Re - exploration of the Possible Original Appearance of the Yongning Temple Pagoda in Luoyang during the Northern Wei Dynasty [1]

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Translated by Qijun Wang

Contract: In the 1980s, the author paid close attention to the research on the Pagoda of Yongning Temple in Luoyang, Northen-Wei Dynasty(386-534) and tried to discuss the possibility of the original situation, but stopped because of lack of data. In the 1990s, two scholars of architectural history carried out original restoration research on the pagoda of Yongning Temple on the basis of archaeological materials. After that, the author participated in the restoration of Yongning Temple Pagoda again due to a special reason. Based on the historical records of Yongning Temple Pagoda and the characteristics of the number "seven" existing in archaeological excavations, combined with the proportion rules of Chinese and Japanese pagodas in the tower body in similar times, complete a discussion of possible restoration of the original state. However, there have always been some doubts about the proportions and figures in this study. In the following years, the author reconsidered and reanalyzed the number "nine" in the records of the plane and the height of the tower body at the archaeological site, and the possible data control effect of this number in the ratio of the plane and height of the tower body. At the same time, the adobe center column of the tower in the previous restoration was also analyzed and discussed. This paper is the new paper based on this thinking and research.

Key Words: Pagoda in Yongning Temple, Restoration, Factors of Number Seven, Factors of Number Nine, Dimensions on Building Plane and Height

Introduction

The Yongning Temple Pagoda in Luoyang during the Northern Wei Dynasty was the tallest wooden structure ever built in Chinese history and even in world history. The academic community has been paying attention to and researching this tall wooden pagoda for decades. The earlier research can be first seen in the book "History of Ancient Chinese Architectural Technology" (compiled by the Institute for the History of Natural Sciences, Chinese Academy of Sciences) published by Science Press in 1985. In this book, Mr. Chen Mingda （陈明达）expressed doubts about the height of the Yongning Temple Pagoda in the Northern Wei Dynasty as recorded in historical documents. Mr. Chen believed that according to the description in historical materials, the tower body might be more than one hundred meters high, which was almost impossible to achieve in ancient wooden structure practices. He believes that "the total height of the entire Yongning Temple Pagoda should not exceed twenty-seven zhang （丈） and one chi（尺） (the total height is 75.60 meters.)" [2]. This conclusion

was the earliest research based on the academic judgment of the structural rationality of the Yongning Temple Pagoda.

In the early 1980s, Ye Dasong（叶大松）, a Taiwanese scholar, in order to prove the height of the Yongning Temple Pagoda, based on historical records that there was a golden treasure bottle at the top of the pagoda's spire that could hold twenty-five shi (石， shi is an ancient Chinese unit for calculating weight). "In the second year of Xiaochang (孝昌二年, 526), a strong wind blew down houses and uprooted trees. The treasure bottle on the spire fell with the wind and sank more than one zhang（about 2.78 meters deep） into the ground." [3] Taking the possible weight of this metal ball, combined with the gravitational force of the earth and the impact force formed by the acceleration of high-altitude falling objects, and the depth of more than one zhang that it sank into the special collapsible loess in the Henan region, he calculated the possible height of the pagoda in reverse. He believed that what Yang Xuanzhi（杨衒之） of the Northern Wei Dynasty said: "There is a nine-story stupa (pagoda) in the middle, built with wood. The height of the pagoda body is ninety zhang. There is a spire (a component on the top of the pagoda) on it, which is another ten zhang high, equivalent to one thousand chi from the ground."[4] should be true. Based on this, Ye Dasong believed that the incredible height of several hundred meters might be real.

Obviously, the two viewpoints push the judgment of the height of the Yongning Temple Pagoda to two extremes: First, considering the rationality of ancient wooden structures, it is unlikely that the height of the pagoda exceeded more than 70 meters. Second, by using modern physics thinking, it is proven that the descriptions in ancient texts are reasonable. However, the latter view only relies on the records in the book "Notes on the Monasteries of Luoyang（洛阳伽蓝记）", while ignoring another description by Li Daoyuan（郦道元）, who was also from the Northern Wei Dynasty. Around the same time, the author also became interested in this issue. Around 1984, the author wrote an article titled "Research on the Credibility of the Height of the Yongning Temple Pagoda in Luoyang during the Northern Wei Dynasty". The materials on which this article is based mainly come from the records in "Commentary on the Waterways Classic（水经注）" by Li Daoyuan: "West of the water, there is the Yongning Temple, which was first built during the Xiping（熙平） period (516 - 518). A nine - storey pagoda was constructed. The base of the pagoda is square with each side being fourteen zhang long. From the golden dew plate to the ground, it is forty - nine zhang high. It drew on the style of the seven - storey pagoda in the capital of the Dai (Pingcheng, now Datong in Shanxi Province), but it is taller and broader. Even in the prosperous Eastern and Western Capitals (Luoyang and Chang'an), and the wealthy Five Capitals (in the Han Dynasty, Luoyang, Handan, Linzi, Wan, and Chengdu were regarded as the Five Capitals), among those famous temples and pagodas, there is no such building."[5]

Li Daoyuan provided a specific measurement of the tower's height that differed from Yang Xuanzhi's: from the base of the tower to the bottom of the finial, it was 49 zhang high, and the base of the tower was 14 zhang square. This height was only half of what Yang claimed. The official history "Book of Wei"（魏书） also corroborated this height: "During the Xiping（熙平） years of Emperor Suzong of the Northern Wei

Dynasty, Yongning Temple was built to the west of the Taishe (a place where ancient emperors and feudal lords sacrificed to the gods of earth and grain) in the capital city. The Empress Dowager Ling personally led many court officials to determine the foundation of the temple and erect the finial post of the pagoda. The pagoda had nine stories and was over forty zhang high. The various expenses for building the temple were incalculable."[6] The author of "Book of Wei" was from the Northern Qi Dynasty (550 - 577), which was very close in time to the Northern Wei Dynasty. This record and Li Daoyuan's description can corroborate each other.

The "Book of Wei" （魏书）also mentions the designers and builders of this pagoda: "During the reigns of Emperor Shizong (500 - 515) and Emperor Suzong (515 - 528), Liu Jian （柳俭）from Yuzhou, Guan Wenbei（关文备）, a general in the palace, and Guo Anxing（郭安兴） were all ingenious. When building the nine - storey Buddha pagoda of Yongning Temple in Luoyang, Guo Anxing served as the chief craftsman."[7] It can be seen that this wooden pagoda, which was unparalleled in height in ancient and modern times, was designed and built by the craftsman Guo Anxing. Unfortunately, no further information about Guo Anxing can be found in historical records.

Out of curiosity, or due to the inner entanglement of being unable to agree with either of the two different viewpoints, based on the two basic data of the base being 14 zhang and the height below the pagoda finial being 49 zhang, the author made a speculation about the original appearance of the pagoda. From the possible construction relationship of the central column structure of this pagoda, as well as the possibilities of the longest timber used in logging, transportation, and construction, following the logic of ancient building structures, and repeatedly speculating on the drawing according to the length of the Northern Wei chi（尺）, the author roughly sketched the plan, elevation, section, and exterior views of this pagoda. The author believes that it was possible to build this wooden pagoda with a height of approximately 50 zhang. The purpose of this article is merely to verify whether this wooden pagoda recorded in ancient books is a historical truth or just the casual talk of the ancients. After the article was completed, it was not published. One of the reasons is that the author was looking forward to the publication of a detailed archaeological report to reduce blind misjudgment. Therefore, that manuscript and the analysis diagrams drawn on tracing paper were stuffed into a corner by the author.

In the 1990s, I noticed two published texts on the restoration of the Yongning Temple Pagoda, as well as a restoration drawing of the Yongning Temple Pagoda based on archaeological data and combined with the height data of the pagoda recorded in "Commentary on the Water Classic"（水经注）. Since this is the case, the author's goal of demonstrating the credibility of the height of this pagoda has been proven, and the article written by the author previously to prove the credibility of the height of this pagoda is no longer meaningful.

After years of changes and relocations, the handwritten manuscript from the early 1980s, which was almost forgotten, and the imaginative perspective sketches painstakingly drawn on fragile tracing paper have disappeared. The only trace of this research can only be found in a drawing I made in the 1980s during my study of

ancient high - rise wooden structures. In this comparison diagram, I presented the heights and volumes of the Wooden Pagoda of Yongning Temple in Luoyang during the Northern Wei Dynasty, the seven - story pagoda in Pingcheng（平城） of the Northern Wei Dynasty as recorded in history, the Chanding Temple（禅定寺） Pagoda in Chang'an of the Tang Dynasty, as well as high - rise wooden structures such as the Yingxian（应县） Wooden Pagoda, the Hall of Prayer for Good Harvests in the Temple of Heaven in Beijing, and the Dacheng Pavilion（大乘阁)of Yongning Temple in Chengde（承德）. (Figure - 1)

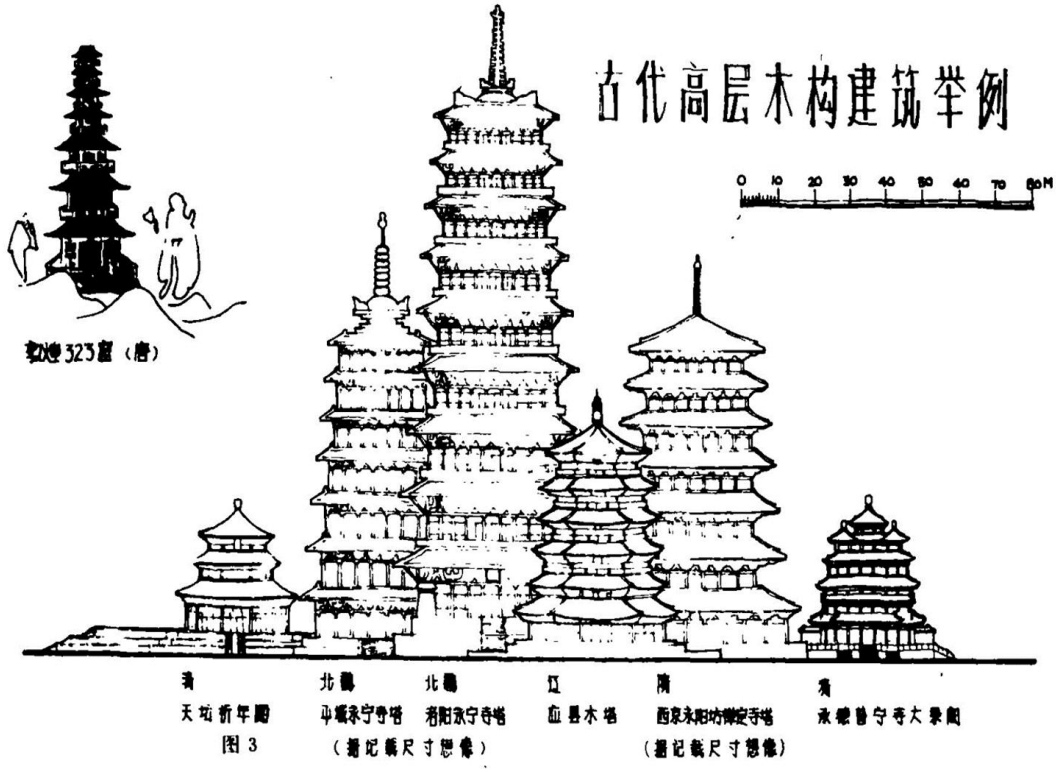

Figure - 1 The appearance of Yongning Temple Pagoda initially conjectured by the author (from "Ancient Architecture, Gardens and Technology", 1985 - 3)

1. Two important papers by peer scholars

In the 1970s of the last century, the archaeological community began to pay attention to the ruins of the Luoyang City of the Han and Wei dynasties, and also touched on some situations of the Yongning Temple Pagoda. In the 4th issue of the journal "Archaeology" in 1973, the article "Preliminary Exploration of the Luoyang City of the Han（From 202 BC to 220 AD） and Wei（386-534） Dynasties" was published. One of the subsections briefly described the temple walls, gate sites, and pagoda foundation of the Yongning Temple: "The plane of the pagoda foundation is square, rising in three layers. The top two layers can be seen standing on the current ground. The base of the bottom layer of rammed earth is nearly square, about 101 meters in the east-west direction, about 98 meters in the north-south direction, and the base of

the lowest layer is about 2.1 meters high; the area of the middle layer of rammed foundation is smaller, square in shape, 50 meters long in both the east-west and north-south directions, and about 3.6 meters high; the top layer of the platform base is built with adobe bricks, square in shape, with an area of about 10 meters square, and the remaining height is 2.2 meters."[8]

In the third issue of the journal "Archaeology" in 1981, an article titled "Brief Report on the Excavation of the Pagoda Foundation of Yongning Temple in the Northern Wei Dynasty" was published, revealing a bit more information: "In the central part of the lower rammed-earth foundation, an upper rammed-earth platform was built, and the four sides of the platform were paved and edged with bluestone. This was the foundation of the wooden pagoda built above the ground at that time. It was 2.2 meters high, and both the length and width were 38.2 meters. …… Some animal-shaped stone carvings were unearthed around the platform, and it is speculated that they should be components such as 'chi shou' (mythical animal heads) decorated around the platform. In the middle of each of the four sides of the platform, there was a'slow path'（慢道）."[9] The site plan has not been seen in the article.

What's important is that the "briefing" mentions: "In the 'Annotations to the Water Classic' by Li Daoyuan of the Northern Wei Dynasty, in the section on the Gu River（谷水）, it is recorded that the Yongning Temple's 'the base of the pagoda is fourteen zhang square'. If calculated according to the conversion of each chi in the Northern Wei Dynasty to 27.9 centimeters today, fourteen zhang should be equivalent to 39.06 meters today. The width of the base of the platform inlaid with bluestone actually excavated is 38.2 meters. The two are not much different, which fully shows that Li Daoyuan's description is relatively in line with the actual situation."[10]

In the article "Explanation of the Restoration Sketch of the Yongning Temple Pagoda in Luoyang during the Northern Wei Dynasty" published by Mr. Yang Hongxun（杨鸿勋） in the 9th issue of "Cultural Relics"（文物） in 1992, it was the first paper to conduct a restoration study of the Yongning Temple Pagoda in a strict sense. The article presented the building plan based on the site excavation, and according to the logic of structure and shape, drew the cross - section and exterior perspective of the Yongning Temple Pagoda. Combining the known information that "the length of one chi in the early Northern Wei Dynasty = 27.881 cm" and the site dimensions, the author speculated: "The most likely situation is that the construction chi used in this project at that time was not the chi of the early Northern Wei Dynasty that we currently refer to, but a slightly shorter one. If we take fourteen zhang as the standard, that is, fourteen zhang is equal to 3820 cm, and when converting the chi used in this project at that time, then 1 chi = 27.285 cm. I think when discussing the restoration of this pagoda, we might as well adopt this measurement scale."[11]

This article is not only the earliest scientific restoration of this thousand-year-old ancient pagoda, but also the earliest attempt since the 1990s in the field of architectural history. This important idea involves inferring the possible rulers used in the original construction from the remains of ancient examples, and through speculating on the rulers, exploring the construction and restoration of the example in history.

In "Collected Papers on Architectural Archaeology by Yang Hongxun", the paper "Research on the Restoration of the Yongning Temple Pagoda in Luoyang during the Northern Wei Dynasty", which is a more detailed study of this topic, is included. In this article with a very in - depth train of thought, the author not only provides detailed archaeological plans, elevations, and sections of the Yongning Temple Pagoda site, but also makes a slight revision to the previous speculation that the possible unit of measurement for the Yongning Temple Pagoda was 27.285 centimeters: "Now, by equating the side length of the base, which is 38.20 meters in kind, with the 'fourteen zhang' recorded in the literature, we can obtain the unit of measurement used in building the pagoda at that time. One yingzao chi （营造尺）= 0.27285 meters. Discarding the decimal at the end and rounding it off, that is, one chi = 0.2729 meters. This unit of measurement can be used to infer the height of the pagoda in accordance with the literature."[1 2]

Another important article is "Exploration of the Restoration of the Yongning Temple Pagoda in Luoyang during the Northern Wei Dynasty" published by Ms. Zhong Xiaoqing（钟晓青）, a scholar at the Institute of Architectural History of the China Academy of Building Research, in the 5th issue of "Cultural Relics" in 1998. This is a research paper on the restoration of ancient architecture with highly admirable evidence and inferences. This article not only deeply analyzes the archaeological data, but also makes logical deductions and proofs in line with architecture and structure regarding the architectural dimensions of various parts of the pagoda base sorted out from the archaeological data, the dimensions of various components unearthed from the foundation site, as well as key data such as the first - floor plan of the pagoda, the distribution spacing of each circle of column grids, etc., and lists data tables. For the elevation of the pagoda, such as the pagoda height, the proportion of the pagoda body, the height of each floor, the column height, the height of the bracket set（铺作） and the height of the balcony（平坐）, etc., and the most difficult restoration of the framework of the Yongning Temple Pagoda based on the relevant ancient architectural remains of the same era, in - depth analysis and tabulation are carried out. The thoroughness of its analysis and the meticulousness of its deductions can be regarded as a model work in the field of ancient architecture restoration research.

