l'industria italiana del Cemento

The 3rd International *fib* Congress

Washington DC, May 29 – June 2, 2010

Italian National Report

Research and Construction

ISSUE € 30,00

ISSN 0019-7637

ASSOCIAZIONE ITALIANA
TECNICO ECONOMICA
DEL CEMENTO

SPECIAL ISSUE

ANNO / *YEAR* LXXX
APRILE / *APRIL* 2010

854

● *3- Emptying of the bridge, with the heads of the piles already driven. 4- The emptied bridge. 5- Longitudinal section through the project site's geology. 6- Longitudinal section. 7- Cross section. 8- Laying the aseismic isolations. 9- Laying the precast beams.*

Cable-stayed footbridge over the Frodolfo river

Project
Cable-stayed footbridge over the Frodolfo river

Location
Bormio, (Italy)

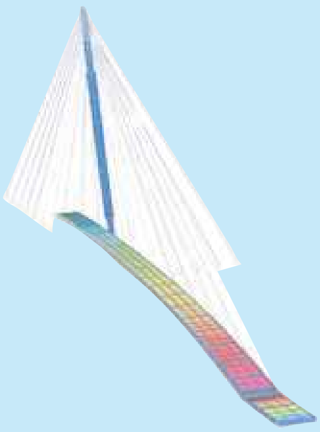
Client
Bormio Municipality

Structural detailing
Prof. Gian Michele Calvi CE, Dario Compagnoni CE, Matteo Moratti CE

Architect
Prof. Gian Michele Calvi CE

Contract Management
Studio Calvi s.r.l., Pavia, Italy

General contractor
G.A.L. costruzioni, Bormio, Italy



The bridge has a single span of about 66 m passing over an important road and a river, is curved in plan and in elevation, the deck has a variable thickness of about 300 mm and is sustained by a single pylon, hinged at the base. The main structure has been mounted in four days, without any temporary support, using six identical prefabricated deck sections, each one being 12 m long, and a 35 m monolithic steel pylon to which the deck sections are anchored, by means of four cables each. The total construction cost has been approximately 500,000 €. The bridge is technologically highly innovative, light, beautifully inserted in the environment and very cost effective. The design choices were essentially guided by the environmental constraints:

- *no intermediate support was really possible, and only on the west side topography and building locations permitted a relatively easy construction of foundations; on the same side, an underground parking under construction provided some appropriate anchoring mass;*
- *the beauty of the valley and the presence of an ancient stone bridge required a light structure, with minimum interference with the surroundings;*
- *the construction time on site needed to be reduced to a minimum, to mitigate as much as possible traffic interruption on the main road.*

It was decided to design an asymmetric steel pylon, rotated both vertically (about 7 degrees) and horizontally, in order to optimize the force distribution.

The pylon is made of a monolithic 35 m steel pipe (812 mm external diameter) with a second external co-axial pipe (850-1100 mm variable diameter) welded to the internal one by six radial steel wings).

The pylon is hinged at the base and its position is essentially governed by the actual loading, with a variable inclination. Eleven tendons (52 mm maximum diameter) restrain the pylon at the ground.

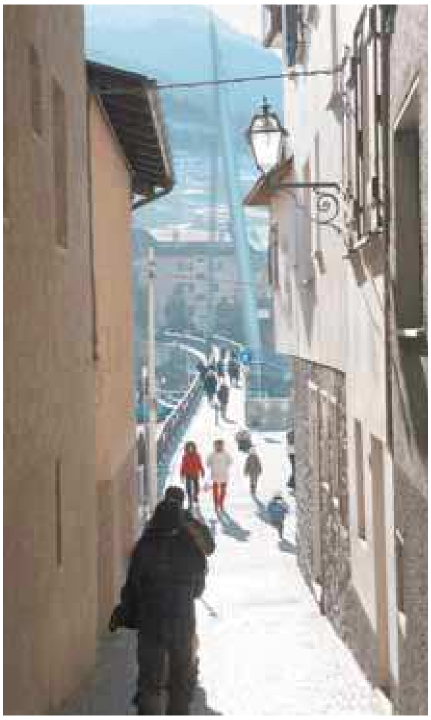
The deck is formed by five precast high performance concrete elements supported on 10 couples of thinner cables. Each segment has the same length (12 m) and the same radius of curvature both in plan (about 300 m) and in elevation (about 1200 m).

