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Geometrical Inscriptions in Elevations of Qajar Architecture (Case Study: Panjshanbe-Bazaar; Babol)

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Abstract: Since the creation of architecture; geometry has been used in buildings' form and space; and though space was perceived through geometry. Geometry is seen in general appearance, elements and aesthetics characteristics of architecture; and using architectural ornaments is an important aspect of Islamic architecture. Investigating the geometry dependent to architectural ornaments in historic city of Babol, is the purpose of this article. In this paper, which is an application of qualitative research using participatory methods, documentation and field observation and harvest practices, a combination of descriptive and historical research has been done to shape the structural paradigm. This essay introduces the basic concepts of vernacular architecture such as *axis, equilibrium, symmetry and rhythm*; and modifies them as significant factors for ordering elevations' inscriptions in the studied area. The result is classifying architectural ornaments of elevations and passes based on materials; analyzing geometrical function of inscriptions; and investigating the role of geometry in formation of architectural ornaments.

Key words: Panjshanbe-Bazar · Vernacular architecture · Geometry · Architectural ornaments

INTRODUCTION

Differentiations and characteristics of different shapes, their relations, angles and distances between them are studied in the science of *geometry*. The word geometry as *Hendeseh* in Persian; is derived from the word *measurement*. Geometry is so valuable for Muslim architects, some haw that only professional architects and pitmen were called engineers and workshops and scientific communities for architects and mathematicians were exhibited in Islamic countries[1]. It seems that Egyptians were the first nation to discover geometrical rules and have used the rules in daily life; because of annual rages of Nile River and the distortion of border's forms, Egyptians renewed the boundaries as a sacred action. In this way the concept of geometry is to represent regulation on earth. In western contexts the word geometry has a Greek root which means surveyor, topographer and also land measurement [1]. Since renaissance, geometry was practically used in architecture. Inscriptional patterns of Islam are also based on accurate geometrical rules. On the other hand in different eras of architecture history; from Vitruvius to Einstein; the existence of equilibrium and order and the effect of geometry on these qualities have been insisted some haw that geometry was the provider of aesthetical and functional needs of human in architectural space.

From the sight of some Muslim philosophers geometrical regulations and orders have supernatural roots and their appearance regard to centuries ago. The duty of geometry is to make human's soul ready for thinking and perceiving facts with no need to sensible world, in order for the soul to leave this world and connect to comprehension world in eternal life through a heavenly ascension [2]. In lots of historical references geometry is placed after number's science. For architects and industrialists practical training of geometry is so essential; because geometry presents shapes in the most

[1]http:// mehremihan.ir/honar (2013: feb13, 11:23am)

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abstract and summarized form which makes mind straight and clear; it's almost impossible for the geometrical reasoning to make mistake [3]. In whole; it can be mentioned that geometry orders place through measuring relations of shapes for reading the mind as a Chanel by which earth could capture abstract world or cosmic life and finding a method for the world to get ordered and protected [4].

It's obvious that architecture is mainly perceived through geometry and finding the order in different parts of the building; because architecture is the art of organizing and creating space and architectural space is mostly perceived visually which is modified by its form; and form is originated from geometry which can be inscribed by shapes and proportions. So architecture uses geometry in order to choose form, represents not only qualities but also attitudes, emotions and thoughts of the architect. The specific geometry of a space can induce concepts. This is the factor used in ancient architecture from the smallest elements of space to the huge scale residential complexes that are mostly based on geometric elements. Geometry not only organizes space visually and mentally, but also effects on structure.

This essay tries to investigate geometrical inscriptions dependent to architecture in historical site of *Panjshanbe- Bazaar* in *Babol*. This way first, specific elements and valuable buildings are modified and then inscriptions of each elevation is analyzed based on the architectural qualities and structure of *Qajar* buildings; and in the end a geometrical pattern is presented for the formation of elevations in this area are. Qajar period is of eras in which buildings obey geometrical rules; whether in elevation's inscriptions or in interior space. Buildings of this era in Babol include residential and religious buildings. The construction and architectural ornaments of these buildings are based on specific geometrical rules, which relate to special culture. Basic concepts of vernacular architecture such as *axis*, *equilibrium*, *symmetry* and *rhythm* were investigated in inscriptions of elevations in Panjshanbe- bazaar. This way first specific effective elements in passes of the area were modified and then any of these elements are studied based on architectural ornaments and the existence and amount of the impact of these basic concepts in architecture are studied.

