



## Design Method of Zen-style Bracket Sets Recorded in the Japanese Carpentry Manual *Kamakura Zoei Myomoku* (Part 2): A Comparative Study with the Chinese Manual *Gongcheng Zuofa Zeli* – A Secondary Publication

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### ABSTRACT

This paper looks into Zen-style bracket composition and design methods recorded in *Kamakura Zoei Myomoku*, an architectural manual kept by the Kawachi family, the hereditary carpenter family for the Kenchoji Temple in Kamakura, Japan from the 13th to 19th century. It then makes a comparison with *Gongcheng Zuofa Zeli* (*Engineering Manual for the Board of Works*), a Chinese architectural engineering manual in the Qing dynasty (1644–1911). The study results indicate that the cross-sectional dimension of bracket is used as the base measurement unit in both China and Japan, while the use of equidistant baseline and rafter dimension as base unit are considered to be Japanized improvement.

**Keywords:** Zen-style, bracket set or dougong, carpentry manual, *Kamakura Zoei Myomoku*, *Yingzao Fashi*, *Gongcheng Zuofa Zeli*

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## 1. INTRODUCTION

This article looks into *Kamakura Zoei Myomoku*, a precious firsthand document about Zen-style architecture in Japan discovered and named as such in the 1980s. It is the original records and notes kept between the 13th and 19th century by the Kawachi family, the hereditary carpenter family for the Kenchoji Temple in Kamakura, Japan, which was the first authentic Japanese Zen temple built in 1253. The first paper in this series has offered historical information of *Kamakura Zoei Myomoku* and terminologies from Japanese architectural history, including Japanese Zen style, *wayō* style, *Kiwari*, *shiwari*, *ayita*, and unique names for Japanese bracket components. It has also compared *Kamakura Zoei Myomoku* with *Yingzao Fashi* (*Technical Treatise on Architecture and Craftsmanship*), a Chinese architectural manual in the Song dynasty (960–1279) [1]. This second paper compares the design and composition methods of Zen-style bracket from the Japanese *Kamakura Zoei Myomoku*, with the Chinese *Gongcheng Zuofa Zeli* (*Engineering Manual for the Board of Works*) in the Qing dynasty (1644–1911) [2], to find out what techniques of Japanese Zen-style architecture were influenced by Chinese methods.

## 2. COMPARISON WITH THE DESIGN METHODS OF DOUKE FROM GONGCHENG ZUOFA ZELI IN THE QING DYNASTY

Six hundred years after *Yingzao Fashi* was published, officials in the Qing dynasty compiled and published the architectural engineering manual *Gongcheng Zuofa Zeli* [1] (1734). Research on this manual was first conducted by Chinese architect Sicheng Liang [3], and later by Japanese scholar Kazuyoshi Fumoto, among others [4,5]. By

referring to their research findings, the authors have summarized a few key points relevant to our comparative study of Chinese and Japanese architectural styles, which are presented as follows.

*Gongcheng Zuofa Zeli* details specifications in the order of horizontal design, wood structure, decoration, roof truss, and eave. Horizontal design features the two dimensions of breadth and depth. For buildings with brackets, the size of a columned bay is dictated by the number of *zan* (one bracket set) [2] and the dimension of *zan* is measured by the base unit of *doukou* (width of bracket cross section). The example from Volume 1 Section 1, “Hall with single *qiao* (petal) and multiple *ang* (lever),” stipulates that 1 *zan* equals to 11 *doukou*. It also specifies that the breath of *mingjian* (central bay), *cijian* (rooms on the two sides of *mingjian*), *shaojian* (rooms on the two sides of *cijian*) and *langzi* (corridor room) are 7, 6, 6 and 2 *zan* respectively, and that the depth of *mingjian*, *cijian*, and *langzi* are 4, 4, and 2 *zan* respectively. The concept of *zan* in *Gongcheng Zuofa Zeli* is similar to that of *duo* (spacing) in *Yingzao Fashi*, or *ayita* in *Kamakura Zoei Myomoku*. Compared to *Yingzao Fashi*, the number of bracket sets between adjacent columns increases from 3 to 6 in *Gongcheng Zuofa Zeli*. As a result, the dimension of one bracket set shrinks, which means the function of *zan* as a measurement unit is strengthened.

*Doukou* dictates the size of *zan* and it works as a base unit for measuring the dimension of various bracket components. The actual dimension of *doukou* varies from first, second, and all the way through to eleventh class of wood material, with its width decreasing from 6 *cun* (1 *cun* = 3.33 cm) to 1 *cun* in an order of 0.5 *cun*. Design methods of *Gongcheng Zuofa Zeli* highlight

<sup>1</sup> The compilation was led by Shuogu Prince Yunli who oversaw affairs of Ministry or Works. With 74 volumes and 20 books in total, it is divided into several parts, i.e., wood structure, *douke*, decoration, and foundation. Based on different architectural forms, the part on wood structure further breaks down.

<sup>2</sup> In the paper, Composition of Chinese Classical Architectural Book “*Gongcheng Zuofa Zeli*,” Jun Cai and Kazuyoshi Fumoto summarize dimensional measurement methods of the manual as three types: use of *doukou* as base unit; buildings without brackets use columned bay dimension as base unit, or breath/depth method; the hybrid mode, using *doukou*, breath/depth and column height as base units.

