

Analysis of “Reality” and “Abstract” in Dunhuang Architectural Art and Its Modern Applications

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Abstract

As a pivotal node on the ancient Silk Road, the Mogao Grottoes in Dunhuang preserve a millennium-long architectural heritage spanning from the 4th to the 14th century CE. This study establishes a dual-dimensional analytical framework of “Reality-Abstraction” to conduct a systematic investigation into Dunhuang’s architectural art: the “Reality” dimension focuses on physical cave structures (encompassing six primary types, namely meditation caves, pagoda-temple caves, hall caves, nirvana caves, giant Buddha caves, and tomb caves), wooden-eaves buildings, and rammed-earth buildings, exploring how architectural forms adapted to dynamically evolving religious and functional demands; the “Abstraction” dimension examines architectural images in murals, including structural components, building complexes, and pagodas, which can be regarded as visual documents recording eight centuries of historical architectural practices. Through in-depth analysis of 15 representative caves, more than 40 mural scenes depicting architecture, and 8 contemporary architectural projects, this study draws three core conclusions: first, Dunhuang architecture possesses dual-dimensional attributes-physical buildings exhibit functional adaptability and the integration of Chinese and Indian styles, while mural images provide crucial empirical evidence for reconstructing lost architectural traditions; second, the modern translation of Dunhuang elements (rammed-earth craftsmanship, dougong systems, and apsaras patterns) in projects such as the Dunhuang International Convention and Exhibition Center and the Beijing 2022 Winter Olympic Venues has realized the organic integration of traditional cultural connotations and modern architectural functions; third, both physical buildings and murals collectively reflect the cultural integration process along the Silk Road, providing material evidence for the exchange of architectural techniques between the East and the West. This integrated “Reality-Abstraction” framework not only expands the academic dimension of Dunhuang architectural research but also offers methodological references for the study of heritage site-based cultural heritage, while laying a theoretical foundation for the creative transformation of cultural heritage in contemporary architectural design.

Keywords

Dunhuang, Mogao Caves, ancient buildings, mural element, architectural image, Dunhuang and modern architecture

1. Introduction

The Mogao Caves in Dunhuang represent a unique architectural heritage that bridges material construction and artistic representation. While scholars have extensively studied either the physical cave structures or the architectural imagery in murals, these two dimensions have rarely been examined as interconnected components of a unified architectural culture. This study proposes a “Reality-Abstract” analytical framework

to address this gap: the “Reality” dimension investigates the tangible cave typologies, wooden eaves, and rammed-earth buildings, examining how architectural forms adapted to evolving religious and functional needs from the 4th to 14th centuries; the “Abstract” dimension analyzes architectural representations in murals as visual documentation that preserves lost building traditions and reflects contemporary construction practices. By synthesizing these complementary perspectives, this research seeks to reconstruct a more complete understanding of Dunhuang’s architectural evolution while tracing how ancient design elements have been extracted and transformed in modern applications. Through systematic analysis of representative cave structures, mural architectural imagery spanning eight centuries, and contemporary design projects, this study addresses three core questions: How did cave typologies evolve in response to changing religious practices? What historical architectural knowledge can be recovered from mural representations? And what principles govern the successful integration of Dunhuang elements in modern architecture? Beyond enriching Dunhuang scholarship, this integrated approach offers methodological insights for architectural history research at heritage sites where physical and visual evidence coexist, while providing theoretical foundations for contemporary practices of cultural heritage activation in architectural design.

2. “Reality” - The stone caves, wooden structures, and rammed earth buildings of the Mogao Caves

2.1 Stone cave buildings

The stone cave buildings of the Mogao Caves show different characteristics due to different time periods, mainly in 6 types:

2.1.1 Zen caves (monk grottoes)

(1) Definition:

During the early Northern Dynasties to the middle Northern Dynasties period, there were many caves of this type, which evolved and changed from the Indian vihara caves. Most of the existing monk grottoes are located in the northern area of Mogao Caves (the caves were mostly built before the Yuan Dynasty), with a total of sixty-four, while only two grottoes remain in the southern area (Mogao Grottoes Cave 488 and 489). The size of the monk grottoes varies, most of them are single-roomed,

with a square or rectangular layout. There are usually stoves and kang beds inside the caves, with the stove generally located on either side of the door; the shape of the kang beds is mostly rectangular, with a few irregular shapes, including gravel kangs and adobe kangs. The construction of the cave roof and walls is relatively sophisticated, the roof can be divided into gable, truncated pyramidal, and flat roofs, while the gable roofs being the most common. (Figure 1)

(2) Formation reasons:

The morphological characteristics of meditation caves are shaped by multiple factors: their square or rectangular floor plan directly stems from the functional needs of monks’ long-term residence, as the regular space facilitates arranging kang beds (heated brick beds) and stoves along the walls to maximize the use of cave area-stoves are mostly placed on both sides of the door, enabling ventilation and smoke exhaust while preventing smoke from polluting the sleeping area. The gable roof becoming the dominant form is closely linked to the geological characteristics of the glutenite at Mogao Grottoes; this rock stratum has moderate strength, so excavating a gable roof not only ensures structural stability but also simplifies construction, and compared with domed or flat roofs, it is more effective in drainage and seepage prevention. Meanwhile, though meditation caves originated from the Indian vihara, their internal layout has undergone in-depth localization: kang beds have replaced Indian stone beds to align with the heating habits of northern China, and the addition of stoves reflects the lifestyle of Chinese monks who “cook and eat by themselves,” different from the tradition of Indian monks begging for alms with bowls. Furthermore, with the popularization of sutra translation activities and the expansion of the believer community, some meditation caves gradually transformed into worship caves—a shift that marks the development of Buddhism in China from an elite practice to a popular belief.(figure 2)

Figure 1: Elevation and Plan of Cave 268

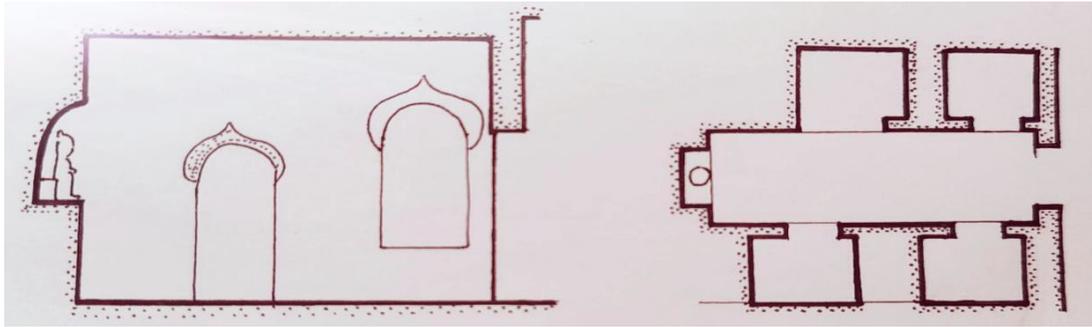
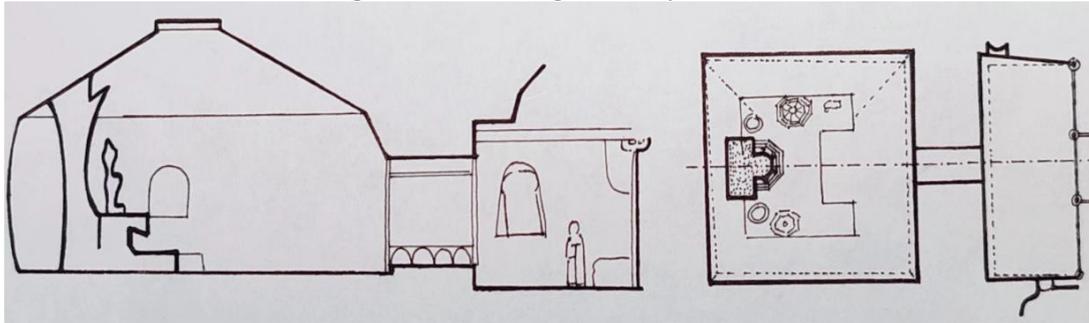


