

# The Rehabilitation of Palmyra's Tomb and its Funerary Rites (Case Study of the Tower Tombs)

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## Abstract

The main factor influencing the proposed intervention framework for the Palmyrene burial towers is the architectural, historical, and symbolic identity of these monuments, which has been studied through a comparative analysis of their design characteristics and surviving physical evidence. From this perspective, this research aims to develop a systematic restoration approach based on architectural heritage values and multiple levels of intervention applicable to post-conflict heritage sites, using a selection of eight tomb tower models located in the Valley of the Tombs in Palmyra. The study consists of three interrelated states: 1. documentation and comparative architectural analysis based on historical references, architectural records, and photographic evidence; 2. analytical classification of architectural components, including construction system, facade composition, burial pattern, and state of preservation; and 3. creation of an integrated intervention framework encompassing conservation, rehabilitation, and restoration, supported by technological construction tools where necessary. The results of the study show that tower tombs include stable architectural elements influenced by symbolic funerary concepts and environmental considerations, while decorative and stylistic differences reflect temporal evolution and social hierarchy. Based on these findings, the proposed intervention guidelines offer a step-by-step methodology that can be adapted to each tower according to its level of deterioration, authenticity value, and reconstruction potential.

## Keywords

funerary architecture, Palmyra's funerary towers, archaeological conservation, Palmyra

## 1 Introduction

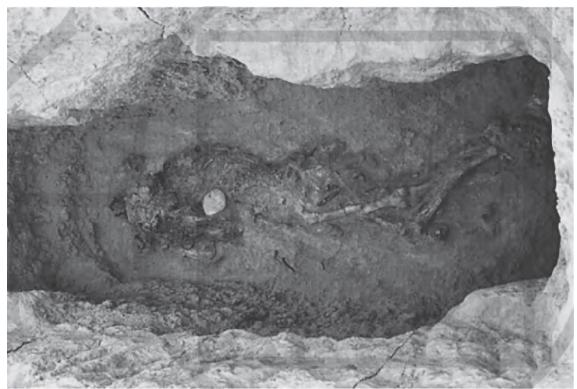
The city of Palmyra is located 240 km northeast of the capital Damascus in the Syrian desert. The city is famous for its "tomb towers", which are unique among other ancient Near Eastern sites and were formed as huge limestone family tombs over centuries (Al-As'ad and Bounni, 2000). These towers were built mainly on the hills overlooking the city and along the main trade routes, where they formed a prominent landmark in the natural and cultural landscape. The area surrounding the city was designated a World Heritage Site in 1980 due to its unique historical and architectural value (UNESCO, 1972). Its greatness stemmed not only from its economic wealth but also from its profound intellectual and religious fabric, most notably manifested in its attitude toward death and the afterlife. The Palmyrene's viewed death not as an end, but as a "transition of the soul from the body to another life", a belief shared by many ancient Near Eastern civilizations (Saad, 2007).

These funerary monuments can be broadly classified into four main categories:

1. tower tombs, which are multi-story family burials with a vertical design;
2. underground tombs (hypogea), which consist of underground chambers accessible via staircases;
3. individual tombs, which are generally smaller in size and limited in space;
4. temple- or house-like tombs, which take architectural forms inspired by residential or religious buildings (Sartre, 1989).

Together, these classifications reflect the architectural diversity of the Palmyra necropolis and provide a basic framework for understanding the prominence and symbolic significance of tower tombs, as illustrated in this study (Table 1).

**Table 1** Principal types of tombs in Palmyra

| Type                              | Period                                                            | Characteristics                                                                                                          | Function                                                                             | Photo                                                                                                                                        |
|-----------------------------------|-------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| Tower tombs                       | 1 <sup>st</sup> century BC<br>– mid-2 <sup>nd</sup><br>century AD | Multi-storied, tall towers<br>on a square base; most<br>distinctive feature of the<br>Palmyrene landscape.               | Collective family<br>burial; display of<br>wealth and social<br>status.              |  <p>Tower tombs, Palmyra, Syria (Gagnon, 2010)</p>         |
| Hypogea<br>(underground<br>tombs) | 2 <sup>nd</sup> century AD<br>– 4 <sup>th</sup> century<br>AD     | Subterranean complexes<br>accessed by a staircase;<br>typically feature a<br>T-shaped plan.                              | Collective family<br>burial; often<br>a less costly<br>alternative to<br>towers.     |  <p>The entrance to the tomb (Gawlikowski, 2005:p.69)</p> |
| House tombs<br>(temple<br>tombs)  | AD 143<br>– AD 253                                                | Freestanding structures<br>resembling temples<br>or houses, often with<br>a central colonnaded<br>courtyard (peristyle). | Lavish collective<br>family burial;<br>reflected peak<br>of luxury and<br>influence. |  <p>Marona's burial place (Gawlikowski, 2021:p.154)</p>  |
| Individual<br>tombs               | Multiple periods<br>(Hellenistic,<br>Roman,<br>Byzantine)         | Simple pits or shaft<br>graves, intended for a<br>single individual.                                                     | Burial of<br>individuals, often<br>from less affluent<br>social strata.              |  <p>Burial ground G (Saito, 2005)</p>                    |

The burial towers were constructed between the 1<sup>st</sup> century BC and the 2<sup>nd</sup> century AD and are characterized by their vertical, multi-story design, which includes dozens of finely carved funerary plaques (loculi) (Sartre, 1989). This distinctive architectural art reflects the unique fusion of local traditions and Hellenistic-Parthian-Roman elements, making it an exceptional testimony to the cultural diversity that characterized Palmyra as an international trading center. The harsh desert climate of the region, with high temperatures and significant thermal fluctuations between night and day, had a profound influence on the design of these towers, their construction materials, and methods of preservation (Gawlikowski, 1970) (Table 2).

The inscriptions and carvings on the facades and interior walls of the towers feature detailed depictions of Palmyrene families in traditional dress, with Aramaic and Greek texts documenting individuals' names, dates of death, and genealogical information. These elements make each tower a living stone record of the social and economic composition of the city during its heyday. The most famous towers include the Tower of Elahbel, the Tower of Kitot, and the Tower of Yarhai, which have been documented by international archaeological missions since the 19<sup>th</sup> century (Al-As'ad and Bounni, 2000).

Like the rest of Palmyra's monuments, these towers have suffered severe damage as a result of recent armed conflicts, raising widespread international concern and highlighting the urgent need for innovative documentation,

conservation, and rehabilitation strategies. Palmyra and the funerary towers in particular attract the attention of researchers in the field of archaeology and architectural heritage and have great tourism potential as a priceless human heritage site (UNESCO, 1972).

