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Original Research Article

Mountain Fortresses of Northwestern Iran: A Study on the Risks to Defensive Architectural Heritage*

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Abstract

Problem statement: In Iran, fortresses are generally classified into two categories: mountain fortresses and plain fortresses. Mountain fortresses were constructed along mountain passes, on ridgelines, beside valleys, or near rivers, primarily with the purpose of providing security and defense. In northwestern Iran, due to its distinctive topographical features, thousands of mountain fortresses exist. These structures have been built from the fourth millennium BCE coinciding with the emergence of political and social instability and their construction continued until the Qajar period. The architectural plans of these fortresses were strongly influenced by the topographical characteristics of their surrounding landscapes, and local stone materials were predominantly used in their construction. Owing to their mountainous geographical setting and the use of indigenous materials, these fortresses are highly vulnerable to various forms of deterioration. The research addresses two main questions: What materials were most commonly used in the construction of mountain fortresses? And which factors have had the greatest impact on their deterioration?

Research method: This article, employing a descriptive-analytical method and relying on both fieldwork and library-based studies, examines the natural and human factors contributing to the destruction of these monuments, including precipitation, frost action, soil erosion, and anthropogenic impacts.

Conclusion: The findings indicate that the primary construction materials of mountain fortresses in northwestern Iran are stone and sarooj mortar, while factors such as erosion, earthquakes, human intervention, and environmental conditions have had the most significant impact on their destruction.

Keywords: *Defensive architecture, endangered architecture, mountainous regions, materials, plan.*

Introduction and Problem Statement

The mountainous regions of northwestern Iran, due to their distinctive geographical position and location at the crossroads of ancient civilizations, have always held significant strategic importance. Throughout history,

particularly during the pre-Islamic period and the early centuries of Islam, this region served as a battleground for various political and military powers. This circumstance led to the formation of an extensive network of defensive fortifications in the form of mountain fortresses. These fortresses were often constructed on inaccessible heights, natural rock formations, and alongside major communication routes an intelligent site selection strategy that enabled effective surveillance, control, and

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defense against external threats. The mountain fortresses of northwestern Iran are not merely military structures; they represent a remarkable integration of indigenous knowledge, historical experience, and human adaptation to the natural environment. The use of local materials, the adaptation of architectural forms to the region's topography, and the strategic utilization of natural elements such as rock formations, elevation, and land slope reflect a high level of technical and engineering knowledge across different historical periods. These characteristics make such fortresses valuable not only for their defensive role but also as significant examples of sustainable and environmentally adaptive architecture. Despite their historical, cultural, and architectural significance, many of these fortresses are currently under serious threat. Natural deterioration processes including rainfall, frost action, earthquakes, and landslides alongside human interventions such as illegal excavations, destruction caused by unbalanced development, and the lack of coherent conservation programs, have accelerated the degradation of these monuments. Neglecting the heritage value of these structures poses a serious risk of losing an important part of the historical identity of the region. According to archaeological evidence, more than one thousand fortresses from different historical periods have been identified in northwestern Iran, a significant number of which belong to the pre-Islamic and early Islamic periods. Archaeological surveys conducted by Mehdi Kazempour (2011) in the northeastern part of East Azerbaijan Province, Salmanpour & Abtahi (2019) in the southwestern and western districts of Ahar County, Rahim Velayati (2019) in Bostanabad, and Mehdi Kazempour (2020) in Charuymaq County have identified and registered numerous archaeological sites and fortresses dating to various historical periods. This temporal and spatial diversity further highlights the necessity of a systematic study of these monuments. In this context, the present study adopts an analytical approach and, based on non-random sampling, examines ten significant military fortresses spanning a chronological range from the first millennium BCE to the third century AH. The main objective of this article is to identify the materials used in their construction and to determine the principal factors contributing to the deterioration of mountain fortresses in

northwestern Iran. Preserving this heritage is essential not only for understanding the history of the region but also for transmitting its cultural identity to future generations.

Research Background

Numerous studies have been conducted on the cultural heritage and defensive architecture of Iran. The research of Nourbakhsh et al. (2017) indicates that climatic conditions in mountainous regions cause the greatest damage to mudbrick and stone structures. Although extensive studies on the fortresses of Azerbaijan have not been carried out, the book by Khamachi (1998) entitled "Historical Castles of Azerbaijan" provides valuable information on the geographical distribution and chronology of these fortresses. Several other works have also addressed mountain fortresses and offered relevant information. Among them, Willey (2005/2007), in his book "Eagle's Nest: Ismaili Castles in Iran and Syria", introduces the fortresses of Iran and Syria during the Ismaili period while discussing different historical periods of both regions. Molazadeh & Mohammadi (2006), in the sixth volume of their work "Military Castles and Fortifications", present fortresses and military fortifications of Iran and provide a classification and chronology of Iranian military fortresses. Similarly, Wolfram Kleiss (2008), in his article "Castles", introduces fortresses identified during archaeological surveys, with particular emphasis on construction materials and chronological classification. Reza Shaterian (2011), in his book "Architecture & climate", examines the impact of climate on Iranian architecture. Likewise, Maxime Siroux (1949/1978) in "Caravanserais d'Iran et petites constructions routieres" refers to structures and fortresses constructed along commercial routes. A number of scholarly articles have also contributed to the understanding of mountain fortresses. Mohamadifar & Hemati Azandaryani (2016), in their article "A Study and Analysis of Troglodytic Architecture in Iran", analyzed the structure and defensive role of historical Iranian fortresses and shelters, identifying the main factors in the formation of defensive architecture. Their study concluded that defensive barriers, hidden surveillance, and route control were among the most important factors in the construction of extra-urban fortresses. Kamalizad et al. (2011), in the

article “Khan Lenjan Castle of Isfahan: An Archaeological Survey”, examined this mountain fortress and analyzed the environmental factors contributing to its deterioration (Kamalizad, 2011). Zarei et al. (2021), in their article “A Study of the Architectural and Typological Function of the Castle of Dastgardan Tabas in the Islamic Period”, investigated the typology of Tabas fortresses and the materials used in the construction of mountain fortresses in that region. Furthermore, Farahani & Karimian (2022), in their article “Space Organization, Form and Operation of Mountain Castles, Tehran Province; Case study: Castle-City of Firuzkooh”, studied the mountain fortresses of Tehran Province and their functional characteristics. The distinguishing feature of the present study, compared with the aforementioned works, lies in its specific focus on the construction materials used in mountain fortresses and the principal factors affecting their deterioration. This approach represents a significant research innovation in the field.

Research Method / Materials and Methods

Cultural heritage comprises a collection of tangible and intangible assets that shape the historical and cultural identity of societies. Among these, defensive structures such as fortresses, as tangible heritage, are particularly vulnerable to natural transformations and environmental impacts. According to conservation theories proposed by Pythagoras (2015), the sustainable preservation of historical monuments is only possible when both natural and human factors are considered simultaneously. In the case of the mountain fortresses of northwestern Iran, the region’s unique topography, indigenous building materials, and climatic conditions must be analyzed in an integrated and comprehensive manner. The present study was conducted using a descriptive–analytical approach based on both library-based and field data. In the documentary phase, scientific articles, cultural heritage reports, and UNESCO documents were reviewed and analyzed. In the fieldwork phase, site visits and case studies of the fortresses selected for this research were carried out in order to document their architectural characteristics, construction materials, and the main factors contributing to their deterioration.

