

# A STUDY ON DIGITAL RESTORATION METHODS OF DISAPPEARING HERITAGE—TAKING THE SOUTH GATE OF SHANGJING PALACE CITY IN LIAO DYNASTY AS AN EXAMPLE

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**KEY WORDS:** Disappearing Heritage, Digital Restoration, Methodological Process, Shangjing of the Liao Dynasty, South Gate of the Palace City.

## ABSTRACT:

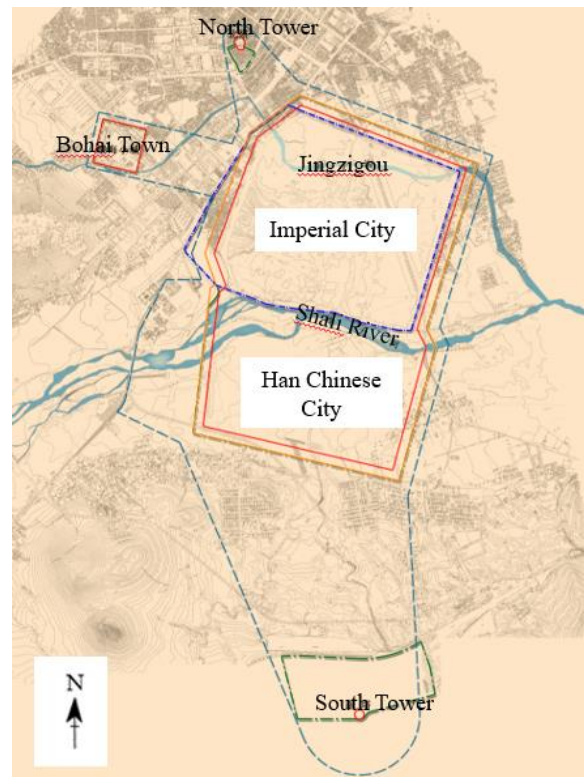
The process of digital restoration of lost cultural heritage often takes a lot of effort and it is difficult to judge the accuracy of the restoration. In this paper, we propose a set of basic methods and processes for digital restoration based on the lost heritage by mining materials and information, and can trace the evidence based on the restoration results. Taking the restoration of the South Gate of the Shangjing Palace in the Liao Dynasty as an example, this paper introduces the methods and processes of establishing a database of restoration materials and identifying relevant information, restoration design steps and accuracy assessment in the process of digital restoration, and finally realizing the digital presentation of the lost heritage. It is hoped that this paper can provide problem-solving ideas and methods for workers in the field of digital restoration of vanished heritage.

## 1. INTRODUCTION

### 1.1 Background

The Liao Dynasty Shangjing was the capital city established at the beginning of the Khitan Empire. Historically, there were five capitals in Liao, namely, the Shangjing Linzhufu, the Zhongjing Dadingfu, the Zuoging Liaoyangfu, the Nanjing Yazinfu and the Xijing Datongfu. Shangjing was the first of the five capitals of Liao and was the political center of Liao, with its address in today's Balinzuo Banner of Inner Mongolia Autonomous Region. Generally speaking, the construction of the Liao upper capital reflected the Han imperial power idea and preserved the custom of the Khitan tribe. It was the first capital city established in the grassland region by the minority groups in the north, and the creation of the intermingling of nomadic and agricultural civilizations.

In the Liao Dynasty, Shangjing City was divided into two cities: the northern city was called Huangcheng (Imperial City), which was the residence of the imperial family, and the southern city was called Hancheng (Han Chinese City), which was the residence of the Han people. The two cities are connected in the shape of a "sun" (Figure 1). This city, which existed for more than 200 years (918-1120), has a blend of nomadic and agrarian civilizations, and is the only physical object that can be used to study the diversity of urban construction in the Liao Dynasty. Some archaeological work has been carried out for the South Gate of Shangjing Palace City in Liao Dynasty, but there are few historical archives, so it is difficult to carry out accurate digital recovery. There are palace cities within the Imperial City. This time, we take the architectural restoration of the South Gate of Shangjing Palace City in Liao Dynasty as an example to give a general introduction to the restoration method of vanishing heritage.



