

# Pastiglia Ornaments in Persian Architecture: An Analysis of Manufacturing Technologies

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**Abstract:** Pastiglia ornaments (Layeh-chini), often gilded, represent a distinctive and highly valued art form of the Safavid period. Although such architectural ornamentation was employed to a very limited extent during the Timurid era — e.g., at the Shah Mosque and the Tomb of Khwaja Yusuf in Mashhad — its peak in both quality and quantity occurred under the Safavids. Questions remain regarding the regional and cultural variations of Pastiglia: whether it was applied in Muslim palaces or Armenian churches, in central, northwestern, or eastern Iran, and whether differences existed in materials, composition, or preparation techniques, or if a single material and method prevailed universally. This study aims to review previous research and consolidate field study results to achieve a technical understanding of Pastiglia in selected Safavid monuments. Initially, both published and unpublished written sources were examined, followed by close field investigations of the Shah Mosque and Tomb of Khwaja Yusuf (Mashhad), Chehel Sotoun, Ali Qapu, Hasht Behesht, Talār-e Ashraf (Isfahan), Vank and Bethlehem Churches, Chehel Sotoun (Qazvin), and the Sheikh Jebrail Mausoleum (Kalkhoran). Both laboratory analyses and field study results are discussed. The gypsum-to-red clay ratio in these Pastiglia works was determined, approximate proportions and mineral additives were identified, and comparatively analyzed. Additionally, the type of binder, gilding techniques, and adhesive systems used in the gilding process were thoroughly examined.

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## Keywords:

Architectural ornaments  
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## 1. Introduction

Architecture is one of the most prominent manifestations of any civilization, and its ornamental components constitute a major element influencing both meaning and perception. Architectural ornaments form the outermost layer of interior and exterior surfaces and may be integral to the structure or added afterward. They serve conceptual, aesthetic, and/or protective functions; without such functions, they cannot be considered true ornaments. Among the various materials employed, gypsum-based mortars have played a central role.

*Pastiglia* (layeh-chini) represents one of the most striking relief arts, particularly in Safavid Iran, where its brilliant red grounds and gold leaf created a distinctive visual effect. Although earlier examples exist, its use reached a peak in quantity and quality during the Safavid period. Defined as building up multiple red-tinted layers to create high-relief motifs for subsequent gilding, *Pastiglia* has been variously regarded as an Italian import or an indigenous Iranian craft. Because over half of its composition is gypsum, it is classified among plaster ornaments.

Despite its artistic value, *Pastiglia* is labor-intensive and increasingly neglected, leading to its gradual disappearance. Accurate documentation of its materials, techniques, and regional variations is therefore crucial for conservation and restoration. Yet, despite the abundance of surviving masterpieces, rigorous technological studies with laboratory evidence remain scarce,

making systematic research essential for preserving this 500-year-old heritage and understanding its historical development.

Given that *Pastiglia* is among the arts at risk of being forgotten, and that the conservation and restoration of these works require precise knowledge of their constituent elements and fabrication details, research, documentation, and technical characterization of these ornaments — many of which are over 500 years old — appear essential. It should be noted that *Pastiglia*-like ornaments were executed on the Dome of Soltaniyeh in Zanjan; however, no thorough technical study has yet been conducted on those features, and a dedicated future research project is warranted. Based on available information, it can currently be stated that the oldest examples of *Pastiglia* in Iranian architecture are preserved in two Shahrukh-Timurid period monuments in Mashhad (the Shah Mosque and the tomb of Khwaja Yusuf).

## 2. Methodology

This study reviews *Pastiglia* (layeh-chini) ornaments of major Safavid monuments, including ‘Alī Qāpū, Chehel Sotoun (Isfahan and Qazvin), Hasht Behesht, Talār-e Ashraf, Vank and Bethlehem Churches, and the shrine of Shaykh Amīn-al-Dīn Jabrā’īl (Kalkhoran). Previous case studies employed diverse analytical techniques — XRD, XRF, SEM-EDS, FTIR, GC/MS, Raman, Py-GC/MS — combined with digital, optical, and scanning electron microscopy and classical chemistry to identify organic and mineral components. In the present research, these findings are integrated and content-analysed to provide comprehensive technological information on Safavid *Pastiglia* ornaments.