Fortresses: The fortress, as an architectural form, has been employed in various contexts and represents one

of the ancient characteristics of Iranian civilization in Central Asia and the Near East. According to Nourbakhsh (1987, 147), fortresses constitute a broad range of architectural structures with diverse functions. The variation in their physical forms has led to the assumption that their existence was not solely a response to geographical adaptation or increasing insecurity, but was also influenced by particular architectural styles (Zarei & Babakamal, 2014). In Iran, fortresses were constructed for different purposes. Some served military and defensive functions, while others functioned as the residence of provincial governors or as administrative centers for urban governance. The location and setting of a fortress often provide important indications of its function. Fortresses situated outside cities and villages, particularly in mountainous locations, generally had military and defensive purposes and were built to resist enemies and protect local populations (Ghiabi, 2020). Researchers have broadly classified Iranian fortresses into two main categories: mountain fortresses and plain fortresses. Based on geographical setting and functional use, they can also be categorized into military and border fortresses, road-control fortresses, gubernatorial residences, and other types (Molazadeh & Mohammadi, 2006, 16). In mountain fortresses, the structures were usually built on the most inaccessible mountain heights. Since they were not based on predetermined architectural plans, architects and builders designed walls, towers, rooms, and entrances according to the natural configuration of the rocks and terrain. As a result, mountain fortresses often lacked a regular geometric plan. In contrast, fortresses built on plains generally followed clear geometric designs, such as square, rectangular, polygonal, or circular layouts (Kiani, 2007). Providing security for the region where the fortress was constructed was the primary factor shaping the architecture of Iranian fortresses. In all these structures, specific architectural elements can be identified that together formed the main framework of Iranian fortress architecture, with military and defensive functions taking priority. In terms of settlement patterns, Iranian fortresses were also shaped by the natural environment and the available building materials. The construction of fortresses in both pre-Islamic and Islamic Iran was closely linked to political, economic, and geographical necessities. Therefore, fortresses were often

established on inaccessible mountains, near water sources and springs, around cities, or overlooking urban centers. In Islamic-period fortresses, the form, material, and number of towers and walls depended on the importance and size of the city as well as the social and environmental conditions of each region. However, most of them shared common features: high, wide, and long defensive walls, cylindrical or polygonal towers, one or more gates for access, and, in some cases, surrounding moats that made entry more difficult. Despite differences in shape, dimensions, design, and materials, the social organization governing the lives of fortress inhabitants was largely similar. These social relations, together with the natural and geographical conditions of the region, played a decisive role in shaping the architectural fabric and functional organization of fortresses, bringing them together within a distinct architectural tradition (Zarei & Heidari Babakamal, 2014, 199-201).

Fortification Walls: This section consisted of walls and towers. The walls were built as integrated structures using rammed earth, mudbrick, brick, or stone, enclosing the designated area with sufficient height. Stone was often used at the base of the walls for reinforcement, while openings and battlements were constructed in the upper sections. Towers were typically built in square, rectangular, or circular plans. Their placement at the corners of fortresses strengthened the walls and provided surveillance points. Decorative elements and geometric brickwork were also sometimes used in tower construction.

Moats: Moats were deep and wide trenches excavated around the fortress walls and often filled with water to prevent enemy access to the defensive walls. **Gates:** Gates were among the most important components of the defensive enclosure, serving as the main access points to and from the fortress. Therefore, guarding and controlling movement were concentrated at the gates. Usually, rooms or spaces for guards were constructed above the gateways.

Protective Strategies of Mountain Fortresses: Following the changes that occurred during the Middle Bronze Age, when settlements in defensive fortresses and mountainous regions replaced settlement patterns in open plains, the construction of stone defensive walls around fortresses became widespread in areas with evidence of occupation from the Middle Bronze Age to Iron Age I. The preference for settlement in mountain fortresses, the presence of

defensive walls, and the discovery of numerous bronze weapons within burials of Middle and Late Bronze Age and Iron Age I sites (Smith et al., 2003) indicate political conflicts and struggles among the communities of these periods, who sought to establish control over their territories. Similar defensive stone walls have been reported in Anatolia from the Middle Bronze Age to Iron Age I and in Armenia during the same periods (Kushnareva, 1997; Belli, 1999; Belli & Konyar, 2003). Numerous examples of such dry-stone defensive walls have also been identified in fortresses dating to the Late Bronze Age and Iron Age I in Ardabil Province (Rezaloo, 2007) and East Azerbaijan Province. The construction materials of mountain fortresses generally consisted of uncut stones, such as mountain or river stones, combined with screened gypsum mortar. Deep cliffs were often incorporated below the fortress foundations, creating natural defensive barriers. At the upper parts of towers and, in some cases, the ramparts, battlements were constructed for archers, enabling them to target enemies through narrow openings. In some fortresses, such as Alamut Castle in Qazvin, the lower areas of the fortress served as residential spaces for villagers. During wartime, these fortresses functioned as shelters, where local inhabitants remained as long as enemy threats persisted. Essential food supplies for several months were usually stored within the fortress. To protect the buildings and fortifications, ramparts and defensive barriers were built. Defensive walls, embankments, and adjacent moats—some of which date back to the earliest human settlements—still survive today. Their forms evolved in parallel with advancements in offensive and defensive weaponry. During prehistoric and early historical periods, the type of fortification largely depended on the location of the fortress or settlement and the natural conditions of the land. Building designs were based more on practical knowledge and military experience than on local traditions. In other words, each historical period developed specific methods of designing fortifications according to prevailing warfare strategies. For this reason, fortresses can be classified based on the warfare methods of different historical periods, and their distinctive architectural features can serve as indicators for dating the structures. For example, circular loopholes are clearly associated with the age of firearms, whereas

elongated vertical loopholes belong to the era of cold weapons such as bows and arrows.

Risks and Threats to Mountain Fortresses

• Natural factors

Mountain fortresses are exposed to a wide range of natural hazards that threaten their structural integrity and long-term survival. These risks include climatic impacts, vegetation growth, harmful insects, floods, earthquakes, heavy rainfall, and erosion. Together, these factors form a continuous cycle of natural deterioration that places mountain fortresses at significant risk.

- Soil erosion as the primary threat to mountain fortresses

Soil erosion as the most significant factor in the destruction of mountain castles. Soil erosion is one of the most fundamental and destructive hazards threatening mountain castles. Due to the geographical location of these castles, which are often built on mountain ridges, steep slopes, cliff edges, and precipices, their stability is directly dependent on the stability of the ground substrate. The gradual erosion of soil caused by natural factors such as rainfall, wind, temperature fluctuations, and surface runoff reduces the cohesion of the soil beneath the foundations and walls of the castle, ultimately leading to settlement, cracking, and even the complete collapse of parts of the structure (Feilden, 2003). Soil erosion usually occurs gradually and over long periods of time, which means that in many cases it is not noticed until serious damage has already occurred. In mountain castles lacking proper drainage systems, the accumulation of water in the underlying soil layers intensifies erosion and increases the risk of landslides. On the other hand, human activities such as the construction of inappropriate access routes, the destruction of the vegetation cover surrounding the castle, and illegal excavations also exacerbate soil erosion. The removal of vegetation leaves the soil unprotected against rainfall and wind, thereby accelerating the rate of degradation. Protecting mountain castles against soil erosion requires a comprehensive approach that includes slope stabilization, restoration of native vegetation cover, control of surface runoff, and continuous monitoring of the geological condition of the

site. Without attention to these measures, any structural restoration alone will not be effective in the long term.

