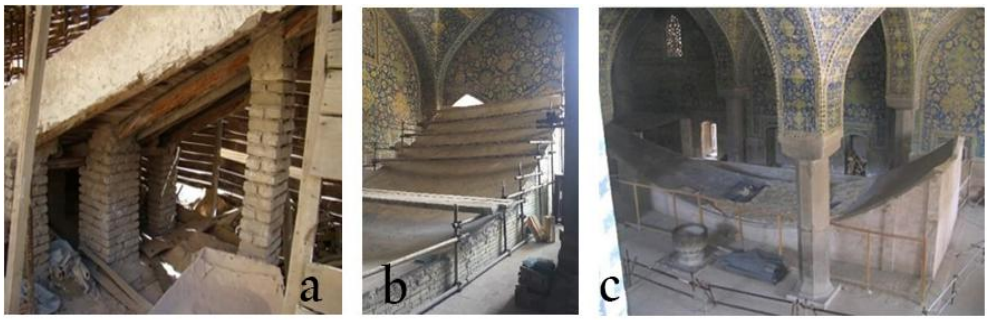


Fig. 19. a. the lower part of the old curved restoration mold of the *Chahar-bagh* school dome; b, c. curved mold of the recent restoration of the *Jame-Abbasi Mosque* tiling dome (sources: a. Motalebi 2010; b, c. CHO)

d. Copying the dome's designs, its transfer, and spreading on the mold's surface (duplicate or mosanna-bardari). One *Tark* of the dome is picked up, containing the best-preserved design of the tile with the most authenticity. Copying of the dome tiling design is

carried out on very thin paper to be glued by the traditional *Sirish*[10], followed by drawing the design by pencil (Fig. 20a). As the designs are symmetrical on each *Tark,* copying is done from the center of symmetry to one side, becoming complete just later and independently on the ground. Numbers are given to each drawing in all steps, specifying the corresponding color of the design. Then the designs become more secure by copying them on better papers (Fig. 20b).

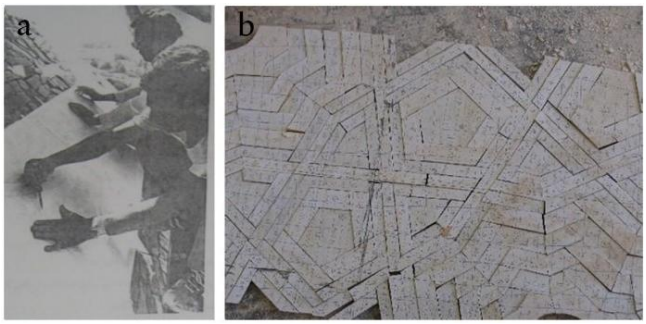


Fig. 20. a. copying of dome's designs; b. papers glued to the surface of the glaze of the faience mosaic (Sources: a. [36]; b. Enayati)

Thereafter the design will be transferred over the curved mold surface to be carried out by two methods:

- Tracing method (*Garteh-bardari*): In this method the lines become needled, design paper is put on the surface of the mold, and finally the design is traced using a colored powder (e.g., coal powder). Then it is firmed over the mold surface by pencil.

- The "copy-paper" method: In this method the design of the dome is implemented over the mold surface using a "copy-paper" embedded below the design paper. Then the resulting design is colored with oils (except for the background color of the dome). Now its surface becomes fixed by linseed oil to prevent fading of the color (Fig. 21).

Fig. 21. a: Implementation of the design over the mold, using oils, of previous restorations of *Jame-Abbasi Mosque*; b: *Lotfollah Mosque,* drawing of design over the mold of the dome; c: *Lotfollah Mosque,* completion of design over the curved mold. (source: a, b, c. CHO)

e. Preparation of the design, its numbering, and its cutting. In this step the tile workers provide several copies from the original dome's design. Then parts of the dome, which is to be restored, are divided into pieces of 60×60cm or 60×30cm rectangles with their marginal areas being flat and free of any complicacy of the design. Each of these pieces puzzled together is named as *Parcheh* (Fig. 22a and b). Then each part will be marked, e.g., by a pencil of the same color; the jointing location of each tile with the adjacent one is determined by drawing a line at their intersection, and finally each *Parcheh* is coded with a number (Fig. 22c).