It is worth noting that the author also proposed here that the tower can be estimated and judged with a chi: "It is known that there are three lengths of chi in the Northern Wei Dynasty, namely 27.88 cm, 27.97 cm, and 27.59 cm in the early, middle, and late periods. Using these data to convert the side length of the tower base, it is 38.2 meters, which is 13.7, 13.66, and 12.91 zhang respectively. The result of conversion with the chi in the early period is relatively close to the 'fourteen zhang square' recorded in Commentary on the Waterways Classic, but it does not match the construction age of the tower. According to the actual situation, such an odd number should not be used when building the tower. The relationship between the ancient construction scale and the officially issued scale is still unclear at present. Therefore, it is considered to find the possible construction scale used at that time from the measured dimensions of the tower base. Through analysis, it is found that when converting the measured dimensions of the tower base, the bay of the tower body, and the unearthed

components with 0.2727 meters/Wei chi（魏尺）, most of the obtained data are complete numbers and are consistent with the literature records."[13] It can be seen that Zhong Xiaoqing also adopted the important method of using the data of ancient building remains to find the possible chi used in construction. The data "0.2727/Wei chi" she selected has a very small difference in length from the "0.2729/Wei chi" selected in Yang Hongxun's article. In other words, both scholars hope to find a restoration chi that is conceptually more in line with the possible original state based on the basic data of "0.27285/Wei chi".

Based on the existing archaeological data analysis, the two scholars each restored the plane size of the first floor of the tower body, the tower height, and the construction ruler used for building the tower. To a large extent, they are quite consistent. Both papers can be regarded as the most important achievements in the research and restoration of the Yongning Temple Tower.

2. Some doubts about the two papers

The papers of the two scholars not only confirm the high credibility of the historical literature records regarding the Yongning Temple Pagoda, but also, based on its architectural and structural logic, preliminarily restore the plane, height, and structure of each layer of the pagoda, thus generally reproducing the approximate appearance of this top wooden structure throughout history.

The main differences in the research of the two scholars lie in the tower's structure and appearance. The structure and appearance of the tower speculated by Yang Hongxun seem to draw more on the shapes of small stone pagodas of the same era, such as the nine - storey stone pagoda of Caotiandu（曹天度） in the first year of Tian'an（天安） of the Northern Wei Dynasty (466 AD) (Figure - 2) and the tower originally housing the Northern Wei stone carvings in Chongfu Temple（崇福寺） in Shuoxian（朔县）County. Yang Hongxun hopes to rely on corresponding materials of the same era to prove his point.

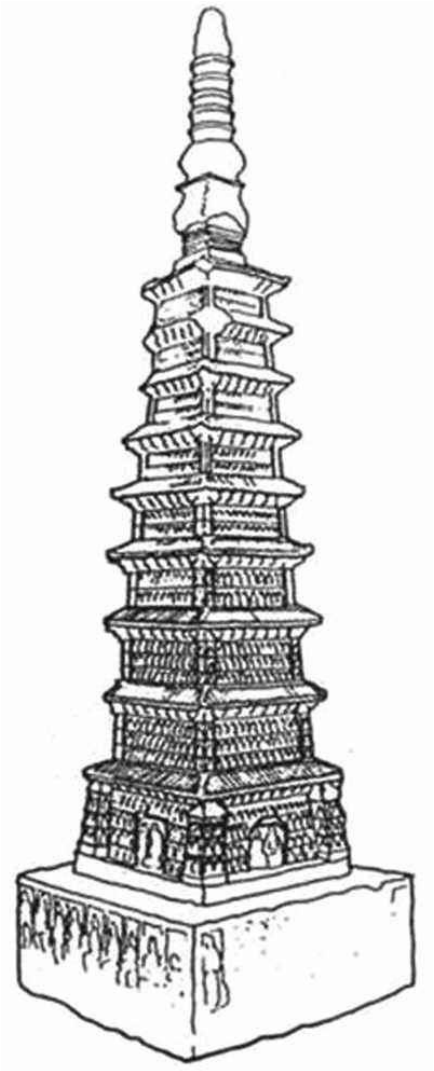

Figure - 2 The nine - story stone pagoda of Caotiandu in the Northern Wei Dynasty (from "Research on the Site of Luoyang City in the Han and Wei Dynasties", P204)

Based on this background information, Yang Hongxun's restoration concept of the tower is to adopt a "timber and earth hybrid structure". Besides the large earthen structure in the center of the tower according to the site excavation, small towers seemingly made of bricks and stones are added to the four corners of each layer of the tower body, aiming to strengthen and support the main structure of the tower body. This brings a puzzling question: for such a high - rise wooden tower, if a small brick (or adobe) tower is added to each corner of each layer, not only is the construction extremely difficult, but also, what about the structural stability of the small towers hanging in mid - air on each layer? Can the load - bearing capacity of the wooden corner structure of the tower body meet the requirements of this shape? Would the wooden Yongning Temple Tower, which was built almost half a century later than the nine - storey stone tower of Caotiandu, add additional brick (or adobe) structural shapes and loads at the corners of the roofs of each layer of the tower? To embody this "timber and earth hybrid" feature, Yang Hongxun also adopted pointed - arch - shaped doors and windows similar to those of brick - stone towers on each layer of

the tower body, making the appearance of the tower body closer to that of a brick - stone tower rather than a wooden tower (Figure - 3).

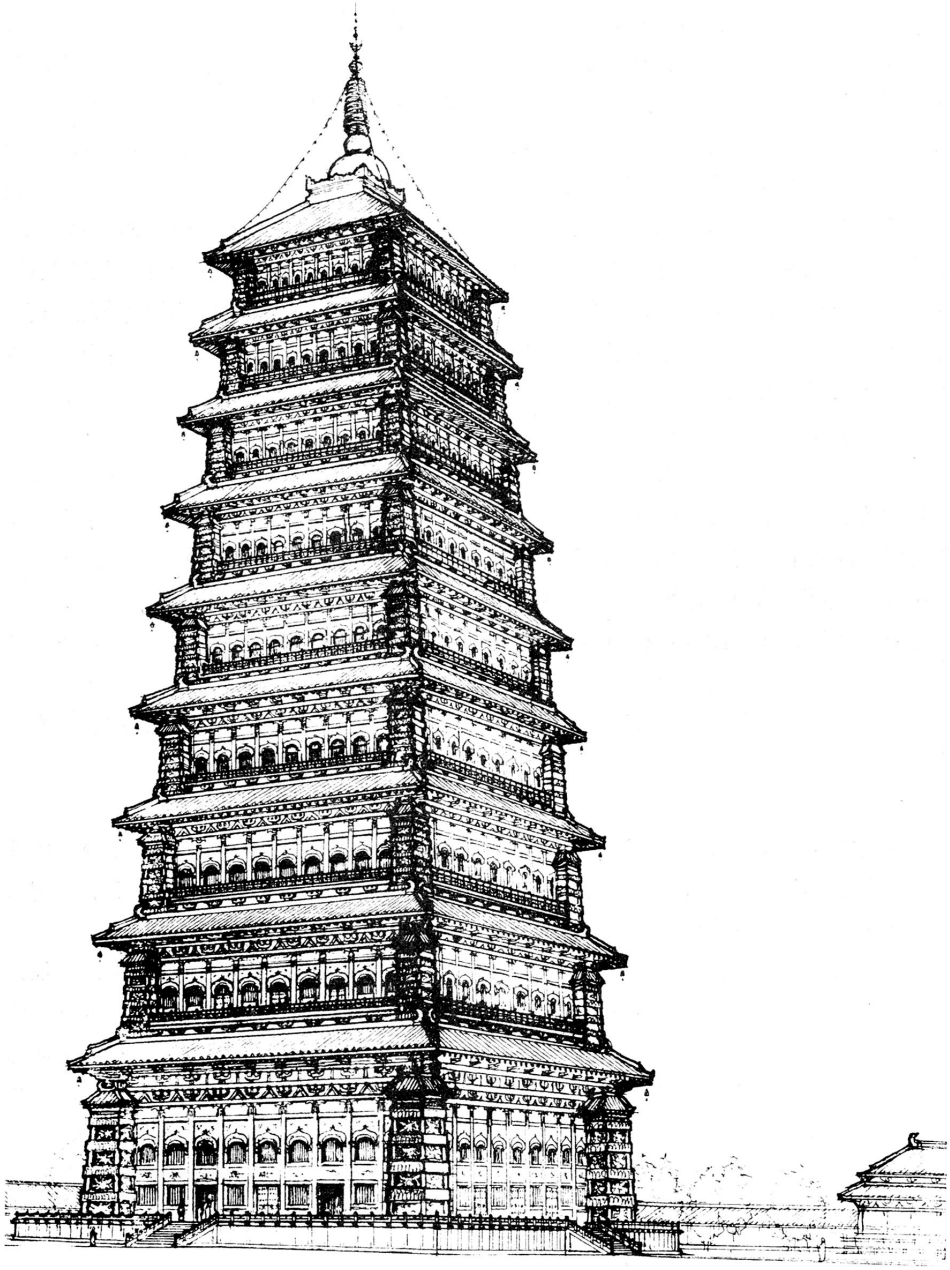

Figure - 3 The perspective of the restoration of Yongning Temple Pagoda by Mr. Yang (from "Research on the Site of Luoyang City in the Han and Wei Dynasties", P208)

Regrettably, in this article by Yang Hongxun in the past, the specific dimensions of the column heights, bracket sets, and balconies of each layer were not given at that time. Only an estimated value of "two zhang and eight chi for each layer" above the second floor was mentioned. His approach of adopting the same floor height for all floors above the second floor is contrary to the rhythmic pattern of the gradual decrease in the floor height of ancient pagodas in China, Japan, and Korea of the same era. At the same time, another characteristic of this restoration is the issue of the height of the first floor of the pagoda. As Yang Hongxun stated in the article: "The

Record of the Monasteries of Luoyang" mentioned that ‘the height of the pagoda is ninety zhang, and the spire is another ten zhang high, totaling one thousand chi：“This number is obviously based on the unit of ‘ten zhang', and nine levels would be ‘ninety zhang'. The author of this book, Yang Xuanzhi, overlooked the gradual contraction of the pagoda and roughly estimated the first level of the pagoda to be ten zhang and then multiplied it by nine to obtain this number.”[14] Based on this judgment, the height of the first floor of the pagoda should be close to 10 zhang (27.29 meters) in the Northern Wei Dynasty chi. (Figure - 4) This speculative judgment is not inappropriate in itself. However, at that time, the north and south China were isolated, and the sources of large-sized timber in the North China and Guanzhong（关中）regions, which were relatively close to Luoyang, were already scarce. If so many thick logs as high as more than 20 meters were used, it would undoubtedly greatly increase the difficulty of finding, cutting, and transporting the timber, and increase the construction difficulties. The designers and builders at that time should not have overlooked this issue.

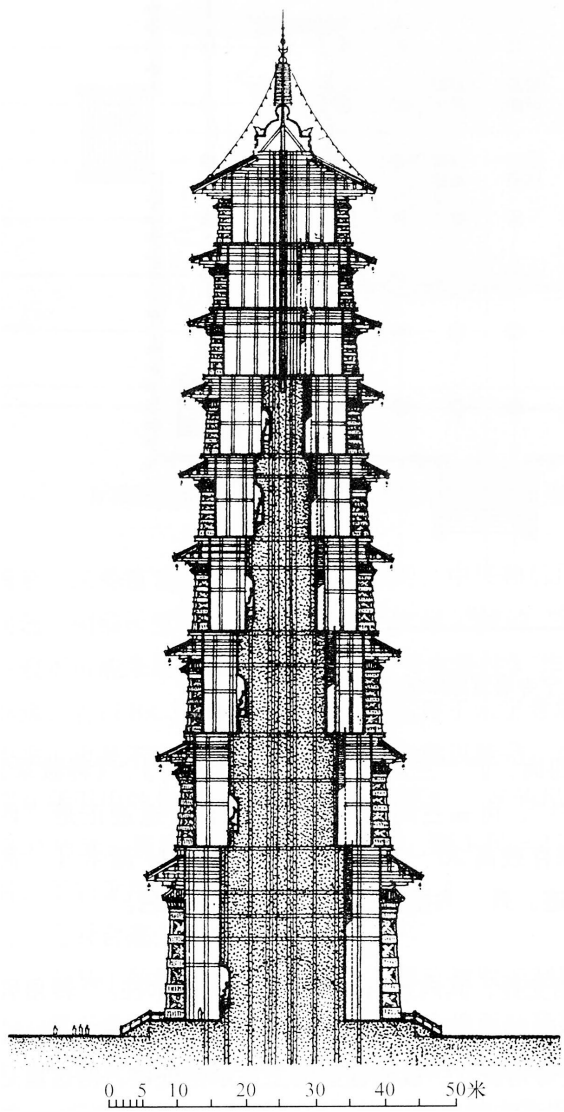

Figure - 4 The sectional view of the restoration of Yongning Temple Pagoda by Mr. Yang (from "Research on the Site of Luoyang City in the Han and Wei Dynasties", P206)

From an academic perspective of architectural history, a large number of unearthed Han Dynasty funerary pottery towers reflect that wooden pavilions were quite common during the Han Dynasty. The Eastern Han Dynasty (25 - 220) pottery tower with a spire unearthed in recent years (Figure - 5) is also a multi - storey wooden - structured tower pavilion. The high platform for offering sacrifices to the gods（神明台） and the wooden building in the log-cabin style（井干楼） during the Western Han Dynasty (202 BC - 8 AD) were also early attempts at high - rise wooden structures. The Lingyun Pavilion（凌云阁） in Luoyang during the Cao Wei period (220 - 280 AD): "Previous historical records state that Emperor Ming of Wei built the Lingyun Pavilion and ordered Wei Dan（韦诞） to inscribe the plaque. The craftsmen accidentally nailed the blank plaque up first, so they put Wei Dan in a cage and hoisted him up with a rope to write the inscription. Wei Dan was twenty - five zhang above the ground."[15] Also, as quoted in "Yiwen Leiju（艺文类聚）": "The ‘Shishuo（世说）’records that the pavilions and towers of the Lingyun Terrace were extremely exquisitely constructed. During construction, various materials were weighed first to ensure proper weight distribution before construction, resulting in no imbalance at all. Although the tower was towering, it often swayed with the wind. When Emperor Ming（明帝） of Wei climbed the tower, fearing its dangerous situation, he used large wooden timbers to support it. As a result, the tower immediately collapsed. Those who discussed this believed that this was because the original weight ratio was changed, causing the center of gravity to shift."[16] This incident occurred in the late Three Kingdoms period, several hundred years earlier than the middle of the Northern Wei Dynasty. At that time, the Lingyun Tower was already a high - rise wooden pavilion. Therefore, defining the Yongning Temple Pagoda as a 'tamped - earth and wood hybrid structure' and over - emphasizing the proportion and role of the tamped - earth structure may not be consistent with the development history of Chinese wooden - structured architecture.

