DEVELOPMENTS IN JAPANESE TIMBER ARCHITECTURE

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INTRODUCTION

Japan is a country of some importance for New Zealand timber designers. It is a major importer of our timber. But despite lacking its own timber resources, it provides most interesting examples of contemporary creative architectural timber design. These should inspire New Zealand designers to exploit our own resource to create timber architecture of delight. It might appear ironic that Japanese designers are using imported material with at least as much inventiveness as designers from the source countries, but contemporary Japanese timber design often has its roots deep in Japanese architectural tradition. This is, in many cases, the source of inspiration.

This article arises from the second author's research report, *Developments in Timber Structural Systems in Japan*. Comprising a literature survey and a historical review of the subject, the report concluded with some contemporary case studies. The same format is followed here, but now the emphasis is on more recently completed Japanese buildings.

HISTORICAL OVERVIEW

Timber architecture in Japan has been an integral part of Japanese culture. Timber, to the Japanese, is more than merely a building material. It is valued especially for its association with nature, and its colour and texture.

Japanese architecture of the first and second centuries AD witnessed the progression from pit to pile supported dwellings, and established the style on which Shinto architecture (late third century) was based. Characteristics of this style were the straight lines of roof and eaves, with circular columns placed directly into the earth. The introduction of Buddhism in AD552 was accompanied by a new style based on Chinese architecture that featured complex brackets. These supported deep overhanging eaves and curved roof lines. By the fifteenth century the range of architectural expression had broadened, encompassing buildings such as castles and elaborate temples. Timber's versatility was evident, with its ability to achieve many different aesthetic effects and levels of refinement.

Due to particularly devastating fires in the early twentieth century, building authorities restricted the use of timber. On 1st September 1923 the Great Earthquake struck Tokyo, a city consisting largely of timber buildings. Many buildings survived the earthquake, but in the following forty hours fire destroyed almost two thirds of those remaining. Japan moved away from the use of timber in public buildings to lessen fire risk. Reinforced concrete, brick and steel construction became more popular. This trend was also accelerated by the burgeoning influence of the modern movement that rejected traditional construction materials. Timber, other than for interior work, almost disappeared in new buildings. Modern materials, especially reinforced concrete, became the standard.

After the second World War, timber structures continued to be restricted. Apart from traditional buildings like temples, timber construction was allowed only in buildings up to and including two storeys, and provided the floor area was less than $1000m^2$. The building code was revised in 1950, with emphasis placed on the achievement of fire resistance and durability. Timber was still considered not to satisfy these requirements, and consequently its usage decreased even further. Even the smallest schools in rural areas were built in reinforced concrete.

During the 1970s, traditional permanent materials such as bricks, stone and tiles reappeared, mainly on the exteriors of public buildings. Indigenous materials were being introduced again, breaking away from the uniformity of exposed concrete, and expressing regional qualities. However, during this period there were few noteworthy examples of timber architecture in Japan. Real advances in the use of timber in Japanese architecture were to be made in the following decade.

In the 1980s, the attitude amongst the authorities towards timber public buildings changed. As explained in a recent touring exhibition of Contemporary Japanese Architecture: "Since the beginning of the 1980s there has, if anything, been a resurgence of interest in structural technology based on a human approach which satisfies people's desire for a sense of space and form imbued with emotion

and meaning. Interest in traditional wooden structures should be viewed in this light." The following case studies illustrate the subsequent celebration of timber architectural design.

CASE STUDIES

Seitogakushi Communal Residence
Photographs 1 & 2.

The Seitogakushi communal residence was designed by Shin Takasuga and completed 1980. Located on Miyake island, south of Tokyo, it is an example of timber being recycled. The architectural approach has evolved from the decision to construct the building from short lengths of used timber with the appearance of railway sleepers. They are used for all the walls, beams, posts, roof and furniture. The load-bearing elements consist mostly of stacked members, such as are encountered in a log house. The interior and exterior aesthetic is quite unlike a more conventional timber framed building. These solid horizontal layered walls interlock to form cruciform shapes in plan and are load-bearing, not merely infill panels between structural posts as with traditional Japanese timber construction. Although the construction method has led to quite cellular planning, in the two largest open spaces members are used as free-standing columns and beams. They form quite visually powerful skeletal frames. Spaces are opened up and natural light penetrates through the structure from roof skylights above. A subdued but naturally rugged architectural expression results.

