The story of the transformation of a structure: from arch bridge to…

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ABSTRACT: The acquaintance of the constructive rules to assume in the recovery operations, often disregarded, should represent the cultural background in order to properly face operation of preservation and transformation.
To this aim the case of Druso bridge is wanted to be introduced. The bridge was planned and realized in the first years thirty from the engineer Eugenio Miozzi, managing of the state roads division of the province of Belluno, Bolzano and Trento, and the engineer Gilberto Ricci. The designers, for this 3 arches bridge in reinforced concrete, covered with rose porphyry, planned a particular sagacity, the "systematic cracks", based on the use of compensating joints. Miozzi improved then the technique, so that it was adopted in subsequent projects, such as the bridge of the Barefoot ones in Venice. The Druso bridge has been an experimentation that has affected the planning of the arch bridges, one of the many intuitions that confirm the technical talent of the Miozzi. The procedure of "stylistic washing" used in the seventies besides modifying the design has also altered the structural conception. In fact, all the elements, such as parapet and statues, curved out of stone from Vittorio Morelli, have been removed. As the method has been immediately criticized from the population, in the nineties the need to widen the bridge has required a new project. The street centre has been increased arranging the parapet and some ornamental elements similar to the original ones.
The history of the bridge becomes therefore a good example to make us comprise that the improvement and therefore the preservation of the built environmental cannot be based just on formal parameters, but also on the technological ones.

1. THE STORY

In a restoration project, the acquisition of knowledge should be a cultural requisite for tackling conservation and transformation correctly. Often however this knowledge acquisition process is neglected and a structure is restored or modified on the basis of a superficial assessment of architectural quality and the values affecting the history and evolution of the built fabric.
Our recently acquired sensitivity to the valorisation and conservation of the environment should make us proceed more cautiously, generalised protection of the old as opposed to a superficial approach to more recent structures does not, in fact, make sense. In the case of modernist architecture, the re-appraisal is still extremely complex and difficult, but often demolition and injudicious modification have unfortunate consequences. This is even truer in the infrastructure sector which has undergone profound changes in the name of imprudent functional modifications or unfavourable political alliances.
So while the buildings of our recent history are at risk, even more so is the infrastructure of the last century, whose architectural and particularly constructional merits are hardly remembered.
One of the least considered categories is that of bridges, structures in which the architectural form goes hand in hand with the structural and constructional conception, a sector in which

there has been maximum technological experimentation, but where the architectural value is considered only if the bridges were designed by well-known engineers and architects.
In this sector however, outstanding works are not the sole prerogative of the great and often names little known to architectural and engineering critics have managed to produce interesting formal and technological experiments. This heritage is at risk because superficial transformations in order to bring the bridge in line with the standards and functional indications of modern times have proved to be devastating with regard to the dignity of the original designs and their cultural conservation. In the specific infrastructure sector, with the exception of a few rare cases, there have been no valorisation or safeguarding schemes through the special legislation on the cultural heritage, while there have, on the other hand, been a number of projects debatable with respect to the principles of restoration.
In order to arrive at correct and appropriate operating criteria, perhaps the time has come to analyse what has been done in the past in order to verify whether the best practices of restoration are also applicable to this category of structure.
We therefore felt it would be interesting to present the case of the Druso Bridge designed and constructed in the early 1930s by engineers Eugenio Miozzi and Gilberto Ricci. The history of this bridge helps understand why the valorisation and conservation of a structure cannot be based on verification of functionality alone, but must also take the formal and technological values of the original into account.

