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Fortifications of Ganja: A historical and architectural study

Abstract. The aim of the study was to analyse the historical development and architectural characteristics of the fortifications of Ganja from late antiquity to the late medieval period. Particular attention was paid to the relationship between the city's defensive structures, its changing urban morphology, and the environmental conditions of the Ganja-Chay River valley. The research combined architectural analysis, archaeological excavation data, stratigraphic analysis, radiocarbon dating, and the study of historical written and cartographic sources in order to reconstruct the evolution of the city's defensive system. The findings indicated that the fortifications of Ganja developed in several chronological phases and were adapted to changing military, political, hydrological, and seismic conditions. The evidence demonstrated the use of layered stone-and-brick masonry, differentiated tower types, and complex wall-building techniques that reflected both local construction traditions and broader regional fortification practices. Stratigraphic observations and radiocarbon analyses helped clarify the sequence of construction and rebuilding, while comparative analysis with fortified cities of the Caucasus and the Middle East highlighted the architectural distinctiveness of Ganja. The results further demonstrated that the city's defensive system evolved incrementally through repeated phases of reconstruction rather than as the product of a single building campaign. Archaeological evidence confirmed that riverbank fortifications performed both military and hydrological functions, protecting the settlement from enemy attacks and erosion caused by the Ganja-Chay River. The study also differentiated between archaeologically documented remains, later reconstructions, and comparative visual sources, thereby reducing the risk of treating illustrative material as direct evidence. The practical value of the study lies in providing a scholarly basis for conservation, restoration, and historically grounded reconstruction of medieval fortification systems in Azerbaijan

Keywords: fortification architecture; defensive structures; masonry techniques; urban morphology; cultural heritage

INTRODUCTION

The territory of modern Azerbaijan preserved an important corpus of fortified settlements, whose architectural study contributed to the wider history of urban defence in the South Caucasus. Recent scholarship had increasingly approached fortifications through the combined lenses of heritage conservation, urban morphology, and material analysis. S. Li *et al.* (2024) examined the development of cultural-heritage conservation planning and showed how historical urban layers need to be analysed as part of a long-term planning system. The authors demonstrated that

effective conservation planning requires the integration of archaeological evidence, urban development policies, and stakeholder participation rather than focusing exclusively on individual monuments. Researchers also concluded that preserving historical stratification improves the resilience of historic cities and supports sustainable urban management by maintaining the continuity of cultural landscapes. J.P. Jara Molineros *et al.* (2022) discussed the interpretation of heritage and underlined the importance of reading built fabric through both conventional and less visible material

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traces. Scientists' study argued that architectural heritage should be interpreted through a combination of physical structures, construction techniques, and intangible historical evidence, allowing hidden phases of building development to be identified. The authors further emphasised that this approach improves the accuracy of conservation decisions by recognising multiple historical layers embedded within architectural monuments. M. Hasanov *et al.* (2022) analysed the administrative and political organisation of Caucasian Albania and provided historical context for fortified urban centres in the region. The study demonstrated that the political and administrative system directly influenced the distribution of fortified settlements and their defensive functions. It also showed that major urban centres served simultaneously as administrative, military, and economic hubs, explaining the strategic importance of fortified cities such as Ganja. M. Pashayeva (2021) connected the history of Albania with broader cultural traditions relevant to architectural development. The author argued that the evolution of urban culture and architectural forms in Caucasian Albania was closely associated with long-standing regional traditions and intercultural exchange. The research highlighted the continuity of construction practices that influenced later medieval architectural development across Azerbaijan. N.H. Viki & H. Al-Harithy (2024) demonstrated how historic-city regeneration can be informed by the architectural value of defensive ensembles. The authors' findings showed that successful regeneration strategies should preserve the spatial integrity of defensive systems while adapting them to contemporary urban needs. Researchers further argued that historic fortifications should be considered active components of urban identity rather than isolated archaeological remains. O. Spāritis (2022) emphasised the methodological importance of balancing conservation and interpretation in the study of medieval architecture. The author concluded that restoration should preserve the authenticity of surviving fabric while clearly distinguishing original structures from modern interventions. The study also stressed that careful interpretation of archaeological and architectural evidence is essential for avoiding speculative reconstructions of medieval monuments. However, the existing literature tended to discuss Ganja either within broad historical narratives of Caucasian Albania or through separate archaeological observations, without sufficiently integrating construction technology, urban morphology, defensive function, and later historical transformations into one architectural interpretation. Within this context, Ganja occupied a special place because its fortifications reflected a long urban history extending from early settlement layers to the medieval expansion of the city. J.V. Baghirzade (2020) noted the significance of early medieval political structures for understanding regional urban centres, and G.G. Nagiev (2020) specifically discussed medieval Ganja as a fortified city shaped by defensive and social organisation. Additional studies on Ganja's late medieval architectural heritage and written sources confirmed the importance of archival,