Ryujin Gymnasium
Photographs 3 & 4.

Timber design has been celebrated throughout a gymnasium designed by Toyokazu Watanabe. It is situated in the small forested mountain village of Ryujin. The building, completed in 1987, was designed with the intention of conjuring up images of a Gothic cathedral, and by so doing, to relate its architecture to elements of the forest around the site. Building in timber meant confronting the restrictions imposed by the building code. The gymnasium floor area was larger than allowed but Watanabe overcame the problem by using reinforced concrete for the lower part of the structure, and timber for the roof space frame and wall structures above. At the time of completion the twenty-eight metre timber span was the longest used in Japan since the second World War. The external wooden buttresses, which provide lateral support in the transverse direction, do have some resemblance to stone flying buttresses. However, more significantly, they create an exterior elevation of complexity and interest. They rise from horizontally cantilevered reinforced concrete beams, themselves detailed to resemble traditional layered cantilevered timber beams passing through posts.

Japan Performing Arts Centre
Photograph 5.

Arata Isozaki was the designer of the Japan Performing Arts Centre located in Toga-mura in the Toyama prefecture and constructed in 1987. Timber is used in this building only for the roof structure and some internal finishes, such as the wooden block floor. The timber roof of the main performance space is octagonal in plan. It encloses a room intended to be flexible enough for a variety of purposes. Because a central column was inappropriate, Isozaki designed an elaborate system involving four radial king post trusses. A combination of compression and bending in the timber members and tension in steel rods permits the thirteen metre span. A perimeter timber compression ring provides stability against wind uplift.

The underside of the roof structure is like an umbrella. The central steel pole seemingly props up eight inclined struts supporting the steeply pitched rafters, designed for severe snowfalls. The imagery is accentuated by the extension of the pole two metres down into the space. The roof structure performs in much the same way as a conventional truss, with the bottom chord being replaced by steel rods, tensioned with turnbuckles.

The steel rods and centre post used here create a visually much lighter structure than would have been possible with timber construction alone. The steel centre post, effectively the central upright member of four trusses, has led to elegant connections between all members. It is a good example of the harmonious and appropriate combination of timber and steel.

Oguni Dome
Photographs 6 & 7.

The Oguni Dome located in Oguni-machi in the Kumamoto prefecture an area, well known for its cedar, was designed by the Yoh Design Office, and construction was completed in May 1988. The Dome is notable for its timber space frame roof structure. It was built four years after its designer, Shoei Yoh, had proposed that future public buildings in Oguni be constructed with seasoned young cedar in three dimensional truss structures jointed by spherical steel nodes. In this system timber members are connected by epoxy grouted bolts and centrally inserted plates. It had already proved itself in a smaller building before being adopted for the large column free space under the Dome. Covering an area of approximately 60 m by 40 m, it set a record for clear span lengths in Japan. The gracefully curved and high-tech stainless steel clad form belies the use of a more traditional structural material inside.

Seiwa Bunraku Puppet Theatre

Photographs 8 & 9.

The theatre, designed by Kazuhiro Ishii and completed in 1992, consists of two main spaces, a faceted circular exhibition room pavilion and an auditorium.

The two principal roof structures are most unusual, with that of the exhibition room being the more dynamic. It has been suggested that traditional construction techniques based on eleventh century Buddhist architectural practices are the inspiration for the spiral roof structure. At eaves level, a geometrically complex ring of interlocking members supports twelve steeply inclined members that layer and spiral as they rise towards the apex. A stunning spatial form has been achieved.

