The Technology of Camorcanna Vaults: Examples of Use in Palaces and Villas in the Este Territory in the Seventeenth and Eighteenth Century

Laura Balboni, Paolo Corradini

Politecnico in Milan, Italy

ABSTRACT: The research investigates the constructive technique of “plaster and reeds” vaults, consisting in wooden centring structures which a plaster support is attached to. Starting from a careful study of its specific application in the wide camorcanna complex in the Rocca in Spilamberto (Modena), dated back to 1660, the study is extended to other similar examples in the dukedom of Este between the second half of the 17th and the 18th century. The comparison has introduced useful information about the historical evolution of the Rocca, coherent to the previous datation. Moreover, the research can be considered as the first step of a more extended and systematic study of this construction technique, firstly in the same cultural and political area, and secondly in a wider territory to investigate it in its historical and chronological meanings.

INTRODUCTION

Behind the precious ornaments often enriching the vaulted ceilings and recalling the figures of famous decorators from Emilia, it is not rare to discover the presence of light structures built quickly and cheaply but not less interesting: the “plaster and reeds” or cameracanna-camorcanna vaults, as in the Vitruvian definition. Used in churches and civil buildings from the 13th and 14th centuries and described in the treaties by many authors starting from the 16th century, the “light vaults” technique has spread thanks to its lightness, rapid execution and economic advantages, and in the 19th century it reached its greatest diffusion.

This kind of construction technology, even if in the specificity of the different applications, consists of a wooden centring structure, which are assembled in different ways and shaped in the intrados, where a support for the plaster is attached. Some usually gypsum – based coats of plaster face the vault and make the surface for the decorators’ paintings. Thanks to its qualities it was also used for false ceilings – plafoni, external cornices and partition walls.

During a wide university research, carried out by D.I.A.P. – restoration branch - of the Politecnico in Milan and coordinated by prof. Carolina Di Biase, it was possible to study the Rocca in Spilamberto closely, a notable building connected to the powerful Rangoni family for many centuries, and to investigate a camorcanna vaults complex (fig. 1). This research moves from the precise study of the material and characteristics of this constructive technique application, like the elaboration of the single elements and their assemblage, the riveting system anchorage, the centring – masonry joint, the type and the working of the reeds, the stratigraphy and composition of the plasters. The research investigates the similarities and differences in their connection to the geometry of the rooms as well as to the periods they date back to, with the final purpose to introduce new information about the historical evolution of the Rocca.

THE VAULTS IN THE ROCCA RANGONI IN SPILAMBERTO

Going over the events of the Rocca means telling the Rangoni history; the important aristocratic dynasty from Modena has always been tied to Spilamberto, located a few kilometres from Modena, as the so called Spilamberto branch of the family reveals. Even since 1353 they have become the lords of this region, donated to Aldobrandino Rangoni by Aldobrandino d’Este, the marquise Obizzo’s son (Tiraboschi, 1824, p.98), and they were officially invested of the feud by duke Borso d’Este in 1454 (ASMo a).
It’s not possible in this context to talk about the relevant events related to the family, both in the local area and in the largest framework. The Rocca is often a theatre of these episodes (Di Biase, 2007, 62–90): it was a fortress to protect the feud at the end of the 14th century, built on a previous tower of a fortified outpost at the limits between the rival communes of Modena and Bologna; then aristocratic residence which lodged the condottiere Nicolò Rangoni and his wife Bianca, lord of Bologna Giovanni Bentivoglio’s daughter; palace with arrangement and dimensions of spaces accorded to the new manners and needs of the 17th century; countryside residence whose decorated rooms hosted notable guests delighted by the salubrious air in Spilamberto, until the slow decay beginning from the end of ancien régime.