2. THE EXPANSION OF BOLZANO AND THE NEED FOR BRIDGES

Between the last few decades of the 19th century and beginning of the 20th century, Bolzano grew greatly, expanding to the west and south towards areas near the rivers Talvera and Isarco, once unhealthy and dangerous, then reclaimed and made safe by the construction of embankments. The railway station, luxury hotels, theatre, residential districts and barracks are therefore located on land to the south of Bolzano.
At the same time, the neighbouring agricultural town of Gries also underwent gradual transformation and new enterprises in the tourism and accommodation sector sprang up alongside the existing farms.
After annexation of the province to Italy, the Fascist regime decided to continue the Hapsburg development plan which was also in line with the policy of Italianisation. It was decided that the expansion should occupy land on the right bank of the Talvera, making use of and connecting to the existing services and infrastructure (schools, hospitals, etc) of Bolzano. In drawing up the development plan, it was immediately obvious that the one existing bridge over the Talvera was not adequate, not only because of its size, but also due to the system of connecting roads which would create routes inappropriate to the new traffic requirements.
To the administrators of the time, it was immediately evident that in a modern and rational city it was necessary to construct new connections with wide streets and bridges.
The first to be designed was over the Talvera to the south of the existing bridge, defining a second road axis between Bolzano and Gries. Its size made it the preferential route for Merano, Verona and Innsbruck.
Discussions on a bridge to connect the two parts of the city separated by the Talvera torrent began in 1924 when a proposal was put forward to merge Bolzano with Gries[1]. In 1926, after the merger had taken place, Bolzano City Council announced a competition[2] based on a proposal drawn up by the City Engineers' Department of Roads and Bridges, inviting numerous building firms throughout Italy to present their technological proposals. Only seven companies[3] took part in the competition with constructional and financial proposals and from these, the Delugan company was chosen for the higher bidding discount. This was followed (letter of 17 November 1926) by a commission to produce the final design[4] which was consigned to the City Engineers' department at the beginning of 1927. Engineer Delugan's company designed a concrete structure consisting of three longitudinal girders with a constant cross-section simply resting on the intermediate piers, for a total length of 90 m and width of 8 m. Approved by the City Council, the design was criticised by the Prefecture[5] who blocked construction, referring to notes from the Civil Engineers (different width between roads and bridge, shallowness of foundations, etc).

On the basis of agreements between Bolzano City Council and the Regime, the design was entrusted to the Azienda Statale delle Strade (State Road Company) in the persons of engineer Eugenio Miozzi, head of the division for the provinces of Belluno, Bolzano and Trento, and engineer Gilberto Ricci, head of the Civil Engineers in the Adige province. It is not known whether design of the bridge continued as a duet, but it is presumed that the most incisive role in the architectural and structural design was played by engineer Miozzi.
The fact remains that the public administration, deferential to the instructions of the Fascist regime, not only obliged the City Council to contribute financially to the construction, but also demanded a symbolic and solemn design.
The first project was for a three arch bridge. The central arch with a span of 35 m rested on concrete piers, while the lateral arches each with a 15 m span rested on piers and abutments on the embankments. The two bowstring girders and a system of coupled cross girders supported the horizontal deck. The abutments consisted of large stone-clad concrete buttresses decorated with friezes and emblems of the Roman tradition. Four obelisks continuing the line of the piers supported voluminous porphyry Roman eagles. With its monumental but slender structure, the design did not apparently impose its presence with as heavy an impact on the surrounding landscape as the regime would have liked. A second version was therefore developed, based on the hypothesis of a structure which, from a link section starting well in advance on the embankments, rose up with respect to water level, necessitating considerable landfill to join with the level of the road. The bridge had a span of 78 m and was constructed with a three-arch system and a wider road deck. In the new version, the side arches had a span of 22 m and the central arch 34 m in order to create a rise and make the grandeur of the bridge visible from a great distance.
Using the Séjourné system, appropriate for the width of the bridge, the bearing structure involved a pair of arches side by side on which the cross girders forming the principal frame of the carriageway were rested. This system was chosen as the cost was considerably lower than a traditional solid continuous vault structure.
Right from the first design proposed by Miozzi and Del Ricci, the bridge abutments and piers were given sturdy reinforced concrete foundations of a remarkable size in both plan and height. The particular nature of the land (porphyry gravel mixed with clay) made it possible to dig open excavations and cast the concrete with the help of moderate pumping.
A wall of stones and cement mortar was built in elevation to bear the concrete arches.
The arches were built using ordinary systems and key joints and 1 mm thick lead sheets were inserted at the imposts.
Drawing on other similar structures known at the time designed by engineer Freyssinet, during static and constructional definition of the vaults, Miozzi developed the so-called "systematic crack" system, later patented. The technique involved reducing unit stresses by eliminating parasitic stresses, establishing an equilibrium between arch and support which limited warping.
To avoid the affects of stress between the elements, there was maximum independence between the components of the structure. The roadbed consisted of elements resting on articulated devices which allowed for the variations in length caused by shrinking of the concrete, temperature changes, elastic contraction, etc.
Following the principles adopted by Séjourné, Miozzi believed a masonry bridge should have a simple shape, based on the correct proportions between span and height and rise and capacity, and that decoration should be functional to structural rather than formal considerations. However, along with the structural design, considerable attention was also paid to formal aspects with particular emphasis on decoration. As Miozzi wrote in an article, the bridge "… having to recall a past of dominion and greatness and at the same time fit in with an Alpine scenery of strong eruptive rocks demanded architecturally severe shapes …". To express a sense of grandeur, the viaduct was clad with massive porphyry ashlars and richly decorated because, according to the designer, it was necessary "to separate the various members and mark and accentuate the function and importance of each, but at the same time they must be one with the bridge itself, and not appear to be merely resting or connected. It must be simple, discreet, modest, reasonable and useful. …".
For Miozzi, unlike buildings, a bridge must be perceived only from a great distance and the decorative elements must thus have a high impact. The groups of Fascist fasces topped by imposing imperial eagles were therefore emphasised, emerging for more than 8 m from the level