The ceiling structure above the auditorium also provides a most distinctive, and possibly unsettling aesthetic. It appears that short members are bolted together to act as a two-way beam grillage. Joints between each member consist of two metal bearing plates tensioned up by bolts, not only joining the two members together, but clamping a third perpendicular member in position. The system could be seen as quite crude and inefficient from an engineering perspective. However, irrespective of its span there is no doubt that the architect has obtained the desired "distinctive non-ordinary space".

EXPO 92 Japan Pavilion

Photograph 10.

The Seville Pavilion was designed by Tadao Ando with the aim to "show the people of the world the traditional aesthetic of Japan". The pavilion's most arresting feature is undoubtedly the structural system of posts and beams. Images of traditional elaborate Buddhist temple brackets and roof structure are conjured up immediately.

The interior structure consists of ten clustered column groups arranged in two rows along the building's length. Each comprises four separate glue-laminated timber columns rising to a height of twenty five metres. Towards the top, beams are built up in layers, similar to a traditional bracket system. The lowest beams are attached to the sides of columns, extending out far enough to support the next set of beams above. The process continues, building the beams out from the columns, just as brackets extend to support the eaves of Buddhist temples. Upper projecting beams are supported by secondary beams attached directly to the columns to increase rigidity. The secondary beams were not part of the original design, but were added later when it was realised extra strength was necessary. However, they also reinforce a powerful sense of layering that enhances the visual effect.

CONCLUSIONS

Although timber as a structural material has been neglected for most of this century, there appears to be an upsurge in its use. Given the high quality of design exhibited in these case studies, and that some are by leading designers, further developments in Japanese timber design are likely to continue. Contemporary Japanese timber designers often seem to draw inspiration from traditional construction practices. They are also prepared to explore timber's potential in less common forms to express their design ideas. The combination of modern technology with the traditionally exploited natural qualities of timber can be expected to continue to be developed. New Zealand timber designers should seek to emulate the creativity displayed by their Japanese colleagues.

ACKNOWLEDGEMENTS

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Figures of the Seitogakushi Communal Residence are from *Contemporary Architecture of Japan 1958-1984* published by Rizzoli, and all other figures are from *The Japan Architect*. Reproduced with permission of the publishers.

