Repair of the stay cables of the Polcevera Viaduct in Genova, Italy

Autor(en): **Camomilla, Gabriele / Pisani, Francesco / Martinez y Cabrera, F.**

Objekttyp: **Article**

Zeitschrift: **IABSE reports = Rapports AIPC = IVBH Berichte**

Band (Jahr): **73/1/73/2 (1995)**

PDF erstellt am: **20.10.2018**

Persistenter Link: http://doi.org/10.5169/seals-55236

Repair of the Stay Cables of the Polcevera Viaduct in Genova, Italy

Réparation des câbles de haubans du Viaduc de Polcevera, Gênes, Italie

Reparatur der Hängeseile des Polcevera Viaduktes in Genua, Italien

Gabriele CAMOMILLA
Civil Engineer
Autostrade SpA
Rome, Italy

F. MARTINEZ Y CABRERA
Civil Engineer
Professor
Milan, Italy

Francesco PISANI
Civil Engineer
Studio Pisani
Rome, Italy

Agostino MARIONI
Civil Engineer
Alga SpA
Milan, Italy

SUMMARY

The Polcevera Viaduct, designed by Prof. R. Morandi, was built in the 1960s. It is one of Italy's most important bridges with prestressed concrete stays. The article describes the restoring project of the concrete stays and the works performed without stopping the traffic. The project required the installation of new tendons for each couple of concrete stays.

RÉSUMÉ

Le viaduc de Polcevera, conçu par le Professeur R. Morandi, a été construit dans les années 1960. C'est l'un des plus importants ponts en béton précontraint. L'article décrit le projet de réparation des haubans en béton et les travaux exécutés sans bloquer la circu-lation. Le projet a nécessité l'installation de nouveaux câbles pour chaque couple de haubans en béton.

ZUSAMMENFASSUNG

Das Polcevera-Viadukt, das von Prof. R. Morandi entworfen wurde, wurde während den 60er Jahren gebaut. Sie ist eine der wichtigsten vorgespannten Brücken. Der Abschnitt beschreibt den Restaurierungsentwurf der Betonschrägseile und die Arbeiten, die ausgeführt wurden, ohne den Verkehr anzuhalten. Der Entwurf erforderte die Einrichtung von Schrägkabeln für jedes Paar von Betonschrägseilen.

1. INTRODUCTION

The Polcevera Viaduct, designed by Prof. R. Morandi, was built in the '63 - '66 years to connect the motorways Milano-Genova and Genova-Savona.
The concrete bridge, with 11 spans 24 m wide ranging from 43 m to 208 m for a total length of 1121 m, passes over the Polcevera river, the marshalling yard and a town quarter.
The main important and striking part of the viaduct consists of three up to 172 m stayed cantilever box girders, that, with the 36 m central closing girders, arrives to cover 208 m.
During the periodical inspections and the restoring works made in the course of last years to the structure, furthermore the general degradation of the concrete stays, some local higher fault was found at the pilon 11.
At the bottom of the connection of the concrete stays with the transverse beam on the pilon top, a big void was pointed out, where several 0,5" strands were completely corroded.
A severe series of investigations were immediately started in order to make a complete check-up of the structure.
The investigations have the double aim to evaluate the phisical-technical characteristics of the concrete and of the reinforcements and to analize the conditions of the prestressing tendons, defining their tensioning level with particular care for the concrete stays.
About the first aim the following tests were made:

- on the concrete : ultrasounds; pull-out; Windsor; crushing of carrots; strength investigations; determination of the thickness of the concrete affected by carbonation

- on the steel : laboratory tests made on samples of bars and strands

About the second aim the following tests were made:

- endoscopic inspections on prestressing tendons
- releasing of tension on the concrete carrots
- reflectometric inspections
- dynamic investigations

The analyses and the valuations of the results have remarked the necessity of a general restoring of the bridge with some localized particular interventions and the necessity of a structural reinforcement of the concrete stays of pilon 11.
Many reasons, as the conservation of the bridge architecture, the minimisation of structural risks due to the eventual demolition of the prestressed concrete of the stays, the impossibility of closing the bridge to the traffic, the opportunity of maintaining the rigidity of the existing concrete stays, have addressed to the solution of reinforcing the concrete stays with additional tendons.