Figure - 5 The pottery tower with a wheel - like structure unearthed in Xiangyang from the Eastern Han Dynasty (from image.baidu.com)

The research of Zhong Xiaoqing's thesis focuses on the timber structure, supplemented by the method of building a central column with adobe. In terms of structural details, it is closer to the construction method of timber - framed buildings in the Southern and Northern Dynasties, and its appearance is more like a timber - framed tower. However, there are two points similar to the arguments put forward in Yang Hongxun's thesis: First, the height of the first floor is significantly higher, and

the height of each floor above the second floor is significantly reduced. Second, the adobe central column not only has an indistinct taper, but also its height reaches the ground of the eighth floor. (Figure - 6)

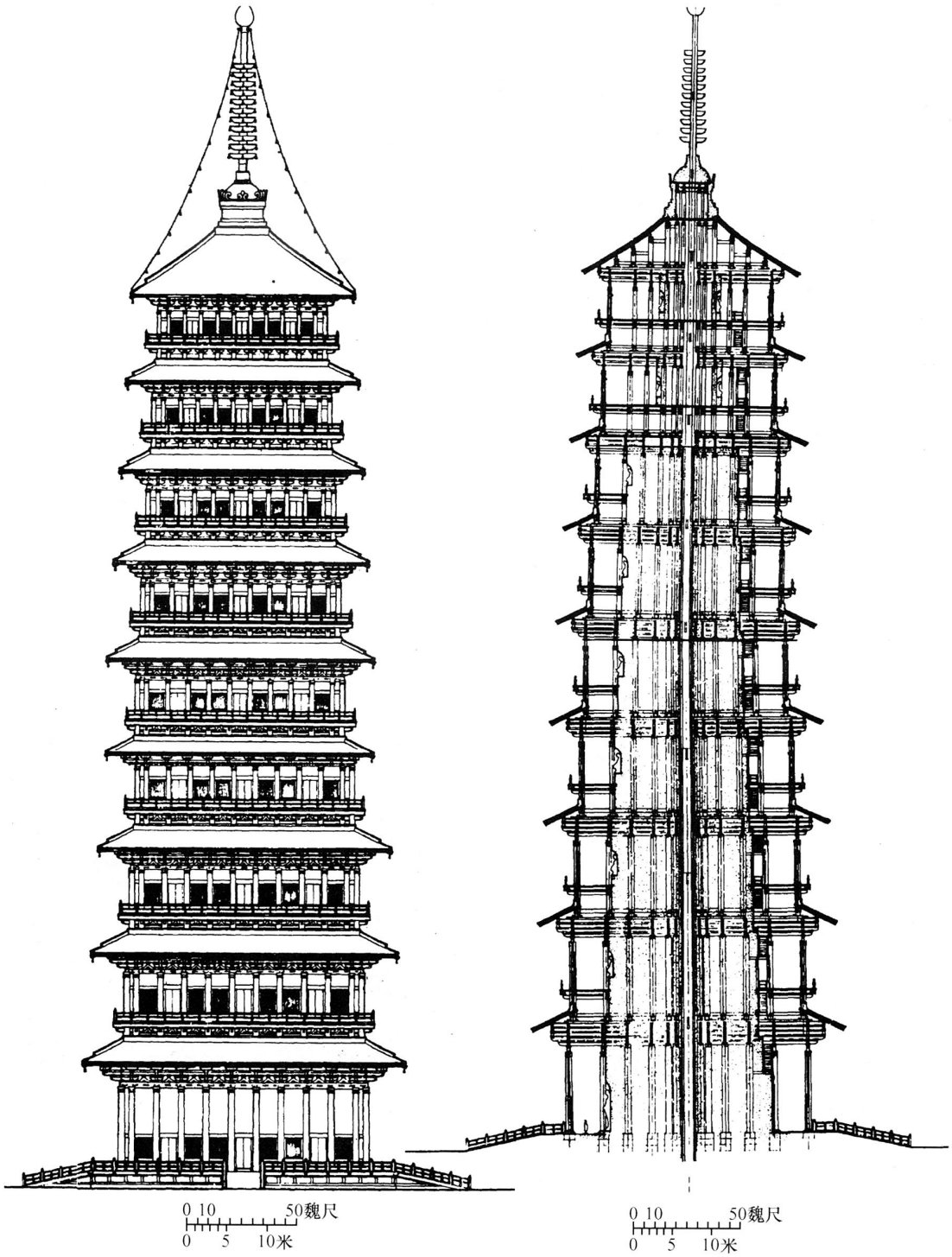

Figure - 6 The elevation and sectional view of the restoration of Yongning Temple Pagoda by Researcher Zhong (from "Research on the Site of Luoyang City in the Han and Wei Dynasties", P311)

3. Further Exploration of the Possible Original Appearance of the Yongning Temple Pagoda

Despite the above two doubts, I understand that the restoration of ancient buildings is an academic subject with great difficulty and risks. No matter how meticulous the deduction is, the results can only approximate the possible original appearance of ancient buildings to a certain extent, rather than the true original appearance. Therefore, with the research results of the two scholars, people generally accept the construction height and general form of this wooden pagoda recorded in the literature, which is already an account of history. Further research does not seem to be that necessary.

But if people hope to truly reproduce this building, things should be different. Around 2013, an entrepreneur engaged in the tourism industry approached the author, hoping to showcase the appearance of the Yongning Temple Pagoda in history in a tourism project. This put the author in a difficult situation. If based on Zhong Xiaoqing's paper, which is closer to the appearance of the wooden pagoda, at least in terms of the height ratio of each layer of the tower body and the overall appearance, it is not something that I fully accept. If based on Yang Hongxun's "civil - timber hybrid structure" appearance, it is even further from my understanding of the appearance form of the pagoda. Therefore, if it is necessary to truly reproduce the Yongning Temple Pagoda, it becomes inevitable to re - deliberate on the possible original appearance of this pagoda.

Based on this background, out of a sense of responsibility towards investors and this historical building, before the formal design, the author of this paper needs to conduct further research on the Yongning Temple Pagoda based on the papers of the previous two scholars. This is the main motivation for me to re - explore the possible original appearance of the Yongning Temple Pagoda.

First, let's analyze the substantive content of the existing papers of the two scholars again. This is an important foundation for the research of the author of this paper. In terms of the plane, especially Zhong Xiaoqing's paper, it provides a detailed description of the site conditions, the detailed dimensions of the tower base, and the components excavated from the site. The first - floor plan she drew is based on solid evidence, with detailed dimensions and rigorous argumentation, which is an important foundation for further research. The focus of this paper by the author is:

1. Based on the first-floor plan of Zhong Xiaoqing's thesis, I re-studie the plans of each floor, especially the inward recession of the outer eaves tower columns on each floor and the overall tapering caused thereby.
2. I further explore the decreasing rules of the column height of each layer and the height of the tower body.
3. I further ponders over the structural details of the wooden pagoda, such as the columns and lintels of each floor, the dougong brackets, the dougong brackets of the mezzanine（平坐斗栱）, and the distribution of the column network inside the pagoda after the adobe core column rises above.
4. I will conduct further research on the height and taper control of the adobe central core column.

In addition to the above four aspects, any details of the unearthed remains of the wooden pagoda and the structural basis of wooden structures of the same era that

have been described in the papers of the previous two scholars will not be introduced repeatedly in this paper.

The purpose of this article is to provide builders with an appearance of the wooden pagoda that the author believes is closer to its original historical state. At the same time, it also hopes to conduct academic exploration. That is, this thesis aims to make new explorations into the possible structural and styling logic when the ancients built this high - rise wooden pagoda, and to re - explore the overall proportion control of the pagoda body, as well as the decreasing proportions of the height of each floor and the height of columns, in order to explain the author's doubts about the papers of the previous two scholars.

(1) Proportion Weighing of the Tower Body Based on the Number "Seven"

Regarding the restoration in Yang Hongxun's aforementioned paper, the tower body of the first floor is evidently too high. Although the tower of the first floor in Zhong Xiaoqing's paper is slightly lowered, it still appears relatively high. The common point of these two papers is that the height of the tower on the second floor is significantly reduced. The heights of the tower bodies of the upper floors either maintain a uniform height of 2.8 zhang or, although there is a slight decrease, the reduction rhythm is not obvious.

Chinese ancient pagodas, especially those remaining from the Northern Dynasties (386 - 581), the Sui Dynasty (581 - 618), and the Tang Dynasty (618 - 907). For pavilion-style pagodas, the height of each layer generally decreases in a regular pattern. That is, the height of the first layer of the pagoda is taken as a modular basis, and the height of each layer above the second layer is reduced rhythmically. Many central pagoda columns and stone-carved relief pagodas in the Yungang（云冈）Grottoes during the Northern Wei Dynasty (Figure - 7) demonstrated this regular decreasing rhythm. For example, the nine-story stone pagoda of Caotiandu in the Northern Wei Dynasty. The Xuanzang（玄奘） Pagoda of Xingjiao Temple（兴教寺）in the early Tang Dynasty (Figure - 8), although it is a brick and stone pagoda imitating a wooden structure, also exhibits this rather rhythmic characteristic of the pagoda body proportion.

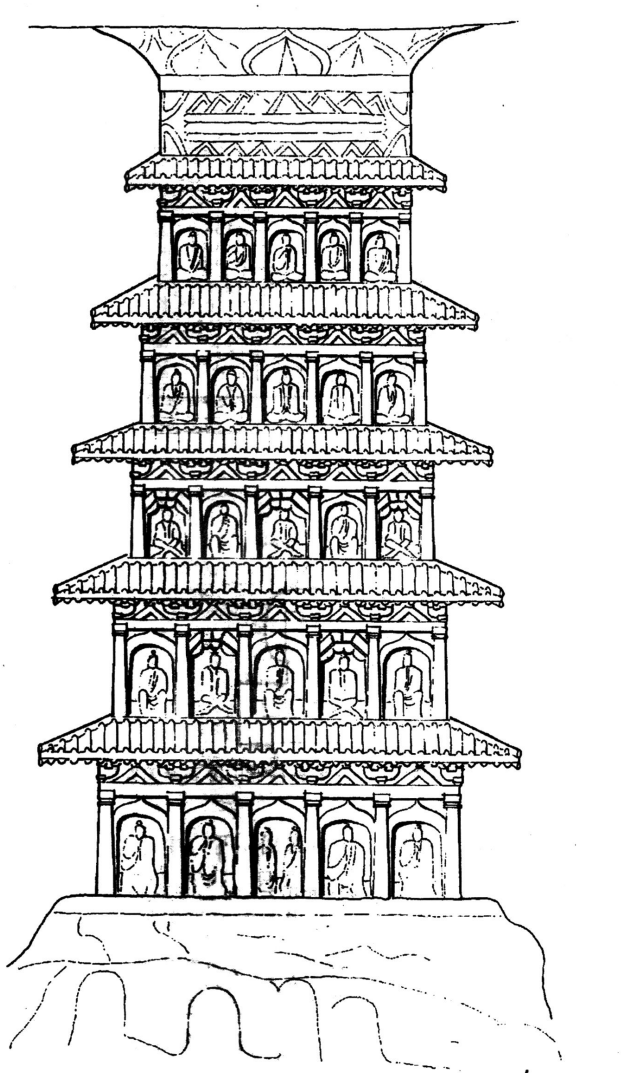

Figure - 7 The central tower pillar of Cave 39 in Yungang Grottoes (Fu Xinian, "History of Ancient Chinese Architecture", Volume II)

Figure - 8 The stone pagoda of the Northern Wei Dynasty and the Xuanzang Pagoda of Xingjiao Temple in the Tang Dynasty (Fu Xinian, "History of Ancient Chinese Architecture", Volume II)

There are two exceptional cases: one is the multi-eaved pagoda（密檐塔）, such as the Songyue Temple（嵩岳寺） Pagoda on Songshan（嵩山） Mountain, where the height of the first-story tower is very prominent; the other is that for some individual pavilion-style brick and stone pagodas, the first-story tower body is significantly taller, and the floor height of the second floor and above suddenly decreases. When viewed from a distance, it is slightly similar to a multi-eaved pagoda, such as the Xiangji Temple（香积寺） Pagoda in Xi'an.

According to Mr. Fu Xinian's （傅熹年）research, the early multi - storey wooden pagodas in China and Japan both demonstrated a strong concept of proportional balance. For example, the height of a certain storey of the pagoda was used as the basic unit of proportional balance for the height of the entire pagoda. More examples show that the ancients took the height of the columns of the outer eaves of the first storey of the pagoda as a base number to deliberate and control the height of the entire pagoda, so as to control the proportion of the tower body and the rhythm of the decreasing height of each storey as a whole.

Based on this, the author re-organizes the materials of the Yongning Temple Pagoda. Interestingly, in Li Daoyuan's description of the Yongning Temple Pagoda, two numbers are mentioned: "The base of the stupa is fourteen zhang square, and from the golden dew plate（金露槃） to the ground is forty-nine zhang." Both numbers happen to be multiples of 7. Can we guess that the designer might have divided the height of the entire pagoda into 7 sections, with each section being 7 zhang high, as the expansion modulus for the height of the entire pagoda? If so, the height of the first floor of the pagoda might be controlled within a size related to 7 zhang, as the base number for determining the height of each floor. From the second floor upwards, the height of each floor decreases regularly, forming an appropriate proportion and rhythm of the pagoda body's decrease.

In Mr. Fu's research, a phenomenon was mentioned: the elevation of the second - floor ground of some ancient pavilions and towers may be twice the height of the eave columns on the first floor. Based on this, half of the extended module of 7 zhang, that is, 3.5 zhang, could be set as the column height of the first - floor tower. To a certain extent, the number 3.5 can still be classified under the proportional control method based on the number "7".

The idea of controlling the height of the whole house based on the height of the eaves columns on the first floor is also reflected in "Treatise on Architectural Methods"（营造法式）: "If the columns inside the hall and other buildings, their lengths are determined according to the pitching trend, with the lower eaves columns as the standard."[17] The so - called "taking the lower eaves columns as the standard" here is only for determining the height of the columns inside the hall and other buildings. However, considering that the lower - layer eaves columns in ancient wooden - structured buildings serve as a basic reference number in terms of structure and shape for the entire building, including multi - storey and high - rise buildings, it should be a kind of thinking that conforms to the construction logic of ancient Chinese wooden - structured buildings.

Starting from the second floor, based on the height of the eaves columns on the first floor, the height of the tower should be reduced regularly. The author initially tried to roughly estimate with a reduction rate of 5.5% for the height of each floor's columns compared to the columns of the lower floor, with the height of each floor's columns being reduced by 2.0 chi compared to the lower floor. In this case, the height of the columns on the first floor is 3.5 zhang, 3.3 zhang on the second floor, 3.1 zhang on the third floor, 2.9 zhang on the fourth floor, 2.7 zhang on the fifth floor, 2.5 zhang on the sixth floor, 2.3 zhang on the seventh floor, 2.1 zhang on the eighth floor, and 1.9 zhang on the ninth floor.

Suppose that the Dougong (bracket sets) adopt the size standard of the first-class material in the Northern Wei Dynasty. Since the chi (a unit of length) in the Northern Wei Dynasty was relatively short and the materials used for palaces and pavilions before the Tang Dynasty were relatively large, it seems reasonable to speculate that the height of the first-class material in the Northern Wei Dynasty might be 1.5 Northern Wei chi. Then, based on the form of the column-head Dougong (bracket sets), calculate the height difference from the top surface of the eave column to the

top surface of the column of the upper mezzanine, and integrate the construction methods and heights of the mezzanine Dougong on each floor into a unified form to calculate its height value. Subsequently, add the height difference from the column head of each layer to the top surface of the mezzanine above it between the tower layer structures that decrease layer by layer. In this way, the elevation of the upper surface of the Liaoyan Fang (eave-supporting beam) of the column-head bracket set on the ninth floor accumulates to 462.25 chi. This height only has a difference of 27.75 chi from the 490 chi recorded by Li Daoyuan as the height below the Golden Dew Plate（金露槃）. This figure seems to be regarded as the height of the roof structure's pitch of the tower on the ninth floor. Based on this analysis, the author proposes a basic proportion of the tower body height of the Yongning Temple Pagoda, with 3.5 zhang as the height of the first-floor columns and 7.0 zhang as the expansion modulus. (Figure - 9)

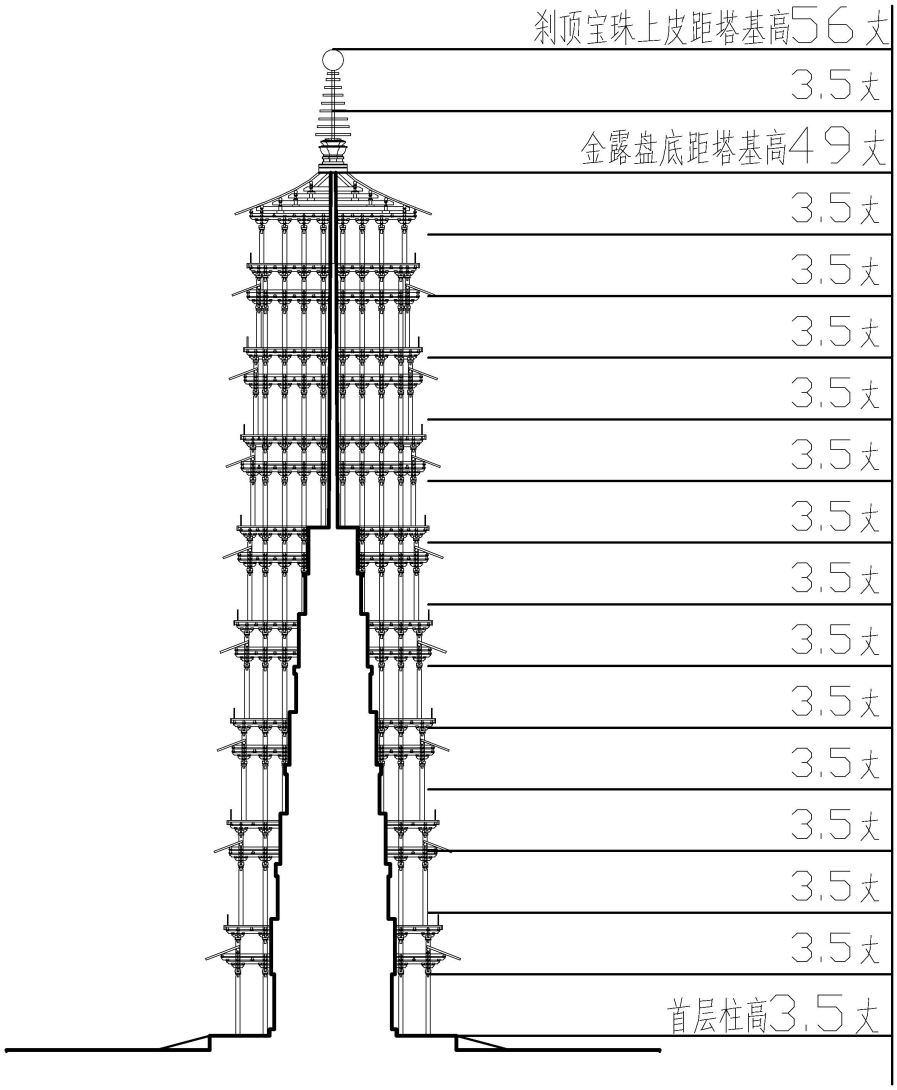

Figure - 9 The height proportion of Yongning Temple Pagoda based on the number "7" (self - drawn - 2013)

(2) The problem of the tapering of the tower body

The tapering of the tower body is a problem that is difficult to solve by logical judgment. Initially, I noticed a characteristic of the first - floor plan of the tower: there are 9 standard bays in the outer-eave column network on each side, with a column spacing of 1.1 zhang per bay, totaling 9.9 zhang. In addition to these 9 standard bays, there is a small end - bay (the rooms at the two ends of the eleven - bay arrangement) added at each corner, and the column spacing of the small end - bay is approximately 4.5 chi.