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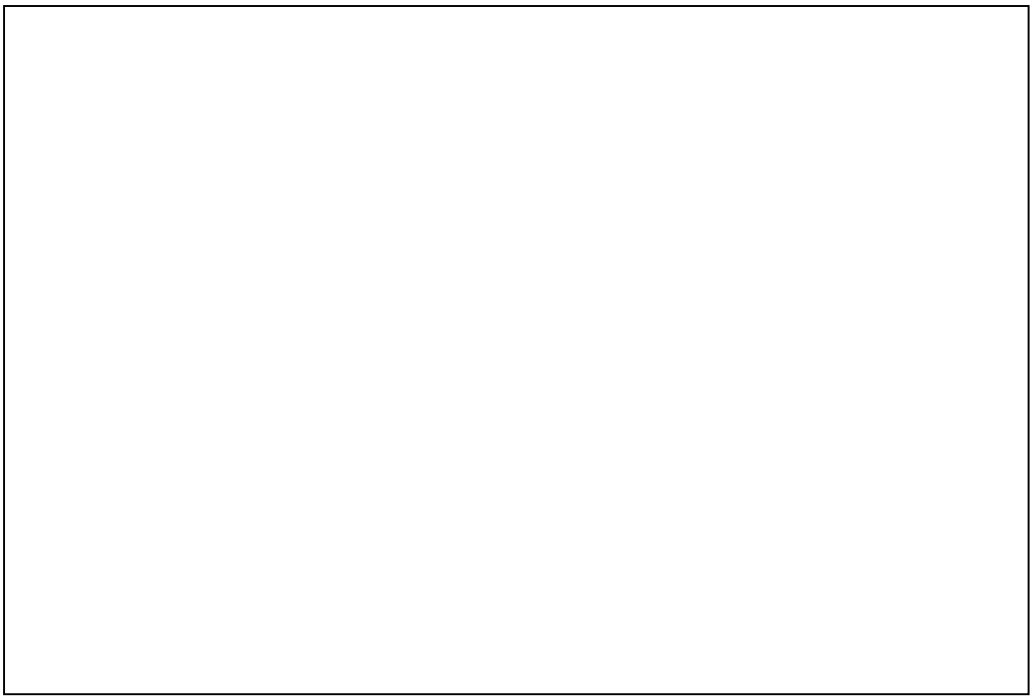
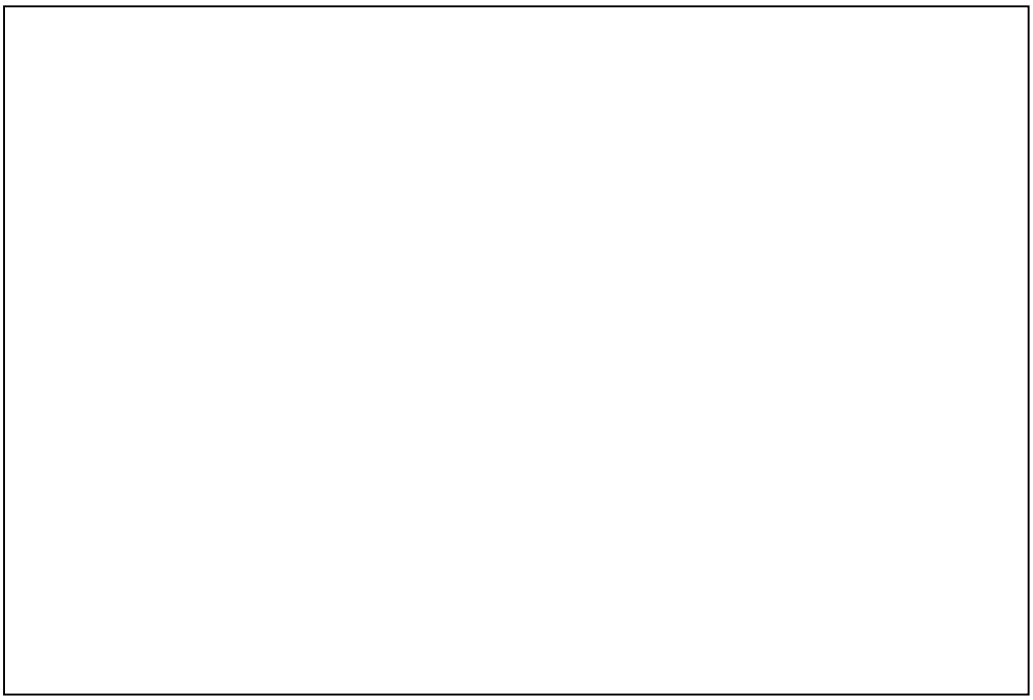
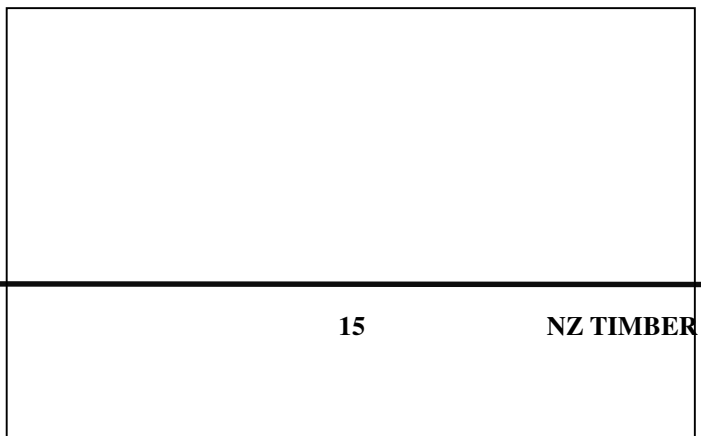


