

Steel arches for small and medium span bridges

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ABSTRACT: On the following pages will be presented some arch bridges whose conception belongs to the concept of the Structural architecture, promoted by author of this paper in the module “Theory and design of bridges” at the University of Architecture IUAV in Venice, and by its group of co-operators.

The bridge presented are constituted by metallic arches and show the potential, not only in structural terms, of this typology. Among the numerous advantages of the arch, there is the attitude to cope well with almost any environment and with the historic heritage.

1 INTRODUCTION

A bridge permits the link between two elements which are divided by an obstacle. The union of two river banks has always permitted the fusion of cultures and civilizations, contributing to the social evolution of the human beings. The bridge has always been essential for traffics.

Besides its functions, a bridge is also a “formal Expression” , and together these two characteristics form a structural conception which transfers to the ground the loads induced by men and their vehicles, hopefully transmitting a sense of safety to the fruitors.

The sensation of solidity, “Utilitas”, transmitted by the perception of the structure, “Venustas”, is a founding and constructive element of the affirmation of the bridge on the environment.

The typology of a bridge depends on its structural needs: for example cable stayed bridges or suspended ones are suitable for big spans, while arch and beams are better used for smaller dimensions.

The arch is the best solution to express conceptual simplicity, which should be a characterizing mark of a bridge. The use of the arch for the realization of big infrastructures dates back to the Romans period, as testified, for example, by the beautiful aqueducts which are present in vast part of Italy and Europe. The arch works mainly in compression and tension, which permit to maximise the structural efficiency, and for this reason it might be considered a primary system.

2 BRIDGE IN CAGNOLA: REHABILITATION OF A BRIDGE BELIEVED TO BE DESIGNED BY GIUSEPPE JAPPELLI (PADOVA 1993/1994)

This work is part of the functional adaptation of a 19th century bridge designed by the famous engineer and architect Giuseppe Jappelli. It is a three span arch bridge, with the central span larger than the lateral ones, crossing the channel Bovolenta and serving a provincial road of Roman origins.

Considering its structural deterioration and its viability inadequacy, it has been necessary to make a radical intervention of static consolidation and amelioration in order to guarantee an higher degree of safety.



Fig 1

The project consists on the enlargement of the existing bridge and the creation of a new cycle-pedestrian bridge, 15 m far from the existing one.

The main structure of the new bridge is a lowered steel arch, spanning 33 m between the external abutments of the girder 44m long. The choice of a single span permits a complete transparency and the respect for the important existing structure (fig.1).

3 BRIDGE BETWEEN VALLE DI CADORE AND CIBIANA DI CADORE BELLUNO 1998

The whole project consists on the modernization of the State Road 347, with a new structure crossing the valley of the “Boite” river and its road accesses.

Considering the beautiful surrounding landscape, it has been necessary to have a structure with a reduced visual impact, perfectly related with the area. The new bridge is a lowered arch, set at a point of minimum distance between the two mountain slopes, so with a span of 210 m.

Its light and transparent configuration and its position permitted to obey at the request of the Superintendence, to preserve the visual of the Dolomites mountains.

Regarding the deck, there are two possible solution, different only for aesthetical aspects:

- the first solution is a spatial reticular truss, made of tubular elements from 250 to 325mm of diameter, linked by transversal metallic beams distant 4.1m from each other, over which is set the concrete slab.

- an alternative to this solution is a caisson structure, made of steel elements with a different section, and a stiffened steel plate.

In both cases the concrete slab over the steel profiles is 20 cm deep.



Fig. 2

The total width of the section varies from 16.10 m to 19.30 m and is composed of a road 10.50 m wide, flanked by sidewalks which get larger in some points in order to permit to the pedestrians to stop and appreciate the landscape of the dolomites (fig.2).

4 FOOTBRIDGE ON THE “CANAL BIANCO” IN BRESSANE – ROVIGO, 1999

In this case some different solutions have been proposed, with different structural and architectonic characteristics, all satisfying the needs for a pleasant insertion in the landscape and for a functional structure, permitting the river navigation (30 m width and 6.5m height).