archaeological, and historical evidence for reconstructing the city's development, but it do not fully resolve the architectural sequence of its walls, towers, masonry types, and riverbank defensive structures. The novelty of the article lain in treating Ganja's fortifications as a layered defensive system and in combining field-based architectural description with stratigraphic, cartographic, historical, and comparative evidence. This approach made it possible to distinguish documented remained from reconstruction hypotheses and to explain, why the city's defensive architecture changed across different historical periods. The aim of this study was to examine the historical development of the city of Ganja and its fortifications and to analyse the architectural and construction features of its defensive walls and towers. The study pursued three objectives: 1) to analyse the principal historical stages in the development of Ganja's fortifications; 2) to identify the architectural and construction features of the fortress walls and towers; 3) to evaluate the role of fortifications in the defense and urban development of Ganja. Accordingly, the article addressed the following research question: how did the defensive architecture of Ganja evolve in response to changing political, urban, constructional, seismic, and hydrological conditions?

MATERIALS AND METHODS

This study used a multidisciplinary approach to analyse the historical development and architectural features of Ganja's fortifications. The analysis was organised chronologically in order to trace the development of Ganja's fortifications from the early settlement horizon to the ancient, early medieval, post-earthquake, later medieval, and early modern phases. The research combined architectural analysis, archaeological excavation data, and historical documentation in order to reconstruct the city's defensive system from antiquity to the medieval period. Archaeological data were drawn from published excavation materials and surveys relating to Ganja Mound, the ancient city of Arran, and the preserved remains of defensive structures in and around Ganja, including evidence from stratigraphic layers, masonry fragments, towers, walls, bridges, and riverbank fortifications. The documentary base included the geographical description of Strabo, medieval narrative accounts, published archaeological reports, and historical maps and plans used for the reconstruction of the city's layout, particularly for understanding the regional geography, settlement patterns, and trade routes of the South Caucasus (ToposText, n.d.). As the surviving remains were fragmentary and belong to different construction phases, the evidence was assessed according to source type: excavated masonry and stratigraphy were treated as primary architectural evidence. Historical texts and maps were used to reconstruct urban context; and comparative examples were used only to clarify typological and constructional parallels. The following analytical procedures were applied:

1) Examination of stone and brick types, mortar composition, and construction techniques.



2) Stratigraphic analysis, published dating evidence, including available radiocarbon data from associated archaeological contexts, and the comparison of construction techniques across different masonry phases.

3) Analysis of historical maps, plans, and reconstructions to assess the layout, phasing, and spatial evolution of the defensive structures.

4) Comparison of Ganja's fortification styles with those of other contemporary fortified cities to identify similarities and differences in architectural approaches.

5) Materials were examined through architectural description and published archaeological evidence in order to identify their constructional role, visual characteristics, dimensions, and use in different parts of the defensive system.

6) Examination of burnt bricks, cobblestones, and tuff stones used in the masonry, including their dimensions, composition, and placement techniques.

7) Mortar types, including lime, clay, gypsum, and mixed mortars, were considered as indicators of construction technique, repair phases, and possible chronological differences in the masonry.

Selected sources, including the miniature "The Construction of the Castle of Khawarnaq" from Nizami's *Khamasa*, were used only as comparative material for understanding construction practices in the broader medieval Islamic architectural context and not as direct evidence for Ganja. The study also referred to the cities of Derbent, Ani and Tbilisi, as well as selected defensive parallels from Babylon. The data relating to these cities were used not to establish direct influence, but to identify recurring defensive principles. The comparison with Babylon was retained only as a typological parallel for the defensive treatment of the riverbank, rather than as evidence of historical borrowing. The study acknowledged the fragmentary nature of some archaeological data and therefore relies on cross-checking between excavation evidence, construction analysis, historical sources and cartographic materials.

