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Expressive Form and Structure in Islamic Architecture: Al-Mustansiriya School as a Case Study

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ABSTRACT

Despite the visual and structural integration that characterizes Islamic architecture, reflecting religious and cultural values, the expressive relationship between form and structure has not yet been systematically studied in a comprehensive manner that reveals its symbolic, functional, and aesthetic dimensions. Hence, a research problem arose in the absence of a theoretical framework that interprets this relationship as a single unit that conveys meaning and embodies identity. Therefore, this is research aiming to analyze the expressive relationship between form and structure in Islamic architecture, using the Al-Mustansiriya School as a model to uncover the mechanisms that enable form and structure to work in tandem to produce an authentic aesthetic-symbolic discourse. The research hypothesis is based on the premise that architectural expressiveness in Islamic architecture arises from an inseparable integration between form and structure, such that aesthetic performance is linked to the effectiveness of the structural system. The research relied on the dual analytical approach between descriptive-theoretical and structural analysis using the ETABS program to evaluate the efficiency of the structural elements and their consistency with the architectural expression. The results concluded that Al-Mustansiriya School embodies an organic integration between beauty and structure, where structural elements, such as arches and walls, show both a functional and aesthetic role. Some elements were emptied of their structural function and transformed into symbolic.

Keywords: Islamic architecture, Structural expression, Abbasid architecture, Architectural symbolism, Structural analysis.

1. INTRODUCTION

Islamic architecture has always represented a cultural expression of a comprehensive intellectual, religious, and cultural system. Its characteristics have crystallized over the ages as a visual and structural discourse that carries within it symbols and connotations that transcend the functional dimension to encompass aesthetic, spiritual, and philosophical horizons **(Awaliyah, 2023)**. In this context, "expressionism" in Islamic architecture is not a fleeting aesthetic issue, but rather a product of a profound interaction between form and

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structure **(Fountain Magazine, 2024)**. The building manifests itself as a living entity that addresses the values of society and expresses its visions and aspirations. Therefore, expressiveness in architecture is a complex and multidimensional subject that combines aesthetics, philosophy, and function **(Al-Sabouni, 2020).** In the Abbasid context, architecture was distinguished by its ability to express religious, social, and political values through its formal and structural formations.

Many studies have addressed the topic of expressiveness and Islamic architecture. For example, **(Salam, 1990)** examined the architectural expressions of the Islamic religion and asserted that mosques represent symbolic centres of cultural and social identity. It also focused on their traditional elements, such as the minaret, dome, and mihrab, as architectural symbols that transcend time and space. **(Tonna, 1990)** analysed the formal structure of Islamic architecture, demonstrating that unity and rhythmic repetition in columns, arches, and decorations create pleasing and dynamic visual effects. She emphasized that the principle of similarity and radiant structure reflect centrality and unity, giving Islamic architecture a character of purity and contemplative serenity. The study **(Bonta, 1996)** demonstrated that expressionism in architecture is not merely a form, but rather a system of meanings and forms that conveys cultural and civilizational values through a multi-stage interpretive process. It argues that the gap between material reality (form) and civilizational reality (meaning) is bridged through semiotics, ensuring communication and continuity of meaning between the designer and the recipient. On the other hand, **(Al-Tamimi, 2012)** explained that architectural form is a product of the potential of the structural system, where expressiveness is embodied through performance, structural frankness, and tectonics. She proposed four patterns for perceiving expression (associative, physiological, objective, and personal), emphasizing that expression is a cognitive and emotional process. Related to the structural system. **(Al-Samarrai, 2022)** addressed the aesthetic characteristics of Abbasid architecture across four levels: form, construction, material, and functional and decorative elements. She concluded that beauty is achieved through harmony between parts, and that the ratio $\sqrt{2}$:1 was used in formations, as the material and structure reflect the building's identity and expressive power. **(Stein, 2025)** Expressionism in architecture, like its counterpart in painting, aimed to convey raw emotions and inner feelings through form and structure. This movement rejects the constraints of classical order and embraces dynamism and expressiveness. Buildings seek expressiveness and focus on the psychological impact of space, such as towering, angular forms, asymmetrical compositions, and the use of raw, often unfinished, materials such as concrete and exposed brick. This is clearly embodied in the Sydney Opera House building and the Guggenheim Museum Bilbao, shown in **Fig. 1.**

Figure 1. Expressionism in architecture: Right: Bilbao Museum, Left: Sydney Opera House **(Stein, 2025).**

To analyse previous studies in this context, it is obvious to claim that expressionism in Islamic architecture has been proposed at multiple levels, including religious and social symbols, the formal and rhythmic analysis of architectural elements, as well as the aesthetic and structural dimensions. However, most of these proposals remained general and did not address in depth the direct relationship between form and structure as an integrated system of expression.
Hence, this study seeks to bridge this gap by revealing how structural elements transform from functional tools into visual and cultural symbols that express civilizational and spiritual values. In this way, the research contributes to formulating a theoretical framework that describes the relationship between form and structure in Islamic architecture and clarifies the expressive mechanisms that give it its symbolic dimension and distinctive identity. Hence, the research questions related to the subject of this study arise: What is the nature of the relationship between form and structure in Islamic architecture, and how can it be theoretically described as an integrated system? What are the expressive mechanisms that transform structural elements from mere structural functions into elements carrying aesthetic and symbolic meaning? Following this, the study seeks to analyse this phenomenon within the philosophical, aesthetic, and structural framework through analysing the Abbasid architecture in Iraq, and showing the expressive relationship between form and structure in Islamic architecture, towards uncovering the mechanisms that enable a building to fulfil its role as a medium that carries meaning and embodies identity.

2. THEORETICAL FRAMEWORK

2.1 Structure Expression in Architecture

The structure is linguistically defined as a building, structure, or construction, or it refers to the human effort expended to accomplish it **(Al-Baalbaki, 2001).** The structure is also considered the essence of architecture and its fundamental component, as it makes the architectural product a standing figure against the external and internal forces affecting it, achieving stability and beauty. In other words, the structural framework chosen for the building achieves an aesthetic expression consisting of the designer's intention for the design, in addition to its structural function in constructing the building **(Holgate, 1986). Fig. 2** illustrates the expressive and aesthetic function of the installation in structure. The mechanical function is represented by the process of transferring loads and forces applied to the structure, ultimately revealing the shape of the structural framework. The symbolic and aesthetic aspects are also embodied in the architectural product through the building materials and the general form of the structure **(Hameed, 2018)**. At the same time, the structure is the system that achieves the building's balance and maintains its shape. Construction represents the physical aspect of design by arranging components to resist loads and transfer them to the ground **(Khuraibet, 2016).** In this context, **(Al-Khafaji, 1999)** also addressed in his proposals that the expressiveness of the structural framework is the basis for its work in giving architecture its expressiveness, considering that the aesthetics of architecture are formed through the distinctiveness and beauty of the structural elements that comprise the structural form**.**
In Islamic architecture, the structure is more than just a structural framework that bears loads; rather, it represents an expressive system that reflects the symbolic, aesthetic, and spiritual aspects of architecture. Through the use of specific materials and specific structural systems, Islamic architecture was able to transform the structure into an architectural language that expresses its values and doctrinal content **(Al-Sultani, 2006).** Later, **(Sharif et al., 2014)** emphasize that beauty in a structure is achieved through honest expression when

using natural materials, satisfying aesthetic and functional Aspects: The standard of a building's beauty is based on three basic points: shape, mass, and texture**.** Muslims used many structural elements such as domes, vaults, arches, muqarnas, columns, and capitals, all of which express the identity of Islamic architecture **Fig. 3**. This figure shows a dome structure in the Mosque of Cordoba, which expresses the identity of Islamic architecture. These elements can also be aesthetically pleasing decorative elements in themselves. Some architectural theorists have emphasized this, considering construction to be decoration. In Islamic architecture, surfaces have a visual impact that distinguishes buildings through their structural elements **(Darby and Owen, 1993).**

