A multidisciplinary approach: the conservation of an ancient bridge over the greater Zab River as part of community development plan of Deralok hydropower project under Japanese international cooperation agency loan

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1. Introduction
This paper investigates the usefulness of a multidisciplinary approach for heritage enhancing in the specific case of a subject of recognized historic value, now lying in a state of ruin, devoid of its function, which turns out to be almost completely devoid of documentary sources, illustrative or written testimonies. The lack of different sources from the same artefact that makes clear the need for the project of architectural restoration to rely on the specificity of other disciplines. Essential, in fact, is the close interaction between methods and tools of architectural restoration and methods and tools of the disciplines on which they depend:
- Surveys and analyses conducted to understand the built heritage and its background.
- Representation, both as regards the phase of knowledge of the actual state of the historical artefact and as regards the graphic restoration of the phases and of the methods of the project.
- The virtual reconstruction of the conditions in which the artefact was made and the project hypothesis
- Historical analysis and the study of material culture which led to the construction of the building.
- The project as a tool to investigate the hypothesis of enhancement.

2. The ancient Deralock Bridge
The project for the conservation and enhancement of the ruins of the ancient bridge over the river Zab is part of a broader territorial development activities in the vicinity of the village of Deralok (Amadia district, region of Dohuk within the autonomous region of Iraqi Kurdistan), a complex of works related to the construction of a hydroelectric plant on the Greater Zab River, the largest tributary of the Tigris, at the foot of the Zagros mountain and near the Turkish border. The Deralok plant is the first attempt in the hydroelectric sector of Iraq post-Saddam era, with a view to develop a long term energetic policy in alternative to oil, and represents the pilot project as part of a program of construction of other future hydroelectric plants in the autonomous region of Kurdistan. The planned facility works with a system with flowing water with a cross barrier, has a catchments area at the dam section of about 7,300 sq km with a concrete dam and supplies a free flow along the left bank which conveys the flow a sediment trap basin and feeds two turbines. To integrate the hydroelectric plant there are other components of the project: the creation of a museum space, (built on the ruins of the ancient village Galya), a dining facility, some
residences for operators, the arrangement of open spaces to ensure a system of public pathways and enhancement of the historical artefact present, the ruins of the ancient bridge.

The project is funded by JICA, the Japanese agency for international cooperation, which requires the presence of an international consultant to work alongside the Employer, in this case the Ministry of Electricity, in the design phase and in the supervision of the works as a guarantee of compliance with environmental and social policies of the bank, the procurement, the quality of the intervention and transparency in the management of the project. The selected international consultant is ELC-Electro consult, engineering company, whose main activity is to follow the processes of environmental protection and transformation of the territory as a whole (from the pre-feasibility studies and institutional executive design and management of construction works) mainly in measures related to the implementation of water projects, hydroelectric plants and dams and multipurpose projects dealing with irrigation and agricultural development.

The current district of Deralok has about 10,000 inhabitants and is located at approximately one kilometre downstream of the intervention. This distance is intended, according to the demographic forecasts and the instruments of urban planning, to shrink considerably in the coming decades.

It is in fact foreseen a significant increase of local urbanization, resulting in economic development in place and the forecasts of tourist flow, since the region, a few years ago, is the subject of seasonal tourism, with the arrival of numerous guests from the south of Iraq, attracted by the mild climate of the mountains.

The project of conservation and enhancement of the remains of the ancient bridge is then part of a major engineering project sensitive to the integration of an industrial structure in a significant environmental, historical and urban planning context.

The project has seen the direct involvement of stakeholders from the Authority (the City hall of Deralok, the Swiss Agency for local urban development, the environment management) to local communities in a process of public consultation aimed at active participation of the population and local authorities in the design process.

In parallel to the local consultation a horizontal coordination was conducted of Ministries (Ministries of electricity, the Ministry of Antiquities) and international financing.

The Galya Bridge was an ancient stone bridge. Currently only some of its parts are still visible: six pillars, with two arches in the remaining portion at the left bank of the river. Local history of the place shows that the bridge was continually demolished by floods, earthquakes or by human actions and thus it was rebuilt several times with various shapes.

