

The Complexity and the Logic Behind Historical Buildings: the Case-Study of Palazzo del Podestà in Mantova, Italy

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Abstract The Palazzo del Podestà, situated in the centre of Mantua, has Medieval origins, but it is the result of many additions and reconstructions and it is now abandoned. In 2005 the Town Council commissioned the Politecnico of Milan a research on the real situation of the palaces, in order to determine the future possible uses of the buildings. The causes of the structural decays were investigated and furtherly studied by means of a comparison between archive records and diagnostic tests.

Keywords: Palazzo del Podestà, Mantova, Luca Fancelli, archive record



Figure 1: On the left view of the Palazzo del Podestà and, on the right, the Palazzo della Ragione and the Torre delle Ore

The *Palazzo del Podestà* in Mantova had been the seat of the Justice Department, the Jails and the public Notarial Archives since the times of the Medieval City and the Seignior of the Gonzaga family. In the course of time, other structures were added to the pre-existing ones creating new buildings and bringing about many works of renovation according to the most urgent needs (Davari 1874).

Such changes in the structure of the buildings were made separately, without considering or carrying out a global plan in which all the different parts could have a close connection to each other. So all the works of restoring and renovation have been effected without respecting the pre-existing consolidated buildings. Consequently the result was that every new building was somewhat isolated from the others and characterized by its own spacial and structural features.

However, this structure is partly screened by faced wall walls (a wall having a masonry facing bonded to a backing so as to exert a common action under load) which cover the *Palazzo del Podestà*

towards the near streets: the façades were designed and built in the XVth century following a different criterion from the one used in the internal spaces; the façades are harmonious and tend to create a kind of urban scenography suitable to give a unitary image to the complex, thus concealing the real internal structure. The Law-Courts and the Jails remained in the building till the end of the XIXth century, when the building was abandoned owing to its unhealthy small rooms and its morphological and structural characteristics (Calzona 1991).

In 2005 the *Palazzo del Podestà* was suggested to become the seat of a part of the Municipal Administration. The *Politecnico di Milano* was asked to collaborate with the Town Council of Mantova in order to carry out a research on the real situation of the palaces: that is, an analysis of its functions, limits and peculiarities. Besides the Town Council requested a study of the guide-line of the plan, as well as a detailed check to examine whether the various functions were consistent with the space, structure and material elements of the building. The palaces were described by means of systematic historical researches and diagnostic tests.

In this study we will try to focus the attention on the problem of the static decay of the building, which required a proper and multidisciplinary investigation into the study of the Palaces.

The Problem of Decays In the history of the palace the numberless additions, reconstructions and adaptations involved many changes in the arrangement of the buildings. The decays are not only due to general causes but to events which occurred in particular periods of the palace's history and they must be carefully investigated. Such complexity of cases grows even more owing to restorations which have been executed to repair the damages caused by external events such as fires and earthquakes; these events are very frequent in the history of the palace as proved by archive researches. The archive records describe also several settlements due to a bad execution of the masonry, free and easy restorations as well as a decay in the materials. Besides the palace had been in state of neglect for long times.

The Method of Study This research has been carried out in three phases: at first a phase of historical research, then a second phase of analysis of the causes of the decay in situ; at last all the data which had been gathered from the previous phases were compared one with the other. The historical research has tried to go back to the origins and to define the time length of the settlements referring to the numerous archive records. This has made it possible to ascertain the existence of former restorations and to value their effectiveness.

The analysis of the structural decay has brought forth a detailed survey of the cracks, their dimensions and shapes: for instance, the survey proved the displacement of the crack edges, the depth and the dimension of cracks, the presence of sedimented materials, the coincidence with head joints, or with stoppings of window-openings and holes.

During this analysis the archive records were always consulted and compared; some stratigraphy tests were done, so that it was possible to gain a deeper knowledge about the development of the building. In the third phase the comparison between all the findings resulting from the previous phases allowed to achieve some targets: for instance, it was possible to date back to the different periods in which the settlements had taken place, and to determine exactly when static problems had arisen in the course of time. It was also possible to explain the transformation the different parts of the building had undergone more clearly.