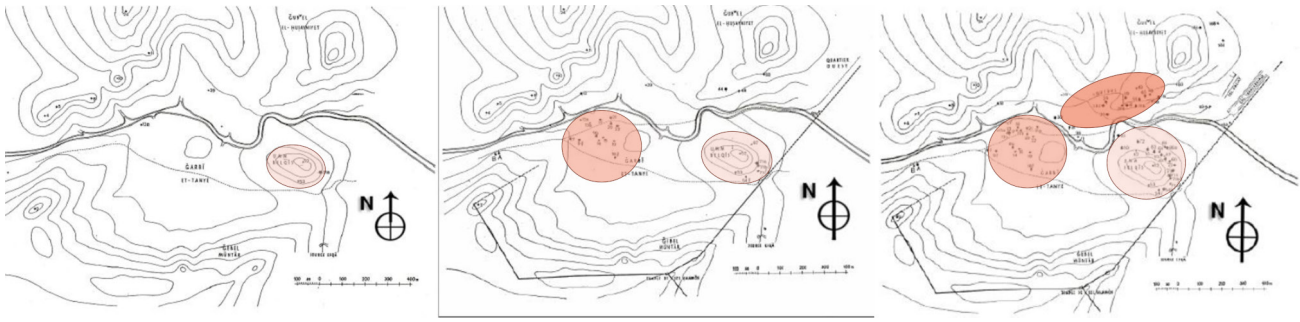
### 1.1 Study area and site configuration

The main area selected for this study is the Valley of the Tombs (Western Necropolis), a site that uniquely embodies this funerary tradition. This choice is based on its symbolic significance as the pinnacle of Palmyrene funerary architecture and on its distinctive geomorphological configuration. The valley itself is a natural passage formed between two hillsides (see Fig. 1 for the geomorphological development of the valley), with the eastern section containing a large number of tombs as it forms the main passageway for caravans traveling between Palmyra and the Mediterranean coast. This central location explains the proliferation of well-preserved funerary towers, whose main facades face the valley, designed to welcome trade routes and proclaim the status of their owners. The topography of the site plays a decisive role in shaping its identity. The surrounding terrain is mostly sloping, and the natural incline of the valley complements the structures of the towers and reinforces their rear ends. Furthermore, a natural watercourse to the west of Palmyra defines a clear natural boundary for the valley. This strategic and specific natural environment contrasts with other major cemeteries in

**Table 2** Chronological phases of Palmyrene tower tomb development

| Phase/Division                                            | Sub-models within the phase                             | Architectural characteristics                                                                                                                               | Examples                                              |
|-----------------------------------------------------------|---------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
| Phase I<br>(Hellenistic Period<br>– 9 BC)                 | A. Towers without clear burial loculi.                  | Solid core construction; rough, irregular stones; possible external loculi in the base.                                                                     | Towers 25, 27                                         |
|                                                           | B. Towers with external loculi.                         | Stepped base; burial niches carved into the exterior faces of the base.                                                                                     | Towers 2, 4, 6, 52                                    |
|                                                           | C. Towers with internal and external loculi.            | Emergence of internal burial chambers while retaining some external niches.                                                                                 | Tower 5, A12                                          |
| Phase II<br>(9 BC – mid-1 <sup>st</sup><br>century AD)    | A. Towers with internal loculi and a winding staircase. | Full utilization of internal space; a staircase winding around the interior walls; larger, semi-dressed stones.                                             | Tomb of Atenatan (9 BC),<br>Tomb of Kitot (AD 40)     |
|                                                           | B. Composite Towers (Tower + Hypogeum).                 | A tower superstructure built over a separate, underground hypogeum; likely an economical solution.                                                          | Tower 14, 19                                          |
| Phase III<br>(mid-1 <sup>st</sup> century<br>AD – AD 128) | A. Towers with a staircase occupying a single corner.   | Regular, straight staircase confined to one corner; symmetrical layout across all floors; improved masonry.                                                 | Tower 71, 63                                          |
|                                                           | B. Regularized Towers with Architectural Decoration.    | Well-dressed, smooth ashlar masonry; decorated façades; lavish interior decor (Corinthian columns, funerary banqueting reliefs, painted coffered ceilings). | Tomb of Elahbel (AD 103),<br>Tomb of Iamilkus (AD 83) |





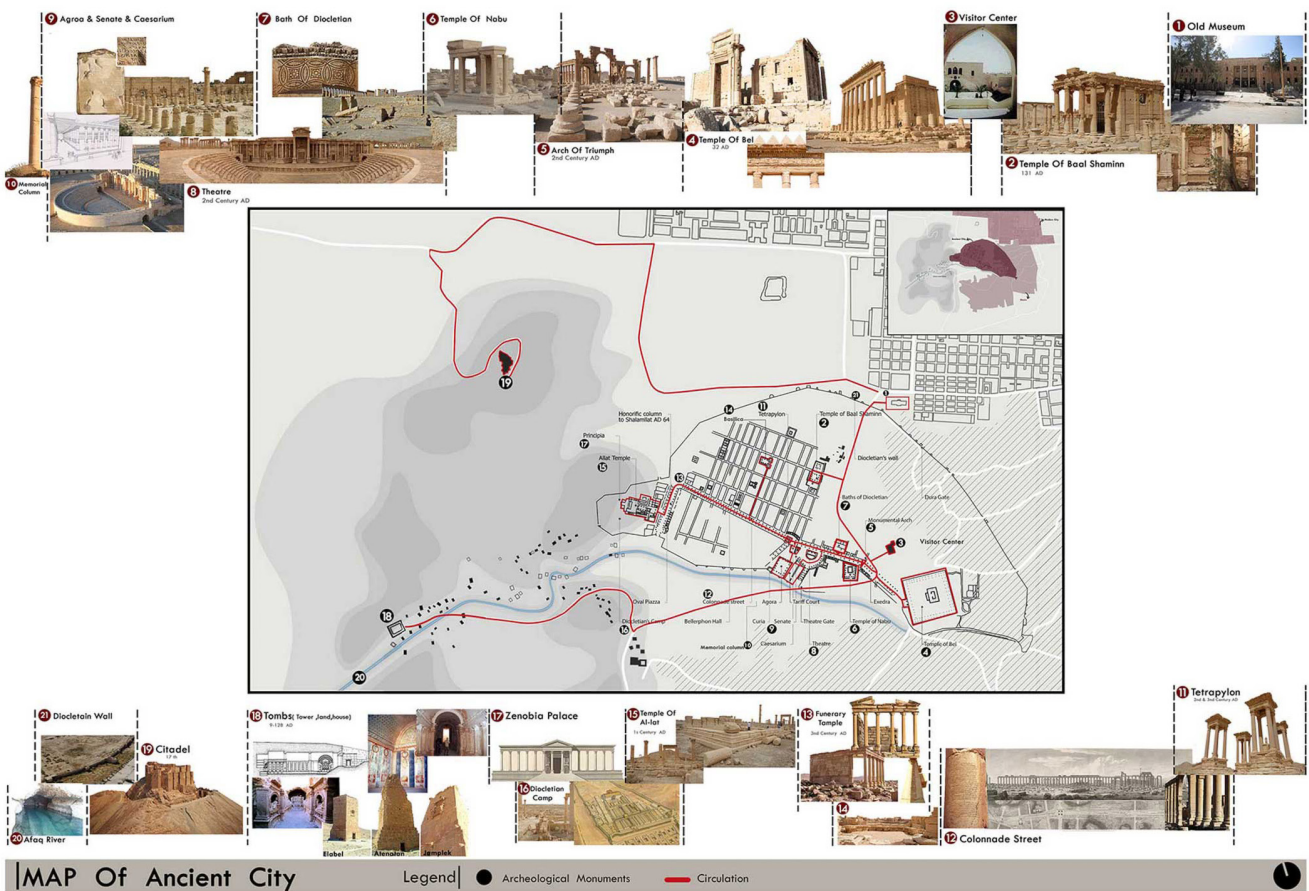
**Fig. 1** A diagram showing the development of Wadi al-Qubur (Saad (2007) edited by Dana Kahwaji)

