

YEREVAN BRICKWORK RESIDENTIAL BUILDING ARCHITECTURE AND THE IMPORTANCE OF GEOGRAPHIC INFORMATION SYSTEMS (GIS) IN PRESERVATION OF ARCHITECTURAL MONUMENTS AND STRUCTURES



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Abstract: Many buildings were built in Yerevan with bricks. The specifics of brickwork, residential buildings, architecture, and building art in Yerevan have become the subject of the article. Especially, the characteristics of Iranian architecture are observed in the architecture of residential houses in Yerevan. The building material is mainly brick, and the front decoration of the buildings is carried out through the decorative brick masonry, which is more typical of Iranian architecture, with unique solutions of the decoration elements and wooden balconies. This combination points to the skill of Armenian architects and masters. This research aims to gather and maintain accurate information about brick structures, which significantly impacts their preservation. In a GIS environment, it is possible to combine vector and text information. The recommended technology makes it possible to see the location of the object on the map, not only in two dimensions but also in a 3D model. The proposed data processing in the GIS environment, both graphic (vector) data processing and linking of textual data to them, is already carried out. As a result, a complete database is obtained, which can be published for free use as well as serve as a basis for the preparation of maintenance or restoration projects, further monitoring, and analysis.

Keywords: brickwork buildings, residential houses, architecture, Yerevan, information database, geo information data, GIS.

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Introduction

Residential houses built on the brick of Yerevan were built mainly in the late 18th and early 19th centuries. During this period, Yerevan was under the control of the Iranian khanate. Yerevan had three residential districts: Shaharas (the royal palace) was in the northeastern part of the city, the Thapabashi (hill, present Kond) was in the eastern part, and in the southeastern part was Damir-Bhulag (iron fountain) [1-3]. Most of the brickwork structures in Yerevan were demolished in the early 20th century for the implementation of the master plan of A. Tamanyan (Fig.1).

Materials and Methods

The brick houses in Yerevan have come to us with some modifications. They are mainly adapted to modern requirements. Initially, the houses had a large plot of land and a lot of supporting structures, but today residents only benefit from the residential sector, and the supporting structures have been demolished and destroyed.



Fig. 1. Placement of residential houses in Yerevan
● - standing building, ● - destroyed building

It is evident that houses built by the Sardars and Khans had Qajar dynasty architectural stylistic points. These are distinguished by compositional, artistic, and constructional characteristics. Specific types of decorative masonry are made of different sizes of bricks (Table). This diversity of sizes was based on that decorative style, each of which had its own meaning¹[4].

The master plan of the residential houses of this period had the following structure: the residence part, the garden, and the little yard surrounded by several supporting structures like the kitchen, storage, bathroom, barn, and summer rooms^{2,3} (Fig.2 [4]). In the central part of the yard, there was a fountain stone pool that was designed for ventilation and air conditioning. The yard was also greenish, especially with mulberry trees.

Table. Different sizes of bricks

Dimension of bricks used in residential houses (cm)			
	Width	Length	Height
1.	21	21	5
2.	25	13	7
3.	20	20	6
4.	30	25	7
5.	20	10	5