Fig. 22. Papers glued to the surface of the tile's *Parcheh.* a: *Parcheh*s laid together in a recent restoration of the *Jame-Abbasi* dome to be installed on it; b: *Parcheh*s of tile of another dome; c: *Parcheh*s of tile in a recent restoration of *Lotfollah* mosque. (source: b. Enayati; a, c. CHO)

f. Making and carving of tiles. After finishing marking of the pieces of the design, the paper is cut in such a way that its dimensions don't exceed those of the Narreh tile. Then the pieces are glued with *Sirish* over the glazed surface of the tiles. When the *Sirish* gets dried, the carving of the tiles begins with light and heavy chisels[11] (Fig. 23a, b, c, and d). The next step is *Gel-Bordegi*[12] and thinning the width of the tile's back (Figs. 23e and f).

Fig. 23. a: Carving and chiseling of the tile in the past; b: Gluing of cut papers of the tile's design over the glazed surface of the tile by *Sirish*; c: Chiseling and carving in a recent restoration workshop of *Jame-Abbasi* Mosque; d: Chiseling and carving; e, f: Removal of clay. (sources: top, CHO; bottom, Enayati)

g. Pouring mortars at the back of the *Parcheh*s over the mold (*Parche-rizi)*. After finishing the tile carvings, pieces corresponding to each *Parcheh are* laid out together in their numbered turn from their glazed face over the curved mold surface at their appropriate location (Fig. 24). Thereafter, by putting clay wicks[13] between the *Parchehs* of the tiles to a height of 3cm, the intervening borders of two adjacent tiles are separated to prevent sticking to each other during mortar pouring. Now a mortar of water and gypsum is poured to the back of *Parcheh*s embedded in the curved mold (Fig. 25).

A mortar of gypsum and water was and still is used for sticking tiles together and to the body of the dome itself, but the quality of mortars used for restoration of domes is not the same as that of the past. For example, the use of the so-called *gircharou*[14] mortar has been withdrawn today [6]. An important factor for the durability of the mortar is the baking of gypsum and a sort of processing of the former. Recently a mixture of the traditional gypsum of Isfahan with the micronized gypsum of Semnan with the same ratios has been used, while in a recent restoration of the dome of *Lofollah* Mosque, the ratio of the item from Semnan has been

considerably reduced compared with that of Isfahan, and the mixture is added with an amount of clay. The result of the operation is yet to be announced. Generally, the mortar used in the back of the tiles in the curved mold is denser and more viscous than the one used in the space between the tiles and the tough surface of the dome itself (*Zebreh*); i.e., the consumed water of the former is less than that of the latter (Fig. 25). It is for the more dilute nature of the latter that it is referred to as *Dough-ab* of gypsum (Fig. 25).

Fig. 24. Embedding of *Narreh* mosaic tiles inversely on the surface of the curved mold. (top): mold of *Jame-Abbasi* Mosque (source: CHO); (bottom): mold of dome, *Chaharbagh* school (source: Panjehpoor)

Fig. 25. Mortar pouring to the back of the *Narreh* mosaic over the curved mold and flutings of this somewhat denser mortar. Recent restoration of the *Jame-Abbasi* dome (source: CHO)

Due to the heavier weight of the *Parcheh* and for the sake of its firmness and also a better attachment of *Narreh* to the mortar on its back, ropes known as *Sazouii* (Scrophularia) made from fibers of palm are used, which are spirally embedded in the back of the *Parcheh* of the tile (Fig. 26). Mortar of gypsum is poured up to the level of clay-wicking between the *Parcheh*s. The surface of the mortar becomes fluted before becoming dried (Fig. 25) so that at the onset of installing the *Parcheh*s over the dome, it becomes better engaged with the *Dough-ab* to be poured later to its back once more. As soon as the mortar becomes dried, *Parcheh*s are separated from the curved mold's surface and (after numbering) become ready to be transferred to the dome for installation (Fig. 22). Part of the rope remains out of the mortar's level in a coil shape to play, firstly, the role of a handle in their transferring, and secondly, after installing the *Parcheh* over the dome and *dough-ab* was poured to their back, the same handle provides a better engagement and contributes to the firmness of the *Parchehs* over the dome's body (Fig. 26).

h. Installation of the new tiles, "Numbered" *Parcheh*s of the tiles are transferred to the roof of the dome by the installer group after being put on the mold, to be delivered ultimately to master-workers (Fig. 27).