RESULTS AND DISCUSSION

Azerbaijan contained a significant body of fortified settlements and defensive structures that were essential for understanding the architectural history of the South Caucasus. The historical geography of Caucasian Albania also provided important context for understanding the emergence of fortified urban centres in the Ganja region, including their strategic relationship to communication routes, river systems, and territorial organisation (Mamedova, 1986). The architectural and planning composition of fortifications was determined by defensive logic, construction technology, and the topographic conditions of the site. This interpretation was consistent with broader archaeological studies of fortified settlement systems in the South Caucasus, which demonstrated that defensive architecture often influenced settlement organisation, territorial control, and patterns of urban development (Hammer, 2014). In the case of Ganja, the historical urban development of the fortified city can be reconstructed through

archaeological evidence, preserved masonry, and comparative analysis with other fortified centres in the Caucasus and the Middle East. The comparison was especially relevant for Derbent (Russia), Ani (Turkey), and Tbilisi (Georgia), where wall systems and towers demonstrated similar principles of perimeter defence, although Ganja possessed distinctive local masonry patterns and construction solutions. To preserve the chronological logic of the analysis, the results were presented according to the main stages in the development of Ganja's fortifications: the early settlement horizon, the ancient and early medieval fortified town, the 9th-11th-century defensive system, the post-earthquake rebuilding phase, the 12th-13th-century expansion, and later medieval and early modern transformations.

The documentation and classification of architectural monuments through digital methods have also been recognised as important tools for preserving and analysing historic defensive architecture, particularly, where surviving remains were fragmentary and required reconstruction from archaeological and documentary evidence (Comneno, 2020). The results also supported contemporary approaches to heritage conservation planning, which emphasised the integration of historical layers, archaeological evidence, and urban development processes in the management of historic sites (Li *et al.*, 2024). In the end of the 18th-first half of the 19th century of the Caucasus developed in different political contexts, studies of strategic defensive systems in the region demonstrated the continuing importance of fortified lines, controlled access points, and territorial defence in shaping settlement networks and regional security landscapes (Çaycıoğlu, 2022). Figure 1 demonstrated the principal masonry patterns used in the fortifications of Ganja and showed how the combination of fired brick, stone, and mortar generated both structural stability and a distinctive visual language. The masonry should therefore be read not only as a technical solution, but also as evidence of the Arran architectural tradition, in which constructional logic and decorative surface treatment were closely connected.



Figure 1. Stone-and-brick masonry patterns in the defensive walls of Ganja

Source: based on R. Amenzadeh (2024)



The development of construction techniques reflected several chronological stages in the evolution of Ganja's fortifications, including the early settlement phase, the formation of a fortified town in the ancient and early medieval periods, the reconstruction following the earthquake of 1139, and the later medieval rebuilding and reinforcement of the defensive system. Understanding of building materials, particularly stone and fired brick, and of their texture, colour, and tectonic behaviour allowed builders to create walls with both defensive strength and architectural expressiveness. These material and constructional choices also shaped the spatial organisation of the city, influencing the positioning of gates in relation to major access routes, connections to bridges across the Ganja-Chay, the formation of trade routes, the delimitation of urban expansion, and the relationship between the citadel, residential quarters, craft districts, and riverbank fortifications. In construction, baked brick, fine-grained limestone, marble, river stone, crushed stones of different sizes, and lime, clay and gypsum mortars, as well as timber and iron elements, were used. The distinctive use of fired brick, stone, and mortar in Ganja found parallels in material studies of other medieval fortifications, where scientific analysis of construction materials and surface finishes had shown how the selection of local resources contributed to both structural performance and architectural expression (Holakooei *et al.*, 2020).

The specific shape of the brick, along with its coloristic, textural, and plastic qualities, defined the continuous motifs of the tectonic development of planes and surfaces. It inspired the creation of intricate relief patterns in brickwork, while the structuring of the material and the reinforcement of its strength properties through jointing techniques enabled the artistic expression of patterns such as "Herringbone" and "Ganja masonry". The integrity of the artistic and architectural image of the construction was determined by the structure and character of limestone, a natural building material with excellent physical and technical parameters such as moisture resistance, thermal conductivity, and durability. The earliest stage identified in the archaeological record preceded the formation of the medieval fortified city and provided the basis for understanding the later continuity of occupation and defensive organisation. Architectural and archaeological research indicated that the earliest settlement horizon in the Ganja area dates to the 3rd millennium BC and that later fortified phases developed above earlier cultural layers. Stratigraphic analysis made it possible to distinguish successive occupation layers and to identify episodes of wall construction, repair, and rebuilding through differences in masonry, mortar composition, and depositional sequences. Radiocarbon dating of organic inclusions from associated archaeological contexts was used to correlate these stratigraphic layers with approximate chronological periods, thereby refining the dating of individual construction phases and confirming that

some defensive structures belonged to different episodes of development rather than to a single building campaign (Allahverdiyeva, 1995). These data showed that the defensive system developed incrementally rather than as a single campaign and that the later medieval fortifications reused and transformed earlier spatial and constructional traditions. The archaeological evidence for these early construction phases and their spatial organisation was illustrated in Figure 2.