Figure 2: Frontal and plan view of Cave 85



2.1.2 Tower-Temple Caves (Central Caves)

(1) Definition:

The central tower pillar caves of the Mogao Caves are influenced by the Indian Vihara Caves, originating from the Indian Chaitya Caves. A Chinese square-shaped

tower in the form of a pavilion is excavated in the middle of the cave, reaching from the ground to the top, with niches of Buddha statues on all four sides of the tower pillar, symbolizing the stupa. This is meant for practitioners to enter the cave, circumambulate the tower, observe the statues, and worship. The structures are unique and mostly square-shaped, with Buddha statues and niches carved on all four sides, also known as central square pillar caves or tower-temple caves. The wooden structure elements like beams and rafters are sculpted to mimic wood, with a front roof in a zigzag pattern and a flat roof at the back. Behind the central cube-shaped tower pillar, apart from the niches on both sides of the 248 tower pillars, the front of the tower pillars in other caves have a large niche, while the other three sides have two niches each. Sculptures are placed inside the niches, with most caves having no niches on the four walls, and some caves having niches on the sides or back walls; the niches are divided into three types: rectilinear niches, double-tree niches, and pointed arch niches.

The evolution of Taoist temples can be divided into four stages. By the late Tang Dynasty, they had entered the final stage, with various changes in appearance. The front part of the main hall became like a water bucket, with a large niche on the front side of the central pillar, topped by a vault, while the other three sides had no niches. The passages on the left and right sides of the central pillar had lowered ceilings, similar to the central pillar cave in the Jiqier Stone Cave in Xinjiang (Figure 3).

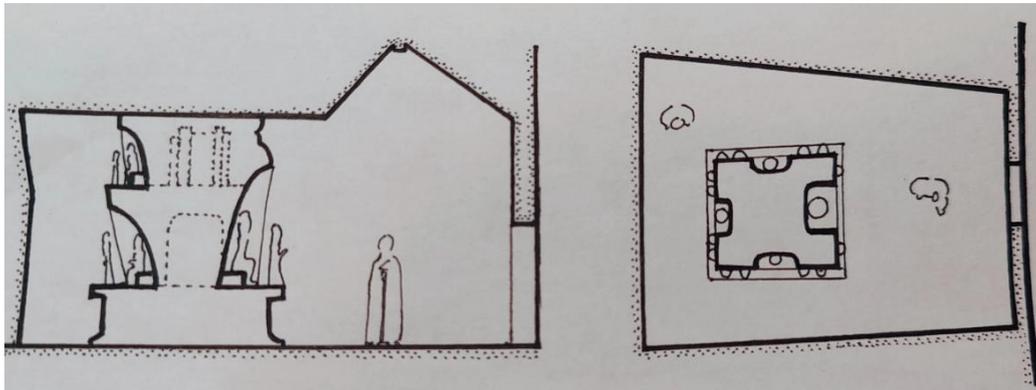
The collapsed cave is a unique form of central pillar cave. The cave has a unique shape, with the central pillar resembling an inverted pagoda of Mount Sumeru, supported by a coiled dragon. The main chamber of the central pillar cave is square in plan, with a front roof in the shape of a person's top and a flat roof at the back. The central part of the back of the cave roof is connected to the inverted stupa on the central pillar. The back of the cave roof is flat, with a square well in the center. Surrounding the connection between the square well and the top of the central pillar stupa are circular hanging curtains, with four corners depicting a meditating Buddha, and surrounding them are thousands of Buddhas. The central pillar stupa is in the shape of Mount Meru, with a circular seven-tier inverted stupa at the top. The top six tiers originally had sculptures of thousands of Buddhas (which have now peeled off), and the bottom tier depicts reclining lotuses with four coiled dragons

supporting the pillar. Below the inverted stupa is a square pedestal with niches on all four sides. The west-facing niche is the main niche of Mogao Grottoes Cave 302 and 303 from the Sui Dynasty.

(2) Formation reasons:

The spatial design and evolution of pagoda-temple caves are deeply linked to religious needs and localization adaptation: their central pagoda pillar design directly serves the Buddhist ritual of “pradakshina” (circumambulation), where believers must walk clockwise around the pillar to view the statues in the niches on its four sides and accumulate merit; the pillar extends from the ground to the cave roof, symbolizing Mount Sumeru or a Buddhist pagoda, and the layout of niches on all four sides ensures the continuity of the circumambulation path and the integrity of the ritual. Though originating from the Indian Chaitya cave, pagoda-temple caves underwent significant modifications in China: the domed stupa at the center of Indian Chaitya caves was transformed into a square pagoda pillar, with niches on its four sides for enshrining Buddha statues, integrating the functions of a “pagoda” (object of worship) and a “temple” (place of enshrinement). In terms of spatial form evolution, the central pillars of early pagoda-temple caves were simple with symmetrically arranged niches on four sides; during the late Tang Dynasty, notable changes emerged—niches on the front side were expanded and added with arched tops, while the ceilings of the left and right passages were lowered, forming a “primary-secondary” spatial hierarchy. This transformation reflected the shift in Buddhist worship rituals from equal viewing of statues to emphasizing the worship of the main Buddha. The disappearance of pagoda-temple caves was closely tied to the secularization of Buddhism: as the meditation practice of “circumambulating the pagoda to view statues” was replaced by the more straightforward “face-to-face worship,” the central pagoda pillar instead became a spatial obstacle—believers desired a more spacious area in front of the Buddha statues for prostration. Additionally, the central pillar was difficult and costly to excavate; against the backdrop of simplified Buddhist rituals, it was gradually replaced by the more economical and practical Buddha altar cave.