Fig. 26. Gypsum mortar with the *Sazou* rope at the back of the tile and the separating "walls" of each *Parcheh;*
(top): *Lotfollah Mosque's* dome restoration (source: CHO);
(bottom): *Chahar-bagh* school's dome restoration (source: Panjehpoor)

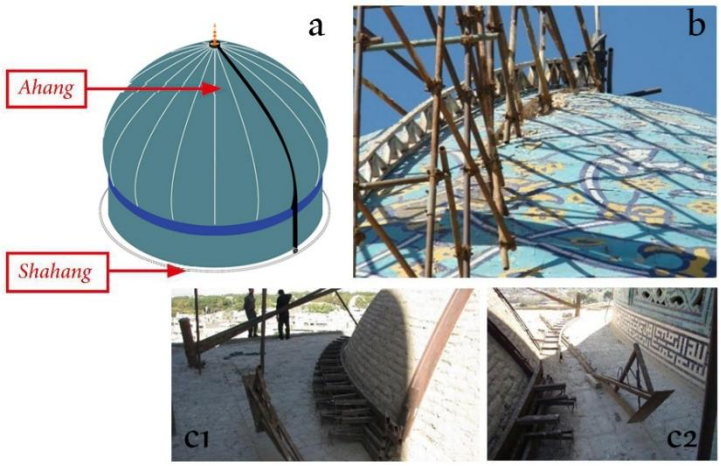


Fig. 27. *Shahang* and *Ahang*, to be used in the past for assuring the accommodation of the tiling coverage of the dome's *Zebreh*, and which, as a sort of specific template, rotates about the dome's arc and finds probable drawbacks: a. Schematic pattern; b. *Ahang* over the dome of *Chahar-bagh* during an unsuccessful restoration of 2010; c1, c2. *Shahang* and *Ahang*

- Hollow bricks: Before installing *Parcheh*s over the dome and to decrease the empty space between them and the wall of the dome and increase the strength of the jointing, hollow bricks are used. The process is termed as *Pakofteh kardan*[15]. These bricks are embedded vertically or horizontally on the dome's *Zebreh* (Fig. 28a, b, d, and g).

- Installation of *Kafgirak*[16] (anthraxes): Anthrax plummets to the body of the dome before insertion of a *Parcheh* of tile. Then the *Parcheh* is embedded over it to decrease the pressure resulting from the weight of previous rows of tile and transfer it to the body of the dome, and to

strengthen the attachment of the *Parcheh*s of tile to the dome's body after filling the back of the tile with gypsum mortar (Figs. 28b and f).

- Installation of *Parche*s of tile, after embedding of hollow bricks and anthraxes (Fig. 22a and b), it is the turn of *parcheh*s of tile themselves. The jointing of the first installed *Parcheh* is important, as the next *Parcheh*s are to be regulated with this. This is termed as the *Ostad-kar* or *Usta,* namely the "master" *Parcheh*. After embedding a *parcheh* at its place, a brick is inserted between the dome's "wall" and the uppermost part of the *Parcheh* to fix the former. This brick attaches the dome's wall to the backward surface of the *Parcheh* of the tile. This brick is termed as *Darab* (Fig. 28c and e). After laying one row of *Parcheh,* it is the time of their final fixing over the dome using a sort of *Dough-ab* to fill the caves behind the *Parchehs.* Sometimes brick-and-tile debris is added to this gypsum mortar for the saving of the latter and as a filler as well (Fig. 28a, c, d, and i).

Fig. 28. Installation of hollow bricks (a, b, d, g: red arrow); installation of anthrax (b, f: yellow); installation of *Parcheh*s of tile (c, h: orange); installation of *Darab* (c, e: yellow); gypsum mortar poured in back of the *Parcheh*s (a, c, d: blue) (source: CHO)

Sometimes processes are made at the outer margin of the *Parcheh*s due to the complicacy of the design (Fig. 29a), but they perturb coupling of the *Parcheh*s with the adjacent ones. For this reason, these prominent bricks (processes) are usually numbered and removed, to be embedded later and after fixing one row of *Parcheh* over the dome (Fig. 29b and c). *Doug-ab* takes time to be dried (Fig. 29d), after which the next row is worked out following the installation of anthrax.