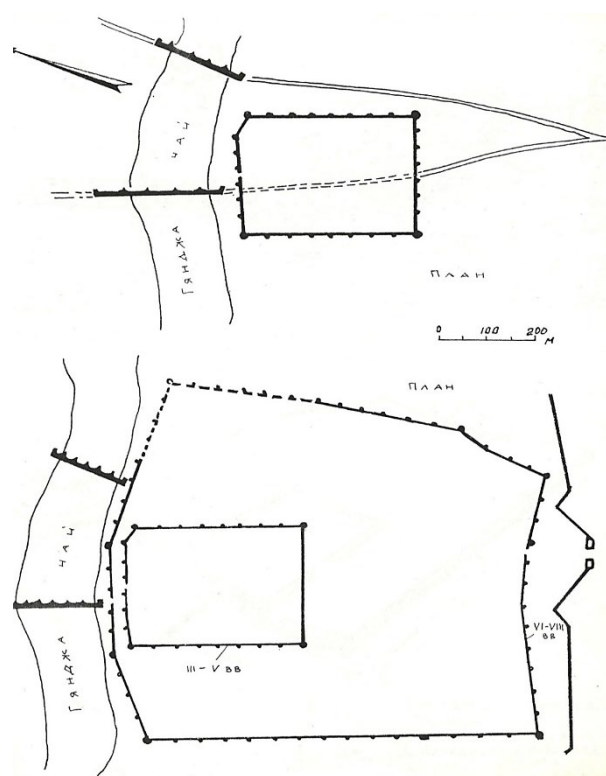


Figure 2. Fortification remains at Ganja Mound, 3rd-8th centuries

Source: based on S. Allahverdiyeva (1995)

So, early fortification horizon of Ganja and were significant because it demonstrated continuity in the occupation and defensive organisation of the site before the later medieval rebuilding phases represented in Figure 3. The figure presented the excavated plan of the fortified settlement, including the defensive perimeter, enclosed interior area, and associated structural elements identified during archaeological investigations. These two plans illustrated different stages or sectors of the fortified complex and showed the relationship between the enclosure walls and the surrounding landscape, including the nearby river corridor. The documented spatial arrangement and scale of the early defensive system provide archaeological evidence of organised fortifications that existed before the later medieval reconstructions. These data are therefore important for reconstructing the successive development of Ganja's defensive architecture and urban layout.

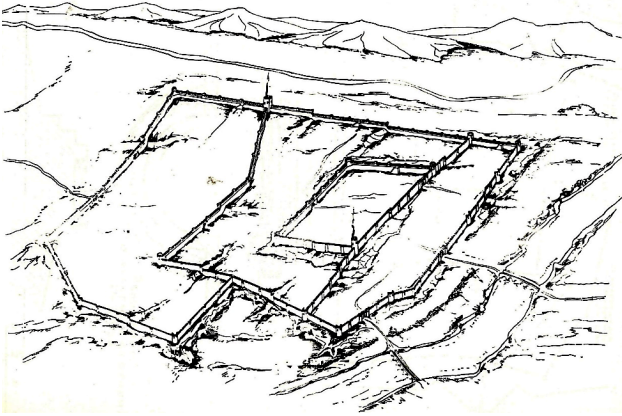


Figure 3. Reconstructed plan of the fortified settlement of Ganja, 9th-11th centuries

Source: based on S. Allahverdiyeva (1995)

The next stage of the analysis concerned the ancient and early medieval context of Ganja and its relationship with the wider riverine and trade network of Arran. In 1988, archaeologist R.J. Akhmedov discovered and examined the ruins of the pier of the ancient city of Arran, located in a bay on the right bank of the Kura River, 4 km in a straight line from the ancient settlement of Ganja. According to Strabo's descriptions, this city had a significant port trade with neighboring countries, particularly India (Topos-Text, n.d.). This evidence was relevant to Ganja because it situated the settlement within a wider network of riverine and overland exchange, helping to explain, why fortified control of movement corridors was architecturally and politically important. Within this ancient phase, the fortified city already demonstrated a regular defensive layout and a developed system of walls, towers, and gate structures. The ancient fortress city of Ganja, dating back to the first centuries AD, was designed as a closed regular quadrangle. Its walls and powerful corner towers were oriented to the cardinal points and feature numerous half-towers (Alikberov & Mudrak, 2020). The citadel walls, constructed from river boulders and layered with baked brick. On either side of the gate stood gate towers, and above the gate were three drains for pouring boiling water or burning oil. The description of drains was retained as a functional interpretation of defensive architecture and should be read together with the evidence for gate towers and elevated fighting platforms (Gippert, 2023). It should be noted that the city was not situated directly on the bank of the Ganja-Chay River but was located 175 meters inland. The fortress area covered approximately 10 hectares. The inner citadel, constructed of adobe walls, was surrounded by an outer wall made of cobblestones interspersed with red and white stones brought from neighboring regions. The masonry of the towers featured a complex geometric pattern. The fortress walls were built of cobblestones set in lime mortar, with individual well-fired bricks and large slabs of red tuff bricks, approximately 75×75×40 cm in size, incorporated in

specific parts of the wall. These bricks were laid vertically on the sides and horizontally on the top and bottom. Rows of stone and brick masonry alternated parallel with each other, covering the surface of the surviving observation tower, giving it a picturesque appearance.

