Korea at the Exhibition: Making the Appearance of Korean Style with ‘Hybrid Roof’ in Early 20th Century

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Abstract: This study analyzed 15 unique cases of buildings designed by the Japanese that had the exterior appearance of traditional Korean architecture while the Western timber truss was applied. The characteristics of Korean-style roofs were first categorized into three parts: structural frame, roof curve, and eaves space. Then, the analytic drawings were prepared in order to scrutinize the cases in accordance with these characteristics. The analysis revealed that the Western truss was hybridized to embody the Korean-style roofs. The truss was segmented, diagonal supplementary building components were added, or some components of the Korean or Japanese-style timber structure were partially applied. The advent of such a ‘hybrid roof’ shares a background with the westernization of the construction techniques of the timber structure since the late 19th century in Japan. The political initiatives of Japan deliberately led to the exhibition of exotic Joseon in the expositions, thereby requiring Korean-style pavilions. As a result, the pavilion reflected double layers of hybridization: a Korean timber structure transformed through the Japanese westernization method. Although the buildings studied in this research were designed by non-Koreans and were already demolished, they are noteworthy for the unprecedented attempts to realize the appearance of traditional Korean architecture by using truss structures.

Keywords: hybrid roof; modern Asian wooden roof; Joseon pavilions of expos; Korean modern truss roof

1. Introduction

The early 20th century of Korea, during its Japanese Colonization period, marks a tumultuous period of political and social change, thereby showing the inevitable juxtaposition of exchanges with Western countries, the impact of colonial rule, and modernization. As for architecture, new materials and construction techniques were introduced, and therefore, buildings that were completely different from the previous form—so-called pre-modern—of architecture began to appear [1,2]. During this time, interesting building types could be found: a single building showing various construction methods and heterogeneous exterior forms intertwined with many styles of multiple cultures. This raises the following questions: Is there a close relationship between the construction method (structure and material) and the exterior (mass and form) of a building? Does architecture function as an image representing a specific country or culture?

The National Archives of Korea has released approximately 26,000 architectural drawings generated by the Japanese Government-General of Korea during the Japanese Colonization period [3]. These drawings are well preserved, so it is possible to check the detailed appearance of the buildings as they were first planned, despite all of them having been demolished. According to these drawings, most cases had a Western truss structure for their roofs, a condition that confirms the inflow of Western architectural building techniques, including truss-building techniques, through the Japanese Government-General of Korea [4]. When a truss is used inside, its triangular shape is also reflected on its exterior,
and it is common that the proportion or shape of the roof is significantly different from that of the roof of ‘traditional Korean’ architecture. However, while scrutinizing this archive, the authors found very unusual and interesting cases in which trusses were used inside whereas the exterior had the appearance of traditional Korean wooden architecture. An exemplary case is shown in Figure 1, which is an architectural drawing of the building used as the Korea Pavilion (Korean Pavilion) for the 1914 Tokyo Taisho Expo. Although the use of the truss is clearly confirmed in the section drawing, its roof looks like that of the traditional Korean architecture from the outside, as shown in the elevation drawings of Figure 2. In other words, this building deviated from the convention that ‘a roof made of truss structures usually has a flat slope on its exterior’, forming the ‘exterior’ of traditional Korean architecture with a curved slope and protruding eaves.

Figure 1. Original Section Drawings of the Korea Pavilion at the 1914 Tokyo Taisho Expo (Source: National Archives of Korea) [5].

Figure 2. Overall Plan and Section Drawings of the Korea Pavilion at the 1914 Tokyo Taisho Expo (Source: National Archives of Korea) [5].
Figure 3 is an analytic diagram showing the interior and exterior structure of a typical traditional Korean architecture in the upper part and the Korea Pavilion at the Tokyo Taisho Expo in the lower part to depict the uniqueness of this building, making it easier to see the difference. In traditional Korean timber architecture, roof tiles are placed above the layer of soil (in light yellow), which is placed on the wooden plates over the timber frame (in yellow) composed of columns and beams. The exterior of the roof is formed of a smoothly curved surface with repeating layers of roof tiles, and it is common to construct an ‘eaves space’ under the roof by extruding building components called seokkarae (rafters, shown in blue) as cantilevered. In the Korea Pavilion at the Tokyo Taisho Expo, the truss (in dark yellow) and various building components (in blue and brown) were integrated to embody the ‘appearance’ of traditional Korean timber architecture.

Figure 3. Comparison Diagram of Roofs. (Bottom) Original Drawings of the Korea Pavilion at the 1914 Tokyo Taisho Expo (redrawn by authors based on the drawings from the National Archives of Korea). (Middle) Details of a traditional Korean roof (drawn by authors). (Top right) Layer of soil (photos from Hanok Magazine [6]).
If so, did precedent studies deal with buildings like the above Korea Pavilion at the Tokyo Taisho Expo? Kim Tae-young, who summarized the introduction process of the truss in Korea and its types, categorized the truss types of the period into three main categories [7–9]. The first type is where the structure and exterior of a truss roof of the West are applied as they are, and the second type is where a truss is applied to a Japanese-style roof structure. Both of these types are different from the Korea Pavilion at the Tokyo Taisho Expo in that they have the ‘flat-sloped roof’, which is distinct from the exterior roof form of traditional Korean architecture. Figure 4 shows a section drawing and photograph of Jeonggwanheon Hall in Deoksugung Palace [10], classified as the first type in the study of Kim Tae-young.