**Figure 1.** The overall layout of Shangjing City in the Liao Dynasty

### 1.2 Relevance

The site of the palace city of Shangjing in the Liao Dynasty has been basically clarified in terms of scale, architectural layout

and format after excavation. For the restoration of the south gate of the palace city, we can only search for as much information as possible about the original appearance and pay more attention to observation and analysis from the little information available.

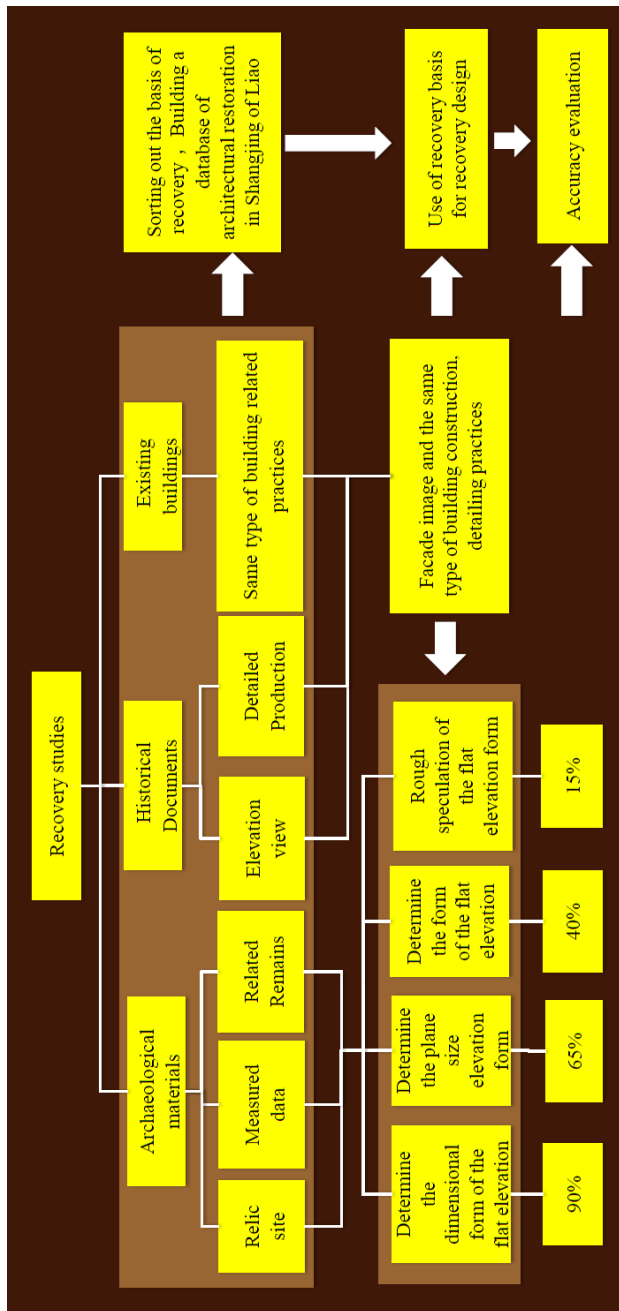


Figure 2. Overall idea of recovery study

For the restoration of the South Gate of the Shangjing Palace in the Liao Dynasty, archaeological information is the most reliable information for the restoration study, supplemented by ancient documents and buildings of the same period as evidence. The digital restoration is carried out based on the principle of conformity to reason and the search for the principle that is most likely to be close to the original state of history.

## 2. SOLUTIONS

### 2.1 Preliminary work

Collect as much information as possible that can be verified at present. We will sort out archaeological information, historical documents and existing buildings as the basis for restoration, and establish a database for restoration of Liao Dynasty buildings in Shangjing. We will give priority to the use of archaeological information as the basis for restoration, and use historical documents and buildings of the same period as the basis for reference and corroboration.