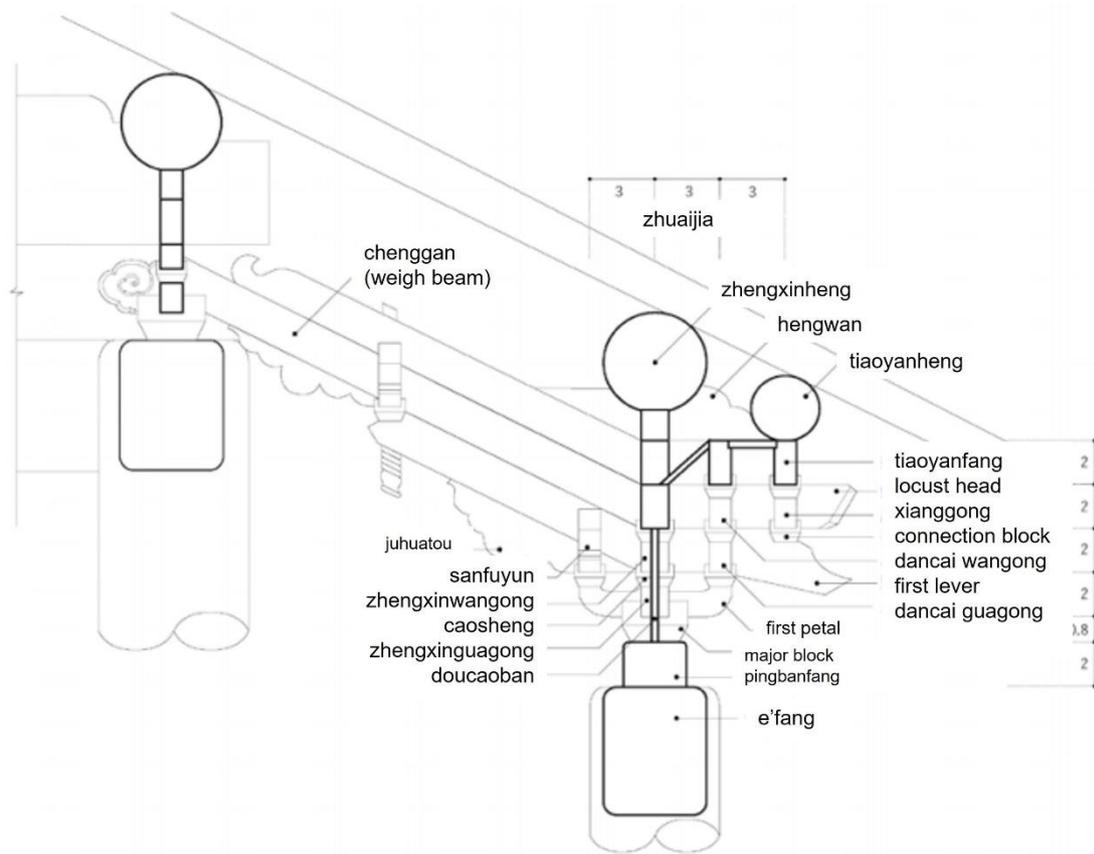
the full use of *doukou* as a base measurement unit. *Doukou* is used in deciding not only the dimension of horizontal plane or bracket, but also thickness, width and height of bigger wood components or even the dimension of eaves.

The next part is about bracket techniques in *Gongcheng Zuofa Zeli*, in which *douke* (the name for *dougong* in the Qing dynasty) corresponds to *puzuo* (the name for *dougong* in the Song dynasty) in *Yingzao Fashi*. *zhutou* (pillar top) *puzuo*, *zhuanjiao* (corner column) *puzuo* and *bujian* (between-columns) *puzuo* in *Yingzao Fashi* correspond to *zhutouke*, *jiaoke* and *pingshenke* in *Gongcheng Zuofa Zeli*. Figure 1 is a detailed illustration of *douke* components.

The Japanese *Hijiki* corresponds to both *gong* (bracket arm) and petal. Bracket arm (*Hijiki*) is the component extended in parallel to the wall while petal (*Hijiki*) is the

component extended perpendicularly to it. Different names indicate different extension directions. Bracket arm that is parallel to the wall is further broken down into five types: two short arms called *zhengxin guagong* and *zhengxin wangong* (the first and second arms right above the column), similar two short arms called *dancai guagong* and *dancai wangong* (the first and second arms on the extension), as well as *xianggong* (*Hakari-Hijiki* in Japan) on *sandou* (a supportive block) of the outermost extension.

Lever is the same as in *Yingzao Fashi*, which corresponds to the Japanese *Odaruki*. However, as lever was combined with petal in *pingshenke*, it lost the structural function of lever and became formalistic. With *tiaojin* and *liujin douke*, the protruded lever visible under the eave extends to the inside of roof truss and combine with the slant wood piece called *chenggan* (weigh beam).



**Figure 1.** Composition of liujin bracket in Qing-dynasty *Gongcheng Zuofa Zeli*. Source: Drawing by Tadanori Sakamoto by referring to Figure 6 of Qing-dynasty *Yingzao Zeli* by Sicheng Liang

*Sheng* and *dou* (bracket block) are differentiated in *Gongcheng Zuofa Zeli*, with the former one supporting petal or lever, and the latter being *sandou*, the wood piece supporting bracket arm or purlin parallel to the wall. *Sheng* includes *caosheng* and *sancaisheng*, with the former one as *makito* (*juandou*) block on *zhengxin guagong* and *zhengxin wangong*, and the later as *makito* (*juandou*) block on *dancai guagong* and *dancai wangong*. Besides, there are *dadou* (major block) and *shibadou* (connection block), with the latter corresponding to Japanese *kaketo* (Chinese *dou*). The uppermost petal is called *chengtoumu* (supportive wood), Japanese *kobushibana* (Chinese *quanbi*) is called *mazhatou* (locust head) and the bumper piece which shields the eave-rafter gap on the top is called *hengwan*. In terms of purlin, *zhengxin fang* (lateral wood piece right above the column) placed on the central axis of the wall corresponds to *Tooshi-Hijiki* in Japan, which supports the round *zhengxin lin* (purlin right above the column) on the top. Besides, the outermost *xianggong* supports the square *tiaoyan fang* (wood piece supporting the eave), which further supports *tiaoyan lin* or *gangyo* in Japan (purlin supporting the eave). This is different from the practice of inserting the square *tiaoyan fang* right on the bracket block as specified in *Kamakura Zoei Myomoku* and *Yingzao Fashi*.