Figure 3: Elevation and Plan of Cave 260



2.1.3 Hall Grottoes

(1) Definition:

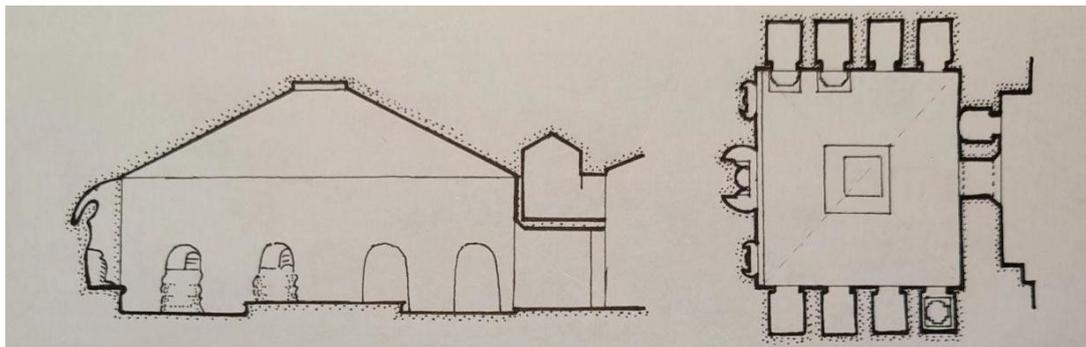
Hall Grottoes, also known as central Buddha hall cave or Buddha hall cave, was popular from the Tang Dynasty to the Song Dynasty period. It is also the most typical type of Chinese grottoes, with the widest distribution and the longest prevalence. The origins of Hall Grottoes lie in the increasing number of Buddhist believers, with the common worship practice of five-point kowtowing in front of the Buddha. Therefore, the space in front of the Buddha needed to be spacious. The typical styles are square plan, truncated pyramidal ceilings, with slightly concave arch surfaces at the four corners of the cave roof, and a Buddha altar built slightly back in the center of the cave, topped with Buddha statues. The flat square canopy roof of the Buddha’s cave temple can be said to be a kind of cave form localized in China. Its spatial style is intended to imitate the popular curtains in secular social life (Figure 4).

(2) Formation reasons:

The rise and development of Buddha altar caves were jointly driven by the reform of worship rituals, functional expansion, and cultural integration: Their emergence stemmed from the fundamental transformation

of Buddhist worship rituals after the Tang Dynasty, when the prostration ritual of “five-body prostration” became mainstream-believers required a large, flat space in front of Buddha statues for collective prostration. The central pillar of pagoda-temple caves hindered this frontal worship and thus gradually fell out of use, while Buddha altar caves, with their layout of concentrating Buddha statues on a high platform at the back and leaving an open space at the front, perfectly adapted to the new worship needs. Meanwhile, the square floor plan and spacious front hall of Buddha altar caves were particularly suitable for sutra lectures and dharma preaching; taking Cave 61 of Mogao Grottoes as an example, its massive mural depicting the panoramic view of Mount Wutai required a space for explanation, and the open area in front of the Buddha altar could accommodate dozens of listeners. Some caves were even equipped with scripture storage rooms, reflecting the functional expansion from “worship through statue viewing” to “practice through dharma listening and learning.” In terms of spatial form, the truncated pyramidal ceiling (caisson ceiling) was a typical feature of Buddha altar caves-this was not merely a structural choice, but an imitation of the “canopy” culture in Chinese secular architecture. The caisson symbolized a ceremonial canopy, and the slightly concave arched surfaces at the four corners simulated the drooping shape of curtains, creating a solemn and sacred worship atmosphere. This multi-layered metaphor of “grottoes imitating wooden structures, and wooden structures imitating canopies” highlighted the high degree of localization of Buddha altar caves in China. Compared with the “circumambulation and statue viewing” of pagoda-temple caves, Buddha altar caves integrated the dual functions of “frontal worship + collective dharma listening,” boasting higher space utilization and lower construction difficulty. As a result, they became the most prevalent type of grottoes during the Tang and Song dynasties and marked the mature form of localized Buddhist architecture in China.

Figure 4 Facade and plan of Cave-Temple



2.1.4 Nirvana Cave (Reclining Buddha Cave)

(1) Definition:

Taking Mogao Cave 158 as an example (Figure 5), this cave is a typical Nirvana cave. It is shaped like a rectangular vaulted ceiling, with a Nirvana Buddha altar on the west wall. The so-called Nirvana cave places Nirvana as the main body of the cave, without any obstruction in front, allowing the reclining Buddha statue to be prominently displayed in front of the viewer. Therefore, the plan of Nirvana caves is generally rectangular. This cave has a rectangular shape, with a depth of 7.28 meters and a width of 17.20 meters. There is a tall platform 1.43 meters high along the back wall, and on top of this platform there is a smaller platform resembling a bed, where the Buddha statue lies. This Nirvana statue is made of mud and stone, with a height of

15.6 meters. The Nirvana statue on the altar of Cave 158 depicts the scene of Sakyamuni’s Nirvana. The statue shows Sakyamuni with half-closed eyes, a smile on his lips, devoid of the pain and sadness of ordinary people’s death. Instead, he appears content and satisfied, peacefully falling asleep, vividly portraying the state of Nirvana as “extinction is bliss”.

(2) Formation reasons:

Nirvana caves construct an immersive narrative scene through spatial design and visual language. Their narrow rectangular floor plan (e.g., Cave 158 measures 7.28 meters in depth and 17.20 meters in width) is a dramatic space tailored for narrative viewing. When believers enter through the cave door, their line of sight is naturally guided by the long axis, eventually focusing on the reclining Buddha on the back wall. This spatial

sequence of “progressive revelation” accurately simulates the scene where the Buddha’s disciples mourned him from a distance to up close at his parinirvana, greatly enhancing the emotional impact of the ritual. The reclining Buddha statue (e.g., the 15.6-meter-tall one in Cave 158) occupies the entire back wall, with a scale far exceeding that of an ordinary person. This “monumental” enlargement is not a display of technical skill, but a profound expression of religious intent: it evokes awe in viewers through the sense of oppression brought by the scale, while conveying the doctrine that “the Buddha has entered parinirvana but his dharmakaya (dharma body) endures forever” - the huge body symbolizes the immortality of the Dharma.

The form of Nirvana caves inherits tradition while embodying innovation. Their narrow rectangular chambers easily bring to mind stone coffins, a design directly derived from the Indian Nirvana cave tradition. However, Mogao Grottoes made innovations that broke the limitations of Indian grottoes: Indian Nirvana caves are usually small and dim, whereas Mogao Grottoes created a bright and open space by expanding the cave width and raising the cave roof, making the reclining Buddha appear to be “peacefully asleep” rather than in a state of “death.” This atmosphere echoes the serene expression of the Buddha in murals - “smiling lips and half-closed eyes” - jointly interpreting the philosophical connotation that “parinirvana is the bliss of extinction.” Meanwhile, unlike the multi-functional Buddha altar caves, Nirvana caves are commemorative spaces with a highly specialized function, used only for displaying the scene of the Buddha’s parinirvana and not undertaking daily worship or sutra-preaching functions. Their narrow form is also not conducive to crowd gathering, and this design of “being viewable but not accessible” further strengthens the sanctity and sense of distance of the parinirvana theme.