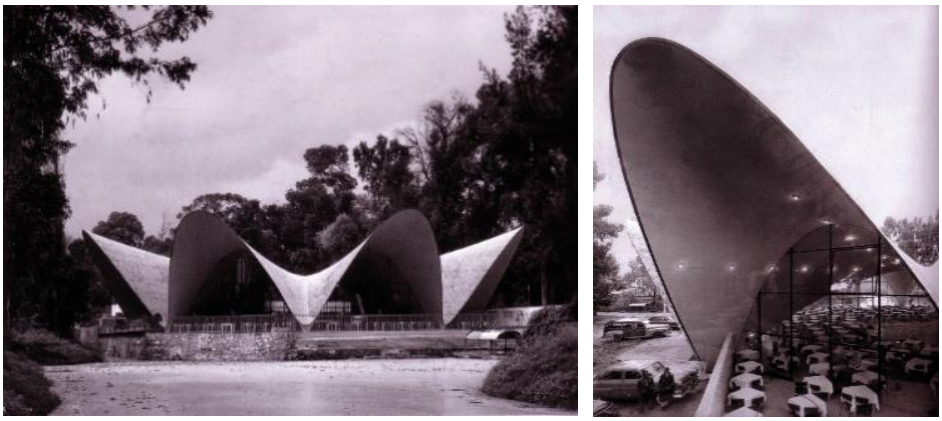


Figure 2. Structure and Non-Structural Elements **(Miller, 2014).**

Figure 3. The Dome in Front of the Mihrab in the Mosque of Cordoba **(Kaptan,2013).**

2.2 Form Expression in Islamic Architecture

Form is of great importance in architecture, as architecture begins with images and ideas, and these images and ideas need to be transformed and translated into a tangible physical form. This stage depends on the capabilities available to the architect and the constructional means. Physical form is the means of communication and information transfer from the architect to the recipient. This process depends on the intended idea to be communicated, the received idea, and the recipient's cultural background **(Hoshyar, 2003).** Form is perceived mentally through the senses, so shape includes several meanings, including

sensory meanings to distinguish the content of the structure and structural meanings to perceive the connection and proportion between its parts **(Khuraibet, 2015).**

In Islamic architecture, form refers to the visual and material aspects of an architectural structure, including geometric composition, decoration, and the relationships between mass and space **(Ching, 2007).** The creation of form in Islamic architecture is not merely the product of a structural equation, but rather a reflection of a symbolic world, where universal principles are transformed into geometric patterns that translate divine unity into architectural imagery." Islamic architecture is not merely an assemblage of forms, but a symbolic reproduction of the structure of the universe. Geometry here is a language, and the circle, square, and star are not incidental motifs, but rather references to universal principles. Every form expresses to the contemplator the unseen world and reflects divine unity, manifested in repetition, symmetry, and infinite extension **(Ardalan and Laleh 1973).** As for its expressiveness, **(Tharwat, 1994)** pointed out that the language of form in Islamic architecture relies on principles of balance that combine simplicity and complexity to represent the most important characteristic of its buildings. For example, the entrances of mosques usually have a symbolic meaning, as they represent the dividing line between the interior and the exterior, between the non-sacred and the sacred. Similarly, the entrance is usually in a low, not prominent shape, and its height and verticality symbolize the aspiration toward the sanctity of the sky. Form in Islamic architecture carry values of diversity and difference, while maintaining a harmonious unification of these shapes through the stability of certain relationships and other variable ones, as in the columns used in the Mosque of Cordoba, which contribute to creating a regular, repetitive visual rhythm within the space, in addition to their structural function **(Tonna, 1990)**, as illustrated in **Fig. 4.**

Figure 4. Columns in the Mosque of Cordoba **(Llorente, 2025).**

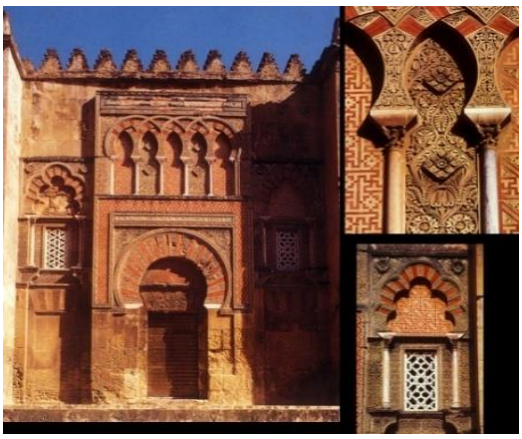
Therefore, the form is a visual material representation resulting from the interaction of a set of social and technological requirements to establish a perceivable material. The architectural form was never the apparent structure, but rather the distinct perceivable structure **(Shaheen et al., 2014).**

The research thus concludes that the expressiveness of form and structure in Islamic architecture reflects the integration of aesthetic, structural, and spiritual aspects. Form is not viewed as a structure independent of the structural system, but rather as a dynamic component that embodies intellectual and religious values. Islamic architecture has developed a rich architectural system based on formal and structural qualities that interact

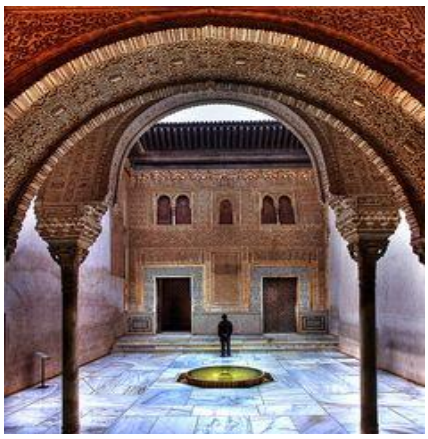
with materials, light, and symbolism to produce spaces that express sublimity, unity, and balance.