The numerous works over the course of history make difficult to provide a unique interpretation of the remains of the bridge, the origins remain unclear and thus contradictory are the dates of the constructions.

Written sources state that the construction of the bridge dates back to the period of the Abbasid Empire (Abbasid rule ended in AD 1258). This hypothesis
is supported by the presence of buildings in the surrounding area with features similar to those in the remains of Galya Bridge, and that appear to have been built under the Abbasids.

The origins of the bridge are linked to the need to connect the territories and villages laying east of the great Zab River and those located to the west, and in particular to facilitate transport and communications between the capital, Amadiya, and the important city of Rewandiz.

The precise location of the bridge is mainly related to orographic reasons:
1. it was built where the Zab River crosses the border between the plains of the plateau and the mountain range to the north. Being part of a path set “amidst” the plain and the mountain and offered the opportunity to have a smooth crossing and at the same time easily defended from the military standpoint;
2. in this area the construction of the bridge is further fostered by the presence of a rocky surface in proximity of the riversides. The presence of a solid soil and stones allows an easy positioning of the pillars of support and the possibility to obtain locally construction materials. The proximity of the riversides allows also having a relative reduction in size to pass with as little effort as possible.

Therefore, despite the constant collapses throughout history, the bridge has been continuously rebuilt in the same place where the actual ruins of the building to be preserved stand.

3. Disciplines and modes of intervention

3.1 Relief

The choice of the type of relief, the tool that translates reality to graphic transcription, constitutes a fundamental element of a documental project design and constitutes main methodologies to ensure the achievement of coded purposes with fixed operative destination. The outcome of the knowledge of an architectural structure is made through the reconstruction of a homologous model, a model which is able to make explicit the meaning of reality.

The field survey involved both the territorial surrounding area to identify the relationship between the artefact and its historical and geographical context within which it is inserted, and the artefact within its various aspects.

The methodology used to measure the geometrical Galya Bridge is laser scanning technology and the relief carried has produced:
1. Drawings of the surfaces constituting the artefact, used to define the size of the stone elements.
2. Drawings for macroscopic identification of lithotypes.

In parallel to the program of laser scans of the architectural elements, a photographic report (to map the walls surfaces) has been carried out.

During the vectorization of the complete three-dimensional model has been divided or partially skimmed according to the vectorized section (this is needed to handle with multi-speed model). Then the primary profiles are defined for the representation of the architectural element. The model point cloud was then triangulated for determining mesh for the creation of ortofotogrammittry of the bridge walls.
From the cloud of points it has been possible to reconstruct the virtual model of the actual state of the building. The virtual reconstruction of the building with the territory in which it is located is a fundamental process in order to analyze the artefact from various points of view, to be able to relate the different parts that make up the artefact and to understand the relationship with the surrounding location.

Only through the virtual reconstruction is possible to grasp at a glance the complex shape of the building, the close relationship between the bedrock on which it was built and the reasons that determined the shape of the existing building and the causes of the original building.

3.2. The study of the original form: the model of the monument, model of the missing parts, structural and historical analysis

The virtual reconstruction of the existing building was followed by the study of virtual models of assumptions about how the Galya Bridge could have been in its entirety. The use of instrumentation for the production of three-dimensional scans has, in fact, given greater ease in realization of 3D virtual models that have formed the basis of the studies to understand the possible hypotheses of the formal aspects of the missing parts.

Processed data provided by the 3D scanner, were analyzed individually to draw elements that indicated the methods of construction of the missing parts (as for example the basis of the arches, statistic assumptions related to both construction techniques and quality of used materials, the results of the crack, the data emerging from the holes, etc..) and then all data were placed in relation to each other.

The various emerging solutions have been analysed and compared with the aim to distinguish those that were not clearly consistent with the overall picture of conveyed data with rather plausible.

The data obtained have led to the identification of the forms that have been transformed into a cloud of points and processed to form a 3D polygon mesh representative of the volume of the product.

The virtual reconstruction of the bridge was subjected to structural tests, linking it with the data of the river flow and the collection of seismic data in order to ensure its compatibility with the existing building.