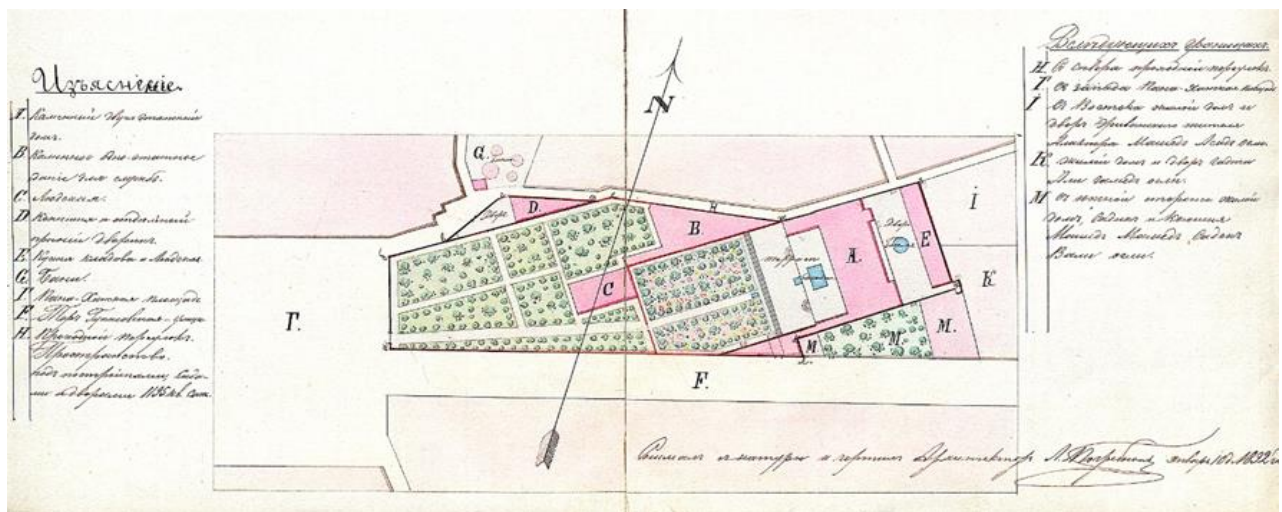


Fig. 1. Panakhan residential house master plan (1892)

A. Two floors residential house, B. Service building, C. Summer room,
D. Barn and store for animals with its adjacent yard, E. Kitchen and store, G. Bath,
F. Nowadays Nalbandyan street, I, K. Residential building, M. Interior summer rooms

Plans of the residential houses in this region were mainly built with two floors: a basement and a second main residential floor. Each floor had its own room layout, and it was the layout of these rooms that characterized the residential houses of the Iranian period. The basement floor was mainly used for storage, but there were also rooms for maids and servants. The second and main floor was considered the residential part. The rooms on this floor vary, but there are rooms that are basic in all houses. When entering the entrance, we find ourselves in a corridor or in the part of today's vestibule. There are rooms to the right or left of the vestibule, but only one of these rooms has a door opening to the vestibule, which is considered a common room or a room for receiving guests. From the opening in the opposite section, we enter the dining hall or luxurious living room, where the main and important guests were received. To the right of this room is the fireplace or brazier room, which was mainly used in winter. The room on the left was already the bedroom, where the men of the house were accommodated, and next to the fireplace room was the women's bedroom, which was less visible from the common room. In the houses of the rich, there were several additional rooms. On the first floor, there was a laundry room and a bathroom, along with a bathtub. On the second floor, there were kitchen and utility rooms (Fig.3) [4,5].

¹ Hin u nor Yerevan (author's edition). Yerevan History Museum, 2009 (in Armenian).

² Ibid.

³ Panakhani bnakeli tan glkhavor hatakagitsy. Hayastani azgayin arkhiv, 1892.

The main facades of the houses were located by the side of the yard. They were decorated with decorative bricks and large stained glass windows. The rooms were bright and colorful according to the transparency of these windows. On the main facade, windows and opening parts were emphasized with arches. Such elements were used in Armenian architecture, but they were more typical of Iranian architecture.

The facade was not only a functional but also an artistic element with a wooden balcony, which mostly had ornaments. The balconies were on the main and the street façade. The balconies of Yerevan houses often have been on the street façade (Fig.4).

The rooms were covered with white plaster and ornaments (with light relief) that were very similar to the ornaments of European chambers. The heating of the rooms was carried out through fireplaces and also used for the firepan (manghal). In the ordinary, people did not have furniture in their homes; the walls were covered with carpets. The houses of the rich (khan) were furnished. On the walls were two levels of niches, which were placed in the bottom part of the boxes, and in the upper part there were bottles of rose water (Gulab), wine, and vodka, as well as crystalline plates. The niches were covered with gold filament pieces [4,6,7].