2.3 Islamic Architecture Expressionism

Islamic architecture is one of the most distinctive architectural styles, reflecting the spiritual and cultural values of Islamic societies throughout the ages. This architecture is characterized by its deep connection to the elements of form and structure, with each element contributing to the creation of an architectural identity that expresses spiritual, aesthetic, and technical dimensions **(Al-Sayegh, 2024)**. Islamic architecture is presented as a comprehensive cultural product, shaped by a complex interaction between religious, social, political, economic, and environmental factors. It is not merely a stylistic or aesthetic tradition but rather reflects the identity of a Muslim nation. Islamic architecture is highlighted as a means of communication between humanity, religion, and the environment in a balanced and cohesive manner **(Tribak and Klaina, 2025).** These elements, which constitute the final form of Islamic architecture, possess aesthetic and functional value. Muslim architects did not limit their buildings to the functional and structural aspects alone, but rather considered the aesthetic and expressive aspects, ensuring that these buildings possessed a formal and aesthetic value that served as a source of visual attraction and communication across the ages **(Al-Dabbaj and Al-Ubaidi, 2018).** Islamic architecture has characteristics that reflect its expression, which are unity and diversity, balance, functionality and aesthetics, simplicity and abstraction, symmetry, and the human scale, as in **Fig. 5**. These characteristics reflect the identity of Islamic architecture.



A: Unity and diversity **(Llorente, 2025)**



B: Symmetry in Islamic architecture **(Bhat, 2025)**

Figure 5. Expressive Characteristics in Islamic Architecture.

On the other hand, the Islamic architecture is distinguished by its precise geometric and mathematical sense, as the Muslim architect combines imagination and feeling with a homogeneous geometry, producing a form that gives two realities: one is material that people can understand, and the other is its metaphysical concept that give it a visible form which can be perceive **(Ghaleb, 1988)**. Linking ideas with geometric and mathematical aspects contributes to the creativity of forms, which cannot be produced without the presence of the capabilities of the geometric and mathematical sense of aesthetic and

harmony. Islamic architecture is a symbolic architecture in addition to its physical reality **(Al-Maliki, 1996).** The formal treatments of the structure were designed to align with the formative and expressive objectives that were intended to be left in the mind of the recipient of the building's architectural form. Thus, a harmonious connection was achieved between beauty and construction, and the boundaries between construction and form were dissolved. Construction in Islamic architecture became an integrated whole, with its proportions, dimensions, and the sequence, distribution, and dimensions of its elements, in conjunction with the architectural form and its expressive objectives **(Al-Khafaji and Al-Klidar,2015).**

Form in Islamic architecture is embodied in repetitive geometric shapes such as domes and arches and expresses symbolic and spiritual values in addition to its structural function. The structure, however, is not merely a structural system, but rather an expressive language that embodies beauty and balance through materials and elements such as domes and muqarnas. These elements complement each other to form a unified Islamic architecture that combines aesthetic, symbolic, and functional dimensions within a framework that reflects spiritual and cultural identity. Accordingly, what is stated in the theoretical framework can be summarized in the following diagram, **Fig. 6.**

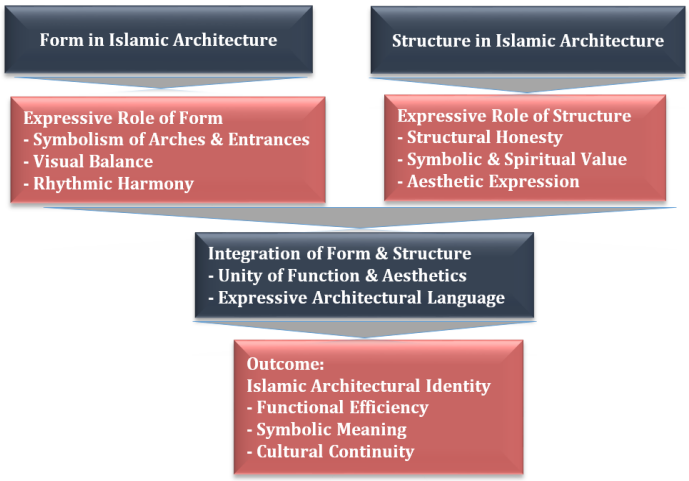


Figure 6. Summary of the theoretical framework of expressionism, form, and structure in Islamic architecture.

3. THE PRACTICAL SIDE

The experimental computer-based aspect addresses structural analysis using ETABS software, which was used to analyze the structural systems in one of the tested buildings, Al-Mustansiriya School. The aim was to verify its structural logic and evaluate the structural performance of the structure and the extent to which it expresses the intended meanings. This digital analysis was employed as a supporting tool for qualitative analysis, revealing the relationship between structural strength and architectural expression. The structural performance of the building was tested, and the logic of load distribution and force paths was determined, linking this to the expressive effect resulting from the structure. This methodology represents a flexible and comprehensive measuring tool, enabling the evaluation of Islamic architecture from an expressive perspective that transcends the traditional division between aesthetics and functionality, seeking to understand architecture as an integrated structural-symbolic discourse.

It is worth noting that the spatial boundaries of this experimental aspect were limited to the city of Baghdad, represented by one of its most important architectural landmarks, the historic building of Al-Mustansiriya School. The temporal boundaries were the Abbasid era (seventh century AH / thirteenth century AD), the period during which the school was constructed, reflecting its intellectual, aesthetic, and structural characteristics within that historical context.

3.1 Al-Mustansiriya School Building in Baghdad (625-631)

Al-Mustansiriya School was chosen as a model for the analytical study due to its authenticity and richness in formal and structural details. The Mustansiriya School is considered one of the most prominent architectural landmarks of Abbasid architecture in Iraq. It was built by the Abbasid Caliph Al-Mustansir Billah to teach the four schools of Islamic jurisprudence (madhhabs). It is considered the first Arab university to combine the four Islamic schools: Hanafi, Shafi'i, Hanbali, and Maliki, in a single building **(Bahnasi, 1998)**. Al-Mustansiriya School is located on the eastern bank of the Tigris River and extends over a distance of 105 meters. Its width on the northern side is 44.20 meters, while on the southern side it is 48.80 meters. The courtyard measures 48.80 x 27.40 meters. The most prominent architectural feature of Al-Mustansiriya School building is the extension of the iwan in the middle of its interior facade over two floors surrounding the building. This emphasizes the importance of the central space in illuminating such a large building, which was used for study and learning. Then comes the open space, i.e., the covered open corridor, then the rooms or halls that contain the facilities for housing, studying, and reading **(Al-Maliki, 2002)**.
Architecturally, the building's architectural style is characterized by an Islamic style, with the interior facades adorned with pointed arches, sunken facades, arcades, and elevated entrances. These include mihrabs, skylights, and inscriptions embroidering the building's walls. In addition to the aesthetic architectural elements, Islamic decorative elements are evident in the carved inscriptions and inscriptions, which can be seen in the building's design. Pointed arches are widely used, with emphasis placed on this type of arch, the quadrilateral arch. The school was built from the well-known yellow brick, and its facade, corners, interior walls, and cornices were decorated with delicate Islamic inscriptions typical of that era, clearly conferring its Abbasid identity. These inscriptions and decorations are extremely precise and beautiful, varying between geometric and structural motifs. These inscriptions extend widely across all corners of the building, both internally and externally, and are engraved on the brick **(Al-Samarrai, 2022).**

