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Full Length Research Paper

Bridge architecture in Japan

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A bridge is a structure built to span physical obstacle such as a body of water, city, or road, for the purpose of providing passage over the obstacle. Bridges are a unique offshoot of architecture and possess their own associated terms, components and styles. This paper presents the second part of Japanese bridges by investigating architectural aspects of its design. Limited usable land in heavily populated areas of Japan has often necessitated the design of unique bridge approaches. One of such design is the spiral viaduct bridge approach. When this design is used, care is taken to make the structures aesthetically appealing. An important reason for the bridge construction will lead into a critical study of bridge aesthetics and structural design. According to the configuration of frameworks, bridges may be described as arched, girdered and cable stayed or suspension. Refereeing to Japanese bridges, those most frequently provided cable stayed in the construction of bridges are important factor in architecture and bridges aesthetic. This paper presents a brief history of bridge design in Japan, and then discusses the influence of technical factors on Japan bridges design.

Key words: Bridge architecture, Japan, cable stayed, aesthetic, grid box, arched.

INTRODUCTION

The role of the designer and architect in the planning and design of bridges is undergoing radical change, with architects now being appointed before the engineer on a growing number of projects. The relationship between the two roles is therefore on a different level than either will have previously experienced. A bridge is a structure built to span physical obstacle such as a body of water, city, or road, for the purpose of providing passage over the obstacle. Bridges types are involved as beam bridges, cantilever bridges, arch bridges, suspension bridges, cable-stayed bridges and truss bridges (Figure 1).The term "aesthetics" is defined, followed by a discussion of the following elements of design: context, alignments, positions of viewers, structure types, spans, piers, abut-ments and wing walls, bearings and parapets. Aesthetic appreciation and visual beauty are difficult concepts to define. Aesthetic or the science of perception is concerned with the material qualities we perceive, color, texture, tone, smoothness and so on, and the physical reaction to what we see in the arrangement of the shape and form of the materials. The following factors of design are then addressed: nature of materials, form and space, line and plane, texture, color, proportion, scale and rhythm. Bennett (1997) investigated the bridges design that, bridges designs depends on the function of the bridge, the nature of the terrain where the bridge is constructed, the material used to make it and the funds available to build it, but good design is not just engineering. Bridges needs a beautiful architecture because bridge architecture is very important, and it is by all means, a matter of life and death. Bridge architecture is important to us because people need it. Bridge architecture improves and change human lifestyle. It makes us create communities, spaces to interact and to experience a new world within the confines of a structure. In Japanese, a bridge is called "hashi", but when hashi is placed afterwards, "bashi" or "kyo" can be used depending on the places and time variations. Japan is involved with many bridges as follows:

