Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 161 (2016) 207 – 212

Procedia Engineering

www.elsevier.com/locate/procedia

World Multidisciplinary Civil Engineering-Architecture-Urban Planning Symposium 2016, WMCAUS 2016

Bridges in Urban Planning and Architectural Culture

Marek Salamak[a,*], Klaudiusz Fross[b]

[a] *Silesian University of Technology, Faculty of Civil Engineering, ul. Akademicka 5, 44-100 Gliwice, Poland*
[b] *Silesian University of Technology, Faculty of Architecture, ul. Akademicka 7, 44-100 Gliwice, Poland*

Abstract

Bridges obviously serve multiple functions but the primary purpose is to traverse a terrain obstacle to get goods and/or people across to the other side. Bridges are often viewed as an indicator of progress in technical capability, engineering skills as well as a symbol of economic potential of a particular city, region or a country. Often, this is the reason why many urban bridges become the most important infrastructure in some cities. This paper discusses several examples of bridges which have made a significant impact on the perception of a city and resulted in substantial changes to landscape configuration. The following available research methods of evaluation were used: analysis of literature, observational in-situ studies of objects and own research. Analysis were performed on dozens of bridges constructed over the centuries. The example selection was directed to the well-known objects, the spectacular new implementations or icons of bridge architecture. The study involved both contemporary and historical objects.

Peer-review under responsibility of the organizing committee of WMCAUS 2016

Keywords: city bridges; urban planning; architectural culture;

1. Introduction

The primary function of a bridge is obviously to traverse an obstacle to get across to the other side. Over time, overcoming longer span distances became possible due to gains in technical capabilities and application of increasingly more innovative designs. Therefore, bridges are often viewed as an indicator of progress in technical innovation and engineering skills as well as imply economic potential of the particular region. At times, they attract tourists and become characteristic elements of the urban landscape (even icons) by which those cities are easily recognized.

* Corresponding author. Tel.: +48 502 359 037.
E-mail address: marek.salamak@polsl.pl

Peer-review under responsibility of the organizing committee of WMCAUS 2016
doi:10.1016/j.proeng.2016.08.530

A typical urban bridge, in comparison to a highway bridge, also serves pedestrian traffic and therefore must satisfy additional safety and comfort conditions. There are four main functions of an urban bridge: 1) transport link between separated urban areas; 2) creation of an attractive exterior; 3) demonstration of modern technical capabilities; 4) construction of user-friendly structure. Apart from this, a bridge may also have a metaphoric connotation. It is a structure which links two different or distant groups or communities from each other. There are also examples of bridges which, as a result of being located on cultural or ethnic borders, have often served as a role of a symbolic link. Such examples, according to the authors of this report, will contend and confirm the above-mentioned thesis about the multi-functionality of urban bridges in societies.

2. Influence of bridges on urban planning

It can be noted that almost all major metropolitan areas are often separated in some way by a water obstacle of a certain size. It should however be remembered that even though nowadays these cities are developed on both sides of the divide, the initial settlement would have started on one side only. Construction of the bridge across the river would have opened new areas for further development and settlement. Smooth and orderly functioning of growing urban municipalities necessitated the construction of new bridges and associated thoroughfares, which often determined the entire urban layout of the city. Such was the story of the development in many cities around the world.

a)

b)

Fig. 1. (a) Budapest urban layout with bridges; (b) the oldest Chain Bridge in Budapest.

The first example of a bridge which changed the urban layout is a bridge located in Budapest (Fig. 1a) where the construction of the first permanent river crossing in 1848 led to the creation of an entirely new urban municipality (Fig. 1b). Today, two parts of the city are connected by nine bridges located within the city centre - seven road bridges and two railway bridges. A map of Budapest shows how these bridges were fitted to the new urban layout of the rapidly developing Pest municipality. Consecutively with each new bridge, ring roads along the axis of the bridge and radially extending thoroughfares moving traffic away from the city centre were built.

The second example, which shows the effect of bridge construction on the city development, is Brooklyn to Manhattan Bridge in New York City. Manhattan, the most expensive as well as arguably the most attractive part of the metropolis, which is an island, had been substantially changing following the construction of each subsequent bridge or tunnel connecting the island to the mainland and the rest of the city. Not only roads to the other side of the river were shorter. The significance and value of the properties in the immediate vicinity of the bridge was growing. Also on the axis of a new street, which was a natural extension of the axis of the bridge. The greatest impact was by the Brooklyn Bridge over the East River which, when opened in 1883, was the first suspension bridge constructed with steel cables instead of chains. For many years, the neogothic pylons have dominated over New York panorama; moreover, the prices of the real estate with the view of this bridge have always been and are still very high today.