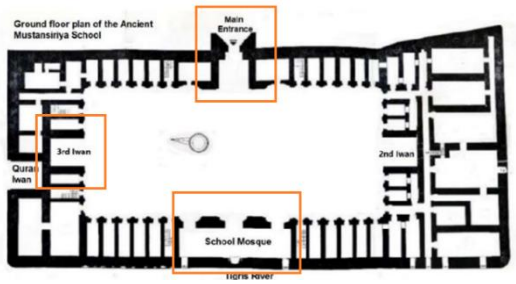
3.2 Structural Evaluation of the Case Study Building Using ETABS

ETABS (which will be used in the practical aspect of this study) was developed by Computers and Structures, Inc. (CSI), an American company specializing in the development of engineering software for structural analysis and design. It is headquartered in Berkeley, California, USA, and is one of the most important software companies specializing in the field of structural analysis and design of buildings. It provides an integrated environment for 3D digital modelling of structural elements (walls, columns, arches, basements, etc.). The software enables the calculation of loads, force transmission paths, and deformations with high accuracy, making it an essential tool for evaluating the efficiency of structural systems and linking them to the architectural and expressive performance of a building **(CSI America, 2025).**

3.2.1 Visual Verification and Reality Check

During the field visit to Al-Mustansiriya School building, which was documented by the researcher, the architectural details of the building and the relationships between these details were examined, including the interconnected structural elements that form geometric shapes such as arches, vaults, and other details. The purpose of examining the actual condition of the building was to directly observe the building in all its details, as well as to identify any damage or cracks, if any, which indicate the transfer of load stresses from large spaces to the side supports and load-bearing walls. Some of the most critical spaces were investigated, as they are the most dangerous and most susceptible to deterioration in the event of excessive vertical loads (weights of building materials and users) or lateral loads (earthquakes and winds).

Another purpose of the visit was to document the building by measuring the dimensions and heights of the spaces, in addition to the types of arches present and the distances they cover, the dimensions of the retaining walls, and the relationships between the arches. Some gates are bridged by more than one arch. This measurement aims to study the expressiveness of form and structure in this building as a model of the Abbasid architecture (the focus era of this study). By measuring all the building details and documenting them with pictures and taking measurements with a laser and manual scale and then drawing all the details with AutoCAD and exporting them to ETABS, it was noticed that some of the porticoes, namely the eastern one, the main entrance and the main portico, are the most critical among all the porticoes in the building, and that most of them are repeated, as shown in **Fig. 7**. The critical areas in the building mentioned above were measured and all the details were drawn accurately, as shown in **Fig. 8**. for the purpose of preparing the building plans for structural analysis using the above-mentioned structural program.



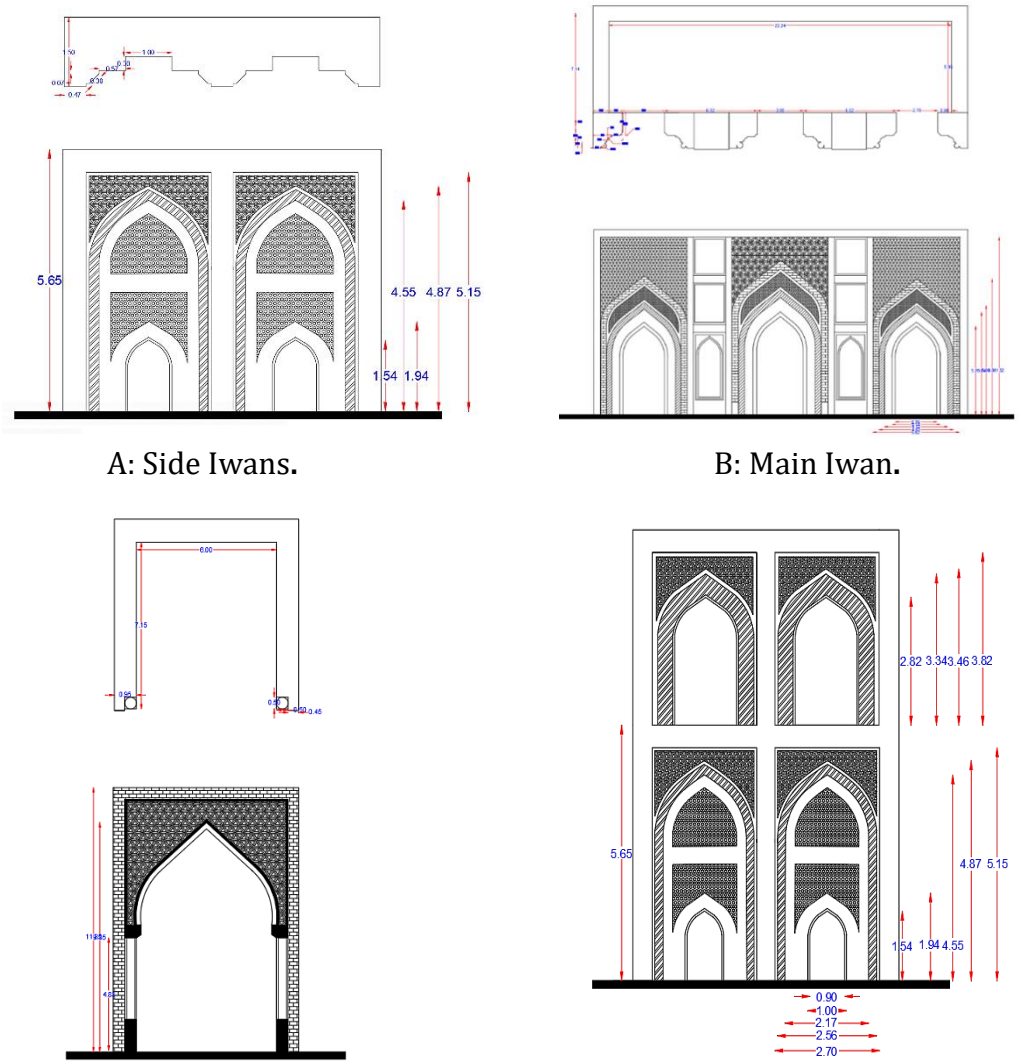
A: Al-Mustansiriya School Plan **(Katana, 2012)**

B: The main iwan in Al-Mustansiriya.