Based on the establishment of the restoration database, different information was set to solve which type of problems of building restoration and to make preliminary judgments on the accuracy of restoration. This resulted in the overall idea of restoration research (Figure 2).

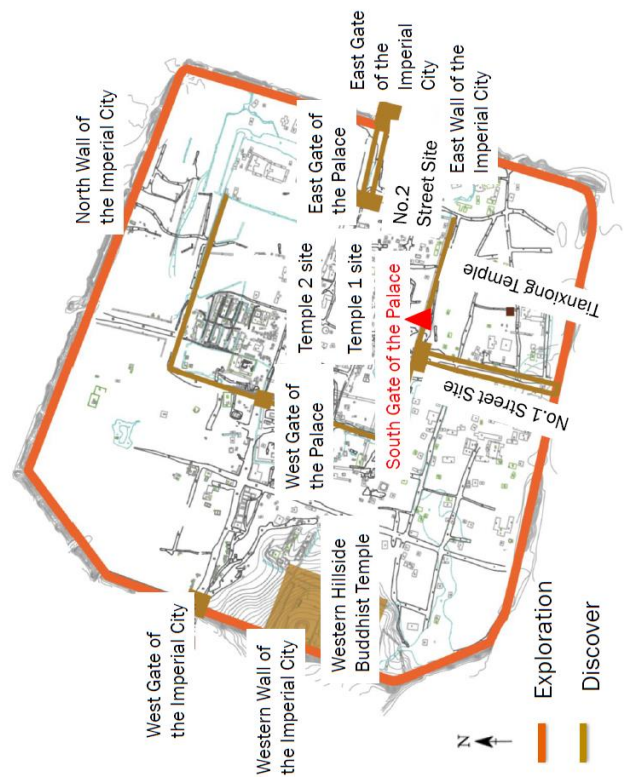


Figure 3. Location map of archaeological sites

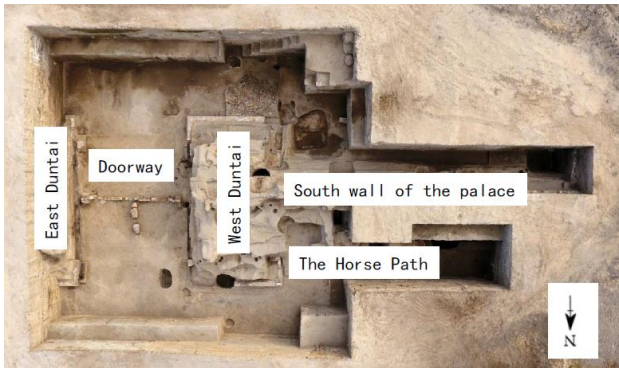
### 2.2 Specific methods

**2.2.1 Composing archaeological data:** The archaeological materials used in this time are mainly, the exploration and excavation report on Shangjing of the Liao Dynasty in 1994 and the archaeological excavation reports of the Institute of Archaeology, Chinese Academy of Social Sciences, Inner Mongolia Task Force 2 and Inner Mongolia Institute of Cultural Relics and Archaeology in 2011-2016. Based on the combed archaeological data, the distribution locations of the archaeological sites involved in the archaeological reports were mapped (Figure 3).

Archaeological data is the core basis for architectural restoration, and restoration studies will start from

archaeological data to complete the related work. This part of the restoration is the most accurate. The part that cannot be restored using archaeological data will lead to a decrease in the accuracy of restoration.

From the archaeological data, it is known that the southern gate of the palace (Chengtianmen) mainly consisted of the city wall, Duntai on both sides, the doorway, the horse path, and the wooden gatehouse building on top of the Duntai (Figure 4). Based on the remains of rammed earth and the piles of collapsed bricks and tiles inside and outside the doorway, it can be judged that there was a wooden gatehouse building above the gate.