MATERIALS AND METHODS

Geometry in Architecture: Geometrical rules have been used in different eras of architecture in the world. As from renaissance the role of practical geometry in architectural visualization has been mostly regulated and explained by famous architects. But in Islamic architecture, geometrical rules were flexibly used to shape a whole, not that only some specific rules presented for designing [5]. Geometry is based on exactness and existence of objects. *Falamaki* claims that first tools for human to create the composition of regular or irregular form were point, distance, line, surface and volume which any has a relation and degree. So it can be mentioned that any architectural work, deals with the qualities of line, surface and shape in space, as a result any analysis on an architectural work is somehow related to geometry [5]. Geometrical inscription's patterns in Muslim architecture and art have gradually changed under the influence of *Mongol*, *Safavid* and *Ottoman* and more real plant like patterns were replaced. In this regard; by the way scale modules are completely regular, but they are so flexible and various in shaping the composition of the whole.

By architecture modules of elements are place behind each other in a regular way in order to shape general plan of the building. Architecture is dependent to *order* (in Greek taxis), *regulation* (in Greek diathesis), equilibrium, *propriety*, *liability* and *economy* (in Greek oikonomia) [6]. So; since being a member of a socialized community, we can't get away from architecture. In this regard *Einstein* claims that human kind have been always looking for a way to find a clear and easily perceived image of the world in which they live. Because of this, they began to simplify their vision of the world. After that human tried to picture this imagination in the experienced world and make this image touchable; and this way have dominance over it [7].

Geometry is divided in two types: *theoretical* geometry and *practical* geometry. Theoretical geometry is about the qualities of lines, surfaces and volumes; which is a non-practical science. Practical geometry is used by architects; and radiates the order of the world, the mystery beyond the numbers, shapes, geometrical inscriptions and also discovering and performing the complex relations of symbolic or non-symbolic shapes and forms. It seems that since the appearance of first communities in villages and by the formation of the first buildings, creating quadrangle residential spaces was the first step for taking advantage of geometry in architecture. From primary geometry of simple volumes to final form of complex buildings, *geometry* is the center and core of architectural design process [7]. By the way there is also a significant difference between architecture and practical geometry. Anyway we cannot exactly determine the origin of geometrical thinking. Nations of *Babylon*, *India*, *Egypt* and *Greek* have had important roles on evolution of

geometrical rules; and their industrialists and artists used these rules. By the way there is enough information about revolutions of geometry along history, but about the processes and relations through which theoretical geometry was practically used in architecture and specifically in Iranian architecture, there is lack of data.

In Qajar architecture; based on ancient architectural methods, spatial creativities were seen in creating new diverse spaces, open spaces and using traditional Iranian patterns of architecture. Architectural ornaments of Qajar contain wooden inscriptions, brickwork, bed, mirrors, paintings and lithograph. Inscriptions in this era are more diverse; and ancient Iranian and Western inscriptions were also used in ornamenting the elevation. The specification of Qajar motifs is abstraction and modality of natural elements and this way renovating nature in decorative inscriptions of building.[2] Any way; scale; as a geometrical rule; have been always subtly perceived and used in Iranian architecture; from plan designing to marking and measuring the site.