Figure 5: Elevation of the Nirvana Cave



2.1.5 Great Buddha Grottoes

(1) Definition:

Named for the giant Buddha statues sculpted inside the cave. The great Buddha grottoes is tall and magnificent, with a square main chamber, smaller on top and larger at the bottom. The stone-constructed statues of giant Buddha are stuck to the vertical wall. Behind the Buddha’s seat, a horseshoe-shaped passage is carved out for pilgrims to pass through. Two large windows are opened in the front wall and in the middle for lighting. “great Buddha” is one of the original names of the caves that can be seen.

The Maitreya statue sits on the mountain cliff, with a stone core covered in colored clay. As the height rises, the space in the Daxiang Cave becomes smaller and smaller. The entire grotto arches upwards and narrows, with the lower part forming a rectangular plane, the top in the shape of a truncated pyramidal or a circular dome, where the junction of the grotto roof and the mural paintings appears natural with no clear boundaries (the roof of Mogao Grottoes Cave 96 is open to the sky, with a wooden structure serving as the top). The space in front of the Buddha statue inside the cave is not very wide, but when people look up to the cave ceiling, they feel the Buddha cave is lofty and profound. The lower level of the Great Buddha Cave has a door, with bright windows on the middle and upper parts serving as passages, for viewing the Buddha, and for allowing natural light. The exterior of the cave is connected to the antechamber, forming a large-scale front hall architecture. The number of floors, depths, and spaces among the various layers of the North and South Great Buddha Caves are different. The lower layer of Cave 96 is five rooms wide and three rooms deep (Figure 6), and the eaves of the cave were originally built as four layers. During the late Tang Dynasty, Zhang Huaishen added a fifth layer, but during the time of Cao Yuanzhong, it was restored to four layers. The current nine-story building is the result of repairs made during the Republic of China era. The architectural form of the

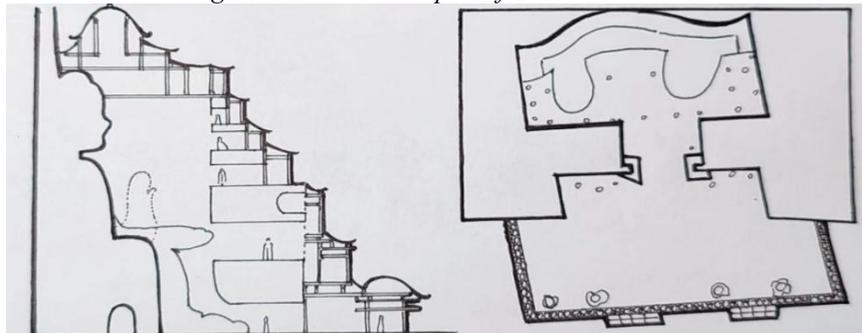
Great Buddha Cave is a combination of traditional Chinese wooden hall architecture and Indian rock cave architecture. Due to the grandeur of the towering Buddha statues and the impressive appearance of the cave eaves, the Great Buddha Cave often becomes the center and symbol of the temple where it is located.

(2) Formation reasons:

The construction of giant Buddha caves combines both political intentions and religious aspirations, and their development is often deeply tied to the religious expression of political power. Taking the Maitreya Buddha (35.5 meters tall) in Cave 96 of Mogao Grottoes as an example, it was built during the period from the Wu Zhou Dynasty to the Kaiyuan era—a peak when Buddhism was integrated into the state system. The giant Buddha statue is not only a visual manifestation of the ruler’s “merit in protecting the Dharma” but also a tool to strengthen public faith and unite the people through visual spectacle. When believers look up at the giant Buddha, secular power and religious authority achieve seamless unification. Meanwhile, constructing giant Buddha caves posed severe technical challenges: the glutenite at Mogao Grottoes could not support fully stone-carved giant statues. To address this, craftsmen innovated the “stone-core clay-sculpture” technique—first chiseling a stone core in the shape of the Buddha’s outline on the cliff wall, then applying clay for shaping and adding pigments for coloring. This composite craftsmanship not only reduced the load-bearing pressure on the rock mass but also allowed for delicate rendering of the statue’s details. Additionally, the attached multi-story wooden eaves solved issues related to lighting, rock protection, and worship paths, ultimately forming the unique “grotto + wooden structure” hybrid architectural type.

The spatial design of giant Buddha caves harbors profound intentions; their “wide at the bottom, narrow at the top” tapered space is not a construction error but a carefully planned outcome. The cramped interior space prevents viewers from seeing the entire Buddha statue at a glance—instead, they must climb up layer by layer using the multi-story platforms of the wooden eaves to view the Buddha’s feet, body, and face in sections. This “layered viewing” experience subtly metaphorizes the spiritual ladder from the mundane to the sacred, transforming the architectural space into a vehicle for spiritual elevation. Furthermore, with their massive size and striking multi-story wooden eaves, giant Buddha caves often serve as the visual and spiritual center of the entire grotto temple complex. For instance, the nine-story building of Cave 96 is visible from several kilometers away—it is not only a regional landmark but also a symbol of the supreme status of the Dharma. This strategy of “using grand scale to highlight faith” is in line with the concept in traditional Chinese architecture of expressing hierarchical order through differences in scale, underscoring the unique position of giant Buddha caves in the cultural context.

Figure 6: Elevation and plan of Cave 96



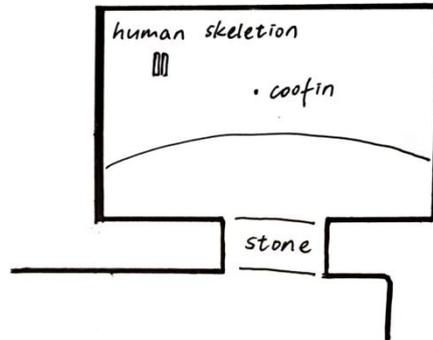
2.1.6 Burial Caves

(1) Definition:

Burial caves are used to bury the remains of monks, and some may also be used to bury deceased lay disciples. The existing burial caves in the Mogao Caves are all located in the northern area, totaling 23, dating from the Sui Dynasty to the Yuan Dynasty (with the possibility of even earlier dates). This is one of the major archaeological discoveries in the Mogao Caves. These caves have diverse forms, some resembling meditation caves, some originally modified from meditation caves or monk rooms, and some resembling cliff tombs. The

cave entrances are sealed with mud and stones, and inside there are coffin beds for the deceased. Funeral customs include supine posture, sitting posture, multi-person burial, secondary burial, sitting burial, coffin burial, cremation, etc. Some tombs contain burial goods such as silver coins, bronze coins, documents, silk, wooden dolls, pottery, while others contain no burial goods (Figure 7).

