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Analyzing the Narrative Use of Sound to Detect a Breach in the Wall in Nizami's *Haft Paykar*: From the Perspective of the History of Technology[1]

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Abstract
Sound has long been used to obtain information about the surrounding environment, while in classical Persian literature, sound and echo predominantly serve metaphorical, epic, or mystical functions. A notable passage in Nizami's *Haft Paykar*, however, describes the use of sound around a fortress rampart to locate a concealed breach. This study examines the passage from the perspectives of the history of technology and empirical architectural knowledge. This interdisciplinary, descriptive–analytical study was based on library research. The primary unit of analysis comprised verses from *Haft Paykar* that connect sound production, acoustic searching around the rampart, and the discovery of a breach. Selected Persian literary and technical sources were also examined to contextualize the practical use of sound for identifying concealed structural features. The analysis indicates that practical uses of sound for identifying hidden spaces are rare in the examined Persian literary corpus. In Nizami's account, sound is not used merely as a metaphor or aesthetic device; rather, it forms part of a narrative sequence in which a sound stimulus is produced, its response is investigated around the rampart, and a concealed breach is inferred from the acoustic clue. This logic bears a conceptual resemblance to acoustic approaches in non-destructive structural assessment, where hidden discontinuities may be inferred indirectly from variations in acoustic response. Nevertheless, the text provides no evidence of modern measurement, signal recording, or quantitative analysis. Nizami's account constitutes a notable literary representation of the functional use of sound to identify a concealed breach or space within a wall. While it cannot be considered evidence of modern acoustic testing, it provides a valuable case for investigating historical empirical knowledge and the relationship between sound, architecture, and material practice in medieval Iran. The passage also demonstrates the potential of classical Persian literature as a source for interdisciplinary research in the history of technology, archaeoacoustics, and cultural heritage conservation.

Keywords: Archaeoacoustics; Acoustic Testing; Conservation and Restoration; *Haft Paykar*; Nizami Ganjavi

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1. Introduction

Throughout history, humans have relied on the physical properties of sound to perceive and interpret their surrounding environments. Variations in resonance, intensity, and sound reflection can provide valuable information about the presence of cavities, voids, cracks, and discontinuities within structures. This principle underlies many modern non-destructive testing (NDT) techniques used in the conservation of historical monuments, civil engineering, and structural health assessment (Bungey & Grantham, 2006; ASTM E1002-23). Although such techniques have been formally developed within modern engineering, historical evidence suggests that empirical knowledge of acoustic behavior in relation to materials and structures has a much longer history. Craftsmen, architects, and builders in different civilizations appear to have used changes in resonance to assess material quality, detect hollow spaces, and evaluate structural conditions (Valière & Palazzo-Bertholon, 2019). In recent decades, the development of archaeoacoustics has further demonstrated that the acoustic properties of historical spaces were not merely incidental features of architecture, but could also constitute part of the experiential and practical knowledge of their builders and users (Till, 2017). Archaeoacoustics is an interdisciplinary field concerned with the acoustic properties and experiences associated with historical and archaeological spaces, buildings, and sites, examining the relationship between sound, architecture, and human activities (Navas-Reascos et al., 2023; Díaz-Andreu, 2025). In the present study, however, archaeoacoustics is not employed as a direct method for detecting structural voids. Rather, it provides an interdisciplinary framework for examining the relationship between sound, space, and historical architecture. In classical Persian literature, sound, echo, and the return of the voice occur frequently, particularly in descriptions of mountains, caves, and open landscapes. Major poets such as Ferdowsi, Sanai, Attar, Rumi, Saadi, and Hafez repeatedly employed echoes and reflected sounds for epic, mystical, ethical, and aesthetic purposes. In these texts, however, acoustic reflection generally functions as a literary and metaphorical device rather than as a means of identifying the physical properties of an environment. A distinction must therefore be made between the literary representation of echo and its practical use in architectural or structural investigation. A preliminary examination of accessible sources, including Ferdowsi's *Shahnameh* and Saadi's *Bustan* and *Gulistan*, suggests that the use of sound to identify a concealed space or structural void is relatively rare, at least in the examples examined. Against this background, a narrative passage in Nizami's *Haft Paykar* constitutes a particularly noteworthy case. In this passage, Nizami describes a scene in which a protagonist produces sound around the wall of a fortress and searches for variations in the acoustic response along the wall in order to locate an approximately hidden breach. From the perspective of certain general principles underlying modern acoustic and impact-based testing, this procedure may be understood as conceptually analogous to non-destructive methods for detecting voids and discontinuities. Unlike the more common metaphorical uses of echo in Persian poetry, the scene presents sound as a functional element in a process of identifying a concealed structural feature. It may therefore be interpreted, cautiously, as a form of indirect detection. From the perspective of the history of technology, the account bears conceptual similarities to acoustic and impact-based approaches currently used in the non-destructive assessment of historical structures, including the detection of delamination and internal cavities (ASTM E1002-23; Bungey & Grantham, 2006). Despite the significance of this account, scholarship on *Haft Paykar* has predominantly focused on its literary dimensions, narrative structure, symbolism, color symbolism, astronomy, and philosophical and mystical ideas (Meisami, 1987; de Blois, 2002). Although studies of Nizami have also recognized his knowledge of astronomy, architecture, medicine, and philosophy, this particular passage has not, to the best of our knowledge, been examined from the perspectives of the history of sound technology, architectural engineering, or empirical techniques for detecting concealed spaces. Conversely, archaeoacoustic research has largely concentrated on the acoustic characteristics of ritual spaces, caves, amphitheaters, and historical buildings, while connections between this field and evidence found in classical Persian literature have received comparatively little attention (McMurray, 2021; Till, 2017). The analysis of this passage can therefore contribute to an interdisciplinary research gap at the intersection of Persian literary studies, the history of engineering, archaeoacoustics, and heritage conservation. It may also demonstrate that classical Persian literature, in addition to its literary and symbolic significance, can preserve representations of technical and empirical knowledge. In this particular case, the narrative depicts the use of changes in sound