## 3. Background

*Pastiglia* is a craft technique whose primary purpose is to produce a raised background for gilding (Holakuee, 2009). Several studies have been carried out on *Pastiglia* and gilded ornaments of Safavid and pre- and post-Safavid monuments. Among them, Hājī-Seyyed-Javadi et al. (2020a) examined and identified the mineral components of *Pastiglia* and gilded ornaments from the Safavid period in Chehel Sotoun Palace, Qazvin. Tīnati et al. (2020), in an article titled “Structural Analysis of *Pastiglia* Gilded Ornaments in Vank and Bethlehem Churches, Isfahan,” conducted a fully technical structural study. Hājī-Seyyed-Javadi et al. (2020b) in “Investigation and Identification of Organic Components of *Pastiglia* and Gilding in the Safavid Period, Chehel Sotoun Palace in Qazvin” analyzed the organic materials present in *Pastiglia* ornaments.

In “Technical Study of Gilded Ornaments on the Stone Inscriptions of Vank Cathedral, Isfahan,” Mohtasham (2017) introduced the oil-mediated gold leaf technique using SEM-EDS and FTIR analyses. In “Identification and Conservation of Painted Inscriptions of the Eastern Kiriya’s of the Great Congregational Mosque of Yazd,” Hamzavi et al. (2015) reported the use of gold leaf in the painted inscriptions of the Great Congregational Mosque of Yazd and in the decorative mural of the Sāti Fāṭemeh shrine from the Timurid period. In “Discovery of an Ancient Inscription in Vank Cathedral, Isfahan,” Hamzavi (2014) discussed the *Pastiglia* and gilding of this building, which contains one of the largest volumes of *Pastiglia* and gilding in Iran. In “Gilding of Cast Plaster Ornaments in the Seyyed Rokn-al-Dīn Shrine, Yazd,” Hamzavi et al. (2013) identified and introduced a particular type of gilding using tin foil with a transparent yellow covering during the Muzaffarid period.

Karimi and Vatankhah (2014) identified painting binders in Iran using wet-chemistry methods. In “Architectural Ornaments of the Tomb Chamber of the Historical Building of Pir-Bakran and Its Hidden Inscription,” Hamzavi and Moazeni (2013) studied gilding on a plaster inscription from the Ilkhanid period. In “Technical Examination of *Pastiglia* Gilded Ornaments of the Safavid Period in Isfahan with Emphasis on the *Pastiglia* of ‘Alī Qāpū, Chehel Sotoun and Hasht Behesht,” Holakuee et al. (2009), after a brief review of *Pastiglia* terminology and the history of raised gilded ornaments in Europe and Iran, investigated the history and technique of execution in these three monuments.

#### 4. Study of Pastiglia Ornamentation in the Examined Monuments

**A:** Chehel Sotoun Palace, Isfahan: The vast garden of Chehel Sotoun was initiated by Shah ‘Abbās I, and its pavilion with surrounding rooms was built in his time; the grand halls date from Shah ‘Abbās II’s reign and served for official receptions. During 1956, repairs three painted rooms were uncovered (Honarfar, 1971). Wall paintings from both monarchs are classified into three styles and four periods (Aghajani Eṣfahānī & Javani, 2007). Flandin admired its intact state under Moḥammad-Shāh Qājār (Honarfar, 1971); Madame Dieulafoy in 1881 praised its gilded raised ornaments (Honarfar, 1971). The halls, rooms, porticoes, and ceiling combine extensive *Pastiglia* with gilding (Holakuee, 2009; Razanī, 2009). In many areas, the gold leaf has disappeared, leaving only the red *Pastiglia* visible (Fig. 1).