While the technical reasons, inherent in the structure, although the analysis of the built through the study of 3D models, have led to identify a “likely” form of the bridge in origin, on the other, in parallel, a series of historical research was conducted related to artefacts, comparable on various degrees.

The analytical work of the building was then accompanied by the study of the building type, constructive consolidated model of the bridge, starting from structures dated to the same period, from declinations of the surrounding area in order to reach artefacts that have the same problems, or which employ the same technical and constructive solutions.

At the same time from the virtual model of the hypothesis of the bridge it was also possible to have an immediate physical reconstruction of a real model, made with a 3D printer, to discuss, get feedback and share studies with local communities.
4. Towards an active conservation of the monument

The virtual reconstruction of the bridge was determined by the need to study the existing structure and to be able to understand it before proceeding with the work of conservation. It’s inevitable, when the care of a monumental property is taken, to ask if what is being done is sufficient to ensure the survival and development of a monumental property, of the conservation work or whether it is, however, necessary and appropriate to think of an “active” conservation of a monumental property, able to preserve the historic and artistic interest?

What remains of Galya Bridge is in ruins, which, after the intervention of conservation, is bound to remain an archaeological building. But the place, the monumental property in itself with its original function and its history requires that the ancient artefact is not only properly stored and protected, but that it should be returned to “active” role within the territory and regain its function as an element part of a territory. The monumental assets are fragile: they need continued assistance, care, sometimes also of prostheses, in order not to decay.

A position supporter of positions meaninglessly intransigent (no addition to the artefact) is likely, in the specific case in question, to conduct a monument in a state of increasing “ruined” and up to determine its loss. It is the coexistence of old and new that can ensure the preservation and salvation of the monument: otherwise it would continue to persist in its state of disrepair and, since it is devoid of an active role within a territory, except its being a picturesque ruin, would ultimately be abandoned to its fate.

The project must, therefore, take on a dual instance: to ensure a strict conservation project for the monument, prepared in accordance with contemporary theories of scientific restoration, based on a “critical-conservative” able to ensure absolute respect of the ancient work ‘matter’ and its complex layers of history, and to verify whether a strategy of active preservation method of the object, can guarantee the good function of the monument as a connecting element between the two sides and its vital role in the economy of an area.

In what ways can action be taken for the enhancement of a fine monumental artefact returning it to its function as a “part of the bridge”?

Given that the project solution, properly being a “project”, is one of the possible hypotheses (and not the only “unambiguously correct), has the obligation to make their own instances of the criterion of “distinctiveness”, of minimum intervention, of “compatibility” and “reversibility” to ensure minimal invasiveness and the possibility of future changes or corrections without damage to the ancient monument.

The method “as it was where it was” is not acceptable (the principle of contemporaneity is established for several decades in the theory of restoration) nor would it be possible, as the artefact is not sufficiently documented. The nature of the place and the needs of the surrounding area require a solution that does not necessarily affirm with ostentation, while declaring, the contemporary intervention

Is Camillo Boito, one of the staunchest supporters of archaeological restoration, with his theories capable of going beyond ideological categories, the
scientist who shows the way: “as concerns parts that never existed or which lacks the sure knowledge of the primitive form, additions or renovations must be made in our contemporary way, warning that possibly in the apparent view of the new works do not damage the appearance of the old building.” This means not to advance towards the historic falsity and arbitrariness, as it has been criticized for the whole current of studies that sees in E. E. Viollet le Duc the founder, but this means to cultivate that loving care for the monument and to respect “the reasons of history and art without arbitrary deformations and false shifts. If only necessary and proper additions and accommodation requested by value and use.” With the precaution, that the same Boito used to repeat, “I have to make so that every one may discern/being a modern work addition”.

The project then becomes the specific instrument to assess the feasibility of reconstruction of a bridge “working”, making the manner of the ancient with contemporary criteria, rejecting both the logic of a reconstruction “in style” is that of a “new at all costs and proudly contemporary “. The project then becomes the fundamental mean for exploring the reasons of the artefact itself and identifying solutions that makes them eloquent, revealing practical reasons and the sense of their being within a territory and contributing to the enhancement of the historic monument and archaeology within the landscape setting in which it is inserted.

References
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