The first quadrangular tower was designed with a slightly tapering top using the Ganja masonry method, which combined burnt red bricks and cobblestones in lime mortar. This masonry technique involved inserting cobblestones into a "cage". These "cages" were arranged in parallel rows, spaced four to five rows of bricks apart, with stones inserted into them. The seams along the entire perimeter of the tower were covered with lime mortar. Inside, the tower had a round shape, built of raw bricks without straw admixture (the bricks in the tower measured 28×28×5 cm and 30×30×6 cm). The combination of a quadrangular exterior and circular interior was architecturally significant because it increased the mass and stability of the tower, while creating a more efficient internal space for circulation and defence. These features indicated the defensive purpose of the tower, which accommodated throwing weapons on its upper platform alongside patrol soldiers. At the corners of the tower, the nature of the masonry changed for greater strength, with cobblestone rows replaced by rows of brick. The second quadrangular tower was primarily constructed from river cobblestones. In its foundation, the cobblestones were bound with lime mortar, and above, a combination of lime and clay mortar was used. The change in mortar composition suggested either a phased construction process or later repair work, and it should be interpreted cautiously as evidence of chronological complexity rather than as proof of a single building campaign. This type of combined cementing material was discovered for the first time in Azerbaijan, indicating that the tower's construction or restoration took place at different times. The seams were not filled with mortar. Inside this tower, the masonry featured both cobblestones and burnt bricks, which were inserted into the wall in various positions to form different patterns.

So, comparative studies of medieval defensive structures demonstrated that variations in masonry layout, bonding techniques, and wall construction may reflect different construction traditions, functional requirements, or phases of rebuilding. In this context, the absence of a herringbone arrangement in the cobblestone masonry of the second tower suggested a construction approach distinct from other documented defensive structures and should not be interpreted solely as a chronological indicator (Antipov, 2019). These quadrangular towers are rare among the defensive structures discovered in Azerbaijan. The distinctiveness of the rectangular towers and their aesthetic appeal indicated that the architects aimed to provide these structures with both strong strategic significance and artistic expressiveness. The city walls approaching the tower, constructed using Ganja masonry, were adobe on the inside and lined with cobblestone armour on the outside. The cobblestone lining was one meter thick, while the adobe

was five meters thick, with the cobblestone part of the wall rising above the battle path in the form of stone merlons. The dressing of the masonry of both walls was achieved by having rows of cobblestone masonry merged into the adobe at certain points. These walls, which reliably protected the city, testify to the extraordinary abilities and profound knowledge of military-strategic art possessed by Azerbaijani architects. Coastal fortifications, resembling armour, protected the city from riverbank erosion and consisted of a slightly inclined stone-brick wall with half-towers. The walls were laid with cobblestones on an extremely durable, now petrified, solution, with different types of masonry used in the cladding. Only pure masonry was observed in the coastal towers (Fig. 4).

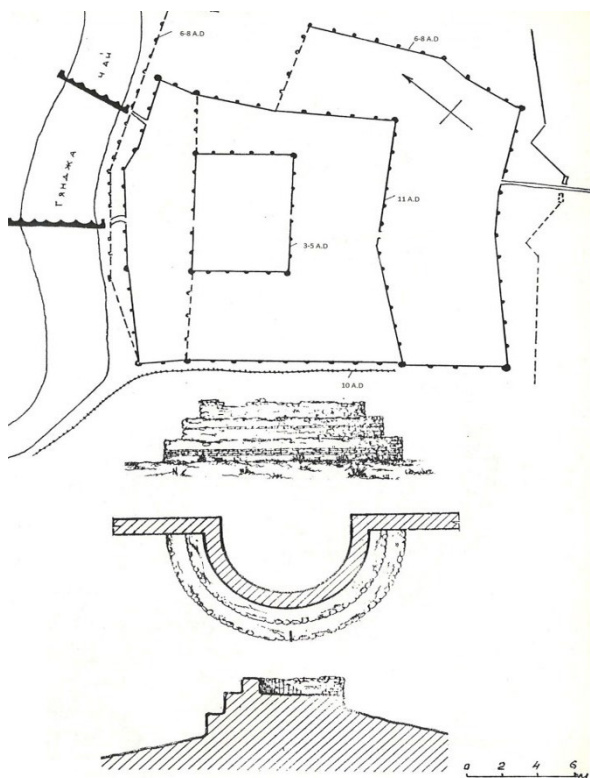


Figure 4. Defensive structures of Ganja Mound, 9th-11th centuries

Source: based on S. Allahverdiyeva (1995)