Palmyra, such as the southwestern cemetery—which features underground tombs and is located outside the wall—and the more distant southeastern cemetery. The Valley of the Tombs thus represents the most concentrated and artistically significant group of burial towers, justifying its selection for detailed analysis (Fig. 2).

## 2 Methodology and sample selection

Within this area, towers that have lost their original architectural integrity were excluded from the detailed survey. The study focuses on a sample of eight well-preserved or

partially damaged towers that faithfully reflect the original construction techniques and artistic features of the cemetery (Figs. 3–10). These models were analyzed according to a methodological framework that includes: general layout (orientation, topographical adaptation, and relationship to trade routes); internal spatial organization (number of floors, room arrangement, and circulation patterns); facade composition (entrance design, windows, niches, and decorative details); structural system (wall construction techniques, stonework, roofing methods); decorative elements (reliefs, inscriptions, symbols); and burial arrangements (loculi organization).



**Fig. 2** A diagram showing the types of Palmyra tombs (Al-Mohammad, 2021)



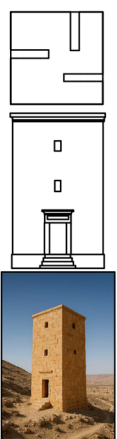
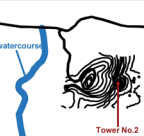
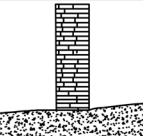
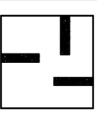
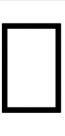
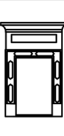
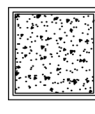
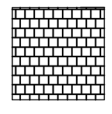
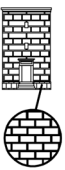
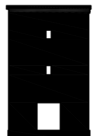
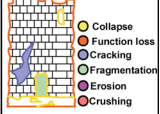
| Model T.1                                                                         | 1- Genel Settlement                                                               |                                                                                   |                                                                                   | 2- Planning                                                                       |                                                                                                                                                                                                                               | 3- Façade Elements                                                                  |                                                                                     |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Tower No.2                                                                        | Location                                                                          | Restrictive Elements                                                              | Land Settlement and Use                                                           | Plan / Living Space Relations                                                     | Number of Floors                                                                                                                                                                                                              | Window Forms                                                                        | Door Forms                                                                          |
|  |  |  |  |  |                                                                                                                                            |  |  |
|                                                                                   | 4- Roof                                                                           |                                                                                   |                                                                                   | 5- Building System                                                                |                                                                                                                                                                                                                               | 6- Occupancy / Vacancy                                                              | 7- Damage                                                                           |
|                                                                                   | Roof Form                                                                         | Material                                                                          | Lighting                                                                          | Stone                                                                             | Technique                                                                                                                                                                                                                     |                                                                                     |                                                                                     |
|                                                                                   |  |  |  |  | <p>The construction system relied on high-quality local limestone, which was cut into smooth-surfaced rectangular blocks and arranged in successive horizontal courses without the need for additional internal supports.</p> |  |  |

Fig. 3 The analysis of Palmyrene tower tomb at Wadi al-Qubur – Model T.1

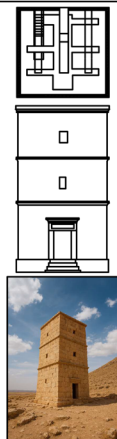
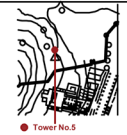
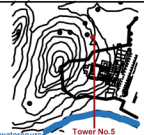
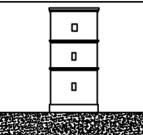
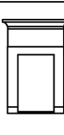
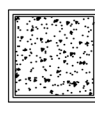
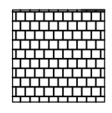
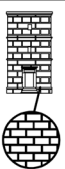
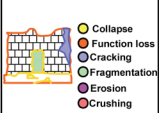
| Model T.2                                                                          | 1- Genel Settlement                                                                 |                                                                                     |                                                                                     | 2- Planning                                                                         |                                                                                                                                                                                                                               | 3- Façade Elements                                                                    |                                                                                       |
|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Tower No.5                                                                         | Location                                                                            | Restrictive Elements                                                                | Land Settlement and Use                                                             | Plan / Living Space Relations                                                       | Number of Floors                                                                                                                                                                                                              | Window Forms                                                                          | Door Forms                                                                            |
|  |   |   |   |   |                                                                                                                                           |   |   |
|                                                                                    | 4- Roof                                                                             |                                                                                     |                                                                                     | 5- Building System                                                                  |                                                                                                                                                                                                                               | 6- Occupancy / Vacancy                                                                | 7- Damage                                                                             |
|                                                                                    | Roof Form                                                                           | Material                                                                            | Lighting                                                                            | Stone                                                                               | Technique                                                                                                                                                                                                                     |                                                                                       |                                                                                       |
|                                                                                    |  |  |  |  | <p>The construction system relied on high-quality local limestone, which was cut into smooth-surfaced rectangular blocks and arranged in successive horizontal courses without the need for additional internal supports.</p> |  |  |

