Deconstruction of the Corso Grosseto viaduct and setup of a testing site for full scale load tests

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ABSTRACT: BRIDGE|50 is a research project recently launched in Italy in the context of the Torino-Ceres construction works jointly with Politecnico di Milano, Politecnico di Torino, public authorities and private companies. The aim of the BRIDGE|50 research project is to investigate the residual structural performance of the Corso Grosseto 50-year-old prestressed concrete bridge thorough an in-depth experimental campaign. The dismantling and demolition procedure of Corso Grosseto viaduct are presented in this paper, including the setup of the field laboratory where several deck beams and pier caps will be tested up to collapse.

1 INTRODUCTION

Life-cycle concepts and methodologies and effective tools have been developed over the last two decades for long-term design, assessment, maintenance and management of bridges and infrastructure systems (Biondini and Frangopol 2016, 2019). Calibration and experimental validation of life-cycle criteria, methods, and tools is a crucial part of these developments. BRIDGE|50 is a research project recently launched to this purpose. The project will investigate the residual structural performance of a 50-year-old Prestressed Concrete (PC) bridge by putting in practice the current theoretical research trends with a thorough experimental campaign.

The research project has been framed in the context of the Torino-Ceres railway construction works in Turin, Italy, and it is part of a research agreement involving universities, public authorities, and private companies, including: Politecnico di Milano, Politecnico di Torino, Piedmont Region, Municipality of Turin, Metropolitan Municipality of Turin, Lombardi Ingegneria, Torino Nuova Economia, ATI Itinera & C.M.B., ATI Despe & Perino Piero, and Studio Ing. Luigi Quaranta.

A historical view of the viaduct is shown in Figure 1. The bridge was built in 1970 in the northern suburbs of Turin. In 2018, the viaduct demolition started to build a new railway infrastructure which interfered with the viaduct foundations. The bridge demolition allowed the investigation of a typical existing concrete bridge exposed to aging and deterioration processes. Several PC elements, including deck beams and pier caps, have been dismantled and moved to a testing site where they will be tested up to collapse.

This paper presents the dismantling and demolition process of the 50-year-old Corso Grosseto viaduct and the setup of the testing laboratory.

Figure 1. Corso Grosseto viaduct during construction (1970).

2 CORSO GROSSETO VIADUCT

The investigated viaduct was located between Corso Grosseto and Corso Potenza roads, in the northern suburbs of Turin. It was opened in 1970. The demolition started at the end of 2018 to build a new railway connection which will graft to the existing railway infrastructural system which connect the city of Turin to “Sandro Pertini” airport. The new infrastructural connection will consist on a 3.3 km-long artificial underground railway line. It will connect the historical Torino-Ceres railways line and the existing RFI (Rete Ferroviaria Italiana) railway track (Figure 2). The new railway connection is funded by Piemonte region and CIPE, the Italian inter-ministerial committee for economic planning. Moreover, it will be managed by S.C.R Piemonte S.p.A., an Italian client company.

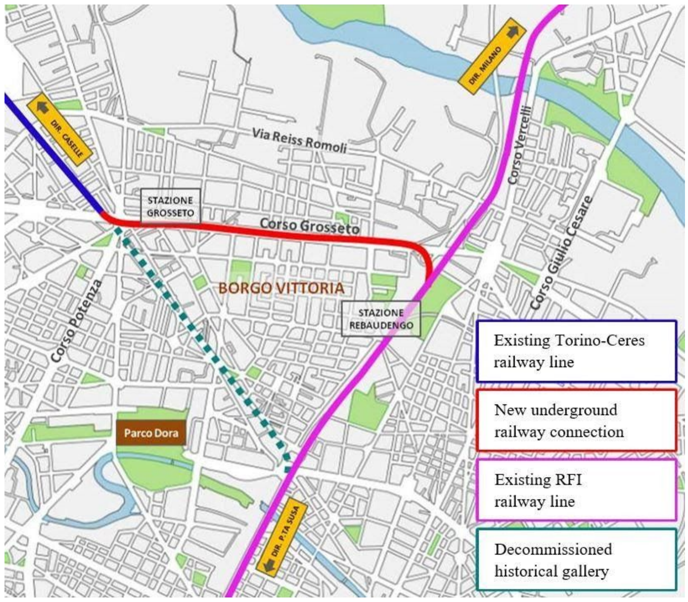

Figure 2. New infrastructural network.

In addition to restore the airport and Turin city connection, the new infrastructural system represents a unique opportunity for urban redevelopment and sub-services renewal. Once the viaduct has been deconstructed, the Corso Grosseto functionality will be ensured by a new four-lane vehicle underpass and a traffic light intersection.