The riverbank defences were especially important because it showed that Ganja's fortification system responded not only to military threats, but also to hydrological risk, including erosion and changing river dynamics. This interpretation was consistent with later descriptions of Ganja's location along the Ganja-Chay River and of surviving fortress walls close to the river corridor. It should be noted that a similar method of protecting the coast with a continuous line of fortifications was also found in the history of ancient Babylon. The advantageous location of Ganja contributed to its rapid growth and transformation into one of the most strongly protected and prosperous cultural centres of the Near East. Plan of the fortified enclosure

together with sectional drawings of defensive elements illustrated the relationship between the outer defensive wall, the enclosed central area, and the tower structures. The lower drawings showed the constructional form of the fortifications, including the profile of the wall, the semicircular tower configuration, and the arrangement of masonry elements. The figure was important because it provided archaeological evidence for the construction techniques, spatial organisation, and defensive features of the settlement during the 9th-11th centuries. The separation of these figures clarified the distinction between archaeological evidence and historical reconstruction. Figure 5 presented the reconstructed spatial configuration of the later 12th-13th century defensive system.

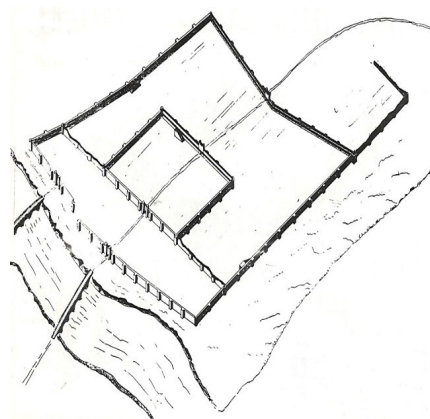


Figure 5. Reconstructed fortification layout of Old Ganja, 12th-13th centuries

Source: based on S. Allahverdiyeva (1995)

Reconstructed layout of the fortified settlement during the 12th-13th centuries showed the enlarged defensive perimeter, the position of the inner fortified zone, and the relationship between the fortifications and the surrounding landscape. The reconstruction demonstrated how the defensive system expanded in response to urban growth and how the walls enclosed a larger settlement area than during the 9th-11th centuries (Allahverdiyeva, 1995). A subsequent phase of development is associated with the 9th-11th centuries, when the defensive system was reconstructed and adapted to the changing political and urban conditions of the region. In the 9th century, fortifications damaged during political instability were reconstructed, and the city was enclosed by a new wall with semicircular intermediate towers placed at approximately 20-metre intervals. The masonry displays decorative treatment, including traces of herringbone arrangement. The regular spacing of towers indicated an organised defensive concept, in which visual surveillance, flanking fire, and structural rhythm were integrated into a single perimeter system.

The miniature "The Construction of the Castle of Khawarnaq" (Herat, 1494), preserved in the manuscript of Nizami's *Khamisa* and commonly attributed to Kamal al-Din Bihzad, was relevant here not as direct evidence for



Ganja, but as a comparative visual source illustrating construction practices in the broader architectural culture of the late medieval Islamic world. The original visual source was the Herat manuscript of Nizami's *Khamisa*, with the relevant folio widely identified as Construction of the Castle of Khawarnaq, painted by Bihzad and preserved in the British Museum, Or. 6810 (Gray, 1961). In the foreground of the miniature, mortar troughs, construction platforms, and lifting devices were depicted, helping to interpret the organisation of labour and the technical processes associated with the erection of large masonry structures. This historical context clarified the late 9th- and 10th-century strengthening of Ganja's defensive role before the later 12th-13th-century expansion. By approximately 944-951 CE, after the destruction of Barda and the reorientation of regional trade routes, Ganja emerged as the principal urban centre of Arran, resulting in an increased strategic need for fortified defences and urban expansion (Nagiev, 2020; Hasanov, 2025). The resulting need for strengthened defence led to fortifications on the left bank of the Ganja-Chay. The left-bank city was laid out as an irregular rectangle oriented south-north and enclosed by a double wall with semicircular towers. This arrangement was illustrated in Figure 6.