The third type suggested by Kim Tae-young is where the truss system is partially applied to the traditional Korean timber architecture. Although the truss itself is not used, some diagonal building components are added to the existing Korean or Japanese-style column-beam roof structure to apply the truss system. The extent of the change is not significant, and there are only a few cases of this type. Kim Tae-young mentions Iksan Nabawi Church as a representative example of this third type [11]. Although its exterior looks like a traditional Korean roof, composed of Korean roof tiles, a roof curve, and eaves, the internal structure is composed of a Japanese timber structure strengthened with the principles of truss structure by adding bitdaegong, diagonal building components (Figure 5). In other words, the exterior appearance resembles that of a traditional Korean roof, but the Japanese roof structure and truss structure coexist inside.

This third type looks similar to the Korea Pavilion at the Tokyo Taisho Expo in that this structure has a style—partially applying the building principles of the truss by adding diagonal building components—that was not commonly found in the quintessential Korean-style roofs. However, there is a big difference between these two cases as the main structural frame was not thoroughly replaced with the Western truss in the Nabawi Church, and therefore, the Korea Pavilion of the Tokyo Taisho Expo should not be included in the three types categorized by Kim Tae-young. To sum up, the Korea Pavilion at the Tokyo Taisho Expo can be considered as a very peculiar case because it has a Korean-style roof form, uses a Western truss inside, and was designed by the Japanese, thus exhibiting multiple layers of hybridity and being marginalized from the scope of each country’s architectural history study. Although this pavilion was built in 1919, its architectural drawings were released in 2008 [12], which is later than Kim Tae-young’s study. This might be the reason why this pavilion was not considered in Kim’s study. Other than his study, it is difficult to find relevant studies. The lack of precedent studies on this transposition might have stemmed from the fact that these architectural drawings were produced by the Japanese rulers, or it may be due to the tendency that these buildings’ visage was regarded as mere mimicry of Korean-style buildings. These
aspects could have contributed to the difficulty of these cases finding their position within the study of architectural history in Korea or Japan.

Figure 5. (Top) Characteristics of a Korean-style Roof Shown in the Exterior of Nabawi Church—Curved Roof and Eaves Space. (Bottom) Japanese Structure and Truss Principles Used in the Roof Structure of Nabawi Church—Diagonal Members.

In the National Archives of Korea [13], the authors found a total of 11 drawings of buildings with structures and exteriors similar to those of the Korea Pavilion at the Tokyo Taisho Expo. Nine of them are the drawings of the Korea Pavilions at the expositions hosted by Japan in 1914, 1921, 1929, 1930, and 1932, and one each for the museum and the science hall. In addition, four cases were found among the architectural drawings of the buildings that were newly constructed in the Changdeokgung Palace between 1908 and 1910. These drawings were produced between 1908 and 1914 and are currently archived in the Jangseogak Royal Archives at the Academy of Korean Studies [14]. Figure 6 lists the original drawings of these 15 cases in chronological order, and in this study, they were referred to as ‘hybrid roofs.’ Unfortunately, none of these 15 cases have survived to date, and all remain as drawings.

While examining the architectural drawings of these 15 cases of ‘hybrid roofs’, we were the most curious about why the inside (roof structure) and the outside (roof exterior) were so different. When we think of the design and construction of a building within the concept of so-called ‘architectural style’, the construction method and appearance are often closely interrelated—at least if it is pre-modern architecture—as the appearance is largely attributable to how the structure is formed. What makes these cases very interesting is that their construction methods are independent of appearance. From the outside, it seems to faithfully follow the traditional Korean architectural style, but the internal construction method is completely different as it is composed of a Western truss. Why did it have to be built in this way? Why and when did trusses come to be used for Korean-style roofs? What kind of transformation was drawn out from the truss that was used in these cases to realize the exterior form of a Korean-style roof? This study intends to answer these questions.
Figure 6. 15 Cases of ‘Hybridized Roofs’ That Had a Korean-Style Roof Form, Applied a Western Truss, and Was Designed by the Japanese: 4 Drawings from the Academy of Korean Studies, and 11 Drawings from the National Archives of Korea.
2. Materials and Methods

This study was conducted in the following order. First, 15 cases were analyzed by comparing Western-style truss roofs and Korean-style roofs through three perspectives—structural frame, roof curve, and eaves space—as a focus of analysis. Then, 15 drawings were reproduced in the form of color-coded analysis drawings, and the following steps of analysis included the examination of which construction method was used, what was different from the existing construction method, and where the transformation occurred. The last part of this study dealt with the periodic, historical context, their political implications, and their historical significance within the overall architectural history.

2.1. Analytic Framework

For these 15 cases, it is difficult to describe the common characteristics at a glance because the structure and appearance of a Korean-style roof, a Western-style truss roof, and sometimes a Japanese-style roof coexist. Most pre-modern buildings have sloped roofs, but the exterior and interior structures are significantly different depending on the culture and region. Let us take a look at the structure and appearance of the three roofs, respectively, and think about the correspondence and distinctiveness.