General Description of the Cracks The causes of the structural decay can be classified into two categories: in the former we can include the more complex cracks related to the building characteristics as well as to the differential settlements of the structures. In the latter category we can take into account localized decays due to unequal masonry texture, stoppings, flues and concentrated loads.

Most cracks belonging to the former category are very ancient; many elements prove that the cracks originated during a lapse of time rather close to the first building of the palaces. Moreover it is very important to distinguish the cracks which are already settled from the active ones; the latter cracks might become a serious limit for the security of the building. Several present cracks were already repaired in the past, but the cause of the decay was not properly removed in the course of the old

restoration. In particular, in the most outstanding cases where the cracks might potentially be still active, the data derived from the historical researches have helped to define the areas where to check these cracks by means of scientific instruments.

The Building Facing *Piazza Delle Erbe* As a specific case the building facing *Piazza delle Erbe* is particularly fit for explaining the course of our research and for illustrating in detail one of the most interesting examples about the static decays of the palace. Besides this case shows all the complex elements which can help to define the origin and development of a historical building.

The present aspect of the façade looking on to *Piazza delle Erbe* is the result of a work of restoration dated 1969-1971 (Gazzola 1973): at that time the faced walls were partially rebuilt in the areas where the signs of decay of mortar and bricks were evident; besides deep cracks, passing from one side to the other of the wall, were repaired in the areas between the openings.

The orderly XVth century façade conceals a unhomogeneous whole of rooms and structures: small barrel-vaulted rooms are on the lower levels, two wider cross-vaulted rooms are on the third level and large halls with wooden beamed floors are on the two upper levels.

Although some archives are incomplete, it is possible to express a hypothesis about the building. In 1413 a fire destroyed a part of the palace and in 1466 Ludovico II, Marquis of Mantova, gave the architects Luca Fancelli and Giovanni Antonio d'Arezzo the task to definitely arrange the façade looking on to *Piazza delle Erbe* (Carpeggiani and Lorenzoni 1998, Vatovec 1979). They probably had to deal with pre-existing composite structures set against the medieval nucleus of the palace. Probably the architects' restoration consisted in enlarging, raising and rebuilding the façade so to give dignity to the public square. On the lower floors a faced wall was set against the existent brick masonry in order to thicken it: so both structures could better support the load of the added upper storeys and wooden floors. At first this hypothesis was considered only by the historian Giovanni Paccagnini (Paccagnini 1961); now it is confirmed by a test carried out on the internal side of the façade looking on to *Piazza delle Erbe*.

The test suggests the presence of two well distinguished brick masonry walls: nowadays the windows are in the outer faced wall, but the test shows the presence of an inner seat of a window.



Figure 2: From left to right: pictures of the rectangular room on the third level. Site of the two stratigraphic tests on the wall. Stratigraphic test n° 5.11c: it confirmed that the exterior wall of the building is formed of two well-distinguished brick walls: the hole on the left was completely filled with mortar. The stratigraphic test n°5.11d, made on the edge between the outer wall and one of the four piers: the brick masonry of the pier and the wall are tightly connected

The analysis of the decays. Outside, the most outstanding crack involved the third axis of the windows on the left and came down almost vertically, in the centre line of the openings, from the fourth to the first level. A second crack over the arch, in the second axis of the windows, came down from the fourth level to the second level, leaning towards the right. A third crack, this time sloping towards the left, came down along the first axis of the windows from the fourth level to almost the ground floor of the corner tower; then it branched out through a swarm of cracks reaching the second level. Such a situation had been present for a long time, probably for centuries as can be noticed from the historical iconography. Inside, the cracks concentrate in the two vaulted rooms on the third level, involving the lower and upper levels to a smaller extent.

In the rectangular room towards Palazzo della Ragione, on the third level, the original vaults rest on transversal toothed piers, along the perimetral wall. The vault weight partly rests on the underlying barrel-vault and on the walls which partly sustain all these vaults.

Both the shape and the span, which is very limited in comparison with the rise, minimize the drifts. Thick tie rods help to oppose outward forces.