The technical concept

In order to better understand the originality of the designed solution, it is necessary to know the statical behaviour of the prestressed concrete stays.

The stays are constituted by two orders of 0,5" strand tendons.
The main tendons (24 x 12T13 strands), were tensioned at the extremity of the bridge and principally they support almost all the dead load of the cantilever box girders.
Successively the concrete beams of the stays were casted in situ along the main tendons, in segmental way, till 3 m from the deck and the concrete beams were post-tensioned by means of the secondary tendons (28 x 4T13 strands).
The secondary tendons were then extended till the anchoring points (the abutment or the transverse beams), the gap was concreted and finally the extensions of the tendons were tensioned and all the tendons grouted.
So, the post-tensioned stay-beams support almost all the live loads.
In this way the Designer reached the aim to minimize the variations of tensions (fatigue loading) in the strands, because all the prestressed concrete of the stay-beams is working under the effect of the traffic.
The repair solution has taken care of this situation as well as the necessity to control the compressive stresses in the concrete stays.
Because of the corrosion at present some strands are broken and other ones could be broken in the future, causing an additional loading on the concrete up and down of the breaking sections; it is therefore necessary to regulate the stress in the concrete to avoid its indesired bursting.
The reinforcement solution, designed by F. Pisani, provides two orders of cables for each concrete-stay:

6 + 6 , 22T15 Super strands, "long" cables
3 + 3 , 31T15 Super strands, "short" cables

The long cables, located along the two vertical faces of the concrete-stays, are linked to them by means of steel "ties", fixed on the top of the pilon to the steel "caps" and under the bottom of the transverse beam or abutment to the steel plates, "breeches", that on the transverse beam is a bi-direction ribbed plate.
The short cables, located on the two sub-horizontal faces of the concrete stays, are fixed to the lower extremities of the concrete stays through the steel "checks" and to the same "breeches".
The long cables can be compared with the main tendons of the concrete-stays and the short one with the secondary tendons.
The short cables have also the temporary function to bear all the load of the bridge during the cutting operation of all the old strands in the lower extremity of the concrete stays.
They have also the permanent function to allow the regulation of the stress level in the concrete stays.
The new stay cables have been manufactured with unbonded strand encased in a HDPE duct finally grouted. They can be checked, tension regulated and substituted entirely or strand by strand.
The structural analysis of the intervention has been made by means of the F.E. code SAP 90.
The effects of any operation on the structure were checked through:

- topographic survey of the top of the pilon, of the extremities of the cantilever box girder, of the sag of the concrete stays.
- monitoring, with the deformameters, 6 characteristic sections along the concrete stays and 3 ones in the cantilever box girder.

The sequence of the restoring operations

All the restoring operations were made in symmetrical way, first on the couple of concrete stays to mountain side and after on the sea side one.

Phase 1 - Installation of the monitoring instruments and totographic marks

2 - Installation of the "caps", "ties" and "breeches"

3 - Installation of 4+4 long tendons

4 - Tensioning of the oversaid tendons. This operation is made in order to compensate the effects of the additional loads applied to the structure (ties, breeches, strands)

5 - Installation of 8 + 8 long tendons

6 - Tensioning of only 4 + 4 tendons of the oversaid ones

7 - Demolition of the ending 50 cm of the concrete stays. During this operation 8 + 8, 1000 kN capacity jacks, were used to prevent the bursting of the prestressed concrete of the stays.

8 - Demolition of other 6,50 m of the ending concrete of the stays. During the phases from 1 to 9, the shoulders have been reinforced by means of injected Titan bars and of a concrete structure that made up also the necessary room for the post-tensioning operations.

9 - Re-building of the 6,50 m tract, using high resistance reinforced concrete.
The efficency of the adherence of the concrete to the naked old strands of the concrete stays, were checked with several laboratory tests. The tensioning force of the short tendons will be entrusted to that adherence.

10 - Installation of the "checks" and their fixing to the concrete extremities with 80 + 80 steel bars.

11 - Installation and tensioning of the 6 + 6 short tendons, step by step, through 8 stages.
At this point all the load of the bridge previously supported by the concrete stays, is transferred to the short tendons.