I believe that it is probably not a coincidence that the width of each of the nine standard rooms is set at 1.1 zhang. It might be a deliberate design choice. The most likely reason is to associate the tower's plane with the number "99", which is related to the double nine. There may be a possibility that the designer hoped to maintain this dimension, symbolizing the supremacy of yang（阳） numbers（odd number）, up to the top floor of the tower. In this way, only the 4.5 chi of the two end rooms on each side of the first floor need to be gradually reduced inward layer by layer, eventually disappearing on the ground of the ninth floor, thus ensuring that the ninth floor of the tower maintains a scale of "9.9 zhang" on each of the four sides.

Based on this thinking, I drew the cross-section and elevation of the tower. The result was that the overall shape of the tower had a relatively small tapering, appearing slightly bloated. This seemingly logical but overly naive idea of the tower's tapering was obviously inappropriate. However, relating the overall width of the top floor of the tower to the yang number "nine" was still a consideration that needed to be incorporated. In further research, the author also envisioned the overall width of the top floor to be "8.1 zhang", which conforms to the number "9×9" (九九). If so, starting from the first floor of the tower, the width of each floor would be reduced inward by 1.725 chi. From the first floor to the top floor, the total length of the inward tapering on each side was 13.5 chi, and a total of 27 chi on both sides. This tapering slope seemed to be generally in line with the proportion of the ancient tower's shape.

(3) The height and taper of the adobe central pillar and the central pillar of the tower body

There were obvious differences in the presentation of the construction method of the adobe tower core column in the papers of the two previous scholars regarding restoration. In Yang Hongxun's paper, the adobe column had a distinct taper, and its highest point ended at the floor of the seventh layer. In Zhong Xiaoqing's paper, the adobe column appeared rather tall and straight, seemingly extending the remaining adobe central platform on the site ground upwards to the floor of the eighth layer, with only a slight taper. Above the eighth layer, the adobe tower core column in the central part was even extended.

Even without considering the materials, when observed solely from the structural perspective, this kind of tall building with nearly identical upper and lower cross-sections is inherently unstable. The adobe central column, apart from being relatively easy to construct, does not have many advantages when compared with the structure of the rammed earth central column. The ancients understood the principle

of tapering in the construction of earth structures very early. Even for the most stable earth structures, such as rammed earth city walls, obvious tapering is required.

As stated in the "Treatise on Architectural Methods" (营造法式): "The method of building a city wall: for every 40 feet in height, the thickness should be increased by 20 feet. That is, it is smaller at the top and larger at the bottom, and the contraction ratio at the top is half of the height of the city wall. If the height of the city wall is increased by one chi, then the thickness of the lower part of the city wall should be increased by another chi, and the width of the top of the city wall is equivalent to half of the height of the city wall."[18] The thickness of the base of the city wall is 1/3 more than its height, and the thickness at the top after tapering is equivalent to 1/2 of the thickness of the base. A similar situation also occurs in earthen walls. As mentioned in the section on exposed walls in the "Treatise on Architectural Methods" （营造法式）: "For any wall exposed above the ground, if the height of each wall is one zhang, then the thickness of the wall is half less than the height, and the width of the tapering part at the top of the wall is one-fifth less than the height."[19] From this, it can be seen that the ancients knew very early on that in order to ensure the stability of earthen structures, they should have a distinct tapering shape with a larger bottom and a smaller top.

Or we can analyze it from another perspective, by analyzing the possible original volume of the masonry of this tower. Yang Hongxun's paper mentioned: "The 'Luoyang County Annals' compiled in the 10th year of Emperor Qianlong's reign in the Qing Dynasty (1745 AD) mistook the site of the Yongning Temple Pagoda, which was '6 zhang high', for the 'Jingling（静陵） Mausoleum of Emperor Zhi （质帝） of the Han Dynasty.'" It can be seen that the height of the soil pile at the site of the Yongning Temple Pagoda is about 6 zhang. Calculating based on the length of the chi in the Qing Dynasty and converting it to the length of the chi in the present day, the height of the soil pile at this site is about more than 18 meters. Taking this base as a square with a side length of 40 meters, if we assume that the soil pile is a cube, the volume of the 18 - meter - high soil pile is approximately nearly 28,000 cubic meters. However, since the soil pile should be a square - pointed conical mound with a smaller top and a larger bottom, the actual volume of the soil pile will be significantly smaller than this value. For example, it may be only around 25,000 cubic meters?

From the Northern Wei Dynasty to the Qing Dynasty, if there was no large-scale excavation near the site of Yongning Temple Pagoda, this earthen mound, about 6 zhang high, was formed by the accumulation of the central pillar of the adobe materials of the pagoda after it collapsed. It may also include the remnants of some components of the tower body and the rubble of the roofs of each floor. By this calculation, the actual volume of the original central pillar of the tower is likely not to exceed 24,000 cubic meters. If, as previously speculated by Yang Hongxun and Zhong Xiaoqing, the original central pillar of the tower extended to the ground of the eighth floor, and calculated with the bottom side of its adobe central pillar being about 20 meters and the height being 85 meters, the volume would be at least 34,000 cubic meters. The difference between the two is nearly 10,000 cubic meters.

It can be seen from this that, based on the volume of the remaining earth mounds during the Qianlong period (from 1736 to 1795), with a base of 20 meters square, the height of the adobe central pillar would not exceed around 60 meters, that is, it would reach the limit when it reaches approximately the ground of the sixth - floor tower. For the tower body above the sixth floor, it is likely that an ordinary wooden tower body was used, supplemented by a central wooden pillar. The structural form is more similar to the construction method of wooden pagodas during the Asuka period in Japan, which was influenced by the Northern and Southern Dynasties (420 - 589 AD) in China.

Therefore, it can be seen that Yang Hongxun's understanding of the adobe central pillar in the pagoda seems to be more reasonable. In the restoration of this paper, I has made some minor revisions based on this feature: First, extend the adobe central pillar to the ground of the sixth - floor of the pagoda; Second, for the central pillar made of adobe materials, make step - backs that shrink layer by layer to ensure the stability of the central pillar. However, in order to ensure the integrity of the space inside each floor of the pagoda, this step - back method requires that the four walls of the central pillar on each floor still maintain an upright form, so that people at that time could build concave niches on the walls.

Similarly, with the setbacks on each floor, the space inside the tower gradually expands. On the floors above the sixth floor, an indoor space of a wooden pagoda with a central pillar in the true sense appears. This should be in line with the internal logic of the original builders' high - profile promotion of this super - high - rise Buddhist pagoda. Of course, statues of Buddha can still be arranged around the central wooden pillar inside the room.

The subsequent question is, with the expansion of the space inside the tower, how should the column grid around the central column be arranged? Zhong Xiaoqing's paper directly extends the square columns inside the tower, which have an adobe structure at the bottom layer as the center, to the ninth floor of the tower. In other words, the square - section columns of the central tower column are regarded as part of the complete wooden structure system of the tower body.

I believe that the square columns buried in the adobe tower core column play a role of strengthening the adobe tower core column to a greater extent. It is equivalent to the "chou ren" wall（抽紝墻） in the ancient rammed earth wall, or the concept of adding yacha wood（夜叉木） in the wall. If the upper load is directly transmitted to these square columns, it is difficult to ensure that the columns of each layer are completely vertical and structurally connected to each other. Instead, lateral pressure will be generated in the adobe tower core column, which is even less conducive to the structural integrity of the tower core column.

In addition, judging from the fact that the column spacing of the outer-eave columns around the tower is not aligned with the column grid distribution of the square columns in the adobe material tower core columns, this understanding will also be strengthened: the square columns buried in these tower core columns are mainly for the structural reinforcement of the adobe tower core columns. With the expansion of the space on each floor of the tower, whenever new columns can be implanted inside

the tower, from the perspective of structure and architectural logic, the constructors will surely align the inner columns of the tower body with the outer-eave columns of the corresponding bay of the tower body to ensure the reasonable connection and firm stability of the upper structure. At this time, as long as the craftsmen take certain measures to strengthen the column foundation on the ground of the new tower floor, they can set up the inner columns of the tower corresponding to the outer-eave columns. The load of their weight will be transmitted downward through the thick adobe masonry below, and there is no need to necessarily correspond to the square wooden columns in the adobe masonry.

If the craftsmen had to extend the column grid inside the central column upwards, then the inner and outer column grid systems of the wooden structure on the upper part of the tower would also need to be continuously adjusted, resulting in a more complex structural stress state. This perhaps should not have been the choice of ancient craftsmen.

Based on this analysis, I drew the sectional and elevation views of the Yongning Temple Pagoda (Figure - 10, Figure - 11). And the author wrote the article "A Re - study on the Restoration of the Yongning Temple Pagoda in Luoyang during the Northern Wei Dynasty", which was published in "Research Papers on Ancient Chinese Buddhist Architecture" edited by the author and published by Tsinghua University Press in 2014.

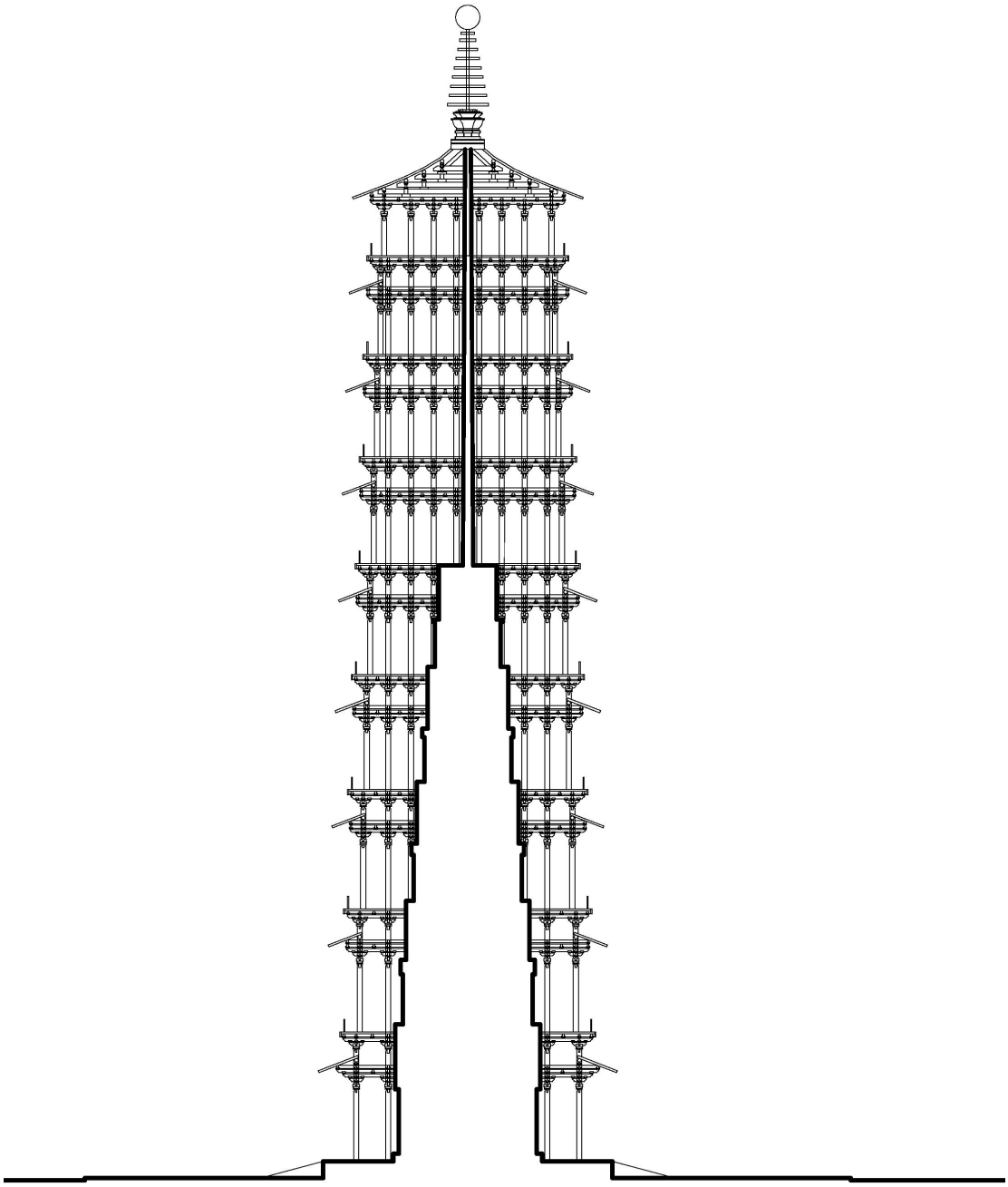

Figure - 10 The sectional restoration of Yongning Temple Pagoda based on the number "7" (self - drawn - 2013)

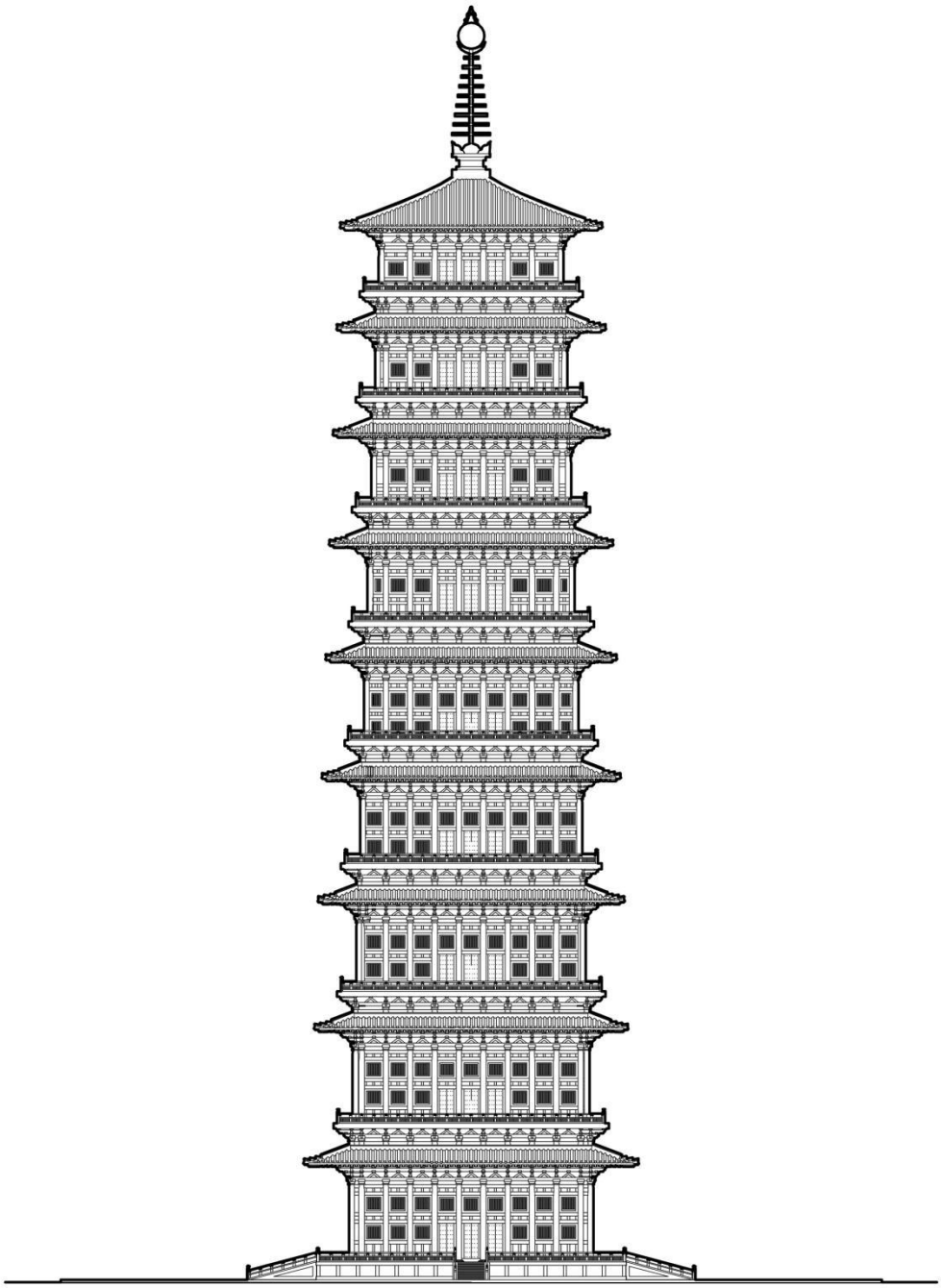

Figure - 11 The elevation restoration of Yongning Temple Pagoda based on the number "7" (self - drawn - 2013)

4.Re - research Based on the Law of Negation of Negation

However, I still has some unresolved doubts about the above-mentioned research. After years of repeated thinking, I increasingly feel that it is necessary to further explore the proportions of each layer of this historical tower and the possible symbolic meanings it contains. Even if it is not for the constructive reproduction of this ancient tower, from the perspective of academic research alone, it is still necessary to further revise my previous research, in the hope of making a more in -

depth exploration of the possible original appearance of the Yongning Temple Tower. This is the main theme of this article of mine.