Fig. 29. a: *Parcheh*s of tile involving a distension; b, c: modification and addition of some of the tiles after installation of *Parcheh*s; d: and after *Doagh-ab* pouring (source: CHO)

After *Dough-ab* pouring, it is the time for jointing (*Band-keshi*) and filling the cracks between the tiles and *Parcheh*s through moisturizing the cracks and then filling them with a mortar of sifted gypsum, known as *Narmeh* (fig. 30). The surplus mortar will be later cleaned by cloth. All these steps are carried out separately and identically at each *Tark.*

Fig. 30. Dome of *Jame-Abbasi*, after *Dough-ab* pouring and jointing, but before cleaning (source: CHO)

Local enforcement and replacement of the tiles

This method is applied when parts of the dome's tiling have undergone local or scattered damages without needing to be totally restored (Fig. 31), such as cases when only several tiles needed to be repaired within each *Tark.* In some other cases only the mortar to the back of the tiles should be renewed; otherwise, new tiles with the same color and dimensions should replace the damaged ones. After removal of the powder gypsum or worn mortar and soil, first the supposed surface should be water-sprinkled so that the surface does not absorb the water of the mortar, and then the roughness of the surface becomes flat using a layer of gypsum mortar. Then these parts are filled with the mortar, and tiles are laid out one by one and finally leveled. Sometimes local restorations end up with the re-jointing and filling of cracks.

Fig. 31. Local restoration of dome's tiling (source: CHO)

Results and discussion

Drawbacks and damages of restorations of historical domes of Isfahan

We identified the following main disadvantages of the damages that occurred during the previous restorations of the historical domes of Isfahan:

- Use of very heavy buttresses over the dome for a very long time (Fig. 16).
- Damages exerted by the buttress to the dome and destruction or breaking of the tiles (Fig. 32a).
- The use of a jackhammer for destruction and separation of mortars and old hollow bricks (Fig. 32b).
- Asymmetry of the dome's tiling patterns in one Tark "and" in the adjacent one (Fig. 5a).
- Inhomogeneous color schemes resulted from differences between the original and restored colors (Figs. 3, 4, 5, and 7).
- Extra sizes of some tiles with respect to their supposed location on the dome, giving rise to displacement or distension of tiles (Fig. 3f).
- Inappropriate processing of gypsum mortar on the back of the tiles over the curved mold and the final Dough-ab pouring.
- Displacement of tiles during mortar pouring.
- Use of thin iron staples within gypsum mortar for the solidity of Parchehs.
- Regularity of Parchehs circumference, giving rise to their margins not to be engaged with each other. Parchehs are laid together in a rectangular setting (Fig. 3c).
- Parchehs would experience pressure from each other when they have not been appropriately coupled (Hasht-o-Gir) (in some points, the separation line is in the same direction) (Figs. 3c, d, e, f, g and 5h).
- Inappropriate coupling (the separation line at the background Narreh tiles is also in the same direction) (Fig. 3e, f).
- Elimination or destruction of the old tiles of the dome and their replacement or substitution with new ones.
- Use of several rows of hollow bricks to reduce the distance between the main "wall" of the dome and its ornamentations, giving rise to exertion of heavy loadings.
- Decoupling of hollow bricks, giving rise to raising separation probabilities and gliding over the main wall (Figs. 17(right) a, b; 28 a, d, and e)
- Embedding of hollow bricks from their width (height) over the dome, giving rise to reduction of their tangential surfaces with the dome and their subsequent separation.
- Not using hollow bricks in some parts of the dome, resulting to a high distance between the dome's Zebreh and the Parchehs (being already filled just by Doagh-ab), sometimes up to 50cm's [37]. Using Dough-ab in the same width can't provide whatsoever the necessary power to hold the structure.

– No installed anthraxes or their inappropriate usage in unsuitable locations, or restricting to sporadic use of them, sometimes after embedding of the Parchehs: (Fig. 32).

- Low length of anthraxes: as the distance between the main body of the dome and the mortared surface to the back of the tile Prarchehs, from its impost to the tip, differs from 50 to 15cm and also the length of anthraxes doesn't exceed 25cm, anthraxes had not laid precisely bellow the tile Parchehs to bear the load of the latter in places where that distance is high. Due to this, the pressure from upper Parchehs to the lower one becomes unbearable, giving rise finally to an outward inclination of tile and their wrinkling over each other.

