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THE BRIDGE OF THE VISCONTI FAMILY IN VALEGGIO SUL MINCIO: FROM PRESERVATION TO MAINTENANCE FOR A SAFEGUARD STRATEGY

II. LEVEL MASTER'S THESIS

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AIMS AND CRITERIA

Nowadays, we realize the importance of our historical-artistic heritage only when a dramatic event occurs and it deprives irremediably us of a part of a historical conscience that is the fundamental element of the unity of a people.

However, the loss of a monument is never a sudden and inexplicable action: the ancient construction, designed according to the Vitruvian triad of ***firmitas***, ***utilitas***, ***venustas***, always gives warning signs of its conditions.

But the correct preservation of cultural inheritance also depends on the nature of the projects that are made for it.

These projects often come from the wrong and dangerous idea that the only possible operation is to consolidate the existing construction by using building methods of modern conception.

The recent regulations relevant to the seismic issue have raised, instead, the need to use suitable instruments to intervene on the monument with a methodologically correct process, combining the undelayable necessities to achieve high levels of safety with the need to protect the monument itself.

The case study of the Visconti Bridge in Valeggio sul Mincio, an extraordinary example of hydraulic engineering and military architecture of the late Middle Ages, translates, on the operational plan, the need for an urgent restoration project based on minimum intervention and putting of the construction into safety according to the *all'OPCM 3274/03* [1] *and its following modifications and integrations*, while also verifying the contents of the ‹‹ *Linee Guida per la valutazione e riduzione del rischio sismico del patrimonio culturale con riferimento alle norme tecniche per le costruzioni*›› [2] [**Transl**. ‹‹ *Guidelines for the assessment and reduction of the seismic risk of the cultural inheritance with reference to the technical regulations for construction* ››.

The project includes the definitions of a way of analysis and a cognitive survey of the construction.

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1. THE MINCIO VALLEY DURING THE VISCONTIS' RULE

1.1 THE TERRITORY BETWEEN THE PAST AND THE PRESENT

The municipality of Valeggio sul Mincio rises to the Southwest of Verona, where the green and flat plain starts leaving space to a sweet hill that characterizes the snout where Garda Lake is inserted and protected.

This territory, so slightly closed and fortified by the Mincio River that even the poet Virgil described in his works ‹‹*… là in quella terra ove il Mincio, di molli canneti orlato le rive in lente spire va errando.*›› [1] [**Transl.**‹‹*… there in that land where Mincio, whose banks are bordered by soft reed-beds wanders in slow coils.*››] , has represented a strong point to Valeggio in the course of its history.

The exceptionality of this place was known since ancient times, when, during the Bronze Age, an Indo-European community lived on the Mincio, a few kilometers away from the Borghetto hamlet (a medieval village in Valeggio territory), a palafitte village.

The River was a source of food and protection and so its banks always welcomed numerous civilizations (Gallic, Etruscan and Romans) until it became, starting from the Scaligeris' rule and ending with the Viscontis' rule, a real defensive war weapon of the state.

Only in this geographic point of the territory since the Romans times had there been the unique passage between the Veneto and the Lombardy through the ancient Via Postumia and Via Gallica, a sort of *door* for the communications in Northern Italy. And, in the Middle Ages, the main way connecting the Po Plain with Germany passed through this territory. This and the particular conformation of the landscape made this land a nerve centre for several centuries, as well as a strategic place for historical events that occurred both at national and European level.

Still, nowadays, this *historical access* represents a crucial point for the communications in Northern Italy and it is also an instrument to organize the territory.
The transformation of buildings is focused along the roads that start from the centre and radiate out like a fan.

Indeed, in the Encyclopedic Atlas "Touring" [2], Valeggio is quoted as a characteristic example of this kind of development by defining it as a "development with a bridge at the centre" since the village is focused on its symbolic monument: the Visconti bridge.

Imposing, exceptional and unique work of hydraulic engineering of the late Middle Ages in Italy and Northern Europe, the Visconti Bridge, as it is named nowadays (even if it was designed to operate as a dam), was built on this *ancient road* and still now summarizes the exceptionality of this place. The no. 55 Provincial Road Valeggio – Volta Mantovana, which connects the Veneto Region to the Lombardy Region, passes on it and reconfirms the importance of the *passage* to the Northwest that history has handed down as well as how the bridge has become the distributive element of Valeggio buildings.

Even now, the peculiar elements of the landscape of the village of Valeggio are the Mincio river and the stout that are mainly unchanged in their morphology; these natural elements allowed the realization in 1393 of this *architectonic unicum* for the territory defense.

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[1]. Virgilio, *Georgiche,* book three , lines 14-15. Transl.

[2]. *Atlante Enciclopedico Touring, v. 1- Italia* – 1st Edition, Milan C. T. I., 1986, page 17, Map D.

1.2 THE MINCIO RIVER AND THE MORAINIC AMPHITEATRE

Important protagonists of the Lake Garda area, where Valeggio is located, are the Mincio river and the stout.

Speaking of their origins means telling a story that intertwines itself until mixing itself up and becoming, maybe, all one, inseparable elements in their genesis.

Even if they now look like two different landscapes in the remote post-glacial period, the configuration of the River and the glacial basin probably originated almost at the same time.

In fact, during the inter-glacial period, Mindel – Riss, the glaciers that covered the region of the Alps, started to retract because of the increase in temperature all over Europe and left a huge quantity of rocky debris in their place that a raging flooding river, scoring the territory with a large gorge, brought downstream.

The materials that laid down in this phase of terrestrial settlements with a semi-circular shape (from where the word "amphitheatre" comes from) was named *moraine*, whilst the raging avalanche of water and debris was less and less violent and reduced in its watercourse.

From this new land conformation and the slow draining of water in a course of limited dimensions, the Mincio River originated.

With a probable Latin root, the *Minctio* (Mincio) word, with the literal meaning of *drain*, can technically be translated as an “outflowing stream”; in fact, it is the only river coming out from Lake Garda.

Despite its limited dimensions (it is about 75 km long), the River passes through different natural environments: it outflows majestically from the Lake Garda; with a winding course, the Mincio longitudinally passes through the glacial rises and crosses them from the North to the South, passes the sweet unevenness that it meets in the tract between the Frati Mount and the Ogheri Mount, and then keeps an even course and reaches the large fan of Valeggio where it builds a series of palaeowatercourses.

In the surroundings of Grazie a Borgoforte (Mantua) where there is the most important paleowatercourse of Mincio, the River modifies its course and takes a new direction: West-East.

Now it licks a mostly marshy environment with its green water up to the town of Mantua. There, together with numerous resurgences, it contributes to the formation of three lakes from which it outflows.

Similar to an artificial canal, the Mincio starts its course again to meet and join the Po River.

Therefore, the territory where the Mincio passes through is very varied : the sweet profiles of the glacial hills that gradually descend to the river, passes the rapid slope with the characteristic trend of a mountain ridge and then the river "gets lost" in the open plain of Mantua.

If the Po Plain appeals for its infinite space, the stout, especially the Garda one, shocks for its numerous evidences of the glaciations that stratified on its rocks.

The *moraines* are accumulations of filling material with a curve conformation [1] of three different types:

- front moraines;
- side moraines;
- bottom moraines.

In the Garda area, there are the first two types of *moraines* that give the landscape the typical conformation of an amphitheatre for their semi-circular shape, which is a kind of natural basin in an even land.

This rich and complex environmental context has its raison d'être, thanks to the existence of the Lake Garda.

This is the largest Italian lake that originated its primordial shape during the Pliocene, in the Tertiary Era, when slow and strong telluric movements made large limestone masses detach from the Monte Baldo and created the concave shape that started the transformation defined a *lake* [2].

Later, in the Quaternary Era, glaciers started their descent to the valley and their forward movement modified the lake banks and created the typical inlets that edge still now the lake borders.

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1.3 THE FORTIFICATION : A CONSTRUCTION IN SYMBIOSIS WITH THE CHARACTER OF THE PLACES

In a country such as Italy [1], which, in every corner of its territory, can still boast endless examples of historical architectures that keep, even in the case of the simplest work, high stylistic and decorative categories, the interest in fortified architecture is quite recent.

These structures, considered up to a few decades ago only as places of domination, injustice and torture, were designed, according to such deep structural and spatial knowledge of the places where they were built, that only few other historical constructions can be compared to them.

Then, if we add that, thanks to these fortifications, entire populations in the course of history found a safe shelter from war and devastating plagues, and even that they allowed the defense of urban centers, we realize why the attention to this architectonic heritage has been increasing in these most recent years.

The castles, the fortified hamlets and the turreted walls are no longer classified by the academics only as sinister defense means, but as an organizing element of our territory that comes from it, uses the materials of the place and becomes an integrating part of the landscape by strengthening those places, which that were already naturally strategic, with its structures.

According to this point of view, the defensive system is no longer in contrast with the environment where it is inserted. Instead, it is an integral part of it.

The case of the Visconti bridge in Valeggio sul Mincio is a demonstration of how human work blended with the particular conformation of the place.

The place that nature had created - a particular fortified place by a semicircle of glacial hills, a large water mirror, Garda Lake and its only outflowing stream, the Mincio River, the Visconti dam-bridge with its typical barrage implant that stresses it in such a way that it can be considered *safe* and *beautiful* over centuries.

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1.4 THE VISCONTIS' RULE: THE TERRITORY AS AN EXPERIENCE LABORATORY FOR FORTIFIED ARCHITECTURE

Since the remotest time, when choosing a settling place, every population has always tried to create defensive structures in order to fight enemy attacks. Yet the simple *fence* was an easy, but unmistakable way, to defend a property.

Then, every historical period has elaborated its own fortified architecture that showed power and, at the same time, could organize society.

In fact, during the Middle Ages, the birth of the *urban commune*, whose centre often developed around a castle, led to the creation of independent states with their own statutes.

Finally, each rule at the end of its own political confirmation has used military work as an instrument to strengthen the State.

It is during the rule of Gian Galeazzo Visconti (1378-1402) that the expansionist policy of the Milanese family reached borders never touched before.

However, the family of Milan was always aware that the fortified structure was a construction to defend themselves from the external threats and, above all, from the most frightening internal aggressions [1].

Only thanks to large military structures were they able to ensure a methodical internal unity and a potential external defense.

Moreover, the Viscontis knew that they had to be enterprising builders of fortified structures in order to be great leaders and powerful rulers of a very large territory.

Thus, their dominations became *laboratories* of trials for unique experiences.

The works all have huge dimensions and have a common denominator : natural border, the river and a strategic geographic position to defend.

The centrality of the place and the orographic conformation of the territory are fundamental basis where resting the new expansionistic policy.

The **fortified bridge of Lecco** (1336), the **covered and fortified bridge of Pavia** (1351), the **fortified bridge of Trezzo d'Adda** (1377 probable date of completion), the **bridge–dam of Valeggio sul Mincio** (1393) and, exactly at the end of the Visconti domination, the **bridge-dam of Bassano del Grappa** (1402) were large scale interventions that allowed to consolidate the rule of the Lords from Milan.

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1.5 THE BRIDGE-DAM OF VALEGGIO SUL MINCIO: A MEDIEVAL CONSTRUCTION, A MODERN CONCEPTION BUILDING YARD

In 1393, the year when the *construction* of Valeggio sul Mincio began, the Visconti's were the masters of the Upper Veneto. The new expansionistic aims of the Milanese family targeted the Southern part.

The success of this project was certain : Gian Galeazzo Visconti, better than his predecessors, was aware that the consolidation of the territorial states under the Viscontis'rule was possible only by an aggressive military policy and the use of imposing defensive structures designed as *war machines.*

The alarm in Northern Italy was so high that since 1392, to contain the expansionistic aims of the Visconti's, people of Mantua, Este, Modena, Padua, Faenza, Bologna and Florence set up a League to defend themselves against the invasions of the Milanese Lords; the union was also supported by Venice, concerned with defending the land just conquered.

Mantua was the state that, in that period, was mostly under the pressure of the Viscontis' ambitious aims.

The bridge – dam that the Count of Virtue was having built on the Mincio River in Valeggio (Ill. 1), at a few steps from the Gonzaga family town, appeared to be able to neutralize those natural defenses that had always protected these lands.