Photograph 1. Seitogakushi communal residence

Photograph 2. A larger internal space dominated by columns and beams

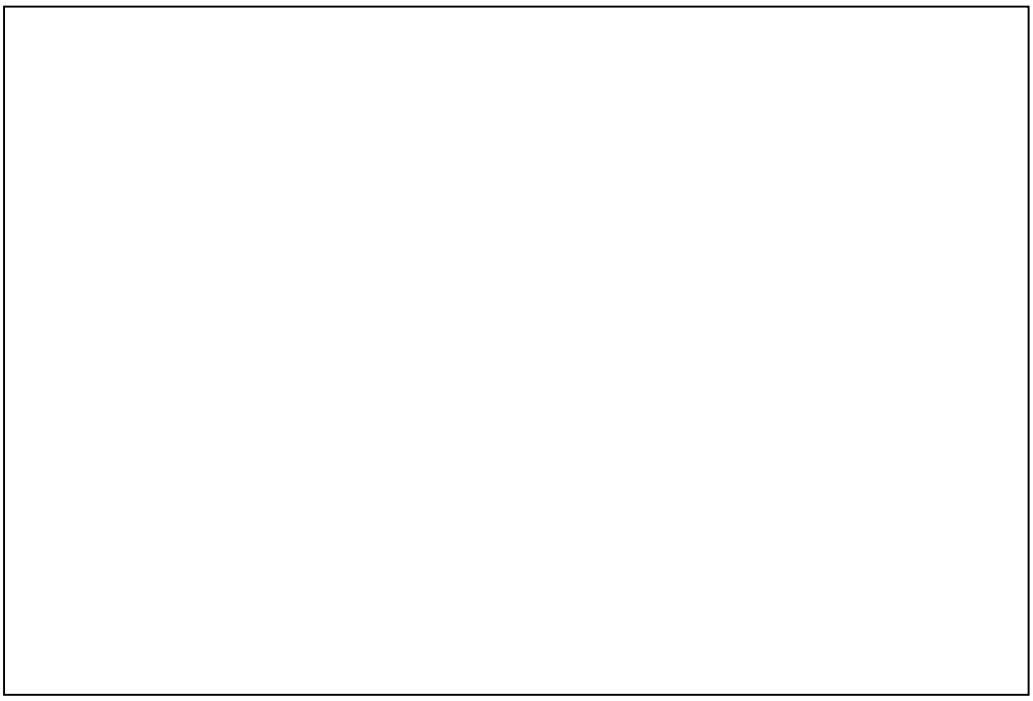


Photograph 3. Ryujin gymnasium

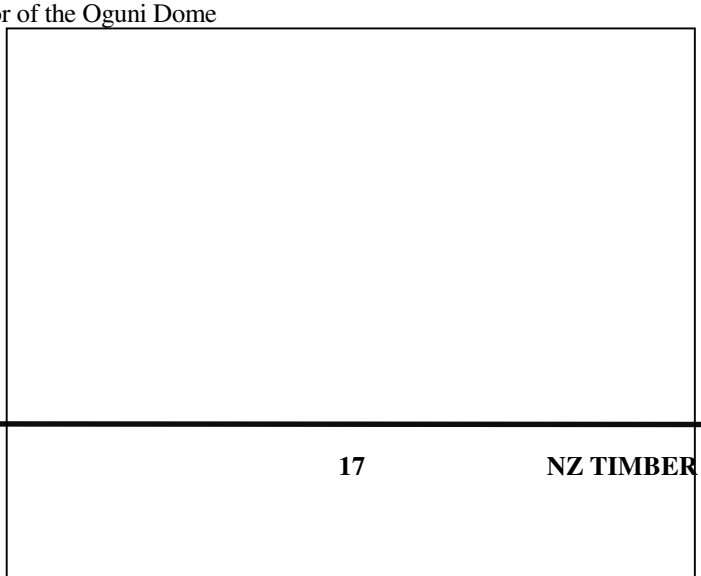


Photograph 4. Exterior timber truss buttresses

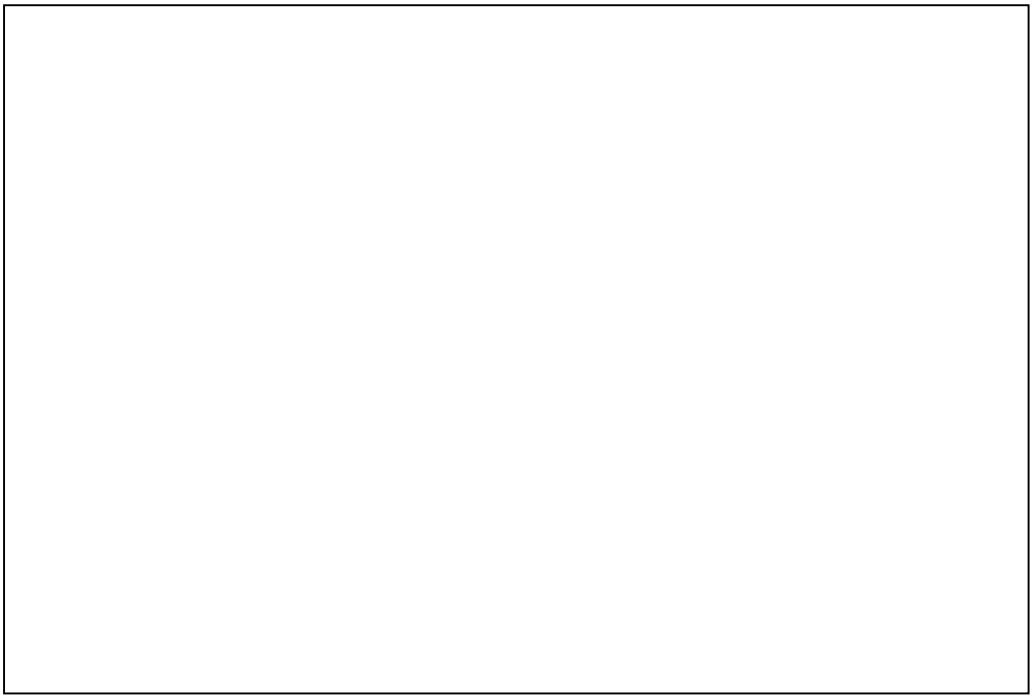