The next part is about component dimensions, for which *pingshenke* differs from *zhutouke*. This paper focuses on *pingshenke* as it is the majority<sup>[6]</sup><sup>3</sup>. The following dimensional figures are ratios worked out by assuming *doukou* to be 1.

First of all, dimensions of the major block are stipulated as 3 for width, 2 for height, 0.8 for the height of *doukou*, 2.2 for both bottom width (*tojiri-haba* in Japanese) and bottom length, 0.8 for bottom height

(*toguri-daka* in Japanese) and 0.4 for upper height (space from *shikimen-daka* to *toguri-daka*). One can see that dimensional specification of brackets in the Qing dynasty fully relied on *doukou* as base measurement unit as all these dimensions are clearly in proportion to *doukou*. The overall width to height ratio of the block is 3:2. Dimensions of various components increase or decrease in an order of 0.5 *cun*. The connection block, equivalent to Japanese *kaketo*, features a rectangular shape horizontally. It is 1.8 in frontal width, 1.48 in depth, 1 in height, 0.6 in bottom and upper height combined and 1.1 in bottom width. That shows the frontal width of connection block is roughly 40 percent bigger than *sancaisheng*. *Caosheng*, the block on lateral arm, is 1.3 in frontal width, 1.72 in depth, 1.72 in height and 1.32 in bottom width. *Caosheng* is bigger than *sancaisheng* in depth and width, presumably because the bracket arm under *caosheng* has different width. Besides, the bottom part of bracket blocks is invariably wider than bracket cross section.

The next part is about the dimensions of bracket arm pieces. Components extended perpendicular to the wall, including first petal, second petal, first lever, second lever, locust head, and *chengtoumu*, all are precisely 1 and 2 times of the base unit in width and height. On the other hand, lateral arms right above the column axis, including *zhengxin guagong* and *zhengxin wangong*, all have a width of 1.24 and height of 2, which make them slightly wider. That is because the *yagongban* (wood piece pressing the bracket arm) inserted to the column center adds some thickness of 0.24.

Lateral arms under the eave, including *dancai guagong*, *dancai wangong* and *xianggong*, on the contrary, have a width of 1 and height of 1.4. The height is smaller because this does not account for the 0.6 of upper and bottom height combined. Accounting for that would make it 2, which is

<sup>3</sup> Xin Chen and Heshan Lu concluded in the paper that the width of the cross-section of the warped and raised beams supporting the topmost, large pointed beam gradually widens from the lower floor to the upper floor. See 《中国古典建筑书『工程做法则例』における翹昂斗科の設計技法》 (translated as “Design technique of bracket complex called *Qiao Ang Dou Ke* in Chinese classical architectural book *Gongcheng Zuofa Zeli*) by Xin Chen and Kazuyoshi Fumoto.

equivalent to the height of arms perpendicular to the wall. Besides, such dimensional specification indicates that one extension is 2 in height.

The horizontal length of extension is called *zhuaijia* in *Gongcheng Zuofa Zeli*, which records 1 *zhuaijia* as equivalent to 3 *doukou*. In case of the first petal, horizontal length of the extension is 7.1, which is a combination of 2 *zhuaijia* plus the bottom width of the connection block (6+1.1=7.1). As is shown above, the length of the bracket arm is stipulated via *zhuaijia* or *doukou*. Besides, the protrusion size of lever or locust head should also be stipulated via the base unit of *zhuaijia*. In other words, the dimensional specification for brackets in the Qing dynasty had a clear principle - bracket component dimensions were stipulated via the base unit of *doukou*, and their width, length, and height were all integral times of *doukou*.

Next, let us examine whether bracket design in the Qing dynasty required that the upper and lower end lines of bracket block to be aligned vertically, that is, the principle of *To-chigai* in *Kamakura Zoei Myomoku*.

To calculate the clearance of *caosheng* on *zhengxin guagong*:

$$\begin{aligned} &\text{Clearance of } caosheng \\ &= \text{length of } zhengxin\ guagong - \text{bottom length} \\ &\quad \text{of } caosheng - \text{length of } caosheng \\ &= 6.2 - 0.9 - 1.3 \\ &= 4 \end{aligned}$$

The length of *pingshenke* major block is 3, which means the end lines on the left and right of major block are not aligned vertically to the end lines of *caosheng* from the above. In other words, it does not follow the principle of *To-chigai*. However, the length of *zhutouke* major block is 4, which means the end lines of *zhutouke* major block and *caosheng* block are aligned neatly to each other vertically.

To calculate the clearance of *caosheng* on *zhengxin wangong*:

$$\begin{aligned} &\text{Clearance of } caosheng \\ &= \text{length of } zhengxin\ wangong - \text{bottom} \\ &\quad \text{length of } caosheng - \text{length of } caosheng \\ &= 9.2 - 0.9 - 1.3 \\ &= 7.0 \end{aligned}$$

To calculate the clearance from the exterior of *caosheng* on *zhengxin guagong* to the structure exterior:

$$\begin{aligned} &\text{Clearance from } caosheng \text{ exterior to structure} \\ &\text{exterior} \\ &= \text{length of } zhengxin\ guagong - \text{bottom length} \\ &\quad \text{of } caosheng + \text{length of } caosheng \\ &= 6.2 - 0.9 + 1.3 \\ &= 6.6 \end{aligned}$$

There is a gap of 0.4 between the two, which means it does not follow the principle of *To-chigai*.

### 3. SIMILARITIES AND DIFFERENCES BETWEEN *KAMAKURA ZOEI MYOMOKU* AND *GONGCHENG ZUOFA ZELI*

*Gongcheng Zuofa Zeli* was compiled later than *Kamakura Zoei Myomoku*, hence there is no interplay between the two. Rather, they indicate how the design methods of *Yingzao Fashi* have changed respectively in China and Japan after it was introduced to Japan. That is to say, the difference between *Gongcheng Zuofa Zeli* and *Kamakura Zoei Myomoku* stands for different evolvement of *Yingzao Fashi* in China and Japan, which is of greater significance in terms of historical and geographical background. Moreover, it is imperative that we conduct restorative examination and research on *Gongcheng Zuofa Zeli*, and from this perspective, we explore the themes of architectural design in ancient China. With such views, the above-mentioned design methods and bracket composition from *Gongcheng Zuofa Zeli* are compared to corresponding records in *Kamakura Zoei Myomoku* as follows.