First, the roof of the Korean timber structure is composed of diagonal rafters placed above the framing with horizontal beams, short columns (dongjaju), and purlins (the name and composition of each component are shown in Figure 7). The Korean timber structure was derived from the Chinese one, which transfers the heavy load of the tiled roof to the structure underneath using beams, truss posts, and purlins without a truss or bracing. Since its establishment in the 5th century BC, it had not undergone significant changes for over 2000 years and remained dominant in Asia until modern Western architecture was introduced. [15] Beams are the most critical structural members that transfer the roof’s load to columns, and their cross-sectional area is about two or three times larger than that of rafters. Rafters form the roof slope, and the inclination of long rafters and short rafters are made slightly different to adjust the roof’s height and width. Wooden plates cover the long and short rafters, and the layer of soil and wood is placed over the plates before laying the roof tiles, whose inclination is carefully adjusted. (Figure 7) The difference between the inclination of long and short rafters sometimes becomes the basis for realizing the roof curve. Another quintessential characteristic of the traditional roof is the space under the eaves, as the eaves are notably protruded further from the columns. One end of the long rafters is placed over the middle purlin, and another end is protruded outwards as a cantilever. Sometimes, additional extension rafters called buyeon are used to secure a larger space under the eaves.

Figure 7. Two Beams and a Short Column (Dongjaju) with Diagonal Connecting Members/Two Rafter Types in a Different Inclination (Traditional Korean Heavy Timber Framing) Reprint with permission [16]; 2007, Dongnyok Publishers.

Figure 8 shows a Western-style truss roof that appears in the case of Choongang High School, built in 1917. The horizontal members and the diagonal members are connected in
a triangle shape, and unlike the Korean-style roof, the thickness of the members is constant because the load can be evenly distributed to each member. The diagonal member, called the top chord, is a single long member that determines the slope of the entire roof, and this slope is directly reflected on the exterior. A typical Western-style truss roof does not have the vast eaves space as that under a Korean-style roof. However, as shown in Figure 9, there are cases where the top chord is pulled outward from the column, but it is different in shape from that of a Korean roof.

Figure 8. Western Queen Truss (Chungang High School, 1917).

Figure 9. Hybrid Roof Structure—Triangular Arrangement of Structural Members and Additional Members Added to the Truss Structure to Articulate Roof Curve and Eaves Space (Korea Pavilion, Tokyo Taisho Exhibition, 1917).

Figure 9 is a section drawing of the Korea Pavilion at the Tokyo Taisho Expo, which is one of the 15 cases that are highlighted in this study. It is interesting that the internal structure is made of a truss, but its exterior is curved in appearance. Instead of piling up the soil on the long and short rafters, the roof curve is realized by placing members of various heights on the top chord. When creating the eaves, it is different from the Western-style truss roof in Figure 10 in that the diagonal members (the blue member in Figure 9) are placed on the top chord. Rather, this method is quite similar to the form and building techniques of ‘buyeon’ used in the Korean-style roof (the blue member in Figure 7).

Based on the characteristics of the structure and appearance of Korean-style roofs and Western-style truss roofs, we will focus on the following three perspectives in analyzing the 15 cases that are the subject of this study:

1. Structural Frame—What kind of truss replaced the Korean-style roof structure? Are there any parts of the typical truss transformed? How and why do transformations occur primarily? This will be covered in detail in Section 3.1.
2. Roof Curve—What building components were added to create the characteristic curve of the Korean-style roof? This will be covered in Section 3.2.
3. Eaves space—What building components were used to create the eaves space? This will be covered in Section 3.3.
2. Methodology: Creating Analytic Drawings

To analyze the 15 cases according to three features explained above (structural frame, eaves protrusion, roof curve, and eaves space), the original drawings were simplified and redrawn as a diagram in Figure 11 with color-coding.

Figure 10. A roof truss with overhang [17].

2.2. Methodology: Creating Analytic Drawings

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Figure 11. Process of Preparing Analytic Diagrams (Members used for Basic Structural Frame: Yellow; Members used for Protruding Eaves: Blue; Members used for Creating Roof Curve: Dark Brown; Roof Surface: Light Brown; Other Supplementary Diagonal Members: Gray).

2.3. Background and Preceding Studies

The history of truss roofs in Korea began with the opening of ports at the end of the 19th century. The first building to use trusses on the roof was Beonsachang (Joseon’s weapon factory), built in 1884. From the end of the 19th century to the beginning of the 20th century, which was before the ‘manuals on modern building techniques’ were distributed by the Japanese, Western-style truss structures could mainly be found in religious buildings and consulate offices, designed and constructed by Westerners. A wooden king truss was used in ‘Yongsan Theological School’ built in 1892, a roof truss using both wood and iron was used for the first time in ‘Jeonggwanheon Hall’ of Deoksugung Palace (Figure 4) built in 1900, and a wooden queen truss was used in ‘Choongang High School’ (Figure 8) built in 1921 [9].

Trusses have been actively used in Korea since the introduction of Western-style building techniques through the above-mentioned manuals during the Japanese Colonization period. Among the 1045 books on modern building techniques stored in the National Library of Korea, 16 books had the content of ‘Western-style wooden roof trusses.’ The truss types introduced in these manuals can be categorized into four: the king post truss, queen post truss, mansard, and compound truss (see in Figure 12). Likewise, the ‘Western-style truss roof’ was introduced and used in Korea after already being reinterpreted by Japan, and therefore, attempts to improve traditional Korean wooden structures or infuse truss systems with traditional structures were quite limited [18].
On the other hand, Japanese scholars tried to improve the traditional Japanese wooden structure, starting from the end of the 19th century. There was a debate among scholars about the strength and weakness of traditional structures and Western-style trusses, and efforts were made to improve the downside of traditional structures by applying Western-style trusses. For example, it was possible to increase the rigidity by using diagonal members such as braces, or to reduce the thickness of the timber by using metal joints instead of traditional wood joinery. This was also more favorable from the perspective of seismic design. Such an improved roof structure was referenced by practitioners through the 20th-century books on architectural techniques that were published later [19].