- The impacts of weather and climate change on mountain castles

Weather is considered one of the determining factors in the stability and durability of mountain castles. These structures are usually located at high altitudes and are directly exposed to harsh climatic conditions such as severe temperature fluctuations, frost, heavy rainfall, and direct solar radiation. Repeated freeze-thaw cycles of water within the cracks and pores of building materials, especially in cold regions, lead to increased cracking and disintegration of the materials (Feilden, 2003). The impact of weather varies depending on the type of construction materials used in the castles. Castles built with stone generally show greater resistance to temperature and moisture changes. In contrast, structures made of adobe or brick are highly vulnerable to moisture and rainfall, particularly when protective plaster coatings are absent. In recent years, climate change and the increasing occurrence of extreme events such as torrential rains and prolonged drought periods have created new threats for mountain castles. Increased rainfall intensity not only causes water penetration into the structure but also intensifies soil erosion and slope instability (UNESCO, 2011). For effective protection, it is necessary to study the climatic conditions of each site accurately and to implement measures such as improving drainage systems, using materials compatible with environmental conditions, and continuously monitoring climate-related damage.

- Vegetation growth and its harmful effects on castle structures

Neglecting the weather factor can significantly accelerate the process of deterioration in mountain castles. Vegetation growth and its harmful effects on castle structures: The growth of vegetation, especially wild plants and shrubs, is considered one of the hidden yet highly destructive hazards for mountain castles. Plant seeds easily penetrate into cracks and joints in the walls, and as the roots grow, they gradually cause the widening of cracks and the displacement of building materials. Plant roots, by absorbing moisture and exerting mechanical pressure, reduce the cohesion of the walls and, in the long term, lead to the collapse of parts of the structure. In addition, the accumulation of moisture around the roots creates favorable conditions for the growth

of microorganisms and the chemical erosion of building materials (Feilden, 2003). In many mountain castles, due to difficult access and the absence of regular maintenance programs, vegetation growth continues uncontrollably. This issue is particularly more severe in humid and temperate regions. Improper removal of vegetation can also be dangerous, as the sudden extraction of roots may cause the collapse of walls. Vegetation management should be carried out according to conservation principles and should include the identification of harmful species, their gradual removal, and replacement with controlled vegetation cover around the site. This approach, while maintaining environmental stability, prevents further damage to the structure.

- Pests and destructive biological factors

Biological factors, including pests, birds, and rodents, also play a significant role in the deterioration of mountain castles. These factors are particularly more active in castles that contain wooden elements, organic mortars, or abandoned spaces (Jokilehto, 1999). Insects weaken the structure of materials by creating nests in cracks and excavating small tunnels. Bird droppings, due to their acidic properties, gradually cause the corrosion of stone and mortar. In addition, the presence of these biological factors is often associated with increased localized moisture, which itself creates conditions for secondary damage (UNESCO, 2010). The control of biological factors requires a regular program based on conservation principles. The use of non-invasive methods, continuous monitoring, and the prevention of conditions favorable to the habitation of these factors are considered among the effective strategies in this field.

- Floods, heavy rainfall, and natural disasters

Floods and heavy rainfall are considered among the most destructive hazards for mountain castles. These phenomena, by generating intense surface runoff, damage both the castle structure and the ground substrate. Water penetration into the foundations and walls reduces the strength of building materials and accelerates erosion (Feilden, 2003). In many cases, the absence of proper water drainage and guiding systems causes rainwater to accumulate around the structure, leading to irreversible damage. In addition, floods can destroy access routes and increase the isolation of the castle, which itself becomes an obstacle to conservation measures.

- Earthquakes

Earthquakes, as a natural factor, although less predictable, also represent a potential threat to these structures in mountainous regions. Historical structures lacking seismic reinforcement are highly vulnerable to earthquakes. The protection of mountain castles against natural disasters requires risk assessment, the design of preventive measures, and the development of crisis management plans. These measures can play an important role in reducing damage and increasing the resilience of this valuable heritage.

• Human factors

In addition to natural factors, human factors play a decisive role in the destruction of the mountain castles of northwestern Iran, the most important of which are as follows.

- Illegal and profit-driven excavations

Illegal excavations carried out with the aim of treasure hunting or discovering antiquities are considered among the most significant causes of damage to historical sites and structures. These activities cause direct damage to architectural structures, destroy cultural layers, and distort archaeological data, thereby eliminating the possibility of scientifically reconstructing the past. In mountain castles, due to their remoteness and weak supervision, the intensity of this phenomenon is greater (Cleer, 2000; UNESCO, 2011).

- Mining and industrial exploitation

The expansion of mining activities, especially in mountainous regions, is regarded as one of the serious threats to defensive architectural heritage. Extraction activities carried out without compliance with cultural heritage regulations and without cultural impact assessments have led to the direct or indirect destruction of historical castles. The increasing issuance of mining permits in recent years has intensified this threat (Unesco, 2010, 2012, 2015).

- Extraction and reuse of historical materials

In many areas, traditional materials of castles, such as stone and brick, are reused by residents for new constructions. This practice reduces the structural stability of the castles and leads to the gradual collapse of parts of the structures, and it is considered one of the common forms of gradual destruction of architectural heritage (Feilden, 2023).

- Uncontrolled tourism

The increase in visitors without proper planning and

protective infrastructure can lead to the erosion of pathways, damage to sensitive parts of the structure, graffiti, and inappropriate behavioral patterns. Numerous studies have shown that tourism lacking sustainable management itself becomes a threatening factor for the survival of historical monuments (UNESCO, 2012; ICOMOS, 2017).

- Expansion of agricultural lands and land-use change

The conversion of lands surrounding castles for the development of agricultural or باغی activities causes the destruction of historical buffer zones, soil instability, and reduced structural stability of the buildings. This issue is considered one of the common challenges in protecting historical sites in rural areas (Jokilehto, 1999).

- Road construction and the development of infrastructural facilities

The construction of roads, highways, and infrastructural facilities near mountain castles causes physical and structural damage to the buildings by generating vibrations, altering drainage patterns, and transforming the natural environment (Feilden, 2003; ICOMOS, 2011).

- Unplanned construction activities

New constructions and development projects within the historical boundaries of castles are often carried out without cultural heritage impact assessments and may result in the unintended destruction of parts of the structures or sites (UNESCO, 2010).

- Lack of awareness and public neglect

The lack of awareness among local communities regarding the historical and cultural values of castles leads to unintentional destruction, removal of building materials, and incompatible physical alterations, which in the long term leave irreparable effects on architectural heritage (Smith, 2006; Cleere, 2000).

- Intentional destruction and vandalism

Deliberate acts such as graffiti, dismantling walls, destroying decorations, or setting fire to interior spaces, which are referred to in conservation literature as "vandalism," are among the destructive and rapidly effective factors in the deterioration of historical buildings (Feilden, 2003; UNESCO, 2012).

- Encroachment and violation of heritage boundaries

Encroachment upon the legal and customary boundaries of castles for residential, commercial, or agricultural uses is considered one of the fundamental challenges of cultural heritage protection in Iran and leads to the weakening of the spatial and historical integrity of the sites (ICOMOS, 2011).

- Socio-political crises (war and conflict)

Although the direct impact of this factor in northwestern Iran has been more limited, global experiences demonstrate that war, insecurity, and conflicts can lead to the sudden destruction of historical monuments, increased illegal excavations, and the weakening of protection systems (Stone, 2013).