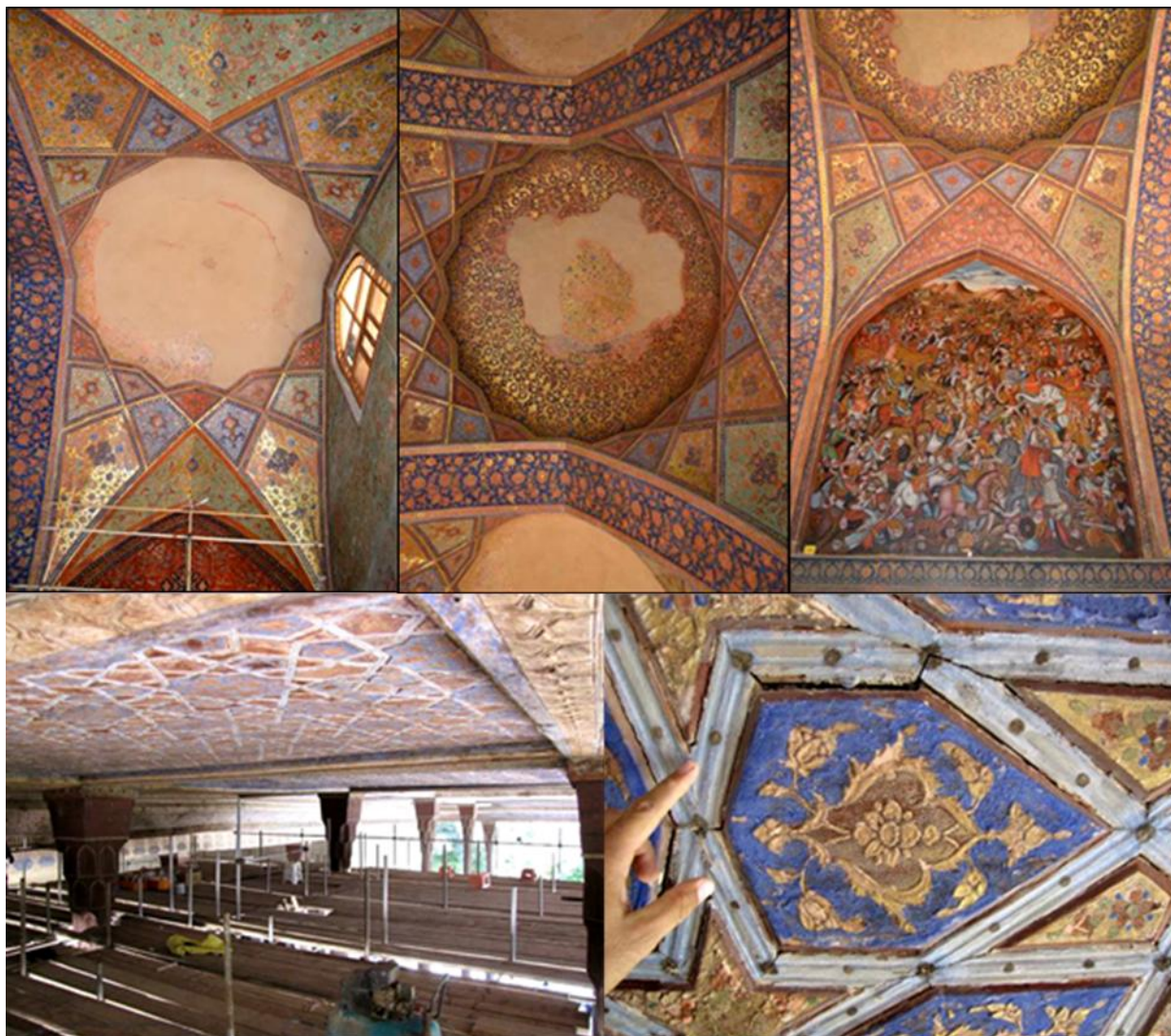


Figure 1. Pastiglia and gilding arrangements in various sections of the Chehel Sotoun Palace, Isfahan.