Fig. 4 The analysis of Palmyrene tower tomb at Wadi al-Qubur – Model T.2

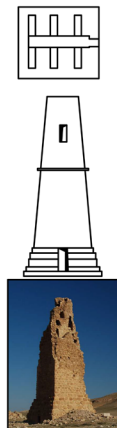
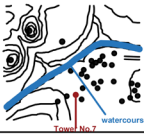
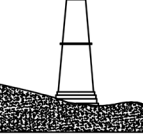
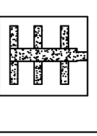
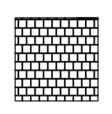
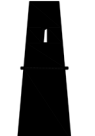
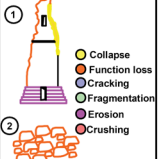
| Model T.3                                                                           | 1- Genel Settlement                                                                 |                                                                                     |                                                                                     | 2- Planning                                                                         |                                                                                                                                                                                                        | 3- Façade Elements                                                                    |                                                                                       |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Tower No.7<br>(Tower of Alexander)                                                  | Location                                                                            | Restrictive Elements                                                                | Land Settlement and Use                                                             | Plan / Living Space Relations                                                       | Number of Floors                                                                                                                                                                                       | Window Forms                                                                          | Door Forms                                                                            |
|  |  |  |  |  |                                                                                                                   |  |  |
|                                                                                     | 4- Roof                                                                             |                                                                                     |                                                                                     | 5- Building System                                                                  |                                                                                                                                                                                                        | 6- Occupancy / Vacancy                                                                | 7- Damage                                                                             |
|                                                                                     | Roof Form                                                                           | Material                                                                            | Lighting                                                                            | Stone                                                                               | Technique                                                                                                                                                                                              |                                                                                       |                                                                                       |
|                                                                                     |  |  |  |  | <p>The tower's construction system is based on rubble wall technology, where irregularly shaped, uncut stone blocks are stacked together and held in place with thick mortar made of clay or lime.</p> |  |  |

Fig. 5 The analysis of Palmyrene tower tomb at Wadi al-Qubur – Model T.3

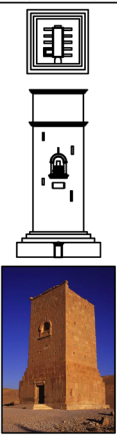
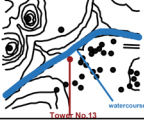
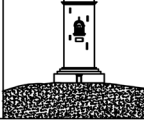
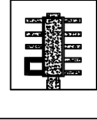
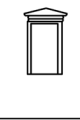
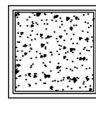
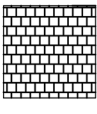
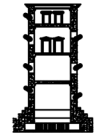
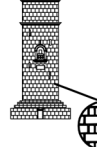
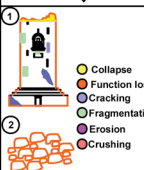
| Model T.4                                                                         | 1- Genel Settlement                                                               |                                                                                   |                                                                                   | 2- Planning                                                                       |                                                                                                                                                                                       | 3- Façade Elements                                                                  |                                                                                     |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Tower No.13<br>(Tower of Elahbet)                                                 | Location                                                                          | Restrictive Elements                                                              | Land Settlement and Use                                                           | Plan / Living Space Relations                                                     | Number of Floors                                                                                                                                                                      | Window Forms                                                                        | Door Forms                                                                          |
|  |  |  |  |  |                                                                                                     |  |  |
|                                                                                   | 4- Roof                                                                           |                                                                                   |                                                                                   | 5- Building System                                                                |                                                                                                                                                                                       | 6- Occupancy / Vacancy                                                              | 7- Damage                                                                           |
|                                                                                   | Roof Form                                                                         | Material                                                                          | Lighting                                                                          | Stone                                                                             | Technique                                                                                                                                                                             |                                                                                     |                                                                                     |
|                                                                                   |  |  |  |  | The tower is characterized by a rough wall system, where uncut stone blocks with irregular surfaces were used, assembled at uneven intervals and bound together with abundant mortar. |  |  |

Fig. 6 The analysis of Palmyrene tower tomb at Wadi al-Qubur – Model T.4

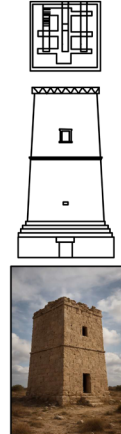
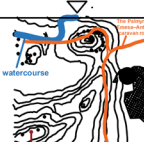
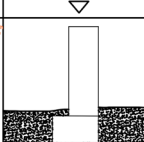
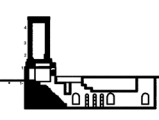
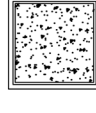
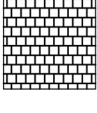
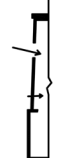
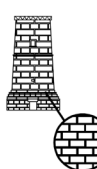
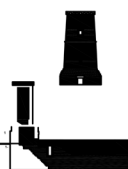
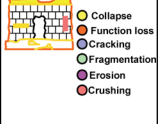
| Model T.5                                                                          | 1- Genel Settlement                                                                 |                                                                                     |                                                                                     | 2- Planning                                                                         |                                                                                                                                                                                                                        | 3- Façade Elements                                                                    |                                                                                       |
|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Tower No.19                                                                        | Location                                                                            | Restrictive Elements                                                                | Land Settlement and Use                                                             | Plan / Living Space Relations                                                       | Number of Floors                                                                                                                                                                                                       | Window Forms                                                                          | Door Forms                                                                            |
|  |   |   |   |   |                                                                                                                                     |   |   |
|                                                                                    | 4- Roof                                                                             |                                                                                     |                                                                                     | 5- Building System                                                                  |                                                                                                                                                                                                                        | 6- Occupancy / Vacancy                                                                | 7- Damage                                                                             |
|                                                                                    | Roof Form                                                                           | Material                                                                            | Lighting                                                                            | Stone                                                                               | Technique                                                                                                                                                                                                              |                                                                                       |                                                                                       |
|                                                                                    |  |  |  |  | The construction system relied on high-quality local limestone, which was cut into smooth-surfaced rectangular blocks and arranged in successive horizontal courses without the need for additional internal supports. |  |  |