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resonance to locate a concealed space within a defensive structure, making it worthy of further investigation within the history of technology and architecture in medieval Iran. Accordingly, this study examines Nizami's account of locating a breach in a fortress wall and analyzes the role of sound in this scene from literary, historical, and technological perspectives. It asks how sound is employed in the narrative as part of the process of identifying the breach and to what extent this procedure can be considered conceptually comparable to general acoustic approaches for detecting discontinuities and concealed spaces in structures. A further question concerns the extent to which this literary account may support a hypothesis concerning the existence of empirical knowledge of acoustic behavior within the architectural and fortification traditions of medieval Iran, without imposing modern acoustic concepts or technologies retrospectively upon the historical text. The central premise of the study is therefore that, at least at the textual and literary level, the passage presents sound as a functional element in the identification of a concealed breach. However, attributing this account to a specific technical method or to an acoustic technology in the modern sense would require independent and substantiated historical evidence. The study consequently treats this literary representation not as direct proof of a historical NDT technique, but as evidence worthy of interdisciplinary investigation into the possible relationship between empirical acoustic knowledge, architectural practice, and literary representation in medieval Iran.

2. Literature Review

In recent years, the relationship between sound, architecture, and the identification of concealed structural features has emerged as an interdisciplinary field spanning archaeology, architectural history, cultural heritage conservation, and acoustics. Archaeoacoustic studies have shown that historical architectural spaces were not merely visual environments; their acoustic properties also contributed to architectural design, function, and human experience In this study, a laptop was used to generate the acoustic signal. The Apple Logic Pro – Impulse Response Utility software generated a swept sine-wave signal ranging from 20 Hz to 20 kHz. The signal was reproduced through a portable B&O Beolit loudspeaker. Two omnidirectional DPA 4006 microphones were used to record the sound. The positions of the loudspeaker and microphones were varied at different locations within the archaeological space, and the resulting data were subsequently analyzed using Odeon, Sonic Visualiser, and Audacity software (Till, 2017) (Fig. 1).