Île de la Cité in Paris (Fig. 2a), where the Notre-Dame Cathedral is located, is much smaller than Manhattan, but has nine bridges leading to the cathedral, including the oldest Pont Neuf built at the beginning of 17th century (Fig. 2b). Even though at the time of Napoleon III, the centre of the island was extensively modified by Baron Haussmann, who was the redevelopment construction manager, the bridge itself and associated access roads remained unchanged. Furthermore, the roads connecting the major boulevards of Paris were aligned with them. In the past, the streets were leading outside of the medieval city walls. Today, these streets form the diametrical axis of the oldest part of the city and run perpendicularly to the main axis formed by the Rue de Rivoli and Avenue des Champs-Elysees.

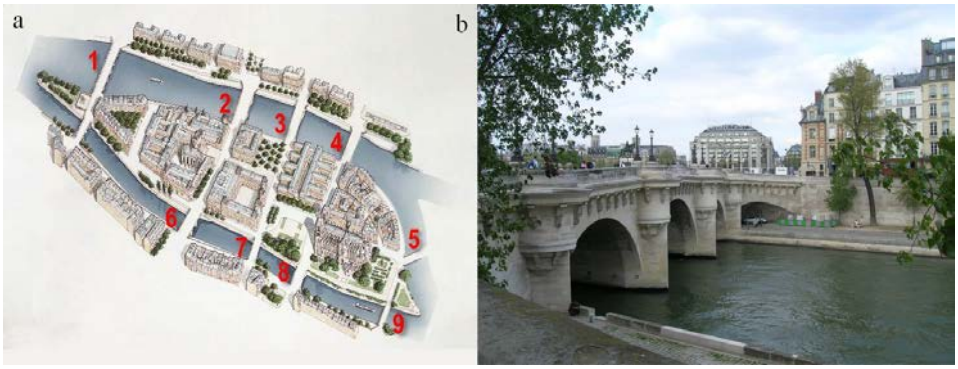

Fig. 2. (a) Île de la Cité in Paris with 9 bridges; (b) the oldest Pont Neuf in Paris.

3. Bridges create an image of the city

In present day pictorial culture, readily recognizable visual symbols representing certain associations are of great importance. In the case of a city, its icon can be a symbol that visually and verbally represents the values and history of the place. The role of contemporary urban icons can serve as the source of awareness of city existence as well as trigger associations and opinions about it, initiate the means of communication, or provide elements of visual identity and inspiration for city branding strategy.

Charles Bridge in Prague was probably not considered as the city's icon when it was being built in the Middle Ages. Today however, the bridge is one of the most recognizable bridges in the world. There are similar cases with other bridges built much later – until the beginning of 20th century. Some of the typical examples can be structures mentioned previously, such as Chain Bridge in Budapest and Brooklyn Bridge in New York. Further examples can be Harbour Bridge in Sydney with the characteristic opera house in the foreground, the drawbridge over River Thames

in London, the two-level Luis I Bridge in Porto and Golden Gate suspension bridge in San Francisco. Although all of these bridges are very different in terms of appearance, size and age, and not all of them were meant to be an icon, all these bridges eventually became readily recognisable icons

4. Bridges demonstrate technical capabilities

Many great bridges, especially urban bridges, were in their time either a major technical breakthrough in engineering or even a record breaker – most often in terms of the span [5]. John Roebling with his Brooklyn Bridge (1883) broke the world record for the suspended span. The Golden Gate Bridge which links the centre of San Francisco with Marin Peninsula, due to the water depth in the bay, strong currents, winds and earthquakes, has been by far one of the most expensive investments in history [1].

The idea of amalgamating the aesthetic and engineering aspects, especially in footbridges, is well represented by the Spanish architect and constructor Santiago Calatrava [3]. Alamillo Bridge, which is one of his most famous works, was built in 1992 specifically for the Expo in Seville. The opening of the World's Fair in 1900 in Paris coincided with the completion of the steel and richly decorated Alexander III Bridge, which provides a fantastic perspective on the Invalides Square, visible from the Av des Champs-Élysées.

Chinese authorities showcase technical capabilities and competencies of the country by building spectacular bridges. Many world records have been broken by Chinese engineers, although cities in other countries do not want to fall far behind. Competition in building longest span urban arch bridges can be still seen today. Typical examples can be Lupu Bridge in Shanghai with a span of 550 m (2003) and then Chaotianmen in Chongqing with span of 552 m (2009). Similar competitive situation is with cable-stayed bridges: Stonecutters Bridge – 1018 m, Sutong Bridge – 1088 m and the current record holder – Russky Bridge in Vladivostok with span of 1104 m.

4. Bridges as user-friendly structures

People move along the bridge slower than cars do, so they have a direct contact with the structure. They can touch and see it up close. This is why the designer must show a greater attention to detail and seek interesting aesthetic solutions. In contrast to non-urban bridges, whose main objective is the shortest connection between two sides of the obstacle, urban bridges give the designer great opportunities to break off with one-dimensionality. The bridge surface can be constructed of various materials, not just asphalt and concrete. Also, the handrails can be shaped in any way. New prototype design solutions and new materials are being constantly introduced.