Fig. 7 The analysis of Palmyrene tower tomb at Wadi al-Qubur – Model T.5

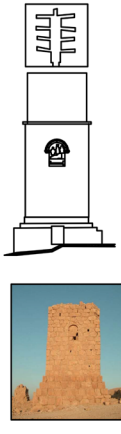
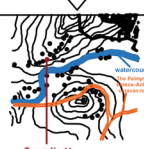
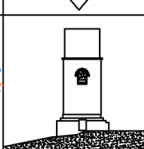
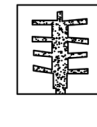
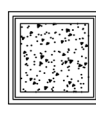
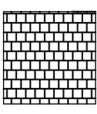
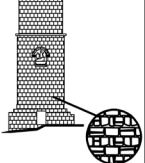
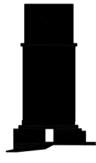
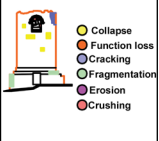
| Model T.6                                                                           | 1- Genel Settlement                                                                 |                                                                                     |                                                                                                                                                                                                                                                                                                                       | 2- Planning                                                                         |                                                                                                                                                                                                                                                                  | 3- Façade Elements                                                                    |                                                                                       |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Tower No.44<br>(Tower of Klot)                                                      | Location                                                                            | Restrictive Elements                                                                | Land Settlement and Use                                                                                                                                                                                                                                                                                               | Plan / Living Space Relations                                                       | Number of Floors                                                                                                                                                                                                                                                 | Window Forms                                                                          | Door Forms                                                                            |
|  |  |  |                                                                                                                                                                                                                                    |  |                                                                                                                                                                             |  |  |
|                                                                                     | 4- Roof                                                                             |                                                                                     |                                                                                                                                                                                                                                                                                                                       | 5- Building System                                                                  |                                                                                                                                                                                                                                                                  | 6- Occupancy / Vacancy                                                                | 7- Damage                                                                             |
|                                                                                     | Roof Form                                                                           | Material                                                                            | Lighting                                                                                                                                                                                                                                                                                                              | Stone                                                                               | Technique                                                                                                                                                                                                                                                        |                                                                                       |                                                                                       |
|                                                                                     |  |  | Lighting in the Klot Tower tomb is provided through a limited number of small, narrow openings that allow dim, controlled natural light to enter. This restricted lighting strategy maintains the sanctity of the funerary space, while also taking climate conditions into account by reducing exposure to sunlight. |  | The structural framework is based on a system of cut stone walls, where load-bearing walls made of carefully trimmed limestone blocks—stacked in regular horizontal courses—form an integrated box structure that transfers loads vertically to the foundations. |  |  |

Fig. 8 The analysis of Palmyrene tower tomb at Wadi al-Qubur – Model T.6

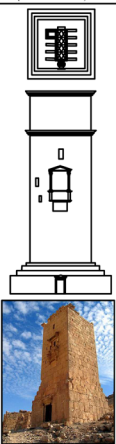
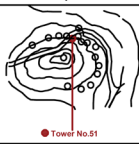
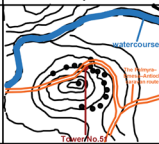
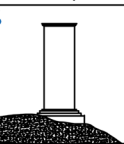
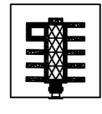
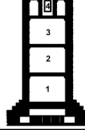
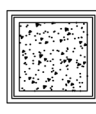
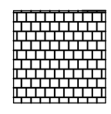
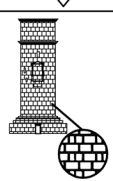
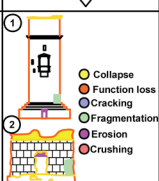
| Model T.7                                                                         | 1- Genel Settlement                                                               |                                                                                   |                                                                                   | 2- Planning                                                                       |                                                                                                                                                                                       | 3- Façade Elements                                                                  |                                                                                     |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Tower No.51<br>(Tower of Yamika)                                                  | Location                                                                          | Restrictive Elements                                                              | Land Settlement and Use                                                           | Plan / Living Space Relations                                                     | Number of Floors                                                                                                                                                                      | Window Forms                                                                        | Door Forms                                                                          |
|  |  |  |  |  |                                                                                                    |  |  |
|                                                                                   | 4- Roof                                                                           |                                                                                   |                                                                                   | 5- Building System                                                                |                                                                                                                                                                                       | 6- Occupancy / Vacancy                                                              | 7- Damage                                                                           |
|                                                                                   | Roof Form                                                                         | Material                                                                          | Lighting                                                                          | Stone                                                                             | Technique                                                                                                                                                                             |                                                                                     |                                                                                     |
|                                                                                   |  |  |  |  | The tower is characterized by a rough wall system, where uncut stone blocks with irregular surfaces were used, assembled at uneven intervals and bound together with abundant mortar. |  |  |

Fig. 9 The analysis of Palmyrene tower tomb at Wadi al-Qubur – Model T.7

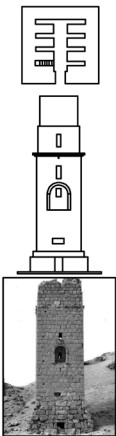
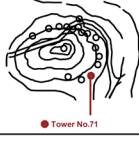
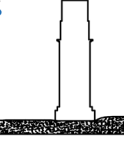
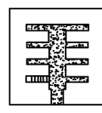
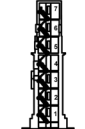
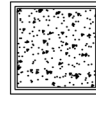
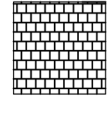
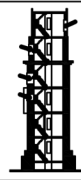
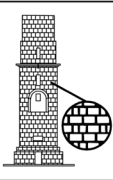
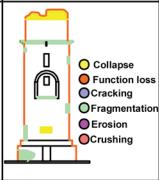
| Model T.8                                                                          | 1- Genel Settlement                                                                 |                                                                                     |                                                                                     | 2- Planning                                                                         |                                                                                                                                                                                       | 3- Façade Elements                                                                    |                                                                                       |
|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Tower No.71                                                                        | Location                                                                            | Restrictive Elements                                                                | Land Settlement and Use                                                             | Plan / Living Space Relations                                                       | Number of Floors                                                                                                                                                                      | Window Forms                                                                          | Door Forms                                                                            |
|  |   |   |   |   |                                                                                                   |   |   |
|                                                                                    | 4- Roof                                                                             |                                                                                     |                                                                                     | 5- Building System                                                                  |                                                                                                                                                                                       | 6- Occupancy / Vacancy                                                                | 7- Damage                                                                             |
|                                                                                    | Roof Form                                                                           | Material                                                                            | Lighting                                                                            | Stone                                                                               | Technique                                                                                                                                                                             |                                                                                       |                                                                                       |
|                                                                                    |  |  |  |  | The tower is characterized by a rough wall system, where uncut stone blocks with irregular surfaces were used, assembled at uneven intervals and bound together with abundant mortar. |  |  |

Fig. 10 The analysis of Palmyrene tower tomb at Wadi al-Qubur – Model T.8

The main characteristics, particularly those relating to construction techniques, roof forms, and patterns of damage observed, were documented using schematic drawings supplemented by descriptive text.