The cracks evident in the eastern medieval masonry only show the openings which were stopped in the past; they are well visible in the thermographic analysis. On the faced wall, cracks can be seen over the two windows; they even originated before the restorations in 1969-71.

The present cracks over the windows spread in correspondence of the first two vaults; the pier separating them does not rest on an underlying wall, but directly on the barrel-vault over vicolo Lattonai. On the contrary the next pier, between the second and third vault, results eccentric – in all its whole thickness – as regards the underlying wall.

The drift of the ogival vaults, though reduced, was nevertheless opposed by the two tower walls connecting the Palazzo della Ragione. The tower, which certainly helped to reinforce this structures as a whole, was demolished in 1942.

In the square room, the cracks on the vault are more evident. In the northern wall towards via Broletto, a row of niches and windows has reduced the function of the walls fit for giving stability, a very essential element in this case, because the masonry is only made of stones. Outside a well visible joint separates the wall from the medieval brick masonry. Between the cracks on the vault and the ones in the walls reflect the decays which were described in the XIXth century archive records and not fully repaired.

In both halls, the plasters and the present colours allow to give a date to the most recent reopening of the cracks which occurred after the repairs in 1963. Once more it is necessary to carefully check the most outstanding cracks by means of scientific instruments.

The Causes of Decays A technical report dated July 1741 describes a rather dangerous situation: the entire building ran the risk of collapsing and at that time the propping was thought to be inadequate. In the archive record the causes of the decay are taken into consideration and a few hypotheses about the consolidation of the structures are suggested:

1. the insufficient building of the load-bearing walls, “*perché costrutti di sassi [...] vestiti con una sol testa di pietre cotte*” (ASMn, IC, b.14).
2. the vibrations brought about by the swings of the big bell in the near tower.
3. The reduction of the piers at the base of the building; their thickness resulted thinner than 4 ounces as regards that on the upper levels.

The last cause was the result of a progressive chiselling into the walls on the lower levels made by the shopkeepers in order to have larger rooms. Dorcilio Moscatelli's survey dated 1722 (ASMn, N, b.2212) shows an enlargement of the shop-openings on the ground level involving a thinner wall thickness, if we make a comparison with another survey dated 1794 (ASMn, MCN, b.140).

Besides other further causes can be added:

4. the thrust on the corners of the cross vault in the square hall on the third level;
5. the eccentric load on the vaults underlying the piers bearing the cross vaults on third level.

Owing to the above mentioned observations considerations, the earthquake which took place in 1740 was particularly strong and caused a further decay of the building.

Cases of combined compressive and bending stress occurred when the faced wall detached from the masonry; in addition cases of compression affected the stability of the vaults.

In 1741, in order to obviate these problems, it was even thought to demolish the fourth floor of the tower, but such operation was not executed. At last three piers were built in the southern, eastern and western sides and walls of two bricks' thickness were built both inside and outside, as one can notice also nowadays. The transformation of the wide arch which was lowered along over the vicolo Lattonai dates back to the same period and was probably due to the above mentioned problems.