Geometry is helpful for architects not only in shaping forms, but also its effective on both visual and structural aspects of the building. Vitruvius enumerates three features for architecture: *stability* (structure), *comfort* (function) and *aesthetic*; and he modify geometry as a factor which can bring all these three together. *Stability*, is done when columns are high enough to reach the tough ground and materials are wisely selected for enough amounts; we have *comfort* when residential units are perfectly set and there is no inconvenience and any part of building are suitably shaped and built; and *aesthetic* is performed when the elevation is pleasant and tasteful and components are completely appropriate [6]. Space is created for human's use by architecture. Architecture is about form and geometry is although the language of form, so any architect should have a deep perception of geometrical concepts. In ancient times when architecture was not yet based on academic science, building's stability, ornament's form, size of the building and relations between form and aesthetic, were based on simple geometric rules and exact math.[3] This construction, was widely used; from plan designing to ornament performing. The science of geometry has been also a powerful instrument in hand for architects to measure spatial proportions and create equilibrium, order and aesthetic on earth.

A Geometrical Categorization and Analysis on Elevation Components in Site of Panjshanbe-bazaar, Babol: Identifying and recognizing architectural history of any culture is not detachable of their architectural characteristics. Geometry of plans in any era emphasizes on the significance of recognizing practical geometry in designing and p erforming of architectural ornaments. For more equilibrium between inscriptions and architectural ornaments and buildings construction, designing and performing were always based on geometrical rules [4]. In this regard some theorists classify architectural ornaments in four groups; one of them is geometrical inscriptions [5]. As Muslims developed their knowledge in math and geometry, geometrical designs were widely used in building's inscriptions [8]. It seems that these inscriptions were first based on propriety, similarity, rhythm and symmetry. Although organization of form have been always changing in Iranian architecture. Historical buildings in Iran used to obey nature's rules. There are significant proportions in natural elements; any of which are symbolically used in buildings [7]. In some of elevations in site of Panjshanbe- Bazaar of Babol samples of simulation and purification symbolism can be recognized which is presented by *Sarv* (cedar) inscription; the symbol of immortality; and other plant and animal inscriptions.[4] (Figure1)

In Qajar period northern areas especially *Mazandaran* were important as local traffic for foreigners [9]. As a result lots of noticeable buildings were built in cities of the province. Architecture of Qajar in this area contains residential and religious buildings. Residential buildings have panoramic views through large windows and entrances which are modified by columns and capitals and pedestals (Figure 2 and 3). Gable roof is extensively used in this area (Figure 4). But the architecture of religious buildings continued the way of ancient architecture; specifically Safavid architecture.[5]

Many historians amongst *Broniar* and *Mirza- Mohandes* have talked of Mazandaran in their itinerary and discussed about the importance of developing roads which end to Mazandaran and especially to cities like Sari and *Barforush- Deh* (ancient Babol); they have also sealed on recording historical and religious buildings, nature and road qualifications in cities such as Barforoush [9]. There are lots of valuable buildings like *Hasir- Foroushan* district

[2] http://www.civilica.com/Printable-CHALOOSCIVIL01_097.html (2013: mar28, 08:00am)

[3] http:// mehremihan.ir/honar (2013: feb13, 11:23am)

[4] http://www.cloob.com/timeline/blog_1637340_1866746 (2013: mar2, 12:05pm)

[5] http://www.iraninfoweb.com/university-bank/mhndsymmry/mmryqjr.html (2013: jan21, 11:12am)

Plan 1: Significant elements of the pass, Ref: the authors

Picture 1: Simulation and purification symbolism in site of Panjshanbe- Bazaar using Sarv inscription on elevations, Ref. the authors

Picture 2: Performing a panoramic view through large windows in site of Panjshanbe- Bazaar, Ref. the authors

and its famous weekly bazaar called *Panjshanbe-Bazaar*. These complexes are valuable in terms of architecture and function and present a persistent image of the city. Historical elevations gather in Panjshanbe-Bazaar, along the pass through bazaar and beyond the square.