Among the many transformations of the Rocca during the centuries, we focus our attention on the great building programme of the second half of the 17th century, when the wide vaults system that covers almost all the rooms of the piano nobile was built. At the beginning of the 17th century, when Modena became the new capital of the Este States where the Duke and his court moved to, an intense building activity began, transforming the city to adequate to its new role (Folin, 1999, pp. 11-37). Chronicles and archived documents inform of a certain unrest of the local aristocracy, in order to be equal to the new Este sites, as in the ducal palace. This building ferment also concerned the countryside: the ducal palace in Sassuolo, promoted by Francesco I d’Este, the restructure of Gualtieri palace by the marquis Ippolito Bentivoglio and of the Rocca in Scandiano by the Thiene (Ceccarelli, 1999, pp.153-177) are some examples of these great sites during the first half of the 17th century. In Spilamberto the situation isn’t very different; when the marquis Guido IV inherits the Rocca, it was probably a heterogeneous building, result of past transformations and additions. For long the rooms of the ancient fortress hadn’t lodged the main members of the Spilamberto branch of Rangoni, who preferred living in their feuds in dukedom of Parma. As a local chronicle relates (APS p a), the marquis, who got the feud primogeniture by Francesco I in 1648, lived in the Rocca, and promoted the conversion of the building into a homogeneous countryside palace in 1660. Only a few years later, in 1666, the flats and rooms in the piano nobile housed the newly-married Filippo, Guido’s son, and Anna Teresa Rangoni, whose marriage brought to the family a great part of inheritance of her father Alfonso I Rangoni, without male heirs. Documents related to their arrival to the Rocca after the wedding, describe the richly decorated rooms of the flats in the piano nobile, camere, camerini, Oratorio da Messe, Gallaria (ACS p a), whose arrangement corresponds to the current one.

Plaster and reeds vaults are the support for the painted architectures that enrich vaulted surfaces of all the rooms in piano nobile, actually hidden in most part by a rude whitewashing; the use of this construction technique wasn’t uncommon in that period in sites of aristocratic palaces; for example, it was widely adopted to cover many rooms in palazzo Ducale in Modena (Farinella, pers. com), as the precious stanze di rappresentanza in east side of piano nobile toward the city, probably built in the second half of 17th century. (Pacciani, 1987, p. 79) (Bentini, 1987, pp. 135 - 136).

Their investigation both in the extrados and in the intrados thanks to missing parts due to collapses, allowed to analyse the whole constructive system. Barrel vaults with cross extremities with a reduced curvature are mostly
used and they contribute to uniform the entilade of the rectangular or almost square rooms. Their investigation allowed to recognize some differences in the constructive choices, otherwise impossible to notice. They could be approximately interpreted as two different constructions; the first above the northern “double body”, so called because of the 2 rows of rooms composing the wing, the second above the remaining rooms of the palace. This hypothesis seems to be more interesting if we think of the different dimensions and construction evolution of the two areas.

Above the galleria (A - letters identify vaults and refer to table 1 - , location in fig. 1) and the rooms of the eastern [B. image and location in fig. 1] and western wings; whose span doesn’t exceed 5.70 m in the principal frame direction, parallel wooden centrings built on longer walls make the bearing structure; they cover the central area and are the support for the transversal elements, diagonally placed in the corners in the intersection between the cross extrados surfaces. Shorter opposed elements are leant against the diagonal centrings on both sides, to reduce the distance between the wooden structures that have to sustain the reeds. Frequently in the corners you can observe a fan-shaped disposition, probably an empirical attempt to regularise the area between the centrings orthogonal to the wall and the diagonal ones. Almost the same scheme is used and is adapted to the dimensions and specifications of each room.

All the boards of the structure are probably made of poplar (Del Curto, unpubl., p. 32).

The centrings distances are quite irregular for each vault; moreover, the main structures distances of the rooms in the east wing (between 75 and 90cm) are larger than those in the west wing and in the central towers (from 42 to 73cm). The secondary centres distances measure from 84 to 46cm in the various rooms. Smaller structures, corresponding to the ancient S. Antonio and S. Filippo chapels and the galleria, are organized in the main structure with less distances (about 50cm – only one is 86cm), and the secondary ones about 60cm. It’s not possible to interpret the differences and irregularities only as fitting to the other building elements like the chimneys; in any case all the values are coherent to the size of 1 - 1½foot (from 60 to 90 cm) that Scamozzi suggests in his treaty of 1615 (Scamozzi, 1615, p.327).