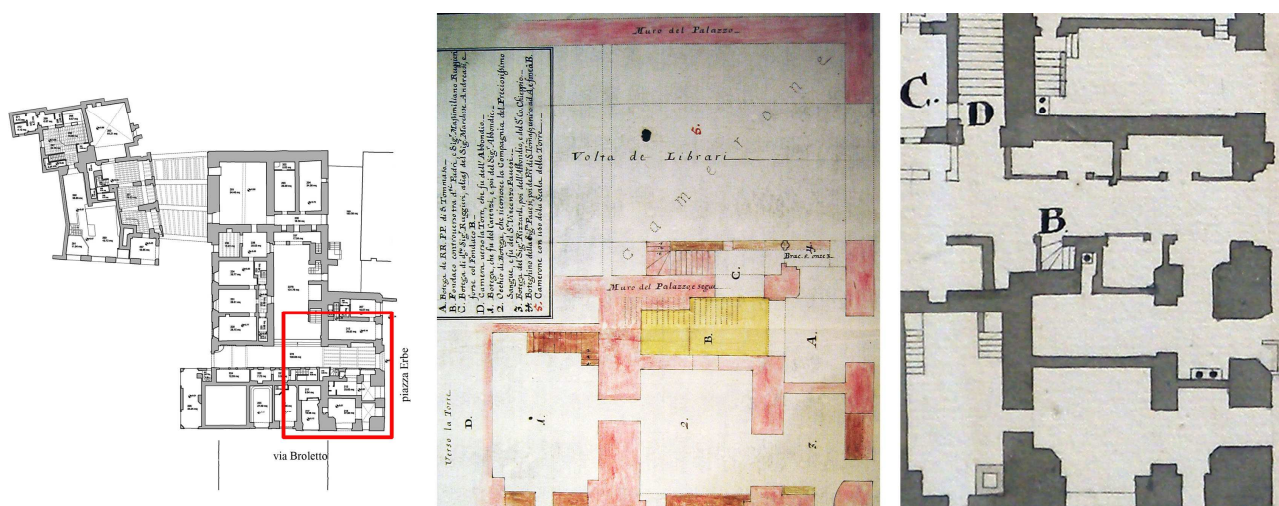


Figure 3: From left to right, the ground level of the Palazzo del Podestà facing piazza delle Erbe; a survey of the same part of the building dated 1722, by Doricilio Moscatelli Battaglia; survey by Paolo Pozzo, dated 1794, shows many different features if compared to the previous one: it can be noticed the thicker external walls on the northern and western side, the presence of three masonry piers inside the corner rooms, some different openings and the resizing of the vicolo Lattonai (where a new shop was built).

The dimensions of the arch were reduced so it was substituted by a round arch which was less thrusting in order to resist the settlements. During this restoration a new shop was built on the ground level: it defined the new boundaries of the building towards vicolo Lattonai and the court yard.

The previous arrangement of the arch and of the rooms on the ground level towards Piazza delle Erbe is given evidence by a fresco and by a survey made by Moscatelli Battaglia in 1722.

A short part of the previous arch can still be seen on the face looking on to the public square.

New causes of decay: the XIXth and the XXth century restorations During the two centuries several restorations have been carried out, even though they sometimes caused further structural problems:

1. the opening of the two large French windows on the first level, towards *Palazzo della Ragione*, took the place of two pre-existing windows determining a further reduction of the masonry.

2. in 1942 the restoring executed by the architect Aldo Andreani (A.Andreani, 1915 and 1942) involved the demolition of the tower which was connected to *Palazzo della Ragione*. This restoring probably gave rise to the cracks of the ogival vaults on the third level. Such a bad restoring was repaired on the outer façade in 1969-71, but it is still present inside.

Conclusion

In the course of this case-study it has been possible to realize how many complex problems can arise while investigating the decay of a historical building. The contribution of the historical research was fundamental to probe into such situations, even if it was not exhaustive: in fact it is necessary to underline that not always the systematic recourse to the archive records helped to understand and solve structural problems. Besides it is to be taken into account that the archive records were written down for other purposes, different from the ones we are interested in nowadays.

Even if we are aware of such limits, we think that the interpretation of structural decays supported by a historical research, may be useful also in a planning phase:

1. to address the diagnostic investigations and to carry out an instrumental check on cracks.
2. to give a guide-line in executing static or dynamic models, taking into account the real conditions of the building.
3. to limit invasive restorations in the building structures.

