

## The Building Technique Features in Design of Arak Historical Monuments from Qajar Period

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**Abstract:** Since Arak city has been built based on a pre-determined pattern, Therefore, not only in the steps of planning, urban design and architecture, but also in the stage of building techniques, exclusive patterns have been designed and implemented by following the certain styles and considering the buildings typology. Building techniques in every group of architectural monuments have particular styles and can be extended to all buildings belonging to a group. Goal of the research is to identify the properties of building techniques in design of historical monuments in Arak from Qajar period including roof structure, types of arches, structural systems, combination of materials in wall, roof & floor, bearing, supporting elements and beams. Methodology of the study concentrates on the documentation, descriptive analysis of building techniques in historical monuments considering their classification. The combination of qualitative factors with quantitative factors for analysis of building techniques in monuments has been used. Conclusion of the study is presentation of classification about the building techniques separately for different groups of monuments including religious, public, residential, communal, memorial buildings & minor architectural forms.

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### Introduction

Arak city as the capital of central province is located in Iran central plateau and near the Zagros Mountains. Arak as a symbol of pre-determined designed historical cities in Iran was constructed in 1812 A.D & in the period of Qajar dynasty. In Qajar period, confrontation of vertical and lateral forces has been considered in design of the structure in order to creation the most static and stable forms. The use of static coating forms in architectural scale, with strong mathematical logic and unique stability, kept the structure in place for a long duration. Qajar architecture is rated as more evolved compared with prior periods like Zandieh and Safavid era. In this period creativity and diversity in space increased and spaces tend to be opener and lighter. In Qajar architecture, module plays an important role as a criterion for structural system. With the help of module as means of measurement, architects have managed to present beautiful designs and would connect urban components and organs whereby they managed to create a harmonious and proportional artwork. In the old fabric of Arak, Module has played a determining role not only in the order of urban blocks, community centers, path ways and neighboring spaces, but also in the size and dimension of pillars, rooms, hallways, structures, facades, door and windows. In monuments, Zarbi arch was an innovation in building technique which has led to cover broad spans. The historical monuments belonging to the Qajar period in Arak are divided into 6 groups including religious, public, residential,

memorial, communal buildings and minor architectural forms. In each group, the buildings are divided into several types thus an index building from each type has been selected as a representative of the type for analyzing the building technique. The properties of building techniques consist of roof structure, types of arches, structural systems, combination of materials in wall, roof & floor, bearing, supporting elements and beams which are presented separately for each group.

### A. Religious buildings

In the group of religious buildings, mosques of Sepahdari and Sheikh Abolhassan have been selected as index buildings and representative of types. These two old mosques have remained with the original structure.

#### a. Mosque and School of Sepahdari

Roof structure of all rooms is in the form of rocking arches made of bricks. The interior cover of dome ceiling is combination of brick and tile and in all rooms is a mix of plaster and soil and the final coating is a layer of gypsum. The outer cover of roof is thatch and ash. The floor of yard and rooms is laid by mosaic with dimensions of 30\*30 cm, and floor of porches is covered with marble with dimensions of 20 × 20 cm. Structural system in the building is load bearing wall with thickness of 70-80 cm. All load bearing walls are located on a modular network with width of 4 meters. In the load bearing walls all openings are the same width (1 m) and are all in one direction. In all load

bearing walls, niches with different width have been embedded so that they are located on a modular network. In making the walls, brick, mortar and lime plaster and clay has been used. In construction of foundation, large stones and lime mud slurry has been used. The only part where structural system is the wall and columns is the dome space located on the southern side of the building. In this space, the columns are made of brick and are load-bearing and copper and lead sheets have been used at the base of the columns.

#### **b. Mosque of Sheikh Abolhassan**

Roof structure in the first floor is in the form of rocking arches made of bricks and roof structure in the second floor is wooden boards. The interior cover of ceiling in the first floor is brick and in the second floor are wooden beams. The body cover in all interior walls is decorative brick. The outer cover of roof is thatch and ash. The floor of yard is laid by stone with dimensions of 20\*20 cm, and floor of interior spaces is covered by brick with dimensions of 20 × 20 cm. Structural system in the first floor is combination of load bearing wall and brick columns and in the second floor is combination of load bearing wall and wooden columns. All load bearing walls are located on a modular network with dimensions of 3\*3 meters. In all load bearing walls, niches end openings are located on a modular network. In making the walls, brick, mortar and lime plaster and clay has been used. In construction of foundation, large stones and lime mud slurry has been used.