C: Main entrance Iwan

D: Eastern Iwan

Figure 7. The Iwans that were Measured and Studied Structurally**.**



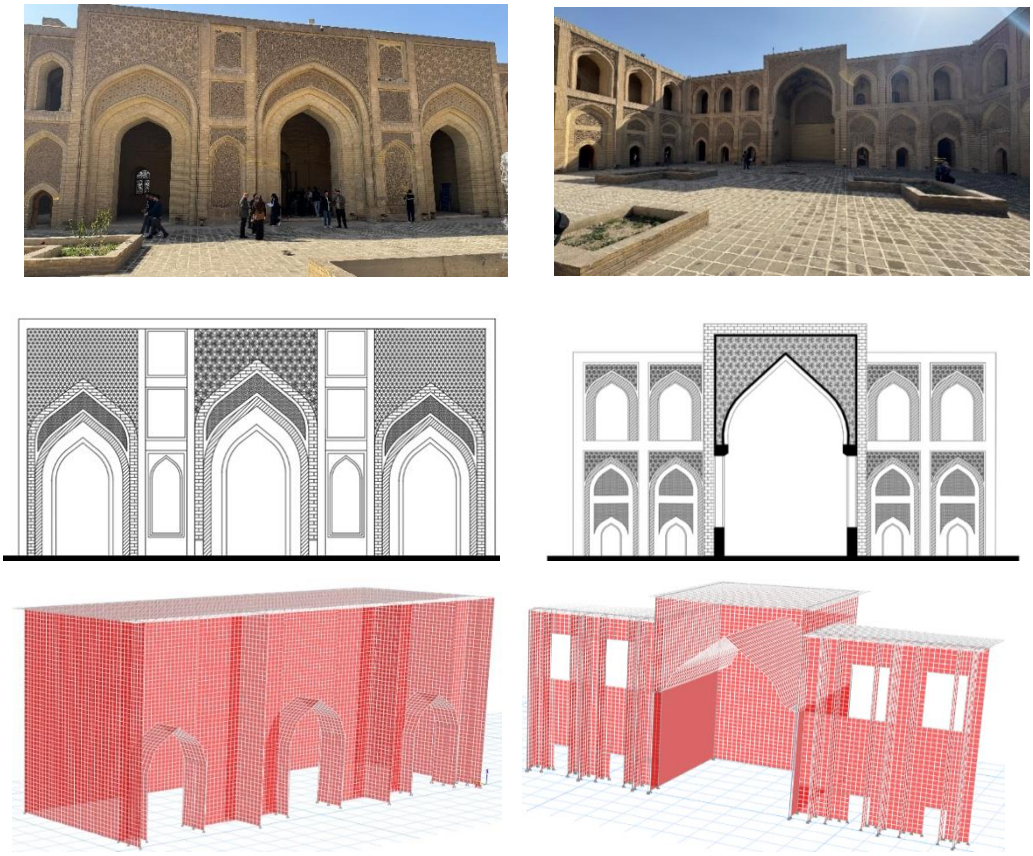
A: Side Iwans. B: Main Iwan.

C: Eastern Iwan.

Figure 8. The arches that were measured and Redrawn as a Reality.

3.2.2 Modelling and Simulation of the Building Structural Elements

As previously mentioned, ETABS has the capability and capacity to model historical buildings constructed using brick, plaster, or stone. The software adequately describes the geometry and morphology of the actual building, including the structural form, joints, and interconnections between structural elements, in addition to the distribution of masses and applied forces. The results obtained from the linear structural analysis included the mechanical reactions of the structural elements modelled in the software, namely deformations, stresses, and forces. The modelling and simulation process in the software focused on the arcades and the way the arches represent the openings within them. The brick walls and columns supporting these arches, and the roofing in general, refer to **Fig. 9.** This figure shows the structural model for two examples of the details found in Al-Mustansiriya School, namely the main arcade and the eastern arcade, where arches are the most challenging and critical element, from a structural point of view.



A: Main Iwan. B: Eastern Iwan.

Figure 9. Structural model of two models of the iwans in the Mustansiriya School (A) the main iwan and (B) the eastern iwan.

The material specifications used in the structural modelling are masonry, as it is isotropic (i.e., the behavior of the material is equal in all directions (directional symmetry). The arch in the eastern iwan was represented using the Shell-Thin element, which is used in modelling walls and panels. It is thin and flexible and can resist external and internal forces in the plane, including bending and shearing. It has a thickness of 500 mm to be supported on both sides with simple support on a circular column with a diameter of 500 mm. It is made of brick construction materials using the Frame Element with a stiffness modification factor of 0.75 based on the American ACI code **(American Concrete Institute, 2019)**. The arch in the main iwan was divided into equal segments to represent the arch due to the difficulty of modelling arches in general. Each of these segments was subjected to loads represented by a live load of 1 Newton per mm and a dead load representing the weight of the ceiling applied to the arch, in addition to the weight of the bricks that form the formal arches (non-load-bearing) above the main arch (load-bearing).

4. STRUCTURAL ANALYSIS RESULTS

After modeling the structural elements in terms of geometric shape and mechanical specifications, and applying all types of vertical loads, a structural analysis of the building was conducted using ETABS. The results were discussed in the following sections.

4.1 Building Distortion

The distortions occurring in the building, especially in the arches in the main iwan, are considered very minor compared to spaces spanned by the arch with a span greater than 3 meters, referring to **Fig. 10.** The figure shows the largest vertical deviation in the largest arch (the central portal), where the deviation varies by 1 mm on the sides of the arch, meaning horizontal distortion, as well as vertical distortion at the apex of the arch, ranging between 0.78-0.42 mm. The deviation in the arches in the side portals of the main iwan portion is reduced by 40%. As for the eastern iwan, the largest distortion ranges between 0.66-0.72 mm over a span of 6 meters. This deviation exists at the top of the arch because it is the largest part of the structure that is free without support, and the height of the brick wall (decorated) above it rests on the arch itself, compared to the back part of the arch, which is supported by a brick wall with a thickness exceeding 2 m.

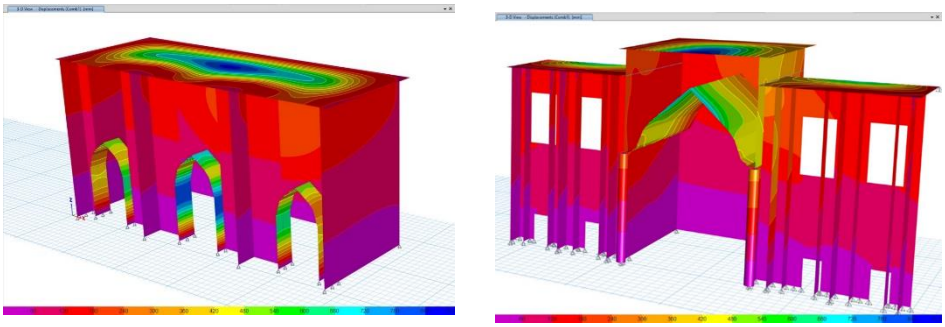


Figure 10. Structural Deviations Resulting from the Structural Elements of the Iwans, based on ETABS software**.**

It is worth noting that the brick column that supports part of the arch deviates by a very small amount, ranging between 0.18-0.3 mm. This result indicates that the column in this iwan has a formal function rather than a structural one, as the largest part of the arch is supported by the relatively thick brick walls, and the arch in the facade transfers a load to the inner shell and the column as shown in **Fig. 11.** The column was removed from the structural model, and it was noted that the deformation value in the arch or the shell in the eastern iwan did not change, as the largest deformation still ranged between 0.66-0.72 mm. **Fig. 12.** shows the joints between the structural elements that make up the iwans.