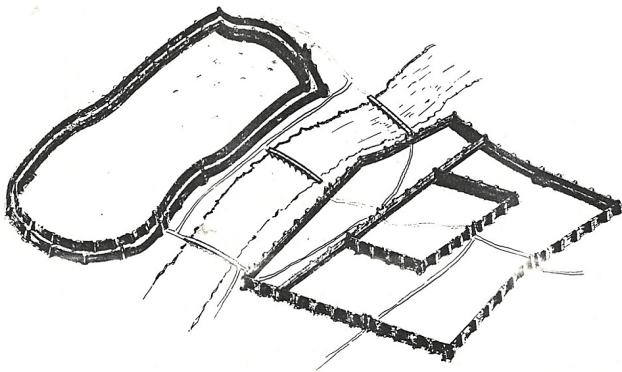


Figure 6. Plan of the ancient settlement of Ganja, 12th-13th centuries

Source: based on S. Allahverdiyeva (1995)

The next major chronological turning point in the development of Ganja's fortifications was the earthquake of 1139, which created the need for rebuilding and structural adaptation. Ganja was severely affected by the earthquake of 1139 and was restored shortly afterwards, a process that coincided with renewed handicraft production, trade, and agricultural activity. The earthquake was relevant to the architectural argument because historical and seismological sources described the 1139 event as a major destructive episode near Ganja, after which rebuilding and defensive reorganisation became necessary. As of 2026, one of the southern towers of the left-bank sector has survived; this hollow corner tower had a diameter of 13.50 m, walls 2.15 m thick, and radially oriented through-holes measuring 18-20 cm in diameter. Comparable openings were recorded at Khanega on the Pirsagat River and at old fortresses in Nakhchivan, Shamakhi, and Ordubad, where it was interpreted as

structural devices related to seismic conditions. In this context, the through-holes may have functioned as anti-seismic relieving devices, constructional ties, or ventilation and drainage features; their exact role required further material and structural analysis. The coastal fortifications on the left bank were less substantial than those on the right bank and were preserved in a more fragmentary condition in the archaeological record (Allahverdiyeva, 1995). The later medieval and early modern stages showed that the defensive system continued to be modified in response to new political and military circumstances. At the end of the 14th and the beginning of the 15th centuries, Ganja came under the rule of Timur. In 1587, the city was taken by the Ottomans, who undertook strengthening works around the area of modern Ganja. In 1606, Shah Abbas I captured the fortress and ordered the construction of new public buildings and the rebuilding of the defensive walls (Guliyev, 2016).

Surveys of the fortress walls, bridges, Kyagriz canals, and cultural layers discovered under the foundations, along with other data, indicate that Ganja was not relocated but continuously inhabited, rebuilt, and expanded on its original site along the banks of the Ganja-Chay River, near three old bridges. The construction of fortress walls, bridges, and residential and public buildings utilised a variety of abundant local building materials, including clay and adobe bricks, cobblestones of different sizes and colours, rubble stone, red tuff, reeds, and the magnificent Chilikdag marble stone. Burnt bricks of various square sizes were especially prevalent. Eleven types of adobe bricks, differing in thickness and dimensions, and twenty-one types of burnt bricks were identified in the masonry (Fig. 7). The mortars used for brick and stone masonry were diverse, incorporating gyza, lime, sand, gravel, and pebbles, with seam thicknesses ranging from one to eight centimeters. The internal masonry was extensively reinforced with mortar, creating a robust monolith that is difficult to dismantle.

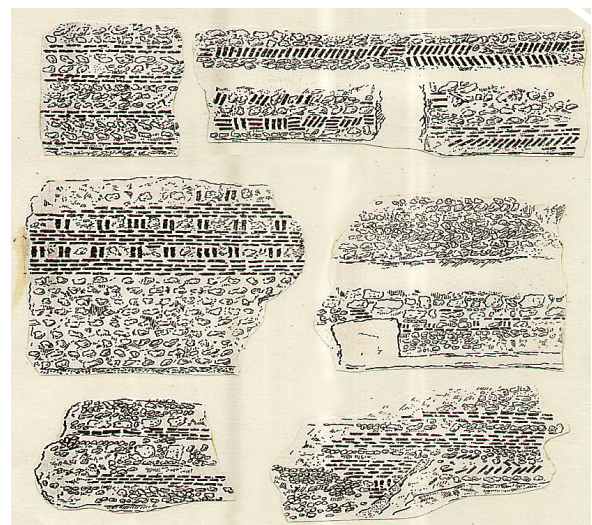


Figure 7. Types of wall masonry in Old Ganja, 12th-13th centuries

Source: based on G.G. Nagiyev (2020)