Figure 7: Plan of Cave 96

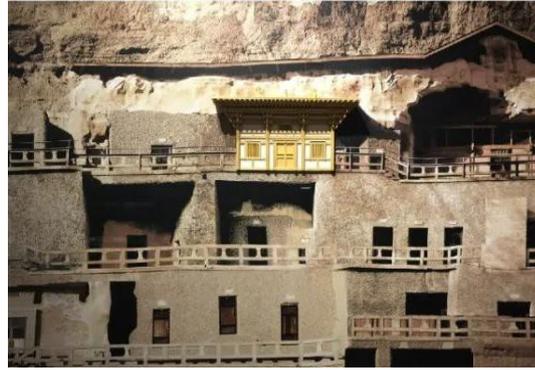


2.2 Wooden Cave Eaves

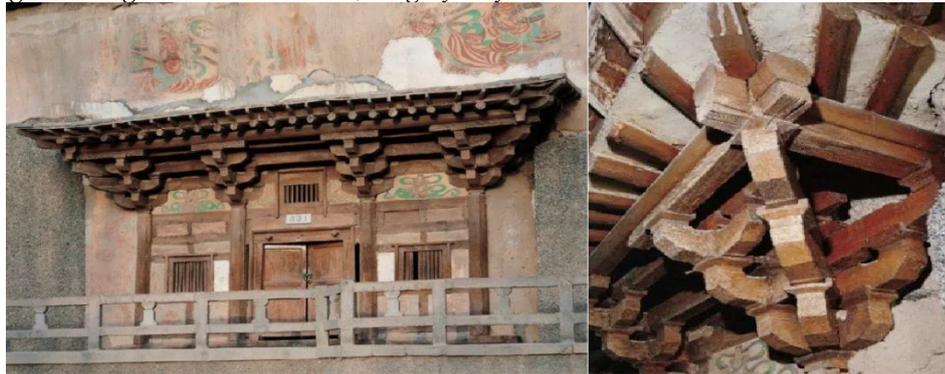
The emergence and development of burial caves are deeply linked to the localized transformation of Buddhist views on life and death, as well as the integration of diverse cultures. Their appearance reflects adjustments in Chinese monks' perceptions of life and death: while Indian Buddhism primarily practiced cremation, Chinese monks not only retained the Confucian concept of "returning to the earth for peace" but also upheld the belief of "bodies resting by Buddha caves and souls drawing near to the Dharma," holding that being buried at their practice site would keep them connected to the Dharma. The 23 burial caves in the northern area of Mogao Grottoes are precisely the material embodiment of this belief. Meanwhile, the diverse burial styles found in these caves further demonstrate the integration of different cultures—sitting burial originated from the concept of "sitting in meditation until death" (zuohua), cremation followed Indian Buddhist traditions, and supine burial continued the customs of the Han region. The presence or absence of burial objects also reflects differences in the strictness of precept observance: monks who strictly adhered to precepts had no burial objects, while more secularized monks or lay believers were buried with items such as silver coins and documents.

The spatial utilization and distribution logic of burial caves not only highlight pragmatic thinking but also imply traditional spatial planning awareness. Many burial caves were converted from abandoned meditation caves or monks' quarters; this "secondary use" not only saved resources but also realized the life-cycle continuity of "living space → practice space → burial space." The simple design of sealing cave doors with mud and stone and installing coffin beds inside stands in sharp contrast to the exquisitely decorated worship caves, directly embodying the Buddhist transcendent concept of "the four great elements (earth, water, fire, air) being empty." Additionally, all burial caves are concentrated in the northern area of Mogao Grottoes—this spatial differentiation reflects clear functional zoning planning: the southern area served as public religious spaces for worship and sutra preaching, while the northern area functioned as private spaces for monks' daily life, practice, and burial. This layout, similar to the "front court for official affairs, rear quarters for residence" pattern, draws on the spatial organization principles of traditional Chinese palaces or temples, highlighting the holistic nature of the grotto temple as a "religious community."

Figure 8: Structural diagram of Cave 431 of the Mogao Caves (From *Mogao Caves Illustrated*, Dunhuang Academy Exhibition Center)



▲ Figure 9: Mogao Grottoes Cave 431, Song Dynasty wooden eaves and outer eaves buckets



2.3 Wooden Structures and Rammed Earth Buildings

Apart from the grottoes themselves and the wooden eaves of the Mogao Caves, there are also some representative ancient buildings in the surrounding area, including both wooden structures and rammed earth buildings. The wooden structures are represented by the Song Dynasty Laojun Hall and Cishi Pagoda, which were brought down from the Sanwei Mountain. The architectural style of these buildings can be found in the murals of the Mogao Caves. Another example is the small gate built in the Qing Dynasty at the entrance of the Mogao Caves scenic area. The rammed earth buildings mainly consist of pagodas, with the most famous being the Wang Daoshi Pagoda built in the Qing Dynasty.

3. “Abstract” - Architectural Images in Cave Paintings

In addition to the concentration of buildings mentioned above, the most numerous architectural representations in Dunhuang come from the cave murals. The art style of Dunhuang murals integrates traditional Chinese art techniques and stylistic features. In terms of formal style, it is a combination of several aspects such as line drawing, decorative composition, meticulous and colorful painting, and portraying the divine through form. The Dunhuang murals reflect the cultural exchange between the Han region and the Western Regions at that time, showing the aesthetic preferences and secular characteristics of the period. The architectural images are one of the outcomes of this cultural exchange. In Dunhuang murals, except for the lack of architectural paintings in the caves of the Yuan Dynasty, from the late Sixteen Kingdoms period to the end of the Western Xia, for a period of around 800 years, numerous buildings were depicted in the murals, showing us a constantly evolving architectural history. In fact, apart from architectural images, many different types of architectural images can also be found in narrative paintings and gradual paintings, which can be further divided into architectural components and architectural scenes.

3.1 Architectural components

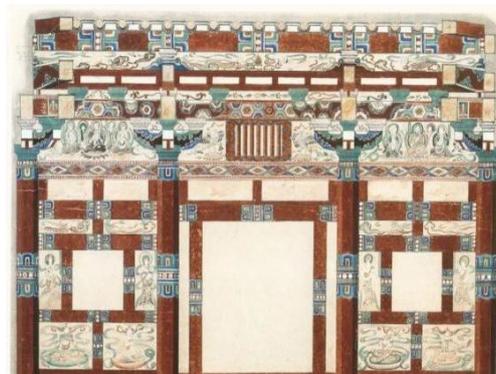
Architectural components are one of the components of cave architecture. Wall pillars on both sides of the niche are most typical, such as the octagonal pillars painted on both sides of the niche in Mogao Grottoes Cave

57 (Figure 10), with lotus patterns drawn at one-quarter intervals on the pillar bodies. Octagonal pillars frequently appeared in the Sui Dynasty caves, only appearing in Cave 57, Cave 60, and Cave 204 of the early Tang Dynasty caves, and were not seen in the caves of the flourishing and middle Tang periods. It was not until the late Tang Dynasty period that a kind of lotus bundle pillar appeared on both sides of the west niche in some caves, such as Cave 29 of the Mogao Grottoes, but due to the lack of clear interface distinction on the pillar body, it cannot be determined whether it is an octagonal pillar. In addition to images, octagonal columns can also be seen in the Dunhuang Mogao Grottoes, which are the existing wooden cave eaves from the Song Dynasty and earlier (such as Mogao Grottoes Cave 196, 427, 431, 437, 444). As seen in Figure 11, the Cave 444 has lotus and pearl patterns painted on the column heads and mid-sections of the eaves columns (Figure 11).