of the carriageway. The end blocks of the two bridge abutments had, on the other hand, more modest impact. Inspired by a Roman altar, they supported an imperial shield resting on four helmets. The sides were decorated with Roman swords… "the symbols of Roman glory were thus close to those of our victory and the emblems of Druso to those of the Regime".
The monolithic elements were entirely covered with massive ashlars and slabs of pink porphyry to establish a relationship between the formal character and static function. The balustrade elements, on the other hand, were made of concrete stone during whose preparation porphyry grit had been added to the mixture to achieve a perfect chromatic amalgam. The overbridge was decorated with elements designed by sculptor Vittorio Morelli and made from green porphyry, while the carriageway was also paved with small cubes of the same material.
Building[6] began in March 1930 with a ceremony which brought together the top authorities of the province and ended in October the following year. When the bridge was opened to traffic on 28 October during celebrations of the March on Rome which had taken place nine years previously, the structure was so heavily criticised by the local press[7] that demolition was proposed.

3. SUBSEQUENT MODIFICATIONS

The link constructed in the 1930s rapidly became of key importance in the city's road system and was fundamental during the urban expansion after the War. The local community recognised the functionality of the route, but for local politicians the bridge represented the architecture of the hated Fascist regime which had to be demolished or at least purified of the stone elements portraying the past power.
As is often the case, little attention to design and too great a value attributed to historical ethnic contrasts[8] once again resulted in everything produced by the Fascist Regime being considered as negative or at least "awkward". Therefore to restore the "virginity" of the local memory, all Fascist elements were eliminated.
In the 1970s, as no structural degradation was revealed, "stylistic purification" was the only objective of a project entrusted to engineer Egon Parteli to widen the carriageway. The presence of a number of Hapsburg buildings (former barracks) on the left bank of the torrent would have allowed a maximum widening of two metres, ineffective in improving the road system. Reinforced concrete brackets were rested on the existing structure, thus modifying the original structural concept. To achieve this, the cladding was completely removed from the deck, leading to transverse warping of the slab and a tendency to stress the stone face with a transverse thrust.
The concrete stone parts were disposed of in a dump, while the stone elements were placed in the courtyard of the civic museum where they remained for many years before being transferred to the City Gardens Service.
The new pavements were given anonymous metal railings with vertical elements, obviously an extraneous addition to the bearing structure. The modification was criticised by citizens, but well received by local administrations and politicians.
After a long cohabitation between two cultures[9] through various historical periods and political changes, stylistic purification in Bolzano led to the most representative buildings being modified. During the Fascist period, buildings with Germanic stylistic elements were "purified", while since then, the aulic rationalist buildings built during the Fascist period have been transformed without any form of preventive critical historical evaluation, not considering the rationalist language which imposed its presence in areas with a heterogeneous political matrix as architecturally productive.
At the threshold of the 2000s, people again began talking about the "ugliness" of the Druso bridge and in 2002, professor engineer Leonardo Pagnini and engineer Francesco Pecorella were commissioned to draw up a project to improve the Druso bridge. The new project involved repairing and protecting the concrete elements of the intrados, adaptation of the cross joints and demolition of the metal railings to be replaced by a new stone balustrade.
Action was then taken to eliminate the carbonation phenomena affecting the structure (the intrados of the arches, main and secondary girders and slab were treated), with elimination of the degraded concrete by hydrodemolition, then cleaning, passivation and integration of the

existing structural ironwork with new steel bars and restoration of the removed concrete[10]. A protective system based on methacrylates in solvent particularly suitable for elements subjected to cyclic loads and thermal expansion was applied to all concrete surfaces.
After restoration of the badly degraded structural edges, the old expansion joints were replaced with Algaflex T30 type elements.
The roadbed was again widened by demolishing the pavements constructed during the 1970s and using overhanging reinforced concrete slabs on the same plane as the road deck.
In obedience to the alternation of political cycles and a greater respect for the history of the structure, this project proposed constructing a stone balustrade and eight pedestals to hold braziers corresponding to the projection of the arch imposts on the plane of the road surface and the structures were also clad with 4 cm thick pink porphyry slabs.
In the end, the city gave the project a positive reception, recognising a positive attempt to give the bridge "character and originality", although without having reinstated the original eagles, still kept badly in the City Gardens Service.

