PONTE CICLOPEDONALE SOSPESO SULLE CASSANDRE DEL MALLERO A SONDRIO

PEDESTRIAN SUSPENDED FOOTBRIDGE ABOVE THE MALLERO RIVER (SONDRIO)

Fabio Ceccato, Massimo Maffeis, Massimo Viviani
Maffeis Engineering SpA (VI)
m.viviani@maffeis.it

ABSTRACT

The pedestrian footbridge that connects the Mossini and Ponchiera is a suspended bridge at 100 meters above the spectacular ravine created by the Mallero river in Valmalenco (SO). The structural architecture of the bridge is of the tensile structure, that is a suspended walkway with upper main bearing cables and lower secondary stabilizing cables. The bridge span is about 146 meters with a width of 2.90 meters. Throughout the whole design process, from the preliminary design to the detail design, all the peculiar aspects of a structure of this type were deeply investigated. Considering the place of insertion, the typological and technical characteristics of the work, the objective was pursued of combining the architectural need for a light and transparent structure with the engineering and functional needs of a footbridge subject to the dynamic actions induced by the wind as well as to the problem of the comfort of the crossing crowd.

SOMMARIO

Sorge sospeso a 100 metri di altezza, sopra lo spettacolare orrido creato dal torrente Malle-ro in Valmalenco (SO), il ponte ciclopedonale che collega le località di Mossini e Ponchiera. L'architettura strutturale del ponte è di tipo tensostrutturale, ovvero una passerella sospesa con funi superiori portanti principali e funi stabilizzanti inferiori secondarie. L'opera ha una luce di attraversamento di circa 146 mt ed una larghezza calpestabile di 2.90 mt. Durante tutto l'iter progettuale, dal preliminare all'esecutivo, si sono indagate in modo approfondito tutte le specificità di una struttura di questo tipo. In particolare, considerando il luogo di inserimento, le caratteristiche tipologiche e tecniche dell'opera, si è perseguito l'obiettivo di coniugare l'esigenza architettonica di un'opera leggera e trasparente alla vista con le esigenze ingegneristiche e funzionali di un'opera soggetta alle azioni dinamiche indotte dal vento oltre che alla problematica del comfort della folla in attraversamento.

1 A COMBINATION OF ENGINEERING AND ARCHITECTURE

The pedestrian footbridge that connects the Mossini and Ponchiera is a suspended bridge at 100 meters above the spectacular ravine created by the Mallero river in Valmalenco (SO). The structural architecture of the bridge is of the tensile structure, that is a suspended walkway with upper main bearing cables and lower secondary stabilizing cables. The bridge span is about 146 meters with a width of 2.90 meters.

Fig. 1. Overview of the Suspended bridge above the Mallero river

The structure consists of a steel metal deck (consisting of two I-section main girders with an inclined core) and a concrete slab. The deck is connected to the supporting ropes by means of a hanger having a pitch of about 7.20 meters. To obtain a stable structure also for the lateral actions due to the wind, stabilizing ropes were arranged according to a spatial configuration, initially in equilibrium under the initial tension actions due to the permanent loads.
The suspension system is made with ropes made of hot-dip galvanized high-strength steel wires. Both the supporting ropes (hooked to the 16 m high pylons) and the stabilizing cables are closed FLC ropes, while the hangers are made with spiral ropes; the main cables have a diameter of 80-84 mm, the stabilizers 56 mm and the hangers between 16 and 20 mm. The stabilizing ropes are characterized by curvatures in the vertical and horizontal planes to obtain an effective response against the actions of gravitational loads and the lifting and dragging actions induced by the wind.
Throughout the whole design process, from the preliminary design to the detail design, all the peculiar aspects of a structure of this type were deeply investigated. Considering the place of insertion, the typological and technical characteristics of the work, the objective was pursued of combining the architectural need for a light and transparent structure with the engineering and functional needs of a footbridge subject to the dynamic actions induced by the wind as well as to the problem of the comfort of the crossing crowd.
The bridge is subject to vibrations induced by the interaction with the wind, due to different types of aeroelastic interaction, such as vibrations due to the vortex detachment or aeroelastic instability (one / two degrees of freedom). Therefore, in order to mitigate the risk associated with the action

of the wind, the structure was equipped with open parapets (without blind closing elements) and in order to avoid significant pressure differences between the intrados and extrados of the deck, openings were provided.