The 50-year-old Corso Grosseto bridge was located in a strategic urban city node nearby important infrastructures, such as Turin airport and Allianz Stadium. Corso Grosseto and Corso Potenza roads are characterized by an urban context with heavy public and private traffic. The viaduct was composed by 80 simply supported spans. Two adjacent spans, highlighted in Figure 3, have been dismantled and placed in a testing site in Turin where 31 prestressed concrete elements will be tested and monitored. In particular, a set of 29 beams (25 I-beams and 4 box beams) and 2 piers caps have been moved in the testing laboratory. The bridge section view is presented in Figure 4.

Figure 3. Corso Grosseto viaduct (Turin). The highlighted portion will be tested within BRIDGE|50 research project.

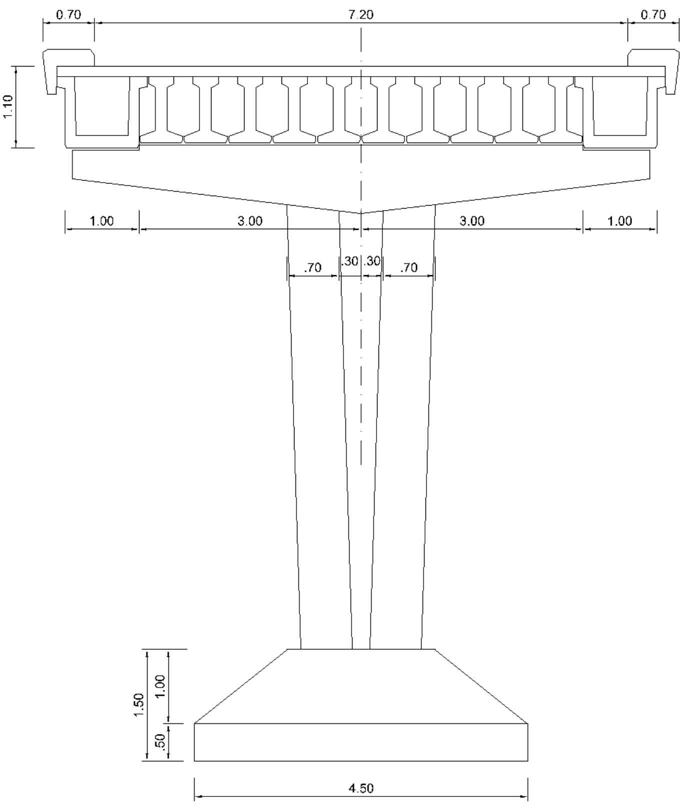

Figure 4. Bridge section view. Measures in [m].

3 BRIDGE DECONSTRUCTION

3.1 *Introduction*

The demolition of Corso Grosseto viaduct started as initial phase of the new Torino-Ceres railway construction which will connect the city of Turin and its airport. The demolition of the bridge was necessary since the viaduct interfered with the new underground railway and road tunnel constructions. However, the demolition of a strategic infrastructure system characterized by heavy traffic had to provide appropriate measures and technical solutions to mitigate the environmental impacts. Moreover, the bridge deconstruction process had to avoid the traffic flow limitations, particularly for public transportations. The project included a preliminary study of traffic flows in the viaduct area. Moreover, appropriate demolition phases have been decided to ensure standard public and private traffic flows. In particular, day and night shifts have been adopted during the bridge deconstruction.

3.2 *Environmental impact mitigation*

A demanding key factor of the demolition process has been the adaptation of several measures to mitigate the environmental impact in the surrounding area. In particular, dust control and abutment measures have been used with real time control units. Hydraulic crushers have been adopted for vibration control. Moreover, sand layers have been spread on road surface for vibration mitigation. Several sound-absorbing barriers, equipped with measurement units, allowed mitigation and noise emission control during the entire demolition process.

Periodic technical meetings with the municipality of Turin and the stakeholders of the management of underground utilities and traffic flows, facilitated the environmental impact techniques. Moreover, a constant communication with Turin citizens, through appropriate online surveys and leafleting, fulfilled the needs of the city.

3.3 *Demolition project*

The Corso Grosseto viaduct was demolished using hydraulic pliers and crushers for the spans furthest from the Corso Grosseto-Corso Potenza node, as illustrated in Figure 5. This demolition procedure involved almost 40% of the bridge. The remaining portion of the viaduct has been deconstructed by cutting individual structural elements with disk with diamond wires (Figure 6). Instead, two adjacent spans, of interest of BRIDGE|50 research project, have been dismantled and placed in a testing site in Turin.

The new infrastructural system will restore the railway connection of the airport with the city. It represents a fundamental opportunity for urban development of one of the main Italian infrastructural system, as well as an opportunity to renew the sub-services system.