Things have returned to the status of the number "nine" representing the supremacy of yang numbers (positive numbers or odd numbers). As can be known from historical materials, the ruling class of the Northern Wei Dynasty had a special affection for the number "nine". "The History of the Wei Dynasty"（魏书） states: As one of the twenty-five sons of the Yellow Emperor, " Changyi (昌意)，the youngest son of the Yellow Emperor was enfeoffed in the land of the north. His fief had a large Xianbei Mountain（大鲜卑山）, and his tribe took 'Xianbei' as its title. … After sixty-seven generations, when Emperor Zhicheng whose personal name was Maoli (志成皇帝讳毛立) ascended the throne, he was intelligent, bright, and rich in military strategies. People near and far respected him. He governed thirty-six fiefs and had ninety-nine large surname tribes. His power and influence shocked the tribes in the north, and none did not submit."[20]

After the establishment of the Northern Wei Dynasty, there was an idea of building the Mingtang（明堂）. "At the beginning, during the Yongping（永平） and Yanchang（延昌） reigns of Emperor Shizong (世宗元恪), there was an intention to build the Mingtang. However, among those discussing the matter, some believed that the Mingtang should have five chambers, while others thought it should have nine chambers. Successive years of famine ensued, so the plan to build the Mingtang was put on hold. By this time, the matter of building the Mingtang was discussed again, and an imperial edict was issued to adopt the plan of building five chambers. When Yuan Yi（元议） was in charge of government affairs, it was then rebuilt into nine chambers.“[21] In addition, the people of the Northern Wei Dynasty highly esteemed the music of the Rites of Zhou. "The Gong scale is the foundation（黄钟为宫）, the Diao scale is the top note（大吕为角）, the Taocu scale is the third note（太蔟为徵）, and the Yingzhong scale is the bottom note（应钟为羽）. Using musical instruments such as the Lugu drum（路鼓） and Lutao drum（路鼗）, as well as Bamboo tubes of the Yinzhu (阴竹之管), and stringed instruments such as the Qin（琴） and Se（瑟） made from materials produced in Longmen. Playing the music praising the Nine Virtues and performing the Dance of the Nine Shao. The music is played with multiple modulations, and in this way, it is possible to sacrifice to the ancestors and spirits (expressing respect for the ancestors and spirits)."[22]

In fact, the ancients emphasized the "prestige of the supreme nine and five”, and even the Northern Wei people, who adhered to Han culture were no exception. And the Northern Wei people, who inclined towards Han culture, were no exception. As stated in "The History of the Wei Dynasty"（魏书）: "The First Emperor ascended to the throne at the number nine and five, initiating the distant governance and rectifying chaos to establish the state. Even when the sun was high in the sky, he still had no time to rest.”[23]Regarding the construction of the Mingtang (明堂), the Northern Wei people were also very troubled by the concept of the nine and five: "After planning to start the construction of the Mingtang and gathering scholars to discuss its system, the concept of the nine and five remained unresolved for a long time."[24]

Most likely for this reason, when the Yongning Temple Pagoda with nine stories was built in Luoyang, the capital of the Northern Wei Dynasty in the middle period, five-story pagodas were also constructed in various prefectures within the territory: "Empress Dowager Ling was enthusiastic about projects such as building temples. In the capital, she built Buddhist temples like Yongning Temple and Taishanggong Temple（太上公寺）, consuming a great deal of money and manpower. Five-story pagodas were also built in various prefectures outside the capital."[25] Building nine-story pagodas in the capital and five-story pagodas in various prefectures, this practice seems to be in line with the numbers "nine" and "five". It can be inferred from this that the "nine" here is undoubtedly a concept that needs to be emphasized deliberately, so that its connotation has a full symbolic meaning.

Regarding this point, it can also be glimpsed from some basic elements of this tower. For example, the tower has nine stories. As Yang Xuanzhi described: "There is a nine-story stupa in the middle, built with wood, reaching a height of ninety zhang."[26] This strong emphasis on the number "nine" may not just be Yang's personal speculation, but perhaps also something passed down among the ordinary people in Luoyang at that time. Even Li Daoyuan, who was rigorous in his records of the tower's height, specifically mentioned two numbers related to "nine": "a nine-story stupa" and "from the Golden Dew Basin to the ground is forty-nine zhang." It can perhaps be guessed whether the height below the spire being controlled at the value of "forty-nine zhang" also contains the meaning of conforming to the yang number "nine". This is unknown.

There are two other phenomena related to the number "nine" in the Yongning Temple Pagoda. Firstly, on the ground - floor plan of the pagoda, although there are two small end - bays at both ends of each side, making it appear as eleven bays on the elevation, the standard bays are nine in number; (Figure - 12). Secondly, for its standard bays, based on the length of the ruler deduced from the dimensions of the archaeological site, the width of each bay is 1.1 zhang. Excluding the two small end - bays on both sides which have the significance of structural reinforcement, the total width of the nine standard bays is 9.9 zhang. The column - spacing between the two end - bays at both ends of each side on the ground - floor plan and the adjacent bay is approximately 4.5 chi, so the sum of the widths of the two end - bays is also 9 chi. The total width of the ground - floor elevation is 10.8 zhang, which is exactly 12 times of "9 chi", that is, an integer multiple of the number "9".

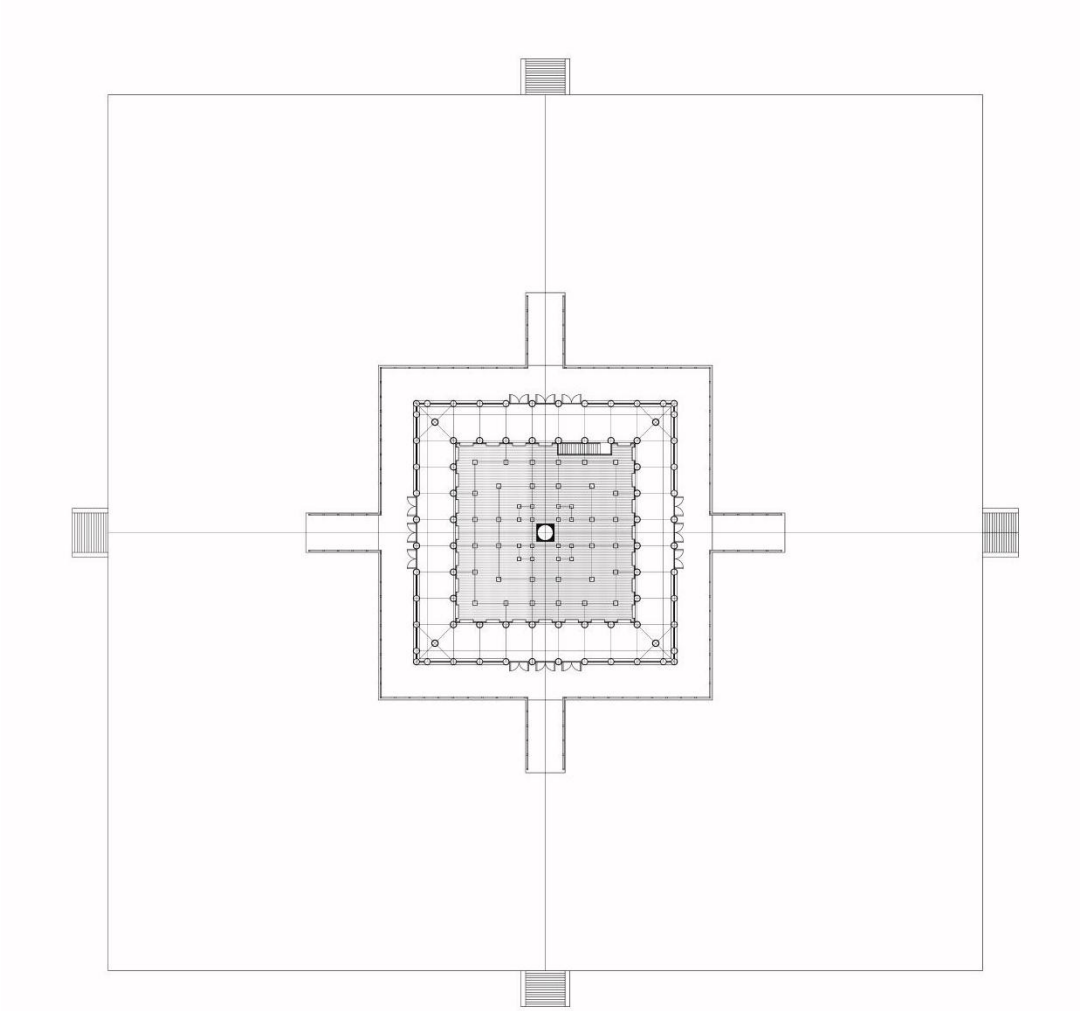

Figure - 12 The speculation of the first - floor plan of Yongning Temple Pagoda (self - drawn)

In my previous research, although it was noted that the total width of the standard bays on the first floor was "9.9 zhang", in the initial speculation, I was overly persistent in applying this value to the ninth - floor plan of the tower, or simply changing the ninth - floor plan to a total width of "8.1 zhang" to match the yang number "9". At that time, the key judgment focused on the tower base width of 14 zhang and the height of the tower body from below the golden disk to 49 zhang. The attention and emphasis on the number "7" between the two were regarded as an important reference system for the restoration of the tower body.

In other words, for this magnificent nine-story pagoda that has impressed through the ages, if we were to select a symbolic number that would particularly appeal to the ruler of that time, would it be more in line with the original intention of the pagoda builders to choose the number "9" or the number "7"? In fact, this is a question that requires further consideration. This question has also caused me to be rather conflicted for a while.

(1) Re - evaluate the proportion of the tower body based on the number "nine"

Any restoration research on ancient architecture is carried out based on limited documentary and archaeological materials. It is a hypothetical attempt to deduce the possible original appearance of ancient architecture following certain scientific and cultural logic. Therefore, each research result is only an approximation to the original state of the building. This approximation is more like a process. In any case, modern people's restoration research cannot achieve a completely true and perfect restoration of the original form of ancient architecture. Each research is only a deepening of the original state of the building in terms of its logical consistency based on a series of logical deductions. In other words, for each restoration research, if its logical consistency is sufficient and reasonable, the restored form has certain rationality and reference value for understanding the original state of the building.

That is to say, the experiment of ancient architecture restoration itself has a hypothesis nature based on scientific significance. To a large extent, the results of its research are also difficult to simply deny or affirm. Each restoration study can be regarded as an exploratory deepening of previous existing research, or a re - observation and re - exploration from different perspectives. In other words, a restoration study that has accumulated relatively sufficient data and made relatively in - depth logical judgments has only, compared with previous similar studies, possibly taken a small step forward in understanding the original state of the architecture.

In addition to raising several doubts about the existing research, the above text also analyzes the unresolved dilemmas in my research. That is, whether the number "seven" or the number "nine" should be used as the basic reference element for the restoration research of the Yongning Temple Pagoda. Previously, starting from the number "seven", the height of the eaves columns on the first floor was set at 3.5 zhang, and the height of the columns on each floor was gradually reduced with an appropriate reduction rate, so that the height of the eaves columns on the top floor was reduced to 1.9 zhang. Although this is also an acceptable column height dimension, it seems to have no relation to the number "seven" or "nine". The proportion of the tower body decreasing according to such rules does not seem to be quite appropriate.

If we change our way of thinking and focus on the symbolic pursuit of the number "nine", in the hope of matching the series of numbers that seem to be no coincidence. These numbers include the 9 - storey tower height mentioned above, the sum of the widths of 9 standard bays being "9.9 zhang", the column spacing of the end bays on both sides of the first - floor plane being "4.5 chi", and the sum of the two being "9.0 chi". The overall width of the first floor is 10.8 zhang, which is exactly 12 times "9 chi". Then, perhaps we can make a slight adjustment to the speculated tower - body expansion modulus. That is, instead of "7 zhang", we change it to "7.2 zhang" which is in line with the number "9". This might be a potentially reasonable attempt.

If this is the case, I can make two adjustments: First, set the height of the eaves columns on the first floor to 7.2/2, that is, 3.6 zhang. Based on this column height, the height of each layer of columns is slightly reduced by a larger margin compared to the lower layer. For example, control the reduction rate to be around 0.93. Simply put,

each layer of eaves columns is 2.25 chi shorter in height than the layer below it. Thus, the heights of the eaves columns of each layer are obtained as follows:
First floor: 3.6 zhang
Second floor: 3.375 zhang
Third floor: 3.15 zhang
Fourth floor: 2.925 zhang
Fifth floor: 2.7 zhang
Sixth floor: 2.475 zhang
Seventh floor: 2.25 zhang
Eighth floor: 2.025 zhang
Ninth floor: 1.8 zhang
To maintain the internal harmony of the decreasing tower height in terms of structural dimensions and to ensure the stability of the wooden structure in the upper part of the tower, no reduction is made between each layer of the tower body and the balcony（平坐） on the layer above it. Between the columns of each balcony and the columns of the tower body below, the "forked column construction method"（叉柱造） is adopted, with the upper and lower columns aligned. The tower body and the balcony maintain consistency in structure.
For each upper layer, except for the outer columns, the inner columns of the tower body still adopt the overlapping column construction method with the columns above and below aligned. Only the outer columns around the tower are retracted inwards, and the retraction rhythm is consistent with the rhythm of the decreasing height of the outer columns, that is, each side of each layer is retracted inwards by 2.25 chi. As a result, the overall width of the elevation of each layer is reduced by 4.5 chi compared to the layer below. From this, the overall width of the elevation of each layer can be obtained:

First floor: 10.8 zhang (9×1.2)
Second floor: 10.35 zhang (9×1.15)
Third floor: 9.9 zhang (9×1.1)
Fourth floor: 9.45 zhang (9×1.05)
Fifth floor: 9.0 zhang (9×1.0)
Sixth floor: 8.55 zhang (9×0.95)
Seventh floor: 8.1 zhang (9×0.9)
Eighth floor: 7.65 zhang (9×0.85)
Ninth floor: 7.2 zhang (9×0.8)
The column heights of each floor and the overall width of the facade obtained in this way have many dimensions that coincide with the number "nine". Not only are the column heights of the first, fifth, and ninth floors exact multiples of 9 chi, but the overall widths of the facades of the first, third (Figure - 13), fifth, seventh, and ninth floors are also exact multiples of 9 chi. For other floors such as the second, fourth, sixth, and eighth floors, the overall widths of their facades can have a relatively regular proportional relationship with the number "9". Moreover, the adobe central column extends upward to the floor of the sixth floor, making the sixth floor present a

typical wooden pagoda form with a central column (Figure - 14). And the ninth floor, that is, the top floor, exactly uses "7.2 zhang", an extended modulus of the tower body height, as the dimension of the entire facade width. (Figure - 15)