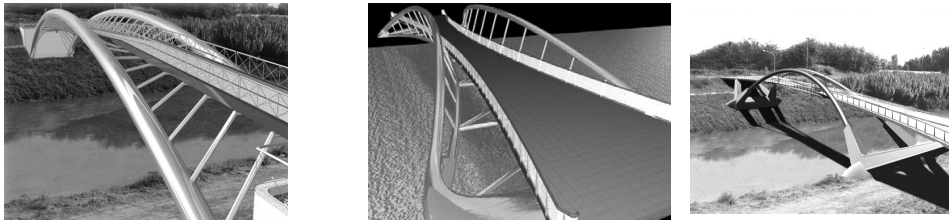


Fig. 3

The aim of this operation is the research of a “shape” which, intended as solution to a series of different issues (functionality, economy, aesthetics) is fundamental in the case of important structures, like the bridge, which often change the characteristics of the surrounding landscape in an irreversible manner (fig. 3).

5 REALIZATION OF THE BRIDGE “BACCARINI” (FERRARA, 2002-2005)

This new plan solves a problem linked to the lacking functional conditions of the infrastructures in this area, characterised by the bifurcation of the river Po in Volano. The global strategy of the intervention is finalised at giving a local but important contribution for the development of the insufficient road system characterising this area. The new bridge is aimed at characterising the site and at satisfying the sensitivity of the inhabitants and of the users that will relate daily with the structure (fig. 4).



Fig. 4

Positioned more downstream with respect to the existing Baccarini bridge, the bridges have similar characteristics. The bridge on the Baccarini is characterised by a composite steel concrete deck suspended, with two lines of tendons, at two box shaped arches, set at different distances and linked at the top, which transmit the loads to the foundation at the river banks. Favouing the global economy of the intervention, the bearing structures of the two bridges have aspect, geometry and erection systems which are identical.

6 NEW BRIDGE OVER THE RIVER BRENTA IN GIARABASSA (PADUA, 2004)

The intervention is focused in the rehabilitation of the main road of the area, the provincial Road n. 27, until its insertion with the Regional road n.47 “Valsugana”, in the council of San Giorgio in Bosco.

The chosen design consisted on a new bridge, upstream of the existing one, sustained by structural arches founded on two piers and two abutments. The new bridge reorganises the viability of the town of San Giorgio In Bosco, enhancing its level of security.



Fig. 5

Moreover, it is expected the realization of two cycle-pedestrian paths on the bridge, decision which is well inserted in the general plan of the mobility, also considering the tourist one.

In order to limit its possible visual impact, the bridge has been studied according to an architectonic design which is light and transparent. Concerning the formal aspects, the mitigation of the structure impact permits to the users to maintain the visual continuity of the landscape (fig 5).

7 BRIDGE OVER THE RIVER BRENTA IN PIOVE DI SACCO (PADUA, 2004)

This intervention is aimed at solving the lacking structural conditions of the bridge over the river Brenta serving the Provincial Road n. 53, near the village of Piove di Sacco in the Province of Padua .

The existing concrete structure, is in poor conditions, and penalises the general mobility of the area, both local and provincial. The aim of the operation is to improve this mobility situation.

The new bridge marks the site, “hitting” the users and the citizens, which relate daily with the structure. Considering the demolition of the actual bridge, it is proposed the realization of a new one, set around 25 m downstream of the existing one.



Fig.6

From a formal point of view the bridge realizes the crossing of the river Brenta by means of a discreet approach with the river. It is characterised by a formal and functional simplicity, and it is made by two steel arches with tubular section, set on elliptic piers and linked by steel elements at two thirds of the span (fig. 6). From the same piers there emerge two couples of sustains with a circular section, leaning towards the abutments. The system of arches which is created is suggestive and sustains a plastic and slender deck. The deck is coated with a steel plate which confers a tapered shape to it. In the central part it is sustained with four steel tendons, sustained by two transversal beams which emerge from the deck, without interrupting its nice geometry.

8 MOVABLE FOOTBRIDGE ON THE BRENTA RIVER (STRA, VENICE 1998)

The area of intervention is characterised by the course of the river Brenta, flanked by the State Road Padana Superiore n.11, and by the Provincial Road n.21.