**Figure 4.** Top view of the site of the South Gate of the Liao Shangjing Palace

The rammed earth Duntai platform is well preserved, of which the west Duntai platform has been revealed to be 11.8 meters long from north to south, 6.65 meters wide from east to west, with a residual height of 2.05-3.25 meters. The side walls of each side of the Duntai wrapped brick, only the bottom few layers now exist, the bottom of the wrapped brick wrapped edge stone foundation is better preserved. East and west rammed earth pier platform in the middle of a single doorway, depth 8.2, width of about 7.8 meters. In situ, the general stone, stone door limit and door anvil stone and other facilities are preserved. The foundation of the gate on both sides of the doorway is a wooden ground medical device on top of a stone pillar base and a row of forked columns. There are 6 stone pillar bases on each side, i.e. the depth of the gate way is 5 rooms.

At the same time, according to archaeological data, the south gate of the palace has been built four times. The first construction, for the east and west walls between the inner columns, not seen protruding from the walls of the Duntai. The second time outside the city wall to expand the Duntai, Duntai four walls outside the plaster. Immediately inside the city wall with a horse path to the Duntai. The foundation practice of stone pillar base, wooden ground medical device and row of fork pillars began to be used in the gate way.

The third and fourth camps were built in different periods, and the practice is to cut down the old rammed earth Duntai. The difference is that the side walls of each side of the third camp Duntai are coated with white ash, while the side walls of each side of the fourth camp Duntai are wrapped with bricks based on the strips of stone, and the side walls of the horse path are also wrapped with bricks. The first construction should be started in early Liao Dynasty; the second addition of Duntai may be related to the "construction of Chengtianmen" by Emperor Taizong of Liao.

**2.2.2 Research on historical documents:** The main ones are the "History of Liao", Dunhuang murals, and the construction method. The "History of Liao" records about the process of building the Shangjing City and its layout. The "History of Liao - Geography" records the reason of building the south gate of the palace city, its name and the height of the imperial city wall.

The South Gate of the Palace City was built only 30 to 40 years after the fall of the Tang Dynasty (907 AD) and presumably retains a significant Tang Dynasty style. Dunhuang murals depicting the form of city gates and towers in the late Tang period can be used as reference material for the design of the south gate of the palace.

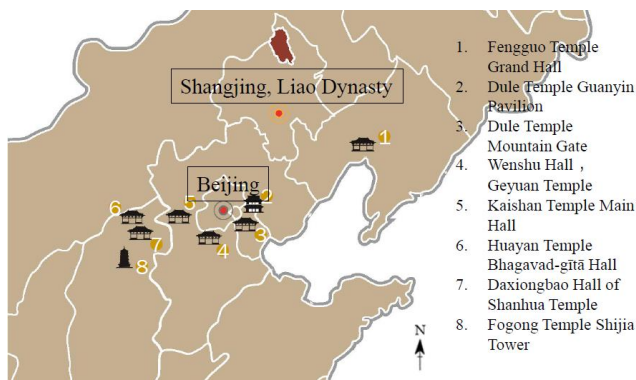
The "Building Method"(Ying Zao Fa Shi) is the most complete book on building techniques in ancient China, published in 1103 AD in the Northern Song Dynasty. It also corresponds to the date of the site we are restoring. Therefore, this book becomes one of the references of historical documents in the restoration design.