Figure 10. The west niche of Cave 57 - featuring octagonal columns with lotus bundles.



Figure 11: Fresco on the eaves of Cave 444 in the Mogao Grottoes



3.2 Urban Architecture

Urban architecture mainly consists of group buildings and individual buildings. Architectural scenes and images not only reflect scriptures and stories of the Buddha's teachings but also imitate real buildings. Through the analysis of architectural images in murals, we can understand the architectural forms of that time.

3.2.1 Group Buildings

Group buildings include cities, palaces, residences, and groups of Buddhist temple buildings.

(1) Fortress

Fortress as important architectural scenes for preaching and teaching by the Buddha are an indispensable part of murals. In Mogao Grottoes Cave 148, the depiction of the city of Kushinara in the Nirvana Sutra transformation (Fig. 12) includes city gates, corner towers, and city walls, with clear representations of battlements on the walls. In Mogao Grottoes Cave 9, in the transformation of the Vimilaki Sutra (Fig. 13), the city of Vaisali is depicted with a clear representation of the city gate structure. In the middle of the city platform, three gateways are depicted with visible wooden doors, noting that the method of supporting the city gate in

the mural is with wooden structures. This type of support can also be clearly seen in the city gate architecture of

Zhang Zeduan's painting *Along the River During the Qingming Festival* from the Northern Song Dynasty. The new city gate recently constructed at the site of the Dafeng Gate ruins in the Daming Palace in Xi'an, Shaanxi, was inspired by the city gate images and architectural examples found in the Dunhuang murals.

Figure 12: Mogao Cave 148, city of Kushinara



Figure 13 Mogao Cave 9, Vimilaki Sutra



(2) Residential Palace

In cave 431 of the Mogao Grottoes, the architectural complex of the “Unborn Resentment” features a Wutou Gate. According to the Tang Dynasty’s Regulations on Construction and Repair, only officials of fifth rank or higher were qualified to build such gates. Since the Song Dynasty, it has also been known as the “Lingxing Gate.” The existing Wutou Gates are mostly made of stone, and Lingxing Gates are commonly seen in Confucian temples. Wutou Gate images are found in caves 23 and 217 of the Mogao Grottoes, conveying the high status of the buildings in the murals. In cave 217, on opposite walls, one can see adjacent representations of buildings in two distinct styles, reflecting the coexistence of Chinese and Western architectural cultures in Dunhuang during the Tang Dynasty. The Cave 172 of Mogao Grottoes “Unborn Resentment” has developed into the form of a scroll painting. In addition to designating it as a palace based on the story content, the location of the story can also be identified as a palace according to the symbolic significance of the architectural hierarchy (Figure 14). Judgment basis: Qiji. In the mural, the form of flags and halberds appeared in front of the gates of the royal palace from the prosperous Tang Dynasty. This was a ceremonial system in which halberds were displayed in front of important buildings or the gates of third-rank official residences to individuals of a certain status during the Tang Dynasty, known as “Qiji”. On one side of the mural, there is a flag and eight halberds, forming a formation of nine halberds, with a total of eighteen halberds on both sides, consistent with the “Eighteen Halberds placed in front of the gates of the Eastern Palace” in Tang Liudian. Based on the comprehensive information of palace architecture and weapons, the structure in Cave 172 “Unborn Resentment” of Mogao Grottoes can be defined as a palace.

The architectural images in Dunhuang murals are not a direct representation of real buildings, as they undergo a certain level of image processing and reflect the artist’s own understanding of architecture. Real palatial structures like the Hall of Ten Thousand Years and Linde Hall in the Tang Dynasty Chang’an Daming Palace were found to be 11 bays wide in archaeological excavation reports. However, the main hall structures in Mogao Grottoes Cave 172, Cave 320, and Cave 148 mentioned above do not exceed five bays in width. In other words, when Dunhuang murals mimic real architecture, they will process the images according to the content and proportion occupied by the individual buildings and will not depict architectural styles that fully express the level of buildings. Despite the main function of murals being to depict Buddhist stories, with buildings often serving as background, and even though there is a tendency towards image simplification during painting, the level of architectural complexes can still be judged and the type of architecture can be understood by examining details such as city gates, tall spears, and pointed gates.

(3) Buddhist Temple Architectural Complex

Buddhist temple architecture is the most abundant type of architecture in Dunhuang murals. The depiction of Buddhist temple images in murals also shows significant differences influenced by factors in the history of painting. From the simple and flat architectural style in the Sui Dynasty murals, the exploration of perspective

in the early Tang Dynasty, to the murals of the Song Dynasty and the late Western Xia period, each period presents a different appearance.

During the peak period of the Tang Dynasty, the method of drawing rituals continued the one-style painting of the early Tang Dynasty. Among them, the murals depicting the Infinite Life Sutra, the Amitabha Sutra, and the Medicine Buddha Sutra mainly showcase large temple complexes. Due to the enlargement of the ritual paintings, the details of the buildings and their relationships with figures are portrayed in greater detail. As shown in the Maitreya Sutra in Cave 148 of the Mogao Caves, people are mainly outside the buildings (Figure 15); in the Cave 217 of the Mogao Caves, people are active inside the buildings. The main figure in Cave 217 (here mainly referring to the Dharma) is in a relationship of parallelism with the architecture. In the center of the Dharma, there is a lotus pool and terrace where the Buddha and bodhisattvas, as well as heavenly beings, are located. There are front and rear Buddha halls on the central axis, with a tower, pavilion, platform, and stele on each side of the front hall, and a platform under the rear Buddha hall, with a surrounding corridor around the Buddha hall. The main characters are in the front, with the architectural background behind them. The proportions of the Buddhist temple are suitable, making the architecture part of the preaching scene. Additionally, for the first time in this mural architectural group, there is a combination of a bell tower and a scripture hall.

Figure 14: Cave 148 of Mogao Grottoes - The Transformation of Maitreya Sutra



Figure 15: depicts Mogao Cave 217, illustrating the transformation of the Sutra of Immeasurable Life.

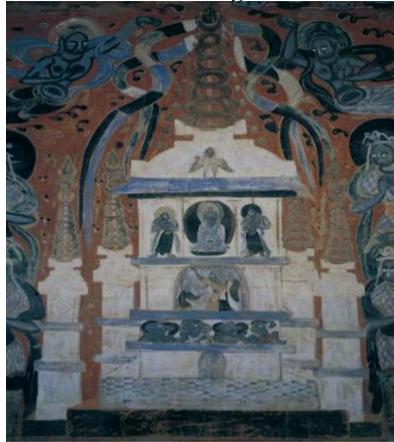


3.2.2 Single Building - Pagoda

The pagoda was introduced to China along with Buddhism and is a building with religious commemorative characteristics. The shape of the pagoda is based on the traditional Chinese multiple-story building, with the addition of an Indian stupa-style tower as the pinnacle. However, from the perspective of the existing mature pagodas, they are all based on the traditional Chinese multiple-story building, integrated with the Indian stupa-style tower as the pinnacle, and completely sinicized. Pagodas are often combined with famous mountains and rivers, becoming part of scenic spots and landscapes. In Cave 428, the west wall painting of the “Diamond Throne” style pagoda group consists of five square pagodas (Figure 16). The central pagoda is comparatively taller and larger, with two levels of step-like platform at the bottom, and a base at the top. The base itself

is divided by a flat balustrade into two sections, with a semi-circular door in the center of the lower section, allowing access to the interior of the pagoda. On the upper section, there are four guardian figures depicted on the front. The pagoda has two levels, with a stupa on top as the wheel base.