In fact, Mantua, an island more than a town because it is surrounded by its lakes also supplied with the waters of the Mincio River, was doubly fortified as regards to other towns.

The barrage work of the Mincio River, if it had been designed with these aims, would have deprived Mantua of its natural defenses and would have made it easily attackable by the troops of Gian Galeazzo Visconti.

According to the studies of Cassi Ramelli [1], who had the merit of having clarified a few fundamental issues about the real function of the Veronese construction, the aim of the dam was not to change the Mincio course.

At those times, the work was not possible for several reasons, such as the following :

- hardness of the grounds;
- great height of the hills;

Illustration 1 – The bridge – dam of Valeggio sul Mincio (Verona)

❖ exaggerated deepness of the deflection canal.

The total draining of the Mantuan lakes was almost impossible since they were not only supplied by the Mincio River, but also by rich resurgences; therefore, the academic hypothesis appears to be valid.

The aim of the bridge-dam of Valeggio sul Mincio was to expand the hilly basin bordered by the Verona Serraglio and crossed by the Mincio river between Peschiera and Valeggio in order to create a natural defense able to repel every enemy attack and to close that *door* that had always been the only existing passage between the Veneto Region and the Lombardy Region.

Despite the aims at the basis of the project, it was surely a huge work for different reasons :

- its dimensions;
- its cost;

its realization time.

It is a construction about 650 meters long, set transversally along the course of the Mincio River, with a trapezoidal section, with a base 25 m large and a top 22 m large and about 9-10 tall from the water for a total of ‹‹*…150.000 mc. di vario muro fuori terra… che, Domenico da Firenze progettò e diresse per conto di Gian Galeazzo Visconti, duca di Milano* ›› [2] [**Transl** ‹‹*…150,000 cubic meters of various wall out of ground … that Domenico da Firenze designed and managed on behalf of Gian Galeazzo Visconti, duke of Milan* ››].

The long wall, without considering the central part directly on the river that was destroyed by *mortars,* is spaced out with 24 turrets and is protected by four doors-towers, two of them placed at the final ends of the barrage whilst the Rivellino Tower and the Castellana Tower are in the center of the structure.

This latest construction of large dimensions was designed as a castle and is surely the crucial point of the entire fortified system.

The cost of the work was 100,000 florins, an amount of money that was enormous and fantastic for those times.

The rapidity the project achieved was also extraordinary: the construction, at least on its foundations, lasted only eight months, from April to November 1393.

Then the works were interrupted for political and military reasons.

The League, set up in 1392 for the defense against the Viscontis' war aims, suspended all works in order to appease the controversies raised among the bordering states and Milan.

After the interruption of construction, the bridge story had the following destiny :

⇒ from 1393 to about 1397, the construction was forgotten until it started its secondary function as a bridge, promoted in the Veneto period (1405-1512);

⇒ 1451 is the year when the first repair works of the bridge date back. The Archives report that the structure was already defined as a *bridge*;

⇒ 1509-1512 collapse of the central part caused by the Venetians and people from Valeggio, in opposition to the tradition according to which the Bridge was mined by French people during their retreat in 1701;

⇒ from 1512 to 1929 the bridge *was not used and kept closed of*;

⇒ 1929 reopening to traffic with the insertion of a metal girder in the central part of the historical structure.

The hypothetical reconstruction of the demolished body (Ill. 2), which is considered very reliable, was made by the historian Gazzola.

According to the academic, after the drawbridges of the Castellana and Rivellino towers were drawn up, the collapsed part of the structure was designed as a separate tower, even if there were large rooms to retreat to in the event of an enemy attack.

This part of the fortress was organized on three levels of communication trench.

The first communication trench, called *ronda (patrol)* and therefore external, was located at a short distance from the River water above the four canals of flow that are now almost completely destroyed.

The second communication trench, for emergency situations, was inside the structure and connected to this part of the construction with the Castellana Tower and Rivellino.

The third communication trench was at the same height of the dam-bridge in top position. Thanks to the drawbridges of the two adjacent Towers, the central body could be isolated from the entire structure and become a fortress itself.

From the architectonic point of view, the entire construction is a large sloped wall, still imposing and admirable, fortified by towers and turrets with a typical medieval structure.

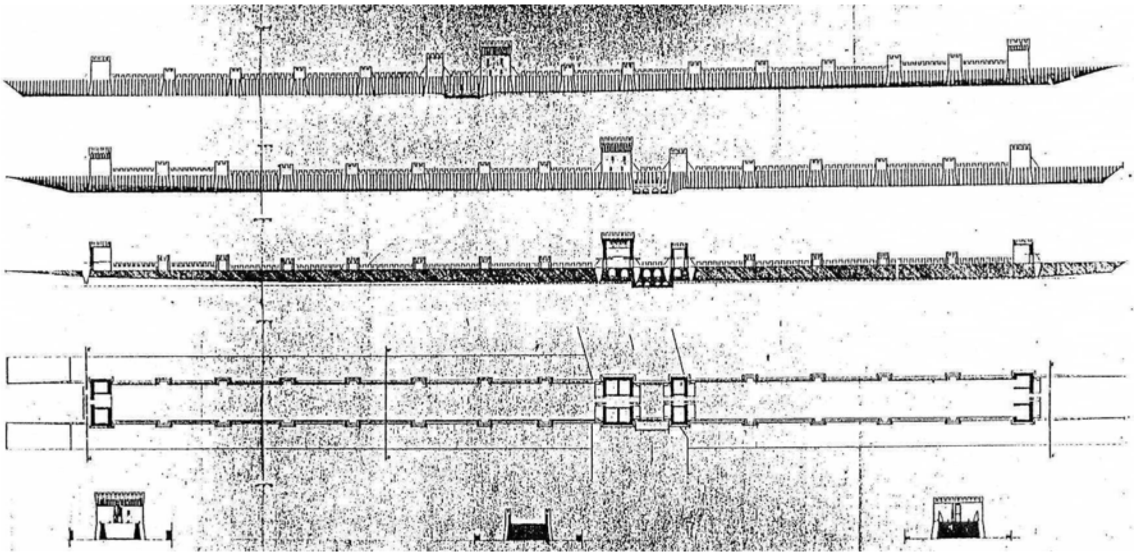

Illustration 2 – Hypotetical reconstruction of medieval setting up bridge
P. Gazzola, *Inventario dei castelli della provincia di Verona* – IBI sez. Italiana 1963, unpublished, sch. I. VR. 89. 5c.

The basement part was realized by a fill-up building technique with a Roman origin and also studied by Andrea Palladio: wooden tables dug perpendicularly on the ground where mortar, morainal stones and filling material were laid.

The building method used in this work could be similar to the one that the Architect Perbellini has hypothesized in his study relevant to this monument [3], that can be compared to a modern tubular structure made from vertical, horizontal and transversal elements with the only exception of the used material that is wood.

Therefore, it is a quite simple structure made in a short time that was made in the following way: a level of works was built, the scaffold was erected and then the second level of works was carried out and similarly all other phases were performed by ensuring that the construction work proceeded fast.

This kind of structure was temporary and was useful to building works; as soon as works were completed, wooden parts were dismantled to be used in another building yard or they were left at the place until they were naturally destroyed. This was the case of the Visconti Bridge.

The entire embankment structure and the tower basement were built in the same period whilst the standing-up part seem to show, also, different moments of working.

Nevertheless, different execution phases can correspond to a precise structural choice.

Presently, only the following assessment can be done: while we see a mainly mixed masonry at the base (pebble-stones, parts of roof tiles mixed to mortar, such as a kind of concrete conglomerate), by proceeding to the upper part of the towers, bricks are prevailing in few points only as coating in others with a continuous section.

Despite the project not being completed because of purely political reasons, the fortified structure of Valeggio sul Mincio was thought as a barrage on the Mincio River as well as Viscontis' castle.

In fact, the Castellana Tower, the only element rising up in the entire construction, had characteristics similar to a real castle and could be easily separated by the remaining part of the fortification of drawbridges.

In the Visconti architecture, the *Torre Castellana*, usually used as a control center, was much bigger than other towers. In fact, in the case of this fortification, the dimensions of the plant and of the raised part are characteristics that immediately impress the visitor.

Such as in a castle, the ground floor was meant to collect machines, food and men of the presidio; there were the rooms with fireplaces in each room to the upper floors; in the basements, there are two large vaulted rooms, about twenty meters long, used in emergency situations.

The stairs had a double function: connecting the floors and making vapors from the masonry arrangement escape.

This construction method is described by Leon Battista Alberti ‹‹ *Negli edifici di grande mole, in cui i muri dovranno essere di maggiore spessore, si devono lasciare all'interno della muratura, dalle fondamenta fino alla cima, degli spiragli aperti, non molto lontani tra loro. Da queste aperture, potranno sgorgare senza difficoltà e senza mettere a repentaglio la struttura dell'opera i vapori eventualmente formatisi sotto terra e ivi postisi in movimento. Più volte gli antichi sistemarono, all'interno di esse, delle scale a chiocciola, vuoi per questo stesso scopo, vuoi per l'utilità della cosa - dandosi in tal modo una salita fino alla sommità dell'edificio – vuoi forse per risparmiare sulla spesa* ›› [4] [**Transl.**‹‹ *In buildings of large dimensions, where walls are thicker, inside masonry, from the foundations up to the top, open air - hole must be left and not be very distant from each other. From these openings, vapors that can be vented underground can escape easily and without endangering the work structure.*

Often the ancients arranged winding staircases inside them, both for this same purpose, and for the fact that they were useful to climb up to the building top and maybe to save on the cost. ››]

In the case of the bridge of Valeggio, even if the stairs are positioned in a corner area and not inside the wall thickness, we can suppose they were probably used as a vent if we also consider the building construction period - at least eight months for the base part and three months for the subsidence of masonry (in these areas of the province of Verona, the values of relative humidity are quite high so that masonry seasoning is slower).

Finally, the system of covering doors- towers.

In the Viscontis' architecture, the horizontal closing element is an integral part of the construction; also, this structure was born for climate reasons and has an almost flat typology.

In the case of the Castellana Tower, the architectonic rising element of the bridge-dam of Valeggio, the covering is no longer there, but its existence is certain.

In fact, from an historical document of 1451 proving that a few repairing works were carried out for an amount of ‹‹… duc. rum LXXX ›› we learn that the towers were covered by roofs and we think also that some rooms were used for lodging.

We do not know anything about the adopted typology of the roof, even if the academic Gazzola puts forward his historical reconstruction of the Castellana Tower redrawing it, with a flat roof and resting on the underneath vaults to this Tower.

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Virgilio, *Georgiche,* Book III , lines 14-15. Transl.

2. THE KNOWLEDGE OF THE BUILDING

2.1 THE METHODOLOGY OF SURVEYING A HISTORICAL BUILDING

The intervention on a historical building is surely an extremely complex operation both because it is necessary to intervene in conformity with the building characteristics by choosing a suitable consolidation intervention [1] and because the old structure has to be adapted to new functional needs.

In the case of structures, such as the Visconti bridge, where the history of the building entwined with the political and economical events of Valeggio and defined its present aspect, it is essential to define a methodological approach of knowledge of the *building* so that a database relevant to the conditions of preservation (and transformations in the course of history) can be available after the surveys are completed. Moreover, the methodological approach also allows for the evaluation of the level of structure’s vulnerability, which is the structure’s seismic risk indicator. This latest aspect is particularly important in the light of recent regulations and indications relevant to the behaviour assessment of historical buildings in seismic zones, in particular the *OPCM 3274/03* [2] *and its following modifications and integrations,* and the ‹‹*Guidelines for the assessment and reduction of the seismic risk of the cultural inheritance with reference to the technical regulations for construction*›› [3].

Therefore, this study aims at evaluating the vulnerability and safety of the Visconti Bridge as regards expected seismic events by using, in particular, the contents of the *Guidelines* as a trace for the analysis and evaluation of the seismic behaviour. Specifically, the method of combining the building knowledge (LCi) with the assessment of the seismic risk (LVi) will be applied, since this method will allow one to define interpretative and corrective patterns in order to pass from mainly qualitative evaluations to quantitative specifications, first on single parts – local verifications – and then on the entire complex – global verifications.

In light of the survey results, an improvement and preservation program relevant to the chosen part of the building will be proposed.