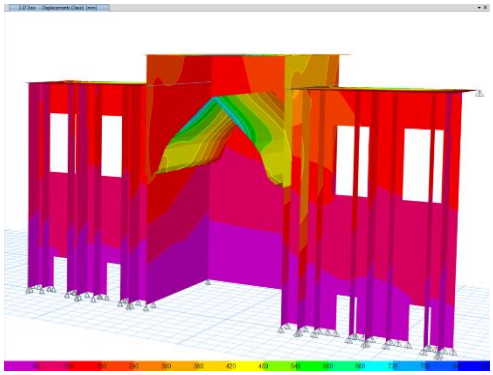


Figure 11. The Structural Deviations Resulting from the Structural Elements of the Iwans from the ETABS Program after Raising the Column in the Façade of the Eastern Iwan**.**

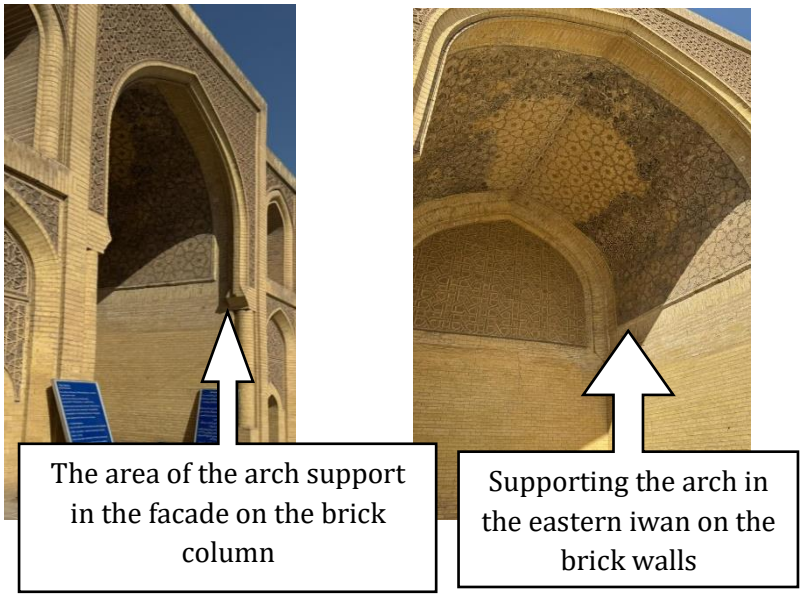


Figure 12. The Joints Between the Structural Elements that make up the Iwans, where the Brick Walls support the Largest Part of the Arch**.**

The results of the numerical analysis indicate that the main structural arches of the iwan, despite their relatively large horizontal span, exhibited only very minor distortions at both sides and the apex of the curvature. For example, the distortion in the largest arch (the central portal) amounted to a vertical deviation of no more than 0.78 mm, with a decrease of up to 40% in the side portals. The eastern iwan exhibited a similar distortion of no more than 0.72 mm over a span of 6 meters, a clear indication of the high structural efficiency of the brick arch system. In this context, the following findings were spotted:
1. Limited deformities ≠ and structural weaknesses, but rather expressive stability because they are within acceptable limits. The low deflection of these arches highlights not only the robustness of the arch system but also the Abbasid designer's desire to visually convey stability. The arch was not merely a load-carrying element, but also a symbol of balance and majesty, embodied by the "silence of movement" at its apex.

2. Asymmetry in distortions = revealing the meaning behind the formation. The variation in the deflection values between the arches of the central and side portals, and their association with the support pattern (the presence or absence of a brick wall behind the arch), indicates that the Abbasids were aware of the delicate balance between the support and the carried object. The arch bearing the decorations deals with a large decorative mass without rear support, which adds an expressive dimension to the function, and makes the deformation itself a visual indicator of the relationship between weight and balance.

3. Function and decoration elaborate superstructure. The decorative wall supported by the arch is not an auxiliary structural element, but rather a precisely directed expressive burden. Its function is not merely aesthetic, but rather structural complexity (assigning a structural element (such as the arch) a function greater than simply transferring loads). The arch carries a greater meaning than its function; that is, it is used to emphasize the structure's load-bearing capacity and amplify the visual language of the architectural opening.

4. Load-bearing wall thickness as a tectonic factor. The wall background supporting the arch on one side, with a thickness exceeding 2 meters, is not only read as a supporting material, but is also understood as part of an integrated tectonic system that connects form to structure, reinforcing the "message of weight" as opposed to the "open void".

Summary of Architectural Expressionism: The limited distortions revealed by the simulation in this section, despite the decoration and the large spaces, reflect a precise correspondence between architectural form and structure, where there is no gap between beauty and stability, but rather a fusion that achieves maximum expressiveness. Each arch is not merely a load-bearing element, but rather a meeting point between strength and meaning, between physical response and symbolic significance. Thus, the analysis results not only confirm the validity of the structure but also reveal a hidden design intent, expressing a wise architectural presence, aware of the profound relationship between form and structure as an expressive language no less important than decorative language.

4.2 Building Shear Stresses

This was represented by the vertical force applied to the structural sections in the arches. It is noted in the structural analysis results that the value of shear stresses is at its lowest value, despite the loads being concentrated on the segments forming the arch model; its value is low compared to the structural section of the arches and walls. **Fig. 13.** shows the values of shear stresses applied to the arches and walls in the main iwan, where the stress values in the structural arch are similar to the entire building, despite the loads of the decorative arches supported on it. Therefore, it can be said that the arches represent a shape and not a structural element, since the structural element is not affected by the value of the shear applied to it. In the eastern iwan, most of the arched shell also has the lowest shear stress value, except for the areas where the arch is supported on the walls. There is a high concentration of shear stress, and the brick column is not affected by any shear stress. The reason for this is that the arched shell is completely supported on the brick wall, which leads to a very small percentage of stress being transferred to the column, and its effect is almost non-existent.

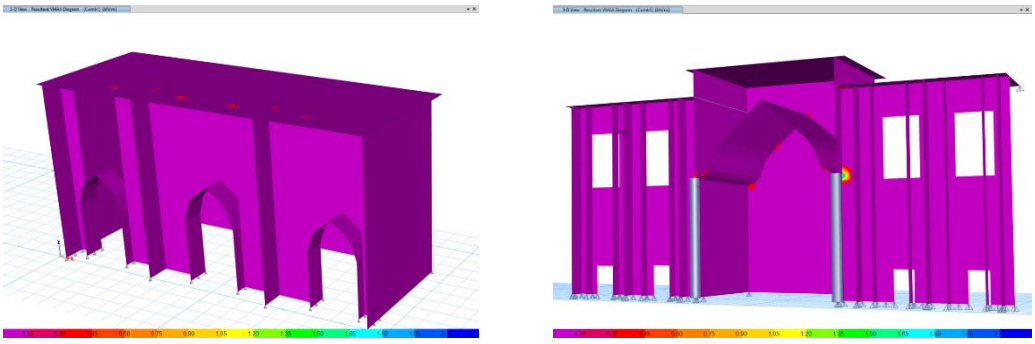


Figure 13. Shear Stresses Resulting in the Structural Elements of the Iwans, based on the ETABS software**.**

The analysis results indicate that the shear stresses in the Iwan elements, particularly the arches and walls, were very low, even when the loads were concentrated on the segments forming these elements. This opens an important door for interpreting these results architecturally, as follows:

1. The arch is an expressive form rather than a direct structural element. Although the arch appears to be a load-bearing element in the overall composition, the minimal shear stresses within it—even when loaded with decorative elements—indicate that the arch here serves a formal-symbolic function rather than an effective structural element . Architecturally: This reflects one of the most important principles of expressive tectonics, where traditional elements with a strong visual language—such as arches—are used to visually express the structure, even if they do not actually transmit the loads. The arch here is not a load-bearing element, but rather a symbol of load and stability.