– Ignoring the factor of gypsum mortar: Experiences and observations of recent years have confirmed that the use of building gypsums as mortar for tiling was unsuccessful, despite the former is made within advanced workshops and factories [38]. Old masters/traditional

artists of Mossadegh family remember that at their times of about half a century ago gypsum used in the indigenous building constructions were produced in the Isfahan's nearby kilns by traditional methods to be transferred daily for the use to local workshops. Anyway, while the process of baking gypsum is out of control of traditional masters, its processing is still in progress according to traditional indigenous knowledge.

– Lack of a sufficient and continuous supervisions, change of managements, and lack of a specialized viewpoint usually give rise to prolonging of restoration projects in this part of the structure.

Fig. 32. a: Dome of *Jame-Abbasi Mosque,* damaged and broken tiles due to pressure exerted by buttress (Motalebi 2010); b: Dome of *Chahar-bagh* school, use of jackhammer to remove old mortar and its separation from tiling [39]; c: Dome of *Jame-Abbasi Mosque,* installation of anthraxes after that of tiles' *Parcheh*s (Motalebi 2012)

Current drawbacks in recent restorations of the domes

In recent restorations of the Jame-Abbasi and Lotfollah Mosques, some of the drawbacks have been modified, some others have remained and been repeated, and some new ones have appeared.

Jame-Abbasi Mosque dome restoration

By dismantling part of the buttress of the recent restoration of the dome, which was hidden below it for more than a decade, the deformed shape of its outer crust became vividly observable. Comparing old and new pictures of the dome shows trusteeship has not been respected, and in addition to a tarnished geometry, some of the designs and colors have undergone drastic changes, as follows:

- Lack of a broad restoration plan;
- Lack of a management plan;
- Tarnishing the geometry of the dome: restoration of the dome from its base to the tip should have proceeded on a circular basis, while practically it has deviated and become elliptical [40].

-Replacement and renewal of all *Narreh* tiles of the dome's crust in recent restoration: no tile of the dome's *balenj*, up to 5 meters higher than its "*belt-line*," had undergone the slightest changes whatsoever during the past 160 years up to 2019 (1398). Each *Tark* of the dome is about 17.5m long. From the 1360s onwards, only tiles of the upper 12.5m of the *Tark* were restored, as those of the downward rest have always enjoyed acceptable solidity [40].

- No use has been made of the dome's arc control apparatus. In the restoration of the last two *Tarks*, the circular curvature hasn't been respected and has produced a sort of bight (Fig. 7).

- Reusing of curved mold of 2010 restoration project for this recent one: this mold has had a 30 to 4cm difference at the 15th and 16th *Tark* of the dome, where it enjoys more arc. Thus, this mold had to be substituted, but by its reusing, the convergence of the upper part of the dome to its middle has been increased, and the height of its tip has lowered some 15cm. The dome seems more stretched in its photos of the Qajar period, namely before the restorations of Mr. Mosadeghzadeh.

- Design and color variations.

- A probable structural problem: the dome is in motion. Two belts have been picketed round the dome, first by the late master, Mr. Ma'arefi, and second in the recent restoration. Tarnishing of the geometry of the dome becomes inevitable if this problem persists [41]. Mehdi Paklel also refers to dome's asymmetry and its *Tark*s inconsistencies with each other and believes that each *Tark* requires a separate mold [42].

Lotfollah Mosque's dome

The first phase of restoration of this dome included ¼ of it, namely, 4 half-*Tarks* out of a total of 16, starting from 2019. But by finishing the restoration of the first 2 half-*Tarks,* it underwent serious criticisms for its supervision policy.

- Lack of supervision by experts of various majors such as architecture, structure, and traditional arts; instead, executors were selected without consulting the experts of the corresponding fields.

- Lack of pilot studies and experiments to investigate the oldness of the tiles. Some of the executors identified the tiles as Safavid, while the others belonged to the Pahlavi era, showing a lack of the slightest necessary knowledge giving rise to a sort of chaos.