- (i) *Gongcheng Zuofa Zeli* uses the base measurement unit of *doukou*, that is, the width of bracket cross section, to specify the dimensions of all building

components. This design method is clearer and more straightforward than the *caiqi* measurement system in *Yingzao Fashi*. Although *Kamakura Zoei Myomoku* also follows the principle of using the bracket dimension to specify other component dimensions, *Gongcheng Zuofa Zeli* makes the most of it – the dimensions of everything, including the height of one bracket extension and the horizontal length of *zhuaijia*, are all integral times of the base dimension, bringing the technique to a supreme level. However, because of that, the principle of eight consecutive wood dimensions corresponding to architectural classes and sizes from *Yingzao Fashi* is absent from *Gongcheng Zuofa Zeli* [5]. One should also note that as bracket became smaller, *zhutouke* and *pingshenke* do not follow the same measurement system because the former works to support beams of large cross section, while the latter does not function in this way.

- (ii) *Gongcheng Zuofa Zeli* uses *zan* as the base measurement unit for horizontal design in a stricter way than *Yingzao Fashi*, which uses the *caiqi* measurement system. *Zan* is adaptable as a base measurement unit, which is probably one of the reasons why a set of brackets became relatively smaller and a bay can accommodate 6–8 sets. *Ayita* from *Kamakura Zoei Myomoku* is not used as strict as that, instead, it relies on the correlation between *ayita* and *shiwari* to control the dimensional relation.
- (iii) *Gongcheng Zuofa Zeli* stipulates that all extensions should be of the same height, and that the horizontal length of extensions, *zhuaijia*, should also be equidistant. This design method is more straightforward than the specification in *Yingzao Fashi*, as it goes a step further to specify all dimensions in integral times of *doukou*. One *zan* equals to 11 *doukou*, and the latter is used to measure dimensions of all components. However, the *To-chigai* principle recorded in

*Kamakura zoei myomoku* is not visible in vertical design.

- (iv) Compared to *Yingzao Fashi*, the overall bracket composition of *Gongcheng Zuofa Zeli* indicates that the structural function of lever (*Odaruki* in Japanese) weakens. Instead, the petal extended perpendicularly to the wall is made into modules that stack up seamlessly. As a result, the structure is reinforced and the bracket becomes simpler. The tight-stacking method of petal in *Gongcheng Zuofa Zeli* is the same as the technique of “*Kasane (stacking)-Hijiki*” in *Kamakura Zoei Myomoku*. Nevertheless, both *Yingzao Fashi* and *Gongcheng Zuofa Zeli* do not include the practice of widening the cross section of stacked pieces by 10 percent as is recorded in *Kamakura Zoei Myomoku*. Besides, *sancaisheng*, which is equivalent to Japanese *Makito* has the same size as the connection block, which is equivalent to Japanese *Kaketo*. Hence there is no common ground with *Kamakura Zoei Myomoku* which records the practice of making *Kaketo* 10 percent wider.
- (v) *Gongcheng Zuofa Zeli* directly stipulates the dimensions for the bottom part of bracket block, which differs from *Yingzao Fashi* and *Kamakura Zoei Myomoku*, as the latter two use frontal width of the block as the base and stipulate the bottom dimensions by deducting several *fen* (1/10 of *cun*) from that. Rather, it is similar to the practice recorded in Japanese *Kiwari* manual from the early modern period (16th–19th century).

#### 4. SIMILARITIES AND DIFFERENCES BETWEEN CHINA AND JAPAN IN BRACKET COMPOSITION AND DESIGN METHODS

The comparisons between *Kamakura Zoei Myomoku* and the two major classical architectural manuals in China, *Yingzao Fashi* and *Gongcheng Zuofa Zeli*, are presented above. After examining each

chapter, we have come to the following summary.

- (i) Similarities and differences between *Kamakura Zoei Myomoku* and *Yingzao Fashi* in bracket composition is covered in the first paper, and is repeated here to contrast with *Gongcheng Zuofa Zeli*. Japanese Zen style took shape as an architectural style after Chinese architecture from the late Southern Song dynasty (1127–1279), which was introduced to Japan. Therefore, the records kept in *Kamakura Zoei Myomoku* by the representative carpenter family for Zen-style architecture naturally shows strong connection with *Yingzao Fashi* from the Song dynasty. The technique of “*Kasane-Hijiki*” in *Kamakura Zoei Myomoku* is particularly noticeable – the height of *Hijiki* (*Huagong* or petal) extended perpendicularly to the wall is made bigger to fill in vertical gap between the wood pieces, which then stack up tightly to reinforce the structure. This technique is only used in Kanto and its surrounding region in Japan but is absent from other technical manuals. Therefore, one may infer that the bracket techniques introduced from China to Kamakura in the late Southern Song dynasty had only been circulated and passed down in the local region. That might be because the eave-supporting technique *Hanegi* was already widely adopted in Japan in the medieval period (13th–15th century), and as a result, they did not need to rely on brackets to support the eave. Hence, there was no need to reinforce the wood pieces perpendicular to the wall, and the technique of *Kasane-hijiki* was not popular. Figure 2 is a picture of a 1:2 model for the Toindo Hall of Yakushi-ji, Nara. Built in 1285 in the Kamakura period, it features an eave of 3.5 m with only two bracket extensions under it [Figure 3]. That is because the *Hanegi* in the roof truss [Figure 4] works as a supportive structure to the roof. This building in the Toindo Hall of Yakushi-