2. Absence of shear ≠, absence of function, but rather the presence of an implicit design intention. The fact that shear forces are not transferred to the brick columns, despite their location at the support areas, means that the brick wall bears the majority of the structural loads, while the columns are freed from their structural role in Favor of a visual or symbolic function. Architecturally, this demonstrates an advanced level of "tectonic organization" in the composition, where structural and aesthetic roles are consciously distributed among the elements, sometimes separating form and structure for the sake of expression

3. Shear stress is concentrated only at the support points. The highest shear stress occurred at the point where the arch meets the wall. This is expected, but it also demonstrates that the arch is treated as a structural shell supported entirely by a solid wall and does not have a structurally distributed function across its entire length or span .Architecturally, this phenomenon leads us to understand how Abbasid architecture treated walls as load-bearing vessels that embrace and display the arched form. The wall thus serves as a support that enables the visual expression of the arch without requiring it to perform a heavy structural function.

4. Distribution of expressive function between form and structure. The results clearly indicate that some of the arch elements (especially the decorative ones) in some places are merely formal covers that do not perform a direct structural function, but are supported by another, invisible structure (the thick wall). This separation between form and structure is not a weakness, but rather a conscious design choice aimed at amplifying the visual and expressive impact of the elements without disrupting the structural balance.

Conclusion of Architectural Expressionism: The low shear stresses in the arch, and their concentration in specific areas, indicate the liberation of architectural elements from their complete dependence on structural function and demonstrate the conscious use of structure as a tool of expression. In Abbasid architecture, the load limits do not always coincide with the limits of form; rather, a new distribution of function and expression occurs, enriching the architectural language of the building.

4.3 Building Bending Moments

The structural elements of the arcades were also estimated using the ETABS software. **Fig. 14.** shows the distribution of negative and positive moments on the walls and arches. In the main arcade, the structural arch that carries the non-structural arches is exposed to positive moments because the arch bends downwards. On the other hand, the load-bearing walls of the arch are exposed to negative and positive moments simultaneously because they bend outwards. The moment value in the arch ranges between 0-30 kN-m, which is the lowest

value for the moment resulting from loading. The moments in the load-bearing walls are higher and range between 30-90 kN-m, in addition to negative moments that do not exceed -30 kN-m. In general, most of the structural elements in the main arcade are exposed to relatively small moments ranging between 30 and -30 kN-m. In the eastern iwan, the arched shell also bears positive and negative moments, and these moments are among the lowest values of moments, and they also range between 30 to -30 kN-m, except for the area where the arched shell meets the walls, which is an area of moment concentration, where the moment ranges between 30 and 90 kN-m. On the other hand, the brick column in eastern iwan was not exposed to effective moments, as in **Fig. 14.** The structural analysis proves that the column here is for form only and not structural. **Fig. 15.** proves that the moment values do not change in the eastern iwan building, especially in the arched shell, which rests mainly on the load-bearing brick walls, without involving the column in a high-value moment. In the architectural interpretation of Bending Moments, the following results were obtained:

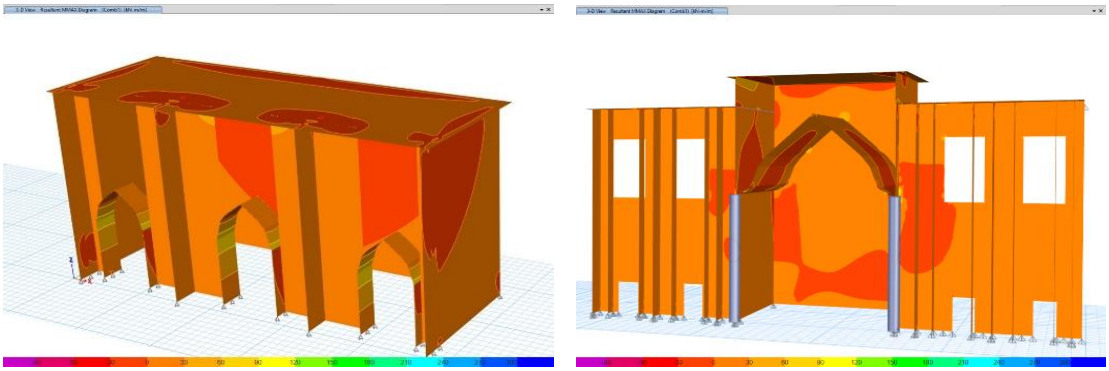


Figure 14. The Resulting Bending Moments in the Structural Elements of the Iwans from the ETABS software**.**

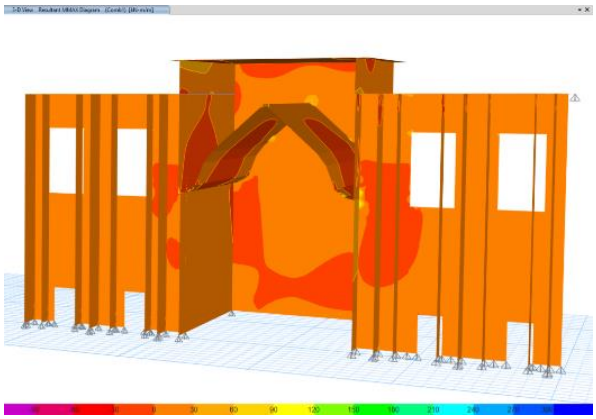


Figure 15. Bending Moments Resulting from the Structural Elements of the Iwans from the ETABS Program after Raising the Column in the Facade of Eastern Iwan.

1. Arched Elements with Low Curvature. The ETABS results showed that the load-bearing structural arch in the main iwan experiences low positive moments ranging from 0–30 kN/m due to its downward bending under overhead loads. Although this arch carries non-structural, formal arches, the moment value remains limited. This indicates that the arch was not designed to carry a heavy structural load, but rather to visually express

"load-bearing force." In other words, the intended expression of equilibrium is the intended meaning, not necessarily achieved through the arch itself.

2. Walls as True and Compensatory Load-bearing Systems. In contrast, the load-bearing walls exhibited higher moments ranging from 30–90 kN/m (positive and negative), reflecting their pivotal structural function in absorbing loads and achieving equilibrium. The negative moments in the wall also indicate an opposite (outward) curvature, meaning that the wall is simultaneously experiencing tensile and compressive stresses. Architecturally, this reveals a clever tectonic arrangement, as visual elements (such as the arch or column) are freed from structural load, while the solid walls bear that load without revealing themselves formally.
3. The column as a form, not as a structure. Analysis indicates that the brick column in the eastern iwan was not subjected to significant moments; rather, the arched shell rested primarily on the brick walls. This architectural result is very important, as the column here serves only a formal-symbolic function. That is, it is an expressive element called upon to complete the balanced architectural image, not to be part of the load-bearing structural system. This clearly embodies the concept of "form mimicking structure without being structure".