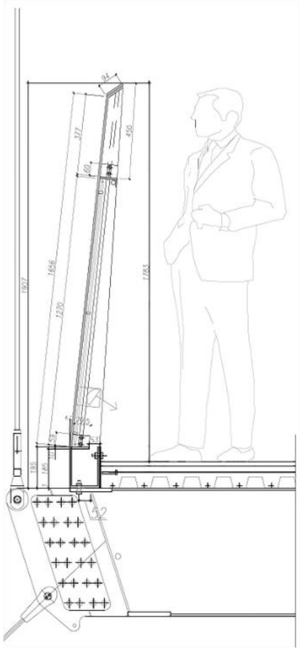

Fig. 2. Detail of the parapet

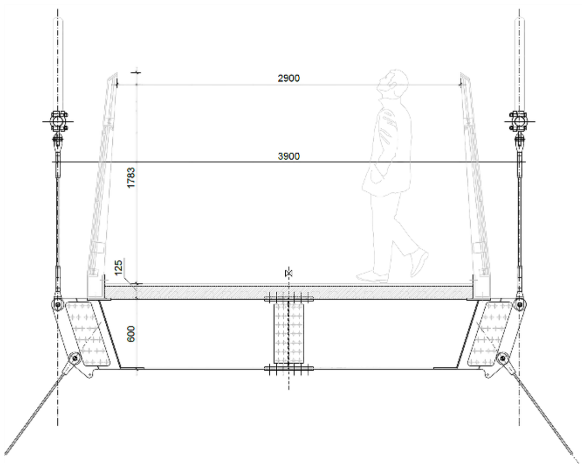

Fig. 3. Transversal section of the deck

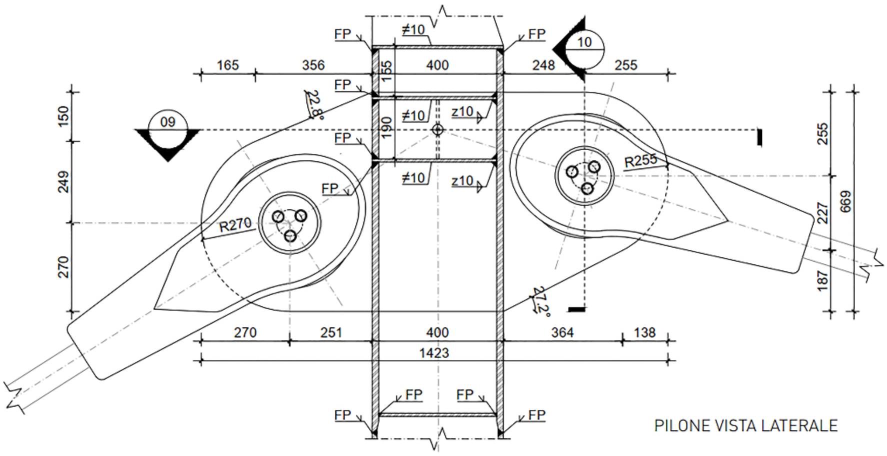

Fig. 4. Detail of the connection at the top of the pylons

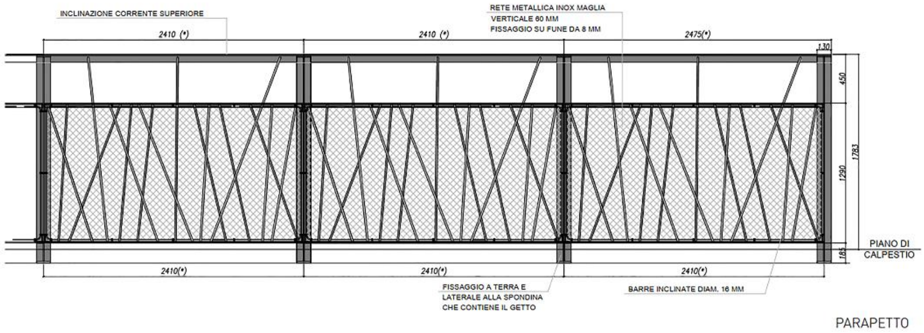

Fig. 5. The architectural solution for the parapet

Fig. 6. Aerial photo of the bridge

2. THE NUMERICAL MODEL AND THE PARAMETRIC APPROACH

To reach the optimal shape of the footbridge, the form-finding has been executed through FE model obtained by means of a parametric approach, realized through the Rhinoceros-Grasshopper interface, thanks to a specific in-house sub-routines developed with the API (Application Program Interface) of the calculation software.

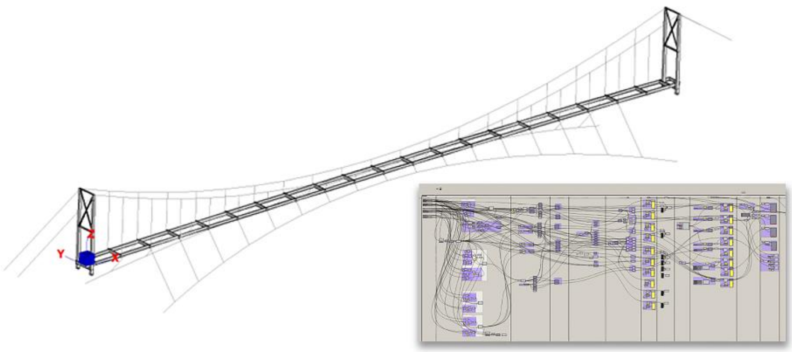

Fig. 7. Overview of the parametrical model (developed in Rhino + grasshopper environment)