- Color changes of the restored *Tark*s compared with unrestored ones: the color of *Tark*s turned out to be different from each other [24]. 20% of discoloration is unavoidable in any restoration project, and the rest is due to poor program management and execution. Most of the changes are related to *Dough-ab* pouring and its leakage over the bricked unglazed surface [24]. Some of these changes were the result of using a spatula and scraper, as was pointed out by the former manager of the project, the late Rezayat. Abrasion of the outermost layer of the brick, or patina, is a principal feature of a monument, denoting its oldness, which should not be violated in any intervention. When the brick suffers from abrasion, it becomes tough and susceptible to absorbing pollution and dirt. In fact, in the restoration of the first two half-*Tarks* of this dome, *Dough-ab* pouring and spattering of the floor were used instead of a final gypsum jointing, thereby destroying the glazed layers of both tiles and bricks.

- The use of water-escapist covering materials over the tiles of restored *Tark*, giving rise to snow-banking over the *Tark.* The former executor of the project has confirmed the use of linseed oil as a final covering of the restored tiles [24].

- The first two restored half-*Tark*s were not of the same size and therefore didn't become appropriately coupled to each other [24].

- Lack of laboratory studies on the mortars used in restoration of the dome's tiles: The main problem concerning restoration of the tiles of *Lotfollah* dome is the unawareness of executors of the gypsum and their incorrect choice of it [24].

Dome of Chaharbagh School

The recent restoration of the monument started in 2012 with restoring 3 *Tarks* out of a total of 12, to be finished several years later. While it obviated most problems of previous restorations, it had its own drawbacks as well:

- A renewal of all tiles of the dome. Firstly, downward tiles of the first two *Tark*s were removed and renewed, and the *Tarks* were restored in this manner. But tiles of this part were of historical value and in the previous restorations had been left intact and thus should not at all be renewed.

- Use of a jackhammer for destruction and removal of tiles, hollow bricks, and the old mortars [39].

Proposals for improvement of the restoration process and modification of current damage

According to "traditional technology" and pathological investigations introduced in this paper, the following proposals are being discussed for improvement of the restoration process of the dome's tiling and durability of performed treatments:

- Pathology as well as specialized investigations of the dome structure, from the geometry of the dome and the movement and push of the structure viewpoint.

- Respecting the theoretical foundations of restoration, conservation, and authenticity of the monument as well as repair measures.

- Employment of various expert groups in different fields such as restoration, architecture, archaeology, chemistry, history of art, and traditional arts, as well as specialized consultations with the experts.

- Relying on a broad management plan: Careful documentation of the dome as well as its topography and identification of its pathological features are required before the start of the restoration.

- Analysis and investigation of the material content of the mortar, biscuit of tiles, and the preserved colors of the glaze of its history.

- Special attention to the kind and quality of the materials, such as tile, gypsum, and brick density, resistance, percentage of porosity, moisture, and baking process.

- Use of safe and secure buttress. The use of buttresses currently in use in other countries and in restoration projects of Notre Dame Cathedral and *Ivan-e Madaen*, known as fast-closing in Iran (contrary to the usual iron-pipe buttresses or *Dar-bast*). The weight of usual buttresses is transferred to the dome's structure and its elements, giving rise to severe damage in the long term [40]. Buttresses should also be erected on the dome to cover the surfaces of its two *Tark*s without damaging its body. For example, the tip of every shaft of the buttress in the dome's proximity should rest on a sponge. The cliff side of the buttress should be covered with metallic nets due to the height of the dome. Wooden slabs should enjoy sufficient wideness, lack any sort of cleft, and be joined to each other firmly.

- Making a good, curved mold leaves the restoration process with the fewest errors.

- Using modern software and hardware technological facilities, e.g., photogrammetry and suitable templates to control the geometry of arcs. For example, a horizontal template (*Shahang*) should be railed round the dome. A vertical and circulating template (*Ahang*) should be placed on the same rail capable of rotating permanently to control every *Tark* up to the end of the arc's restoration.

- Supervising graphic modeling of the designs of the dome and its execution, preferably by laser scanning. All elements should be coded by numbers and by the names of the designs' colors to make it precise and documented. One should avoid any displacement of designs while copying them on the curved mold.

- The paper used for transferring the design over the tile should not undergo dimension variations while becoming wet, resulting in carving the tile over- or undersized. Using thick starch-free papers is recommended.

- *Parche*s of the tile are more easily transferable with moderate dimensions to leave their installation over the curved surface of the dome simpler.