In this section, the most important threatening factors and the characteristics of each castle are examined:

Case Studies

Northwestern Iran, due to its strategic geographical location, has historically been exposed to constant threats and insecurity. As a result, defensive fortresses in this region are more widely distributed and numerous compared to many other parts of Iran. However, given the scope of this study, it is not possible to address all of these fortifications. Furthermore, different types of military fortresses were constructed across this geographical zone, each with distinct architectural and functional characteristics. The present research focuses exclusively on mountain fortresses, as they represent the most prominent and strategically significant type of defensive architecture in the region. The sampling method adopted in this study is non-random (purposeful sampling). Accordingly, efforts have been made to select fortresses that are currently exposed to serious threats and deterioration, and whose architectural structures provide relevant information for addressing the main objectives of this article. The selected case studies were chosen based on criteria such as their geographical location, construction materials, defensive architectural features, and the extent of damage caused by natural and human factors. This approach allows for a more focused analysis of the materials used in their construction and the principal factors contributing to their deterioration (Fig. 1).

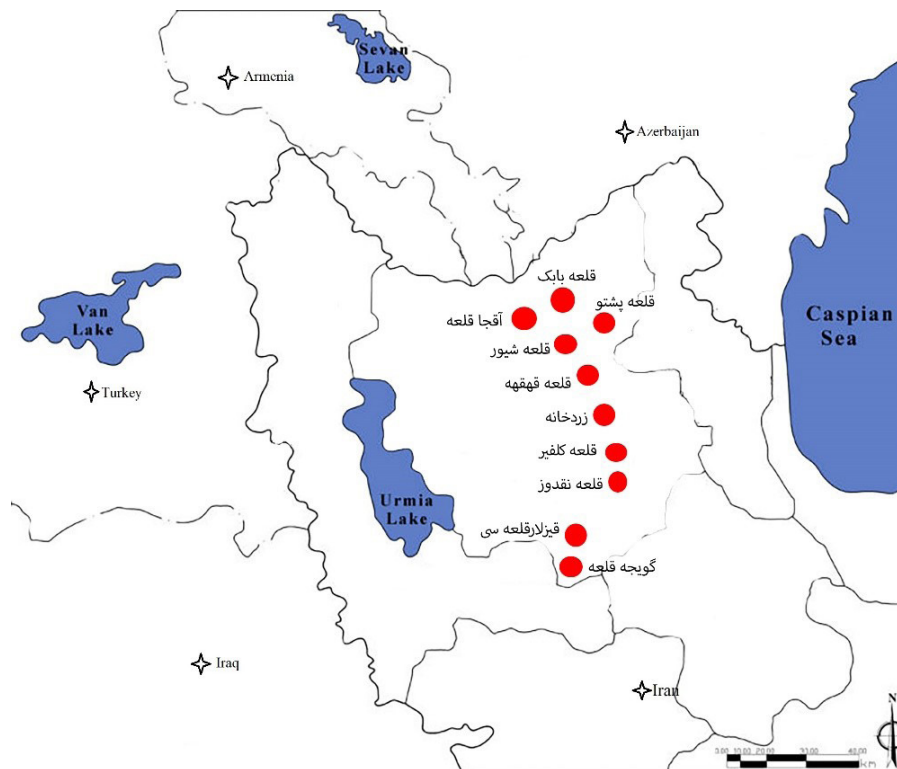


Fig. 1. Geographic location and spatial distribution of the studied fortresses. Source: Author.

• Zardkhaneh fortress

Zardkhaneh Fortress, located at an elevation of 1,724 meters above sea level, is situated in East Azerbaijan Province, approximately 22 kilometers northeast of Ahar County. During the archaeological survey and identification project carried out in 2011 in the Zardkhaneh region, a relatively extensive area including the Zardkhaneh site itself and its surrounding environment was systematically investigated through field survey methods (Kazempour, 2012). The presence of a deep valley on the eastern side, commanding views over the surrounding landscape, and large natural rock formations around Hill A were among the most important factors influencing the construction of defensive walls around and above the hill, transforming it into a defensive fortress. Surface remains of stone walls indicate that the fortress originally had at least four rows of defensive stone walls, extending from the lower parts of the hill to its summit. Additional defensive walls are also visible at both the western and eastern ends of the fortress slopes.

A. Lower Section of the Fortress: The lower section, particularly on the southern and eastern fronts, is characterized by steep slopes and the presence of a deep valley, which gave this part of the fortress a highly

strategic defensive position. On the eastern and northern sides of this area, a large stone-built cemetery was identified, associated with polished gray and buff pottery. From the upper part of the cemetery, defensive walls and architectural remains begin to appear. In this area, a single-row dry-stone wall separates the cemetery from the architectural spaces.

B. Middle Section of the Fortress: In the middle section of the hill, especially on the northern and eastern sides, defensive walls connected to architectural spaces were identified. These structures extend from the lower areas up toward the upper part of the fortress. In the southern section, due to the steepness of the hill and the presence of vertical rock faces, the distribution of defensive walls and burials is limited.

C. Upper Section of the Fortress: In the upper section, the steep slope of the hill and the vertical rock formations themselves function as the primary natural defensive elements, even in the absence of constructed defensive walls. Two notable architectural features can be identified in the southern part of this section: 1. A rock-cut staircase (approximately 0.5 meters wide and 5 meters high), carved directly into the limestone bedrock. Today, due to the weathering of the limestone surface caused by

environmental and human factors, the staircase itself has largely disappeared, and only traces of its original form remain visible on the rock surface. 2. A completely stone-built structure (approximately 1.5 meters wide and 3 meters high), created by placing a large monolithic stone over vertical rock faces, forming a fully stone architectural feature. Due to the accumulation of debris from the collapse of upper fortress structures, its original function remains unclear.

In the uppermost part of the fortress, traces of stone foundations and defensive walls are still visible on the surface. However, due to the debris from the destruction of upper structures, the exact architectural form and layout of these remains cannot be clearly identified (Fig. 2).

The structures at this site are arranged in a continuous layout extending from east to west and are predominantly characterized by rectangular (quadrangular) plans. The collapse of superstructural materials into the interior spaces of residential units has made the identification of the original architectural layouts difficult. All identified structures follow a four-sided plan, with dimensions ranging from approximately 20 × 30 meters to 4 × 5 meters. The construction technique is based on dry-stone masonry, using unworked stones measuring approximately 40 × 30 cm (Fig. 3). Comparable architectural examples dating to the Iron Age have been identified in several regions, including Armenia (Smith, 2006), Nakhchivan Autonomous Republic (Belli & Konyar, 2003, 85), Anatolia (Rezaloo, 2007), Georgia, as well as in Ardabil Province and East Azerbaijan Province.