Figure 5. Demolition bridge process using hydraulic pliers.

Figure 6. Deconstruction bridge process.

3.4 *Bridge dismantling*

The demolition phase of Corso Grosseto viaduct allowed the dismantling, investigation and testing of different structural elements. The bridge dismantling process involved a precise cutting and transportation phase. Disks with diamond wires have been used to separate longitudinal PC beams to the concrete connecting slab. Exceptional transport trucks have been adopted to move the structural elements. In particular, a set of 29 prestressed concrete beams (25 I-beams and 4 box beams) and 2 piers caps have been dismantled and will be tested during 2020.

The bridge dismantling operations can be described with the following phases. During phase 1, the bridge deck has been cut to separate from the upper 14 cm-thick concrete slab, 24 PC beams which composed each viaduct span, as displayed in Figure 7. The cutting phase used circular disks with diamond wires.

Figure 7. Concrete beam cutting phase.

Phase 2 regarded the drilling of the bridge deck using a drilling machine on top, and an electric (manual) drill at the bottom of the deck. A different technique has been adopted for the lower surface to avoid of cutting prestressing tendons. Drilling holes in concrete slab were fundamental to use slinging ropes to lift the elements adopting a 500-ton crane.

Figure 8. Concrete beam drilling phase.

Instead, a specific procedure has been used to lift pier caps. The separation of those elements from the supporting pylons occurred cutting with a diamond disk, while the pier cap was suitably supported by a mobile crane. The design and the work of this delicate operation can be seen in Figure 9 and Figure 10.

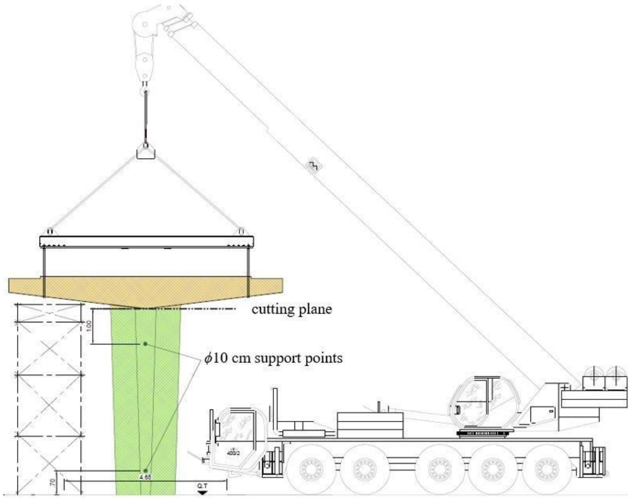

Figure 9. Design project of pier caps deconstruction.

Figure 10. Dismantling phase of pier caps.

During phase 3, the prestressed concrete members were placed on a transportation truck and moved to testing site in Turin. A proper identification code has been established for each structural member in order to understand the element position with respect to the original location along the demolished viaduct. Each transport was characterized by the movement of three PC I-beams or a single PC box beam or pier cap. A maximum weight of 40 ton was allowed for the adopted transportation truck. Appropriate security measures, coordinated by the municipality of Turin, have been used during the entire transportation phase.

Figure 11. PC beams transportation phase.

During phase 4, the elements have been moved in the testing site and placed on New Jersey supporting reinforced concrete (RC) elements. Moreover, to maintain the same operating structural scheme, PC beams storage took place by positioning the beams on the New Jersey elements spaced as they were located in-situ supported by pier caps. A concrete class C28/35 has been used for the supporting elements. In Figure 12 the configuration of PC beams on the New Jersey elements, is shown. A three-dimensional finite element analysis has been developed to check local contact pressure between beams and supporting elements. Solid finite elements have been used to model both beams and New Jersey elements (Figure 13).

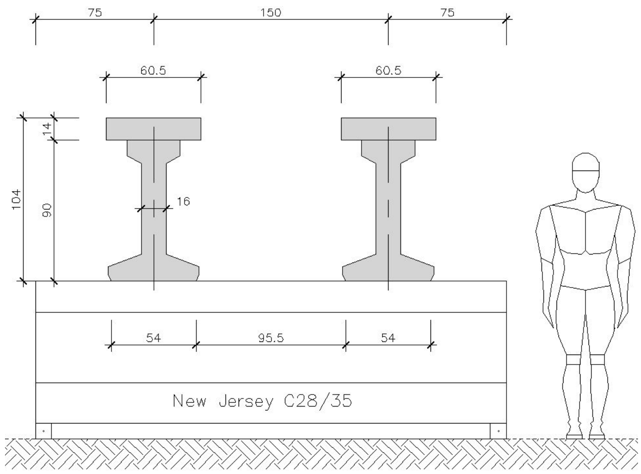

Figure 12. I-shaped PC beams on RC New Jersey elements [cm].