### 3 Architectural characteristics of the tower tombs

All tower tombs are located within the Valley of the Tombs and are usually built close to each other; however, each tomb has a distinct and separate arrangement. The natural watercourse surrounding the valley west of Palmyra represents a specific natural boundary. Thanks to their central location, distinctive structural elements provide privacy and symbolic separation. The vertical mass and solid stone of the towers themselves act as key dividers. The surrounding terrain is often sloping, with the natural slope of the valley itself integrating with and reinforcing the rear of the buildings (Fig. 11).

Tower tombs consist of several floors (3–7), with the lower floors often used as mass graves or for secondary uses, while the upper floors and ground floor are sometimes reserved for receiving visitors or performing funeral rites.

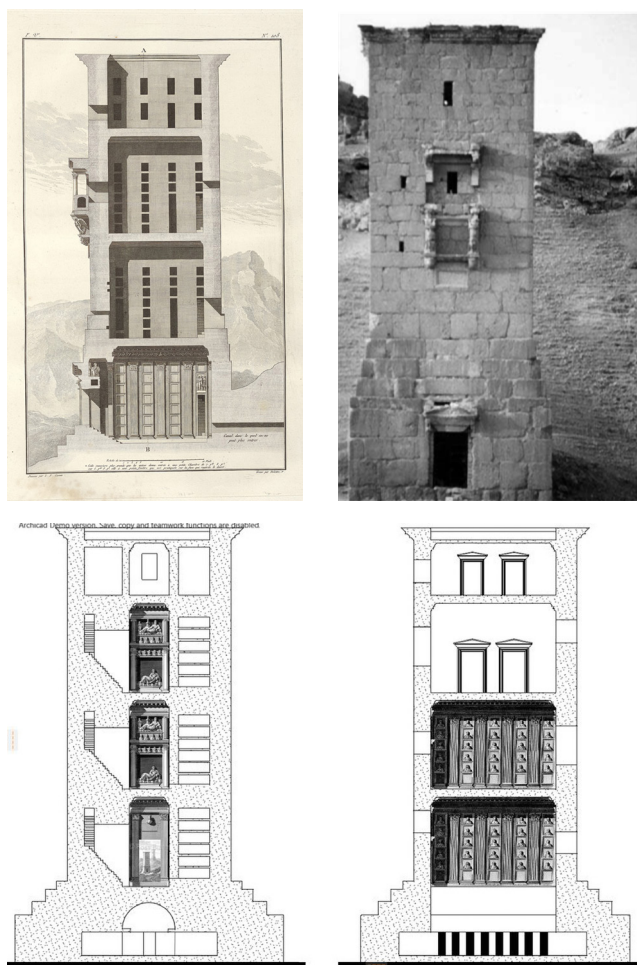
The rooms and niches (loculi) are organized around a central void or main corridor and are structurally isolated from the outside world due to their sacred funerary nature and the harsh climatic conditions of the region. These interior spaces were designed to serve multiple and sequential ritual purposes, such as burial, remembrance and visitation, with architectural elements that temper the internal atmosphere, especially during periods of extreme heat (Fig. 12).

The tower tombs are closed, imposing architectural structures with no external extensions or annexes, their exterior facades displaying solidity and complete closure. The main entrances to these tombs stand out as unique





**Fig. 11** Natural topography and built boundaries defining privacy in the Valley of the Tombs (Raja, 2022; Saad, 2007)



**Fig. 12** Internal organization: burial niches and memorial spaces (Getty Research Institute, online; Henning, 2013)

architectural elements, designed in the form of cornices and huge sculpted frames, decorated with inscriptions and motifs reflecting the status of the royal family of the tower. These entrances open directly onto the natural landscape of the valley or desert, reinforcing their symbolic role during burial ceremonies. The interior burial floors are built completely isolated from the outside environment by thick stone walls to maintain an atmosphere of stability and sanctity. Each burial chamber has a ventilation opening or small window that allows dim light to enter. The openings in the main façade are larger and more ornate and organized, while those on the other sides are smaller and less decorative, serving a purely functional purpose (Fig. 13).

The roofs of the tower tombs are flat in some models, with prominent architectural cornices that are well suited to the unpredictable desert weather. Local stone materials were used to cover these roofs, reflecting the utilizing available natural resources and supporting the visual harmony between the building and its surroundings (Fig. 14).

Tower tombs are constructed using locally sourced natural stone, which is used to build the main facades and the base of the structure. Architectural openings are concentrated in the stone facades to provide ventilation and natural lighting for the interior spaces, with a total area not exceeding 15–20% of the total area of the facades, concentrated in the upper two-thirds of the building's height to maintain structural integrity. Some of these tombs also contain special niches or cavities in the stone walls for placing offerings or funerary jewelry. These cavities are often located on the side facing the entrance or in directions overlooking the landscape.

The tower tombs show a high degree of cohesion that exceeds the proportion of empty space in their facades, where solid stone blocks dominate most of the exterior spaces with few narrow openings, in response to the harsh climatic conditions in the region and to ensure the durability of the construction (Fig. 15).

The tower tombs studied in the Valley of the Tombs suffer from widespread abandonment and gradual deterioration because of a combination of long-term natural factors and human influences. Prolonged exposure to harsh climatic conditions, such as extreme temperature fluctuations, wind erosion, and intermittent rainfall, has led to significant weathering of the materials, particularly the stone surfaces, mortar joints, and decorative elements. In many cases, these environmental factors have caused partial collapses of facades and roof structures, compromising the overall structural stability of the towers.