Defensive Walls: On the upper parts of Hill A, as well as along its northern, western, and eastern ridges, several



Fig. 2. Architectural spaces around the central castle.
Source: Kazempour et al., 2012.

large dry-stone defensive walls can be observed. These structures were built using locally available stones of varying sizes extracted from the surrounding area. The stone masonry along the ridges and summit is generally irregular, and in some sections, stones have collapsed and rolled down the slope. In contrast, the stone walls on the northern slope of the site are more orderly and demonstrate a clearer structural organization. Here, the defensive walls are arranged sequentially in accordance with the natural gradient of the terrain. In several areas, evidence of land leveling and the modification of natural slopes through large-scale stone constructions can also be observed. The construction material consists entirely of unworked local stone, with considerable variation in size, some blocks reaching up to 2 meters in length. The stones were laid using a dry-stone technique, without mortar. In addition to the perimeter defensive walls, traces of stone structures are also visible around Hill C. Evidence suggests that in the southern and eastern parts of the fortress, due to the steep slopes and vertical rock formations, defensive walls were not constructed. However, in the northern sector, multiple layers of defensive walls were built in a nested arrangement, with several meters of spacing between each line of defense. Although the exact thickness of the walls cannot be precisely determined due to extensive collapse, surviving remains indicate an average thickness of approximately 1 to 1.5 meters (Figs. 4 & 5).

• Babak Castle

Babak Castle is one of the most prominent examples of Iran's military-defensive architecture from the medieval historical periods. It is located in the inaccessible highlands of Khalilabad (Kaleybar) region, built atop a



Fig. 3. Plan of the Architectural Space of Zardkhaneh.
Source: Kazempour et al., 2012.



Fig. 4. Fortification walls around the central castle of Zardkhaneh.
Source: Kazempour et al., 2012.



Fig. 5. Fortification walls around the central castle of Zardkhaneh.
Source: Kazempour et al., 2012.

massive and highly stable rocky outcrop. The selection of such a strategic location reflects the builders' deep understanding of defensive principles and their intelligent use of the natural landscape as an integral part of the fortress's protective system. The first archaeological investigations of the site were conducted by a team led by Seyfollah Kambakhsh-Fard (1966). From an architectural perspective, Babak Castle features a fully organic plan adapted to the natural rock formation. Its layout is irregular and non-geometric, closely conforming to the uneven topography of the bedrock, making it difficult in many areas to distinguish between natural formations and constructed elements. The primary building material is locally sourced rubble stone combined with lime mortar, a rational choice in terms of both availability and structural resistance in a mountainous environment. The fortress walls are notably thick and, in several sections, are directly founded on natural rock, with the bedrock functioning as the structural foundation of the entire complex. Architectural elements such as watchtowers, stepped defensive walls, narrow and steep stairways, and controlled access routes clearly indicate the strong military function of the fortress. The limited number of openings, strategically placed in key positions, minimized the risk of enemy intrusion while maintaining visual control over the surrounding landscape (Fig. 6). Despite these sophisticated defensive strategies, Babak Castle is currently exposed to multiple forms of deterioration resulting from both natural and human factors. The most significant natural threat is the harsh climatic conditions of the region. Repeated freeze-thaw cycles



Fig. 6. The Architectural Structure of Babak Castle.
Photo: Mehdi Kazempour, 2025.

allow water to penetrate cracks within the stone walls; upon freezing, the expansion of water widens these cracks, gradually weakening the cohesion of the mortar and causing localized collapse of masonry elements. In addition, heavy rainfall and surface runoff have intensified the erosion of the rock foundation beneath the castle. Since this bedrock serves as the natural foundation of the structure, its gradual destabilization poses a serious risk to the overall integrity of the fortress and may even lead to slope instability or partial landslides. Alongside natural factors, inappropriate human interventions such as unscientific restoration practices, historical stone removal, and uncontrolled tourism pressure have further aggravated the damage. Effective conservation of Babak Castle requires a comprehensive and multi-layered approach that considers both its architectural characteristics and its natural geological setting. The first step involves

detailed geological and geotechnical studies to assess the stability of the bedrock and identify critical risk zones. Based on these findings, interventions such as slope stabilization, proper surface water drainage, and localized reinforcement of the rock foundation can be implemented. From an architectural conservation perspective, the repair of cracks and damaged walls should be carried out using compatible traditional materials, particularly lime-based mortars, to avoid introducing structural stress. Improving drainage systems around the site is also essential to reduce moisture infiltration and mitigate freeze–thaw damage. Finally, effective tourism management, restriction of access to vulnerable areas, and public awareness programs regarding the cultural and historical significance of the site can significantly reduce human-induced degradation. Babak Castle clearly demonstrates that the longevity of historical monuments depends not only on material strength, but also on the complex interaction between architecture, natural setting, and climatic conditions. Effective preservation of this valuable heritage, therefore, requires an integrated understanding of these interrelated factors and the implementation of coordinated conservation strategies.

• Qahqaha Castle

Qahqaha Castle is one of the most important historical castles in northwestern Iran, located in a highland and mountainous region, and in terms of function, it is considered a prominent example of military–security architecture. The strategic location of this castle, formed atop elevations with a wide view over the surrounding routes, played a significant role in its defensive and controlling function. The selection of such a location, in addition to military considerations, directly exposed the structure to erosive climatic factors, especially strong winds and seasonal rainfall. From an architectural perspective, Qahqaha Castle has a dense and introverted structure, and its plan is largely dependent on the topography of the land. The primary materials used in the structure are brick and indigenous lime–mud mortars, which at the time of the castle’s construction were considered the most common and accessible materials in the region. The walls are relatively thick, and the towers and ramparts were designed in such a way as to provide

the greatest resistance against military attacks. The general form of the towers is often cylindrical or semi-cylindrical, which, in addition to increasing structural stability, helped reduce stress concentration (Figs. 7 & 8). However, these same brick materials are more vulnerable to long-term climatic erosion compared to stone. From the perspective of pathology, the most important factor in the deterioration of Qahqaha Castle is wind erosion. The castle’s location in the path of strong and continuous winds has caused the gradual abrasion of the brick surfaces and the loss of their outer protective layers. Over the long term, this phenomenon reduces the effective thickness of the walls and weakens their mechanical resistance, and it is especially more evident in the towers and edges exposed to the wind (Nourbakhsh, 1366). Alongside wind, seasonal rainfall also plays an important role in intensifying the damages. The penetration of rainwater into the bricks and indigenous mortars gradually weakens the bond between materials over time and has caused flaking, cracking, and localized collapse of parts of the walls. These damages have become more severe in areas where improper restorations were carried out or incompatible cement mortars were used, because such mortars prevent the materials from breathing and trap moisture within the brick fabric. To preserve Qahqaha Castle, it is essential to adopt strategies compatible with the nature of its brick materials and the climatic conditions of the region. In the first step, detailed documentation of the damages and identification of areas exposed to severe wind erosion should be carried out so that the prioritization of interventions becomes possible. The use of mortars compatible with the historical mortars, especially lime mortars with moisture-exchange capability, is considered one of the most important conservation measures. In addition, strengthening damaged brick surfaces through conservative methods and minimal intervention can prevent the continuation of wind abrasion. Controlling the penetration of rainwater through improving the slope of surfaces, restoring jointing, and creating water drainage systems plays an important role in reducing deterioration caused by moisture. Finally, avoiding incompatible restorations and managing visitors, as a complementary factor, can help preserve the physical integrity and historical authenticity of the castle. Overall,

Qahqaha Castle is a clear example of the vulnerability of historical brick structures against the combination of wind and moisture factors in mountainous regions. The sustainable preservation of this valuable monument requires a precise understanding of its architectural characteristics, recognition of erosional processes, and the application of solutions compatible with its materials and climatic context.