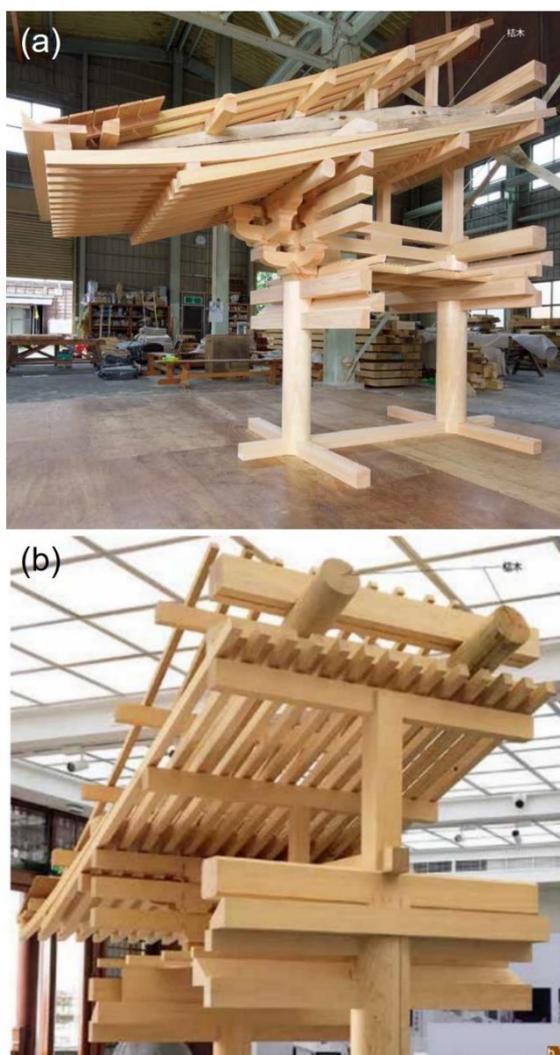
ji is a typical style following the emergence of *Hanegi*. Its emergence not only simplified the bracket and the determination of roof truss gradient, it also no longer relied on the method of *juzhe* (defining the roof truss height based on building depth and roof material). Moreover, the roof curve could be defined by erecting short columns on *Hanegi*. Hence, both the roof gradient and the bracket were no longer limited by its supportive function, and carpenters could dedicate more efforts on how to make elegant roof and bracket curves. It can be concluded that *Hanegi* contributes to a totally different structural characteristic from China in Japanese wooden architecture, which features broad eaves and less advanced brackets.

What is more, *Kamakura Zoei Myomoku* records practices of “*Kasane-Hijiki*” and making *Kaketo* 10 percent larger, which are absent from the two major classical technical manuals of China. Hence, such practice emerged presumably after the publication of *Yingzao Fashi*. But it is not yet certain whether it first emerged in China or was created after the architectural style from the late Southern Song dynasty, which was introduced to Kamakura.

Likewise, the lower one of the two bottom levers recorded in *Kamakura Zoei Myomoku* is a wood piece with two protrusions. The extension inside is *huagong*, while the outside extension is made into a false lever without the function of a lever. The actual component bearing the roof weight is *sasu*, which slants upward from the center of the arm piece. Similarly, this is presumably an evolvement of bracket after *Yingzao Fashi* was published. Though *Yingzao Fashi* also records the false lever and upward lever, they were of limited use.

Among the existing historic architecture in Japan, the practice of double lower levers in western Japan

(Nara and Kyoto, etc.) is the same as in *Yingzao Fashi*. However, double lower levers used in historic architecture in Kamakura and its outskirts in eastern Japan are one real lever plus. Therefore, Kinya Sekiguchi believes that there are two origins for Japanese Zen-style architecture [7], Kyoto and Kamakura, hence the different practices of architectural structures in eastern and western Japan.



**Figure 2.** Scale of 1:2 model for Toindo hall, Yakushi-ji, Nara (wood). (a) Made by Ikaruga-kosha (Tochigi Prefecture of Japan), preserved in Takenaka Carpentry Tools Museum. (b) Picture taken by Muping Bao in Baoguosi (Ningbo) during Takenaka Carpentry Tools Museum Special Exhibition for China.



**Figure 3.** Bracket under eave from the 1:2 model for Toindo hall, Yakushi-ji, Nara. Picture taken by Muping Bao in Baoguosi (Ningbo) during 2019 Takenaka Carpentry Tools Museum Special Exhibition for China.



**Figure 4.** Hanegi from the 1:2 model for Toindo hall, Yakushi-ji, Nara, preserved in Takenaka Carpentry Tools Museum

The geographical distance between Kyoto and Kamakura is not too long to generate different architectural technique circles. However, history of Kyoto at that time as the “old-fashioned” Buddhist center before the arrival of Zen means that Kyoto was the birthplace of *wayō*-style architecture after assimilating Chinese wooden architectural style. Hence, Kyoto is the base of traditional Buddhist and *wayō*-style architecture, while Kamakura is the capital of the new Bakufu regime and the very center for introducing Zen to Japan. Considering that Kamakura Bakufu explicitly invited Zen gurus from Southern Song dynasty to go to Japan and build temples, one cannot exclude the possibility that the

gurus brought Chinese carpenters to Japan with them. According to legend, the hereditary carpenter family Takashina for the Enkakuji Temple in Kamakura was descended from a Chinese carpenter who went to Japan with Wuxue Zuyuan<sup>4</sup>, the first abbot of the temple. But it remains a legend as there is not yet any proof for that history or genealogy.

In *Gongcheng Zuofa Zeli*, head lever extended perpendicularly to the wall is made more integrated and reasonable, hence the authors believe that the technique of *Kasane-Hijiki* in *Kamakura Zoei Myomoku* should have evolved between the publications of *Yingzao Fashi* and *Gongcheng Zuofa Zeli*. But it is not yet certain whether it first emerged as a local practice in the late Southern Song dynasty and later was introduced to Kamakura, or it was a unique innovation after Southern Song architecture which was introduced to Japan.