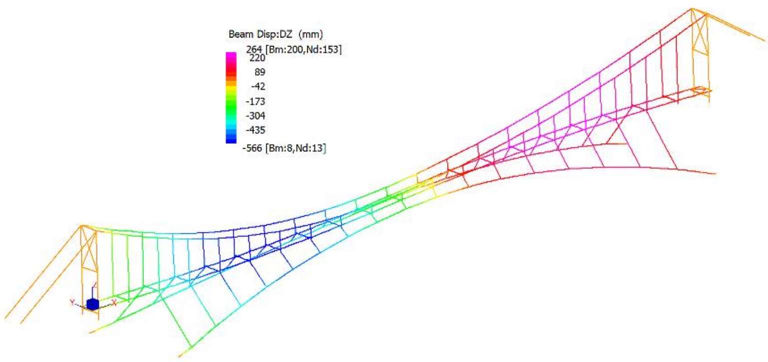

Fig. 8. Numerical model assembled and solved by means of parametric approach

Based on the outcome provided from optimization procedure, the design was subsequently completely developed according to Code requirements.

3. THE CONSTRUCTION PHASES

The construction took place in five main stages. The first of these was the execution of foundations works on the two banks and the cableway that was indispensable for transferring the material to the other side.

Fig. 9. Installation of the cableway

Fig. 10. Installation of the cableway

The second stage involved the installation of the masts, in order to start (using a winch attached to a pull rope) the positioning of the main cables needed to support the deck during assembly.

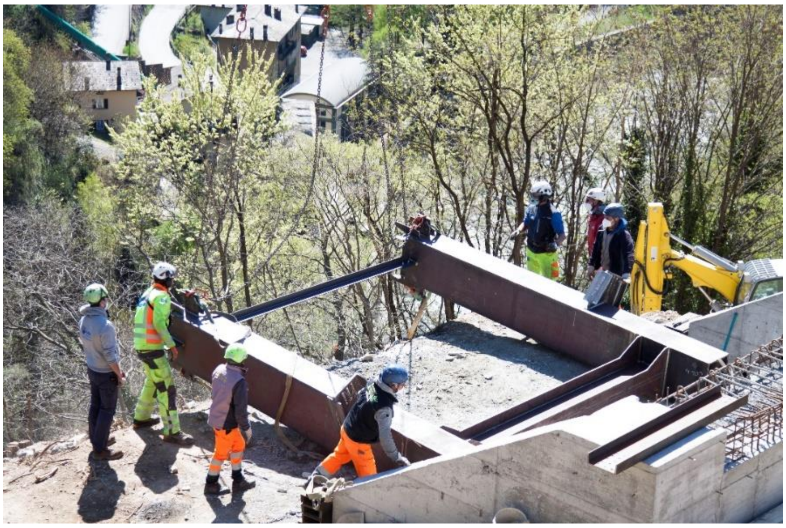

Fig. 11. First phases of pylon installation

This was followed by the third stage with the ashlar construction of the deck, launching the landing modules and proceeding symmetrically on both sides.

Fig. 12. Installation of the first pieces of the deck

The fourth stage involved the pinning of the stabilizing secondary ropes and their stringing.

Fig. 13. Deck installation and preliminary works for the installation of the stabilization cables

This was followed by the fifth stage with the construction of the deck slab and the completion of the finishing touches (flooring, metal parapet, ...).

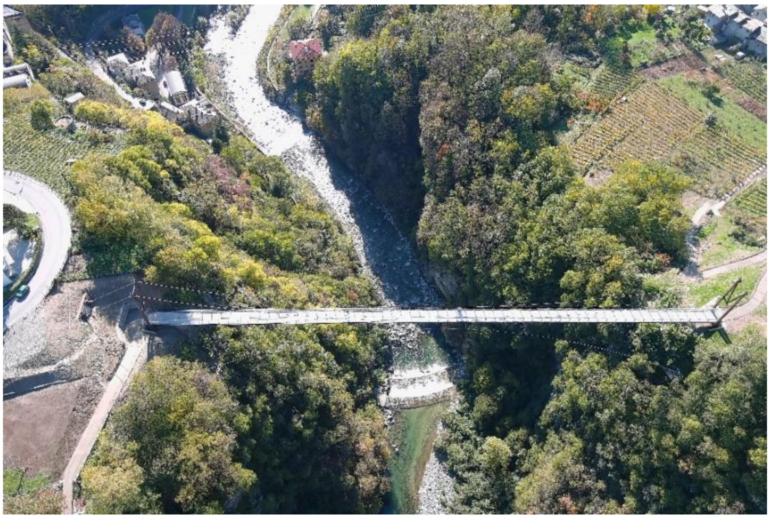

Fig. 14. Aerial view of the suspended bridges above the Mallero river

KEYWORDS

Pedestrian footbridge, suspended bridge, tensile structure, Steel structures.