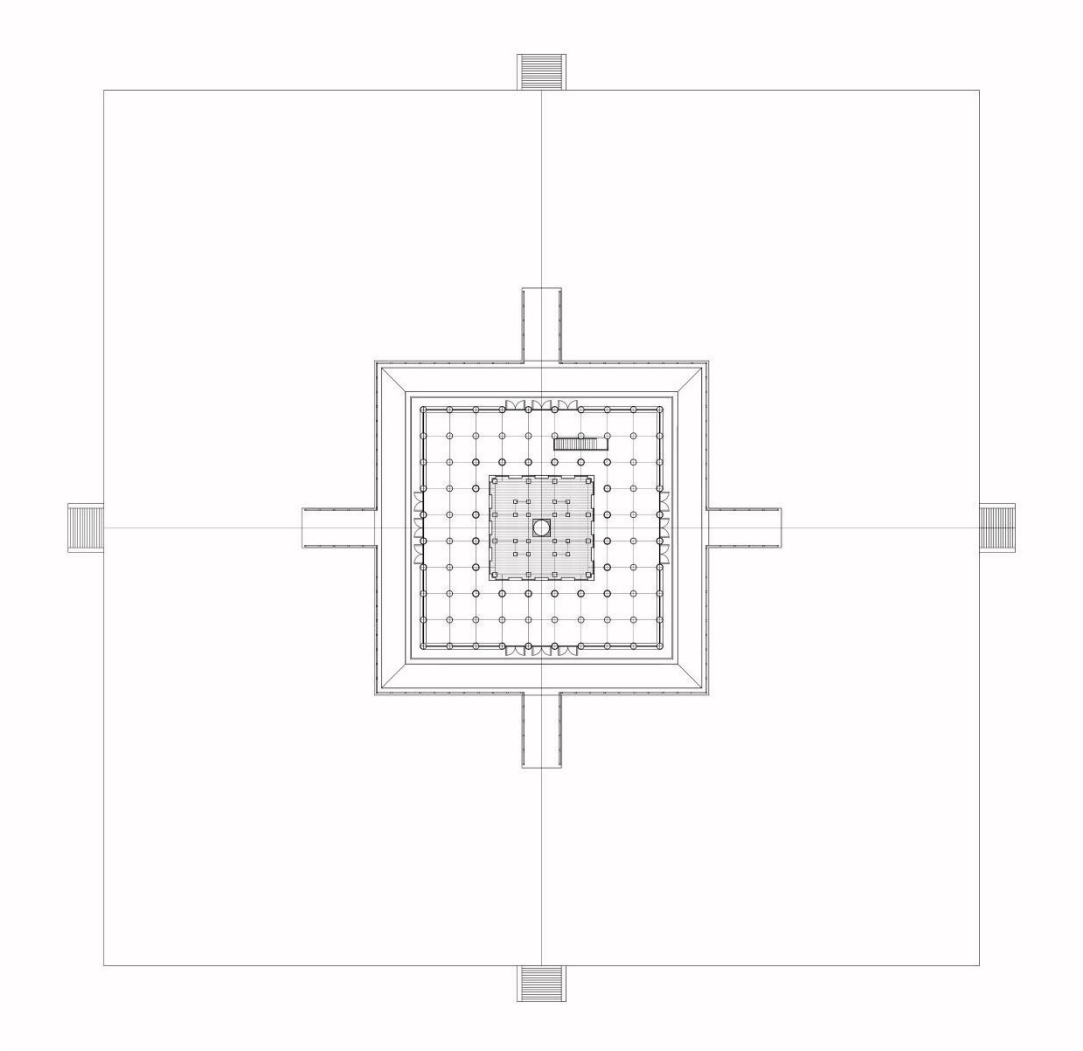

Figure - 13 The speculation of the third - floor plan of Yongning Temple Pagoda (self - drawn)

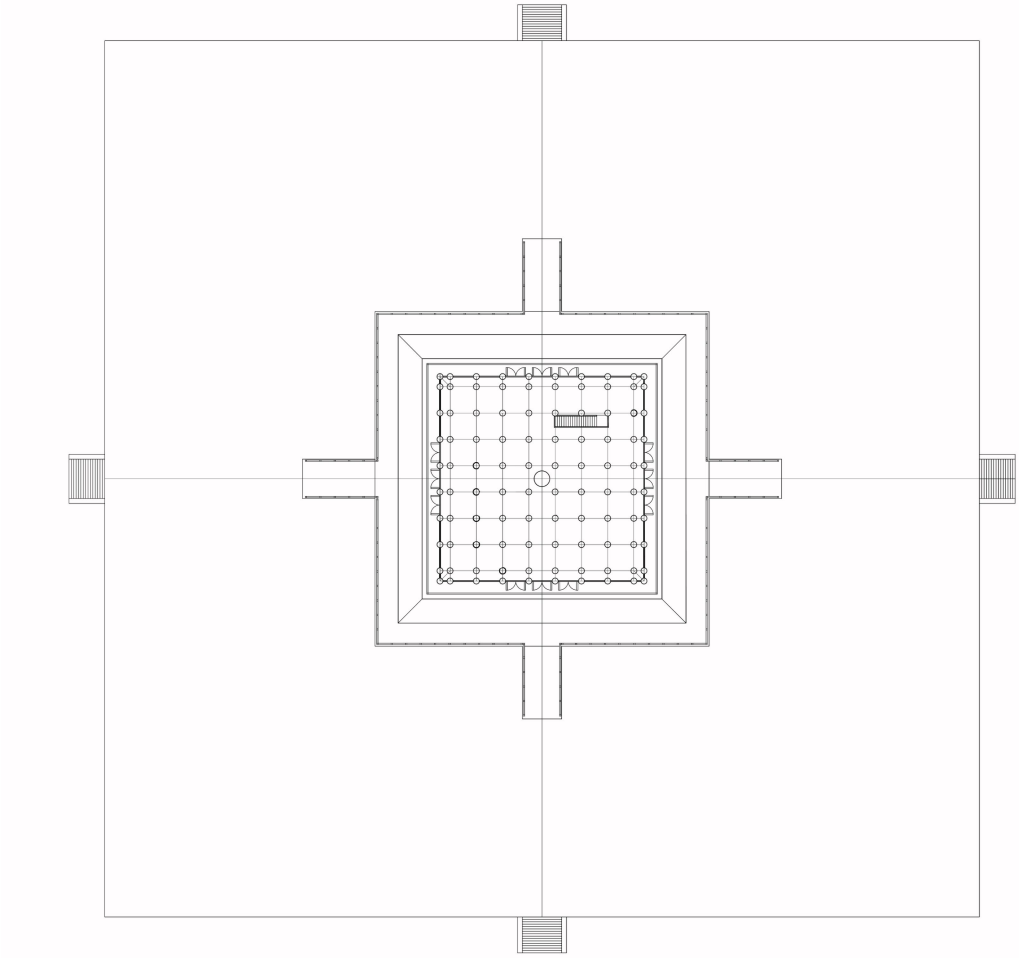

Figure - 14 The speculation of the sixth - floor plan of Yongning Temple Pagoda (self - drawn)

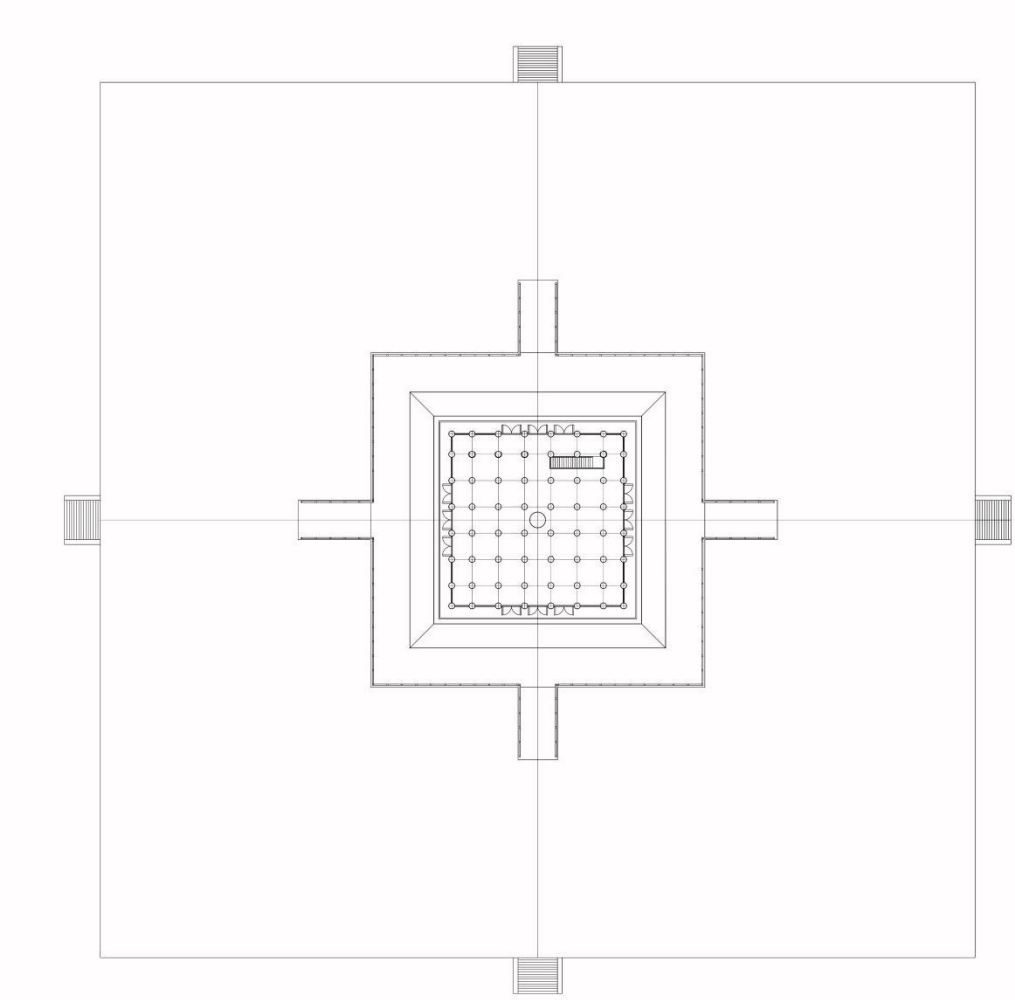

Figure - 15 The speculation of the ninth - floor plan of Yongning Temple Pagoda (self - drawn)

In other words, the rate of decrease in the height of columns on each floor and the rate of inward contraction of the eave columns on each floor not only echo each other but also contain a certain internal sense of rhythm and cadence. Moreover, there is always a certain fit with the number "nine". Therefore, this treatment of proportional decrease seems likely to be closer to the choice of the ancients based on the symbolic appeal of the yang number "nine". (Figure - 16, Figure - 17)

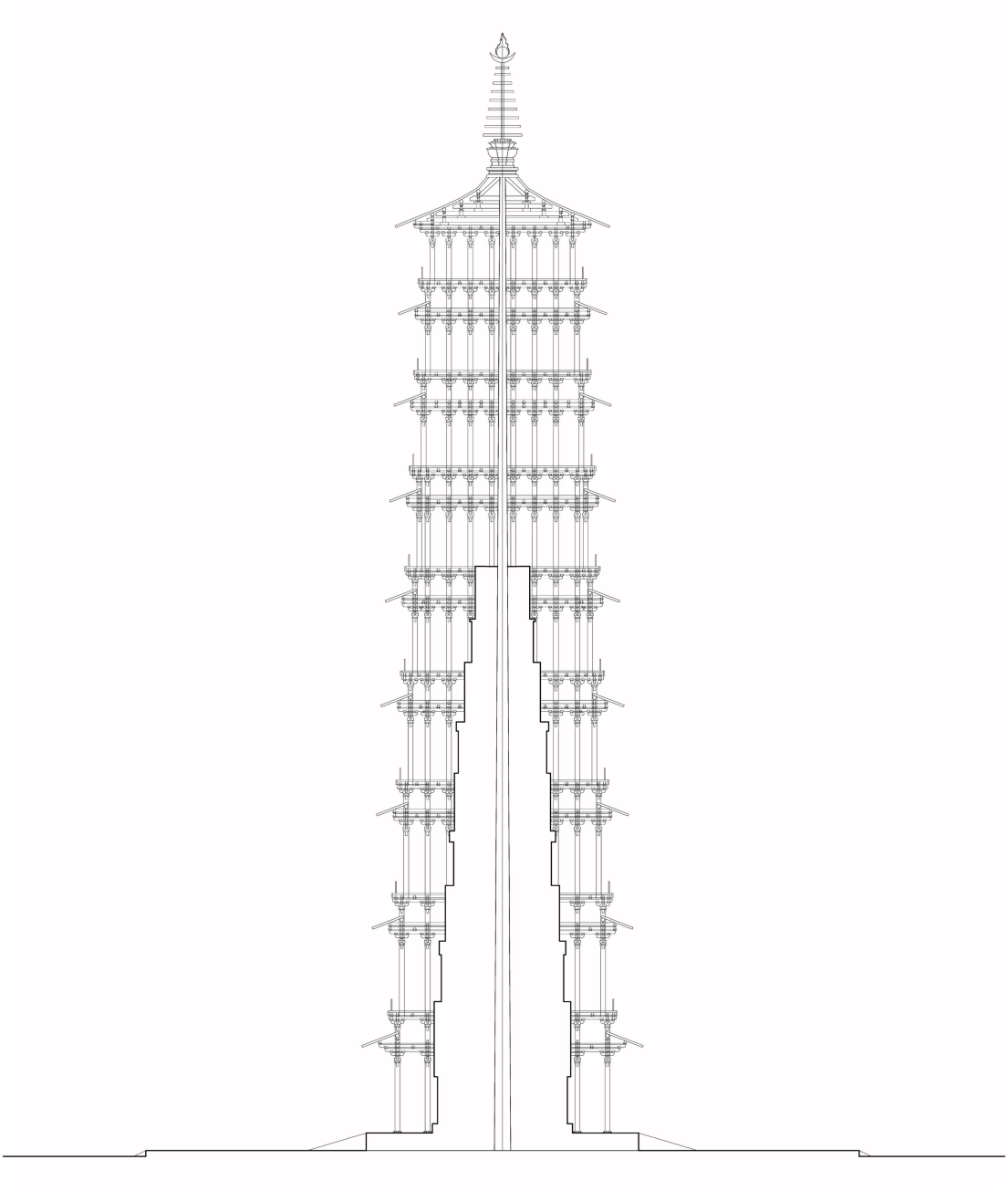

Figure - 16 The sectional restoration of Yongning Temple Pagoda based on the number "9" (self - drawn - 2021)

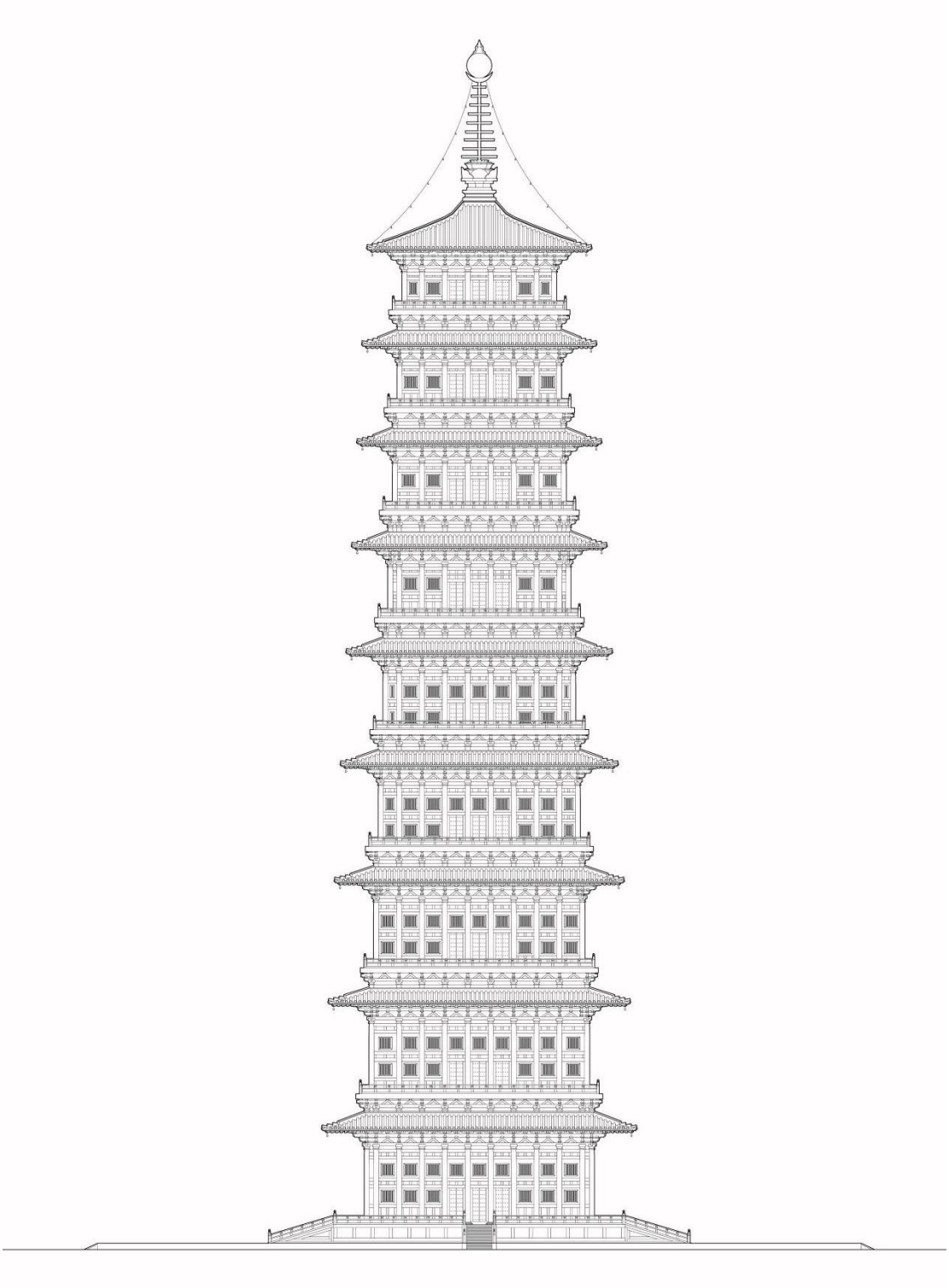

Figure - 17 The elevation restoration of Yongning Temple Pagoda based on the number "9" (self - drawn - 2021)