As the 15 cases discussed in this study were also designed by the Japanese, they may have been influenced by the aforementioned Japanese manuals on modern building techniques. In particular, the Improved Japanese House Structure published in 1919, the earliest among those books, introduces the Japanese wooden structure and construction methods of the Western truss (Figure 13). Some of its figures show hybrid construction methods. In other words, a roofing method for a curved roof and eaves space while replacing the internal structure with a truss is introduced, presumably to realize the appearance of a Japanese roof (elevation drawings showing the finished appearance of the roof are not included in the book). The structural method used in the 15 cases studied in this paper is basically similar to this ‘hybrid’ method, but much more diverse variations are found. These variations are important clues that reflect what was deemed necessary to realize the appearance of a Korean roof, different from similar cases in Japan. It is necessary to pay attention to what kinds of changes were needed to shape the exterior of a Korean-style roof, how each component of the truss was segmented or transformed, and whether the influence of the traditional Korean wooden structure could be found in the transformation process.

Figure 12. Four Types of Western Roof Truss Shown in Japanese Books on Modern Building Techniques (Lin and Kim) [9].

![Figure 12. Four Types of Western Roof Truss Shown in Japanese Books on Modern Building Techniques (Lin and Kim) [9].](image)

Figure 13. Japanese–Western Hybrid Roof Structure Introduced in Improved Japanese House Structure, 1919 [20].

![Figure 13. Japanese–Western Hybrid Roof Structure Introduced in Improved Japanese House Structure, 1919 [20].](image)
3. Results

Figure 14 is an analytic diagram of the 15 cases reflecting the three features introduced above. Indexes from A to V were assigned in the order of the construction year of each building. Among the 15 cases, the technical characteristics were analyzed by grouping the cases according to the three categories: structural frame, roof curve, and eaves space.

Figure 14. Analytic Drawing of 15 Cases Focusing on Structural Frame, Roof Curve, and Eaves Space (In the Chronological Order) (Source: (A–D) Jangseogak Royal Archives, (E–O) National Archives of Korea).
3.1. Application and Transformation of Truss

The main framing that supports the roof load consists of either a king post truss or a queen post truss in most cases except case O. As reviewed in Section 2.1, in the case of the Korean roof structure, all building components except for the rafters are connected vertically, so these 15 cases can be collectively referred to as ‘cases in which Western-style trusses were introduced to the Korean-style roofs.’ However, a close analysis of four cases—G, H, J, and N—reveals a very intriguing transformation of the Western-style truss. Four cases shown in Figure 15 have the top chord divided into two parts, a separation of one building component that is similar to the case in which the rafters are composed of long and short rafters in a Korean-style roof structure. In case H, the bottom chord is divided into two, being similar to the Japanese-style roof structure. In cases G, J, and N, in particular, the segmented top chords have notably different angles from each other. The different inclinations of the segmented top chords are not simply stemming from the limitation in the length of the members, but are an attempt to realize a smoothly curved (concave) Korean-style roof. In case G, the horizontally placed members are significantly thick, being the most similar to the Korean-style (heavy) roof structure. In other words, this case can be seen as a tweaked truss structure, but depending on the point of view, it can also be seen as a transformation of the existing Korean-style roof structure. As such, these changes best show the ‘hybrid’ aspect of architecture during this period.

Figure 15. Use of Diagonal Building Components and Influences from Korean Heavy Timber Framing Composition in Hybrid Roof Cases.
Meanwhile, case O is the sole example of using the space truss, and is the most peculiar case from the perspective of the structural frame. As this building was a science hall, it can be assumed that tall story height and modern imagery were expected to fit its program. When the drawings are looked at in further detail, attempts to imitate the decorative aspects of Korean architecture can also be observed. As shown in Figure 16, there are some decorative parts such as beamheads, round purlins, beam supports, and bird’s wing-shaped bracket arms, which are not connected to any of the structure members inside.

![Figure 16. Decorations Added to Mimic Traditional Beamhead, Purlin, and Bracket of Original Traditional Korean Roof.](image)

### 3.2. Double Roof Structure to Create Roof Curve

The roof curve is created by erecting ‘vertical supplementary members’ above the top chord of the truss and layering one more roof surface over them. Therefore, it becomes a double-layered roof. The most distinct difference from the Korean roof structure is that to reduce the weight of the roof; less or no soil is used between the layer of rafters and the layer of roof tiles. As in cases C and M, where there is only one top chord, a roof curve is created by using ‘vertical supplementary members’ at various heights. On the other hand, in the cases where the top chord is segmented as described in Section 3.1, these vertical supplementary members are not used or are used less (Figure 17).

![Figure 17. Roof Curve Created by Vertical Supports of Various Heights on the Top Chord.](image)

When making the roof ridge, it is also notable that only the external shape is mimicked by using short timbers instead of stacking multiple roof tiles as in the traditional method.