Building Name	Era	Location	Number of rooms	Building Scale
Guangren Temple Main Hall	Tang Dynasty 831	Zhonglong Village, Richeng, Shanxi Province	5*3	11.48m*4.94 m
Huayan Temple Bhagavad-gitā Hall	Liao Dynasty 1038	Datong City, Shanxi Province	5*4	25.69m*18.46 m
Fengguo Temple Grand Hall	Liao Dynasty 1020	Yi County, Liaoning Province	9*5	48.56m*26.30 m
Kaishan Temple Grand Hall	Liao Dynasty	Xincheng County, Hebei Province (Gaobeidian)	5*3	————
Shanhua Temple Daxiongbao Hall	Liao Dynasty	Datong City, Shanxi Province	7*3	42.00m*28.00 m
Dule Temple Gate	Liao Dynasty 984	Ji County, Tianjin	3*2	16.76m*8.76 m
Dule Temple Guanyin Pavilion	Liao Dynasty 984	Ji County, Tianjin	5*4 ( two layers )	20.23m*14.26 m
Baoguo Temple,	Northern Song Dynasty 1013	Ningbo, Zhejiang Province	3*3	12.07m*13.36 m
Hualin Temple Grand Hall	Northern Song Dynasty 964	Fuzhou City, Fujian Province	3*4	15.87m*14.68 m
The main hall of Zengguo Temple	Later Han dynasty 963	Pingyao County, Shanxi Province	3*3	11.57m*10.77 m
Chongming Temple Central Buddha Hall	Northern Song Dynasty 971	Gaoping, Shanxi Province	3*2	————
Longmen Temple Grand Hall	Northern Song Dynasty 1098	Pingshun County, Shanxi Province	3*3	————

**Table 1.** Table of Architectural Examples of Major Reference Remains in the Restoration of Shangjing of Liao

**2.2.3 Study of Existing Buildings:** The similar cases that can be referred to in the restoration design were selected in terms of age, location, depth of opening, size and type of building materials. After finishing, we have formed the distribution map of extant Liao dynasty wooden buildings (Figure 5), the genealogy map of extant buildings and the list of extant Tang, Liao and Song dynasties buildings, among which Table 1 is the main reference examples of extant buildings in the restoration of Liao dynasty Shangjing.

**2.2.4 Restoration design:** Firstly, the general plan of the South Gate of the Palace was designed and drawn, and the image map of the site and the archaeological report of the South Gate of the Palace were compared repeatedly to determine the dimensions of the plan and the relationship between the main components (Figure 6).



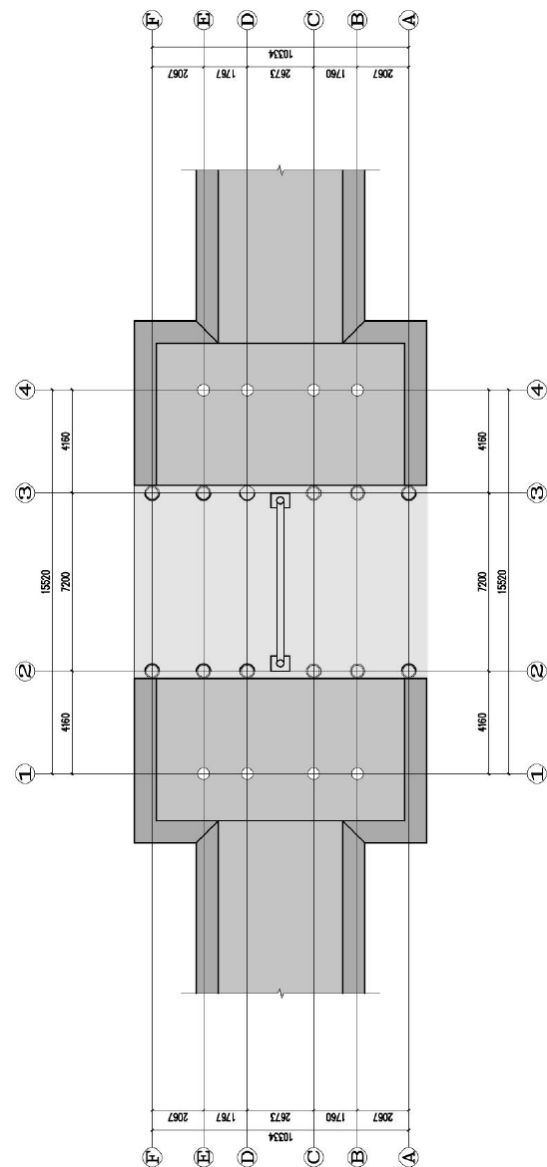
**Figure 5.** Distribution of extant wooden structures of the Liao Dynasty

Then, the archaeological data, historical documents and related practices of existing buildings of the same type were studied and analyzed in detail, and the analysis resulted in diagrams and information materials for further restoration design. The design of the restoration of the south gate of the palace city includes in-depth analysis and research on the Duntai, battlements of the wall, the framework of the gate way, the foundation of the building of the city tower, the large woodwork, the roof, the doors and windows, etc.