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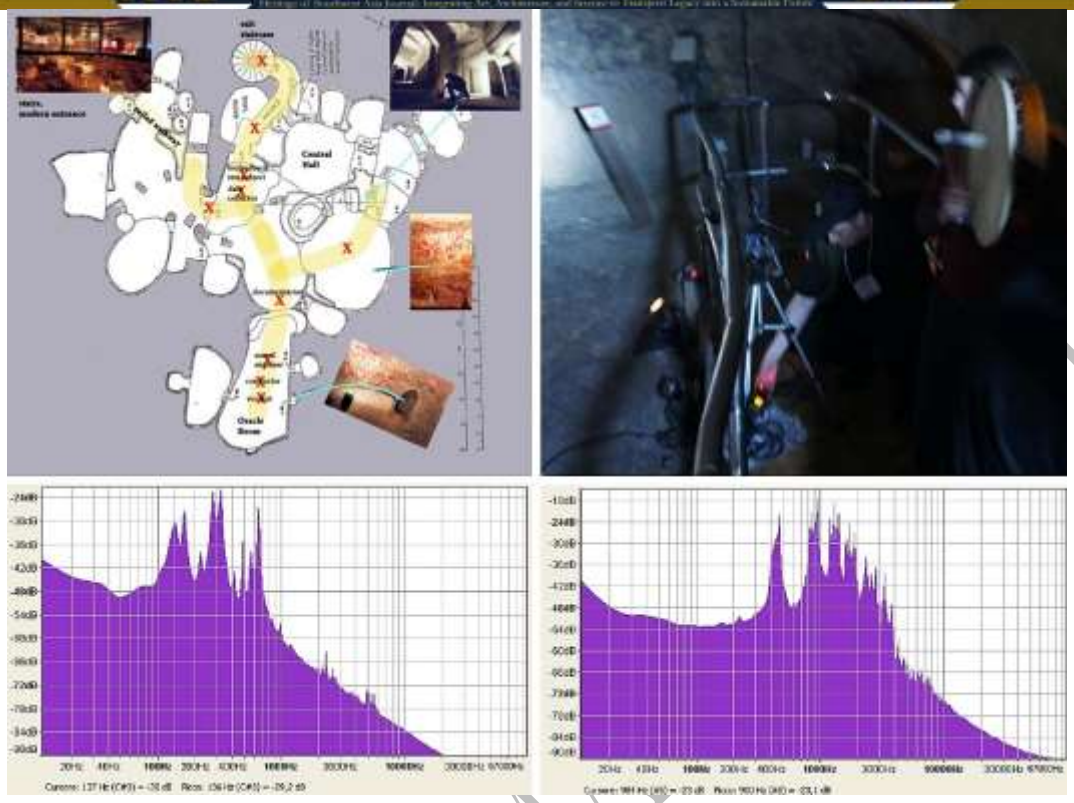


Figure 1. Technical acoustic study of the rock-cut architecture: How does this architectural space produce, amplify, resonate, propagate, and reflect sound? (Till, 2017).

Ortega et al. (2024), in a study focusing on the application of sonic tomography to historical masonry walls, investigated the capability of this method to assess the internal and mechanical condition of walls. By applying controlled loading to stone masonry wall specimens and recording the propagation velocity of acoustic waves along multiple paths, the researchers obtained tomographic images of the internal structure of the walls. The results showed that variations in wave propagation velocity were associated not only with the degree of damage and internal discontinuities but also with the stress state and mechanical changes within the walls. The study demonstrates that, beyond the auditory experience, acoustic waves can serve as a non-destructive tool for detecting and monitoring hidden features within historic structures (Ortega et al., 2024) (Fig. 2).