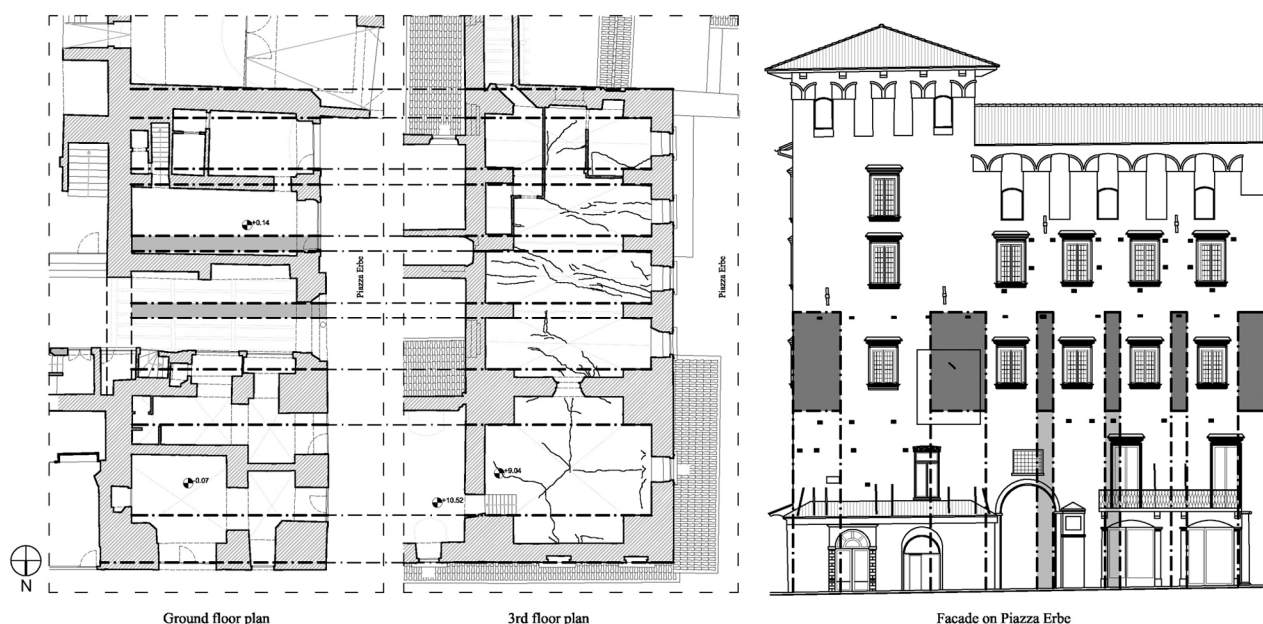


Figure 4: On the left, the ground and the third level of the building facing piazza delle Erbe: the dashed lines show the projection of the piers of the third level on the ground level structures. On the right: the façade looking on to piazza delle Erbe: the projection on the façade of the inner piers on the third level are coloured dark grey. In some cases, at the lower levels, the faced wall shows some openings just below the piers (coloured light grey)

References

- [1] "Because they are made of stones and covered with one brick's thickness." 1741 July 4th, Archivio di Stato di Mantova, Fondo Ingegneri Camerali, busta 14.
- [2] Aldo, A (1915), "*Palatium vetus et palatium novum comunis Mantuae.*" Verona-Ostiglia, A. Mondadori Editore; Aldo Andreani (1942). "*I palazzi del comune di Mantova, assaggi, rilievi, prospetti e restauri.*" Mantova, R. Accademia Virgiliana.
- [3] Archivio di Stato di Mantova, Fondo Magistrato Camerale Nuovo, busta 140, 1794 May 15th.
- [4] Archivio di Stato di Mantova, Fondo Notarile, notaio F. Bina, busta 2212.
- [5] Arturo, C (1991). "*La Rotonda ed il Palatium di Matilde.*" Univ. di Parma, Centro Studi Medioevali, Parma.
- [6] Giovanni, P (1961). "*La questione dei Palazzi Comunali in Mantova - Le Arti.*" vol. I, Mantova.
- [7] Paolo, C , Anna, M L (1998) "*Carteggio di Luca Fancelli con Ludovico Federico e Francesco Gonzaga marchesi di Mantova,*" Arcari, Mantova, and Corinna Vasic Vatovec (1979) "*Luca Fancelli, architetto: epistolario gonzaghese,*" Uniedit, Firenze.
- [8] Piero, G (1973). "*Il Palazzo del Podestà a Mantova.*" Mantova, Banca Agricola Mantovana.
- [9] Stefano, D (1874). "*I Palazzi dell'antico comune di Mantova e gli incendi da essi subiti,*" Adalberto Sartori Editore, Mantova; Ercolano Marani (1961-1981), *Mantova - le arti*, vol. I- II- III, Mantova.