The first phase of the study foresees the development of the ***knowledge trail,*** which will be divided into three moments :

- historical survey and Archives;
- geometric survey;
- material and construction survey with specifications relevant to degradation and building subsidence.

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2.2 THE BRIDGE'S CONSTRUCTIVE HISTORY AND THE PLACES' SEISMIC EVENTS

The first step of knowledge is to reconstruct the entire story of the architectonic element.

The study of the building's history will always be linked to places and landscape that made the building itself imposing and also able to affect the behaviour of construction in the event of natural disasters.

Throughout times of peace and war, the connection between the ancient structure and its environmental context was once of strict dependence and complete abandonment, a symbiotic relationship that was often conflictual.

Besides supplying a complete picture relevant to the construction process and its most significant transformations, the aim of this first survey is to identify, from a quality point of view, the structural behaviour of the construction, its transformation in the course of history and its reactions to particular catastrophic events.

Therefore, this historical research will supply the knowledge that, in which, proper answers will be researched [1].

The historical research on the Visconti Bridge (up to now) showed that the significant moments from the structural point of view can be summarized by the following dates:

- **1393** : between April and November of this year, the basement part of the bridge (about 600 m long) were certainly built
- **1393/1397** : the project of deflection of the Mincio water was interrupted for political reasons ;
- **1451** : first repair works ‹‹…*reparareque certam partem unius muri ruinati a parte interiori et coperire dictam turrim…ad summam circa duc.rum LXXX…*›› [2].
  The construction is already named *bridge*;
- **1509/1512** : collapse of the central part of the dam where Venetian troops and the Valeggio people [3] placed mines while they were retreating. The tradition reports this episode differently.
- **1701** : according to the tradition, but wrong, this is the date of the collapse

caused by the French army;

- **1509/ 1512 - 1929**: the bridge is closed off ;
- end of **1600** : the bridge belongs to the Maffei Counts ;
- **1820/1901** : likely collapse of a large part of the wall of the West front of the CastellanaTower as shows the cross-checking of two historical documents: a printing dating back to 1820 (Ill. 1) and a reproduction of a postcard dating back to August 1901 (Ill. 2).
- **1929** : after the expropriation, the bridge is open to traffic and a metal girder is inserted in the central part of the structure;
- **1950** : for the first time in a photo of the period, a deep threatening crack appears under the springer of the metal bridge;
- **1993** : 600th anniversary of the construction.
- **1993/95** about : restoration interventions on the Castellana Tower and on the Tower to Volta Mantovana;
- **2007** : Pilot Project.

Besides this research, from the consultation of reports relevant to the seismicity of the area, we deduct that, in the most important dates of the building, the places were hit by quite important seismic events.

These latest data add new important information to the historical knowledge of the building [4] and also venture some suggestions that were not known at the time of the Thesis from which this study starts from: the modifications on the Visconti Bridge could have been affected by political-cultural events and also by natural disastrous events in the area where the building is located (Ill. 3).

The chronicles of the seismic events in the Verona area, starting from 1393 (the Visconti bridge building date), report the following information [5]:

1397 dicembre 26: *Circa l'ora di terza si fecero sentire grandi scosse di terremoto in Verona le quali furono rovinose in tutta la Lombardia dove fecero crollare molti edifici.(Rif .6-18-30)*

[**Transl.** *1397 December 26*: At about 9 a.m. *large tremors in Verona were felt, these were disastrous for all of Lombardy and many buildings collapsed.*]

1445 marzo 21: *La Domenica delle Palme alle ore 20 circa " in su la hora che se predicava" in Verona vi fu grandissimo terremoto...(Rif. 6-18)* [**Transl.** *1445 March 21*: *On Palm Sunday at about 8 pm, "while they were preaching", there was a great earthquake in Verona…*]

1492: *…in città uno spaventoso terremoto fece rovinare molte case con la perdita di molte persone. (Rif. 6-18-28-31)** [**Trans**l. *1492*: *…in the town, a terrible earthquake destroyed many houses and lots of people died*]

1501 giugno 05: Alle ore 15 circa in Verona vi fu un grandissimo terremoto…(Rif. 6-18-28) [**Transl**. *1501* June 5: *At about 3, in Verona, there was a very strong earthquake…]*

Illustration 1 – ‹‹ *Ponte lungo sul Mincio al Borghetto* ››

Tav. XXXV. Da Persico Giovanbattista. *Descrizione di Verona* e *della sua Provincia.* Verona, 1820. Private collection.

Illustration 2 - Old postacard reproduction

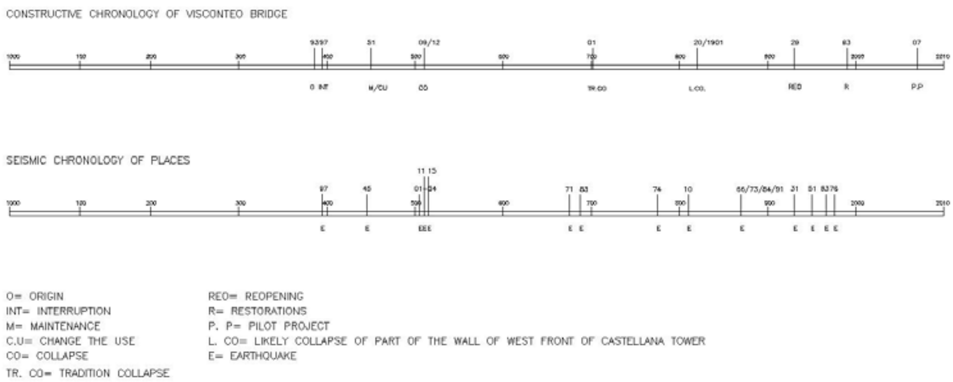

Illustration 3 - The bridge's constructive history and the places' seismic events

1504 dicembre 31: …*A Verona storicamente viene registrato come un grande terremoto. Le repliche si protrarrono anche nell'anno 1505 per un periodo di quattro mesi. (Rif. 6-17-18)* [**Transl**. 1504 December 31: …*A very strong earthquake is recorded in Verona. Tremors continued in 1505 for four month.*]
1505 gennaio 3: …in Verona questa scossa benché sia stata de scritta grande non fece danni.. .(Rif. 6-18) [**Transl**. *1505 January 3*: **…***in Verona this tremor, even if described as a big one, did not cause any damage …*]
*1511 marzo 26: … In Verona… la cronaca riporta …in fra le hore 20 e le 21 fu grandissimo terremoto tanto che nessuno mai ricordava di averne sentito di maggiori…(Rif. 6-17-18-28)** [**Trans**l. *1511 March 26*: *… In Verona… chronicles state that …between 8 and 9 pm, there was a very big earthquake that nobody remembered ever feeling one bigger…*]

At this point of historiography, even if no archive documents report any news relevant to the preservation conditions of the bridge, simple deductions on the ancient wall conditions can be done by observing two historical images (shown above) of the monument.

In the period between 1820/1901, the bridge seems to have suffered from other damages which mainly affect the West front of the Castellana Tower.

From history, we know that these places were fields of great battles (1848 and 1866 Independence wars), but even the seismic chronology of those years seems to entwine again with the destiny of the bridge.

Surely, the monument resisted to exceptional events, such as wars and earthquakes that would cause, even singularly, great stresses to any building.

Leaving apart the historical events of that period, we report the most important telluric movements that hit the Verona territory (hit also by other minor events) and which could have contributed to damaging the bridge.

Shortly before this period, two earthquakes are reported in the area of Mount Baldo, opening a long period of seismic activity that started in these areas:

1809 novembre 21: Si legge nè Ricordi Storici di G. Perazzini da Zevio, che negli anni 1809 e 1810 accadde uno dei massimi sismici nel Monte Baldo…(Rif. 7-22) [**Transl**. *1809 November 21*: *the Ricordi Stoics by G. Perazzini da Zevio reports that, in 1809 and 1810, one of the greatest earthquakse took place at Monte Baldo…*]

1810 maggio 01: *Nel giorno una fortissima scossa del terremoto urtava le falde occidentali del Monte Baldo e venne avvertita sia sulla sponda Orientale che Occidentale del Lago…(Rif. 6-7-7bis-18-30)* [**Transl**. *1810 May 1: On that day, a very strong tremor hit the western stratums of Mount Baldo and was also felt on the Eastern and Western banks of the Lake …*]

1866 febbraio 14: *In quest'anno si aprì un nuovo e lungo periodo di agitazione sismica nel Monte Baldo, tremiti, scotimenti, muggiti sotterranei ed altri fenomeni minori…(Rif. 6-18-22)* [**Transl.** *1866 February 14*: *In this year, a new and long period of seismic agitation in Mount Baldo, tremors, shakes, underground noises and other minor phenomena ….*]

1867: Continuò quest'anno nel Monte Baldo il periodo sismico. Sebbene l'intensità dei fenomeni fosse inferiore a quella dell'anno 1866 non mancarono dei massimi sismici intercalati con periodi di relativa calma ma mai assoluta. Uno di questi massimi sismici (sciami) accadde il 2 di febbraio quando i fenomeni sotterranei si produssero con straordinaria violenza.(Rif. 30) [**Transl.** *1867*: *In this year, the seismic activity continued in the Mount Baldo. But the intensity of the phenomena was inferior to the one in 1866; large seismic swarms were alternated with relatively calm periods, although never completely. One of the greatest swarms took place on 2nd February when underground phenomena was particularly violent…*]

1868 gennaio: *Nel Monte Baldo dal mese di gennaio al luglio i fenomeni sismici non presentarono, si può dire, un periodo di tregua. Furono violentissimi specialmente nella prima e terza decade di gennaio e nella seconda di febbraio…(Rif. 18-19-30-32)****…*[**Transl.** *1868 January*: *From January to July, no seismic phenomena took place in Mount Baldo, we can say it was a period of truce. They were very violent in the first and last ten days of January and in the second ten days of February…*]

1873: *… Il giorno 15 giugno alle ore 9 pom. si avvertiva una scossa di terremoto a Riva del Garda….Nel giorno 29 giugno…..Fu fortissimo in tutta la catena del Monte Baldo e sulle rive del Lago di Garda quasi che il centro sismico Baldense svegliatosi a sua volta sovrapponesse le sue vibrazioni a quelle che si propagavano dal Bellunese…*[**Transl.** *1873*: *… on 15th June at 9 pm, a tremor was felt in Riva del Garda…On 29th June…..a very strong tremor along the entire chain of Mount Baldo and on the banks of Lake Garda as if the seismic centre of Mount Baldo also woke up and superimposed its vibrations to the tremor that propagated from the Belluno area …*]

*1879 gennaio 04***:** *Nel corso dell'anno il Monte baldo si mantenne in uno stato di agitazione quasi mai interrotta…(Rif. 1-6-18-30-32)* [**Transl.** *1879 January 4***:** *In the course of the year, Mount Baldo almost maintained a constant condition of agitation …*]

*1884 febbraio 19***:** *"In questo mese fra il giorno 17 ed il 20 la trepidazione del suolo fu fortissima in Verona e nel Monte Baldo… (Rif. 4-18-30-22)* [**Transl.** *1884 February 19***:** *"In this month, between 17th and 20th , the land tremor was very strong in Verona and Mount Baldo…*]

*1891***:** *…Giornale l'Arena 8 giugno "IL TERREMOTO SENTITO IN CITTA" Da parecchi anni nel Veneto non andavamo soggetti a violenti scosse di terremoto…una terribile scossa sussultoria preceduta da un rombo fortissimo mise soqquadro la popolazione. La scossa fu infatti tremenda…Giornale l'Arena 22 giugno…tutte le scosse telluriche erano precedute dall'urlo del rombo che veniva sempre dalle regioni del Monte Baldo…(Rif. 18-23-25-30-32)** [**Transl.** *1891: …The L'Arena (newspaper) on 8th June, "EARTHQUAKE IN THE CITY". For several years in the Veneto Region, we haven't suffered from the violent shakes of an earthquake. … a terrible shaking tremor proceeded by a very loud roar threw the population in confusion. In fact, the shaking was terrible. …The L'Arena on 22nd June … all telluric movements were proceeded by the roar that always came from the regions of Mount Baldo …*]

1896: …il 18 settembre alle ore 01.17 ant. una scossa abbastanza forte preceduta da leggero rombo a carattere ondulatorio e della durata di 2 secondi si faceva sentire a Badia Calavena ed in tutta la Provincia con direzione Est- Ovest…(Rif. 30-32) [**Transl.** 1896**:** *…on 18th September at 1.17 am, a very strong tremor was proceeded by a light roar with an undulatory movement that lasted 2 seconds and was felt in Badia Calavena and in the entire Province from East-West…*

*1900 marzo 04***:** *Un terremoto che colpiva fortemente il Trevigiano portando leggeri danni e molto panico nella popolazione irradiava le sue oscillazioni in tutto il Veneto compreso Verona e Provincia…(Rif. 32)* [**Transl.** *1900 March 4***:** *A earthquake strongly hit the Treviso area and caused little damage, but much panic in the population and irradiated its shakes throughout the Veneto Region, including Verona and its Province …*]

In the years when the Visconti Bridge was opened to traffic by the insertion of a metal girder, another seismic wave hit the monument.

