The Character and Development of Dapo Type Double-Layered Interior Bracketing Unit Systems in Korean Single-Story Timber Structure Buildings

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Abstract

Among the extant single-story dapo type buildings (having a densely arranged bracketing unit layer), seven buildings have double layers of interior bracketing units: an upper-layer and a lower-layer. The aim of this study is to find out their character, historical development and significance. Firstly, they are classified into Group A and B by the role of upper-layers as structural supports. Each group is then further divided into two subgroups, according to the existence of projections in their upper-layer bracketing units. Groups A1 and B1, the no-projection types, are used in the same building from late Goryeo as a multi-layered system; that could be a part of the general method of dapo type buildings in late Goryeo and before. The upper-layers belonging to Groups A2 and B2 have projections of their bracketing units; these are mainly to achieve a more splendid interior aspect, by imitating the valued aspects of other bracketing units in this period; the structural roles of those projections are however relatively trivial. The construction of upper-layers in roof structures had commenced by the 11th century. In extant Korean buildings, the 17th century saw the peak of the development of double-layered systems, before their decline in the 18th century.

Keywords: interior bracketing units (oknae gongpo); double-layered bracketing unit system (2jung gongpodae); dapo type; Korean timber structure buildings; Korean traditional architecture

1. Introduction

In Korea, there is a kind of bracketing unit system known as the dapo type that has a layer composed of bracketing units (gongpodae) densely arranged side-by-side. In several single-story Buddhist halls, the dapo type bracketing unit layers are placed not only under their eaves, which is their usual position, but also inside the roof structure. These double-layered interior bracketing unit systems (2jung gongpodae) are sometimes used for decorating ceilings, and sometimes for supporting the main framework of the roof structure. They form an unusual method among the extant traditional Korean single-story timber structure buildings with dapo type bracketing units that were built between the late Goryeo (Koryo) and Joseon (Choson), as in most cases, there is only a single layer of bracketing units under the eaves. Among buildings with double-layered bracketing units, the two most notable cases, Yulgoksa Daegunjjeon (Daegung Hall of Yulgok Monastery) in Sancheong-gun, Gyeongsangnam-do and Unmunsa Daegunjjeon (Daegungbo Hall of Unmun Monastery) in Cheongdo-gun, Gyeongsangbuk-do, are well known for their special structure and decorative effect.

However, there is still a need for research to find out their origin and development, and to categorize them. Even though such buildings with double-layered bracketing units have been surveyed in separate reports, and the similarity between Yulgoksa Daegunjjeon and Unmunsa Daegunjjeon has attracted attention, there has to date been no comprehensive research to put this information together.

2. Research Subjects and Methods

The author examined seven cases of dapo type double-layered interior bracketing unit systems in Korean single-story timber structure buildings built between the late Goryeo and late Joseon. Except for
one building built in Hwanghaebuk-do, a midwestern province of Korea, and another in Hamgyeongnam-do, a northeastern province, most are located in Gyeongsangbuk-do and Gyeongsangnam-do, southeastern provinces of Korea.

For convenience in this paper, the author will from now on refer to the bracketing unit layer (gongpodae) under the eaves level of subject buildings as a "lower-layer (habu gongpodae)" or "eaves-layer (cheoma gongpodae)", and the bracketing unit layer inside the roof structure of these buildings as an "upper-layer (sangbu gongpodae)". When referring to both of those layers as a whole, the author will use wording such as "double-layered bracketing unit system", or briefly, "double-layered system" (2jung gongpodae).

In this study, the author firstly looked into relics and buildings from the ancient period, and some extant buildings of China and Korea, to find out prototypes and origins of the double-layered interior bracketing unit system in the subject buildings. Secondly, he classified the subjects by the connection and separation between upper-layers and eaves-layers. In each category, the upper-layers of the buildings are compared with those of other buildings by the types and shapes of their parts, in order to reveal the process of their development, and their relationship to the other categories.