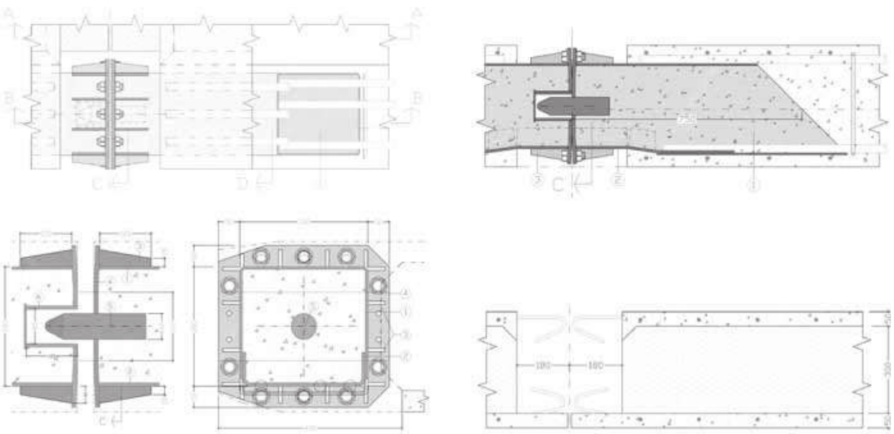
The in–plane curved shape of the deck is effectively reacting to horizontal loads by arching action, whilst vertically the deck is free to rotate around a horizontal axis on the west side and is connected to the east abutments with a double-hinged 6 m long truss that allows vertical free movements and rotations of the deck.

Pylon foundation, abutments and anchor mass for the fixed cables were constructed on site, taking advantage of the contemporary construction of an underground parking lot. The pylon was transported overnight in a single piece and mounted with two cranes; within the subsequent three days it was possible to position and anchor the five deck sections, prefabricated elsewhere. During construction, a temporary connection between the deck sections was provided by steel self centring couplers, later on included in concrete injections that made the deck fully continuous. The results of the complex nonlinear time-history simulations carried out during the design phase were later confirmed by in-situ dynamic testing, with induced vertical displacements of ± 180 mm.

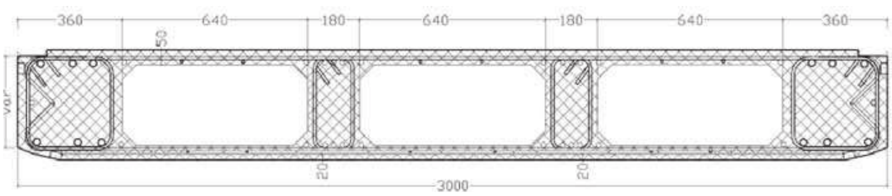
● 1- Post-tensioned concrete plinth at pylon base. 2- Temporary self centring couplers (clockwise: plan view; section B-B; detail of the steel pin; section A-A RC transversal beam cast on site). 3- Main section of the deck (hatched zone indicates RC, dimensions in mm). 4- Main geometry of the footbridge frontal view from South. 5- Horizontal hinged bearings at the West abutment. 6- Deformed shapes under live loads of the f. e. model (from left to right: South-East view; East view; plan view).