Along this river there is the sumptuous facade of the Villa Pisani, the most important architectonic complex of the Brenta's Riviera, now a little spoiled by the presence, on the other side of the river, of buildings with relatively poor architectonic value, erected after Second world war.

The new footbridge has the main aim to mitigate the contrast between the two river banks, creating a better communication among them.

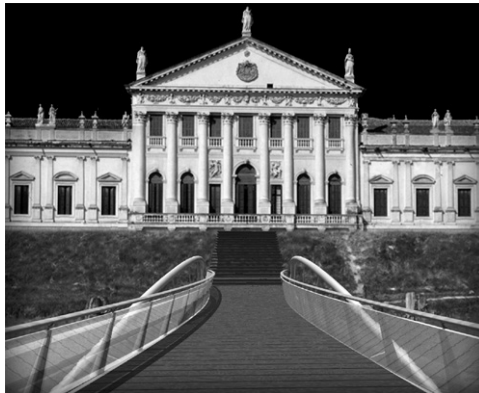


Fig. 7

In plan, the position of the villa is clearly valorised, with the new footbridge being perfectly aligned with the building, stressing its importance in the territory.

As required by the Superintendence to the Architectonical and Environmental goods of oriental Veneto, the structure is set at a lower level with respect to the road, in order to preserve the scenic effect offered by Villa Pisani (fig. 7). The design carefully considered the formal aspect of the structure: particular attention has been given to the typological choice, to the use of materials, in order to guarantee a pleasant architecture, well inserted in the environment, also with respect to the many existing and working movable bridges of the area.

9 “PONTE DEI CONGRESSI” (ROME, 2000)

The “Ponte dei Congressi” in Rome has a single 224m span and links the quarters, nowadays highly degraded, EUR and Magliana. The bridge is designed with a double deck; the upper one hosts six traffic lines and two for cycles; the lower one is for pedestrians and has an area

provided for the organization of small exhibitions, markets and other activities in order to revitalize the area and give the citizens a place where is possible to “live” the river (fig. 8).

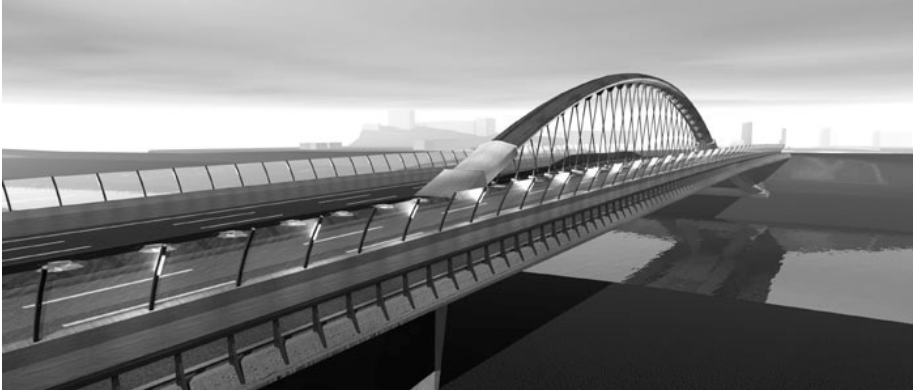


Fig.8

10 CONCLUSIONS

The study of the bridge, treated at different scales and according to different typologies, is originated by the dialogue among the academic ambient, the professional one and the public and private institutions.

In particular, the use of the metallic arch in bridges offers numerous advantages among which, of fundamental importance, there is the attitude to relate well with any context and especially with the historic legacy, permitting larger spans, less invasive towards existing structures.

It is important to keep in mind that in the organization of a place characterized by the presence of a bridge, there exists a wide range of nuances that exercise on the user an effect varying from the strong integration with the territory to the strong differentiation with , to the point of having bridges that become the symbol of an area, like what often happens on the city doors.

The examples described have the arch as the design theme for bridges of small and medium span, conjugating “structural truth” and “architectonic truth”, with an insertion on the environment that, if well studied, gives to the place the “Venustas”, a fundamental requirement nowadays for any project.

REFERENCES

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