### 3.3. Building Components to Create Eaves Space

Most cases show the attempt to create the space under the eaves by fixing a diagonal member—in a similar shape to the rafter or buyeon of a traditional Korean roof—to the
top chord and protruding it as a cantilever (Figure 18). Cases B, H, I, K, and N are also notable for having a Korean-style roof with double-layered eaves—a roof with two rows of rafters. Cases M and O are the exceptions in that the Western construction method of creating eaves is used, as shown in Figure 9.

When observed on a smaller scale, the building components to create the eaves space, which are marked in blue, are very similar in shape to the buyeon of a Korean-style roof. These components are present in all cases except for O and M. This might be because the eaves space is exposed to the outside, and an attempt is made to faithfully replicate the exterior of a Korean-style roof. This contrasts with the inner structural frame that is not exposed to the outside, as noted in Section 3.1, where the influence of the Korean-style roof is hardly observed in each building component whereas a truss, diagonal members, and metalwares are actively used.

Similar techniques could be found in the book published in 1919, Improved Japanese House Structure. As shown in Figure 19, there are four methods for creating the protruding eaves. Among the cases illustrated here, the second drawing shows the eaves protrusion in the truss structure. It is peculiar to use a building component called gokmok (梏木), similar to buyeon of a traditional Korean roof. On the upper left corner, there is an illustration
depicting the distance between two gokmok, which helps further the understanding of the overall structure of the eaves.

Figure 19. Techniques of Protruding Eaves Introduced in Improved Japanese House Structure [20].

4. Discussion

4.1. The History of Hybridized Roof with Truss Structure

In these 15 cases, a truss was used, but additional members were applied to create the characteristics of a Korean-style roof, such as eaves space and roof curve, or the truss itself was transformed. Additionally, construction techniques and building components of Korean or Japanese traditional timber architecture were used if necessary. As such, architectural methods from different cultures were present in a hybridized form. Then, when and for what reason was this hybrid architectural style first tried?

In Japan, the Western-style wooden truss was first used in the building of the Bakubu Nagasaki Steelworks in 1861, and since then, it was used more actively as the need for lighter roofs was raised in earnest. A mixed use of trusses and traditional building techniques was referred to as a ‘Japanese–Western Hybrid Structure’, and this style was originally devised to create a large space in palace architecture where the traditional appearance was important [21]. Among the 15 cases covered in this study, four cases—A, B, C, and D—were earlier cases that were built during the Japanese Colonization period when some building extensions were carried out for the palaces of the Joseon Dynasty. These works are presumed to have been influenced by the ‘Japanese–Western Hybrid Structure’ previously used for Japanese palace architecture during the Meiji period. These roof structures of the four cases, built in 1908, had a form almost similar to that of the Meiji Palace’s Main Hall in the 1880s, as shown in Figure 20 [22].
These drawings were prepared by a department called Takjibu, which was in charge of architectural activities within the palace. Originally, this department was mainly operated by Koreans, but since 1906, with the Japanese taking its power, the overall style, materials, and construction techniques of royal palace architecture began to be highly influenced by those of Japan [24]. It seems like new Western techniques of the truss system were applied to create a lighter frame and build more practically, but the exterior form followed the traditional style because of their status as palace architecture.

The restoration project of the Daibutsuden Hall of Todaiji Temple in Japan, which was conducted between 1906 and 1913, is a representative example where the Japanese–Western hybrid structure was applied to restore cultural heritage, not only to new construction projects [25]. Since the Daibutsuden Hall has such a huge roof, there had been discussion about structural reinforcement since the mid-19th century, but the actual repair was delayed due to financial difficulties and the absence of competent experts. Therefore, when the repair work finally began, it was already the 20th century. The repair work was led by elite architects who received Western-style modern architectural education, and Ito Chuta (伊東忠太) and Sekino Tadashi (關野貞) participated as technical advisers. The core of the structure was substituted by the box truss imported from the United Kingdom, and the diagonal building components were actively used to apply the construction principles of the truss structure (Figure 21). Metalwares such as bolts, nuts, and plates were used in the joints, and diagonal members were also used for brackets under the eaves (Figure 22). According to the construction record confirmed by Coaldrake, Japanese roof tiles were replaced with western roof tiles, thus reducing the weight of the roof by up to 12% [26]. The case of Todaiji Temple suggests that the Japanese at that time did not hesitate to use trusses—a Western architectural and structural technique—in the process of repairing one of their most prominent cultural heritages. It also indicates that the truss system was recognized as a practical and modern technique to ‘improve’ the traditional Japanese timber structure.
The so-called ‘reformed’ or ‘hybrid’ method of applying trusses to a Japanese-style roof became more common through the distribution of ‘books on architectural techniques’ published at the time. *Improved Japanese House Structure* (改良日本家屋構造), published in 1919, introduces some architectural drawings that are very similar to the 11 cases of the expo buildings among the 15 cases covered in this study. Although the Japanese roof’s basic structure of beams and *dongjaju* columns is maintained, it is notable that the diagonal members support them on both sides. This is significant in that it fundamentally changes the vertical...
flow of the load within the post and lintel system. In addition, the use of diagonal building components connecting beams and columns was a new attempt at the time. How they make the eaves space is also noteworthy; the space under the eaves was created by attaching the secondary components on the top chord of the truss as a cantilever structure. These details are difficult to check in the section drawing on the left part of Figure 22, but the drawing on the right side shows the details very well. Multiple methods of creating the space under the eaves are suggested for various building sizes. The top chord was separated into two parts and used at different inclinations to create the roof curve.