With the exception of the smaller rooms, the main centrings are entirely built with two rows of flanked boards, one of which is frequently realized with higher elements; probably it works as the bearing element, and the other mainly as connection. Some details seem to confirm this hypothesis: in the intrados the lower elements are rectilinear, and they don’t follow the curvature vault. With regards to the secondary frame, normally we can observe a simple row with puntual boards in connections, probably because of the reduced span they have to cover (never superior to 270 cm).

The same care-less can be found in the building of the single frame parts. They are constantly 3.5 – 4 cm in thickness, because of the wood board they are gotten from; otherwise their irregular outline makes it hard to give significant sizes in the height (from 6 to 30 cm). The elements are often rectilinear; shadings in extremities aren’t realized in order to follow the outline of the vault extrados, but mainly either to get the passage of cross-bars or to use the obtained material again. This can explain some missing parts of boards, whose profiles are the reverse of the vault ones. A lot of times the shaped elements are the remaining parts of a board which has been previously sawn to get a concave centring for supporting the reeds; this is quite evident for the small elements in segment of circle - shapes, that are often used as connections. Also joints between the boards of the same row are inaccurate. A quite linear riveting, sometimes a double row according to the heights of planks has to fit to the irregular shapes of flanked parts.

The impost of vaults is built with small elements with vertical course which the centrings are connected to; it is the place where there is the main change in the curvature, and it is hard to solve with a single wooden board. Joints with vertical bearing structures are often hidden; the collapse of a vault allows to observe that a single row of centring is fixed in hollows, which are dig ex post in a masonry belonging to a previous constructive period. The white mortar is probably gypsum – based. Some wooden cross – bars with irregular section and outline, sometimes simple twisted stick, join the centrings; generally, the connection is realized with a single element from the diagonal arches. As we can imagine looking at their irregularities, their function is not structural, but to avoid the little relative movements between centrings, which could cause cracks in the intrados plaster. Probably they were mostly spread, as we can imagine looking at the coarse hollows lined up along the different centrings; in some rooms there are 2 rows of cross - bar each side of vault. This means they were considered a necessary part of the structure.

From these observations, the vaults scheme seems to be the result of a not well-organized constructive process, where hands worked in order to rapidly solve the problems, exploiting the wood board as much as they can, as the reduced height of centrings sometimes shows (11 cm).

The plaster support (fig. 1) is made by entire reeds of about 5-12 mm diameter; each 30 cm 2 rushes wrap up couples of reeds in a specular way, in order to realize a lathing. It’s connected to centrings by a string tied to close studs (3 - 5 cm).

In two rooms the 3 coats which form the intrados plaster have been examined in the laboratory by the CNR – Gino Bozza - Politecnico in Milan (one in the east wing and the second in the largest room in the north “double body”), and the results are coherent to the general indications in the treatises: the render is gypsum – based, white – grey coloured, with a strong structure and a fine grading; the middle – coat, with a variable thickness, is also gypsum – based with a presence of lime that gives to the support the light grey colour; the finishing coat is composed by lime, in case gypsum - mixed, with quartz, calcite and plagioclase aggregates; a painting layer is spread-laid on it (Bugini, unpubl., p. 12, 22). According to the Scamozzi suggestions, a light colour lime, probably gypsum - based, also covers the extrados of the reeds lathing, even if sometimes partially.
Despite the common scheme some differences can be observed looking carefully at the structures covering the more spacious rooms of the “double body”. They macroscopically shows a more regular setting, a major quality of manufacture. The centrings profiles are carefully carved to obtain elements with a quite constant height (from 15 to 20cm), following the vault surface; the connections are exacter. This is particularly evident in the south-west room, called the camera della conversazione in a inventory of 1767 (C, image and location in fig. 1), that is covered by the largest vault in Rocca. Moreover, despite the superior sizes of the rooms, main centrings are made by a simple row of wooden boards, with small pieces placed only next to connections. Finally the extras paras of vaults, without exceptions, are totally without plaster.