• Peshtab Castle

It is considered one of the prominent examples of mountainous military architecture in northwestern Iran, whose formation has been directly influenced by topographical conditions and the natural environment. This castle was constructed on a steep and rocky slope and benefits from this feature as a natural defensive element. The plan of the castle is generally irregular and adapted to the shape of the land, in such a way that the walls and spaces follow the ups and downs of the natural bed, and the imposition of regular geometry has been avoided. One of the characteristics of Poshtab Castle is the creation of architectural spaces within its limestone bedrock. In this castle, guard spaces, storage areas, and also access stairways have all been carved entirely into the rock bed. In part of the castle, cobblestone and brick were used for the construction of defensive walls (Figs. 9 & 10). The internal spaces of the castle are also mostly simple, minimally decorated, and functional, and were mainly designed for the accommodation of forces, food storage, and surveillance. Despite these architectural features, the most important damage to Poshtab Castle is observable not in the bodies of the structure, but in its foundation



Fig. 6. The Architectural Structure of Babak Castle.
Photo: Mehdi Kazempour, 2025.

and structural bed. The placement of the castle on a steep slope has exposed it severely to landslides and soil erosion. The gradual erosion of soil in the lower sections and at the base of the walls has weakened the structural chassis and reduced structural integrity; as a result, even relatively walls have lost their stability. This instability of the underlying ground has caused cracking, uneven settlement, and ultimately the collapse of parts of the walls. Therefore, the main damage to the castle can be considered to result from the weakness of the bed and foundation—damage that demonstrates that the preservation of this structure, more than anything else, requires slope stabilization, landslide control, and soil erosion management, rather than merely the restoration of walls and architectural bodies.

• Noduz Castle

Noduz (or Naqduz) Castle is one of the prominent mountain fortresses of northwestern Iran, which, in terms of strategic location, architectural style, and materials, is considered a valuable example of the fortress-building tradition of the Sasanian period and its continuation in the early Islamic era (Khamachi, 1998). Noduz Castle chronologically belongs to the Sasanian period; a period in which the construction of mountain castles for controlling communication routes, border surveillance, and the protection of population and economic centers was highly common. The location of the castle atop elevations overlooking the Ahar Chay River indicates that this fortress was responsible for controlling the transit routes of the Ahar valley and monitoring military and commercial movements. In the early Islamic period,



Fig. 6. The Architectural Structure of Babak Castle.
Photo: Mehdi Kazempour, 2025.

the castle was reused, and sections made of adobe were added to it, which indicates the continuity of settlement and its military–security importance after the fall of the Sasanians. Architectural features of the castle: The castle was built atop a rocky summit with a very steep slope. The only entrance route is the northern ridge, which was controllable from a defensive perspective. The other three sides of the castle consist of deep cliffs that function as natural barriers. The castle contains: two main towers, a circular connecting wall between the towers, and another tower in the lower section (parts of which have been destroyed). The height of the towers ranged between 9 and 11 meters, which was highly suitable for surveillance (Figs. 11 & 12). The towers and walls are mainly supported by the rocky body of the mountain, which increases the structural stability and almost eliminates the possibility of enemy tunneling. Building materials of the castle: The principal materials of the structure are cut sedimentary stones, brick, and yellow colors. Features: high compressive strength, easy local accessibility, the ability to be cut and regularly interlocked; the stones were arranged in regular block forms, indicating the high skill of the architects. Mortar: The principal mortar is sarooj, and in some sections, gypsum and lime were also used. Advantages: resistance against moisture, high adhesion, and long durability under harsh climatic conditions. Adobe and mud: In the upper sections of the walls and the additions of the Islamic period, adobe and mud were used (Rahmatpour & Omrani, 2009). Main weakness: severe sensitivity to rainfall, rapid erosion in the humid

climate of the region. For this reason, a large portion of the wall heights has been destroyed. Destructive factors of the castle: Natural factors: landslides, the placement of the castle on a steep slope, instability of soil layers beneath the walls. Water erosion: continuous rainfall, washing away of soil at the base of the walls. Freeze–thaw cycles. Cracking of stone and mortar. Vegetation growth; penetration of roots into the joints of stones and mortar. Human factors: lack of proper restoration, removal of stones by local people in the past, uncontrolled movement of tourists without protective infrastructure, absence of fencing, and continuous supervision. Environmental protection; controlled removal of destructive vegetation. Directing rainwater away from the foundations of the walls.

• Aghja Castle of Varzaghan

This is one of the ancient fortresses of East Azerbaijan. The castle is located 50 kilometers northwest of the city of Varzaghan. The history of this castle dates back to the Parthian period, and it was also used during the Sasanian and post-Islamic periods. Aghja Qala was built on top of a relatively high hill, and its northern, eastern, and western sides are surrounded by mountainous cliffs overlooking forests. The southern side, which may have been one of the entrance gates of the castle, was not in the form of a cliff but rather a gently sloping hill that, over time and due to erosion, transformed from a high wall into a gentle slope. What currently remains of Aghja Qala consists of eight circular semi-cylindrical towers and eleven sections of thick and wide stone walls. The interior and northern sections of the towers are 4 meters in dimension. The



Fig. 9. Architectural spaces carved into the stone bed of Peshtab castle. Photo: Mehdi Kazempour, 2023.

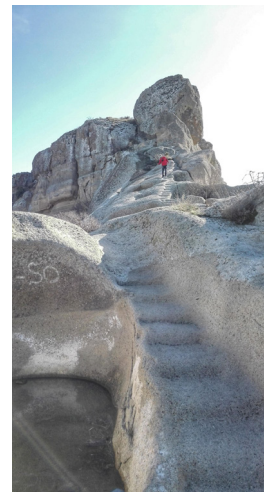


Fig. 10. Stairs carved into the rocky bed of Peshtab castle. Photo: Mehdi Kazempour, 2023.

construction materials used in the towers are entirely roughly cut stone blocks, and the mortar of the walls and towers is made of white sarooj mortar in which lime constitutes the primary component. The walls of the castle, with a width of 2 meters and a height of 3 to 4 meters, are partially preserved. Some parts have collapsed, and their construction materials have been scattered around several surrounding areas of the castle. On the southern side of the castle, five guard towers remain today. The remaining three towers were constructed at the three corners of the castle. All these towers and the very strong and wide ramparts were originally connected in the early years of construction. It is completely evident that guards moved and circulated along the walls (Figs. 13 & 14). What remains of the northern section of the castle is the remains of its entrance gateway, which can be identified from the barrel vaults of the walls, the width and length of the distances between them, and the symmetry of the side walls of the entrance. Access to the castle from the southern side was also through stairways along the route, all of which have been destroyed, and only traces and locations of the stairways remain. The castle site has been estimated to cover an area measuring 150 by 200 meters, with a total area of 3000 square meters. The castle building

was constructed in two distinct and separate main sections. The eastern section of the castle contained several rooms, and there was a connecting passage leading to a hall. Three types of materials were used in the construction of the structure, each indicating a particular historical period and the multi-phase construction of the castle. These materials include rough stone and sarooj mortar related to the Parthian period, adobe bricks related to the Sasanian period, and gypsum mortar related to the Islamic period and later. Inside the castle, graves can also be seen, some of which have been disturbed by illegal excavators hoping to discover antiquities. Around them, fragments of bones and broken pottery are visible. Aghja Castle was also a military and defensive fortress constructed to prevent enemy invasions into the region. This castle is located in the heights of Varzaghan and along the route from Sungun to Tuali. Agh Qal'eh is also a prominent example of mountain castles that are highly vulnerable to moisture and rainfall. The gradual collapse of the adobe walls of Agh Qal'eh can be regarded as a direct result of unsuitable climatic conditions and the absence of continuous maintenance. This castle demonstrates that the type of materials plays a determining role in the intensity and speed of the deterioration of mountain castles.