(2) Bracket sets on columns（柱上铺作）, mezzanine（平坐）, and the rise of the top floor

The two academic papers mentioned previously set the restoration scales as 0.2729 meters per Northern Wei chi and 0.2727 meters per Northern Wei chi respectively. Based on the measured size of the site's platform base, which is 38.2 meters, and by

calculating according to the side length of the platform base, which is 14 zhang as recorded in historical documents, the closest size is approximately 0.272857 meters per Northern Wei chi. In fact, the last digits of these values have reached the millimeter or even a smaller magnitude. Therefore, regardless of which of the two lengths of the Northern Wei chi is adopted, the difference in the conversion of modern measurement values is negligible. Thus, the author adopted the value of the chi length that is closer to the size calculated from the measured data, which is also the median of the chi lengths used by the previous two scholars for restoration, that is, 0.2728 meters per Northern Wei chi. The author took this value as the basic chi length for this restoration research.

Like the viewpoints in Ms. Zhong Xiaoqing's paper, the author also believes that during the Northern Wei Dynasty, the size of building materials was relatively large. Calculating with the first-class material being 1.5 chi, the height of the first-class material at that time was 0.409 meters. For the building materials of wooden structures before the Tang Dynasty, this is a height scale of materials that should be acceptable. Further adopting this view may also help people understand: why did people in the Song Dynasty divide the material value into 15 fen, and whether there was a situation from the Wei and Jin Dynasties to the Sui and Tang Dynasties where the unit of measurement was relatively small, but the building materials used were relatively large, thus forming the rules of the material division system? We don't know at present.

The author sets the bracket sets on each column head as three-jump hidden-heart（三跳偷心） type. On the head of the third jump, no linggong (令栱) is installed, and it directly supports the laoyanfang (橑檐方). The bracket sets of the mezzanine are single-jump hidden-heart type, and they support two cai (材, a unit of measurement in ancient Chinese architecture) and two qi (栔, a unit of measurement in ancient Chinese architecture). The characteristics of the bracket sets are that a vessel-shaped plate（皿板） is set under the ludou (栌斗), and the method of the 16th cave of Tianlongshan（天龙山） Grottoes in the Northern Qi Dynasty is adopted at the column head of the eave column. No huagong (华栱) is extended from the mouth of the ludou, and it is replaced by a column head square. However, for the stability of the column body, a single lintel（单阑额） is added between the column heads of the eave columns and between the column heads of the mezzanine columns. (Figure - 18)

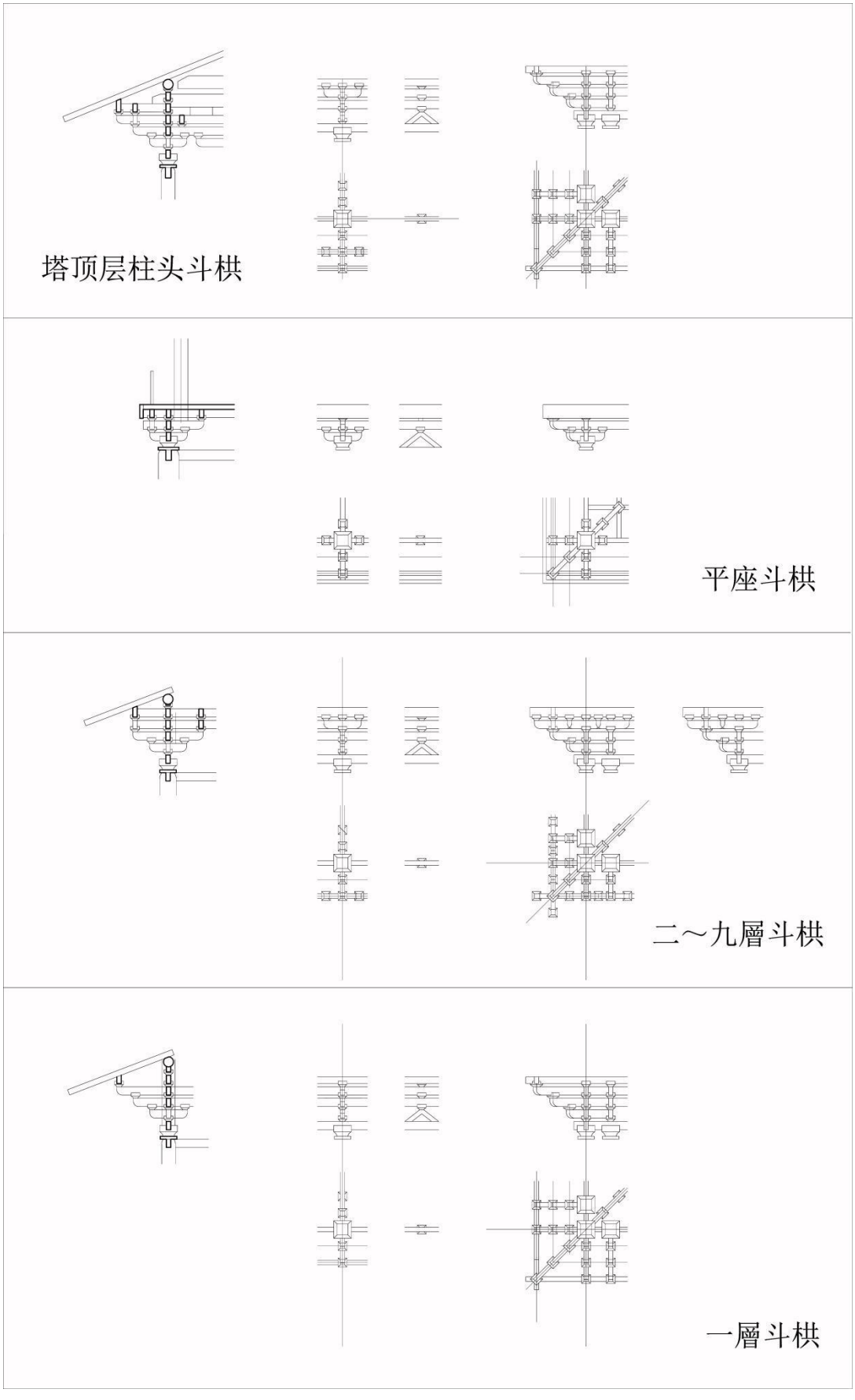

Figure - 18 The speculation of the dougong（） of each floor of Yongning Temple Pagoda (self - drawn)

The result obtained in this way is that the height difference between the top of the column at the lower eave and the ground of the mezzanine above it is 2.673 zhang (equivalent to 7.291 meters in modern feet). This is a dimension obtained through drawing. (Figure - 19)

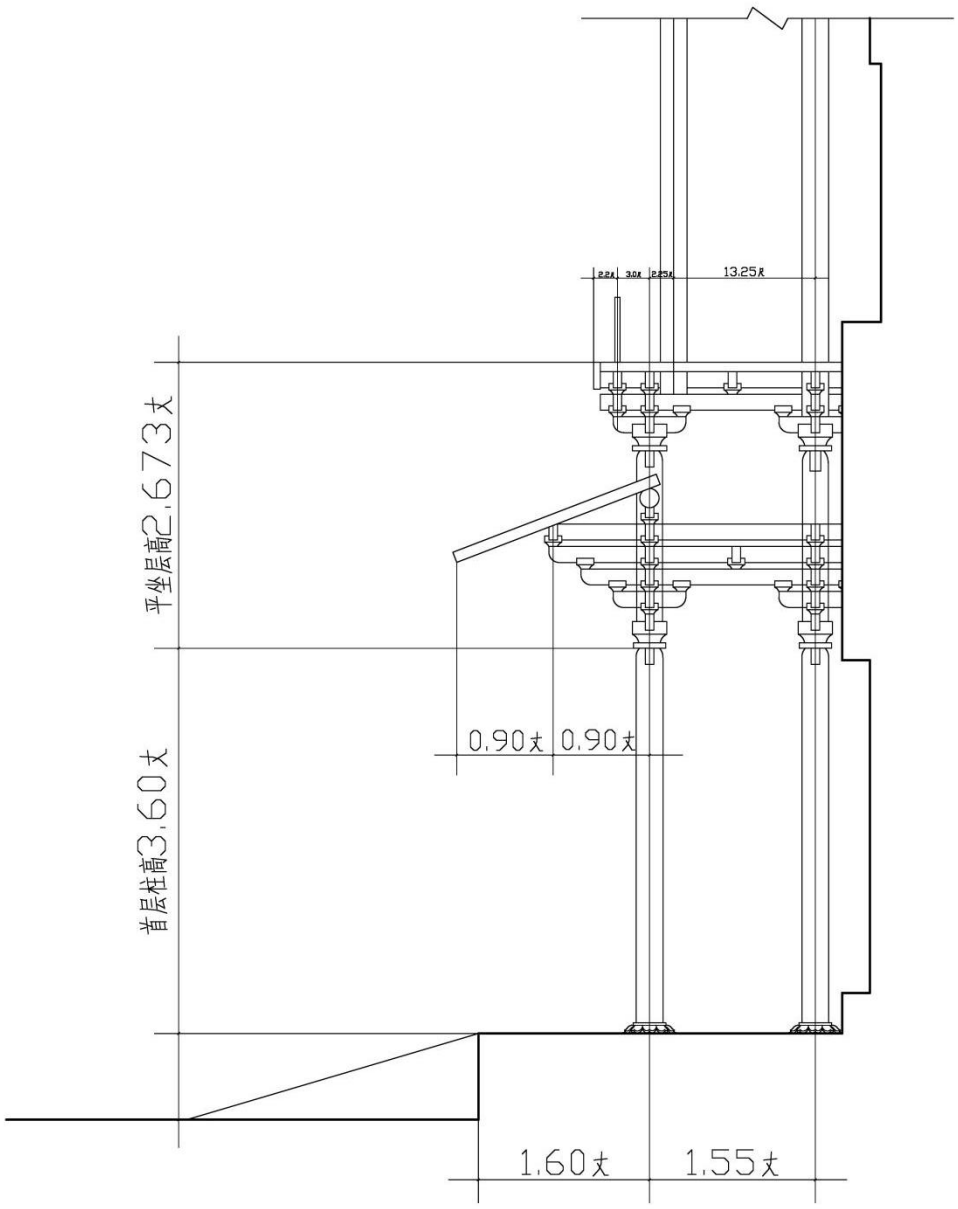

Figure - 19 The details of the first floor and the balcony of Yongning Temple Pagoda (self - drawn)

Thus, the elevation of the upper surface of the column head skin accumulated to the ninth layer is 45.68 zhang. The height of the bracket set above this place is 1.21 zhang. Therefore, the elevation of the upper surface of the purlin eave beam（橑檐方） at the top layer is 46.89 zhang. The distance from the elevation of 49 zhang under the bronze plate mentioned by Li Daoyuan is 2.11 zhang. Since the total length of the three - jump dougong（斗栱） projection is 9 chi, and the total width of the elevation

of the top layer is 7.2 chi, the distance between the front and rear purlin eave beams of the top layer of the tower is 9.0 zhang. If the rise is calculated as 1/4 of the distance between the front and rear purlin eave beams, the rise should be 2.25 zhang. It is very close in value to the 2.11 zhang just deduced by the author.

In fact, the roof pitch of wooden structures before the Tang Dynasty was relatively gentle. Taking the distance between the front and rear liao yan fang（橑檐方） as 9.0 zhang, the remaining 2.11 zhang after accumulation was the lifting height. The lifting height of the top of the tower was approximately 1/4.25 of the distance between the front and rear liao yan fang. From the perspective of architectural history, this lifting ratio was still slightly steeper than the known lifting ratio of the roofs of Tang Dynasty wooden palaces. In other words, if the top of the tower was constructed with a lifting height of 1/4, it did not seem to be very consistent with the historical logic of the development of ancient wooden structures known to the author. Instead, the remaining 2.11 zhang of the accumulated lifting height of the top of the tower was a more appropriate choice that conformed to the structural logic of this era.

(3) Analysis and speculation on the overall proportion of the tower body

Based on the above analysis, the author obtained two extended modules related to the height of the Yongning Temple Pagoda. One is the "7 - zhang" module based on the number "seven", with the height of the first - floor columns being 3.5 zhang. The other is the "7.2 - zhang" module based on the number "nine", with the height of the first - floor columns being 3.6 zhang. Unfortunately, the sum of the heights of the dougong (bracket sets) above the column heads and the mezzanine floor calculated by the author from the drawing is only 2.673 zhang, and it is impossible to establish a proportional relationship where the ground elevation of the second floor is exactly twice the height of the first - floor columns. Therefore, here I only borrows this height ratio that appears in the wooden - structured pavilions of the Tang and Song dynasties, assuming that twice the height of the first - floor columns is used as the extended module of the tower body scale in the concept, and applies it to the overall proportion analysis of the tower body.

Taking "7 zhang" as the expansion modulus, the sum of 7 "7 zhangs" is 49 zhang, which can reach directly to the highest point of the tower top structure. Adding another 7 zhang on it forms the brake base and the Tasha（塔刹）, the top of the tower spire, so the total height of the tower is 56 zhang.

Taking "7.2 zhang" as the extended modulus, with 7 times 7.2 zhang, the height has reached 50.4 zhang, and this height value has exceeded the elevation dimension described by Li Daoyuan below the Golden Dew Plate. If another 7.2 zhang is added on top, the total height of the tower would be 57.6 zhang. This height value seems to be slightly higher than the styling proportion that a tower should have.

An interesting value is 4.9 zhang. In fact, this is a value that can be almost simultaneously associated with the numbers "nine" and "seven". Because 4.9 is exactly 0.7 times of 7, and 4.9 zhang is exactly one-tenth of the height of 49 zhang below the spire as described by Li Daoyuan. In other words, when analyzing the

tower body with this value, the structural vertex of the tower, that is, the height of 49 zhang below the spire, can be exactly divided into ten parts of 4.9 zhang each.

What is more interesting is that in the large-scale proportion control, the upper elevation of the eighth 4.9 - zhang section is 39.2 zhang. This height exactly coincides with the ground elevation of the eighth floor of the tower, with 7.2 zhang as the expansion module. The ground elevation of the eighth floor of the tower can be calculated from the following values:

3.6 + 3.375 + 3.15 + 2.925 + 2.7 + 2.475 + 2.25 + (2.673×7) = 39.186 zhang.

This is a dimension that is very close to the height of 39.2 zhang, which is the accumulation of 8 heights of 4.9 zhang. Above the ground of the eighth floor, add the column heights of the eighth and ninth floors, the height of the Dougong（铺作）between the two floors, the height of the Dougong at the top of the columns on the top floor, and the height of the tower top structure:

2.025 + 2.673 + 1.8 + 1.21 + 2.11 = 9.818 zhang.

39.186 + 9.818 = 49.004 zhang.

That is to say, if we analyze based on the value of 4.9 zhang, the ground elevation of the eighth floor is approximately the height of 8 times 4.9 zhang. From above the eighth floor of the tower structure to the vertex of the tower top structure, that is, within the 49-zhang height below the finial, the remaining height difference is exactly the height of 2 times 4.9 zhang.