Fig. 2. Residential houseplan zoning

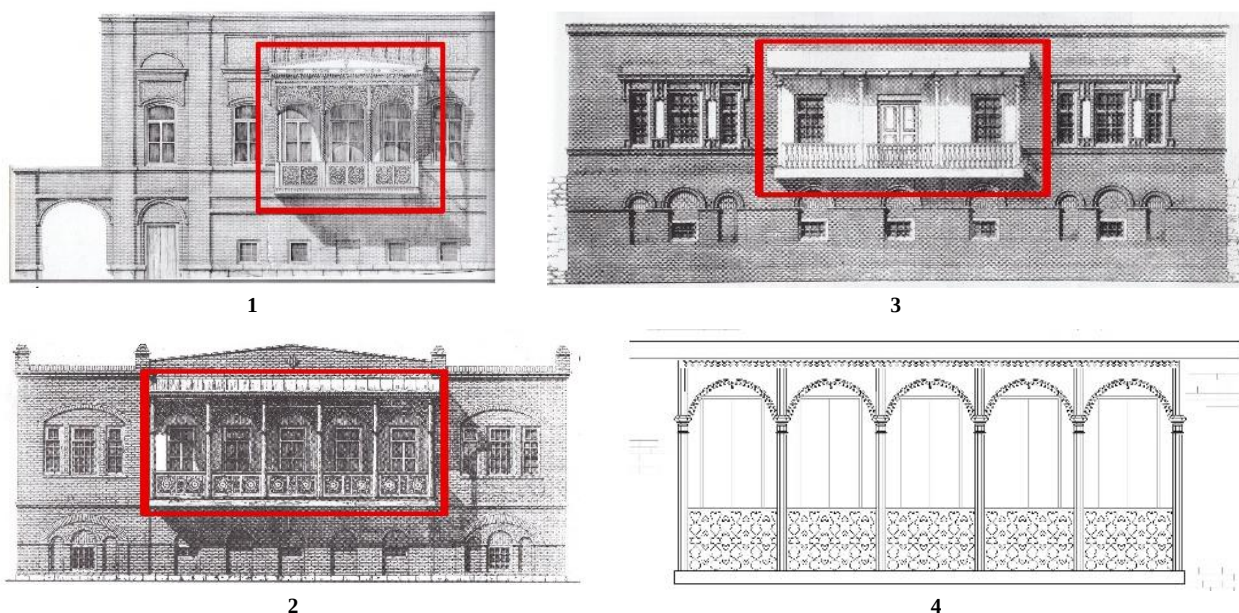


Fig. 4. Wooden balcony of residential house

1. Yesayan house, 2. Kamsars house, 3. Khachatryan house [5], 4. Balcony survey by E.Ordoukhanian



Fig. 5. *Panakhan residential house old view*

The decorative brick masonry was used in the ceilings of the rooms. The brick color was also important; mainly, they were turquoise, green, and red. Each color has its mythological meaning: turquoise, the heavenly world; green, nature and abundance; and red, life and joy⁴.

Panakhan's residential house is a good example of similar houses built in 1824 (Fig.5). Panakh had his own houses and mosques in the Shahar district of Yerevan, which were built with brick and wood. One of his houses has survived to this day but has a few little changes.

The house is located in the northeastern part of Sakharov Square, at the end of the second lane of Vardanants Street. Panakhan's house is separated from the surrounding construction. Its position is justified by the presence of large plots of land adjacent to residential buildings that are part of the former construction system, which have been constructed and got the current situation during urban development. The building is two stories, and in the central part, a three-story attic floor is usually intended for women. There are two entrances on the main façade, which have been opened over the years; none of these entrances is the initial entry of the house. The old entrance to the building has been blocked by a recent build, which also divided the main façade into two parts. The left entrance ceiling is preserved in original form, with decorative brick masonry in turquoise, green, red, and yellow colors (Fig.6)⁵ [8].

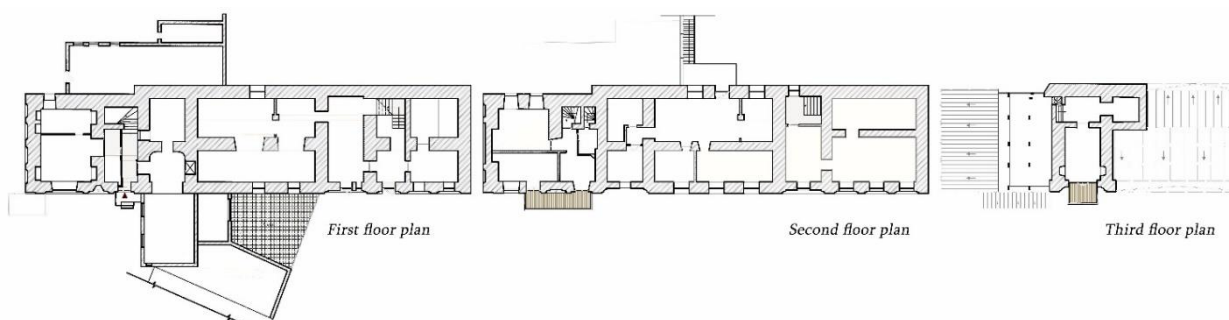


Fig. 6. *Panakhan residential building, survey by E.Ordoukhanian*

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The left-side room on the first floor has also preserved its original appearance, with a niche with openings in the walls and a large wooden window to the yard, and the right-handed room is fully altered and adapted to modern requirements. A staircase is located at the end of the corridor. The second floor has completely lost its original character. At present, there was the addition of a kitchen, a bathroom, and a lavatory. The preserved old wooden balcony is in an emergency condition. The second floor joins to the third floor with the staircase, which is in the wall thickness. The third floor has largely preserved its old look. On the last floor, there is an old wooden ceiling (Baghdad style) and a wall of clay plaster. Also, the niches of the walls, wooden windows, and balconies have been preserved. The old stairs can also be lifted up to a well-preserved flat roof, on which the residents build a slate roof with a tile. The right side of the house has been completely transformed indoors and outward, keeping its original appearance on the first-floor ceiling, but it has also lost color tone (Fig.7)⁶ [8,9,10].