#### **B. Public buildings**

In Arak old fabric, the most important buildings belonging to this group are Timcheh and Sara. These buildings have commercial and chamber use. In the past, merchants who often travelled in from distant towns spent the night on Sara and Timcheh. This group of buildings is along the bazaar and their entrances are connected with the main axis of bazaar. This group of buildings in Arak historical fabric is classified into six types based on the combination of Sara (central courtyard structure) and Timcheh (roofed space with central hall) compared to each other and their location in comparison with bazaar axis. Since for conducting of the analysis process, the sample of any type should be comprehensive and contain all the properties related to the type, so from any type, the building have been chosen that their Structure and details have changed less over the time and have greater diversity. Based on these criteria, the samples have been selected for the type 1, 3,4,5,6 are Timcheh and Sara of Naghshineh, Ketabforushha, Akbarian, Kashani and Nozari respectively. Because all the buildings belonging to type 2 have been demolished

and rebuilt with new style, so this type cannot be analyzed.

#### **a. Timcheh of Naghshineh**

Roof structure of rooms on the basement and first floor is in the form of rocking arches made of bricks and the roof structure on the second floor is mainly wooden boards. Roof structure of central hall is brick arches. The interior cover of ceiling is a mix of plaster and soil and the final coating is a layer of gypsum. The outer cover of roof is thatch and ash. The floor of Timcheh is laid by mosaic with dimensions of 30\*30 cm. Structural system in the building is load bearing wall with thickness of 110 cm. All load bearing walls are located on a modular network with dimension of 4\*4 meters. In the load bearing walls all openings are the same width (1 m) and are all in one direction. In all load bearing walls, niches with width of 50 cm have been embedded so that they are located on a modular network. In making the walls, brick, mortar and lime plaster and clay has been used. At the feet of arches and the distance between floors, wooden beams as supporting elements inhibit tensile forces and neutralize lateral forces. These beams prevent the transfer of horizontal forces into the wall and lead to structural coherence.

#### **b. Sara of Ketabforushha**

Roof structure of Timcheh rooms is in the form of rocking arches made of bricks and the roof structure of Sara is mainly wooden boards. The roof structure in the middle Timcheh is wooden truss with fake cover made of wooden frames, and in the lateral Timcheh roofs are made of bricks. The Noticeable point is a pergola in the center of the middle Timcheh with a roof covered with tinfoil whose function is to provide lighting and ventilation. The interior cover of ceiling is a mix of plaster and soil and the final coating is a layer of gypsum. The outer cover of roof is thatch and ash. The floor of Timcheh is laid rubble axed stone, and in Sara floor is covered with brick with dimensions of 30 × 30 cm. Structural system is load bearing wall. All load bearing walls are 80 cm thick and are all in one direction. All load bearing walls are located on a modular network so that the distance of load bearing walls in Timcheh and adjacent corridors is 3.5 m and the same distance in Sara is 4 m. In the load bearing walls all openings are the same width (1.2 m) and are all in one direction. In all non-load bearing walls of all rooms in Serra three niches of 40 cm width are embedded so that they lie along the 3-piece doors. In making the walls brick, mortar and lime plaster and clay has been used. The only part where structural system is the wall and columns is the porch located on the eastern front of Sara. In this part, the columns are made of stone and

are load-bearing, and consist of base, body and capital. At the feet of arches and the distance between floors, wooden beams as supporting elements inhibit tensile forces and neutralize lateral forces. These beams prevent the transfer of horizontal forces into the wall and lead to structural coherence.