**B:** ‘Āli-Qāpū Palace, Isfahan: Built by Shah ‘Abbās I in the early 17th century as the royal government house (“Dawlat-Khānah-yi Mubārakah-yi Naqsh-i Jahān”), the exact dates of construction and completion remain uncertain, though it was likely finished near the time of Shaykh Luṭf-Allāh Mosque. Chardin described two superimposed decorative layers — those of Shah ‘Abbās II and later additions by Shah Sulṭān Ḥusayn — covered during the late Qajar period (Honarfar, 1971). Pietro Della Valle praised its gilded miniature paintings (Godard et al., 1992). In ‘Āli-Qāpū, *Pastiglia* and gilding are most abundant on the third and sixth floors; in parts, only the red *Pastiglia* remains, while some third-floor work was never gilded. The sixth-floor features extensive *Pastiglia* on the so-called “Tang-bori” stucco (Fig. 2).



Figure 2. Pastiglia and gilding arrangements on the third and sixth floors of the Ali Qapu Palace, Isfahan.

**C:** Hasht Behesht Palace, Isfahan: Built in 1669 during Shah Soleymān’s reign, Hasht Behesht served as a pavilion for princes. Decorative motifs were executed with limited *Pastiglia* and stucco, mainly painted. *Pastiglia* and gilding appear in the central ceiling’s muqarnas, room borders, and wooden ceiling panels, including a gilded iris bouquet (Honarfar, 1971) (Fig. 3).



Figure 3. Pastiglia and gilding arrangements in the Hasht Behesht Palace, Isfahan.

**D:** Vank (Surp Amenapergich) Church, Isfahan: Located in Jolfa, Isfahan, Vank Church was built 1655–1664 on a 1606 chapel site and consecrated by Bishop David ([Hagh-Nazaryan, 2006](#); [Ashjian, 1975](#); [Ghokassian, 1972](#)). *Pastiglia* and gilding, applied in 1667 ([Hamzavi, 2014](#)), decorate the dome, nave, and apse with intricate Iranian-style motifs influenced by Italian art ([Nercissians, 2012](#); [Hovian, 2005](#)) (Fig. 4).



Figure 4. Pastiglia and gilding arrangements in the Vank Cathedral.

**E:** Bethlehem Church, Isfahan: Founded in 1627 by Khwāja Petrus and completed in 1646, Bethlehem Church features the tallest dome among Jolfa’s twelve historic churches ([Nercissians, 2012](#); [Hovsepian, 2007](#); [Hagh-Nazaryan, 2006](#); [Carswell, 1968](#)). The dome and interior walls

display *Pastiglia* and gilding with arabesque motifs. These ornaments predate Vank Church and likely influenced its design, with active contribution from Iranian artisans (Figs. 5 & 6).



Figure 5. *Pastiglia* and gilding arrangements on the dome of the Bethlehem Church.



Figure 6. *Pastiglia* and gilding arrangements in the dome chamber of the Bethlehem Church.

**F:** Chehel Sotoun Palace, Qazvin: Qazvin, Safavid capital 1555–1606, hosts Chehel Sotoun Palace, an octagonal structure with interior and exterior wall paintings from Shah Tāhmāsb’s reign, later modified under Shah ‘Abbās and the Qajar period (Parhizgari, 2012). *Pastiglia* and gilded stucco panels survive partially; some removed for preservation on wooden panels (Fig. 7). Three decorative layers reflect sequential Safavid–Qajar interventions.



Figure 7. Pastiglia and gilding arrangements (on the building and wooden panel) of the Chehel Sotoun Palace, Qazvin.

**G:** Sheikh Amin-al-Din Jebra’il Mausoleum, Kalkhoran: Located in Kalkhoran, the mausoleum dates to 1602 (1011 AH) with repairs under Shah ‘Abbās I (Alaei, 1964; Hillenbrand, 1994; Sarre, 1924; Weaver, 1976). Stucco ornaments, red-brown carved motifs, and exceptional muqarnas ceilings reflect Safavid architectural mastery. Two dated inscriptions confirm original construction and subsequent restorations (Figs. 8, 9, 10).