5. RESULTS AND DISCUSSION

An analysis of Al-Mustansiriya School reveals that its structural elements transcend their functional role, transforming them into expressive tools carrying symbolic and cultural connotations. A study of the arches revealed that they function not only as load-bearing elements but also represent a visual metaphor for stability and continuity, reflecting Abbasid architecture's pursuit of consolidating the values of intellectual and spiritual permanence. As for the columns, although some were relatively free of structural necessity, they performed a symbolic function as rhythmic elements that organize space and direct perception, embodying the values of order and unity.

Digital modelling also revealed that some architectural elements, such as columns and secondary arches, were freed from their direct structural function to perform a symbolic and aesthetic role, organizing space and highlighting the building's internal visual rhythm, while the thick walls bear most of the loads and distribute forces. The analysis confirmed that shear stress values in the arches are very low, reflecting that their primary function was not structural but rather symbolic, while these stresses were concentrated in the load-bearing walls, which bear the greatest structural burden.

Regarding bending moments, it was found that most of the arches did not experience high moments, while the walls exhibited higher moments ranging from 30–90 kN · m, which indicates that the columns were more of a formal element than a structural element, as the moment distribution was not affected when they were removed from the digital model.

Together, these results reveal a conscious integration between form and structure, where structural performance was employed in a symbolic manner that serves the architectural expression of stability and solidity, making Al-Mustansiriya School a comprehensive model that unites physical strength with cultural and spiritual meanings in a single architectural space.

The results of this study reveal a profound interaction between tectonic expression and aesthetic identity in Islamic architecture, beyond what previous studies have proposed. First **(Salam, 1990)** focused on the symbolic dimension of architectural elements such as the dome and the minaret; this research expands the scope of this discussion by analyzing their

structural role within the tectonic framework. Furthermore, the rhythmic repetition in arches and decorations, highlighted by **(Tona, 1990)** as a source of dynamic expression, is re-employed in this study within a context that integrates the aesthetic dimension with structural logic, revealing a deeper interaction between the authenticity of the material and its expressive presence. In contrast to **(Bonta's, 1996)** conception of expressiveness as a semiotic process linking form and meaning, this research offers an analytical reading that combines the structural and aesthetic dimensions, based on the model of Abbasid architecture, and establishes a contemporary methodology that links the authenticity of heritage with the prospects of contemporary innovation. This highlights the novelty of the study and its importance in enriching architectural literature by presenting an integrated analytical framework that can be employed in modern design practices to enhance the integration of authenticity with modernity.

6. CONCLUSIONS

Following the practical study presented and the results outcome, the following conclusions are derived:

1. The research demonstrated that the aesthetics of Abbasid architecture were not merely the product of decoration or formal additions but rather relied on a precise internal structural system that enabled a balance between mass and space, enhancing the building's expressive dimension.
2. The results of the digital analysis (ETABS) revealed that some elements, such as arches and structural decorations, did not perform a direct structural function. Rather, they were used as symbolic and visual elements that reinforced the discourse of stability and prestige, while the load-bearing walls played the primary role of transferring loads.
3. The study showed that deviations and distortions in the structural elements—especially the arches—were extremely limited, reflecting the efficiency of the brick construction system and highlighting that structural stability itself was a tool for expressing stability and permanence in Abbasid architecture.
4. The results revealed a conscious distribution of roles between structural and symbolic elements. While walls and vaults provided structural stability, arches, columns, and decorations conferred symbolic-visual value, producing a comprehensive architectural discourse that combined construction and expression.
5. The study confirmed that digital analysis (ETABS) represents an effective tool for reading Islamic architecture from an expressive perspective, demonstrating how structural performance can transform into a symbolic language that contributes to the formulation of an architectural identity rooted in culture and spirit.
6. What this study reveals is not limited to characterizing the Mustansiriya School as a model of Abbasid architecture but rather provides scientific evidence that the structure itself has transformed into a tool for architectural expression, such that it is no longer possible to separate structural performance from symbolic meaning. Thus, the use of digital analysis (ETABS) not only demonstrates the efficiency of structural elements but also opens a new horizon for reading Islamic architecture as a structural-symbolic text, through which buildings are understood as an integrated civilizational discourse that combines physical stability with a cultural and spiritual message.

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Author Contributions Statement

Athba Turki Khalaf: developing research ideas, collecting and analyzing comprehensive data, drafting the initial version of the thesis, and revising it based on reviewers' comments. Fawzia Irhayyim Hussein: supervision guided the theoretical and methodological frameworks, ensured academic rigor, and conducted a critical review and comprehensive revision of the thesis. Ahmed Khader Abdul Redha: Provided specialized expertise in structural analysis, contributed technical insights, and conducted a critical review of Arhim the structural and engineering components of the research.

Declaration of Conflict of Interest

The authors declare that they have no financial interests or personal relationships that may have influenced the work presented in this paper.

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تعبيرية الشكل والمنشأ في العمارة الإسلامية – المدرسة المستنصرية إنموذجاً

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الخلاصة

رغم ما تتميز به العمارة الإسلامية من تكامل بصري وإنشائي يعكس مفاهيم دينية وثقافية عميقة، إلا أن العلاقة التعبيرية بين الشكل والمنشأ لم تُدرس بصورة متكاملة تجمع بين أبعادها الرمزية والوظيفية والجمالية. ومن هنا، نشأت مشكلة البحث في غياب إطار نظري يفسر هذه وحدة متكاملة تنتج دلالات معمارية متجذّرة في القيم الثقافية والدينية. يهدف هذا البحث إلى تحليل العلاقة التعبيرية بين الشكل والبنية في العمارة الإسلامية، متخذًا المدرسة المستنصرية نموذجًا للكشف عن الآليات التي تُمكّن الشكل والبنية من العمل معًا لإنتاج خطاب جمالي رمزي أصيل. ترتكز فرضية البحث على أن التعبيرية المعمارية في العمارة الإسلامية تنبع من تكامل لا ينفصل بين الشكل والبنية، بحيث يرتبط الأداء الجمالي بفعالية النظام الإنشائي. اعتمد البحث على المنهج التحليلي المزدوج بين التحليل الوصفي النظري والتحليل الإنشائي باستخدام برنامج ETABS لتقييم كفاءة العناصر الإنشائية واتساقها مع التعبير المعماري. خلصت النتائج إلى أن المدرسة المستنصرية تُجسّد تكاملاً عضوياً بين الجمال والبنية، حيث تُظهر العناصر الإنشائية، كالأقواس والجدران، دوراً وظيفياً وجمالياً. وقد فُرغت بعض العناصر من وظيفتها الإنشائية وحُوّلت إلى عناصر رمزية.

الكلمات المفتاحية: العمارة الإسلامية، التعبير الانشائي، العمارة العباسية، الرمزية المعمارية، التحليل الانشائي