Photograph 5. Roof structure of the Japan Performing Arts Centre



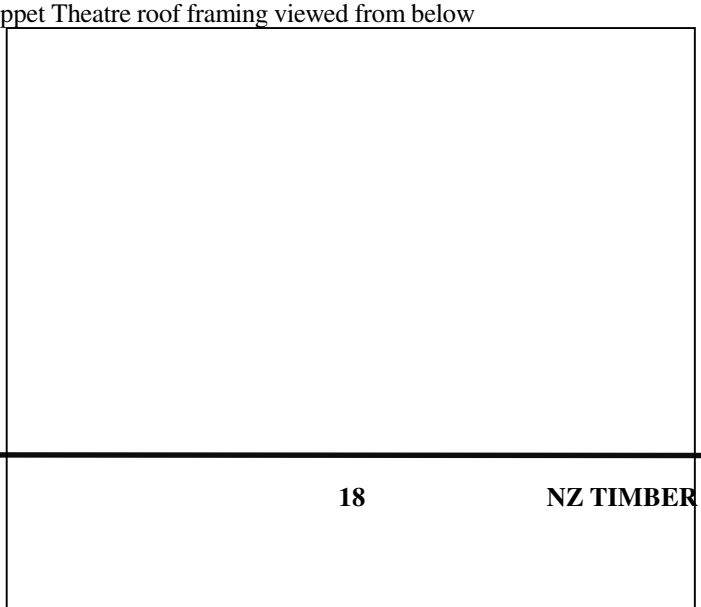
Photograph 6. Exterior of the Oguni Dome



Photograph 7. Timber space frame roof structure



Photograph 8. The Puppet Theatre roof framing viewed from below



Photograph 9. Ceiling structure of the auditorium

Photograph 10. Interior of Expo 92 Japan Pavilion