After the post-earthquake recovery, the 12th-13th centuries marked a phase of urban expansion, during which the fortified system became closely connected with suburbs, gardens, cemeteries, craft areas, and transport routes. In the 12th-13th centuries, Ganja was surrounded by suburbs and gardens and occupied an area estimated at approximately 12-16 km² including the suburban belt. Two kilometres southeast of the settlement were ancient burial mounds, and the same area also contained a 12th-13th-century cemetery associated with the burial place of Nizami. The architectural analysis of fortifications in this period showed that wall surfaces were articulated by elements that established scale, proportion, and rhythm, while the broader political consolidation of Azerbaijani territories in the later 15th century contributed to the strengthening of defensive architecture in urban centres such as Ganja, Barda, and Shabran. Archaeological evidence indicated that these cities developed gradually from earlier settlements rather than appearing suddenly as fully formed urban foundations. This gradual development was central to the interpretation of Ganja: the city's fortifications should be understood as a palimpsest of rebuilding, repair, expansion, and adaptation rather than as the product of a single chronological moment.

CONCLUSIONS

The study demonstrated that the fortifications of Ganja developed through several historical phases and that their masonry, towers, wall systems, and urban layout reflect a high level of technical adaptation to changing political and environmental conditions. The combined use of archaeological evidence, architectural analysis, historical documents, and cartographic comparison made it possible to reconstruct the defensive evolution of the city with

greater precision. The principal contribution of the article was the integration of architectural, archaeological, and urban evidence into a single chronological interpretation of Ganja's defensive system. The analysis showed that the city's fortifications combined military functionality, material experimentation, response to riverine and seismic conditions, and a distinctive aesthetic treatment of masonry. The study showed that the architectural character of Ganja's fortifications was defined by the systematic use of layered stone-and-brick masonry, differentiated tower forms, and construction techniques specifically adapted to the local geological and hydrological environment. It also established that the spatial organisation of the defensive system influenced the historical development of the city by shaping the relationship between the citadel, residential quarters, transport routes, riverbank fortifications, and surrounding urban landscape. Further research should focus on three directions: expanded radiocarbon sampling and finer stratigraphic recording in order to refine the chronology of successive construction phases; GIS-based and 3D digital reconstruction of the fortification system and its relationship to the urban fabric; broader comparative study with fortified cities of the Caucasus and the Middle East in order to define more precisely the local and transregional characteristics of Ganja's defensive architecture.

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Фортифікації Гянджі: історико-архітектурне дослідження

Анотація. Метою дослідження було проаналізувати історичний розвиток та архітектурні особливості фортифікацій Гянджі від пізньої античності до пізнього середньовіччя. Особливу увагу було приділено взаємозв'язку між оборонними спорудами міста, змінами його урбаністичної морфології та природними умовами долини річки Гянджа-Чай. Дослідження поєднувало архітектурний аналіз, дані археологічних розкопок, стратиграфічний аналіз, радіовуглецеве датування, а також вивчення історичних писемних і картографічних джерел з метою реконструкції еволюції оборонної системи міста. Отримані результати засвідчили, що фортифікації Гянджі розвивалися в кілька хронологічних етапів і пристосовувалися до змін військових, політичних, гідрологічних та сейсмічних умов. Матеріали дослідження продемонстрували використання шаруватої кам'яно-цегляної кладки, різних типів башт і складних технік зведення мурів, які відображали як місцеві будівельні традиції, так і ширші регіональні практики фортифікаційного будівництва. Стратиграфічні спостереження та радіовуглецевий аналіз допомогли уточнити послідовність будівництва й перебудов, тоді як порівняльний аналіз з укріпленими містами Кавказу та Близького Сходу дав змогу підкреслити архітектурну своєрідність Гянджі. Результати також показали, що оборонна система міста формувалася поступово, через повторювані етапи реконструкції, а не як результат однієї будівельної кампанії. Археологічні дані підтвердили, що прибережні укріплення виконували як військові, так і гідрологічні функції, захищаючи поселення від ворожих нападів та ерозії, спричиненої річкою Гянджа-Чай. У дослідженні також розмежовано археологічно задокументовані залишки, пізніші реконструкції та порівняльні візуальні джерела, що зменшує ризик трактування ілюстративного матеріалу як прямого доказу. Практична цінність дослідження полягає у формуванні наукової основи для консервації, реставрації та історично обґрунтованої реконструкції середньовічних фортифікаційних систем Азербайджану.

Ключові слова: фортифікаційна архітектура; оборонні споруди; техніки кладки; урбаністична морфологія; культурна спадщина