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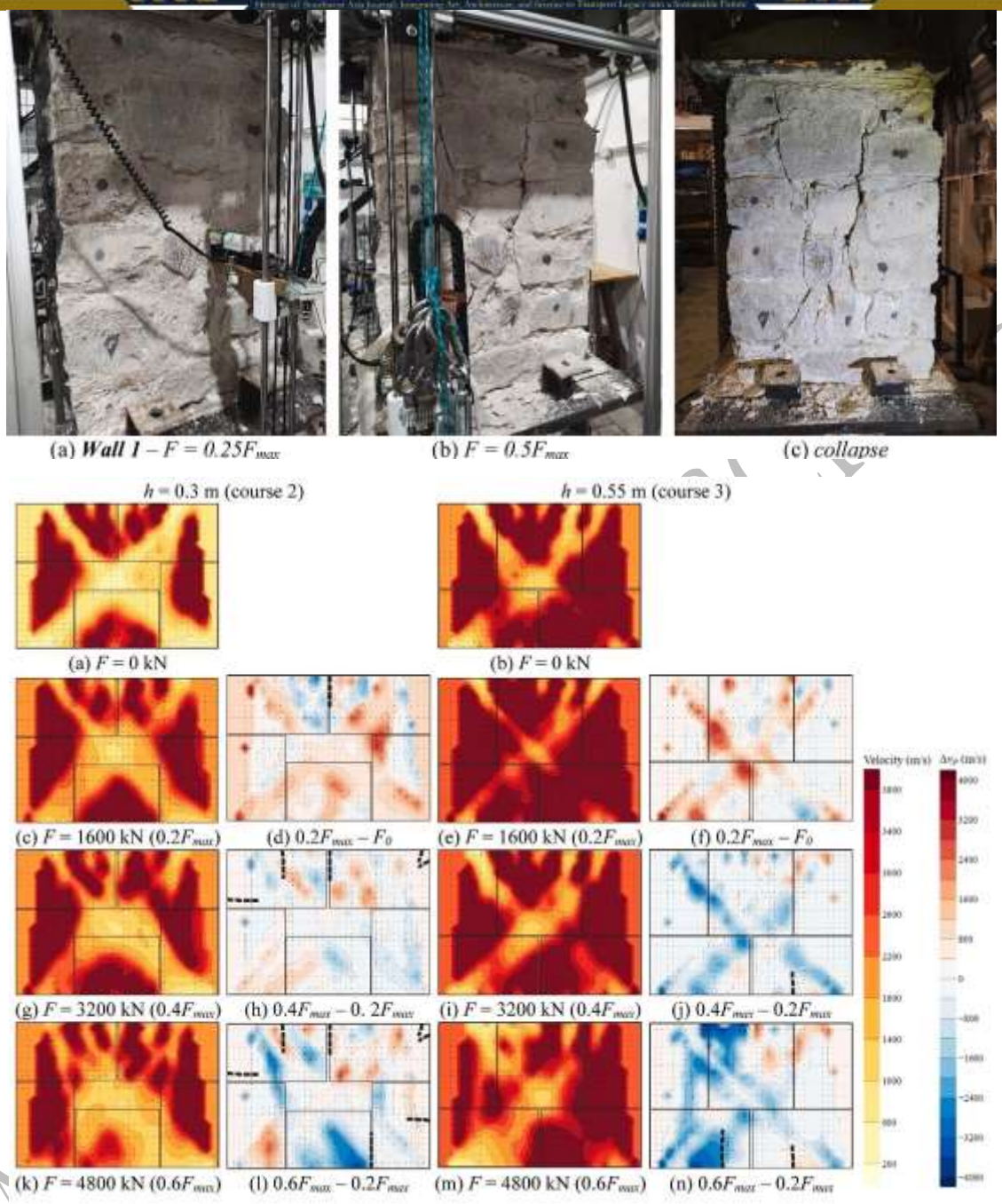


Figure 2. Simulation of historical masonry walls: technical investigation using acoustic methods, involving the application of pressure and the recording of changes in structural details through acoustic technology (Ortega et al., 2024).

In this context, Architectural Acoustics and, particularly, the theory of Teichoacoustics (McMurray, 2021), are relevant to the present study because they emphasize the role of walls and architectural elements in shaping acoustic behavior. Here, however, Teichoacoustics is not used to explain the actual acoustic behavior of the fortress wall, but only to underscore the interdisciplinary relationship between sound and architecture. In cultural heritage conservation, sound- and vibration-based non-destructive methods, including acoustic

and impact testing, are widely used to detect voids, delamination, internal cracks, and material discontinuities through changes in sound-wave propagation and reflection (Valière & Palazzo-Bertholon, 2019). By contrast, practical uses of sound to identify concealed spaces are rare in classical Persian literature, where echoes and reflected sounds in mountains and caves are generally employed metaphorically rather than diagnostically. A notable exception is Nizami Ganjavi's *Haft Paykar*, in which the protagonist produces sound around a fortress wall and identifies a breach or hollow space through changes in resonance. This passage presents a sequence of sound production, acoustic observation, and inference of a concealed space, bearing a notable conceptual resemblance to acoustic testing in non-destructive structural assessment. Yet scholarship on *Haft Paykar* has largely focused on its literary structure, symbolism, color symbolism, and mystical themes, while this passage has not been independently examined in relation to the history of technology, empirical architectural knowledge, or the historical use of acoustic methods for structural investigation (de Blois, 2002).