3. Origin and Prototype of the Double-Layered Bracket Unit System

In Korea, building descriptions in the Goguryeo (Koguryo) tomb mural include the oldest information we know of at that time concerning ancient timber structures, including on bracketing units (gongpo). Among the timber structures in these tomb murals, the earliest bracketing unit systems in Korea that have two layers are depicted. In the murals of Yonggang big tomb and Anak tomb No. 2, each column is shown with a set of bracketing units on its top. A horizontal tie lies across the top of the bracketing units on adjoining columns, and a series of overturned-V-shape supports (in Chinese, renzigong) are densely arranged on the tie (changbang) to make a layer supporting the other tie or purlin (dori).

These are the earliest known cases in Korea that reveal two layers of bracketing units, but this doesn't mean these overturned V-shape support layers are the earliest examples of the upper-layer of a double-layered system inside a roof structure. On the contrary, it is quite probable that both of those two layers are in fact positioned under the eaves level. This is because there are murals for cave temples in Dunhuang: Mogao cave No. 428 from Northern Zhou and Mogao cave No. 433 from Sui, that include the external appearance of buildings that have two layers of bracketing units placed under their eaves.2

Among the extant timber structures of China, some buildings from Northern Song and the Jin dynasty are the oldest known single-story buildings that have double-layered or even multi-layered bracketing unit systems (dajung gongpodae), sharing a somewhat similar composition with the subjects of this study. The Main Hall of Baoguo Monastery (Baoguosi Dadian) in Ningbao, Zhejiang province, is a building from ca. 1013 of Northern Song, and has multiple layers of densely arranged bracket units among its interior columns. For other examples, Sansheng Hall and the Main Gate of Shenhua Monastery (Shenhuasi Sanshengdian) in Datong, Shanxi province from the early 12th century of the Jin dynasty also have upper-layers of bracketing units that lie across their crossbeams. In particular, the upper-layer in the buildings of Shenhua Monastery is made for the same purpose as the upper-layers in Yulgoksa Daeungjeon and Unmunsa Daeungbojeon, that is, to support purlins, and to place a band of decoration at the middle level of the roof structure.

However, most of the roof structures of extant single-story buildings from Tang, Liao and Northern Song do not have the densely arranged layers of bracketing units dealt with in this study. Of course, bracketing units in various shapes have been widely used in roof structures above eaves level before the erection of the Main Hall of Baoguo Monastery or Sansheng Hall of Shenhua Monastery, as can even be seen in the extant

Table 1. Research Subjects

| Name                  | Age of Construction | Location            | Roof Type          | Group |
|-----------------------|---------------------|---------------------|--------------------|-------|
| Bongjeongsa Daeungjeon| Late Goryeo (1361?) | Andong, Gyeongsanbuk-do | Hip-and-gable      | A1, B1|
| Simwonsa Bogwangejon  | Late Goryeo (1374)  | Yeontan, Hwaghaebuk-do | Hip-and-gable      | A2    |
| Main Hall of Yeongheung Seonwonjeon | Early Joseon (1396) | Yeongheung, Hamgjeongnam-do | Hip-and-gable | A1    |
| Unmunsas Daeungbojeon| Mid Joseon (1653)   | Cheongdo, Gyeongsanbuk-do | Hip-and-gable      | B2    |
| Yongmunsas Daejangejon| Mid Joseon (1679)   | Yecheon, Gyeongsangbuk-do | Gable             | A2    |
| Yulgoksa Daeungjeon  | Mid Joseon (1679)   | Sancheong, Gyeongsangnam-do | Hip-and-gable      | B2    |
| Tongdosa Yonghwajeon  | Late Joseon (1725)  | Yangsan, Gyeongsangnam-do | Gable             | AB2   |

Fig.2. Anak Tomb No. 2, Late 5c~Early 6c, Goguryeo (Kim, Lena, 2004)
timber structure buildings from the Tang dynasty. But in many of these buildings, bracketing units are positioned just under the crossing nodes of the main structural parts. Hence, they are placed separately, unlike the bracketing units composing the upper layers in roofs of the research subjects. This is the same method as is used in many extant Korean single-story timber structure buildings, called "podaegong" (bracketing units performing as king or queen posts in roofs). In other cases, the "upper-layers" of buildings are just a composition of small bearing blocks, and a mere imitation of bracket arms painted or carved on strips piled up in their roof structures. Those imitations can be seen as proof of a negotiation between the desire to form bracketing unit layers like those already present under the eaves, and restraint, in order to avoid excess.