Figure 8. Two dated plaster inscriptions bearing the names of the artists in the dome chamber of the Mausoleum of Sheikh Jabra’il.



Figure 9. Pastiglia and gilding arrangements in the Mausoleum of Sheikh Jabra'il, Kalkhoran, Ardabil.

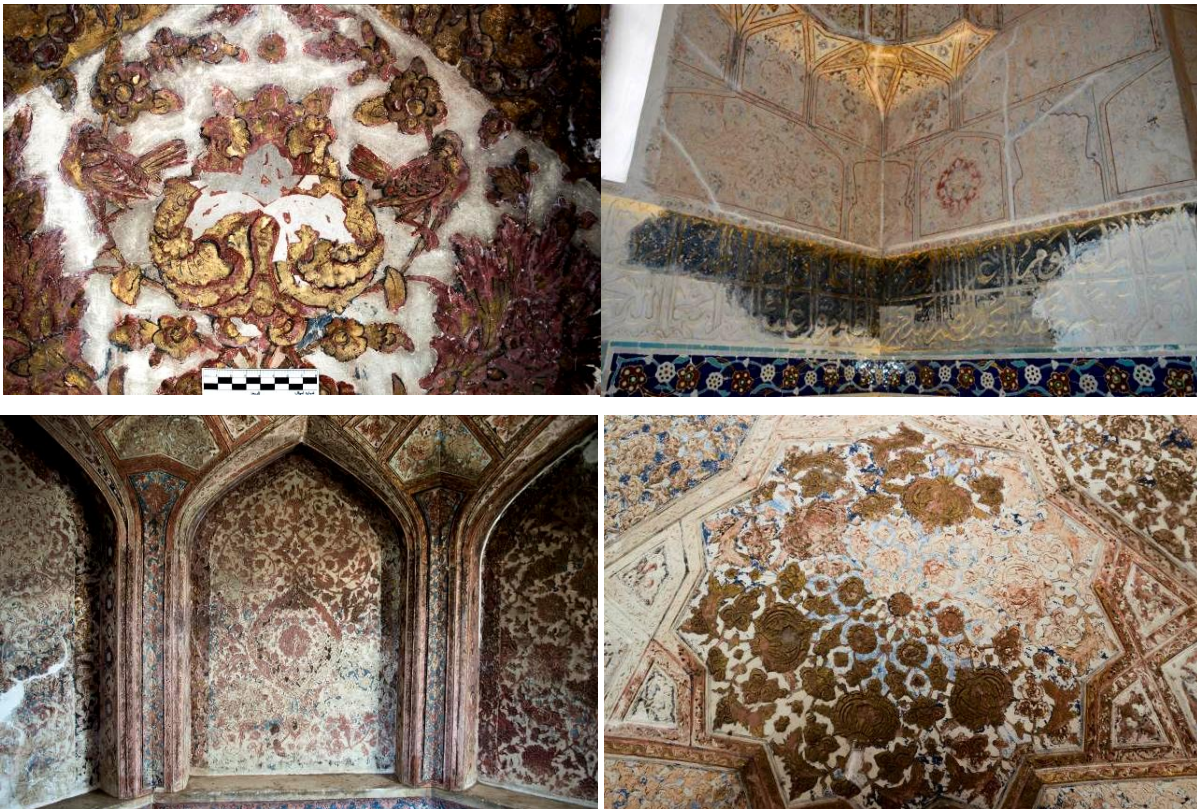


Figure 10. Pastiglia and gilding arrangements in the Mausoleum of Sheikh Jabra'il, Kalkhoran, Ardabil.

**H:** Ashraf Hall, Isfahan: Located in the governorate area, Ashraf Hall, built under Shah `Abbās II and completed under Shah Soleymān, comprises a central hall (14×14 m) flanked by two side rooms (Honarfar, 1971; Pope & Ackermann, 1964; Rafiei Mehrabadi, 1973). *Pastiglia* with gilding dominates the central hall; side rooms were restored in 2014–2015. Stucco protected the ornaments during Qajar and early 20th-century uses (Fig. 11).