4.2. Political Implications of Expo Architecture—Reason Why Exterior Was Realized in Korean Traditional Roof Style

Why was the exterior form of Korean architecture maintained while using the truss for the structure? Cases A, B, C, and D were new buildings constructed by the Japanese rulers within the palace of Joseon to facilitate colonial rule. It can be thought that THE Japanese–Western style construction techniques of the time were more reasonable and practical, while the exterior form of a Korean-style roof was maintained due to the site context of a palace. Then, the remaining 11 cases are the ‘Korea Pavilions’ of the expo that were built after the establishment of the Japanese Government-General of Korea in 1910. They were built with the intention of emphasizing that modern facilities built with the up-to-date technology of the new era were constructed by Japan, not Korea, and that it was Japan that took care of the history and culture of colonial Korea by allowing the public to see them.

Expositions were held to exhibit ‘industry’ as well as to display the power of ‘empire.’ Japan continuously held expositions to promote its successful modernization and industrial development; furthermore, through expositions, Japan propagated the legitimacy of its colonization of Korea. The style of each pavilion also symbolized the hierarchy between the home country and the colony. While other pavilions were in Western styles such as Renaissance, Art Deco, and Modernism, the Korea Pavilion was designed in the traditional style—that is, the pre-modern appearance. The 1915 Joseon Industrial Exhibition was a white building that added the Renaissance style to the Secession style, which was the latest style in Japan at the time. The exhibition hall was built with a simple, lightweight timber structure like a warehouse, and this modernist style was expressed in the façade decoration focusing on the prominent parts. Kang Sang-hoon noted that this stylistic expression, which appeared only in facade decoration, was a characteristic of the expo architecture at the time and evaluated that Japan’s use of Western styles rather than its own reflected the notion of identifying itself on the same line with Western empires. This latest Western-style building made a contrast with the old palace hall where the Industrial Exhibition was held, contributing to the image of colonial Korea being even more humble—that of a less developed country [27].

The 1929 Joseon Expo, which was held by the Japanese Government-General of Korea to commemorate the 20th anniversary of the municipal administration, was primarily designed in a traditional style, unlike other expositions (Figure 23). It was held at an old palace in Korea, and the old-fashioned atmosphere of the palace and the newly built Korean-style pavilion represented the orientalism perspectives of the Japanese toward Korea [28].
Figure 23. 1929 Joseon Expo at Gyeongbokgung Palace in Seoul, Korea: (Left) Pavilions in Traditional Korean Style. (Right) Tokyo Pavilion of the in Modern Architectural Style (Source: Seoul Museum of History) [29].

The Korea Pavilion, built at a local exposition in Japan, reveals a strong regional color through its traditional exterior, and most of them borrowed designs from the palace buildings of the Joseon Dynasty (Figures 24–26). Emphasizing the exotic exterior, it was popular among Japanese visitors, similar to the pavilions of colonies holding the spotlight at the modern Western expos.

Figure 24. (Left) Korea Pavilion at the 1914 Tokyo Taisho Expo. (Right) Tokyo Pavilion at the 1914 Tokyo Taisho Expo (Source: Database of the Pre-1945 East Asian Postcards) [30].

Figure 25. Elevation of the Korea Pavilion at the 1914 Tokyo Taisho Expo (Plans E and F are section drawings of the same building). (Source: National Archives of Korea) [5].
In particular, at the 1922 Tokyo Peace Commemorative Exposition, held for four months to commemorate the end of World War I, exhibition halls for colonies such as Korea and Taiwan were built in a very exotic traditional style in contrast to the modernistic entrance or the Peace Monument (Figure 27). The audience of this expo included not only Japanese, but also a large-scale visiting team from Korea dispatched to witness advanced Japanese culture and technology. Apparently, they were disappointed by the contrasting display of the Korea Pavilion after looking at sophisticated modern structures [31].

The article in Dong-A Il-bo Newspaper in 1922 denotes the Korean public’s reflection on the Korea Pavilion displayed at the 1922 Peace Commemorative Exposition held in the Tokyo Ueno Park, stating that “it is insulting to internationally display the antiquated Korea Pavilion with traditional exterior without any hint of modernity” [32].

Meanwhile, although their intended exterior forms were different, it was common among these pavilion buildings for the expo that the interior construction principles and exterior form be independent of each other. In other words, as in the 15 cases discussed in detail above, even if a truss was used inside, the exterior was formed as a Korean-style roof or a Japanese-style roof, while there are also examples in which a neoclassical dome-shaped exterior was constructed with a truss inside, as shown in Figure 28. All of these are very interesting examples of architecture showing the tendency of materials and construction methods to be independent of form, an autonomy that can be seen as another aspect of ‘modernity’.
These subtle changes reveal the limitations of the previous mainstream studies that argued the significance of these cases. They demonstrated the attempts to form the Korean-style roof by scrutinizing architectural drawings produced during the Japanese Colonization period (1905–1940) in Korea. Their technical characteristics were interpreted to grasp the extent and category of such changes varied. These buildings are exemplary cases of showing multiple layers of hybridization, being designed by the Japanese, having an exterior of a Korean-style roof, and using the truss system for the roof structure. Situated in the margin of both Japanese and Korean architectural history, these are cases that have not been previously studied in depth.