1931 aprile 15: *…A Torri del Benaco fu forte con moto sussultorio – ondulatorio per la durata di parecchi secondi…Secondo l'Osservatorio di Venezia l'epicentro fu nel Lago di Garda – Adamello…(Rif. 32)** [**Transl.** *1931 April 15*: *…In Torri del Benaco, a strong shaking and undulatory movement lasting a few seconds ….According to the Venice Observatory, the epicentre was in Lake Garda – Adamello…*]

*1936 giugno 21: Uno sciame sismico interessò il Basso Garda con scosse più o meno sensibili, alcune delle quali furono intese fino a Verona…(Rif. 24-32)** [**Transl.** *1936 June 21*: *A seismic swarm hit the Basso Garda area with, more or less, considerable tremors, a few of them were also felt in Verona…*]

1948 luglio 19: *…Un particolare allarme il terremoto lo ha suscitato nella zona del Garda dove nel 1930 i fenomeni sismici raggiunsero una eccezionale frequenza destando vivo panico fra quelle popolazioni…(Rif. 32)* [**Transl.** *1948 July 19*: *…A particular earthquake rose alarm in the Lake Garda area where, in 1930, the seismic phenomena was exceptionally frequent and caused great panic in the populations …*]

1951: ...Il giorno 15 maggio un esteso terremoto con epicentro il confine Italo-Svizzero colpiva con notevole entità tutta l'Italia Settentrionale. Le scosse furono intese particolarmente intense nella zona del Lago di Garda...(Rif. 32) [**Transl.** *1951: ...On 15th May, a large earthquake, with the epicentre in the Italian-Swiss border, greatly hit all of Northern Italy. The tremors were particularly felt in the Garda Lake area…*]

A few months later, for a particular coincidence, on 10th February 1952 the Engineer A. Carteri presented a *COST ESTIMATE ‹‹ for the reinforcement and arrangementof works in the Scaligero Castle and Visconti Bridge in Valeggio sul Mincio* ›› [6], the total amount for the bridge restoration was 153,900 liras.

The intervention description is not specified : ‹‹ *consolidation and reinforcement of the walls, top parts and unsafe terracotta and stone walls with terracotta material, stones and concrete mortar …››,* but the amount itself indicates the substance of works.

The exceptional dimensions of the works weighed on the work estimate, but the preservation conditions of the Bridge were surely already bothersome.

In the following years, other seismic tremors were reported, but luckily they were quite moderate.

The last seismic event, sadly known at a national level, dates back to 1976, when a violent earthquake hit the Friuli region and even irradiated the Verona area.

We also report the numerous and very violent tremors that, on **15th September,** struck the lands of the devastated Friuli again and were even felt in the entire Veneto region.

In the Verona area, the telluric phenomenon was mostly perceived in the hilly area and partially in the mountain area of the Lower Plain.

> *1976***:** *…Il 13 dicembre alle ore 06.24.39 un terremoto pari al 6° Mercalli con la durata di 3/4 secondi provocava seri danni agli edifici del Centro storico di Riva del Garda…l'epicentro fu localizzato nella zona del Monte Baldo…(Rif. 32)* *[**Transl.** *1976***:** *…On 13th December at 06.24.39 am, an earthquake, equal to 6 degrees on the Mercalli scale with a duration of 3-4 seconds, caused serious damage to the buildings of the Historical Centre of Riva del Garda…the epicentre was focused in the Mount Baldo area…*]

Also in the 80's and 90's, other telluric movements are reported, but they are not particularly significant.

During those years (1993/1995), there were the first important restoration works on the Castellana Tower and on the Tower towards Volta Mantovana.

To finish this first phase of research, the only historical datum (deducted from an Archives document) that we can deduct from studying the structure is the following : the first repairing works that can be historically datable, also for the amount of the expenses, involved a part of the walls and the covering of one of the towers.

Nothing is said about the preservation conditions of the basement part and, therefore, we suppose that this is the true supporting system of the entire building up to the beginning of the twentieth century.

In fact, the dimensions prove it : the foundations corresponding to the barrage have a trapezoidal section at the base of 25 m and a top of 22 m.

In three documents of the period, a xylograph of 1876 (Ill. 4) and two postcard reproductions, dating back to the first years of the last century (Ill. 5-6), still show the Visconti Bridge interrupted in the central part, but the deep crack that has been marking the wall below the metal girder for several decades is not yet visible.

The first evidence of this subsidence is reported for the first time in a reproduction of the time dating back to 1950 (Ill. 7) and its dimensions are alarming, even at that time.

Nowadays, the situation is quite critical at this point of the structure.

The possible suggestion is that the modern insertion has probably affected (over years) the supporting structure of the historical building that was probably also weakened by seismic events.

Reading the ‹‹ *VISIT REPORT AND TESTING CERTIFICATE of works relevant to the construction of a passageway with a metal girder on the Mincio River for the passage of the new town road on the Visconti Bridge of Borghetto* ›› [7], we learn that, after the load test, they reported a ‹‹…*a permanent failure of the supports of 1 m/m and a maximum permanent bending as regards the original position at the height of the centre-line of m/m 4 for each girder* ››, but these deformations were considered completely normal.

Illustration 4 - ‹‹ *Bridge of Borghetto, near Valeggio* ››

Original Xylograph, Kaden, Milan, 1876. Private collection.

Illustration 5 – Old postacard reproduction

Illustration 6 – Old postcard reproduction

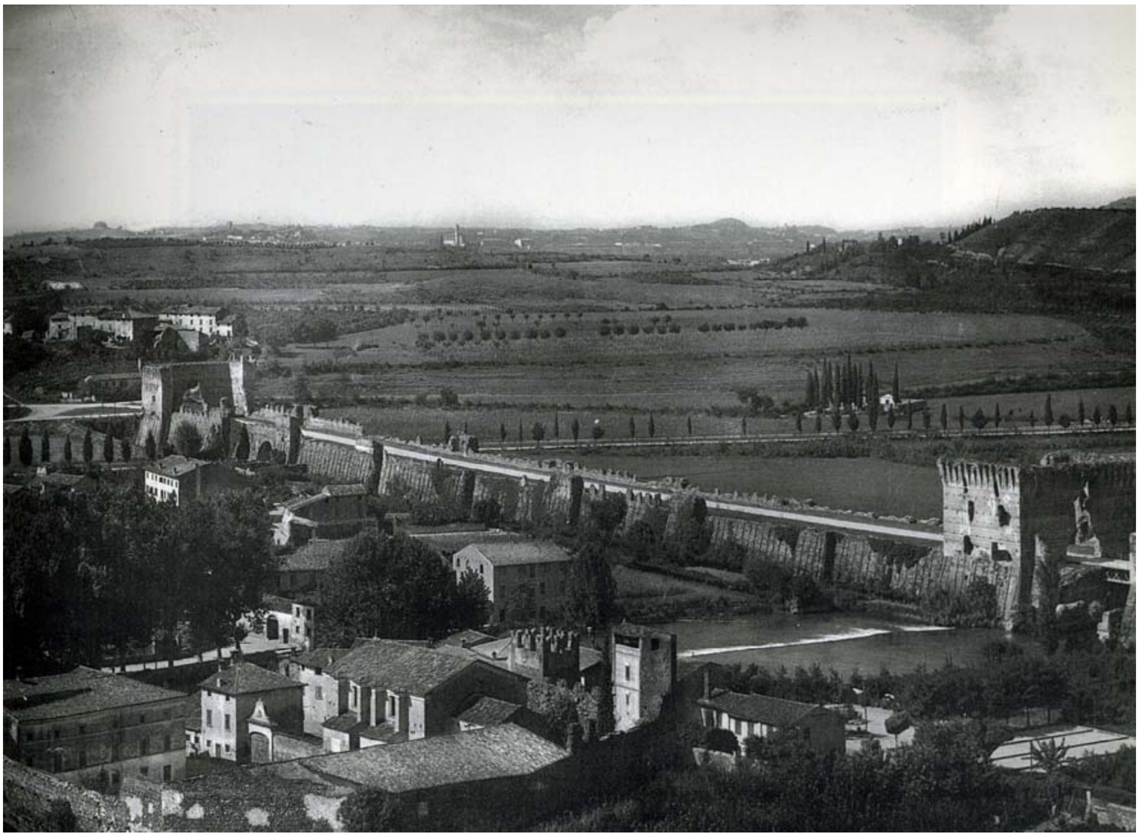

Illustration 7 – ‹‹ *Borghetto, 1950*››
VALEGGIO SUL MINCIO: SENTIMENTO DEL TEMPO.
Cento anni di immagini Fotografiche
Edited by: Cesare Farinelli – Giorgio Rovina.
Associazione Pro loco – Valeggio sul Mincio, Grafiche Ci.Ti., 1995, p. 97

To end this paragraph and to demonstrate the geological nature of the territory entwined with the destiny of a few buildings of Valeggio, two sad events that took place in the village are reported where the collapses were probably caused by delayed effects of the previous earthquakes:

17th April 1963: collapse of the bell tower of a parish church built in 1927 in Vanoni-Remelli [8];

- **21st January 1977:** collapse of the Serraglio Scaligero Tower that was used as a bell tower in Valeggio.

In fact, the seismic chronology reports the following :

*1963 marzo 4***:** *Vivo allarme ma nessun danno per una scossa di terremoto di considerevole intensità avvertita alle ore 23.31 in Verona e Provincia la scossa a carattere ondulatorio e con epicentro nei Monti Lessini è durata pochi secondi ed ha raggiunto l'intensità del 2° Mercalli…(Rif.32)* [**Transl.** *1963 March 4***:** *Great alarm, but no damage, for a considerably intense tremor felt at 23.31 in Verona and Province; the undulatory shake lasted a few seconds and reached the 2nd degree of the Mercalli scale…*]

- 1976 May 7: Verona was hit by a violent earthquake. Moreover, other strong telluric movements took place on 15th September and 13th December of the same year (as already reported in this study).

In the case of the Visconti Bridge, the symbol monument of Valeggio, the historical events, the place seismic nature and human interventions (the use of the historical structure as a road passage since the thirties of last century, which was unsuitable to the building materials) have contributed to create a diffused degradation condition with localized situations that reveal a structurally critical picture.

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[4]. *Le chiese e il terremoto, by* F. Doglioni, V. Petrini, A. Moretti, Trieste, Edizioni LINT, 1994.

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2.3 THE GEOMETRIC SURVEY OF THE BUILDING AND ITS PRESENT DIMENSIONS

The following step for the building’s historical analysis and, in a certain sense, the geometric description of the building is also the most critical moment of the entire *knowledge trail*.

Besides being the interpretation base for the building evolution over the centuries (a valid support to confirm news or suggestions deducted from the historical analysis and archives), this survey is a very important moment because it is the first report relevant to the physical conditions of the building and it is also the unique phase of the survey that is carried out in place and in direct contact with the structure.

Starting from this phase, we will create the support to restoration activities as well as to the following maintenance program to preserve the monument.

The metric reading allows a first macroscopic survey of the degradation and failure in order to assess damage; these pathologies allow one to define the factors that affect the structural efficiency, as their definitions will lead to a following phase relevant to the assessment of vulnerability.

Then, in this study, the geometric survey is like the graphic reconstruction of the parts that made the building and the consistency of the constructive elements; it will be an essential analysis to define the first interpretation pattern of the structural functioning of the building at a qualitative level. The following refinement of knowledge will allow for the development of quantitative assessments corresponding to the different levels of knowledge (LCi) and the assessment (LVi) foreseen by the above-mentioned legislative regulations.