Fig. 11. Material uses at Nodouz castle. Photo: Mehdi Kazempour, 2022.



Fig. 12. sight from the southern part of Nodouz castle. Photo: Mehdi Kazempour, 2022.



Fig. 13. Varzeghan Aghgha Ghaleh Castle . Photo: Mehdi Kazempour , 2021.



Fig. 14. Varzeghan Aghgha Ghaleh Castle. Photo: Mehdi Kazempour , 2021.

• Kalfir (Kalehar) Castle

Kalehar Castle (located in a village of the same name) is situated seven kilometers south of Ahar, between the Ahar Chay River and the heights of Gechi Gharan. This castle, located near Kalehar village and on the route leading to the city of Ahar, is known among the local inhabitants as Kharabaqala. There is also an old qanat (kariz) beside this castle. This castle, which was built on a flat and level surface, was probably not a military or defensive fortress but rather a castle-town (Figs. 15 & 16). With its regular geometric design, this castle not only possesses towers, ramparts, and a gate, but it is also surrounded by large and deep moats, the water of which was supplied from irrigation water that would otherwise be wasted during the cold season in the village. Today, parts of the walls and the remains of the towers still survive on the site. Near the castle, there are agricultural lands known as “Kerpish Khana.” Square-shaped bricks have also been discovered in the middle of the castle. In addition to the moat, the castle was protected by several layers of ramparts. All the castles of the historical and Islamic periods in the city of Ahar were constructed on mountaintops and ridges using stone materials, whereas Kalehar Castle was built in an open and flat area using adobe and brick materials. The type of plan and the materials used in this structure are reminiscent of the Umayyad and Abbasid castles in the deserts of Jordan and Palestine. Kalehar Castle, with its combined structure of stone and adobe, is exposed to dual hazards. On the one hand, adobe materials are vulnerable to moisture, and on the other hand, the stone sections are also subject to erosion in the absence of proper restoration. Nevertheless, the most important factor in the deterioration of this castle is human factors, such as illegal excavations and neglect of restoration principles. These improper



Fig. 15. One of the brick towers of Kalfir castle.
Photo: Reza Salmanpour, 2016.

interventions have not only caused direct damage to the structure but, by disturbing the structural balance, have also created conditions for the intensification of natural damages.

• Qizlar Castle

is located in the central district of Maragheh County, on the surface of a relatively high rocky mountain situated on the margin of the Mordu Chay River (Mordaq River). The distance of the castle from Maragheh is 20 kilometers (Alampour Rajabi, 2004, 73), and access to the castle is through the gravel road from Tazeh Kand-e Qareh Naz village to Leyli Daghi village (Satarnazhad et al., 2020). The historical site of Qizlar Qalasi was established on the surface of a rocky mountain. The castle is surrounded on three sides by steep slopes descending into narrow valleys around it. On the eastern side, the slope of the mountain decreases, and access to the castle in this section is smoother. The surrounding landscape of the site consists of rolling hills, and the surfaces of these hills are used for dry farming (Ahmadi Malek, 1989, 52). One of the most important reasons for selecting this elevation for the establishment of the castle was the existence of water resources adjacent to the site and the natural and suitable form of the mountain, which made it inaccessible from three directions. This castle belongs to the category of mountain castles, in which the extent of the castle is dependent on the natural condition of the mountain, and no fixed or uniform design can be observed in them (Pazouki, 1993, 37). Therefore, the structure of Qizlar Qalasi follows the topography of the mountain, and the defensive fortifications were created in accordance with the site. The structure of this fortification is very similar to the defensive structures of Parthian castles such as Zahhak Castle of Hashtrud (Qandgar, 2000), Qeshlaq Castle of

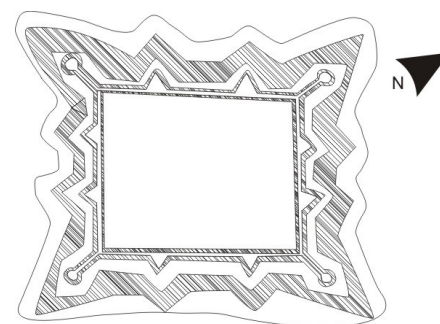


Fig. 16. Plane of Kalfir castle.
Scale: 1/100cm
Photo: Mehdi Kazempour, 2017.

Mahneshan in Zanzan and Qizil Qayeh of Meshgin Shahr (Rezaloo, 2018). Based on the stylistic study of the rock architecture and some of the dry-stone walls of the site, it can be stated that this site, during the first millennium BCE, functioned as one of the important strongholds of Maragheh, a period coinciding with the Urartian and Mannaeian presence in the region (Figs. 17 & 18). During this period, the defensive fortifications of the castle were formed, and these fortifications consist of regularly cut stone blocks (Satamzhad et al., 2020). The presence of water resources adjacent to the site, although one of the reasons for the selection of the location, in the long term can lead to increased moisture and erosion of the rocky substrate. The dry-stone fortifications and cut stone blocks demonstrate the high skill of the builders during the prehistoric and historical periods, but today these same structures have become vulnerable to water penetration and temperature fluctuations (Pazouki, 1993; Qandgar, 2000).

• Goyjeh Castle Complex of Maragheh

This castle was first identified and studied by Wolfram Kleiss in 1973 (Kleiss, 1974, 34). The castle was built on a mountain, has a rectangular shape, and possesses a relatively steep slope. Goyjeh Castle, with its stone architecture, rock-cut tombs, rooms, and storage spaces, was used during the Iron Age, the historical period, and the Islamic Middle Ages (Naseri Som'eh et al., 2015). The relatively steep slope of the mountain and the placement of the structure on a rocky substrate have increased the risk of collapse and localized instability (Kleiss, 1974). The diverse functions of the castle during different periods, from the Iron Age to the Islamic Middle Ages, caused changes in the spatial structures, some of which may have weakened the original structural balance (Naseri Som'eh et al., 2015). In this complex as well, the absence of a coherent conservation program may lead to the intensification of damage in the future (Figs. 19 & 20).

Research Findings

Based on the results of this research, ten military castles in the northwestern region of Iran were examined and analyzed. Chronologically, these castles encompass a range from the Iron Age to the Sasanian period and the early Islamic era. The temporal and spatial distribution of these castles reflects the direct influence of the political, military, environmental, and subsistence conditions of each historical period on

site selection, construction methods, and their defensive functions. The comparative study of these examples makes it possible to identify distinct patterns in the evolution of military architecture over time. The findings indicate that in each historical period, the concentration of castle settlements was dependent on specific political and military conditions. During the Iron Age, the distribution of castles was broader compared to later periods, reflecting local and decentralized defensive structures suited to the smaller communities of that era. In contrast, during the Parthian and Sasanian periods, and especially in the early Islamic era, the concentration of castles increased at strategic points and along major communication routes, reflecting the emergence of centralized governments and the necessity of military control over territories. In the Iron Age, castles were mainly constructed on high elevations, mountain ridges, inaccessible rocky cliffs, and near rivers. The selection of these locations was carried out in such a way as to maximize defensive advantages from the natural environment. The materials used primarily consisted of large, uncut local stones arranged in dry-stone masonry. The defensive system of these castles relied mostly on natural barriers such as precipices and inaccessible cliffs, while stone walls were only constructed in areas where natural weaknesses existed. During this period, many architectural spaces, such as Pashtoo (Pashtab) Castle of Ahar and Qizlar Castle of Maragheh, were directly carved into the rocky mountain substrate. Today, due to severe natural erosion, significant remains of these structures have not survived. Wind erosion, rainfall, temperature fluctuations, and the calcareous nature of the materials are considered among the most important causes of the deterioration of these castles. During the historical Parthian and Sasanian periods, with the formation of centralized governments and organized armies, military architecture underwent a fundamental transformation. Castles of this period possess more regular, complex, and multilayered structures, and the use of watchtowers, continuous defensive walls, controlled entrances, and organized internal spaces is clearly observable. Building materials also changed, and in addition to cut stones, the use of sarooj mortar and, in some cases, brick became common. Although these castles continued to be built in elevated and inaccessible areas, their proximity to major communication and military routes enabled the control of transit roads and



Fig. 17. Maragheh Kizlar castle fortification.
Source: Naseri Som'eh et al., 2019.