Figure 16 Diamond Throne Tower - Mogao Grottoes Cave 428, West Wall



4. Reality and Dunhuang - The Collision of Dunhuang and Modern Architecture

The Dunhuang Mogao Caves are famous for their unique murals, sculptures, and architecture, reflecting the social, cultural, and religious conditions of the time from a multi-dimensional sensory perspective. In contemporary Chinese architectural design, designers often draw inspiration from tradition and incorporate decorative elements, composition methods, and architectural features of the Dunhuang Mogao Caves in modern architecture in order to achieve an integration of traditional art and modern aesthetics.

4.1 Architectural Elements

In modern architecture, elements such as caisson ceilings, lotus column heads, and beam-lifting are often added to the architectural murals based on the Dunhuang cave murals, also Wooden eaves bracket sets inspired by the Tang and Song dynasties, as well as barrel tile roofs, memorial archways, doors and windows, and architectural construction drawings. These buildings, after integrating various Dunhuang elements, have their own unique characteristics.

4.1.1 Dunhuang International Convention and Exhibition Center

The design inspiration for the Dunhuang International Convention and Exhibition Center comes from the architectural styles of the Han and Tang dynasties, combining traditional and modern elements to fully display the majestic and solid architectural style of the Han and Tang dynasties. (Figure 17)

Bracket sets are a unique architectural structure in Dunhuang ancient architecture, and also the most exquisite and decorative part of ancient buildings. In the design of bracket sets in interior decoration, it is necessary to strictly follow the construction proportions in the Treatise on Architectural Methods, carefully consider the construction and proportion relationships within each bracket set, such as the pillar sets, flower sets, and scattered sets, and also to fully reflect their visual impact in the space. Only in this way can the bracket sets be unified with the overall structure and possess rationality. The difficulty in the overall space design lies in the additional short column between the two large beams above the entrance hall due to structural reinforcement. This challenge was ultimately resolved by designers, as seen in the ancient partition bracket sets, and it was well resolved.

Typical features of Dunhuang ancient architecture, such as the caisson-style coffered ceiling and auspicious cloud patterns, have been integrated and applied to modern architecture by blending with modern styles and materials. In the exhibition center, columns and bases are carved with cloud and wave patterns, with the walls made of silk beige stone and the floors made of ocean beige stone, symbolizing the theme of the Belt and Road Initiative. Soft membrane lights are used to create a simple, modern atmosphere without losing the grandeur of the Han and Tang dynasties. (Figure 18)

Figure 17 Dunhuang International Conference Exhibition Center



Figure 18: Entry Hall of Dunhuang International Convention and Exhibition Center



4.1.2 Puzhiyuan rammed earth walls

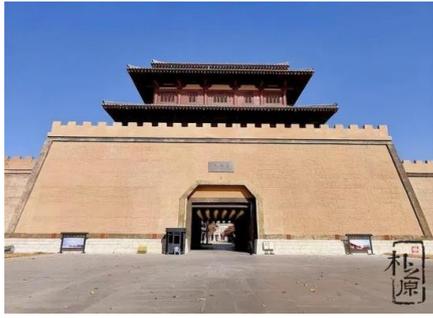
Puzhiyuan, to meet the needs of museums, science and technology museums, art galleries, libraries, art centers, commercial office buildings, theaters, hotels, villas, B&B, etc., to achieve the unity of architectural form and connotation, to achieve a professional organization of modern architecture and decorative arts, dedicated to the integration and shaping of architectural aesthetics, its The company's rammed earth walls and hanging panels, designed naturally, are custom tailored with personalized high-quality craftsmanship, offering exclusive taste.

Rammed earth walls, as a typical earth building form in the Gansu region, are also a traditional building style used in Dunhuang, visible everywhere in and out of Dunhuang. Residential buildings use locally sourced materials, combining earth and rammed earth walls with green and environmentally friendly regional characteristic materials. In addition to using local poplar wood as the main material, the combination of adobe and rammed earth walls is also employed.

Rammed earth walls, as a building technique originating from ancient Dunhuang architecture, have gradually shown their unique application value and charm in the design of tourist attractions. Firstly, rammed earth walls inject a strong humanistic atmosphere into tourist attractions with profound historical and cultural connotations. In the design of various tourist attractions like ancient cities, towns, or landmarks, rammed earth walls serve as important architectural elements that not only protect and restore historical buildings, but also allow visitors to deeply experience the rich historical and cultural heritage. Its unique texture and color make rammed earth walls an important architectural element. (Figure 19) Secondly, the flexibility and malleability of rammed earth walls in the design of tourist attractions provide designers with more creative space. Rammed earth walls can be combined with various modern building materials and technologies to create diverse facade effects and spatial forms, meeting the needs of different styles and themes of attractions. For example, in some ecotourism attractions, designers can utilize the ecological characteristics of rammed earth walls to integrate them with the surrounding natural environment, creating a landscape effect of returning to simplicity and reconnecting with nature. (Figure 20)

▲ *Figure 19*

Figure20 Pu Zhiyuan modern rammed earth wall project



4.2 Mural paintings and pattern elements

4.2.1 The “Flying Apsara” in Dunhuang murals

“With white jade hands holding lotus, lightly stepping in the sky. Draped in neon silks with long ribbons, lightly floating up towards the sky.” This is a poem praised by the Tang Dynasty poet Li Bai during the most prosperous period of Dunhuang “Flying Apsara” culture. The “Flying Apsara” in Dunhuang murals have been present alongside the 492 caves of the Mogao Caves since the Sixteen Kingdoms period. Over a thousand years, the postures, artistic conception and style of the Dunhuang “Flying Apsara” have continued to change due to the succession of dynasties and the continuous influx of Western culture.

(1) “Big Air Shougang” - When intangible cultural heritage meets the Winter Olympics

“Big Air Shougang” - the ski jumping platform at the Beijing Shougang old industrial park, serves as the venue for the freestyle skiing and snowboarding events at the 2022 Beijing Winter Olympics. Its design incorporates elements of the “Flying Apsara” from Dunhuang murals - a Chinese world cultural heritage (Figure 21). Since its creation, the Dunhuang “Flying Apsara” image carries a deep meaning of free soaring, which aligns perfectly with the Winter Olympics design concept, continuously integrating and innovating Indian culture, Western Region culture, and Central Plains culture to create a complete and unique Chinese flying sky(Figure 22).