- Making the dimensions of *Parchehs* as asymmetrical and their sides as toothed (rather than flat edges) to make a better engagement of them.

- Jointing of *Narreh* and *Parcheh*s of tiles in the traditional *Hasht-o-Gir* manner at the onset of their laying over the curved *Takhmiri* mold. It is better that in the background tiles of the dome, the separation line of the *Parcheh*s not be in the same direction. The *Parcheh*s should not be very regular and co-sized, and their separation lines should coincide, e.g., with the spiral of an *Eslimi* (Fig. 31-right) [43].

- Use of intact old tiles in restorations: it should be noted that while using old tiles, their backward powdered mortars should be completely removed and cleaned both from the tile and from the dome itself and then installed once more with new mortars.

- Appropriate and correct execution of *Pakofteh*-bricks, as the brick itself and the dome's wall should firstly become wet to prevent the absorption of mortar's water, resulting in its ineffectiveness. Then the *Pakofteh* bricks are installed to the dome's wall with a 2 to 3cm layer

of gypsum mortar. These also should be joined through the traditional *Hasht-o-Gir* style for better mutual engagement. Drying mortars of the previous step takes an interval of 2 to 3 days. The standard width of the mortar used for *Pakafteh* bricks is estimated as 20, and for the mortar as 3-4cm. The widths shouldn't exceed these numbers to reduce the solidity of holding *Parcheh*s to *Pakofteh* bricks [42, 44] (Fig. 28c, vs. Figs. 28a and 25).

- The importance of anthraxes: these should be installed before the *Parcheh*s. Its wider head should be embedded some 5mm behind the surface of the tiles and below the biscuit of the last row of the *Parcheh* of tiles to bear its load and prevent the movement and push of *Parcheh*s. The short length of the anthrax causes its wide head not to be embedded appropriately beneath the crude body of the tile, being left in the gypsum mortar and thereby not being able to bear the upward pressure, giving rise to wrinkling and pushing of *Parcheh*s. But the partial visibility of anthraxes does not cause a serious problem for a far observer of the dome. Requires the existence of two anthraxes beneath each *Parcheh* [43]. It is better that the anthrax head droop in the body of the dome and not in *Pakofteh* bricks. Their material should be chosen such that it is resistant against oxidation.

- Jointing of the first *Parcheh* of tile (known as *Ostad-kar*) over the dome is of great significance and should be carried out carefully. This is reckoned as the pilot *Parcheh* of the rest, which is to be regulated with respect to it.

- Correct processing of *Dough-ab* of gypsum: it should be provided at the least possible distance from the supposed location of its later pouring, i.e., over the dome itself and not somewhere in its down nearby. It should also take an adhesive honeyed state and be poured on the back of the work to be submerged within all its holes and caves to hold the *Parcheh*s of tile firmly. *Dough-ab* should be provided by the "traditional master" (*Ustad-kar*) and not by workers. It takes 20 to 30 minutes to become dried; thence the next *Parcheh* becomes mounted.

-Then the jointing process as well as filling the clefts between the tile and *Parcheh*s should be enforced carefully and patiently to prevent penetration of water and moisture.

- Of further contrivances one can mention A- fastening a rope round the collar of the dome for erasing snow and ice in winter and dust and bird's garbage in other seasons; and B- designing and making lifts for emergency cases and for periodic inspections of probable damages.

Conclusions

Restoration programs have entered a course in recent years, the last couple of decades, giving rise to domes' tiling crusts suffering from serious damages. It is necessary first to identify the drawbacks and then to adopt improvements on the execution of restoration methods as have already been performed on the *Jame-Abbasi* and *Lotfollah Mosques* and *Chahar-bagh* school of Isfahan. Tiling of domes requires adopting a special conservation method due to the diversity of building methods, historical, moral, and aesthetical values, and precedent of restorations to be able to cover all these values. A prerequisite of a genuine restoration process is the employment of experienced and expert masters. Unfortunately, all experienced masters have already died, except for H. Mosadeghzadeh. While the new generation asserts its capabilities, its result should be assessed in practice. Thus, one of the most important challenges of conservators of cultural and moral heritage is teaching the new generation the tiling methods of historical domes and transferring them to the next generation in a documented manner. It is for this reason that learning all details of tile making, mortar supplying, and installing of tiles used in the past forms the basics of executing a restoration with the least fault or inaccuracy matter for the future operations. One should also prevent prolonging of restoration operations by adopting general management and comprehensive restoration plans and continuous supervision aided by consulting with experts in architecture, archaeology, history, chemistry,

history of art, and traditional arts. Thus, one should avoid adopting methods based on try and error.