Picture 3: Modifying the entrance by columns and capitals in site of Panjshanbe- Bazaar of Babol, Ref. the authors

Picture 4: Gable roofs in site of Panjshanbe- Bazaar of Babol, Ref. the authors

Picture 5: Frequent rhythm of arches in pass and elevations in Panjshanbe- Bazaar of Babol, Ref: the authors

Architectural ornaments in Babol in Qajar mostly contain wooden and brick and clay inscriptions. Wooden decorative elements and inscriptions contain wooden *Shir- Sar*s; which had structural role, increased the refractory surface against rain, protected walls and lightened the roof; *Orsi* windows which mostly faced south controlled light and air; and *doors* decorated with

Table 1: The role of inscriptions on spatial elements in Qajar period in Babol

Inscription type	Spatial elements	Function and purpose of inscriptions
Brick inscriptions	Column and capital and pedestal	Modifier of entrance
	Brick Chinese knot	Decoration, helping the structure, persistent rhythm in elevation
	Netted wall	
	Decorative arch	
	Doorway	Relations of inside- outside, building's identity, beautification of urban environment
Clay inscriptions	Gable roof	Covering the building, moisture prevention
Wooden inscriptions	Orsi windows	Panoramic view, controlling light and air
	Shir- Sar	Structural role,, increasing the refractory surface against rain, protecting walls against rain, lightening the roof
	Door	Modifier of position and reliability of the host

Picture 6: Emphasis on constructional center of different views in Panjshanbe- Bazaar, Ref: the authors

geometrical cuts were the modifier of position and reliability of the host.[6] For entrance doors there was always a frame which not only prepared the relations between inside and outside, but it was also a modifier of the building and effected on urban environment. Majority of doorway inscriptions were *bed*, *tiling* and *brickwork*. By the way some plant and animal inscriptions are seen between these inscriptions [10]. Brick inscriptions of Qajar in Babol contain molds of brick-cutting, decorative brick arches, brick Chinese knot on walls and doorways and brick netted walls; in addition to decorative role these inscriptions help structure.[7] A polarization of these is a variable rhythm along city passes (Figure 5). Among other brick inscriptions of Qajar in Babol; influenced by ancient architecture; are entrances modified by columns, capitals, pedestals, entrance stairway and brick arches. Geometrical inscriptions and *arabesques* are also considerable [10]. Clay is mainly used as tiles in gable roofs.

In plan num.1 valuable buildings in terms of history and architecture are presented through calibration and observational method [11]. As mentioned before valuable buildings of this area are placed along the passes of bazaar and squares of Panjshanbe- Bazaar restrict. Main inscriptions are categorized in brick, clay and wooden ornaments with emphasis on Qajar buildings. Any of these elements follow up specific geometrical and formal rules and belong to special architectural period (Table 1). Totally; taking advantage of geometry in architecture of Qajar buildings in Babol is dependent to rules mentioned below:

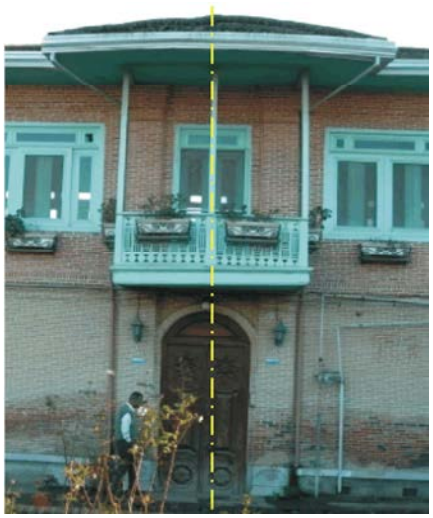
- Propriety, balance and equilibrium and creating a system of spatial and constructional elements
- Emphasis on spatial and constructional center by symmetry (Figure 6)
- Emphasis on spatial and constructional axis
- Emphasis on center in ornaments and decorative elements
- Diversity, rhythm and sequence in inscriptions

In this basis geometrical pattern of elevations in Panjshanbe-Bazaar of Babol in a general classification of basic concepts in vernacular architecture contain *axis, equilibrium, symmetry and rhythm;* in different types of inscriptions of brick, clay and wooden ornaments.