In view of the length, here is an example of the research and design process of the city Duntai. At present, only the archaeological plan dimensions of the city pier are available, and the complete restoration of the city Duntai also requires the height, the Shoufen (tilt angle), and the shape of the Duntai. The height of the city Duntai is inferred from the "Construction Method" and "History of Liao".

In the Song Dynasty, the "Construction Method" records that there are three basic height to width ratios for walls: 2:3 for city walls, 2:1 for exposed walls, and 3:1 for general walls, so the height of walls and piers can be inferred from the height to width ratio of walls. According to the height to width ratio of the city wall is presumed to pier height 6.5m, and according to the "construction method" volume six "version of the door" provisions to judge the width of the version of the door should be equal to or less than its own height. Archaeological data recorded that the width of the south gate of the palace was about 7.8m, minus the width occupied by the rows of columns on both sides of the gate, the width of the gate is about 7.5m, and the height should be greater than or equal to 7.5m. Therefore, the

height of the Duntai is not accurate based on the height to width ratio of the city wall in the "Construction Method".


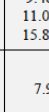







**Figure 6.** General plan of the restoration of the south gate of Miyagi

In the History of Liao - Geography, there is a description of the height of the walls of the Imperial City in Shangjing of Liao, but there is no description of the walls of the Palace City. From the description of the imperial city, the height of the imperial city wall is about 9 m. The palace city wall is larger than the imperial city wall in terms of grade, so assuming the height of the palace city wall is 9 m, the height of the city pier is about 11 m according to the calculation of the battlements of the city wall of 2 m. Comparing the two projections, the latter is more reasonable and the height of the Duntai is finally selected as 11 m.

The design of the Shoufen (tilt angle) of the Duntai also took some efforts. Firstly, were analyzed the closing score of the walls in the ancient literature (Table 2), and compared the examples of the walls in Tang and Song dynasties, we found

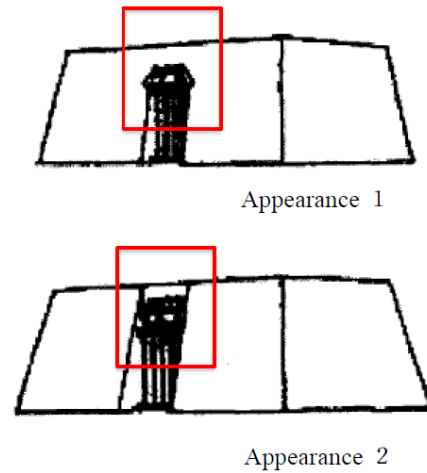
that except for the level of the city, which influenced the size of the wall profile to a certain extent, the height of the walls did not change much, and the height to width ratio of the walls changed from less than 1 to more than 1 in Tang dynasty, which became thicker and transitioned from steep to heavy. Based on the characteristics of the transition from steep to thick, and the fact that the closing score is about 25%, the closing ratio of the walls and Duntai of the Liao Dynasty Shangjing Palace City is initially set at 20%.