Analyzing the architectural drawings from three points of view—structural frame, roof curve, and eaves space—proved that it was obvious that the truss was used to make the roof lighter, but what was more interesting was to observe the transformations of the truss to realize the appearance of a Korean-style roof. The top chord was segmented to create a smooth roof curve in some cases; the cantilever members were attached to secure an eaves space in other cases. However, the extent and category of such changes varied. These subtle changes reveal the limitations of the previous mainstream studies that argued the wooden roofs of East Asia have become lighter due to the ‘inflow’ of Western-style truss technologies. In other words, the architectural style and construction techniques of the modern Western countries, Japan, and Korea were intertwined and had a multi-directional influence on each other.

Another thing to note is that all of these cases were buildings constructed with a clear political purpose, built by Japan in the Korean palaces or for expositions to promote its imperial rule. The 11 cases built at the expo were each called ‘Korea Pavilion’, that is, buildings that exhibited the culture of the colonized country. Although the pavilion of its own country had a Western-style exterior, the ‘Korea Pavilion’ was to show the superiority of the colonists by faithfully replicating traditional Korean architecture—pre-modern architecture—to show the superiority of the colonists through a distinctive contrast.

5. Conclusions

This study analyzed 15 cases where trusses were used for a building with a Korean-style roof by scrutinizing architectural drawings produced during the Japanese Colonization period (1905–1940) in Korea. Their technical characteristics were interpreted to grasp the significance of these cases. They demonstrated the attempts to form the Korean-style roof with a smoothly curved, concave roof and eaves space by re-transforming the ‘Western–Japanese hybrid’ structure that Japan had created by introducing Western trusses in the early 20th century. These buildings are exemplary cases of showing multiple layers of hybridization, being designed by the Japanese, having an exterior of a Korean-style roof, and using the truss system for the roof structure. Situated in the margin of both Japanese and Korean architectural history, these are cases that have not been previously studied in depth.

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It is also noteworthy that even when having a Western-style, a Korean-style, or Japanese-style exterior, the basic structure was built with a truss, and some modifications were made to forge the exterior of an architectural style suitable for the purpose. These flexible adjustments can be seen as a 'change to the modern era', in which materials and construction methods (structural framework and construction principles) do not necessarily have a close relationship with the exterior (what is seen from outside).