Axis: In Oxford axis means an imaginary line around which an object revolves or a fixed line depending to which other situations are measured in a graph [12]. Axis is one of the basic rules of the formation of Iranian architecture in whole and components; from designing an axis for water stream (in Iranian garden) to axis for dividing elevation surface and its inscriptions. In the site of Panjshanbe- Bazaar spatial and constructional axis has a significant role on buildings location in pass and also in external ornaments of the building; elevation. In this area sometimes axis modifies a special constructional element and this way emphasizes on visual and constructional

[6] http://www.mazandaran.irib.ir/component/content/article/80/421-%D8%AE%D8%A7%D9%86%D9%87%20%D9%83%D9%84%D8%A8%D8%A7%D8%AF%D9%8A (2013: feb19, 9:46pm)

[7] http://www.mazandaran.irib.ir/component/content/article/80/421-%D8%AE%D8%A7%D9%86%D9%87%20%D9%83%D9%84%D8%A8%D8%A7%D8%AF%D9%8A (2013: feb19, 9:46pm)



Picture 7: Emphasis on spatial-constructional axis by projection in balcony through the pass, Ref: the authors

Picture 8: Order and divisions of windows in elevations of Panjshanbe- Bazaar, Res: the authors

Picture 9: Geometrical order in functional and decorative elements in Panjshanbe- Bazaar, Ref: the authors

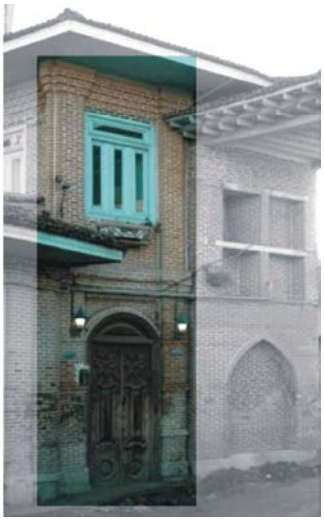
center in specific situation and sometimes acts as symmetry line, from components to whole in brick inscriptions and ordering windows in elevation (Figure 7).

Equilibrium: Wooden inscriptions in Panjshanbe- Bazaar contain windows and *Orsie*s, entrance doors and under-roof beams or *Shir- Sar*s. Windows and entrance doors have dominant role on the formation of elevation. The pattern behind the order of windows in this area is mostly a triple combination of consonant harvester's windows. Any of these windows have a specific geometrical form composed of lots of geometrical elements. Windows opening to alley are smaller; if else Orsies which open to alley have wooden netted owning; which is also a part of window's ornament. These frequent elements protect the privacy of interior space. Color and form of Orsies are eligible to symmetry; in whole and components (Figure 8 and 9).[8]

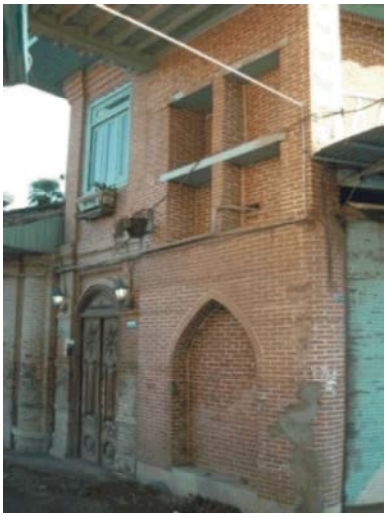
Symmetry: Symbolism by emphasis on axis implies *symmetry.* Symmetry can be performed by one or two or more axis. Sometimes symmetry does not exist in entire elevation, but in some limited parts. The idea of facial axis that presents the whole elevation is not common in Islamic architecture, because it needs a vast environmental space around the building. As a result we can't enter the building from front elevation and inevitably the entrance is located in a corner. This way taking advantage of a fragmental axis and after that using a combination of diverse axis became a common method in Muslim architecture [13]. Proportional vertical systems and designing in third dimension got too much help to architects in order to determine scale. In other hands; by the way using complete symmetry in elevation was dependent to plan design, but symmetrical plan in primary centuries were deeply under the influence of mathematical rules specifically symmetry. Math plays a significant role in architecture; from describing the plan to guiding to discover designer's perceptions. It seems that artist's perceptions of math rules forms the symmetry of plan based on symmetry existing in nature.