12 - Cutting of all the old strands.
Now the old concrete stays are completely separated from the deck.

13 to 18 - Reduction of stress in the short tendons and increasing of tension in the long ones, step by step.
At the end of these phases the tension in the two orders of tendons assumes the final value as well as the geometry of the bridge.

19 - Tendons injection

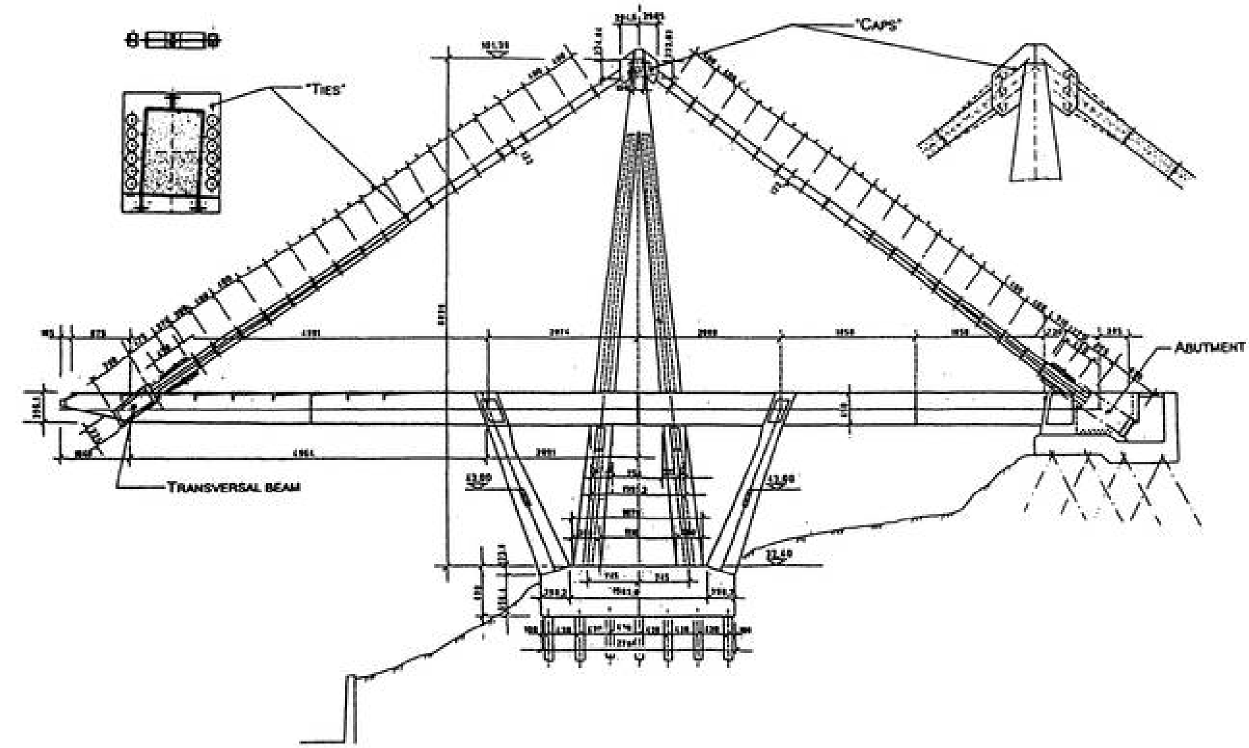
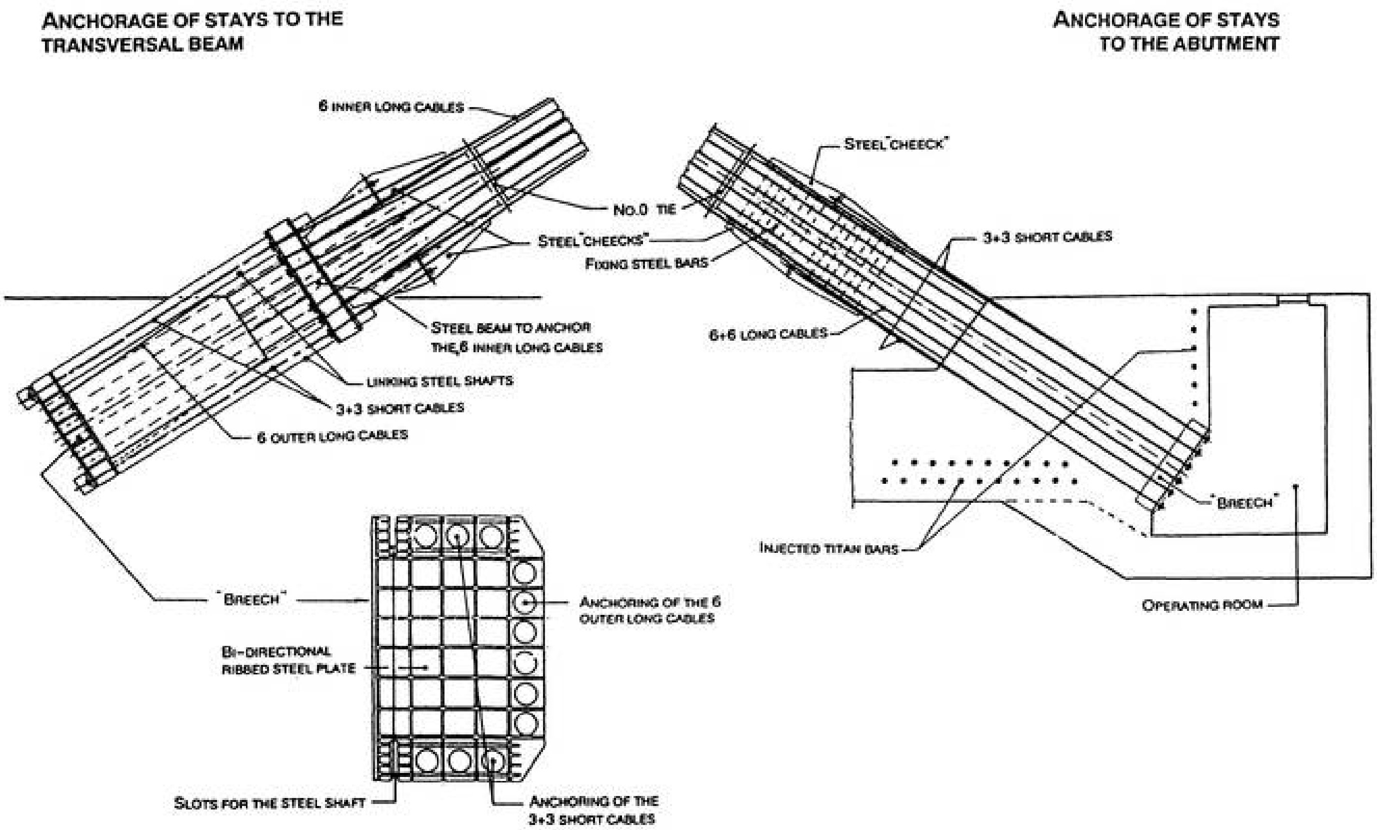