## 5. Analysis and Discussion

Until the late 2000s, *Pastiglia* was thought to rely solely on red clay (Gel-e Hormoz/Armeni). Technical studies in 1999 revealed that 50–75% of the material is gypsum; mixing gypsum with red clay prevents shrinkage cracks. A protein binder, likely Animal Glue, dissolved in warm water, was added. In Ali Qapu, Hasht Behesht, and Chehel Sotoun (Isfahan), gold leaf was applied via gilding with linseed or gum-oil. Vank and Bethlehem Churches follow a similar technique, with slightly different red clay content and higher quality results. Chehel Sotoun (Qazvin) uses more red clay and adds zinc oxide for smoother surfaces. Sheikh Jabra'il Mausoleum's *Pastiglia* has roughly equal gypsum and red clay, gilded with oil, comparable to other studied sites.



Figure 11. Pastiglia and gilding arrangements in the Ashraf Hall, Isfahan.

Table 1. Technical and Material Composition Features in the Pastiglia and Gilding of Iranian Historic Monuments.

Studied Building	Gypsum to Red Clay Ratio	Approx. % Fe <sub>2</sub> O <sub>3</sub>	Mineral Additives	Binder Type	Pastiglia	Gilding Technique	Gold Adhesive
Chehel Sotoun Palace, Isfahan	3:1	6.8	-	Animal Glue	-	Gold leaf application	Oil (Linseed oil or Kaman oil)
Ali Qapu Palace, Isfahan	3:1	5.1	-	Animal Glue	-	Gold leaf application	Oil (Linseed oil or Kaman oil)
Hasht Behesht Palace	3:2	9.32	Calcite (powdered)	Animal Glue	-	Gold leaf application	Oil (Linseed oil or Kaman oil)
Vank Church, Isfahan	3:1	4.46	-	Animal Glue	-	Gold leaf application	Linseed oil
Bethlehem Church, Isfahan	3:1	5.06	-	Animal Glue	-	Gold leaf application	Linseed oil
Chehel Sotoun Palace, Qazvin	3:2	1.8	Zinc oxide (white zinc)	Animal Glue	-	Gold leaf application	Linseed oil
Chehel Sotoun Palace, Qazvin	3:2	9.3	Zinc oxide (white zinc)	Animal Glue	-	Gold leaf application	Linseed oil
Sheikh Kalkhoran Shrine	3:2	8.6	-	Animal Glue	-	Gold leaf application	Kaman oil

For the execution of *Pastiglia*, after completing the ground layer, the base layer, and the preparatory (priming) layer, the intended design was traditionally transferred onto the wall surface using pouncing and tracing techniques. To prepare the *Pastiglia* material, approximately 50% gypsum and 50% red clay were passed through a very fine sieve and thoroughly mixed. Animal glue (Serishom) was gently heated in water using indirect heat until dissolved. Based on the artisan's experience, the glue was diluted with lukewarm water, and a small amount of grape sap was added; this addition was necessary to enhance flexibility, as Serishom alone tends to dry brittle and undergoes significant contraction. The prepared solution was poured into a container, and the gypsum–red clay mixture was gradually incorporated while stirring continuously. The consistency of the material had to be neither too stiff to work with a brush nor too fluid to run on the wall surface.

Once ready, the *Pastiglia* was applied with a brush following the drawn patterns. Multiple applications were necessary to achieve the desired relief height, with the final layers being thinner to ensure a smooth and even surface. After the *Pastiglia* work was completed, gold leaf or copper alloys were adhered using either aqueous glue (Serishom) or oil-based adhesive (Kaman oil or linseed oil). Where required, polychrome painting was carried out; otherwise, brush finishing was applied. A protective topcoat, when applied, was typically Kaman oil.