The first surveys of a historical building usually come from the iconographic material.

Even if this source can be marred by obvious problems, such as :

- *‹‹ marcate imprecisioni nelle misure…››* [**Transl.** ‹‹ *noticeable imprecisions of measurements* …››]
- *‹‹ marcate imprecisioni nelle misure…››*[1] [**Transl.** ‹‹ *decisive historical, architectonic, stylistic orientation etc…*››]

it surely represents the starting point to understand the building nature and its transformations over time.

The first ideal reconstruction of the Visconti Bridge dates back to the sixties by P. Gazzola.

From the mid-eighties up to 1993, the six hundredth anniversary of the Bridge construction, other reconstructions were made by academics or professionals who entered into contact with the historical building for different reasons.

Other scientific surveys were added between 1995 and 1996 and they were developed within a Thesis work as the following:

- topographic survey (of the central part of the Bridge) (Ill. 8);
- the underwater survey of the submerged part, this survey had never been done before.

These latest operations, together with the information from the Archives research, record and show the place conditions as concerns the material consistency and degradation and they even clarify a few points of the Bridge historiography that were still unknown or uncertain, such as the backdating of the central part collapse, compared with the tradition and the definitive evidence of the existence of remains of flooring with a probable function of a platform at the bottom of the Mincio River at the height of the dam body.

Finally the straightening of the entire building is also available [2].

With this survey and a complete and updated photographic documentation of the elements, the operation was not easy because of the thick infesting vegetation that covers the ancient walls; we can give a first evaluation of the damage progression in the building in a precise interval of time by distinguishing the material naturally aged from the material damaged by an external source (the ancient wall is in several points reduced to minimum and worrying dimensions for its preservation) and finally we can carry out the ‹‹ *Structural monitoring* ›› [3] to check for any worrying situations that affect the stability. The final target is to create a pattern to be used for the seismic vulnerability.

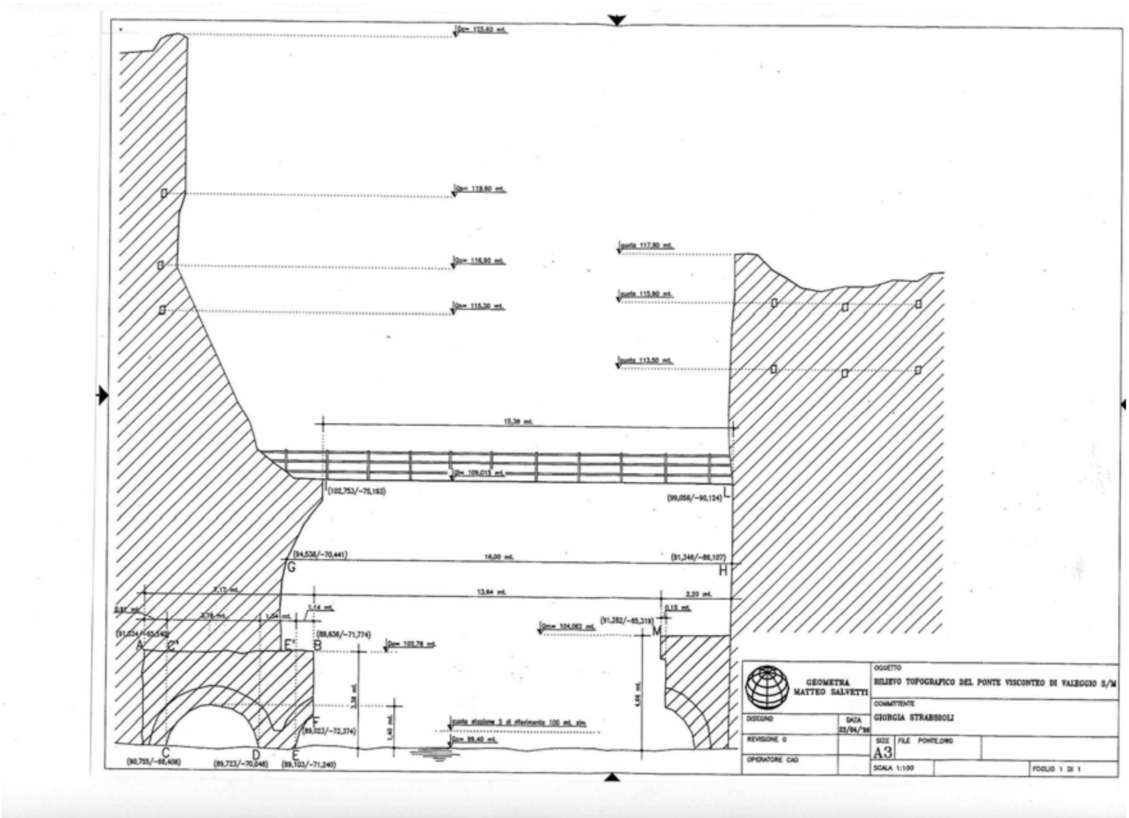

Illustration 8 - Topographic survey

Elaboration for the writer’s Thesis Work

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2. IUAV University in Venice – Circe. Visconti bridge in Valeggio sul Mincio.

3. *Monitoraggio strutturale* (in) *Manuale per la riabilitazione e la ricostruzione postsismica degli edifici.* Quoted work, page 217.

2.4 THE PRESERVATION STATUS AND THE SURVEY OF THE MATERIAL DAMAGE

After reconstructing the bridge geometry and the structures support, the following survey is the analysis of the construction materials.

The preservation status of the materials and construction elements are essential data to define the safety level of the building.

This research phase is very difficult, since it needs surveys on the building itself and these are often obstructed by its critical conditions.

An initial survey on the building's current situation is the visual survey *in the place*. A problematic picture arises immediately: a river context, a source of chemical attack for the ancient walls in direct contact with it, and the road (the Provincial Road n° 55 and heavy traffic that crosses the entire structure daily) greatly *fatigue* the structure .

But the conditions of a ruin, in which the monument is now, also have its roots in history.

The *Ponte Longo (Long Bridge),* as people from Valeggio called it, was probably considered by its habitants as a quarry to collect material freely for their own constructions.

In fact, according to past studies, the quantity of stones collected from the Bridge could be compared to the quantity that a man standing up on a carriage with lifted arms could take away.

Unfortunately, this act of vandalism is still practised on the monument and, if in the past, it was caused by the poverty of a population, it is now an Italian bad habit, the scandalous practice of the *souvenir* has continued for years at the Bridge, continuously damaged by crowds of visitors that assault the structure, especially on holidays (Ill. 9).

The alarming result is the progressive disappearance of the ancient remains of the Bridge (Ill. 10) and the consequent weakening of the structure.

These problems are exacerbated by thick vegetation that covers a large part of the Bridge and worsens the status of preservation (Ill. 11). Oddly, in a few cases, vegetation seems to maintain the architectonic shapes of the fortification that are mostly lost along the long walls (Ill. 12): tangled vegetation seems the only linking element of the wall face (Ill. 13).

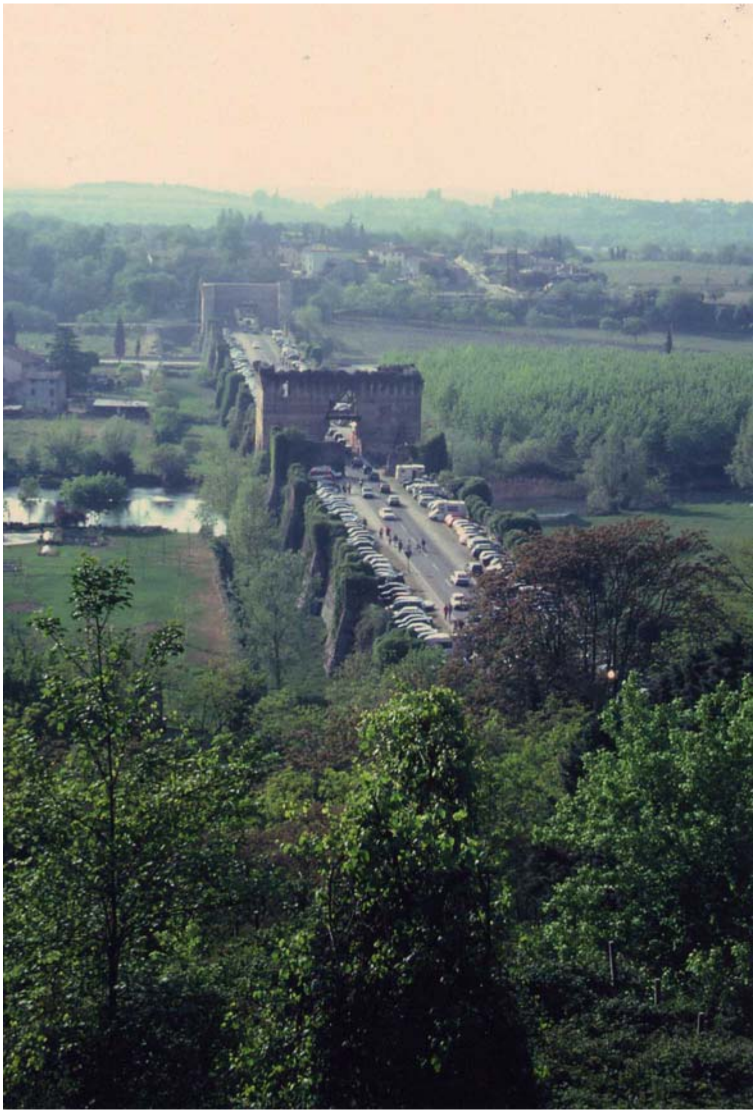

Illustration 9 - Crowds of visitors that assault the structure during the holiday

Illustration 10 - The progressive disappearance of the ancient remains of the Bridge

Illustration 11 - Thick vegetation that covers a large part of the Bridge

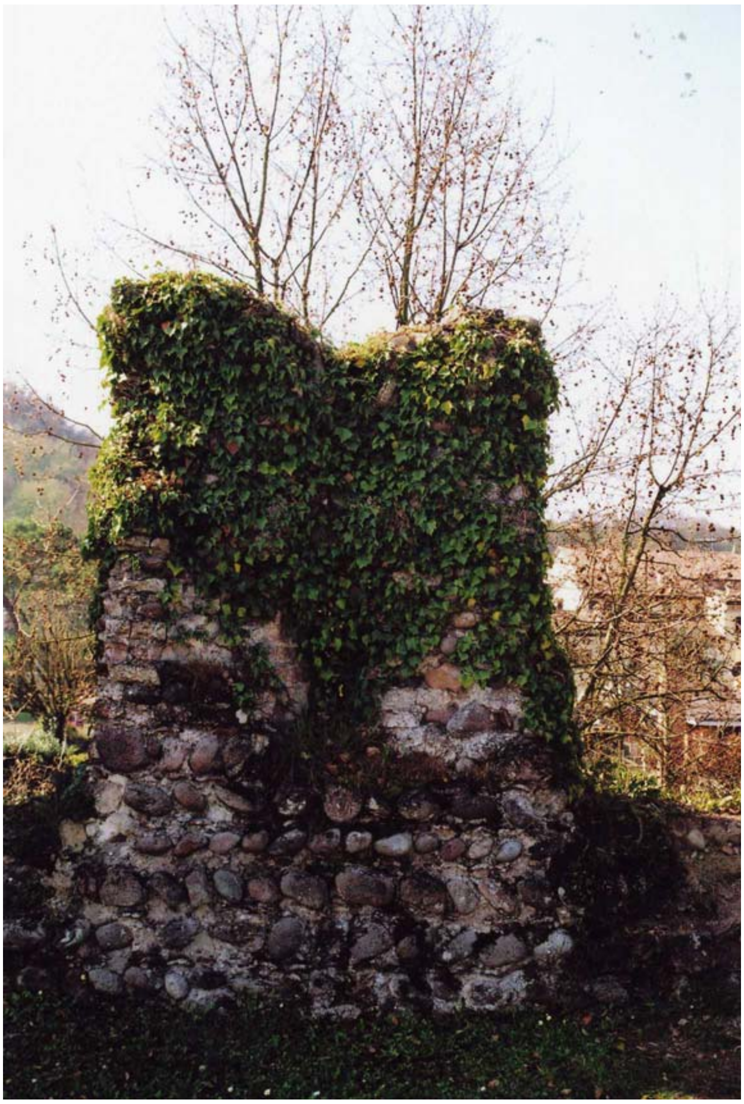

Illustration 12 – The vegetation seems to maintain the architectonic shapes of the fortification

Illustration 13 – The vegetation as the only linking element of the wall face

The preservation of materials and constructive elements are particularly worrying with a diffuse state of ***degradation*** of the wall structures.