On the contrary, some similar elements, as the presence of the same – worked boards of segment of circle-shape to join the elements of the single rows of centrings, the fan – shape layout of the secondary centrings, even if less evident, and the similar centre distances (from 50 up to 80cm for the main structures and between 70 and 90 for the secondary) emphasizes the continuity in the aspect of the whole vault system.

In the sala della conversazione it’s possible to see vault connections with a wood beam; single boards are carved to obtain the sharp curvature in the vault impost, and are placed in specific holes of the horizontal support, in order to contain the horizontal part of the pressure, as well.

APPLICATIONS IN OTHER PALACES AND VILLAS

Looking for further research paths to better understand the similarities and differences seen in vaults in the Rocca, the study has been spread to other plaster and reeds structures; among the criteria of selection there are the period of construction, but unfortunately it has been possible to investigate only a few contemporary structures: urban and country location inside the Este territory; the type of building and its use; the aristocratic property, in a case the same Rangoni family.

Firstly the study has investigated the Rocca Estense in San Martino in Rio; it was also a military outpost towards Reggio, that has been adapted many times until becoming a marvellous country side residence for a cadet branch of Este, invested of the feud in 1430. A light vault is realized in the anticamera of the east apartment, called “dei paesaggi lacustri” (D, fig. 2); in the intrados, painted architectures with vases and Estensi eagles support a balcony with a balustrade that frames the sky; they are linked to hands from Emilia who followed the Bibiena experience, and can be dated back to the end of the 17th century (Severi, 2003, p.21), still near Guido IV interventions. The presence of the important painter Giorgio Magnanini (1682 – 1755) (Severi, 1984, pp. 49-61), who worked in other sites with famous artists as Vellani and Consetti, is documented in Rocca.

A barrel with cross extremities vaults covers the wide rectangular room. Unusually, the chief structure is not built on the longest sides of the room, but on the shortest, and it has to cover the longest dimension of the space; this decision has been taken probably to avoid charging on the west thin wall, and demonstrating the flexibility of this construction technique which is easily adapted to solve each situation.

Like in the “double body” in Rocca in Spilamberto, wooden pieces and centrings are carved quite well; their outline follows the vault surface and the heights are quite constant. But the comparison points out some differences, too. All the centrings, main and secondary, are made by a double board system, and both rows are fit in the wall and fixed with mortar; signs of joints in the masonry of a previous vault make it clear. The transversal centrings are placed in a quite orthogonal way: to avoid the presence of too wide spaces next to the diagonal arches they have more uniform and shorter distances. There aren’t any cross-bars, that are replaced by a few tambocci, shorter wooden elements joint between the centrings to brace them, and extensively used in a recent restoration; in previous photos can be recognised that they are only positioned along the direction connecting the opposite gains where the diagonal arches are linked with the main centrings; it is the place where the transversal forces on the chief structure are stronger.

The support for the gypsum plaster in the extras is made by reeds lathing similar to Spilamberto. Some characteristics of this vault, partly present in Spilamberto, like barrel with cross extremities scheme, the double board centrings, quite well made and uniformly shaped, the extras paras, will be constant elements in the next examples.