- (ii) Regarding the dimensional specifications, both *Yingzao Fashi* and *Gongcheng Zuofa Zeli* stipulate that the horizontal distance between centers of two adjacent bracket sets should be the base measurement unit in horizontal design. In terms of sectional design, the height of bracket cross section is used as the base unit to measure the height or horizontal length of one extension. In particular, they highlight the cross-sectional dimension of bracket as the fundamental base unit. On the contrary, Japanese *Kiwari* manual in the early modern period (16th–19th century) shows the column diameter or the space between rafters as the base unit for the overall architectural dimensions, hence, this is the fundamental difference between Chinese and Japanese methods.

Although dimensional systems of historic wooden architecture are fundamentally different in China and Japan, *Kamakura Zoei Myomoku* stipulates that all components relevant to the bracket should use the bracket's cross-sectional height as an ancillary dimensional unit, which is similar to the Chinese practice. However, *Kamakura Zoei Myomoku* also contains the use of column diameter and the space between rafters, as the base unit, which is recorded in Japanese *Kiwari* manual of the early modern period. For example, the space between rafters was used as the base dimensional unit for horizontal design, while components irrelevant to the bracket had used the column diameter as the base unit. It can be said that *Kamakura Zoei Myomoku* makes a compromise of the two design methods, one from *Yingzao Fashi* and the other from the *Kiwari* manual. As such, *Kamakura Zoei Myomoku* records different from the *Kiwari* manual are supposed to originate from Zen-style architecture introduced to Japan in the late Southern Song dynasty and can be viewed as being influenced by Chinese architectural design methods.

Classical Chinese architecture highlighted bracket dimensions such as *cai*, *qi*, or *doukou* because in the design of bracket, components were interconnected and they restricted each other. Therefore, it was easy to control the overall structure if the key parts were used as the base dimensional units, that is, the dimension of bracket piece or the block height “*ping + qi*” (*shikimen-daka* in Japan). From that perspective, traditional Chinese design methods strove to standardize bracket to the extent that *Gongcheng Zuofa Zeli* in the

<sup>4</sup> Wuxue Zuyuan (or Mugaku Sogen, 1226–1286), born in Yin County, Qingyuan Prefecture (today's Ningbo), was an eminent Zen monk of Linji School in the Kamakura period. He mastered teachings from Wuzhun Shifan, an eminent monk from the Jingshan Temple in Hangzhou. He was invited by Hojo Tokimune in 1279 to serve as abbot of Kenchoji in Kamakura and founded the Engakuji Temple in Kamakura in 1282.

Qing dynasty basically stipulated all dimensions with the base unit of *doukou*.

The Japanese side was different from that. Although the Chinese Zen-Buddhist architecture introduced to Japan in the late Southern Song dynasty and the early Yuan dynasty (1271–1368) led to the creation of the so-called Japanese Zen-style architecture with an extensive impact in the medieval period (13th–15th century), it remained one of the multiple architectural styles, not to the extent of replacing design methods of other styles. Hence, different styles, either Japanese, or *wayō*-style, Kara<sup>5</sup>, or Zen style, existed alongside each other<sup>[8]</sup><sup>6</sup>. It is thus clear that the *wayō*-style design methods, which enjoyed full development since the Heian Period (794–1185), still had fundamental impact in the 13th century. It is neither easy nor efficient to adopt two entirely different systems in architectural design. As a result, the newly-introduced Chinese design methods were properly transformed, assimilated, and integrated into the original Japanese design system. Zen-style architectural design methods recorded in the early modern period *Kiwari* manual such as *Shomei* serves as the best proof for the Japanization.

From this perspective, in *Kamakura Zoei Myomoku*, only the distinctively-styled bracket shows Chinese legacy from post 13th century. Other seemingly Chinese design methods were

transformed from the *wayō*-style. The *ayita* concept is particularly symbolic. In the horizontal design, if the rafter dimension is used as the base unit to stipulate architectural design, it is impossible for *ayita*, the horizontal distance between adjacent bracket sets, to work as an effective base unit. However, *ayita* is recorded in historical documents such as *Kamakura Zoei Myomoku* and *Kenninjiha-kadensho* which means that Chinese Zen-style architecture being introduced to Japan supposedly had used horizontal distance between adjacent bracket sets as the base unit in the horizontal design, just as *zan* was used for the same purpose in *Gongcheng Zuofa Zeli* later on. The horizontal distance between adjacent bracket sets was further divided to work out the base unit for bracket components. Or conversely, the length of *ayita* was worked out by multiplying the dimension of the base unit by integral times. The practice of dividing *ayita* into six rafters (Figure 5, left)<sup>[9]</sup><sup>7</sup> from historical record such as *Kenninjiha-kadensho* was a legacy of that. In this way, 1/6 of *ayita*, the distance between adjacent sets, was equivalent to the length of *juandou* (*sandou*). Therefore, *ayita* precisely equals to six *juandou* and *kyushi*, 9 rafter space, in *shiwari* system in terms of length. As such, the practice of dividing *ayita* into six rafters was the same as *kyushi-gake*<sup>8</sup>.

<sup>5</sup> Kara or “唐” does not refer to the Tang dynasty but rather China. In Heian Period when Japanese government frequently sent delegates to China in the Tang dynasty, kara refers to things related to China. However, by the 13th century, Tang dynasty architecture introduced to Japan since the 7th century has been Japanized, hence the new name *wayō*-style. Meanwhile, Kara here refers to the Song dynasty China. After western influence extensively arrived in Japan in the 16th century, kara refers to things or culture from foreign countries including Southeast Asia, Europe, or the USA. Hence, the meaning of Kara keeps changing as per different eras. After the Age of Discovery, “唐物” or *karamono*, refers to things coming from abroad.

<sup>6</sup> For linguistic difference between *Wayō*-style and *Kara*-style, please refer to *Research on Transition of Meaning of Historical Term “WA-YOU”, “KARA-YOU”, and “TENJIKU-YOU” from the 15th century to the 19th Century* by Wataru Mitsui. The paper highlights different understanding among people towards the two bracket techniques at that time.