#### c. Sara of Akbarian

Roof structure of rooms on the first floor is in the form of rocking arches made of bricks and the roof structure on the second floor is mainly wooden boards. The interior cover of ceiling is a mix of plaster and soil and the final coating is a layer of gypsum. The outer cover of roof is thatch and ash. The floor of Timcheh and Sara is laid by bricks with dimensions of 20\*20 cm so that it has been executed as right corner in Sara and obliquely in Timcheh. Structural system in the building is load bearing wall with thickness of 80-100 cm. All load bearing walls are located on a modular network with width of 4 meters. In the load bearing walls all openings are the same width (1 m) and are all in one direction. In all load bearing walls, niches with different width have been embedded so that they are located on modular network. In making the walls brick, mortar and lime plaster and clay has been used. The only part where structural system is the wall and columns is the porch located on the body of Sara. In this part, the columns are made of stone and are load-bearing and consist of base, body and capital. At the feet of arches and the distance between floors, wooden beams as supporting elements inhibit tensile forces and neutralize lateral forces. These beams prevent the transfer of horizontal forces into the wall and lead to structural coherence.

#### d. Sara of Kashani

Roof structure of rooms on the first floor is in the form of rocking arches made of bricks and the roof structure on the second floor is mainly wooden boards. The interior cover of ceiling is a mix of plaster and soil and the final coating is a layer of gypsum. The outer cover of roof is thatch and ash. The floor of Timcheh is laid by bricks with dimensions of 20\*20 cm, and Sara floor is covered with mosaic with dimensions of 30 × 30 cm. Structural system in the building is load bearing wall with thickness of 90-100 cm. All load bearing walls are located on a modular network with width of 4 meters. In the load bearing walls all openings are the same width (1 m) and are all in one direction. In all load bearing walls, niches with different width have been embedded so that they are located on a modular network. In making the walls brick, mortar and lime plaster and clay has been used. The only part where structural system is the wall and columns is the porch located on the body of Sara. In this part, the columns are made of stone and are load-

bearing and consist of base, body and capital. At the feet of arches and the distance between floors, wooden beams as supporting elements inhibit tensile forces and neutralize lateral forces. These beams prevent the transfer of horizontal forces into the wall and lead to structural coherence.

#### e. Sara of Nozari

Roof structure of rooms in all the building is in the form of rocking arches made of bricks and the roof structure of colonnades is mainly wooden boards. The interior cover of ceiling is a mix of plaster and soil and the final coating is a layer of gypsum. The outer cover of roof is thatch and ash. The floor of Timcheh is laid by rubble axed stone and Sara floor is covered with bricks with dimensions of 30 × 30 and 20×5 cm. Structural system in the building is load bearing wall with thickness of 80-100 cm. All load bearing walls are located on a modular network with width of 4 meters. In the load bearing walls all openings are the same width (1 m) and are all in one direction. In all load bearing walls, niches with different width have been embedded so that they are located on a modular network. In making the walls brick, mortar and lime plaster and clay has been used. The only part where structural system is the wall and columns is the porch located on the body of Sara. In this part, the columns are made of stone and are load-bearing and consist of base, body and capital. At the feet of arches and the distance between floors, wooden beams as supporting elements inhibit tensile forces and neutralize lateral forces. These beams prevent the transfer of horizontal forces into the wall and lead to structural coherence.

### C. Residential buildings

This group of buildings is located in the depth of quarters and their entrances are connected with semi public and semi private passages. The residential buildings in Arak old fabric is classified into three types based on the combination of open and closed spaces compared to each other. Since for conducting of the analysis process, the sample of any type should be comprehensive and contain all the properties related to the type, so from any type, the building have been chosen that their Structure and details have changed less over the time and have greater diversity. Based on these criteria, the samples have been selected for the types 1, 2, 3 are houses of Khakbaz, Hassanpur and Hajagha Mohsen Araki respectively.

#### a. House of Khakbaz

Roof structure of rooms on the basement is in the form of rocking arches made of bricks and the roof structure on the first and second floor is mainly wooden boards. The interior cover of ceiling on the

basement is brick and on the other floors is a mix of plaster and soil and the final coating is a layer of gypsum. The outer cover of roof is gable roof made of tin plate. The floor of the yard is laid by mosaic with dimensions of 30\*30 cm, and room's floor is covered with ceramic with dimensions of 30 × 30 cm. Structural system in the building is load bearing wall with thickness of 60-70 cm. All load bearing walls are located on a modular network with width of 3 meters. In the load bearing walls all openings are the same width (1 m) and are all in one direction. In all load bearing walls, niches with different width have been embedded so that they are located on a modular network. In making the walls, brick, mortar and lime plaster and clay has been used. In construction of foundation, large stones and lime mud slurry has been used. The only parts where structural system is the wall and columns are the basement and the porches located on the first and second floor of the building. On the basement, the columns are made of brick with dimension of 80\*80 cm. On the second floor porches, the columns are made of stone and are load-bearing and consist of base, body and capital.