3. Methodology

This foundational study adopts an interdisciplinary, descriptive–analytical approach based on library research. Its primary unit of analysis is a passage from Nizami's *Haft Paykar* in which sound production, acoustic searching around the fortress wall, and the revelation of a breach are narratively connected. The selected verses were identified according to three criteria: (1) explicit reference to sound or a sound-producing instrument; (2) a direct relationship between sound and the search for a breach or passage; and (3) a clear narrative sequence linking sound production, searching, and the discovery of the breach. The analysis first examines the terms "sound," "search," "breach," and "key," together with the sequence of events. It then considers independent historical and technical sources to determine whether evidence exists for the empirical use of impact or sound to assess the condition of materials and structures. Finally, a limited, non-equivalent comparison is made between the narrative logic and the general principle of indirectly identifying discontinuities through acoustic response, without claiming that a modern or fully developed method existed in Nizami's period.

4. Results and Discussion

Sound-Based Assessment of Damage in Architectural Structures and Ornamentation

Historic buildings often exhibit extensive and dispersed damage patterns resulting from factors such as their original function, construction methods, and loading history. Non-destructive testing (NDT), increasingly used for in situ monitoring, enables reliable assessment of structural condition, durability, and changes over time (Lacidogna et al., 2015). Acoustic techniques are among the most widely used approaches, providing information on the quality and conservation condition of materials and structural elements. Because different materials, as well as defects such as cracks, internal voids, and delamination, respond differently to acoustic-wave propagation, these techniques can be used to assess material quality, detect heterogeneities and hidden damage, and evaluate the effectiveness of conservation treatments. Such methods generally involve transmitting acoustic or ultrasonic waves through the material and measuring their propagation velocity. Major approaches include acoustic transmission, acoustic tomography, acoustic reflection, and ultrasonic reflection (Moazen et al., 2022). Acoustic emission (AE) is another technique, used to detect and analyze elastic waves generated by the initiation and growth of microcracks (Manuello et al., 2024). Applications in heritage structures include AE monitoring of a stone column in the load-bearing section of the Temple of Athena in Syracuse, Sicily (Lacidogna et al., 2015); structural condition assessment of the historic Santa Maria delle Grazie complex (Di Gennaro et al., 2025); analysis of relationships between moisture, crystallized salts, and AE signal characteristics in wooden structures (Bertolin et al., 2020); monitoring the structural stability of an upper floor in a seventeenth-century building following a change of use (Carpinteri et al., 2007); and long-term ultrasonic monitoring of the historic city walls of Diyarbakır, Türkiye (Işık et al., 2020). The same principles can be extended to the investigation of concealed damage within the underlying layers of architectural ornamentation. Elements such as wall paintings, plaster ornamentation, brickwork, and tilework

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are typically multilayered, with only their outermost surfaces directly visible. Acoustic and ultrasonic testing can therefore assist in detecting subsurface deterioration, identifying concealed cracks and detachments, monitoring damage progression, and informing timely conservation and restoration interventions. Taken together, these applications demonstrate that contemporary acoustic methods can obtain information about the internal or layered condition of structures by analyzing their responses to acoustic or vibrational excitation. This general principle provides a basis for a cautious comparison with Nizami's account in *Haft Paykar*. However, the narrative contains no details concerning measurement, signal recording, or quantitative analysis and therefore cannot be regarded as equivalent to a modern non-destructive testing method.

Nizami's Account of Acoustic Breach Detection

The passage examined here, from the story of Bahrām's Tuesday sitting in the Red Dome and the tale told by the daughter of the king of the Fourth Clime in Nizami's *Haft Paykar*, is a notable example in classical Persian literature for examining the relationship between sound and the identification of a concealed structural feature from the perspectives of the history of technology and empirical knowledge. Unlike the predominantly metaphorical uses of "sound" and "echo" in Persian poetry, Nizami presents sound in this narrative as a practical means of addressing a structural problem. The narrative sequence suggests not merely the creation of a literary image, but a representation of empirical reasoning in which sound serves as a clue to a concealed feature within a structure. The verses directly relevant to the present study are presented below (Nizami, *Haft Paykar*, ed. Vahid Dastgerdi; English wording based on Wilson's(1924) translation):