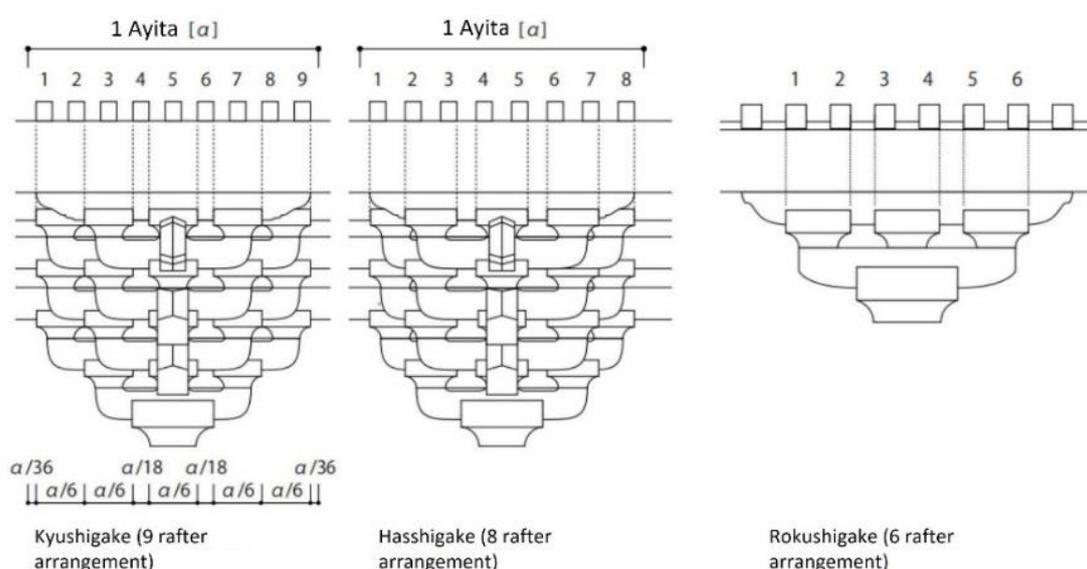
<sup>7</sup> Please refer to the paper “*Kara*-style Architecture Design System in Early Modern Period Architectural Books” by Katsuhiko Kawata, Fumoto Kazuyoshi, Katsuhiko Watanabe etc. for details of “dividing *ayita* into six rafters.”

<sup>8</sup> Bracket using *kyushi-gake* method has two extensions, hence there are five rows of *juandou* to align with rafters vertically. The last 1/6 in length was further divided into three parts, two as gaps on two sides of *qixindou* and one further divided to a half on the two sides of the bracket (*duo*).

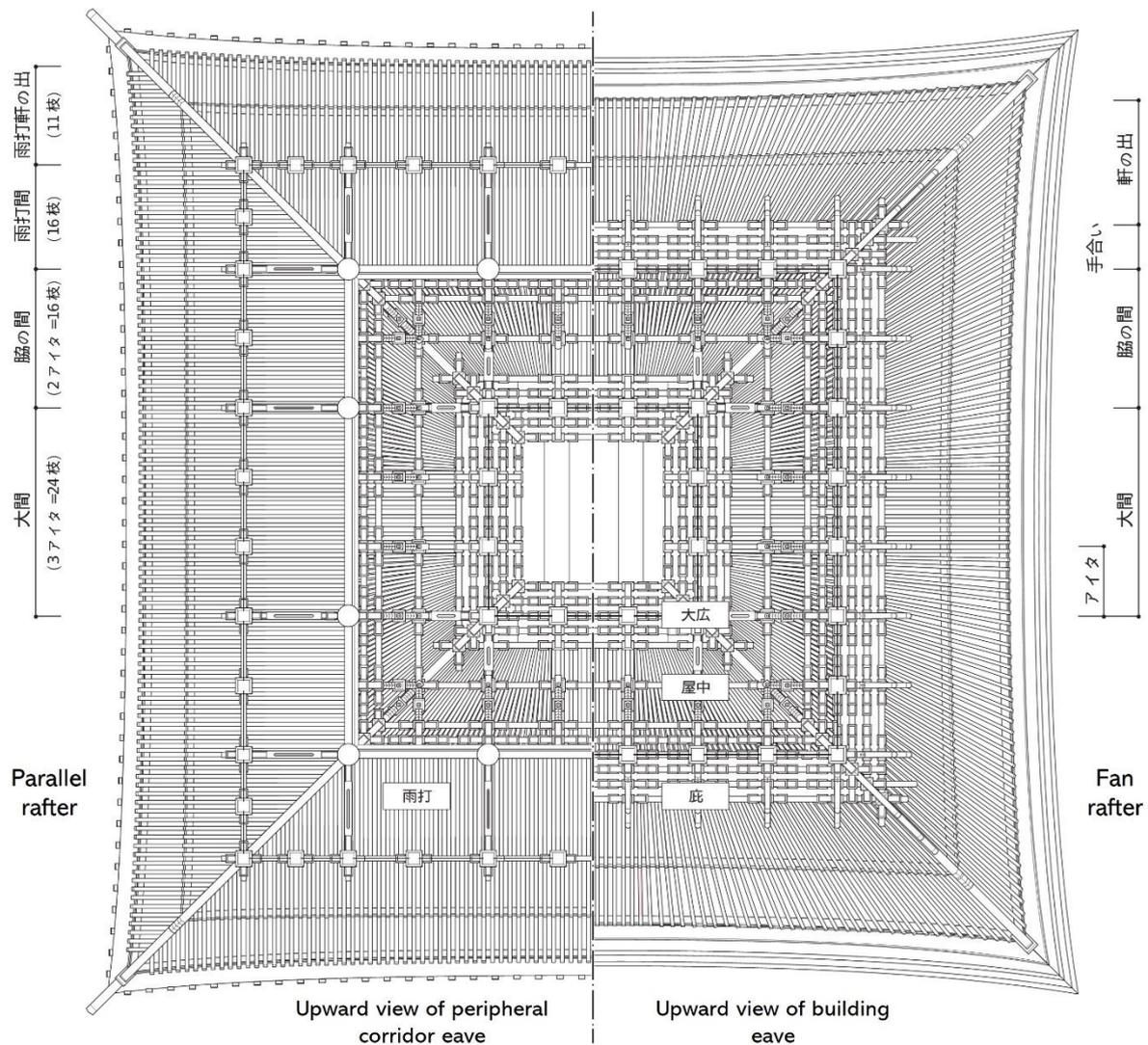
The correlation between the *ayita* dimension and “shiwari,” the rafter dimension, made it easier for the *ayita* system to be integrated with the shiwari system. *Kamakura Zoei Myomoku* specification of one *ayita* equivalent to eight rafter space, *hasshi-gake* [Figure 5, central] and 9 rafter space, *kyushi-gake* [Figure 5, left] <sup>[9]</sup> technique from *Kenninjiha-kadensho* all indicate that Chinese design methods were fully assimilated into the *wayo* methods. In other words, *ayita* was only kept as an intermediary dimension to deal with the horizontal distance between adjacent bracket sets.