Symmetry in Brick Inscriptions: Brick inscriptions in Qajar elevations in Panjshanbe- Bazaar contain columns and capitals and pedestals, brick Chinese knot, archways and brick Chinese knot. Columns reinforced by capitals and pedestals in addition to structural role, influence on urban environment in terms of aesthetics and also modify the entrance (Figure 10). These brick elements contain Chinese knot with plant ornaments and regular geometrical inscriptions. But generally have a simple

[8] http://mehremihan.ir/honar/1095-memari-ersi.html



Picture 10: Symbolic porter columns in elevations of Panjshanbe- Bazaar, Ref: the authors



Picture 11: A sample of geometrical subdivisions in elevations of Panjshanbe- Bazaar, Ref: the authors

Picture 12: Emphasis on center by symmetry in doorway inscriptions in site of Panjshanbe- Bazaar, Ref: the authors

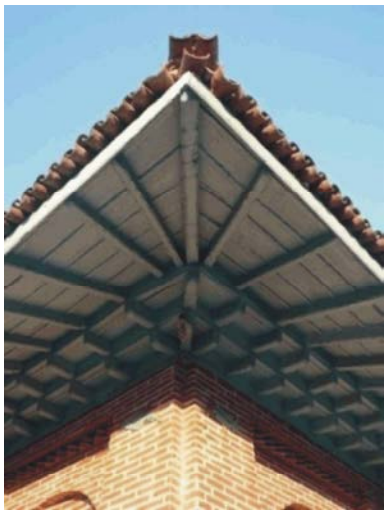
Picture 13: Symmetry of entrance doors in whole and elements in Panjshanbe- Bazaar, Ref: the authors

geometry. Anywhere in the pass and elevations of this area there are geometrical dents and flanges in simple forms of multiple squares or archways with twill or roman arches; which makes a diverse elevation (Figure 11).

Any of these forms not only include symmetry merely, but also when they are put together in a frequent rhythm make the whole elevation symmetric in equilibrium with the scale and dimensions of elevation. In doorways there are symmetric dents for rest; called *Pir- Neshin;* that prepares a shelter for welcoming and escorting guests in addition to performing space needed for entrance. Wholly in doorway elements which contain entrance arch, door and Pir- Neshin, axis symmetry is noticeable. Even the brickworks in two sides of the axis are completely symmetric (Figure 12).

Symmetry in Wooden Inscriptions: Axis symmetry pattern is also considerable in entrance doors' geometrical form. But in geometrical elements of doors' inscriptions there is sometimes central symmetry in form of polygonal stars and other simple geometrical forms (Figure 13).

Rhythm: Rhythm is regular movements or motions of an object. Rhythm in architecture is strongly dependent to ordering of elements and components forming a composition. As mentioned, rhythm of any kind is based on frequency or repetition [12]. In the site of Panjshanbe- Bazaar repeated elements in elevations are amongst gable roofs with wooden cover in beneath and



Picture 14: Frequent rhythm of unde- roof beams in Panjshanbe- Bazaar, Ref: the authors

Picture 15: Clay covering elements in Panjshanbe- Bazaar, Ref: the authors

clay cover on top; any of which help in performing a frequent scenery and act as a pattern that represents vernacular architecture.

Rhythm in Wooden Inscriptions: Under- roof beams or Shir- Sars protect walls against rain and divide roof load through a frequent rhythm; these elements also role as decorative elements for beautification of elevation fronting alley to passersby. These wooden beams sometimes contain small ornamental cuts which present special architectural patterns (Figure 14).