## 6. Conclusion

During the Timurid and Safavid periods, in order to prevent cracking of the *Pastiglia* (relief plaster decoration), caused by the volumetric expansion of gypsum mortar during setting, gypsum was mixed with red clay (*gel-e sorkh*) to compensate for the shrinkage and cracking tendency of the clay. In addition to mineral materials, an organic adhesive was also essential. In the composition of the *Pastiglia* layers in the three monuments of Chehel Sotoun Palace (Isfahan), 'Ali Qapu Palace (Isfahan), and Hasht Behesht Palace (Isfahan), gypsum, red clay, and animal glue (Serishom) were used. The gypsum and red clay were first mixed in dry form, and instead of plain water, a warm aqueous solution containing dissolved animal glue was employed. In all three buildings, gilding was performed using the *oil gilding* technique, with linseed oil or *kaman* oil serving as the adhesive medium.

The technique of executing *Pastiglia* decorations in the Vank and Bethlehem churches of Isfahan is similar to that observed in the aforementioned palaces. In terms of material composition, the *Pastiglia* layers of both churches correspond closely to those of 'Ali Qapu and Chehel Sotoun palaces, while differing slightly from Hasht Behesht Palace in the proportion of red clay used. In both churches, gilding was carried out by the *oil gilding* method, employing linseed oil. Based on the field observations and visual assessment of the studied samples, the *Pastiglia* decorations of the Vank and Bethlehem churches exhibit a higher level of quality and craftsmanship compared to the other examined monuments.

The *Pastiglia* decorations of the Safavid period in Chehel Sotoun Palace of Qazvin were executed similarly to those in the Safavid monuments of Isfahan. In terms of composition, the proportions of gypsum and red clay in the two layers are comparable, showing the closest resemblance to those of Hasht Behesht Palace. In fact, in the *Pastiglia* of Chehel Sotoun Palace in Qazvin, a greater amount of red clay was used compared to the examples from Chehel Sotoun and 'Ali Qapu palaces in Isfahan. Gilding in both layers of the Qazvin palace was also executed using the *oil gilding* technique, employing oil as the adhesive agent.

The *Pastiglia* decorations of the Sheikh Kalkhoran Mausoleum were carried out in the same manner as the other studied buildings. In terms of material composition, the ratio of gypsum to red clay was approximately equal, meaning that the amount of red clay was higher than that observed in the *Pastiglia* of Chehel Sotoun and 'Ali Qapu palaces. The gilding applied over the *Pastiglia* layer in the Sheikh Kalkhoran Mausoleum was of the *oil gilding* type, in which gold leaf was adhered using oil (probably *kaman* oil).

For the execution of *Pastiglia* decoration, after completing the undercoat, bedding, and preparatory (ground) layers, the intended design was transferred onto the wall surface using

traditional *pouncing* and *stenciling* techniques. To prepare the *Pastiglia* material, approximately equal parts (50%–50%) of gypsum and red clay were sieved through a fine mesh and thoroughly mixed. The animal glue was gently heated in water using indirect heat until fully dissolved. Based on the craftsman's experience, the glue solution was diluted with warm water, and a small amount of grape syrup was added — the latter to increase flexibility and reduce the brittleness and shrinkage of the glue. A measured amount of this solution was poured into a vessel, and the gypsum–red clay mixture was gradually added while stirring continuously. The mixture's viscosity had to be such that it was neither too thick for brush application nor too thin to cause dripping on the wall surface.

Once the *Pastiglia* mixture was prepared, it was applied to the designated areas of the design using a brush. This process was repeated several times until the desired relief thickness was achieved. The uppermost layers were made more diluted to obtain a smooth and even surface. Upon completion of the *Pastiglia*, gold leaf or copper alloy foil was adhered to its surface using either an aqueous adhesive (animal glue) or an oil-based adhesive (linseed or *kaman* oil). Subsequently, if color application was required, it was performed; otherwise, fine outlining (*qalamgiri*) was executed. The final protective coating, when applied, usually consisted of *kaman* oil.

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### Conflict of Interest

The authors declare that there is no conflict of interest regarding the authorship or publication of this article.

### Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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