Therefore, to define the safety level of the building and the structure vulnerability, it is essential to know the materials that make the supporting structure so that the degradation mechanisms can be understood, as well as the structure reaction to external stresses.

The basement part of the Visconti Bridge in Valeggio were realized by a filling-up building technique: in a container made from wooden tables dug perpendicularly in the ground with vertical boards nailed up to them, a mix of morainal peddles (whose the area was rich with), stones, parts of tegulae and filling material with mortar were laid.

The construction system changed for the part out of ground.

The long walls were made with almost regular courses of morainal peddles of medium and large dimensions with a slightly inclined lying position; bricks were mostly used in the height (above all, in the main superstructures), bricks were used differently as coating and as a continuous section.

In the specific case of the Castellana Tower, this material was used in a particular way by alternating rows of red and yellow bricks (Ill. 14).

The preservation of the two kinds of bricks was already different at the moment in which my first study was carried out : generally, red bricks looked superficially ruined because of natural ageing, whilst the yellow bricks of the Castellana Tower, showed clear erosion marks (Ill. 15).

Illustration 14 - Alternating rows of red and yellow bricks on the Castellana Tower

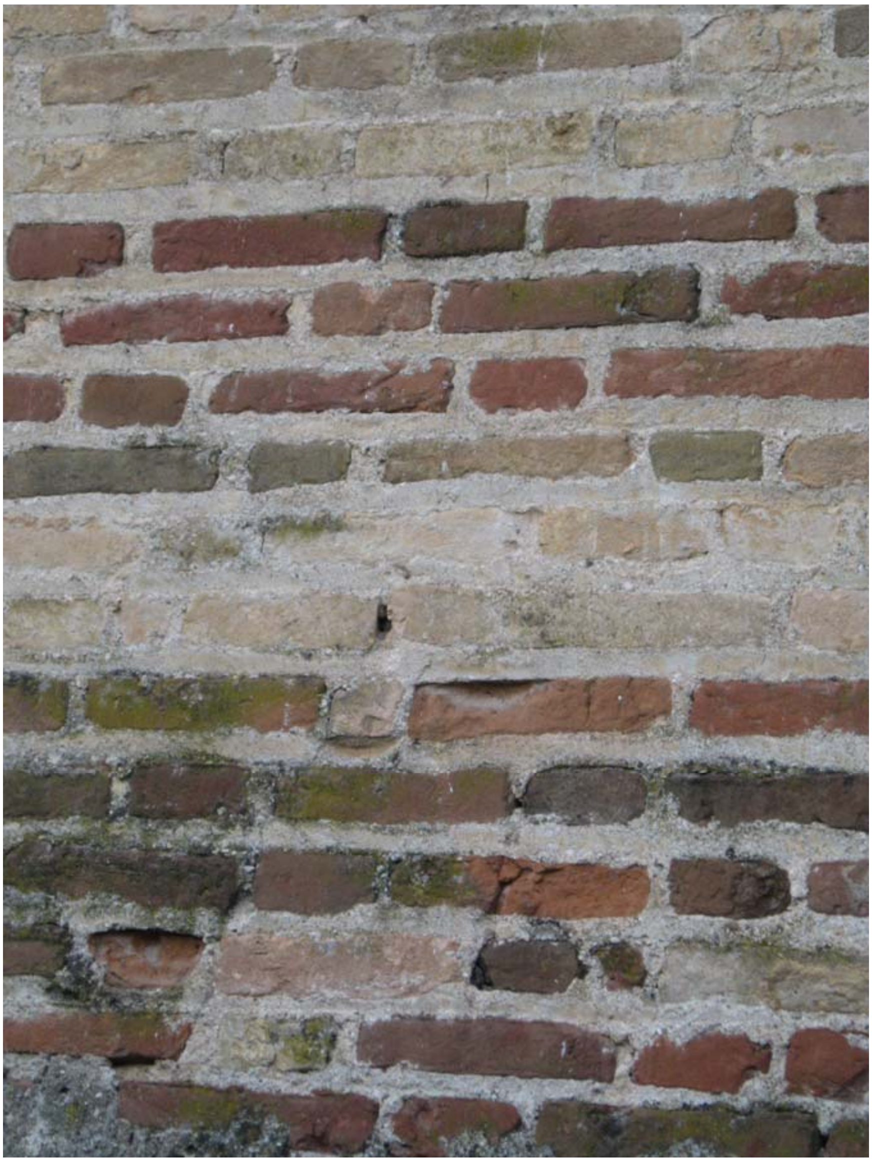

Illustration 15 - The preservation of the two kinds of bricks is different

Finally, the structure mortar net.

Laying mortar usually has minimum thickness between the recourses of brick or stone materials and sometimes seems to be totally lacking.

At a first visual survey, the colour of this layer varies from white to grey with brown dots.

Yellow hues are visible, above all, in those points of the structure where a wall hole is present.

Therefore, it is a mixture of lime with sand and medium-large gravel with a *crumbly* consistency, which is visible when it is uncovered.

Presently, the mortar is in a condition of bad preservation: a general status of poor cohesion of the sublayer is the most diffuse degradation pathology.

Surely, the problem is due to physical reasons: sudden temperature changes, freezing and humidity that characterize these places have contributed to make mortar a critical point of the structure.

Chart 1 **– Masonry analysis table of sample "A"** (Ill. 16)

Survey date	18th August 2007
Structure	Visconti Bridge
Place	Valeggio sul Mincio – Verona
Sample localization	Internal CD stump (Borghetto side)
Sample typology	piece of a crenellated part
Ground height	About 1.70 m

Wall parameter

Composition	Stone elements ($h._{peddles}$= 10 cm. to the base) in regular courses alternated with roof tiles (leveling courses)
Function	Supporting
Texture	Regular in the basement part (h= about 1 m)

Wall section

Type	Pocket wall
Thickness	Section of 45 cm of the protruding part
Filling	Not organized: mix of mortar, peddles and roof tiles

Materials

Composition	Stones
Filling elements	Probably coming from the area: river peddles and morainal materials
Shape	Medium-large rounded peddles
Colour	Dark grey with dark green for peddles, dark red for roof tiles

Surface working	No
Surface finishing	No

Joint

Vertical thickness	/
Horizontal thickness	Generally minimal at the base (h. $_{joint}$= 0,8 /1 cm.)
Characteristics	Setting layer for the base
Consistency	Poor

Binding material

Composition	Lime
Colour	The external crust is dark grey, black and dark green; the internal side is whitish

Aggregates

Composition and granulometry	Sand and gravel with almost fine granulometry
Colour	Whitish

Analysis of decay

Pathology	Crumbling
Description	General state of a lack of cohesion of stones on the entire rising structure

Illustration 16 – Ancient masonry: sample “A”

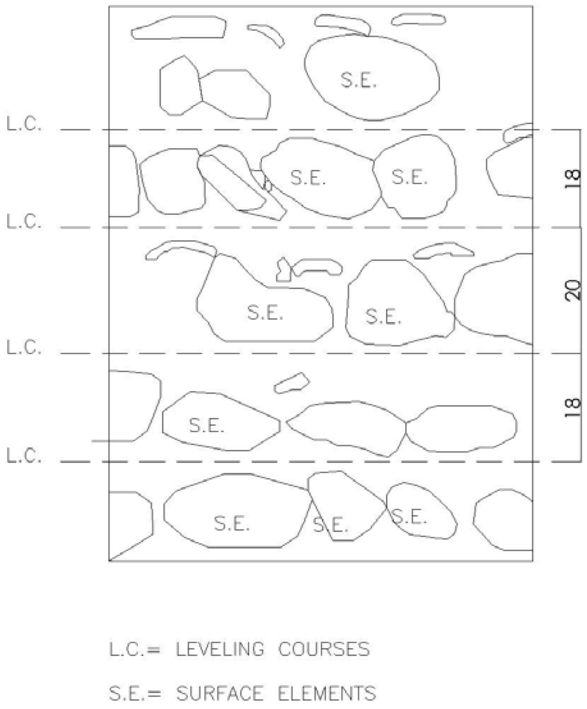

Illustration 17 - Scheme of the part of wall parameter – sample “A”

Chart 2 - **Masonry analysis table of sample “B**” (Ill. 18)

Survey date	18th August 2007
Structure	Visconti Bridge
Place	Valeggio sul Mincio – Verona
Sample localization	Internal CD stump (Borghetto side)
Sample typology	piece of a crenellated part
Ground height	About 2.40 in the highest point

Wall parameter

Composition	Stone elements ($h._{peddles}$= 10 cm. at the base) in regular courses alternated with roof tiles (leveling courses)
Function	Supporting
Texture	Chaotic

Wall section

Type	Pocket wall
Thickness	Max. 65 cm min. 55 cm
Filling	Not organized: mix of mortar, peddles and roof tiles

Materials

Composition	Stones
Filling elements	Probably coming from the area: river peddles and morainal materials
Shape	Medium-large rounded peddles
Colour	Dark grey with diffuse black crusts with dark green gradations, dark red for roof tiles
Surface working	No
Surface finishing	No

Joint

Vertical thickness	/
Horizontal thickness	Generally minimal at the base ($h_{.joint}$ = 0,8 / 1 cm.)
Characteristics	Setting layer for the base
Consistency	Poor

Binding material

Composition	Lime
Colour	The external crust is dark grey, black on the top and few clear gradations

Aggregates

Composition and granulometry	Sand and gravel with almost fine granulometry
Colour	Grey with whitish dotting

Analysis of decay

Pathology	Crumbling
Description	General state of a lack of cohesion of stones on the entire rising structure

Illustration 18 – Ancient masonry: sample B

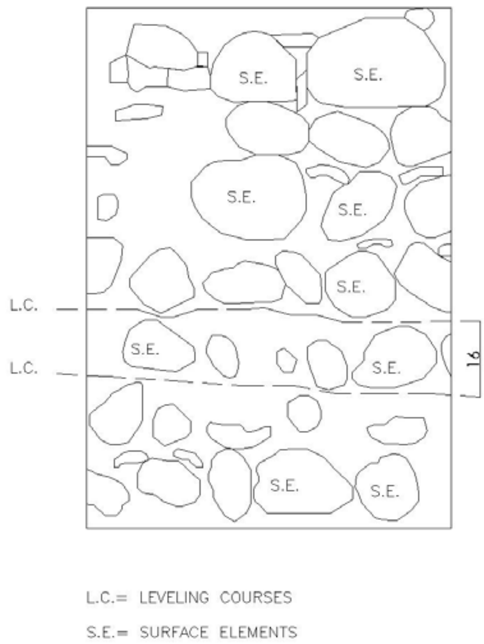

Illustration 19 – Scheme of the part of wall parameter – sample “B”

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2.5 THE EVALUATION OF THE VISCONTI BRIDGE SAFETY LIMITS

The definitions of the safety limits of a historical-cultural building implies an controllable procedure that is completely different from the one that is used for *common* buildings.

Because of their particular nature and the particularity of the intervention, it is not possible to define a unique strategy as a reliable pattern for historical buildings.
Therefore, it is quite difficult to foresee the real contribution of an intervention on a historical structure.

The line that should be followed to define the seismic risk of a legally bound building and the validity of an intervention must be considered on each building by assessing the real capacity of the structure (according to its qualitative and quantitative knowledge) to bear the seismic action.

In fact, the final goal of the processed pattern will be to integrate several aspects of the survey method in the procedure: the qualitative and detailed method that refers to the constructive characteristics of the construction and the quantitative method that will be defined by refining the first interpretative pattern by a further analysis. The pattern will allow the evaluation of the capacity of the construction to support the acceleration of the ground due to expected seismic events. This method defines a technical picture of the real conditions of the historical structure every time, as concerns its vulnerability, but it will be prepared in order to ‹‹…*fornire criteri e supporti decisionali per poter pervenire a giudizi espressi, con la flessibilità necessaria per rappresentare la grande variabilità dei casi reali* ›› [1] [**Transl.** ‹‹..*supply criteria and decisional supports to achieve clear judgements by the necessary flexibility to represent the great variability of the real cases*››].