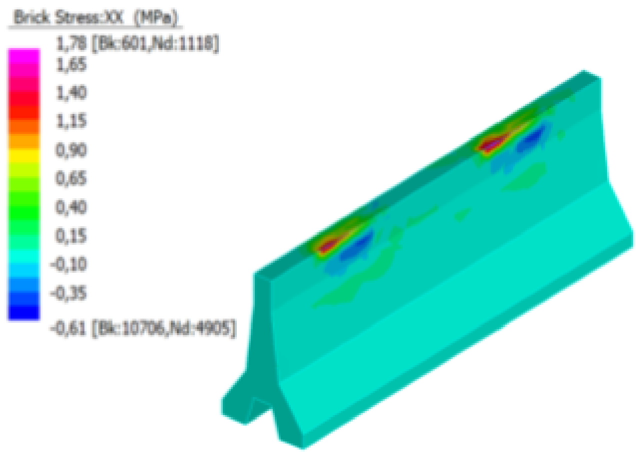

Figure 13. Finite element solid model of a New Jersey element and contour map of longitudinal normal stress σ_{xx} [MPa].

Phase 5 was characterized by the demolition of the remaining structural elements (Figure 14). Hydraulic pliers have been adopted to speed up the final demolition phase.

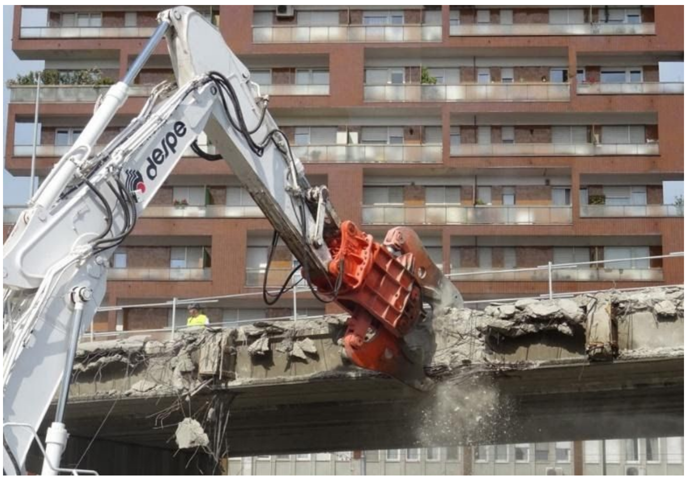

Figure 14. Demolition phase.

The entire dismantling, transportation and demolition phases lasted about 12 days.

4 TESTING LABORATORY

The testing site stores 25 I-shaped PC beams, 4 box PC beams and 2 pier caps. An identification code has been established in order to understand the structural element position with respect to the original location. It is worth noting that a more severe deterioration process and chloride attacks is expected to the external box PC beams and pier caps (Figure 15).

The structural elements are 50-year-old prestressed concrete beams and pier caps. They have been located on New Jersey barriers with a sufficient distance from each other to have a complete view of the members. The total length of I-shaped beams is 19.20 m and the height of the section is 0.90 m. At the top of the beam, a 0.14 m-high RC slab connected the longitudinal elements of the viaduct. Figure 16 illustrates the PC beams testing site arrangement.

Figure 15. Pier caps located in the testing site.

Figure 16. PC beams testing site arrangement.

A load steel frame will be adopted in the testing site to perform several experimental activities, which include full-scale load tests for elastic, post-elastic and ultimate collapse phases. Moreover, non-destructive and laboratory tests will be performed to investigate the condition state of a PC bridge that is typical of the Italian infrastructure system. Figure 9 shows the testing site in Turin (Italy).

Figure 17. Testing laboratory site (Turin, Italy).

5 CONCLUSIONS

The paper presented the dismantling, demolition and testing site setup process for two adjacent spans of Corso Grosseto viaduct within the BRIDGE|50 research project. The project included an appropriate preliminary study of traffic flows around the bridge area. Several measures to mitigate the environmental impact during the viaduct deconstruction have been adopted, in the surrounding area. The bridge dismantling procedure started with concrete beam cutting and drilling phase. Once the structural elements have been lunched on appropriate trucks, they have been moved in a laboratory site in Turin. The remaining viaduct members have been demolished adopting hydraulic pliers. The overall deconstruction and setup of testing site lasted about 12 days.

Several experimental activities which include non-destructive test, full-scale load tests and laboratory tests will be performed on 29 PC beams and 2 pier caps, during 2020.

ACKNOWLEDGEMENTS

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