#### **b. House of Hassanpur**

Roof structure of rooms on the first floor is in the form of rocking arches made of bricks and the roof structure on the second floor is mainly wooden boards. The interior cover of ceiling on the first floor is a mix of plaster and soil and the final coating is a layer of gypsum and on the second floor is decorative wooden networks. The outer cover of roof is thatch and ash. The floor of the house is laid by bricks in the form of L with dimensions of 20\*5 cm, and room's floor is covered with ceramic with dimensions of 40 × 40 cm. Structural system in the building is load bearing wall with thickness of 65-75 cm. All load bearing walls are located on a modular network with width of 4 meters. In the load bearing walls all openings are the same width (1 m) and are all in one direction. In all load bearing walls, niches with different width have been embedded so that they are located on a modular network. In making the walls, brick, mortar and lime plaster and clay has been used. In construction of foundation, large stones and lime mud slurry has been used. The only parts where structural system is the wall and columns are the porches located on the first and second floor of the building. On the second floor porch, the columns are made of stone and are load-bearing and consist of base, body and capital. At the feet of arches and the distance between floors, wooden beams as supporting elements inhibit tensile forces and neutralize lateral forces. These beams prevent the transfer of horizontal forces into the wall and lead to structural coherence.

#### **c. House of Hajagha Mohsen Araki**

Roof structure of rooms on the basement is in the form of rocking arches made of bricks and the roof structure on the first and second floor is mainly wooden boards. The interior cover of ceiling on the basement is brick and on the first and second floor is a mix of plaster and soil and the final coating is a layer of gypsum and on the porches is decorative wooden networks. The outer cover of roof is thatch and ash. The floor of the yard is laid by combination of bricks with dimensions of 20\*5 and 20\*20 cm and stones with irregular dimensions and room's floor is covered with mosaic with dimensions of 30 × 30 cm. Structural system in the building is load bearing wall with thickness of 70-90 cm. All load bearing walls are located on a small modular network with width of 3 meters and a large modular network with width of 4 meters. In the load bearing walls all openings are the same width (1 m) and are all in one direction. In all load bearing walls, niches with different width have been embedded so that they are located on a modular network. In making the walls, brick, mortar and lime plaster and clay has been used. In construction of foundation, large stones and lime mud slurry has been used. The only parts where structural system is the wall and columns are the porches located on the second floor of the building. On the porch, the columns are made of brick and are load-bearing and consist of base, body and capital.

#### **D. communal buildings**

The communal buildings in Arak old fabric are of two types including single & multi complex that baths of Safai & Chaharfasi have been selected as representatives of types.

##### **a. Bath of Safai**

Roof structures of all spaces are of brick arches. The interior cover of ceilings is a combination of soil & lime. The outer cover of roof is thatch and ash. The floor of bath dressing is laid by stones with irregular dimensions. Structural system in the building is load bearing wall with thickness of 80-100 cm. All load bearing walls are located on a modular network. In making the walls, brick, mortar and lime plaster and clay has been used. In construction of foundation, large stones and lime mud slurry has been used.

##### **b. Bath of Chaharfasi**

Roof structure of all spaces is in the form of rocking arches and adobe domes made of bricks. The interior cover of ceiling in men bath dressing is seven colored tile, ceiling cover in the vestibule of men bath is a combination of plaster, soil and tile frames, it is brick in corridors and is a mix of plaster and soil and the final coating is a layer of gypsum in other spaces.

The outer cover of roof is thatch and ash. The floor of men bath dressing is laid by stones with irregular dimensions, and floor of other spaces is covered by mosaic with dimensions of 30 × 30 cm. Structural system in the building is load bearing wall with thickness of 100 cm. All load bearing walls are located on a modular network with width of 1.5 meters. In the load bearing walls, all openings are the same width (1 m) and are on a modular network. In all load bearing walls, niches with different width have been embedded so that they are symmetrical compared to axes. In making the walls, brick, mortar and lime plaster and clay has been used. In construction of foundation, large stones and lime mud slurry has been used. The only parts where structural system is the wall and columns are the dressing & hothouse of men bath. In these parts, the columns are load-bearing and their surface area increases in fulcrum of bearing arches.