Dated back to a few years later, and moving on an application of the constructive technique in the urban context of the dukedom capital, an interesting light vault can be found in the “sala dei cardinali” (E) in the Collegio dei Nobili della Madre di Dio e di San Dionigi Aeropagita in Modena. The building, actually called Collegio San Carlo, has still been lodging the institution born in 1626 with the purpose to give the necessary government culture to the nobler class, and is the result of many additions and transformations. We focus on the interventions under the rector Bartolomeo Fedeli, who manages the institute between 1689 and 1721, in a moment when the collegio fame recalls a lot of young Italian and foreign students. The illusionist architecture of the “sala dei cardinali” throws us immediately into the ornamental context already seen before in San Martino in Rio; the same Magnanini worked in some rooms of this building. A local chronicle of the 17th century brings the name of the artists working in the room, as Consetti and Spaggiari for painted architectures (Bentini; Curti, 1991, pp. 185-198). The knowledge of the artist who were working in the palace gives us a datation post quem for the construction of the vault as well.
The barrel with cross extremities vault is build on an almost square wide room; as usual it is realized by flanked wooden boards, with a shorter height (15 cm) in comparison to the previous examples. We can see an interesting difference in the corner solution: the diagonal centrings are replaced by a complex system that let the structural scheme orthogonal: against the main centring is joint the secondary, that is at the same time the support for another load-bearing arch; this concatenation of orthogonal structures, one against the other, goes on and reaches the corner. It’s not possible to understand the reasons of this constructive change, much more complex and refined in comparison to the previous examples. We can suppose that it was an expedient to reduce the cracks formation, because of the elimination of the weak continuous line where plaster supports joint, which are here more linked. Besides, even according to the visual perception, this kind of intersection in the corners is less marked, and generates a more unitary spatial feeling. The use of this scheme in the place of the diagonal element, where the transversal centrings were concentrated and opposed one to other, creates a complex system of transversal pressures that is probably the reason of the systematic use of tambocci: they extend ideally the secondary centrings which end against the main structure, and their wide presence creates a unitary mesh, spreading the strengths to the whole surface of the vault. The tambocci, rarely used in San Martino, are often realized with recycling material and are lower than the main structure (5-10cm). Because of the impossibility of looking closely at the vault it’s not possible to understand if the missing tambocci in the central area between the 2 main centrings are lost or if it answers to a precise choice: in fact that is the place where the transversal thrusts are less strong.

It is possible to find another difference in the plaster support: the reeds are replaced by wooden lacing, completely wrapped by a light grey plaster, which has also a stiffening function.

Some decades later, a similar structure is built in the Palazzo Carbonieri in Modena. The illusionist architecture of the “sala dei cardinali” certainly influenced the unknown painter of the quadrature of the barrel with cross extremities vault in the state room of the palace of counts Sabbatini. Some frescoes are attributed to the figure - painter Francesco Vellani (1688 – 1768); otherwise there is no information about the hands who built the vaulted structure, realized between the 1752 and the 1754. (Bertuzzi, 2000, pp. 35-47)

In a curious parallel with the influences in the decorative apparata, the vaults, extraordinarily built, show elements of continuity in the construction aspects too, as the same refined solutions of corners. In the vault which covers the scalone (F), the main frame forms with the transversal centrings and tambocci an orthogonal mesh; as shown in the Collegio S. Carlo vault, only in the central area a few tambocci are missing.

It’s very interesting to look closely at the same building scheme in the next state room (G, fig. 2), a long rectangular space where the barrel part of the vault is predominant. The structure presents more or less the same details in the building elements except for the use of tambocci: they complete the orthogonal mesh of the complex system of centrings in the corners, where the transversal thrusts are stronger, and their presence is reduced in the barrel area of the vault.
Entering the precious rooms of the Palazzo Solmi in Modena it’s possible to observe the application of light vaults in a Rangoni site in the city; the palace is the result of a lot of constructive phases, which incorporated more buildings and apartments shared between different members of a branch of the family, who has been living there at least since the 16th century. Later embellishment interventions in the 18th century defined the current aspect of the building (Bertuzzi, 1982, pp. 27-58). The Bonifazio Rangoni will (1714 – 1781) give some information about the dating of the studied vaults, placed in the main room (H), in the sala degli specchi (I) and in the next room (L), informing us that he was the promoter of the “insigne alzamento della gran sala” and of the “abbellimento dell’appartamento nobile” (ASMo b).