⁴ Hin u nor Yerevan (author's edition). Yerevan History Museum, 2009 (in Armenian).

⁵ Ibid.

⁶ Ibid.



Fig. 7. Phanakhan residential house, photos by E. Ordoukhanian (2015)

1. Main façade, 2. Second floor room, 3. Entrance old staircase and ceiling colored brick, 4. Roof, 5. Left side room ceiling decorative masonry, 6. House left façade which covering with cement

In the old district of Yerevan, like Nork, we find a combination of building materials: brick with stone. The majority of these structures are made of stone, and the frames of windows and openings are decorated with bricks made of decorative elements inspired by Iranian architecture. In these structures, the shape of the first-floor ceiling arch is noticeable, which is typical of all the brick houses (Fig.8).

Collecting and maintaining correct information about brick structures has a very important effect on preservation. Modern technologies, such as laser scanning, allow you to obtain millimeter accuracy on the appearance of the building and to have 100 or more points per square meter, which makes it possible to draw up every brick. The study with the method of ultrasound scanning allows getting information about the situation in the walls of the structure [11,12].



Fig. 8. Nork residential houses decorating masonry

GIS and BIM environments of modern technologies provide wide opportunities for classification, processing, and storage of information collected by various methods (Fig.9).

Especially in a GIS environment, it is possible to combine vector and text information [13]. This technology makes it possible to see the location of the object on the map, not only in two dimensions but also in three dimensions (3D) (Fig.10). See information about it, such as name,

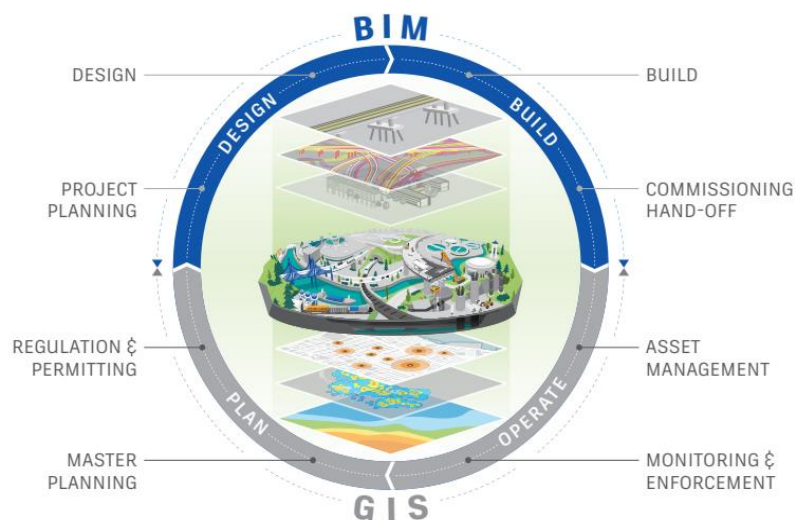


Fig. 9. BIM and GIS integration

practical or applied meaning, date of construction, construction material, construction technology, degree of damage, etc. In the case of correct and complete data collection, it is possible to make classifications very quickly, for example, to distinguish all the buildings that were built before the 5th century, are located in conditions of high air humidity, and have a high degree of preservation. Similar analyses allow us to get quite interesting and memorable information about previously used building materials, technologies, and architectural solutions.

The study of brick structures by geodetic methods allows for an increase in the accuracy of collected data, reduces the influence of anthropogenic factors, and reduces the possibility of random errors.

In order to achieve the maximum efficiency of data collection, the combined use of technologies is important.