Fig. 1 General view of the repair works

Fig. 2 Details of the lower anchorages of the stays



20 - Final controll of the tensions

21 - Installation of the bi-directional restraint and concreting of the final extremity of the concrete-stays. A gap of 10 cm will remain. The bi-directional restraint has the scope to avoid the tail-vagging of the concrete stay extremities and to allow only the sliding of concrete stays along their longitudinal axis.

All the complex restoring works were made with the presence of the traffic on the bridge. Only during the installation of the steel "caps" and "breeches" and the delicate phases from 7 to 18 some limitations or reductions in traffic were applied.

The works were performed during 1992 - 1994.

Mr. F. Pisani of Roma designed the repair solution

Prof. F. Martinez y Cabrera of Milano verified the project and tested his execution
SPEA - Ingegneria Europea - of Genova was the Consulting by means of Mr. S. Bodrato and Mr. R. Rigacci
ALGA-PRECO Company of Milano realized the project with the technical management of Mr. A. Lodigiani
ISA - Costruzioni Generali SPA - of Genova made the building and complementary interventions for the installation of the stays.

REFERENCES

Martinez y Cabrera F., Camomilla G., Donferr Militelli M., Pisani F., Marioni A., Il risanamento del viadotto Polcevera - Rivista "Autostrade" n° 3/1994