The final evaluation will consider the building’s reaction capacity to a seismic event, while also establishing a total and comprehensive judgement of other problem aspects, such as its preservation, the need to give stability, and resistance to the historic building according to its use and function.

The target of this process should not only be the simple application of regulations and their compulsory verifications, but also to combine structure’s safety and preservation problems with the target of the minimum intervention.

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2.6 THE PILOT PROJECT : A SAFEGUARD STRATEGY

The exceptional dimensions of the Visconti bridge, a barrage about 600 m long, 9 m high from the Mincio River to the centre line of the n°55 Provincial Road (excluding the vertical development of the Towers) is one of the greatest limits of intervention when ensuring the safety limits for protection needs.

Moreover, the difficulty of collecting funds by the Administrative Body for consolidating the historical structure and recovering its functionality creates the problem of defining a strategy to safeguard the monument.

Therefore, the idea of a ***pilot project*** that can be later applied to other similar portions of the structure is born from the will to define an analysis trail aiming at identifying the preservative intervention techniques through study-samples of the monument itself. These techniques will be used as a pattern during restoration to confirm the practical procedures.

Moreover, the procedure will allow one to tailor the interventions directly on the monument by avoiding unnecessary operations, but applying the most efficient ones, if necessary.

The Administrative Body will have to organize an intervention of a great economical effort on a series of functional lots that will be prepared in the structure itself.

The part of the monument that will be chosen as a sample will be about 10 m at the base and 12 m of height, equal to 240 sq m of historical wall.

The operations to be carried out before the intervention will foresee the following :

- putting into safety through pre-consolidation works of the walls;
- initial elimination of the infesting vegetation with manual operations;
- definitive elimination of vegetation through the use of chemical products that are not aggressive to mortar;
- control and integration, if necessary, of mortar joints with a mixture with physical-chemical features compatible with already existing mortar.

As concerns cleaning and removal of the infesting vegetation, which covers almost 70% of the fortification, the practice to be followed refers to regulations that will be fitted to the work yard.

In general, the cleaning procedure is as follows:

- Manual removal of plugging and hole covers and their recovery after their selection and storage in the yard area.
- Removal of the wall flues, including chimneys and other accessory parts, including their lowering to the ground and disposal of in the public dumping site
- Manual removal of installations, pipes, flues and electric cables
- Removal of cement plastering parts, if present, and eventual integration of the hole in the wall face that will be adjusted by hooking in bricks and mortar
- Removal of metal parts that are no longer functional
- Removal of loose dry deposits or with flat brushes
- Elimination of upper vegetation and use of biocides
- the demolition and dismantling operations will be in conformity with the Decree of the President of the Republic 7th January 1956, no. 164 (specifically as per articles 10, 68, 70, 71, 72, 73, 74, 75, 76)
- All materials that can be reused, such as bricks, brick tile, roof tiles, beams, and joists, will be properly lowered to the ground, scraped and cleaned (through techniques indicated by the Work Direction) and ordered and stored in storage areas, which will be marked in project reports (the storage areas will be cleaned, dry, covered by PVC sheets, if necessary, and well-ventilated. Moreover, the recovery materials shouldn't be placed directly on the ground, but on wooden platforms or metal stands in order to prevent damage to them while carrying out cleaning, transportation and storage operations. The materials, if not specified differently in the project reports, will remain the property of the public consignor, who may order the contractor to use them completely or partially in the works. Demolition will be carefully carried out to avoid damage to plastering and/or relief or decorative parts.

  The demolition of the walls will be proceeded with proper tests to verify their typology and preservation status. The operators in charge with the procedure will work on scaffolds not connected to the monument: it will not be possible to intervene above the part to be demolished if the material fall height exceeds 2 m. In the event of the demolition of walls above the perimeter of floors or projecting parts, the greatest attention will be paid so as not to trigger structural collapses or sudden falls (even under limited loads or only for their own weight).

Particular attention will be paid with tie bars dug into the wall, since their unintentional break or damage could trigger an instability phenomenon that was not foreseen by the project. Therefore, when ties are present, maximum attention must be paid by clearing the perimeter of the chain and protecting it from material falls that could compromise its pulling capacity.

- total or partial removal of plaster and cement coats will have to be carried out by carefully removing one layer at a time for the entire thickness of the plaster up to reaching the real wall without touching the wall support that, at the end of the intervention, will appear intact without visible grooves and/or breakings. The action will always be controlled and limited to the removal of the part without touching the supporting wall and other areas close to the plastering to be preserved. Demolition will be carried out from the top to the base by removing limited portions with a modest weight and by manually eliminating the parts of swollen plaster with a larger thickness. The operation will be preferably carried out with manual tools, such as uphand hammers, bits and chisels and hack hammers); if the layer of plaster is particularly hard or the extension of the surfaces needs the use of mechanical means, small carving machines , or small pneumatic hammers, will be used by paying particular attention not to touch the supporting wall or other surfaces not included in the procedure.
- The integration and recovery of the wall flatness will aim at putting into safety the fragments in which bricks are divided in, at integrating the holes (caused by crumbling, erosion and the hollowing of material) and at defending the bond from weather conditions. It will be a consolidation and protection operation that will be carried out also on the smallest cracks and breaking of brick, since the surface becomes a solid and compact body that could resist rain and other aggressive and polluting agents. The operation will be carried out after the preliminary operations, such as the removal of non-consistent parts and cleaning of the material surface by abundant deionized water. Then the mixture will be applied on separate and following layers according to the depth of the hole to be filled in to avoid breakage and cracks during seasoning and following risks of detachment. The mortar mixture will be prepared, according to the directions of the project; if no

directions are supplied, one will be able to use a plaster based on lime putty (10 parts) loaded with three parts of terracotta powder (30 parts); as an alternative, terracotta powder may be substituted for a half or whole of pozzolan (binder-aggregate ratio 1:3). This mixture can be "helped", if necessary, by a part of an acrylic resin in a 10% water emulsion with a fluidifying function (quantity < 2%) using paper band or other suitable system. Then the lacking part of the brick will be shaped with a knife by pressing the material in order to eliminate excess water and improve the compactness and adherence to the undamaged part of the brick subjected to the intervention.

The removal of the incoherent deposits on the material that, differently from the crusts, does not corrode the chemical nature of the material, can be carried by using some mechanical systems that are easy to use, such as rags, brush-brooms, brooms, vacuums, etc., together with, if necessary, scalpels, small knives and water washings. Instead, if deposits have amalgamated with the material and need to be removed, more consistent cleaning cycles will be used, such as water based cleaning techniques, cleaning with water packs or chemical substances, mechanical cleaning, cleaning with the use of air abrasive devices, controlled sandblasting, etc.

- Before the cleaning operation, follow specific procedures to protect the integrity of the material and prepare it to guarantee the efficiency, more or less incisive, of the intervention.

Macroflora

Macroflora includes all the microscopic organisms (algae, mosses, lichens, upper vegetation, etc.) whose development on stone surfaces is favoured by the presence of bond breakages, such as cracks, slots, interstices, etc. within which humus can accumulate (it is made from deposits of atmospheric particles and dead organisms) on which spores transported by wind may help reproduce algae, mosses and lichens much easier. Algae cause a corrosive mechanical action on the surface and make the formation of other micro-organisms and macro-organisms easier; lichens create a covering phenomena together with lack of cohesion and corrosion; mosses cover the surface and, when they penetrate deeply, they have a mechanical action of desegregation. The presence of algae, mosses and lichens implies levels of high humidity that fatherly increase their persistency by favouring the accumulation and stagnation of water. As concerns the upper vegetation, the destructive action of the roots rooted inside material cracks can cause mechanical damage that often provoke the fall of material. Their removal should be preferably done in the winter and can be carried out both mechanically, by cutting close to the ground with devices that have low vibration emissions (electrical saws, manual saws, scissors, adzes, axes, etc.) and with liquid disinfesting agents selected according to the product specifications. The two operations can be combined together if the mechanical removal is not sufficient. Biocides can be used when the removal of living plants with deep roots can damage the substratum as well as in abandoned areas where plants are particularly abundant. Biocides can not be used in raining periods, or when it is very windy or when the surfaces are overheated so as to avoid the scattering or removal of the product. Among the biocides suitable to remove macro-vegetable organisms, there are even neutral compounds, such as triazine, with low solubility in water and derivatives of the urea that have very low mobility in the ground; they will reduce pollution in the surrounding areas by localizing the interventions to the concerned areas; chlorotriazine (absorbed by roots) will be efficient for soil applications on large-leaf and small-leaf plants; methoxytriazine can be used also on walls. The verification of the biocides' efficiency, essential in removing the roots, will take place after 30-60 of the application. The product application on vegetation can be carried out by spraying, pumping or compressing application, according to the instructions of the Work Direction. The operation will be completed with an accurate wash of the surfaces with clean water at a moderate pressure to completely eliminate the biocides. Algae, mosses and lichens grow on clay substratum deposited on the stones and they show themselves with more or less adherent and thick growth; their removal can be mechanical, probably not being a definitive solution, by using rigid brushes, scalpels, knives, etc. and paying attention not to damage the surface or with biocides. If the lichens are very thick and difficult to remove, before the mechanical removal, a solution of ammoniac diluted in water at 5% will be applied to the lichen surface to make them easier to be removed. Biocides can be used as an alternative to mechanical removal or together with it. The biocide application can be carried out by spray, brushing on or compresses according to the type of product. The definitive removal of algae, mosses and lichens will be carried out by the use of biocides with an immediate action, such as hydrogen peroxide at 120 volumes (the operation must be repeated every 24 hours up to the complete "burning" of the vegetal organisms), formaldehyde in water solution 0.1-1% and ethylene oxide (ETO) at 10% in gas mixture of water and carbon dioxide. After a period of 5-15 days from the final treatment with biocides, the biologic patina and humus deposits will be removed (they will be fragile, yellowish, dried out and/or powdery) with broom-brushes. Moreover, biocides, such as algaecides and lichencides can be used; algaecides include products such as phenol derivatives, quaternary ammonium salts, organ metallic compounds ant etc. used in solutions or in water dispersions (in concentrations between 1% and 10%). The lichencides include quaternary ammonium salts and proteolytic enzymes; these biocides are soluble in water and applied in weakly concentrated water solutions (1-3%). After the application of the biocide, a repeated washing of the surface with clean water through a jet cleaning machine, if necessary, (pressure should be adjusted according to the surface consistency) is necessary in order to grant the complete removal of the product. The use of the biocide will be carried out according to the product directions and the procedures for plant weed killing.

Microflora

Microflora is made up of bacteria and mushrooms. Their development is favoured by surrounding conditions that are characterized by high relative amounts of humidity and/or presence of stagnant water inside stones and often with limited air circulation. These micro-organisms can cause a mechanical and/or chemical degradation of the surface. In fact, mushrooms can be noxious when they penetrate their filiform process inside the cracks of the structure and stress it mechanically by increasing the lack of cohesion of the material. Their presence on the stone surface is revealed by stains, blooming of soluble salts and patinas of oxalates that change the appearance of the structure. It is important to remember that the removal of the microflora can not be considered as definitive if the surrounding causes that favour its growth have not been previously eliminated.

The removal of the biological patina can be carried out through manual cleaning (with scalpels, brushes, etc), mechanical cleaning (by micro-sandblasting) or through biocides. The efficiency of manual systems is limited because they will not be able to completely remove the pathology; sandblasting can damage the material substratum. The biocide substances will be applied, according to the specific product indications, and will be chosen, according to the nature of the stone, not to damage the substratum and alter its status, which is often precarious. The biocide substances, according to the type of organisms they will be able to remove, will be distinguished in bactericides e fungicides; their application will be carried out with a brush, spray or compress. In the presence of very porous materials, the biocide should be applied with a compress or a brush to make the product penetrate better and make its action longer (thymol and formaldeide can be sprayed because these substances are active as a vapour). The spray application (the operator must use it, using special precautions and protection devices) is particularly suitable if the material is fragile and not compact. The interventions will be repeated a number of times to eliminate the pathology. After the application of the biocide, the patina will be removed manually, then the part will be abundantly washed with deionized water to eliminate all substance residual. If the patinas are thick and adherent, remove them with bristle brushes before applying the biocide.