The construction layout used is the most traditional and simplest we have already seen in Spilamberto and San Martino in Rio; the manufacture of boards isn’t precise too much. The diagonal centrings placed in the corners leaning against the main structure of the barrel vault converge in the same point, because of the moderate bending of vault. As we saw in the Este residence, a few tambocci are used only in positions mostly influenced by pressures; they joint the centrings in the topmost key part, where they are connected with the couples of diagonal arcs; in the room next to the mirror they are placed along the whole length of vault, in the main room there is only one element between the first two parallel centrings. Despite the different size of the rooms, the constructive aspects are very similar; otherwise the data aren’t much different from the others studied.

In the sala degli specchi it’s possible to make a further annotation: here we can see a different scheme, perhaps due to the high weight of the mirror that we can still see in the centre of the square room. A single centring makes the main structure, joint in the central area by 4 wooden opposed arcs; diagonal elements which come up from the angles are connected to them, and in the gains the arches are linked by tambocci which contrast with the transversal thrusts. The result is a quadrilateral structure where the mirror below is placed.

A similar structural solution is used in the barrel with cross extremities vault of the Sala di Aragona (M) in the Rocca Estense in San Martino; it was built in the 18th century during the domination of don Paolo d’Aragona, a noble from Naples who bought the marquise title and the feud of San Martino and Campogalliano on 6th January 1772 (Severi, 2003, p.27).

The dimensions of the elements of the structure are similar to the previous, a part from the superior thickness, while the centrings distance is quite wider, despite the large size of the room. As well as in Spilamberto, the boards are made with poplar; the use of softwoods is often suggested by authors of 19th century, as we can read in treatises (Valadier, 1833)(Cantalupi, 1862)(Lenti, 1884). The tambocci are here totally absent, and the structure is stiffer only by lacing which support the plaster. The size of single battens is 4,5-6 x 2cm, and they are 1-2cm far. According to Scamozzi’s treatises, the used wood for battens hasn’t “sugo dolce come il pioppo” (Scamozzi, 1615), but they are made of deal (Severi, 2003, p.27). Only in a recent restoration it has been inserted a mesh of tambocci and panconcelli, and steel ropes which support the structure from the roof structure. Masonry supports corresponding to each arch face horizontal thrusts in the mainly bended areas.

Even if going out from the period we are examining, it can be useful to the research the investigation of the barrel with cross extremities vault covering the sala del consiglio (N) in the Palazzo Comunale in Modena, which is the widest room analysed up to now. The bibliography dates the vault back to the end of the 19th century (1898) (Martinelli Braglia G., 1985, p. 243-244), but a document of 1825 recently found in the notarial Archive in the ASMa and concerning some works on the plaster and reeds vault, leads its datation to a previous period (ASMo c).

The layout and size of boards are almost the same of the ones we’ve already seen in Spilamberto and other examples of the 18th century described before, and it demonstrates the continuity of this kind of construction technique during the time. The great width of the room is managed using a triple row of wooden boards, well-made, both for the main structure and for the secondary one. A second precaution is the systematic presence of tambocci in the whole surface of the vault, rarely used in the investigated structures with a similar constructive scheme. Here there isn’t the complexity we saw in Collegio dei Nobili or Carbonieri palace: they don’t complete the mesh of the main and secondary structure, but they are regularly placed in order to add a stiffening element. The reason for their use can be the plaster support, realized with reeds instead of the wooden maddings wide-spread in the XVIII century. On this subject it can be useful to remember the building treaties of the 19th century, where the authors, as the Cantalupi, Curioni and Sacchi, suggest to use reeds for their lightness.

In a wall, located in the south-west and realized with “plaster and reed” system, it’s possible to see the lathing closely; it’s realized and fixed to the wooden structure similarly to Spilamberto. It’s possible to observe also the linking between the vault and the “light” wall: on the 14m length complex beam, placed to discharge the ceiling weight to the external walls, are located in particular wholes the wooden centrings of the vault. The skylight on the vault, also realised with studs and round wooden transverses which support reeds and plaster, shares its weight both by wooden pieces above some centrings and by 2 trusses which sustain the roof.
Table 1: Synthetic scheme of measures* of main elements of some investigated vaults. Values are approximate; when the variations are significant two values are noted to suggest the range.