> " ***When he arrived quite near a talisman, he made a stroke and (then) a gap appeared*** **(1)*****; Each talisman he saw upon the road,—he cast it headlong down into the pit*** **(2)*****; When he had (thus) removed them from the mount, he put their swords upon the mountain-peak*** **(3)*****; Then he went quickly to the castle wall, and beat a drum (there) with a leathern strap*** **(4)*****; He studied eagerly the sound (it made), having (in this) prepared a keen device*** **(5)*****; (For) since to crevices the sound was clue, the door by means of crevices was found*** **(6)*****; When she became aware of these events, the moon-faced beauty sent someone to say*** **(7)*****; You who make breaches and who open roads, you whom good fortune guides to his desire*** **(8)*****; Since you have loosened first the talismans, and (then) correctly found the treasure-door*** **(9)**".

The sequence of events in this passage is particularly significant. After reaching the fortress wall, the protagonist investigates the structure not through military force, excavation, or visual inspection, but by producing a sound stimulus. In the narrative, the *dohol* (drum) serves as the instrument for producing sound, and its use provides the immediate basis for searching for a breach around the rampart. The text, however, provides no information about the physical characteristics of the sound produced, such as its intensity, frequency, or penetration into the building material. Any detailed physical interpretation of the drum's acoustic properties would therefore go beyond the direct evidence of the text. Nevertheless, the use of a sound-producing instrument is broadly consistent with the general principle that acoustic waves interact with building materials. The next stage of the narrative is particularly important: "*He studied eagerly the sound (it made), having (in this) prepared a keen device*". In these lines, the verb "searched" in the Persian text is grammatically associated with "sound," rather than directly with the "breach." This distinction is semantically significant. The structure of the verse suggests that the object of investigation is not simply the breach itself; rather, the sound and its variation along the fortress wall constitute the central focus of the search. Sound therefore functions in the narrative as an intermediary through which information about the condition of the wall is obtained. In other words, sound becomes a diagnostic clue. The expression *"the sound was clue"* further clarifies this function. The preceding line indicates that a distinctive condition existed at a particular point along the rampart, and the following line associates this acoustic clue with the location of the breach. The text does not specify whether the difference resulted from a cavity, weakened material, separation between layers, or another type of discontinuity. What it does establish is a sequence in which sound is produced, its behavior around the wall is investigated, and the location of a concealed opening is inferred. The following verse makes this function explicit: in the Persian text, *"sound became the key to the breach"* (*sedā-ye rakhneh rā kelid āmad*), while Wilson renders the phrase as *"the sound was clue."* Sound is thus presented as a means of obtaining information that is not directly accessible through visual observation. Conceptually, this narrative bears a

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limited resemblance to the general logic of some non-destructive testing methods. In both cases, an otherwise inaccessible structural condition is inferred indirectly from a response to external stimulation. Contemporary impact and acoustic methods likewise use variations in resonance, return time, or spectral characteristics to identify features such as cavities, detachments, and voids (Qian et al., 2024). This correspondence should not, however, be taken as evidence that a non-destructive testing method in the modern sense was known or practiced in Nizami's period. The comparison is instead limited to a shared empirical logic: information about an unseen structural condition is inferred from an observable acoustic response. Another noteworthy feature of the passage is its degree of narrative realism. Unlike literary representations in which sound serves primarily to create an image or convey an abstract theme, this account establishes a direct sequence connecting the production of sound, the investigation of the area around the rampart, and the discovery of a concealed opening. This feature alone, however, is insufficient to establish an empirical or technical origin for the narrative. Historical evidence does indicate that craftsmen used tapping or impact to identify hollow or defective areas in walls, columns, and building materials, a principle that also survives in empirical and instrumental forms in the conservation of historic structures (Martinho & Dionísio, 2014; Ortega et al., 2023). From a literary perspective, these verses are also distinctive. A review of major works of classical Persian poetry shows that concepts such as the "call," "echo," and the "response of the mountain" occur frequently, but generally serve abstract, symbolic, or aesthetic purposes rather than describing a practical procedure for identifying physical features of the environment. In contrast, Nizami connects sound directly with the investigation of a concealed architectural feature. Sound therefore moves beyond a merely literary device and assumes a functional role in addressing a structural problem. This feature makes this passage from *Haft Paykar* a noteworthy literary representation of the functional use of sound in relation to an architectural structure. It may consequently be read not simply as a poetic description, but as a literary representation of empirical knowledge based on an observed relationship between acoustic behavior and the physical condition of a structure (Table 1). Although identifying this account as an engineering technology in the modern sense would require considerable methodological caution, its correspondence with established principles of acoustic testing and non-destructive assessment raises the possibility that Nizami incorporated practical knowledge associated with architectural or fortification traditions into his narrative. From this perspective, the verses constitute a significant point of intersection between Persian literature, the history of technology, and architectural knowledge in medieval Iran, particularly in relation to the use of sound to infer concealed structural features.