1

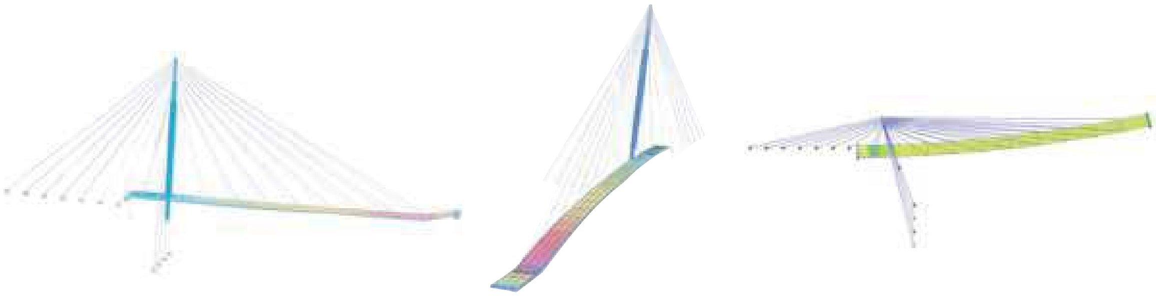




2

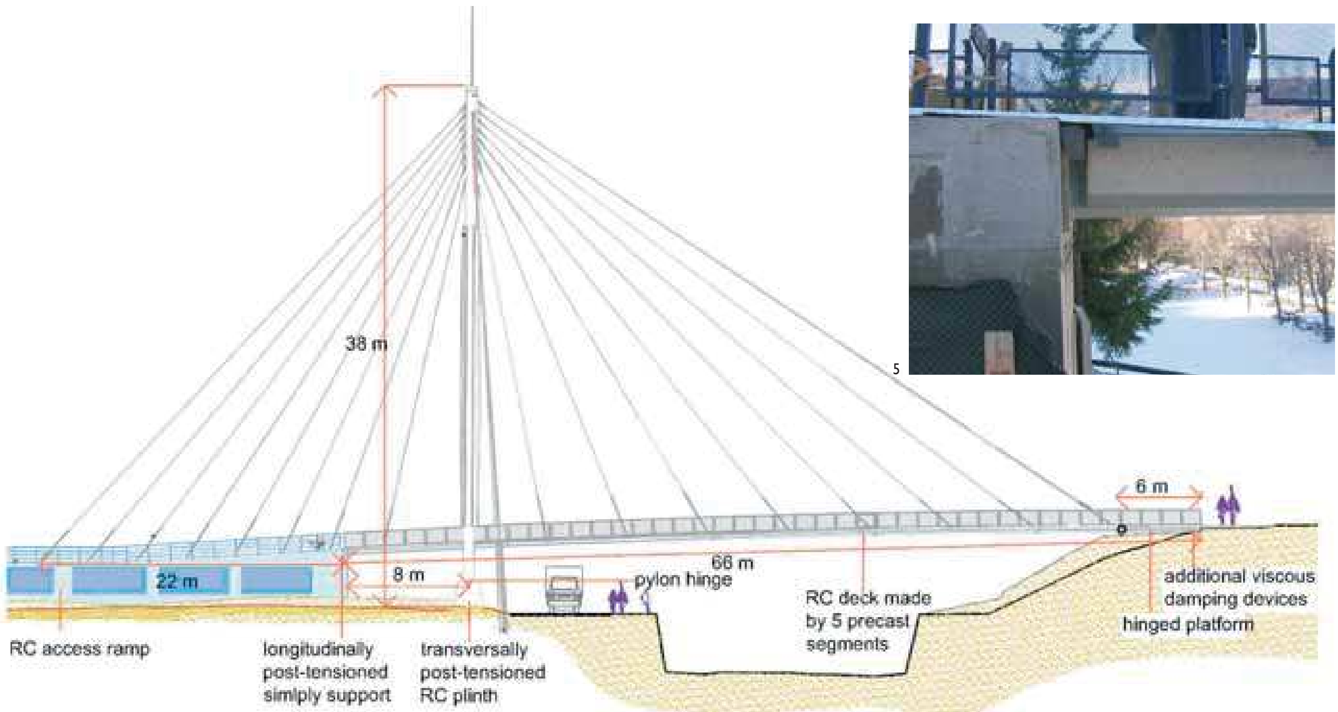


3



6

5


38 m
22 m
8 m
66 m
6 m
pylon hinge
RC access ramp
longitudinally post-tensioned simply support
transversally post-tensioned RC plinth
RC deck made by 5 precast segments
additional viscous damping devices
hinged platform

4