The vertical design methods of bracket recorded in *Kamakura Zoei Myomoku* indicate the Japanization after Chinese architectural techniques were introduced to Japan. In other words, although an equidistant base line was used for dimensional specification in the bracket sectional and vertical designs in Chinese architecture to some degree, it did not go as far as to systematize as in *Kamakura zoei myomoku*. This was probably a new principle created by the Japanese carpenters who systematically improved bracket vertical design methods to pursue a sense of vertical

alignment for brackets. Similar creation can be seen in the way rafters were allocated. The *wayō*-style architecture in Japan used *HFanegi* to bear the roof weight, and corner rafter was thus freed from its function of bearing weight and was made into parallel form, called *heiko-daruki* in Japanese. For example, the *wayō*-style 3 storied pagoda of Kofukuji in Nara repaired after 1180 had a parallel eave-rafter. However, novel wooden architecture techniques were introduced from the Song dynasty when Chogen, the eminent Japanese monk, rebuilt Todaiji in Nara in 1181, and from there evolved an architectural style, later known as the “*Daibutsu* (Great Buddha).” The way rafters were allocated in the *Daibutsu* style totally followed the Song-dynasty Chinese method. Radial slant rafters were used in corner positions only and parallel ones elsewhere. Jodo-do Hall of Jodo-ji (in Hyogoken, built in 1194), a typical *Daibutsu* style architecture built by Chogen later, also only used in corner positions the radial slant rafter, called *sumi-ogi-daruki* in Japanese. Correspondingly, Chinese Zen architecture introduced to Japan after the emergence of *Daibutsu* style was supposed to follow the Song-dynasty



**Figure 5.** Correlation between Shiwari and bracket dimensions, Wa-yō rokushigake “六枝掛”, zenshu-yō (Zen-style) hasshigake “八枝掛” and kyushigake “九枝掛.” Source: Drawing by Tadanori Sakamoto

Horizontal plan of "three Buddha halls" in *Kamakura zoei myomoku*

**Figure 6.** Upward view of "Three Buddha Halls" in *Kamakura Zoei Myomoku*; parallel rafter (L) and fan rafter (R). Source: Drawing by Tadanori Sakamoto based on records of *Kamakura zoei myomoku*

methods, that is, using radial slant rafters in corner positions only and parallel ones elsewhere. However, Japanese Zen-style architecture thereafter used slant rafters in all positions instead of only in corner positions like the Song style, hence, there was the creation of *zenmen-ogi-daruki* (fan rafter arrangement). Figure 6 is an upward view of the eave drawn by the author based on textual records of the "Sanken-butuden (Three Buddha Halls)" in *Kamakura Zoei Myomoku*. The left is an upward view of the peripheral corridor (*yuta*) eave, in which the parallel rafter method was visible and the right

was an upward view of the building eave (*hisashi*), which shows the fan rafters. Because the center point which dictated rafters' horizontal tilt angle was at the center of the square plane, the rafters should be positioned on radial lines connecting the center point to eave-rafter center lines, hence, the name "fan rafter." For Japanese architecture rafter allocation, refer to corresponding research by Sekiguchi Kinya for the evolvement from Song-style "radial slant rafters" to fan rafter after Japanization<sup>[10]</sup>.

As stated above, special techniques handed down in *Kamakura Zoei*

*Myomoku* partly originated from Chinese architectural techniques from the 13th to 14th century. It showcases that in Japanese architectural development, Chinese architectural techniques were assimilated to the Wayō-style and gradually died out in their transition. Thus, it is of historical significance that Chinese architecture was a stamp mark for the evolvement of Japanese architecture.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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#### TRANSLATOR’S NOTE

1. Chinese terminologies, which the translator can access a proper English translation, is provided with the English translation with its pinyin transliteration upon the first mentioning in the article and only the English translation then is used following that. Examples include lever (*ang*) for “昂” and petal (*qiao*) for “翘.”
2. Chinese terminologies, which the translator cannot access a proper English translation, is provided only the Pinyin transliteration. Examples include *tiaojin* “挑金” and *caosheng* for “槽升.” For those the translator is able to provide explanation in English, the explanation is provided, for example “pillar top” for “柱头.”
3. Japanese terminologies, which the translator can access a proper Japanese transliteration, are provided with the transliteration. Examples include *shiwari*

for 枝割 . Otherwise, the original Japanese characteristics are provided, for example 拳鼻 . For Japanese terminologies, of which the translator can access a proper English translation, the English form is provided, e.g., “dividing *ayita* into six rafters” (六枝割).

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#### **AUTHOR’S NOTE**

In paragraph 3 of point (2) in section 4, the authors added after translation that “the original intention is to introduce Chinese Zen architecture to Japan, and a “Zen-like” style of architecture was formed in Japan. There is no concept of “Zen style” in the current Chinese architectural history. In other words, “Zen architecture” and “Zen-style architecture” are not the same concept.

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