4 CONCLUSIONS

From the above, it is clear that the poor historical-static-technological knowledge of the original bridge prevented it from being correctly valorised and conserved. The experimentation which led to patenting of the systematic cracks system based on the use of compensating joints was not understood in the beginning. A refined version of the technique was adopted in later structures such as, for example the Ponte degli Scalzi in Venice and was then adopted by other designers.
After the war, the bridge was incorrectly assessed, neglecting its innovative technology and concentrating exclusively on the aulic style references to the Regime, without giving even minimum consideration to the importance of the architectural concept, carrying out "stylistic purification" of the parts visible to the eye, as is shown by the upstream side of the bottom of the pier on the right looking downstream where Fascist elements still survive.
The latest modifications have further distorted the form and dignity of the bridge with their destructive and useless re-proposal of false stylistic elements, neither congruent with the structure nor coherent with the formal architectural design. Moreover, the modified bridge does not even imitate the original grandeur visible from both near and far.
And yet valorisation has become an incontrovertible objective of today's culture, sensitised by those working in the sector and men of culture, and therefore conservation of the historical-artistic architectural heritage is now a social necessity… but only in the case of buildings destined for predominantly public use.
It is widely known that conservation can be achieved in various ways (environmental control, maintenance, repairs, restoration, renovation, restructuring), but it must be remembered that every operation involves decisions, selections and responsibilities in relation to the heritage as a whole, including for those parts which currently have no particular significance, but which could assume one in the future. This is why interventions which modify the original concept are not permitted.
From the case described and numerous others, it can be deduced that infrastructure is not yet considered "architecture" worth preserving from devastating modifications or demolition, justified by questionable functionalistic considerations or, even worse, political rancour as happened in Bolzano.
To plan restoration or modification for this category of structure as well must involve a long history made up of numerous modifications and the outstanding events which have influenced, sometimes positively, sometimes negatively, ways of operating on the existing, also affected by the cultural evolution, which have been partly incorporated in legislation.
It is now time to take responsibility for the entire built fabric, but to do this requires precise historical knowledge.

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Notes

[1] In 1924 it was decided to merge the two administrations, given that it already represented a single economic, social and cultural entity. In the 19th century, many businesses in Bolzano moved to Gries where the Talvera valley widened and a series of facilities such as the tramline, electricity company, aqueduct and hospital had been financed by both councils. The small amount of land available in Bolzano for building had led to identification of undeveloped areas at the disposition of the middle classes (a city park, public gardens and a walk along the Talvera) at Gries.

[2] The competition did not set out to identify a winner and in fact from summer 1926 it was evident that the council was trying to identify the most appropriate company for the building project, to then proceed with private negotiations. The company was chosen by a commission consisting of the chief engineer of Bolzano City Council, Mr Nolli, an engineer proposed by the Trento college of engineers, Pietro Francescatti, an engineer proposed by the Bolzano Province, Guido Dorna and a well-known freelance architect operating in the area, Mario Amonn.

[3] Impresa Lino Madile of Bolzano, Emenegildo Pitau of Trento, Carlo Cittadini of Trento, Delugan of Merano, SICEA (Società Italiana Costruzioni Edili) in Alto Adige with offices at Milan and Merano, Società Anonima Italiana Ferrobeton of Rom, Società Anonima Engineer Barosi of Milan

[4] Mr Delugan in turn appointed engineers Segalla and Gaffuri of Trento to draw up the design proposal.

[5] Decree no. 11017 of 2 May 1927.

[6] The bridge was built by the Venetian company, Albini.

[7] Province of Bolzano, 18 January 1935.

8 Numerous documents in fact show that the annexation of the Alto Adige to Italy had been proposed some time before the First World War in order to take full benefit from the barrier of the Alps and, above all, to exploit the water resources to produce electricity which was becoming ever more important as the process of industrialisation advanced.

[9] One example of this are the German and Italian porticoes found in medieval Bolzano.

[10] To restore the main and secondary girders, fibre reinforced rheoplastic mortar rendering was applied, while in the arches, high resistance compensated rheoplastic concrete was used.