Fig. 3. (a) Ponte Vecchio in Florence; (b) Pedro and Ines footbridge in Coimbra.

In the Middle Ages, when the walled cities started running out of land for development, bridges were built and adapted for residential purposes. Many residential bridges were constructed in this way (Fig. 3a). The structures were focused on people and their aim was to satisfy their needs. In addition to allowing passage across to the other side, bridges served various forms of other human activities. The last bridge of this kind in Europe was demolished in

London in 1831. Nowadays, as cities run out of space for new buildings, residential bridges can present rather an interesting idea, therefore more and more new futuristic and innovative projects are waiting to be realized.

The end of 20th century was a period during which many footbridges were built [2]. On one hand, this was due to the desire to celebrate the upcoming new millennium; on the other hand, this was often dictated by the need to ensure safe passage over an obstacle in a complete separation from burdensome vehicular traffic, which clearly dominates the transport system in our cities. There is no more space for people and bicycles. Therefore, new pedestrian and bike facilities began to be constructed in many cities, which are accompanied by footbridges, often of very attractive forms [4]. These are mostly located in the areas within shopping centres and sports facilities. Many of them, with their shape, details and materials selection are adapted to the human scale. Examples of such urban structures are footbridge Solferino in Paris as well as footbridges Pedro and Ines in Coimbra in Portugal (Fig. 3b). Footbridges have become almost the typical element of any urban infrastructure, which often stands out from other structures due to its unique shape.

5. Bridges as symbols of joining and dividing

A bridge has been an important symbol in many cultures for many centuries. It is a symbolic place which illustrates a border zone and characterises symbols of dividing and joining at the same time. When it is open, it becomes a link, but when it is intentionally closed, it becomes a symbol of division and narrow, a guarded window to perhaps a better world. Such an inaccessible structure during the Cold War was the Glienicke Bridge, which was the border between West Berlin and East Germany. Journalists called it “a bridge of spies”. A similar role is still played today by the so-called Bridge of No Return linking North and South Korea.

A difficult story has also Danube bridge on Hungarian and Slovak border in Esztergom (Fig. 4a). In its over 100-year history, it was destroyed twice. Difficult relations between the communist governments in Hungary and Czechoslovakia did not foster the need for reconstruction of the bridge. Finally, in October 2001, the reconstructed bridge was officially opened, which for so many years was not deliberately rebuilt in order to keep these two countries apart from each other.

Fig. 4. (a) Maria Valeria bridge in Esztergom; (b) Stari Most in Mostar.

We had been witnessing the tragic fate of another bridge, and also the people who used it. This regards the famous stone Stari Most in Mostar (Fig. 4b). For centuries, the bridge was regarded as an important symbol of reconciliation between East and West, between Christianity and Islam, between Catholics and Orthodox and finally, between Croats and Serbs. This bridge connected the two different communities living on both sides of Neretva River. It was deliberately destroyed by the Croatian tanks in November 1993 as a result the ongoing Bosnian war. The reconstruction of the bridge started two years after the war finished with international support. It was officially opened in July 2004 and, although it is still hard for both sides of the conflict to erase the fresh wounds from their memories, the bridge certainly gives hope for a much-needed reconciliation.

6. Conclusions

As it can be concluded from the examples provided above, the role of bridges in urban planning and architectural culture depends substantially on the function of the bridge. A bridge connecting two sides enhances the communication and becomes the connection of what so far might have separated the local communities. For realization of such a task, the latest technological and material selection solutions are used and the structure becomes a great representation of human possibilities of the city or the region. A bridge co-creates the image of an area being in the new space and sometimes can become a very distinct and recognizable icon of the city. An equally important function, which should not be left out is a human scale of city bridges. Thus, it can be concluded that the highest possible craftsmanship of the "bridge art" in the range of urban structures should involve all of the functions mentioned above.

References

[1] D.J. Brown, Bridges: Three Thousand Years of Defying Nature. MBI Publishing Company, 2001.
[2] P. Dallard et al., The London Millennium Footbridge. Structural Engineer. Nov. 20, 2001, pp. 17-35.
[3] P. Jodidio, Calatrava. Taschen GmbH, Koln, 2007.
[4] M. Salamak, Inspirations in footbridges designing. Proc., 4th International Conference footbridge 2011, Attractive Structures at reasonable costs, 6-8 July, Wroclaw, pp. 132-1335.
[5] M. Salamak, P. Klikowicz, Protections and monitoring of European transportation routes in Upper Silesia mining area., 14th International Multidisciplinary Scientific Conference SGEM 2014, 17-26 June, Albena, Bulgaria, Conference Proceedings, Vol. 2, pp. 403-410.