4. Group A: Additions on Lower-Layers

The double-layered system in Korean extant buildings can be divided into two groups according to their importance for structural support. The first group includes upper-layers that have only subsidiary roles for the lower-layers. These upper-layers usually lie just on the edge of inner projections (naechulmok) of the bracketing units of lower-layers. Therefore, their main structural role is as vertical additions or extensions of those inner projections to support lower purlins (naemokdori in these cases) or ceiling frames in the roof structure. On the other hand, the upper-layers belonging to the second group are placed on crossbeams (daedeulbo), and support the entire upper roof structure. From now on, the author will call the former Group A, and the latter Group B.

Group A and Group B are each further classified into two subdivisions, according to the existence of projections (chulmok) in their bracketing units. One subgroup is for buildings in which upper-layers have no projections toward the interior space of their roof structures. Hence all of their parts lie just on the line across the innermost edge of lower-layers. The other subgroup is for buildings that have upper-layers with projections and inner bracket arms (naechulmok cheomcha) on them. For convenience, the former subgroups will be called Groups A1 and B1, and the latter Groups A2 and B2.

4.1 Group A1: Simplicity

The function of a Group A1 upper-layer is clear and simple. It covers the blank wall between the lower-layer and lower purlins, not only as a structural part, but also as decoration, which is neat but not too ornate. By putting an upper-layer bracketing unit on a lower-layer bracketing unit, the inner part of the lower-layer bracketing unit gains more height to support the purlins, and more bracket arms (cheoncha) are piled up to make the whole bracketing set bigger. But, there is no projection in the upper-layer bracketing unit, so the ceiling joists are not made complicated.

The upper-layers of Group A1 are composed of very simple bracketing units. In both buildings belonging to Group A1, Bongjeongsa Daengjeon (Daengje Hall of Bongjeong Monastery) and the Main Hall of Yeongheung Seonwonjeon (Royal Ancestral Portrait Hall in Yeongheung), bracket units in their upper-layers have one camel-hump plank (tuofeng in Chinese, bokhwaban in Korean) at the bottom and a small bearing block (soro) on the plank. The bearing block supports one bracket arm, with three other bearing blocks on it.

For all its simplicity, the composition of Group A1 is somewhat connected to much older methods, even to the layers of overturned V-shape supports of ancient times. In the double-story pavilion of Sungnyemun (Gate of respect for propriety), the south gate of the capital of the Joseon dynasty has an upper-layer that has only camel-hump planks and bearing blocks on it. It quite directly reveals the character of camel-hump planks as being descended from overturned V-shape supports, even though Sungnyemun is a building from the late 15th century, later than the age of the Group A1 buildings.

4.2 Group A2: Small Scale Copying for Ornament

As previously mentioned, Group A2 upper-layers are composed of bracketing units that include projections. The projections give more complexity to the interior view of the building and the framework of their ceiling joists, and make the inside of the roofs fancier. In detail, the bracketing units in the Group A2 upper-layers are different in their shape and aim, while their overall purpose and method are similar; the projections were made for imitating or copying architectural factors that were valued at that time.

Unlike the buildings belonging to Group A1, the two buildings of Group A2 at first glance have few things in common. They were built in different periods; Simwonsa Bogwangjeon (Bogwang Hall of
Simwon Monastery) in the late Goryeo, and Yongguksa Daejangjeon (Daejang Hall of Yongguk Monastery) in the mid Joseon. Their roofs are different too; a hip-and-gabled (paljak) roof on Simwonsa Bogwangjeon, and a gabled (matbae) roof on Yongguksa Daejangjeon. The details of their projections also differ.