Fig. 18. Overall view of Maragheh Kizlar castle.
Source: Naseri Som'eh et al., 2019.

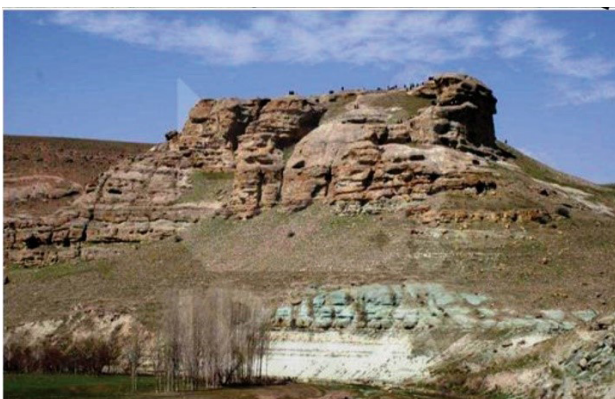


Fig. 19. stone structure of Goyjeh Castle, Maragheh.
Source: Naseri Som'eh et al., 2015.



Fig. 20. A hand-carved on the rocky bed of Goyjeh Castle, Maragheh. Source: Naseri Som'eh et al., 2015.

military movements. Despite the greater structural strength of castles in this period, their vulnerability also increased. The use of brick, although accelerating construction processes, had lower durability against climatic factors and, in many cases, resulted in more rapid deterioration of the structures. Moreover, in later periods, many of these materials were reused in the construction of new buildings, which in itself became an important factor in the destruction of the original castle structures. In addition, spaces carved into rocky substrates, such as stairways and side chambers, have been severely damaged due to natural erosion and lack of protection, reducing the legibility of the architectural plans. With the beginning of the Islamic period and simultaneously with the arrival of Arab armies in Iran, the importance of military fortifications once again increased. Under conditions in which the Sasanian political structure had collapsed, and many cities had been damaged, the remaining castles played a vital role in local resistance movements. During this period, a considerable number of Sasanian castles were restored, reinforced, and reused, while some continued their existence with modifications adapted to new military requirements. This demonstrates the continuity of the defensive function of these structures and their key role in the military and political transformations of the early Islamic period (Tables 1 & 2). Overall, the comparative study of the military castles of northwestern Iran demonstrates that the transformations of military architecture in this region directly reflect political, military, construction, technological, and environmental changes, and their study can provide a deeper understanding of the historical and defensive developments of ancient Iran.



Table 1. The impact of natural factors on the destruction of mountain castles in Northwest Iran. Source: Author.

No.	Castle Name	Earthquake	Soil Erosion	The Weather	Vermin	Planet Growth	Flood and Rain
1	Zardkhaneh	✓	✓	✓		✓	✓
2	Nordouz	✓	✓	✓	✓	✓	✓
3	Peshtab		✓	✓			✓
4	Shivar	✓	✓	✓		✓	✓
5	Babak	✓	✓	✓		✓	✓
6	Kalfir (Kalhor)	✓	✓	✓	✓	✓	✓
7	Aghcha Ghale	✓	✓	✓		✓	✓
8	Ghahghahe Ghale	✓		✓		✓	✓

Table 2. The impact of Human activity factors on the destruction of mountain castles in Northwest Iran. Source: Author.

No.	Castle Name	Mining	Construction Activity	Lake of Awareness	Deliberate Destruction	Violation of Privacy of Works	Using Castle Materials	Illegal excavations	Tourism	Expansion of Agricultural lands
1	Zardkhaneh			✓		✓		✓		✓
2	Nordouz		✓	✓	✓	✓	✓	✓	✓	✓
3	Peshtab		✓	✓	✓	✓		✓	✓	✓
4	Shivar	✓	✓	✓	✓	✓		✓	✓	✓
5	Babak		✓	✓	✓	✓		✓	✓	✓
6	Kalfir (Kalhor)		✓	✓	✓	✓	✓	✓	✓	✓
7	Aghcha Ghale		✓	✓	✓	✓	✓	✓	✓	✓
8	Ghahghahe Ghale		✓	✓	✓	✓		✓	✓	✓

Conclusion

Northwestern Iran, due to its location in the Caucasus region, has always been exposed to threats and invasions and has played a fundamental role as an important corridor in controlling and preventing the entry of foreign peoples. For this reason, the largest number of military castles is located in this region. The castles of this area, in accordance with the geographical patterns and topography of the region, were constructed from prehistoric periods onward in inaccessible and mountainous locations. Therefore, their geometric plans were completely adapted to the topography of the construction site. Accordingly, it is not possible to consider a single unified plan or pattern for them. This characteristic

also applies to the materials used in their construction. The materials used were local and accessible; for this reason, large stone blocks were among the most common building materials. These stone blocks were extracted directly from the mountain itself and used in the construction of the castles. In addition, the creation of architectural spaces through carving into rocky and stone substrates was also common. This practice had both advantages and disadvantages. First, most of the stones in northwestern Iran are calcareous, which are highly vulnerable to atmospheric factors, and this issue has significantly influenced the destruction of mountain castles. Furthermore, the placement of castles in locations around rivers, valleys, or

on mountaintops, which are constantly exposed to erosion, is considered one of the major threats. The growth of vegetation and its penetration into the depths of mountain castles, together with the intrusion of pests such as rats and other animals, are also regarded as important threats to mountain castles. Alongside natural factors, human factors also play a major role in the destruction of mountain castles. Factors such as illegal excavations and the expansion of agricultural lands and orchards toward the protected boundaries and areas of mountain castles are considered among the most important damages. The mountainous location of the castles, which keeps them away from public view, results in more frequent illegal excavations. The ever-increasing expansion of land grabbing and mining activities is also regarded as one of the most significant destructive threats to mountain castles. In general, the study of the castles of northwestern Iran shows that natural factors such as precipitation, freezing, soil erosion, and landslides play the greatest role in the destruction of these monuments. Alongside these factors, human interventions, including illegal excavations and neglect of proper restoration, have also accelerated the process of destruction. Therefore, it is suggested that the following measures be adopted: accurate registration and three-dimensional documentation of all castles; implementation of restoration projects compatible with indigenous materials; establishment of restrictions on human exploitation activities around these monuments; and increasing public awareness regarding the importance of this cultural heritage.

Declaration of Conflicting Interests

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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