

## HIGHLY SOPHISTICATED DESIGNS FOUND IN JAPANESE TRADITIONAL STRUCTURES

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### Summary

The present paper deals with some features of structural expression in traditional Japanese buildings from the viewpoint of elegance in structural design. The concept of structural expression in those traditional buildings is not easy to grasp because of their highly sophisticated designs. Very many people have failed to understand the real structural functions of important components of those buildings because of it. There are always sound reasons for those sophisticated designs which are based on more holistic judgments than mere structural criteria, although careful observation and deep insight are required to find them. This nature of Japanese traditional architecture is illustrated in this paper with the author's hope that this type of study may develop our capability of understanding elegance in traditional as well as modern structures.

### 1. Columns of Ise Shrines

Fig. 1 shows gable façade of the main building of the Ise Shrines (Naiku) which has been considered to be one of the most important prototypes of shrines and Japanese architecture. The form and style of those buildings have been ideally preserved for more than one thousand years by rebuilding them every 20<sup>th</sup> year strictly after the design of the previous



Fig.1: Gable Façade of Ise Shrine ( Naiku)

buildings. The buildings have been widely believed to be of a typical "beam and column system". Actually, however, none of the magnificent columns support anything but themselves. This sophistication has deceived many innocent observers including architects, engineers and critics. Bruno Taut, a famous German architect, is found among those who failed to grasp the structures of Ise Shrines correctly.

The inconsistency between the form and the real structural function can be explained as a result of deliberate design of the builders who pursued the sound air-tightness of the building and the dignity of columns.

### 2. The Central Columns of Pagodas

As Fig. 2 shows anatomically for Yakushiji West Pagoda, every Japanese pagoda has the



Fig. 2: Anatomical Sketch, Yakushiji West Pagoda



Fig. 3: Myououin, Eaves Rafters

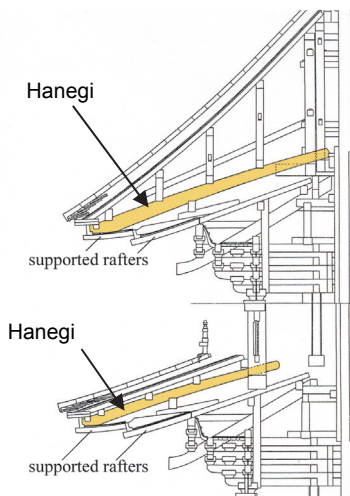


Fig. 4: Myououin, Section

central column which is the biggest in dimensions of all the structural members of the pagoda. So the criteria based on the modern rationalism may suggest that it must have some important structural function, but actually the central column should be independent of all other part of the tower, and it is not allowed to be touched by any other components of the pagoda. This sophistication can be explained by the very divine nature of the central column.

### 3. Design of Eaves

One of the special features of Japanese traditional buildings may be the elegance of the patterns of rafters supporting the very deep eaves projecting outside the main bodies of the buildings, as shown in Fig. 3 for the Myououin Pagoda. Our modern rationalism is again apt to guess that those beautiful rafters in double level are undoubtedly supporting the elegant eaves of the pagoda.

In reality, however, they are not supporting the weight of the eaves, but they are rather supported by the other structural members concealed above the ceilings of the eaves. The invisible members that are actually supporting the weight of the eaves are called "Hanegi" (Fig. 4) which were developed in Japan during the Japanization of architectural style which had been imported from China.

Even after the finding of the Hanegi mechanism the builders did not dare to change the traditional appearance of the rafters.

### 4. Conclusive Remarks

The author is not an historian or an expert of timber structures, but he is a structural engineer who is very much interested in the issue of form and function of structures. The present paper has dealt with this subject in connection with Japanese traditional timber structures with the hope that we might obtain some hints for our design from the ways our forerunners treated the same issue for their structures. We have seen that in attempt to understand Japanese traditional buildings properly we should avoid hasty judgment to be done on the basis of modern rationalism. In many of those building structural components are often designed not only from the mere structural criteria but from more holistic ones sometimes against their appearances.

The author considers that this type of study is useful for us to develop our capability of understanding elegance in structures, traditional or contemporary.

### REFERENCES

[1] Kawaguchi, M. *Mechanism of Structures*. Shokokusha Publishing Co. 2014 (2nd ed.) (in Japanese)