**Fig. 13** Decorations on the main facade of the Tower of Kitot (Getty Research Institute, online; izi.TRAVEL, online; Monikamonia, online)



**Fig. 14** The roof of the Tower of Elahble (Cromwell, online; Demeter, 2015; German Archaeological Institute, online)



**Fig. 15** The tower tombs of Palmyra (Cromwell, online; Demeter, 2015)



Human factors have exacerbated the damage observed. Armed conflicts, deliberate destruction, vandalism, and long-term neglect of regular maintenance have resulted in serious structural losses, the fragmentation of architectural components, and the disappearance of funerary inscriptions and prominent sculptures. The extent of damage varies among the samples studied, reaching about 60% in some towers because of major structural collapses, while surface deterioration, cracks, and loss of material account for about 40% of the total damage. Approximately 70% of the original decorative elements and inscriptions have been damaged or lost, and no more than 50% of the distinctive architectural features, such as cornices and capitals, remain intact (Fig. 16).

Overall, damage caused by natural factors is the main source of deterioration, accounting for approximately 75% of the total observed destruction, while damage caused by human intervention accounts for approximately 25%. Differences in the severity of damage reflect variations in topography, construction quality, and historical circumstances. These findings underscore the urgent need for

systematic, context-sensitive conservation and restoration strategies tailored to the condition and heritage value of each tower (Fig. 17).

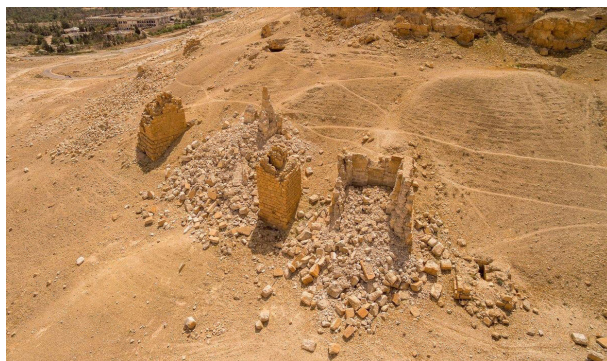
It is clear from the above data that funerary tower models share a set of recurring architectural and environmental features, despite historical variations and stylistic differences between them. These common features represent semi-fixed design principles related to the funerary function on the one hand, and to the surrounding climatic conditions and the symbolic conception of the tower as an "eternal home for the soul" on the other. In contrast, selective architectural elements can be observed that are linked to the time of construction, the social class of those buried, and the level of artistic maturity prevailing in each period. Based on this, Table 3 summarizes the most prominent structural and architectural characteristics common to these models, as fundamental determinants of their overall architectural identity.

A comparative analysis of the funerary towers (T1–T8) reveals a consistent architectural model, characterized by flat roofs, rectangular openings, and solid stone construction.



**Fig. 16** Human-induced damage in Tower Tomb 71 and other tombs (Cromwell, online; Hermans, 2008; High Contrast, 2009)





**Fig. 17** Natural deterioration in Tower Tomb 71 and other tombs (Khleif, 2020; Earth 3D Map, online)

**Table 3** Architectural and structural characteristics of the tower tombs in Palmyra

| Model number        |             | T.1 | T.2 | T.3 | T.4 | T.5 | T.6 | T.7 | T.8 |
|---------------------|-------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Location            | Northwest   | ●   |     |     | ●   |     |     |     |     |
|                     | Southwest   |     | ●   | ●   |     | ●   | ●   | ●   | ●   |
| Topography          | Flat        |     |     |     |     |     |     |     |     |
|                     | Inclined    |     |     |     |     |     |     |     |     |
| Floors              | 3           | ●   |     |     |     |     |     |     |     |
|                     | 4           |     | ●   |     | ●   |     |     | ●   |     |
|                     | 7           |     |     | ●   |     | ●   | ●   |     | ●   |
| Roof                | Flat        | ●   | ●   | ●   | ●   | ●   | ●   | ●   | ●   |
|                     | Pyramidal   |     |     |     |     |     |     |     |     |
| Windows             | Rectangular | ●   | ●   | ●   |     | ●   |     |     |     |
|                     | Ornamented  |     |     |     | ●   |     | ●   | ●   | ●   |
| Doors               | Rectangular | ●   | ●   | ●   | ●   | ●   | ●   |     | ●   |
|                     | Ornamented  | ●   |     |     |     |     |     | ●   |     |
| Materials           | Stone       | ●   | ●   | ●   | ●   | ●   | ●   | ●   | ●   |
| Decorative elements |             | ●   |     |     | ●   |     | ●   | ●   | ●   |
| Occupancy status    | Vacant      |     |     |     |     |     |     |     |     |
|                     | Abandoned   | ●   | ●   | ●   | ●   | ●   | ●   | ●   | ●   |
| Burial system       | Loculi      | ●   |     | ●   | ●   |     | ●   |     | ●   |
|                     | Sarcophagi  |     | ●   |     |     | ●   |     | ●   |     |
| Damage              | Minor       |     |     |     |     |     |     |     | ●   |
|                     | Moderate    | ●   |     |     |     |     |     |     |     |
|                     | Severe      |     | ●   |     |     | ●   | ●   | ●   |     |
|                     | Collapse    |     |     | ●   | ●   |     |     |     |     |

White cell with the black dot in the middle indicates the presence of the corresponding architectural or structural characteristic.

Plain white cell indicates that there has been no data regarding this feature.

Gray cell indicates the not presented feature.



This apparent regularity indicates the adoption of a standard construction model that meets the requirements of structural durability and adaptation to local climatic conditions. The state of neglect common to all samples also shows the continuing deterioration in the absence of any regular maintenance interventions, justifying the urgent need for a systematic framework for conservation and restoration.

The secondary variations observed in decorative elements, burial systems (between pyramids and stone tombs), or entrance design mostly reflect differences related to social status or chronological development, rather than a fundamental change in design principles. This conclusion is supported by the prevalence of features such as closed facades, few openings, and a cohesive vertical mass, which emphasize the introverted and symbolic nature of the funerary space, designed primarily for commemoration and remembrance rather than for everyday functional use.

#### 4 Method/Framework for rehabilitation

Based on the identity of the tower tombs, this study proposes an integrated intervention framework consisting of four complementary approaches: conservation, rehabilitation, renovation, and restoration. These approaches represent different levels of intervention, from physical stabilization to reconstruction using digital tools, and are applied according to the degree of damage, the symbolic importance of the tower, and the possibility of preserving authenticity. Table 4 summarizes the definition of each approach, together with its procedural components, expected outcomes, and applicability in the context of Palmyra.