Honshu-Shikoku bridge

The Honshu-Shikoku bridge is a system of bridges

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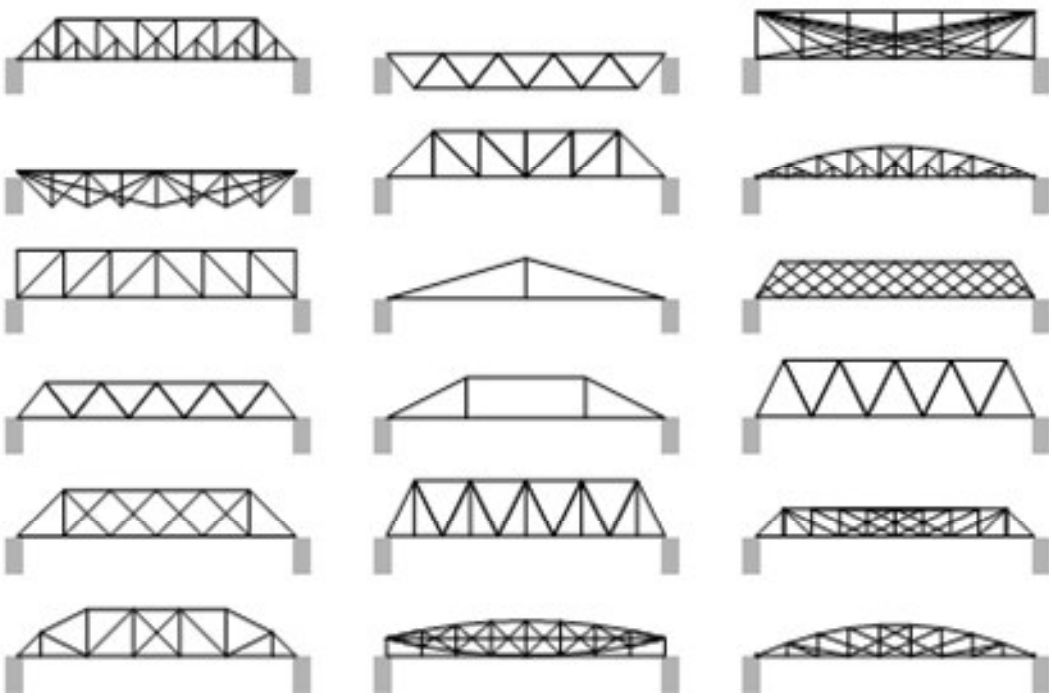

Figure 1. Bridges types.

connecting the islands of Honshu and Shikoku across the Inland sea in Japan. It consists of three major connections that are involved as Kobe-Awaji-Naruto expressway, Seto-Chuo expressway and Nishiseto expressway that are shown in Figure 2.

Horai bridge

The Horai bridge constructed as a wooden walking bridge in Shimada of Japan that is the longest wooden walking bridge with 897 m in length (Figure 3).

Inuyama bridge

The Inuyama bridge, shown in Figure 4 is a bridge over the Kiso river in Japan. It is an iron beam bridge which connects Kakamigahara in the Gifu Prefecture with Inuyama in the Aichi Prefecture.

Spectacles bridge

Meganebashi or spectacles bridge is a double arch stone bridge spanning a pond in the park, as shown in Figure 5. The bridge is twice the size of the famous spectacles bridge in Nagasaki. The Megane-bashi was the only bridge to survive the flood. It is said to be the oldest stone arch bridge in Japan and has been designated as an important cultural property. It received the nickname spectacles bridge because of its two arches and it reflection in the water create the image of a pair of spectacles.

Iwakurojima bridge

The Iwakurojima bridge is a cable-stayed bridge with a center span of 420 m (Figure 6). It is immediately at the south of the identical Hitsuishijima bridge discussed earlier.

Kintai bridge

Kintai bridge is a historical wooden arch bridge, in the city of Iwakuni, in Yamaguchi prefecture. The bridge was built in 1673, spanning the beautiful Nishiki river in a series of five wooden arches. The bridge is composed by five sequential wooden arch bridges on four stone built piers as well as two of wooden piers on the dry riverbed where the bridge begins and ends. Each of the three middle spans is 35.1 m long, while the two end spans are 34.8 m for a total length of about 175 m with a width of 5 m (Figure 7). For nearly three hundred years, many versions of the bridge stood without the use of metal nails. They achieved this by careful fitting of the wooden parts and by building up thick girders by clamping and binding them together with metal belts. The main wooden

(a)

(b)

(c)

Figure 2. Honshu-Shikoku bridges.

parts of the bridge would then be covered by sheets of copper.

Tsujun bridge

Tsūjun bridge is an aqueduct in Yamato (Figure 8). It is an arch bridge completed in 1854 and is 84.0 m long. The arch spans 27.3 m. It is the largest stone aqueduct in Japan. This bridge proves a high level of stone bridge technology at that time.

Figure 3. Horai bridge.

Rainbow bridge

The rainbow bridge is a suspension bridge crossing northern Tokyo Bay between Shibaura Pier and the Odaiba waterfront development in Tokyo. The towers supporting the bridge are white in color, designed to harmonize with the skyline of central Tokyo seen from Odaiba. There are lamps placed on the wires supporting the bridge, which are illuminated into three different colors, such as red, white and green, and at night it uses solar energy obtained during the day (Figure 9).