2.7 THE TECHNIQUES OF INTERVENTION OF CONSOLIDATION

After the wall structure is put into light with the total elimination of infesting vegetation, the consolidation interventions that we suppose are necessary to the bridge's walls are the following :

- wall refacing;
- unstitch and stitch technique;
- consolidation injections;
- portions where walls will be integrated, if necessary, to stabilize any instability;
- insertion of metal check chains from stainless steel to stabilize any pulling actions or turning over movements;
- protective interventions (waterproofing). Because of the material that is used, this intervention is not definitive but it will allow proper wall transpiration.

If the refacing technique implies the replacement of a single brick that is ruined, but inserted, in a substantially compact section, the replacement will be carried out by the *unstitch and stitch* technique.

***Unstitch and stitch* Intervention**

The unstitch and stitch operation will consist of the reconstruction of walls with the partial replacement of material. Walls that are particularly ruined and irrecoverable and unable to carry out their static or mechanic function will be restored with "new" compatible materials for type and dimensions. The intervention will involve only the wall face or all its thickness. The choice of the reconstruction material will be very carefully made and new materials will meet several needs: historical (if the intervention will be carried out on monuments), aesthetical and, above all, technical. The reconstruction will be compatible with the pre-existing part, as concerns dimensions (so that the discontinuity between the wall texture will be avoided as well as the separations between the old and new parts) and nature (a different compactness can imply a different level of absorption with the consequent presence of stains). Where the circumstances will allow it, it will be convenient to use material from the yard itself (collected from demolition and collapses) by properly selecting it not to use damaged and/or ruined elements. Before the unstitch and stitch operation, a new accurate survey of the wall portion to be replaced will be carried out in order to precisely mark the area to restore; then, if necessary, proper cribs will be prepared to avoid any collapse or unwanted deformation.

The walls to be restored will be divided in work portions (dimensionally compared with the surface of the area to be restored, which means that they will not be any more than 1.5 m tall and 1 m wide), then demolitions alternated to reconstructions will be carried out from the top to the base so that the adjacent wall portions will not be damaged and will continue their static function. The demolition will be carried out by manual tools, such as hammers, bits and levers) by paying attention not to stress the structure too much and cause further damage. After the removal, the hole will be cleaned out with brushes, scalpers, or vacuum cleaners to remove powdery and larger scrap (if necessary, use water following the directions on water-based products). The material preparation will allow the insertion of wooden shims between the new and old wall that will be replaced, after their removal, with bricks of a compatible material and fluid mortar. The connection mortar, if not differently specified in the project, will be a natural hydraulic cement mortar NHL 5 (or as an alternative NHL-Z 5) with the aggregate made from silica sand, terracotta powder and pozzolan, which will be selected and washed (binder aggregate ratio 1:2 or 1:3). If expressly indicated in the project, the unstitch and stitch intervention will be cleared out to protect the building's stratigraphy and, by realizing a new wall portion by taking into account that non-coplanarity of the two surfaces so that the area is not easy to ruin.

Specifications: the unstitch and stitch technique will not be suitable, and particularly difficult, to be applied to portions of non-compact wall (for example, walls where stones are irregular), high dimensioned walls and pocket walls.

Consolidation injections

Consolidation injections. The procedure is, in general, suitable for diffuse cracks and stone bonds, where it's often possible to find hallows and internal interruptions that were present from the beginning or that were created by subsidence or other phenomena. The intervention will foresee a careful analysis of the structure to localize the hollows and the chemical-physical composition of its materials.

Support preparation

Plastering and/or sealing on both sides of the walls for cracks, interruptions, small cracks of stones and/or bricks and for mortar joints so that the wall bond will be “perfectly closed” in order to avoid external oozing of the mortar to be injected: if the intervention is to be performed on plastered walls, make sure the coating is suitable to bear the following phases (For further details relevant to the above-described procedures, see articles relevant to plastering and consolidation).

Execution of drilling.

Drilling will be carried out as per the project directions and according to the presence of slots and the type of structure (in the event that no directions are provided, 2-4 holes will be made per 1 sq m). The holes of a proper diameter (on average, a diameter of 16-24 mm will be sufficient, will be carried out by a revolving device equipped with a cutting corer and crown from very hard steel or widia. In wall bonds made from stones, if it is not prescribed differently, the holes will be perpendicular to surfaces and slightly inclined (about 10%) to the internal part so that the mixture introduction will be easier. The holes will be made at the height of the mortar joints at a distance of about 60-80 cm according to the wall consistency; in the full brick walls, the distance of the holes will not exceed 50 cm. In any case, better results will be achieved by a large number of holes of smaller dimensions instead of fewer holes with a larger diameter.

Drilling will be carefully carried out by making sure that the injected area is superimposed and communicating (as an “en quinconce” arrangement) through the use of proper tubes as a “mark”; the exceeding mixture can come out from them. The tubes with a diameter of about 20 mm will be introduced for at least 10-12 cm and then they will be sealed by the same mortar of the injections, but with a thicker consistency (by decreasing the water quantity in the mixture).

Before the injection (at least 24 hours before), water will be injected in the closed injection circuit to saturate the wall and to maintain the mixture density. The pre-washing operation carried out by pure or deionized water will be useful to consolidate the intervention zones (corresponding to humid areas) and to signal breakages that may not be visible. During the cleaning-washing phase, additional operations, such as rendering, piercing of joints and sealing of breakages may be carried out.

Mixture specifications : if it is not differently specified in the project, the liquid mortar for injections will be made from a mixture of hydraulic cement mortar NHL 3.5 or NHL-Z 3.5 (without soluble salts with 85% of granules with the dimensions inferior to 25 μ, unitary heat of hydration less than 135KJ/Kg) and water in variable ratios from 0.8 to 1.2 microfine colloidal in gel. The fluidity of an efficient injection is usually obtained by a binder-water ratio superior to 1, but, in order to avoid the segregation phenomena, add some fluidifying additives (1-2% more than the binder weight) to the liquid mortar and other anti-shrinkage expansive agents (such as aluminum powder from 0.2% to 0.3% of the total weight) to control the natural shrinking and subsidence during the plastic phase (that is in the first hours after the operation) and hygrometric shrinkage (the shrinkage will occur when material hardens after about 28 days and will go on for long periods; usually it is considered complete after 2 years from the application).

2.8 THE MONITORING AS A CONTROL PROGRAM FOR THE PRESERVATION OF THE ARCHITECTONIC STRUCTURE

Checking the behaviour of the structure over the years, even considering its past, is necessary to preserve the historical monument consciously and taking into account the problems and limits of the interventions.

This is the final phase after a long *knowledge trail* of the ancient building because it links all collected information relevant to its structural functioning with reference to pathologic phenomena, as well as the reactions to perturbation phenomena, such as thermal actions.

That way, it is possible to program the maintenance of the building by scheduling repair and consolidation interventions to combine safety with the protection obligations.

Even this project should be considered by directly studying the building, but, in general, a monitoring program has two distinct moments, such as the following:

- visual inspection, meaning a periodical analysis;
- structural inspection, meaning the evaluation of the present damage.

These inspections provide a picture of the monument's real conditions.

Monitoring offers a technical evaluation of the adopted choices of the project; it is a test bench for the interventions that were recommended in the study phase and their real realization in the yard.

Within cultural inheritance, safety and preservation imply another important inspection: the *qualitative* [1] confirmation of the scientific technical solutions together with technical – administrative requirements of the Public Bodies that own the monuments.

In fact, the Administrative Bodies have to evaluate other aspects of the project, such as the financial side and realization time.

Therefore, in a control program, the economical phase of the intervention is as important as the project itself; the more the intervention process is specific and methodologically correct for the historical building, the less the economical risks of the town Administrations.

The case of the Visconti Bridge in Valeggio sul Mincio, for the exceptional dimensions of the building and the risk due to external reasons (such as aggressive environmental conditions and the serious urban situation), asks for a *pilot yard* that confirms the supposed methodologies, organizes the interventions in a series of portions to ensure a technical-administrative control, controls the adopted solutions with a monitoring system and defines a preservation program.

Bibliographic notes

[1]. *Monitoraggio tecnico scientifico degli interventi post sismici sul patrimonio monumentale* Charter 5 (in) *Vulnerabilità, manutenzione e progetto nel recupero post-sismico del patrimonio monumentale,* Quoted work , page 89.

2.9 THE FUNCTIONAL RECOVERY OF THE BRIDGE: THE URBAN CONTEXT AS A PROJECT KEY OF THE INTERVENTION

In 1993, several events took place around the Visconti Bridge in Valeggio sul Mincio to celebrate the six hundredth anniversary of its foundation.

A few years later, the study of the Degree Thesis was started because it was considered that, despite people still being very interested in the building, its potentialities had not been put to light yet and, therefore, the Visconti Bridge had to be discovered in the true meaning of the word because its reopening to traffic by the insertion of a metallic girder in the far 1929 was a limitative operation.

During this research, we knew that the monument and its fame during the centuries are due to its particular typology, as well as to the landscape where the structure is inserted.

History and environment have contributed to make this monument imposing and, still now, from these elements, it is possible to deduct important hints for a new idea of intervention.

The reading of the morphological reality of the places and the constant contact with it can reveal unexpected intervention solutions that present themselves as the research continues.

Therefore, the project relevant to intervention is not only the creation of an architectonic shape, but it is the result that combines the shape and its context.

Starting from the territory as a reading key for the intervention on the building allows the reestablishment of the ancient relationship that made this building exceptional, combining the bridge, the natural environment and the urban situation in a unique creative way in order to make a unique organic system able to create and renovate new synergies.

Studying the history of the monument in the course of its historical events, we could see that, between the Valeggio Territory and the Visconti Bridge, there was a harmonic relationship that meant much more that the *dramatic* view of an ancient medieval hamlet on the banks of the Mincio River.

Therefore, designing is the continuation of a historical and natural relationship that has to lead to a solution where functional, technical and formal aspects join in a unique projectual act.

Nowadays, the bridge needs an intervention that aims at restoration, as well as revitalizing the entire structure towards even its context, proposing that old relationship again, which has always existed between the monument and the surrounding territory.

The reutilization of the structure is connected to a functional need and, at the same time, to the discovery of the context where it is located, to the urban recovery of the area which is rich in many important buildings, such as Villa Maffei, the Sigurtà Park, Guarienti Palace, the Scaligeri Castle and the ancient medieval hamlet of Borghetto, for a projectual solution that the population can really enjoy.

Therefore, another essential element arises as a base of the restorative intervention that is relevant to the use and reutilization of the historical building.

The starting point of the new intervention was to restart a work began in the far past, interrupted because of fortuitous causes.

After centuries, the Visconti Bridge, with its remains of arches and with its dramatically broken banks, seems to wait for the restoration of its architectonic aspect after the unique intervention in 1929.

The ideal architectonical intervention, thought of at the time of the university work [1], was a segmental arch walk that recovered one of the three trench levels (Ill. 20), connecting the other parts of the historical building (the Castellana Tower, the Rivellino and the most hidden parts of the structure, such as the vaulted rooms).

It was possible to descend along two different pathways clung to the monument toward two moats by that walkway, characterized by elements inclined at 30°, even used in the parapet as an ideal reminder of an internal ancient pathway (used as an emergency corridor).

From the moats, using the ancient passages, the imposing monument could be admired and the ancient medieval hamlet could be reached.

A larger project connected the Visconti Bridge with the remaining Valeggio Territory by the restoration of an ancient medieval pathway that climbs the Mount Ogheri from where it is possible to admire the Scaligeri Castle and the entire morainal valley and even reach Valeggio with its architectonic works.

At the time of the study, the connection of the supporting part to the pedestrian bridge was inserted in the existing wall and had a function of stabilizing the damaged part; therefore, this aspect of the project was not analyzed thoroughly.

Nowadays, this new study, based on the recent anti-seismic regulations relevant to safety standards, evaluates the vulnerability of the building as concerns its restoration and its functional recovery to complete the project path that was started ten years ago.

Illustration 20 – The project of functional recovery of the bridge
Writer's Thesis work

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