The proposed approaches reflect a progressive methodology that acknowledges the varying levels of physical deterioration and symbolic value among the tower tombs. Conservation and rehabilitation are more suitable for structures that retain much of their original material and architectural identity, whereas renovation and restoration are more relevant for severely damaged towers or those requiring functional transformation. Rather than imposing a fixed model, this classification supports context-based decision-making that balances archaeological authenticity with contemporary needs. In Palmyra, where partial collapse and surface erosion are predominant, priority should be given to conservation and rehabilitation,

while restoration is more appropriate for heavily destroyed towers or those intended for new cultural functions.

#### 5 Conclusions

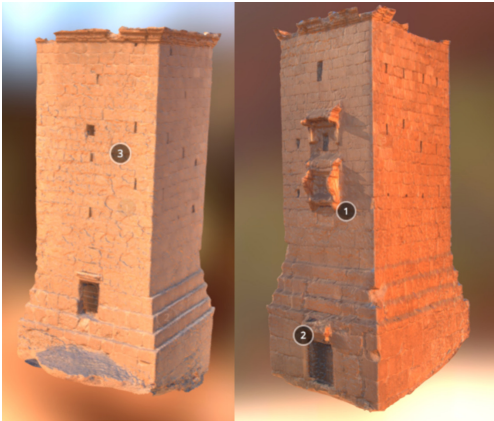
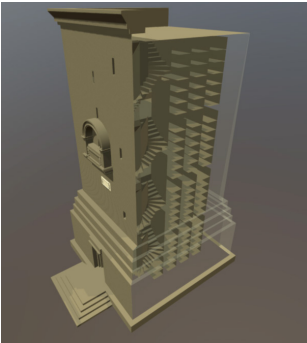
This study shows that the funerary towers in Palmyra were not merely burial structures but rather constituted an integrated cultural system that embodied religious and philosophical conceptions of life and death and reflected the soul's transition to immortality. The architectural developments that these towers underwent, from simple prototypes to multi-story towers, reveal a direct relationship with the economic and social development and technical capabilities that the city had achieved. The systematic destruction of these towers in recent years represents an irreparable loss, affecting both physical and symbolic memory and highlighting the fragility of cultural heritage in conflict zones.

Based on this, the intervention framework proposed in this study—consisting of conservation, restoration, rehabilitation, renovation, and digital reconstruction—offers a range of integrated strategies that can be applied depending on the level of damage, symbolic value, and potential for preserving the physical and spiritual authenticity of each model. The selection of the appropriate measure requires a comprehensive value assessment that considers the physical condition and cultural and contextual specificity.

The revival of these towers, whether physical or virtual, must be based on a deep understanding of their original role as "nafs", or "eternal home of the soul". From this perspective, digital reconstruction emerges as an essential tool that is not limited to documentation but also ensures permanent accessibility and preserves collective memory even in the event of the loss of the original material.

In conclusion, the future of destructive funerary heritage depends on balanced ethical approaches that combine the preservation of archaeological authenticity with the use of contemporary technologies and responsiveness to the needs of society. By repositioning towers as active elements in the continuity of cultural identity, the rehabilitation process becomes an act of cultural resistance, providing a model that can be applied in post-conflict contexts around the world and affirming that the preservation of memory is a prerequisite for the restoration of human dignity and the continuity of civilization.

Table 4 Intervention approaches for Palmyra's tower tombs

|                | Photos                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Explanation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Conservation   | <div><p>Tower Tomb Conservation Strategy Implementation</p><p>Non-inventive structural stabilization to prevent further collapse</p><p>Context-sensitive perimeter protection with monitoring systems.</p><p>Controlled circulation routes that respect archaeological sensitivity.</p><p>Landscape strategies to enhance archaeological interpretation.</p></div> <p>Tower tomb conservation using Nano Banana AI Image Generator by Google (Google, online)</p> | <p>First, structural stabilization and preventive measures focus on preventing further deterioration through non-invasive reinforcement, perimeter protection, and preventive conservation. Second, site interpretation and visitor management aim to promote cultural understanding while preserving the sensitivity of the archaeological site through traffic regulation, viewing platforms, and interpretive documentation. Third, environment development and infrastructure integration aim to support sustainable visitor access through the creation of organized entry points, contextual landscaping, and controlled viewing stations, thereby reinforcing conservation objectives.</p>                                                                                             |
| Rehabilitation | <div></div> <p>Tower tomb after rehabilitation (chancec, 2016)</p>                                                                                                                                                                                                                                                                                                                                                                                               | <p>The first phase involves field documentation and analysis to classify damaged components and identify original construction techniques and materials. The second phase focuses on preparing authentic stone blocks suitable for reuse and sourcing compatible materials from documented quarries, while applying traditional construction techniques. The third phase involves the physical reconstruction process, guided by archival records and original dimensions, while preserving the remaining pieces as historical evidence and ensuring their consistency with the authentic architectural character of the funerary towers.</p>                                                                                                                                                 |
| Renovation     | <div></div> <p>Tower tomb after renovation (CHEI – UC San Diego, 2018)</p>                                                                                                                                                                                                                                                                                                                                                                                      | <p>This rehabilitation strategy is based on a balanced approach that begins with a contextual architectural analysis, identifying the authentic values and elements that must be preserved, alongside those that lend themselves to contemporary interpretation. The structural rehabilitation process gives priority to treated historical materials and invisible fixing methods that protect authenticity. Contemporary interventions are introduced through transparent, lightweight elements that clearly distinguish new additions while maintaining aesthetic harmony. Finally, functional and aesthetic integration ensures the continuity of the historical narrative, while introducing contemporary layers in a clear and respectful manner.</p>                                   |
| Renewal        | <div></div> <p>Showing tower tomb after renewal (Rmn-Grand Palais, 2017)</p>                                                                                                                                                                                                                                                                                                                                                                                    | <p>The proposed renovation approach encourages the transformation of the tower tombs into a contemporary reality through the use of advanced materials and a free-form architectural language that departs from the historical form while expressing temporal continuity. The functional re-employment of the site enables its transition from a funerary monument to a cultural museum with flexible exhibition spaces and interactive interpretation. On a contextual level, the design seeks a new architectural dialogue free from imitation, supported by a service infrastructure that enhances the visitor experience. Ultimately, this intervention generates cultural, educational, and economic value, transforming the site into a sustainable cultural center within Palmyra.</p> |



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