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**References**

1. Yun, I. Exchange of Cultures: Foreign Architect-Designed Buildings in Korea. *Korean Archit.* 2006, 5, 87–93. Available online: https://scienceon.kisti.re.kr/srch/selectPORSRchArticle.do?cn=JAKO200674553275356&dbt=NART (accessed on 1 June 2022).
2. Jung, I. Architecture and the Introduction of New Materials. In *Architecture and Urbanism. In Modern Korea*; Knapp, R.G., Ruan, X., Eds.; University of Hawaii Press: Honolulu, HI, USA, 2013; pp. 36–48. [CrossRef]
3. Jeon, B. Architectural Drawings of National Archives of Korea. In *Proceedings of the Spring Conference of Korea Association for Architectural History; Korea Association for Architectural History: Seoul, Korea, 2009; pp. 150–175.
4. Joo, S. Characteristics of the Use of the Western Building System with the Change of the Architectural Design in the Japanese Colonial Period—Focused on the Facility Built by Japanese Government-General in 1910s. *J. Korea Assoc. Archit. Hist.* 2012, 21, 57–68. Available online: https://www.auric.or.kr/User/Rdoc/DocCmag.aspx?returnVal=CMAG&dn=189335#YpBKyC8Rrvc (accessed on 1 June 2022). [CrossRef]
5. Collection of Architectural Drawings during Japanese Colonial Period. Available online: https://theme.archives.go.kr/next/place/viewMain.do (accessed on 1 June 2022).
6. Hanok Magazine. Available online: https://hanokmag.com/27/?q=YToyOntzOjEyOiJrZXl3b3JkX3R5cGUiO3M6MzoiYWxsIjtzOjQ6 InBhZZUiO2k6Mz9t&bmode=view&idx=8820688&t=board (accessed on 1 June 2022).
7. Kim, M.; Kim, T.; Park, C.B. Treatment of Western Wooden Roof Trusses in Early 20th Century Korea. *J. Archit. Inst. Korea* 2009, 24, 49–56. Available online: https://www.tandfonline.com/doi/pdf/10.3130/jaabe.8.49 (accessed on 1 June 2022). [CrossRef]
8. Park, C.; Kim, M.; Kim, T. A Study on the Type and Characteristics of Wooden Roof Truss in Modern Age of Korea—Focused on the Survey Reports of Modern Architectural Properties. *J. Archit. Inst. Korea* 2008, 24, 159–168.
9. Lin, J.; Kim, T. The Receptiveness of Wooden Roof Truss in Modern Age of Korea. *J. Archit. Inst. Korea* 2006, 22, 163–170. Available online: https://www.auric.or.kr/User/Rdoc/DocRdoc.aspx?returnVal=RD_R&dn=187028#YpA8i8Rrvc (accessed on 1 June 2022).
10. *Cultural Heritage Administration Documentation and Survey Report of Jeonggwangjeon in Deoksugung Palace; Cultural Heritage Administration: Daejeon, Korea, 2004; p. 184.*
11. Iksan City (Ed.) *Iksan Nabawi Church: Survey Report; Iksan City: Iksan, Korea, 2016.*
12. Jeon, B.; Joo, S.; Chang, P. *Commentary of Architectural Drawings during the Japanese Colonial Period; National Archives of Korea: Daejeon, Korea, 2008.*
13. Exposition, Collection of Architectural Drawings during Japanese Colonial Period. Available online: https://theme.archives.go.kr/next/place/subject01.do (accessed on 1 June 2022).
14. Jeon, K.; Lee, K.; Hong, S. *Drawings of Modern Architecture; Academy of Korean Studies: Seoul, Korea, 2009; p. 264.*
15. Jeon, B.; Lee, K. 3 bay × 3 bay; Seoul National University Press: Seoul, Korea, 2006; p. 1.
16. Kim, W. *A Dictionary for an Easy-to-Understand Korean Construction Glossary; Dongnyok Publishers: Seoul, Korea, 2007; pp. 189–190.*
17. Mizoguchi, M. *A Practical Guide to Western Architecture and Structure; Suharaya: Tokyo, Japan, 1930.*
18. Kim, T.; Roh, S.; Park, C. *Early 20th Century History of Technology for Structures in Korea; Kimundang: Seoul, Korea, 2011; pp. 20–25.*
19. Muramatsu, T. *History of the Technology of Architecture in Modern Japan; Shokokusha: Tokyo, Japan, 1976; pp. 76–81.*
20. *Zenko, Y. Improved Japanese House Structure (改良日本家屋構造); Dainippon Institute of Technology: Saitama, Japan, 1919; pp. 36–37.*
21. Onogi, S. *A Study on the Japanese-Western Eclectic Technique of Modern Japanese Style Royal Architecture; Toyohashi University of Technology: Toyohashi, Japan, 1988.*
22. Lee, G. Reorganization of the Main Spaces in Changdeokgung Palace during 1907~1910. J. Archit. Inst. Korea 2015, 31, 151–162. Available online: https://www.auric.or.kr/User/Rdoc/DocRdoc.aspx?returnVal=RD_R&dn=328236#.YpBKFy8Rrvc (accessed on 1 June 2022).
23. Meijimura Sugidoe of Meiji Palace: Meijimura: Nagoya, Japan, 2009; p. 72.
24. Lee, G. Reorganization of Royal Architectural Bureau in Gungnaebu during 1905–1910. J. Korea Assoc. Archit. Hist. 2014, 23, 61–71. Available online: https://www.auric.or.kr/User/Rdoc/DocRdoc.aspx?returnVal=CMAG&dn=204823#.YpB1H8Rrvc (accessed on 1 June 2022).
25. Yamazaki, M. The Restoration of Todai-ji Great Buddha Hall (Daibutsu-den) in the Meiji Era, an Analysis of Changes of the Proposed Restoration Project. J. Archit. Plan. (Trans. AIIJ) 2000, 65, 239–245. Available online: https://cir.nii.ac.jp/crid/1390282679757757696 (accessed on 1 June 2022).
26. Coaldrake, W.H. Western Technology Transfer and the Japanese Architectural Heritage in the Late Nineteenth Century. Fabrications 1994, 5, 21–57. [CrossRef]
27. Kang, S. Symbolic Meanings of Architectural Style of Expo Buildings during Japanese Ruling Era of Korea. J. Korea Assoc. Archit. Hist. 2006, 15, 7–25. Available online: https://www.auric.or.kr/User/Rdoc/DocCmag.aspx?returnVal=CMAG&dn=139289#.YpDhi88Rrvc (accessed on 1 June 2022).
28. Kal, H. Modeling the West, Returning to Asia: Shifting Politics of Representation in Japanese Colonial Expositions in Korea. Comp. Stud. Soc. Hist. 2005, 47, 507–531. Available online: http://www.jstor.org/stable/3879389 (accessed on 1 June 2022). [CrossRef]
29. Exposition, Modern Seoul Photos. Available online: https://museum.seoul.go.kr/archive/archiveNew/NR_archiveList.do?ctgryId=CTGRY829&type=D (accessed on 1 June 2022).
30. Database of the Pre-1945 East Asian Postcards. Available online: https://app.cseas.kyoto-u.ac.jp//infolib/meta_pub/G0000022PPC (accessed on 1 June 2022).
31. Hahn, K.; Noh, G. Tokyo Exhibition in Commemoration of Peace (1922) and the Inspection Parties of Joseon People. J. Stud. Korean Natl. Mov. 2010, 65, 33–72. Available online: https://www.kci.go.kr/kg/kiportal/ri/sereArticleSearch/riSereArtiView.kci?artArticleSearchBean.artId=ART001502897 (accessed on 1 June 2022).
32. A Claim to Burn Down the Korean Pavilion. Dong-A Il-bo Newspaper. 19 April 1922. Available online: https://newslibrary.naver.com (accessed on 1 June 2022).
33. Korea Pavilion, Peace Memorial Tokyo Exhibition Postcard. Available online: https://museum.seoul.go.kr/www/relic/RelicView.do?mcgqmbc=PS010030260101&mcsqno1=022820&mcs-qno2=00000&cdLanguage=KOR&tr_code=sweb#layer_download (accessed on 1 June 2022).
34. Peace Tower, Peace Memorial Tokyo Exhibition: Photographic Scenery Postcards. Available online: https://www.library.metro.tokyo.lg.jp/portals/0/tokyo/chapter1/14_022.html (accessed on 1 June 2022).
35. Main Gate, Peace Memorial Tokyo Exhibition: Photographic Scenery Postcards. Available online: https://www.library.metro.tokyo.lg.jp/portals/0/tokyo/chapter1/14_002.html (accessed on 1 June 2022).