Rhythm in Clay Inscriptions: In this area the complex geometry of clay tiles when gathering in a frequent rhythm shape an integrated whole which is the gable roof. Gable roofs' construction is based on performing angle which applies for both rain to easily stream and tiles not to fall down. By the way this slope when repeated creates a triangle shape that makes a diverse sky- line. In this way geometrical patterns of constructional elements are used to shape geometry of environment. Clay elements covering roofs by their frequent and harmonic rhythm shape parallel lines which end up for water to pour down. In the end gable geometry of roofs contain elements gathering one by one overlapped, in order to reply to expected function (Figure 15).

RESULTS AND DISCUSSION

Geometry is the idea which shapes architecture and makes mental communication possible in order to transform messages. Perceiving geometry is of most important factors in cognition of architectural space. Using geometrical forms and inscriptions in architectural elements and ornaments makes an ease in realizing ideas and concepts and is effective on the quality of residential environments. Along architecture history geometrical rules and characteristic of geometrical forms and shapes in designing and formation of ornaments was widely used. Iranian architecture and especially Qajar architecture is not exceptional. The city of Babol as an important one in north of Iran has valuable buildings of this era; amongst are Hasir- Foroushan district and weekly bazaar of Panjshanbe- Bazaar along passes and around district square; any of these complexes obey specific architectural rules containing emphasis on constructional center from diverse views, emphasis on center in inscriptions, emphasis on constructional elements and geometrical subdivisions. According to Table 2 geometrical rules governing architectural ornaments in Panjshanbe- Bzaar contain axis, equilibrium, symmetry and rhythm; noticeable in brick, clay and wooden inscriptions. Axis sometimes emphasizes visual and constructional centers and sometimes is represented by symmetry in brick and wooden elements by simple geometrical forms. Equilibrium is found in wooden inscriptions; where windows and Orsies are ordered in triploid form to perform spatial privacy rather than stability; or columns and capitals with simple geometrical forms and plant ornaments not only modify entrance but also have a significant impact on stability and beauty of elevation. Concept of symmetry is recognized in both brick and wooden ornaments. Symmetric brick ornaments contain simple geometrical arches along passes and on elevations which have an important role on elevation subdivision and visual

Table 2: Geometric architectural ornaments in Panjshanbe- Bazaar

Geometrical rules	Ornament type	Elevation's elements	Geometrical form of elevation's elements	Geometrical form of inscriptions	Role of geometry in architectural ornaments
Axis	Brick, wooden	Brickworks, windows	Simple geometry	One axis or combination of more axis	Emphasis on visual and constructional center, symmetry line
Equilibrium	Wooden	Windows and Orsies	Triplet geometry	Harvesters with frequent elements	Stability of elements, privacy
		Columns and capitals	Simple and legible geometrical form	Chinese knot with simple geometrical inscriptions or plan ornaments	Modifier of entrance, structural role, beautification of elevation, highlighting and shading elevation
Symmetry	Brick	Elevation	Simple and legible geometrical form in whole and elements	Repeated squares or archways with twill or roman arches	Elevation subdivision, visual diversity
		Doorway	Simple and legible geometrical form	Colorful brickworks, plant and animal and geometric inscriptions	Elevationsubdivision,elevationdecoration
	Wooden	Doors	Simple double doors	Geometrical forms with axis or central symmetry	Decoration, beautification, stability
Rhythm	Clay	Gable roofs	Simple and legible geometrical form	Complex and frequent geometry, parallel lines	Repetition of elements for shaping the whole
	Wooden	Shir- Sar (cut under- roof beams)	Simple geometry	Complex geometry with numerous repeated elements	Structural role, protecting building against rain, reducing and subdividing roof loads

diversity. In doors' wooden ornaments, axis and central symmetry in geometrical forms is both aesthetic and stable. In the end rhythm is noticeable in clay and wooden inscriptions. Repetition of small clay units in a complex geometrical composition shapes a whole with simple geometrical form of a triangle that is the gable roof. Wooden under- roof decorative beams are the same. Numerous wooden elements load the roof in addition to protecting walls against rain through projection. A combination of these concepts all together presents an ordered pattern for architectural ornaments in Panjshanbe-Bazaar of Babol.

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