In the upper-layer of Simwonsa Bogwangjeon, the bracket unit has no capital block (judu) or bearing block at its base. Just two bracket arms, a smaller one (socheomcha) and a bigger one (daecheomcha), are piled one on top of the other. The projection of the bracketing unit is composed of an oblique triangular protruding part stretching from the center line of the bracket arms to the strips lying under the bottom of the mid purlin (jungdori), and two cloud-shape bracket arms inserted on the body of the triangular part. These cloud-shape arms are just for decoration, and do not support anything.

In Yongguksa Daejangjeon, the shape that was copied for the upper-layer was the building's own lower-layer. Like the lower-layer on the outer columns, the upper-layer of the hall is lying on flat ties (pyeongbang) on the edge of inner projections of the lower-layer. On the flat ties, there are capital blocks (judu) that are similar to those of the lower-layer bracket units in shape and size. Two bracket arms (cheomcha) and two projecting arms (jegong) are stacked up on the capital block, crossing each other and connected up and down by bearing blocks (soro). Though the scale is smaller, the composition is similar to that of the lower-layer.

For the function of supporting parts of the roof structure, the two extant upper-layer examples of Group A2 are no better than those of Group A1, even though the bracketing units of the former are bigger and more complicated than those of the latter. The purpose of the upper-layer of Simwonsa Bogwangjeon is to support lower purlins (naemokdori), and to perform a minor function in preventing mid purlins (jungdori) from rolling and falling down. The upper-layer in Yongguksa Daejangjeon has no purlins on it,
nothing but small parts of the ceiling.

The complicated makeup gained by copying aspects of the bracketing units in the lower-layers was mainly to achieve an aesthetically pleasing shape. However, the advanced structure of bracketing units can also allow the upper-layers to be the main factors in roof structures, both for support and for ornament.

5. Group B: Upper-Layers as Main Supports

The main role of the upper-layers of Group B is to transmit the entire weight of the upper roof structure onto the structure beneath. Buildings belonging to Group B have horizontal frames lying across their crossbeams, which work as bases of the upper-layers to support mid purlins, and mid crossbeams (jungbo) or uppermost crossbeams (jongbo), the essential structural parts of the roofs. 4

Group B can be divided in the same way as in Group A: according to the existence of projections in bracketing units. The subgroups will be called Groups B1 and B2, like Groups A1 and A2. For example, the usage of the upper-layer in Sansheng Hall of Shenhua Monastery can be classified as Group B1.

5.1 Group B1: Uniformed Multi-Upper-Layers

Bongjeongsa Daeungjeon has Group B1 type upper-layers in its roof structure over its Group A1 type upper-layer mentioned before. Over the ceiling of that building, there are two more concealed layers; one to support mid purlins, and another to support the ridgepole (jongdori). Therefore, the bracketing unit system in Bongjeongsa Daeungjeon can be called a multi-layered system (dajung gongpodae), and not just a double-layered system.

Even though the two Group B1 type layers in Bongjeongsa Daeungjeon are not exposed, they could have been made not only for structural support, but also for ornament. The upper-layers under the mid purlins and the ridgepole are composed of bracketing units that are uniform with those in the Group A1 type layer under the ceiling. It would be nonsense to have intended to hide the bracketing units in the ceiling from the time of the erection of the building. In Sansheng Hall of Shenhua Monastery, no ceiling panels hide the upper-layer at each purlin. Therefore it is highly probable that the multi-layered system in Bongjeongsa

Fig.8. Double-Layered System in Yongguksa Daejangjeon, ca.1670, Early Joseon (NRICH, 1990)

Fig.9. Multi-layered System; Section of Bongjeongsa Daeungjeon (NRICH, 1989)

Fig.10. Unmunsa DaedungboJeon, ca.1653, Mid Joseon

Daeungjeon was intended to be seen from the start, and to provide some advantages from the tectonic point of view.

5.2 Group B2: Synthesis to Pursue Splendor

The Group B2 type composition in Yulgoksa Daeungjeon and Unmunsa DaeungboJeon shows the improved integration of the features in Groups A and B1.