### **E. Memorial buildings**

The most memorial buildings have been destroyed due to lack of sponsorship. The only buildings which have remained are Hazrat Abolfazl Alabas, Mohammad Ebrahim & Molla Ghasem Saqakhaneh.

#### **a. Saqakhaneh of Hazrat Abolfazl Alabas**

Roof structure of Saqakhaneh is in the form of rocking arches made of bricks. The interior cover of ceiling, body and floor is a layer of mirror as three-dimensional. Structural system in the building is load bearing wall with thickness of 70 cm. In making the walls, brick, mortar and lime plaster and clay has been used.

#### **b. Saqakhaneh of Mohammad Ebrahim**

Roof structure of Saqakhaneh is in the form of rocking arches made of bricks. The interior cover of ceiling, body and floor is colored tiles with arabesque design. Structural system in the building is load bearing wall with thickness of 70 cm. In making the walls, brick, mortar and lime plaster and clay has been used.

#### **c. Saqakhaneh of Molla Ghasem**

Roof structure of Saqakhaneh is in the form of rocking arches made of bricks. The interior cover of ceiling, body and floor is a layer of mirror as three-dimensional. Structural system in the building is load bearing wall with thickness of 70 cm. In making the walls, brick, mortar and lime plaster and clay has been used.

### **F. Minor architectural forms**

#### **a. Pool of Charsuq**

Structural system is in form of octagonal prism which is hollow. The facades and floor are connected through an indentation with depth of 5 cm. In making the form, brick, mortar and clay has been used. The interior cover of the form is a layer of tile in shape of octagonal.

#### **b. Pool of Garmkhaneh**

Structural system is in form of octagonal prism which is hollow. The facades and floor are connected through an indentation with depth of 3 cm. In making the form, brick, mortar and clay has been used. The interior cover of the form is a layer of tiles with different colors.

#### **c. Pool of Sarbineh**

Structural system is in form of octagonal prism which has been combined with four cubes from four sides. The facades and floor are connected through an indentation with depth of 5 cm. In making the form, brick, mortar and clay has been used. The interior cover of the form is a layer of tile in shape of square.

#### **d. Pool of Nozari**

Structural system is in form of octagonal prism. The facades and floor are connected through an indentation with depth of 5 cm. In making the form, brick, mortar and clay has been used. The interior cover of the form is a layer of lime concrete.

#### **e. Pool of Hassanpur**

Structural system is in form of cube which is hollow. The facades and floor are connected through an indentation with depth of 5 cm. In making the form, brick, mortar and clay has been used. The interior cover of the form is a layer of tile in shape of square.

### **Conclusion**

Buildings techniques in roof structure are of 6 types including Zarbi, bilateral, trilateral, foursquare arches, wooden boards & brick dome. In the case of religious buildings, the roof structures in the great mosques are of all types except wooden boards. Regarding small and medium-sized mosques, the roof structures are of foursquare arches & wooden boards. The roof structures in public buildings are of all type except brick dome. In the small spaces, such as rooms and corridors, the roof structures are of Zarbi arch and wooden boards while the roof structure of wider spaces like halls is of foursquare arches. In all public buildings, roof structure of rooms on the basement and the first floor is in the form of arch and is mainly wooden boards on the second floor. The roof structure

in small residential buildings are of Zarbi arch & wooden boards and in great & medium-sized houses are of all types except brick dome. In the case of communal buildings, the roof structure in single complex baths are of Zarbi & foursquare arches and in multi complex baths are of all types except trilateral arch & wooden boards. In the case of memorial buildings, roof structures in all Saqakhaneh are of Zarbi, bilateral & foursquare arches. In all buildings, the interior cover of ceiling is a mix of plaster and soil and the final coating is a layer of gypsum. The outer cover of roof is thatch and ash. Structural system in all building is load bearing wall. All load bearing walls are located on a modular network. In all buildings, structural system of colonnades is the wall and column. At the feet of arches and the distance between floors, wooden beams as supporting elements inhibit tensile forces and neutralize lateral forces.

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