The ground elevation of the eighth floor of the tower body is based on the modulus of 7.2 zhang, which is expanded based on the number 9. That is, the height of the columns on the first floor is set at 3.6 zhang, and the height of the columns on each floor is regularly decreased based on this. The result is formed when the height accumulates to the ground of the eighth floor. If the cumulative height of 10 segments of 4.9 zhang, that is, the height below the pagoda finial is 49 zhang, and the height of the pagoda finial base and the pagoda finial above is also set at 7.2 zhang, then the total height of the whole tower is: 49 + 7.2 = 56.2 zhang. This is a value relatively close to the total height of the tower (56 zhang) previously speculated by the author based on the expansion modulus of 7 zhang.

In the actual proportion analysis, the value of 9.8 zhang, which is twice the value of 4.9, can also be used as a reference value. That is, the height from the top of the pagoda (excluding the finial) to the base of the pagoda is 5 times 9.8 zhang; the elevation of the ground on the eighth floor of the pagoda body is 4 times 9.8 zhang. Such an analysis seems to be simpler and clearer in terms of large-scale proportion control, and its essence is consistent with the proportion analysis based on 4.9 zhang.

According to this way of thinking, the two values of 7.2 zhang and 4.9 zhang can be regarded as important parameters for understanding the height module of this wooden tower. We can be interpreted as the controlling heights of the tower body and the tower top. It is precisely in the combination and interaction between 4.9 zhang (9.8 zhang) with the number 7 as the reference system and 3.6 zhang (7.2 zhang) with the number 9 as the reference system that a certain appropriate proportional coordination is achieved. (Figure - 20, Figure - 21, Figure - 22, Figure - 23, Figure - 24)

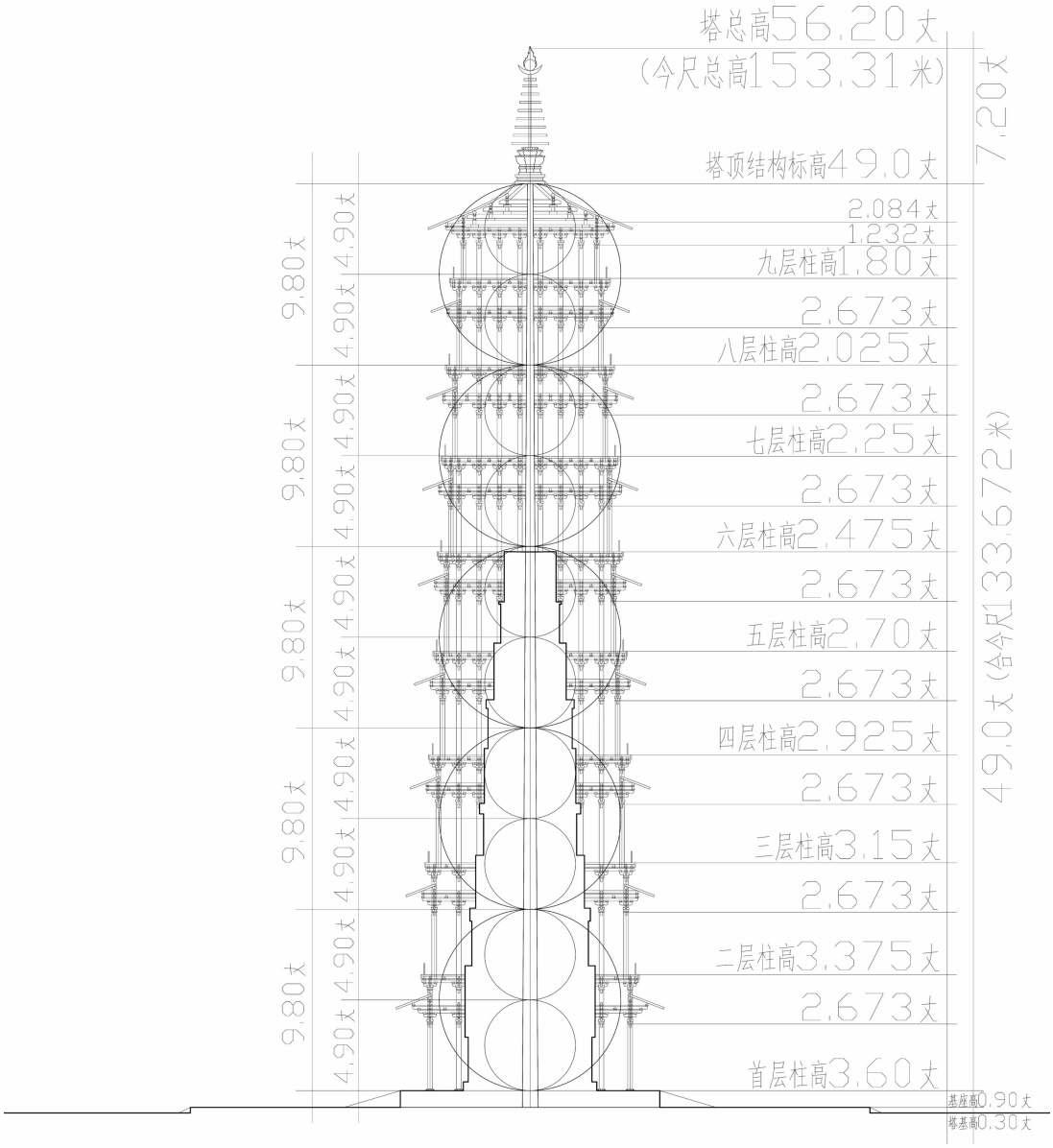

Figure - 20 The sectional dimensions of each floor of Yongning Temple Pagoda based on the number "9" (self - drawn - 2021)

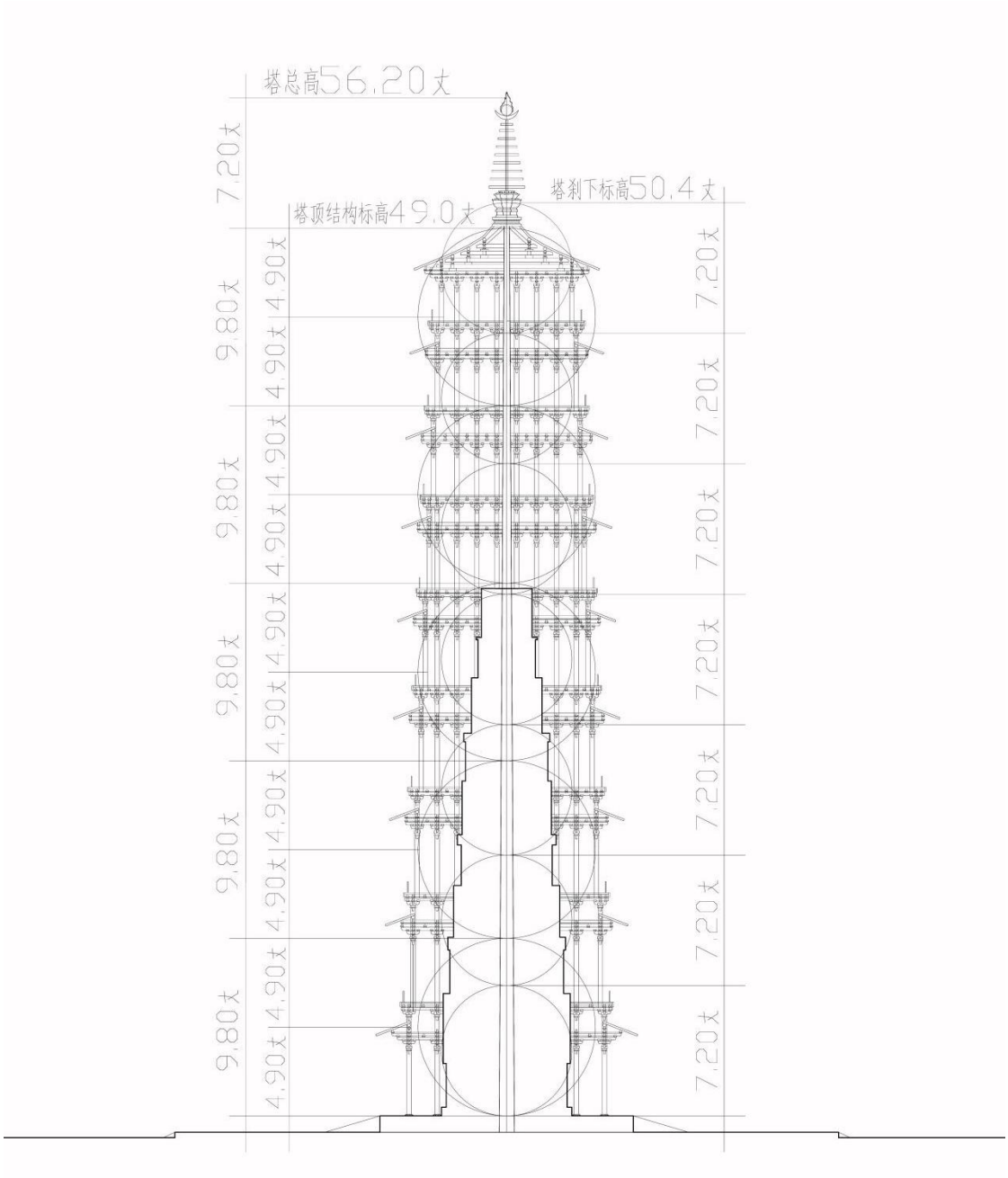

Figure - 21 The sectional proportion analysis of Yongning Temple Pagoda based on the number "9" (self - drawn - 2021)

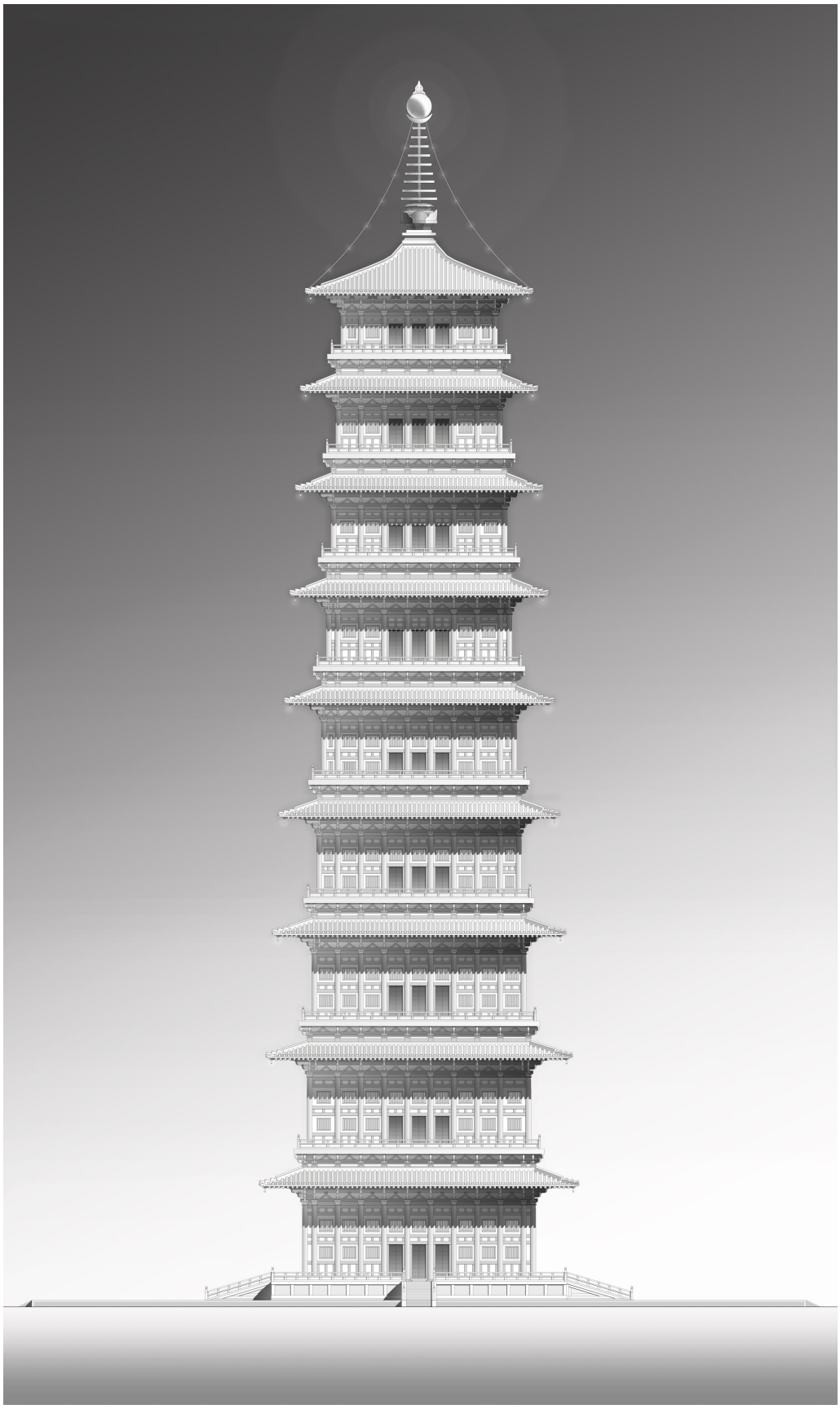

Figure - 22 The elevation restoration of Yongning Temple Pagoda based on the number "9" (rendered by Tang Henglu)

Figure - 23 The colored elevation of Yongning Temple Pagoda based on the number "9" (rendered by Xing Zongman)

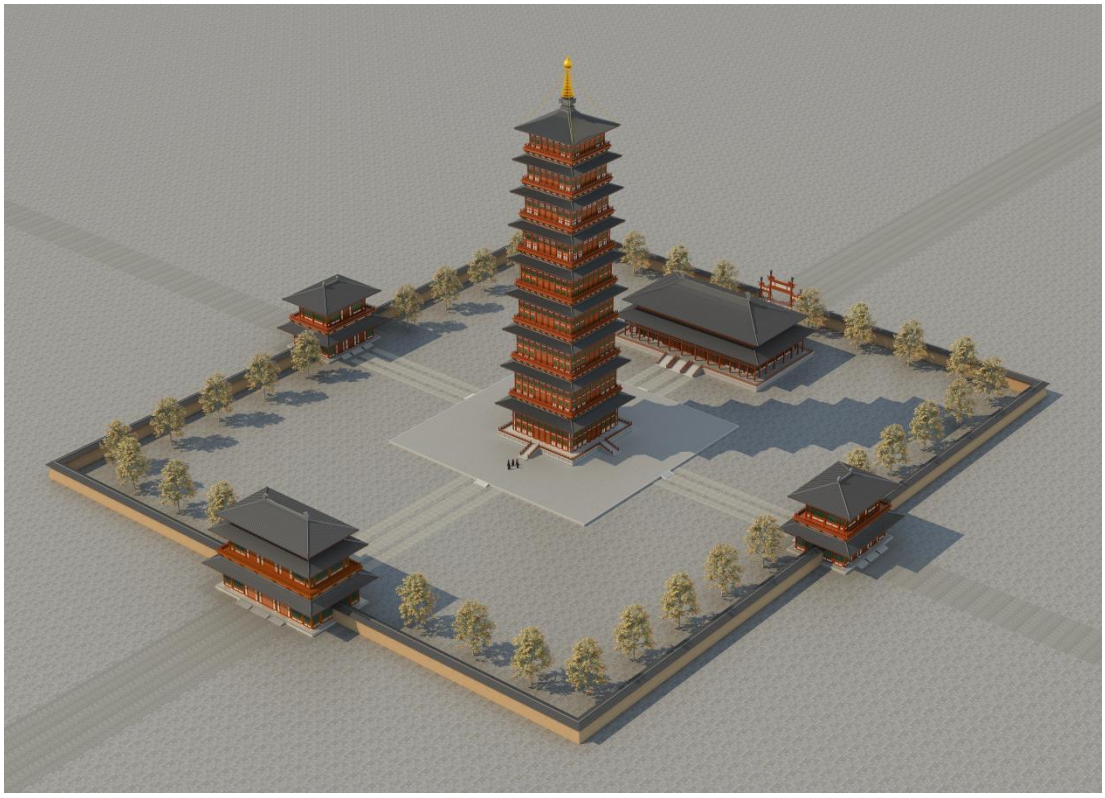

Figure - 24 The bird's - eye view of Yongning Temple and its pagoda in Luoyang during the Northern Wei Dynasty (drawn by Xing Zongman)

Of course, such an analysis is somewhat subjective. This is just an analysis from the author's perspective and does not have any affirmative or negative implications. From this somewhat hypothetical analysis, if it happens to uncover the possible thinking mode that the ancients might have adopted when designing high - rise timber - framed buildings, it can also be regarded as an interesting discovery.

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