While the errors of restoration of *Lotfollah* Mosque are much less than that of *Jame-Abbasi*, they both enjoyed items held in common.

Unfortunately, restoration workshops are not open to interested people or even to students of the field and the restoration major. The Cultural Heritage Organization avoids presenting documentations and reports of contractors as well as executive plans and related pictures to the public and to the private sector, and this sort of "blockade" contributes to the already existing damages. Thus, the mere wills and measures of traditional artists and restoration masters would turn out as irrelevant in changing the appearance of the domes and only offer a perspective of the state of affairs to be remained for posterity.

Notes:

- The Persian calendar and the usual Western calendar have been used interchangeably, depending on the context and on the referred source.
- CHO: archive of the Isfahan cultural heritage organization.

Definitions of Persian Terms

1 - *Balenj*: point, which, due to its less arced shape compared with the upper points on the domes, usually suffers the least damage.
2 - Carving of tiles: The profession of artists who, by carving colored tiles and laying them together, create ornamented patterns with traditional designs such as *Mo-gali, Eslimi,* and geometric meshes.
3 - Baking tiles: The profession of artists who make various kinds of glaze and ceramic body of the mud-brick ornamentations and bake them to produce tiles such as *Haft-Rang*, *Zir-e-lo-abi*, and squared mono-color tiles or *Narreh.*
4 - Body or biscuit of the tile: The main base of the tile before being glazed.
5 - Paste of the stone (*gel-Sang*): Produced from silicate stones usually picked up from the banks of the rivers and then squashed with glass dust and bentonite.
6 - *Jame* Mosque of *Beresian*: The main monument belongs to the Saljuqid period, to be added later in the Safavid period by some further attachments.
7 - Mozaffarid/*Al-e Mozaffar*: An Iranian dynasty of the 8th century of the Muslim calendar, after the Mongol invasion and before that of Tamerlane, governed over the southern provinces of Fars, Kerman, Isfahan, and Khuzestan, with their capital being Shiraz. It also governed for a while over all of greater Iran except for Khorasan.
8 - The mold (known as) *Takhmiri* or *Takhmini*: To be built from a *Tark* of the dome with precisely the same size. Tiles are laid out over it before being installed on the dome itself.
9 - *Zebreh*: The main bricked body of the dome from the outer side.
10 - *Sirish*: A kind of floral plant from whose powdered radicle a kind of traditional glue was made and still is.
11 - Light and heavy chisels: The heavy chisel is used to lighten the tile and carve it up to the edge of its design, and the light chisel for making those same edges.
12 - *Gel-Bordegi:* The *Narreh* tiles are being built from their glazed side to their back so as to provide a space for the mortar while being laid together; the property is being lost while being carved by chisel. To obviate this drawback, a step known as *Gel-Boran* while being carved is added to the process within which the clay on the back of the tile becomes thin with respect to the glazed side.

13 - Clay wick: In the past clay was formed by hand, similar to pipes or wooden wicks, and then was put between *Parcheh*s of the tiles, thereby bordering the tiles. Today radiology talc is used instead.
14 - *Gircharou*: Meaning gypsum. The mortar is made by mixing whitewash, pure clay, *Shekar-Sang*, and half-baked squashed gypsum (instead of water overall).
15 - *Pakafteh-kardan*: The width intended for attachment of ornamentations as well as insertion of mortar is different from the impost up to the tip of the dome, as, e.g., in the lower parts close to the belly, it is 35-40cm in the *Zebreh* of the outer crust and ca. 15cm at the *Tizeh*. This width should be minimized for the installation of ornaments, and for this sake, the surface of the main dome is covered with a sort of hollow brick, and the process is known as *Pakteh-kardan*. Meanwhile, as the outer wall of the dome has a step-like and irregular shape, the process is needed to keep the tiles stuck to the surface of the bricks.
16 - *kafgirak* (Anthrax): A wooden apparatus of the old times, now to be built of steel, having the function of wide nails of 25cm length used to hold tiles' *Parchehs* over the dome.

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This should be a Phrase….

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