Figure 21: Flying Apsara in Mogao Grottoes Cave 305



Figure 22: Big Air Shougang



(2) “Ice Ribbon” - National Speed Skating Oval (Figure 23)

The design of the “Ice Ribbon” - National Speed Skating Oval was actually a recollection of childhood games of “ice spinning top” and the Dunhuang “Flying Apsara” culture by the project director, Chang Yafei. Chang Yafei’s ancestors have been devoted to the study of the Dunhuang Grottoes, which has left a deep impression of Dunhuang art on him. The Flying Apsaras on the grotto murals are not wings born from stories told by his grandmother, but rather freely soaring in the sky with a colorful floating ribbon. Thus, the artistic conception and inspiration of Dunhuang “Flying Apsaras” inspired the design team. Based on the dynamic image of the “ice spinning top”, the design team boldly innovated, creating 22 rotating “ice ribbons” on the exterior facade of the venue, perfectly adding a dynamic artistic conception to the venue and cleverly symbolizing the thrilling moments of speed skaters in high-speed motion. The “ice spinning top” and Dunhuang “Flying Apsaras” ultimately led to the magnificent birth of the “Ice Ribbons”- National Speed Skating Oval, which also transitioned realism to expressiveness in Chinese traditional culture.

Figure 23: National Speed Skating Oval



4.2.2 The Banquet Hall of the Great Hall of the People

The Great Hall of the People is a symbol of China's National Conference Center, as well as a witness to the construction of New China and national unity. It is a solemn and sacred presence, and its architectural design should be overall dignified and elegant. The Tang Dynasty Dunhuang pattern design is in line with this style, fully able to express the theme of architectural design. In particular, the ceiling design of the banquet hall is a perfect combination of art and function.

The ceiling flower lamp in the banquet hall of the Great Hall of the People (Figure 24) was designed by Chinese master of arts and crafts, Chang Shana. Chang Shana is deeply influenced by Dunhuang culture, and in her decorative design of the "Top Ten Buildings", we often see shadows of Dunhuang patterns. The design inspiration for the giant relief flowers comes from Dunhuang caisson patterns (Figure 25) and combines the design concept of flower lamps for ventilation and lighting. Chang Shana incorporates Dunhuang elements into these works, presenting the cultural essence of Dunhuang in a more vivid manner to the public.

Figure 24: The ceiling flowers in the banquet hall of the Great Hall of the People in Beijing



Figure 25: Mogao Grottoes Cave 31 of the Tang Dynasty caisson pattern



4.2.3 Lanzhou Ningwozhuang Hotel

The design concept of Ningwozhuang Hotel is based on the Dunhuang culture, a World Cultural Heritage of China. With golden color as the main tone, using murals, chimes, stone pillars and other Dunhuang characteristic elements, it presents the brilliant humanistic style of the millennium Chinese land and Gansu land, providing domestic and foreign travelers with a unique cultural experience.

5. Conclusion

This study has three core findings in the field of Dunhuang architectural art: First, Dunhuang architectural art presents dual-dimensional characteristics of "reality" and "abstraction". In the "reality" dimension, the physical buildings of the Mogao Grottoes (including 6 types of cave buildings, wooden cave eaves, and surrounding wooden/rammed earth buildings) have unique forms that adapt to functional needs. For instance,

Tower-Temple Caves are used for circumambulating the tower and worshipping, while Hall Grottoes are suitable for worshipping the Buddha and preaching scriptures; these buildings also reflect the early integration of Chinese and Indian architectural styles. In the “abstraction” dimension, the architectural images in murals (covering components, building complexes, and pagodas) fully demonstrate the evolution of architectural history from the Sixteen Kingdoms period to the Western Xia Dynasty, serving as important historical materials. Second, the modern transformation of Dunhuang architectural elements is both innovative and culturally valuable. Rammed earth techniques, bracket set patterns, and “Flying Apsara” motifs have been applied in projects such as Puzhiyuan, Dunhuang International Convention and Exhibition Center, and Winter Olympic venues, realizing the integration of traditional culture and modern functions. Third, the Mogao Grottoes are a key witness to ancient cultural exchanges between China and the West. Both the physical buildings and mural architectural images reflect the collision of diverse cultures on the Silk Road, and they also serve as a microcosm of the evolution of traditional Chinese architectural art.

By establishing the dual-dimensional “Reality-Abstraction” framework, this study not only expands the research perspective on Dunhuang’s architectural art but also provides new methodological insights for the study of Chinese traditional architectural history: physical buildings and image materials should be treated as complementary historical evidence to jointly construct a more comprehensive cognitive system of architectural history. The Dunhuang case proves that when the remains of physical objects are limited, architectural images in murals can serve as important “texts” to reconstruct lost architectural forms and spatial relationships. This method is equally applicable to the study of other historical heritage sites with abundant image materials.

However, the study still has limitations in three aspects: First, the research scope is relatively narrow, focusing mainly on the core area of the Mogao Grottoes, with little coverage of contemporary architectural remains in surrounding Dunhuang areas (such as ancient city ruins and folk traditional buildings), failing to fully present the overall architectural and cultural landscape of the region. Second, the analysis of modern applications lacks depth, remaining mostly at the level of case enumeration; it does not deeply explore the internal logic of “cultural symbol extraction - technological adaptation - cultural connotation inheritance” nor address issues of cultural simplification and formalization (e.g., some buildings only adopt superficial patterns without exploring in-depth cultural meanings). Third, the degree of interdisciplinary integration is low. The study primarily focuses on analyzing architectural forms and artistic characteristics, lacking cross-disciplinary collaboration with history, sociology, and materials science. This makes it difficult to fully explain the social drivers behind architectural evolution (such as the impact of religious dissemination and political changes on architectural functions) and the path of modern innovation for traditional architectural techniques (e.g., rammed earth and wooden structures).

Future research can advance in four directions: First, expand the research scope to cover the entire Dunhuang region, incorporating ancient cities, village traditional buildings, and other samples, and compare the connections and differences between Mogao Grottoes architecture and folk architecture to improve the regional architectural and cultural system. Second, deepen the systematic study of modern applications by establishing an evaluation framework for the modern transformation of Dunhuang elements (including cultural fidelity, functional adaptability, and technical feasibility) and exploring the adaptation rules for different scenarios. Third, promote interdisciplinary integration: combine history to explore the social and religious drivers of architectural evolution, collaborate with materials science to improve traditional techniques, and use digital technologies (such as 3D modeling and VR) to achieve digital restoration and virtual display of Dunhuang architecture. Fourth, focus on the connection between architecture and humanistic life, study the interaction between buildings (e.g., Zen Caves and Burial Caves) and the daily lives of ancient people, explore the humanistic connotations behind the architecture, and enrich the research dimensions. References.

As a crystallization of Silk Road civilization, the study of Dunhuang’s architectural art extends far beyond the scope of architecture itself, encompassing multiple themes such as cultural identity, heritage preservation, and innovative design. With the development of digital humanities technology and the deepening of interdisciplinary cooperation, we have reason to expect that Dunhuang architectural research will open a new chapter and provide a “Chinese solution” for the dynamic utilization of global cultural heritage.

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Conflicts of Interest

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