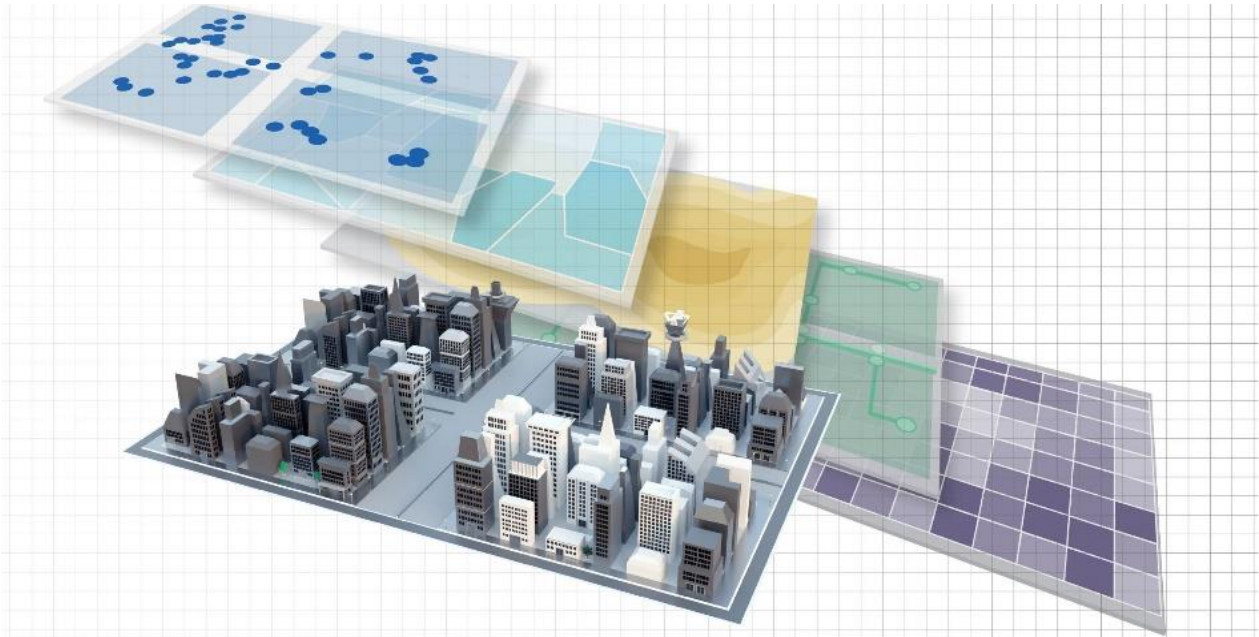


Fig. 10. GIS environment, 2D and 3D information in same time

In the case of using the combined method, for the complete mineralization of the object, a geodetic network is created using GNSS satellite receivers, and then alignment is carried out by means of spatial processing [12,14].

Next, with the use of an electronic tachometer, the mining of the brick structure and its main elements is carried out to obtain its general data and geometric dimensions.

Laser scanners are used in those areas where there are special architectural elements that require more detailed data collection. The use of a laser scanner allows for the abandonment of the implementation of manual drawings, which not only speeds up data collection several times but also excludes the influence of the human factor.

Conclusion

Yerevan's brick residential houses were mainly located in the central part of the city, at the crossroads of Pushkin-Teryan, Nalbandyan, and Sayat-Nova streets and the Kond district. They were built during the Persian period (Fig.11).

The houses of the rich persons have an adjacent yard and a garden surrounded by the rooms.

The use of decorative brick masonry is mainly in facades and ceilings, but the use of colored bricks is mainly in interior design. The shape of the first floor ceiling was arches.

The houses of Old Nork are built in combination with stone and brick. In the stone structure, the frames of windows and openings are decorated with bricks made of decorative elements. Here is the influence of Iranian architectural decorative elements.

	Address	Standing	Broken down	Destroyed	Raw brick	Fired brick	In combination with	Old Photos	New Photos
1	Vardanants street 19	+	-	-	-	+	-		
2	Buzand street 32	-	+	-	-	+	-	-	
3	Noragavit	-	+	-	+	-	-	-	
4	Hanrapetutyan street	-	+	-	-	+	-	-	
5	Parbetsi street	-	+	-	+	+	+	-	
6	Yekmalyan street	+	-	-	-	+	+	-	
7	Hanrapetutyan street 50	-	+	-	-	+	-	-	
8	Pushkin-Teryan intersection	-	-	+	-	+	-		completely destroyed
9	Nalbadyan street	-	-	+	-	+	-		completely destroyed
10	Sayat-Nova street	-	-	+	-	+	-		completely destroyed

Fig. 11. List of brick residential houses located in the central part of Yerevan

The balconies built on the frontal part of the brickwork buildings had Armenian decorative motifs. This combination points to the skill of Armenian architects and masters, preserving traditional Armenian architecture in the Iranian state.

During data processing in the GIS environment, both graphic (vector) data processing and linking of textual data to them are already carried out. As a result, a complete database is obtained, which can be published for free use as well as serve as a basis for the preparation of maintenance or restoration projects, further monitoring, and analysis.

Conflict of Interest

The author declares no conflicts of interest.

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