The upper-layers of bracketing units in those two buildings differ only in scale. Their composition however, is the same. The bracketing units are densely arranged in a #-shape frame lying on crossbeams, and the whole layer provides the support for mid purlins. Unlike the neat and simple upper-layers in Bonjeongsa Daeungjeon, there are ornately carved projections in each of the bracket units in the upper-layers of those two buildings, in both the inner and outer directions, which support and decorate the ceiling above.

Even though the upper-layer and lower-layer are separated, both visually and structurally, by the #-shape frame between them, there are also aspects adopted from the projections of Group A2 bracketing units to connect and combine the two layers as an organized whole. Short strips are piled one on top of the other to
form a rectangular plank just on the edge, at the inner projection of a bracketing unit in the lower-layer, the position where a Group A1 type upper-layer bracketing unit could be placed (Fig.12.). The rectangular plank has decorative projections carved in a cloud-shape, a common method in many Korean bracketing units from mid Joseon and later. The edge of the cloud-shape projection is stretched in an oblique direction, in order to connect to the lowest projection of the opposing upper bracketing unit. On that cloud-shape connector, or spacer, a cloud-shape bracket arm is inserted; that evokes the image of the projections of the Group A2 type upper-layer in Simwonsa Bogwangjeon, despite its substantial transformation from the shape of angweil. 

In Bongjeongsa Daegungjeon, a multi-layered system including Group A1 and B1 types was possible because each layer did not show too much. In Daegungjeon of Unmunsan and Yulgoksa, however, the Group B2 type upper-layer totally copied the density and splendor of the lower-layer, hence aspects from Group A2 type methods had to be used in a controlled and minimized way.

5.3 Mixed Type in Late Joseon and the Decline of the Double-Layered System

Tongdosa Yonghwajeon (Yonghwa Hall of Tongdo Monastery) has an upper-layer that has the characteristics of both Group A2 and B2. In the front and rear wall of the building, the upper-layer is positioned just on the inner edge of the lower-layer. By the design of projections, the bracketing units of the upper-layer appear to be combined with those in the lower-layer. Hence it can be called Group A2. At the sidewalls, there is no lower-layer, because the building has a gabled roof. The upper-layer, however, is extended on sidewalls and supports the roof structure, as a Group B2 type. It differs greatly from the Group A2 upper-layer of Yulgoksa Daegungjeon with the same gabled roof. This is partially because the bracketing units of Tongdosa Yonghwajeon have been recycled from the bracket units from a demolished building. 

Fig.11. Yulgoksa Daeunjeon, ca.1679, Mid Joseon

Tongdosa Yonghwajeon from 1725, about half of a century later than the erection of Yulgoksa Daegungjeon and Yulgoksa Daegungjeon, is the last known extant building with a double-layered system. This is because new and easier methods became available to obtain the same structural and ornamental effect of the double-layered system, and naturally they became more popular. In the 17th century, instead of the installation of an upper-layer, the bracketing units of many buildings had already started to include additional inner projections and bracket arms. This became a tendency in the 18th century, and became more decorative. Sometimes, the projections even extended up onto the crossbeam. To make an ornate interior, these methods were much easier and more effective than making a whole upper-layer upon inner projections or crossbeams.

Fig.12. Tongdosa Yonghwajeon, ca.1725, Late Joseon

Fig.13. Increased, More Decorative Inner Projections: Girimsa Daejeokgwangjeon, ca.1785, Late Joseon

Fig.13. Increased, More Decorative Inner Projections: Girimsa Daejeokgwangjeon, ca.1785, Late Joseon
6. Conclusion

In this study, the author classified dapo type buildings (that exhibit a dense arrangement of bracketing units) having double-layered interior bracketing unit systems into four subgroups: Groups A1, A2, B1, and B2. This classification was made according to the position of their upper-layers and the existence of projections in the upper-layer(s). The author aimed to uncover their characteristics and the relationships between them.