Sanjo Ohashi

Sanjo Ohashi is a bridge in Kyoto (Figure 10). The current concrete bridge, which includes two lanes for driving and a walking path on either side, was built in 1950.

Figure 4. Inuyama bridge.

Tatara bridge

The Tatara bridge is a cable-stayed bridge that is part of the Nishiseto expressway, commonly known as the Shimanami Kaido (Figure 11). The bridge has a center span of 890 m. It has the second longest main span of any cable-stayed bridge after the Sutong bridge. By building a cable-stayed bridge a large excavation for an anchorage would not be needed, thereby lessening the environmental impact on the surrounding area.

Tokyo Bay Aqua-Line

Ponson and Richard (1956) investigated the transportation in Tokyo that the Tokyo Bay Aqua-Line, also known as the Trans-Tokyo Bay highway, is a bridge-tunnel combination across Tokyo bay in Japan (Figure 12). With an overall length of 14 km, it includes a 4.4 km bridge and 9.6 km tunnel underneath the bay-the fourth-longest underwater tunnel in the world.

Toyokawa bridge

The Toyokawa bridge is a bridge over the Toyo river in Japan (Figure 13). It is located at Toyohashi in the Aichi prefecture. The bridge carries route 23 across the river.

Nihonbashi

Nihonbashi is a business district of Tokyo which grew up around the bridge of the same name which has linked two sides of the Nihonbashi river at this site since the 17th century. The first wooden bridge was completed in 1603, and the current bridge made of stone dates from 1911. The Nihonbashi bridge first became famous during the 17th century (Figure 14).

DISCUSSION AND CONCLUSION

Bridges are, in principle and utilitarian works capable of aesthetic qualities. A beautiful bridge is born with the intention of accomplishing a unique, particular, local and independent work, but also with aspirations to the eternal, as a universal testimony of human culture, and for the pleasure and pride of future generations that investigated by Niroumand et al., 2010a; Niroumand et al., 2010b. While respecting the restrictions inherent in every utilitarian work, the designer can give beauty to a bridge by applying artistic sensitivity and technical capacity to the aesthetic elements of form and so integrate them harmoniously with the landscape. The main parts of Japanese bridges are designed with cable stayed. The Japanese bridges used to pedestrian and motor vehicles advances. The majority of structures built segmental have been box girder bridges, covering a large range of span lengths with many different shapes and functions. Following a look at some noteworthy box girder bridges, attention is focused on more specific areas such as long-span bridges, bridges over large bodies of water, structures built in environmentally sensitive areas, urban viaducts and concrete cable-stayed bridges. Japanese bridges are involved of an almost modern architecture using cable stayed in the world. The three mentalities of successful bridge design are outlined in Japan. These are a creative and aesthetic mentality, an analytical mentality and a technical and practical mentality. Final remarks

Figure 5. Spectacles bridge.

Figure 6. Iwakurojima bridge.

Figure 7. Kintai bridge.

Figure 8. Tsujun bridge.

Figure 9. Rainbow bridge.

Figure 10. Sanjo Ohashi bridge.

Figure 11. Tatara bridge.

Figure 12. Tokyo Bay Aqua-Line.

Figure 13. Toyokawa bridge.

Figure 14. Nihonbashi bridge.

concern general aesthetic principles for bridge design.

REFERENCES

Bennett D (1997). The architecture of bridge design, 4-18.
Ponson F, Richard AB (1956). Kyoto: The Old Capital of Japan, pp. 794-1869.
Niroumand H, Zain MFM, Jamil M (2010a). Bridge architecture in Malaysia, ICBEC 2010, Hong Kong, China.
Niroumand H, Zain MFM, Jamil M (2010b). Bridge Architecture in Malaysia, 3rd International Conference on Research and Preservation of Historic Bridges, Nanjing, China.