Table 1. The Use of Sound to Identify a Breach in Nizami's *Haft Paykar* and Its Relation to Modern Acoustics

Selected Verses	Interpretation of the Verses	Conceptual Similarity to Modern Acoustic Principles
Then he went quickly to the castle wall, and beat a drum (there) with a leathern strap	He immediately went to the gate of the fortress, prepared his drum with a leather strap, and beat it to produce a sound	The introduction of an acoustic stimulus through sound production. Similarly, modern acoustic diagnostic methods apply an external stimulus to a structure and analyze its response to assess its condition
He studied eagerly the sound (it made), having (in this) prepared a keen device	He followed and examined the sound around the rampart, and a distinct difference appeared at the point where a breach or discontinuity existed	The most significant conceptual similarity to modern acoustics appears in this verse: sound is produced, its behavior is investigated along the structure, and the acoustic responses of different points are compared, potentially through differences in echo or resonance. In impact testing, variations in resonance or echo can indicate discontinuities, voids, or detachments within a structure
(For) since to crevices the sound was clue, the door by means of crevices was found	When the sound revealed the location of the breach, the breach itself became a	In this passage, sound is used as an indirect diagnostic tool: the concealed

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	means of locating the entrance, and the concealed door was revealed	feature of the structure is not observed directly but is inferred from its acoustic response. This logic bears a conceptual resemblance to the general principle of acoustic non-destructive testing, in which structural discontinuities such as voids and delamination can be inferred from variations in acoustic or stress-wave responses

Conclusion

The findings indicate that the passage in Nizami Ganjavi's *Haft Paykar* should not be read merely as a poetic description of echo or sound reflection. Rather, it presents a functional use of sound to infer a concealed architectural feature. The verses establish a sequence of sound production, acoustic searching along the fortress wall, and the association between a distinctive sound and the discovery of a breach. This sequence suggests that sound functions as an intermediary for obtaining indirect information about structural condition. Although the text provides no details on the measurement, comparison, or quantification of the acoustic response, its underlying logic is conceptually consistent with principles employed in acoustic and non-destructive structural assessment. The passage should not therefore be regarded as evidence of modern engineering technology; rather, it may reflect a form of empirical knowledge potentially associated with architectural, fortification, or siege practices in medieval Iran. A comparative reading of major works of classical Persian literature further suggests that references to sound, echo, and returning calls are common, but are generally symbolic or literary rather than diagnostic. Nizami's account is distinctive in connecting sound directly with the investigation of a physical architectural feature. It may therefore represent a significant example for studying the functional use of sound in Persian literature. However, establishing its historical precedence requires systematic examination of a broader corpus of Persian prose and verse, as well as comparison with contemporary literary and technical traditions beyond the Persian context. From the perspective of the history of science and technology, the passage illustrates how empirical observations of sound and its relationship to the physical properties of materials and structures may have preceded the formal development of acoustic science. Its significance lies not in attributing modern technologies to the past, but in highlighting the role of accumulated experience, observation, and practical knowledge in the development of later scientific and engineering practices. More broadly, the findings demonstrate the potential of classical literary texts as sources for studying historical knowledge of technology, architecture, and material practices. Interdisciplinary research combining literary studies with the history of technology and science, archaeoacoustics, and heritage conservation may therefore reveal less documented dimensions of technological knowledge in historical Iran. Future research should examine additional Persian literary, historical, and technical sources to clarify the place of Nizami's account within the broader development of empirical knowledge concerning acoustic behavior and structural assessment.

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