Actually, Group A1 and B1 techniques are used in the same building, Bongjeongsa Daeungjeon from late Goryeo, as an overall multi-layered system; all of the upper-layers are organized under the same order. Some aspects of the multi-layered system have much in common with those in structures from older periods, hence Groups A1 and B1 can be regarded as part of the general method used in dapo type buildings in late Goryeo and earlier.

In upper-layers belonging to Group A2 and B2, the projections of their bracketing units are mainly to imitate the valued aspects of other bracketing units of the same period, such as angwei or the bracketing units in their lower-layer, for more ornament; the structural roles of those projections are relatively trivial.

The Group B2 type upper-layer of Unmunsa Daeungbojeon from 1653 was the glamorous descendant of the upper-layer in Bongjeongsa Daeungjeon, and also the decoratively adapted miniature of the whole lower-layer of the building itself. That building showcases the peak of the production of the double-layered system, and Tongdosa Yonhwajeon reflects the remaining momentum.

The double-layered system declined in the 18th century as previously mentioned, due to the advent of more cost-effective techniques. But the existence of the double-layered system itself could have been the seed of the new methods that obtained the same results at a more moderate cost. For example, the Group A method of putting small additional bracketing units on the inner projection of main bracketing units could have easily developed into the idea of making additional inner projections, and inserting more bracket arms in the main bracketing units themselves.

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Notes

1 Including this introduction, two-byte characters such as Korean, Chinese, and Japanese fonts cannot be used in this paper, in accordance with the rules of layout in the “Instructions to Authors” of JAABE. To avoid confusion in terminology, however, the Romanization of Korean terms are written in italic script, in parentheses at the right side of some important terms. The Romanization system of the National Institute of the Korean Language is applied to that. The meaning and Romanization of Chinese terms is mainly based on a dictionary of Qinghua Guo as below.

Guo, Qinghua (2002) A visual dictionary of Chinese architecture, Mulgrave; Image Publishing.

2 Lee, Woo-Jong. (2006) p.48.

3 Op.cit. pp.165–167.

4 Lee, Yeonro. (2002) pp.191–193, 199–201.

5 Pae, Byeong-seon. (1993) p.168.

References

1) Andong-si (2004) Bongjeongsa Daeungjeon Haechaeusirigongsa bogoseo.
2) Cultural Heritage Association (of Korea, CHA) (2003) Yulgoksa Daeungjeon haechaebsugongsa bogoseo.
3) CHA (2007) Unmunsan Daeubojeon suri silcheuk bogoseo.
4) Cheongdo-gun (1988) Unmunsan Daeungbojeon silcheukjosa bogoseo.
5) Fu, Xinian et al. (2001) Zhongguogudaijianzhushi 2. Beijing: zhongguojianzhugongyechubanshe.
6) Guo, Daiheng et al. (2003) Zhongguogudaijianzhushi 3. Beijing: zhong guojianzhugongyechubanshe.
7) Guo, Qinghua (2002) A visual dictionary of Chinese architecture. Mulgrave: Images Publishing.
8) Kim, Do Kyoung (2000) A study on the evolution of wooden architecture in ancient Korea. Doctorial thesis, Seoul: Korea University.
9) Kim, Lena (2004) Goguryeo gobunbyookhwa, Seoul: ICOMOS - Korea, Daejeon: CHA.
10) Lee, Woo-Jong (2006) The formation and changes of bracket structures of Korean traditional architecture in Goryeo period (10c–14c). Doctorial thesis, Seoul: Seoul National University.
11) Lee, Yeonro (2002) A study on the beam of traditional Korean wooden architecture. Doctorial thesis, Seoul: Seoul University.
12) National Research Institute of Cultural Heritage (of Korea, NRICH) (1989,1990) Hangukeui Gogeonchuk 11, 12.
13) NRICH (1998,2002) Bukhannumunwajaehaesol II, III.
14) NRICH (2007) Jungguk Saneoseongeui GoGeonchuk.
15) Pae, Byeong-seon (1993) A study on the architectural style with multi-cluster brackets and a gabled roof. Doctorial thesis, Seoul: Seoul National University.