Name of ancient book	Date of publication	Wall size (Unit: m)			Shou Fen (Tilt angle)	Cutaway illustration
		Base width	top width	Height		
<i>Wu Jing Zong Yao</i>	1040—1044 A.D.	7.900	3.950	15.800	12.5%	
		15.800	9.480	15.800	20.0%	
<i>Zhongshi Menxia Zhucheng Kanyang</i>	1077 A.D.	4.740	3.160	6.320	12.5%	
<i>Ying Zao Fa Shi</i>	1103 A.D.	18.960	12.640	12.640	25.0%	
<i>Shou Cheng Lu</i>	1172 A.D.		4.740 5.056 6.32	9.480 11.060 15.800		
		11.85	5.056	7.9	43.00%	
<i>Kuai Ji Zhi</i>	1201 A.D.	15.800	9.480	12.640	25.0%	
		13.809	8.437	11.060	24.3%	
<i>Shu Xue Jiu Zhang</i>	1247 A.D.	23.700	9.480	9.480	75.0%	

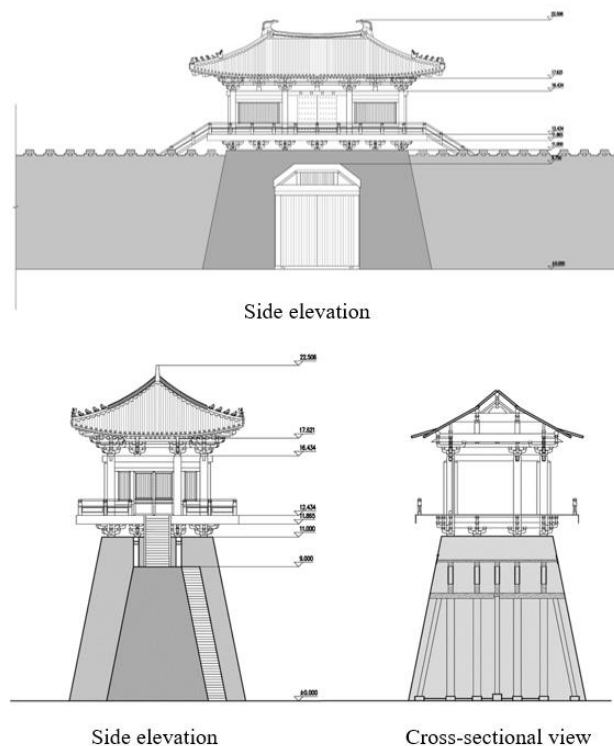
**Table 2.** Study table of the Shoufen (tilt angle) of the city walls in ancient documents

There is no record of the shape of the Duntai in archaeological materials. According to the Dunhuang frescoes and other materials analysis can be seen that there are generally two kinds of Duntai: one is a more complete appearance, the wall above the doorway and the central pier on both sides together. The other is more broken, the Duntai is divided into two by the doorway, the city pier protrudes, the doorway indented, the wall on the doorway vertical not inward tilt. This type has only appeared in the Yuan "Wanghai Lou" and Taian Dai Temple. From this, it can be seen that the former form prevailed in the Song Dynasty and before, and the latter in the Song Dynasty and after. Therefore, the Duntai of the south gate of Shangjing Daini in Liao Dynasty adopts the first form (Figure 7), whose appearance is a whole, and the wall above the doorway and the Duntai on both sides are connected together.

Each special item has many small items, and after similar in-depth analysis and research as above, we finally finish the restoration design of the south gate of the palace city (Figure 8). We will evaluate the accuracy of each restoration design after the whole design is completed. We will be responsible for our own restoration design and also lay the foundation for subsequent research.



**Figure 7.** Duntai shape diagram



**Figure 8.** Restoration of the south gate of Miyagi in plan, elevation and section

### 3. CONCLUSION

The process of digital restoration design of the disappeared cultural heritage needs to be carried out in a practical manner, paying attention to the summarization and sorting of research results and forming a database of restoration bases. In the process of restoration design, in-depth research and design should be conducted for each sub-item, which is conducive to the accurate control of the whole architectural image. At the same time, attention should also be paid to the cross-corroboration between different data, so that multiple data

should form a closed loop of evidence chain. In this way, the digital restoration results will be able to stand up to scrutiny.

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