<table>
<thead>
<tr>
<th>Vault</th>
<th>Dating</th>
<th>Room size</th>
<th>Main centrings</th>
<th>Secondary centrings</th>
<th>Stiffening</th>
<th>Plaster support</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>size</td>
<td>centre distance</td>
<td>centre distance</td>
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<tr>
<td>A</td>
<td>1660</td>
<td>20.35 x 2.60</td>
<td>3.5 x 8 / 17</td>
<td>70</td>
<td>*</td>
<td>66</td>
</tr>
<tr>
<td>B</td>
<td>1660</td>
<td>5.70 x 5.54</td>
<td>3.5 x 23 / 6</td>
<td>85 / 45</td>
<td>3.5 x 20 / 5</td>
<td>60 / 80</td>
</tr>
<tr>
<td>C</td>
<td>1660</td>
<td>7.97 x 7.11</td>
<td>4 x 20</td>
<td>76</td>
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<td>D</td>
<td>end 17th</td>
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<td>4 x 14 / 22</td>
<td>62</td>
<td>*</td>
<td>44</td>
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<tr>
<td>E</td>
<td>1689 / 1721</td>
<td>13 x 12</td>
<td>4 x 16</td>
<td>54 / 67</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>F</td>
<td>1st half 18th</td>
<td>7 x 6.8</td>
<td>* 15</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>G</td>
<td>1st half 18th</td>
<td>11.75 x 6.8</td>
<td>4 x 14</td>
<td>60</td>
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<td>*</td>
</tr>
<tr>
<td>I</td>
<td>2nd half 18th</td>
<td>25 x 9.25</td>
<td>4 x 15 / 20</td>
<td>83</td>
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</tr>
<tr>
<td>L</td>
<td>2nd half 18th</td>
<td>6.5 x 6.5</td>
<td>4 x 15</td>
<td>89</td>
<td>4 x 16 / 20</td>
<td>63 / 83</td>
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<tr>
<td>M</td>
<td>2nd half 18th</td>
<td>11.75 x 5.25</td>
<td>4 x 18</td>
<td>84</td>
<td>4 x 16</td>
<td>78</td>
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<tr>
<td>H</td>
<td>2nd half 18th</td>
<td>9.45 x 8.84</td>
<td>* 106</td>
<td>4.7 x 15 / 20</td>
<td>92 / 118 - lacing</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>ante 1825</td>
<td>10.72 x 5.76</td>
<td>3.5 x 17 / 21</td>
<td>60</td>
<td>4 x 12 / 20</td>
<td>67</td>
</tr>
<tr>
<td>O</td>
<td>end 17th</td>
<td>15 x 10.30**</td>
<td>4.5 x 18***</td>
<td>54***</td>
<td>12 / 8 x 18.5/ 10****</td>
<td>55****</td>
</tr>
</tbody>
</table>

* Impossible to measure or observe
** Elliptic plan. The values are related to diameters
*** Values relating pendentives
**** Values relating lunettes

For the last example it has been chosen the vault covering the elliptic hall in Villa Sorra in Castelfranco Emilia (O, fig. 2), a elliptical dome, with four lunette and a central lantern; it is the most daring example studied in this research, which moves from the barrel with cross extremities vaults seen in the rectangular rooms of palaces, and goes towards a type frequently used in church ceilings; a very similar example, moreover linked to the same architect, is the San Domenico vault in Modena. On the dating of the villa construction different hypothesis were formulated in the past: the most recent studies date back to the last years of the 17th century the building of the “Casa da Padroni per necessario commodo di villegiare”, promoted by count Antonio Sorra, and identify Giuseppe Antonio Torri as the designer (1655 – 1713) and his pupil Francesco Maria Angelici as the work director (Lenzi, 1983, pp. 32-45) (Bergonzini; Di Paolo, 2002, p. 95).

The construction layout shows a great complexity, using the usual elements we’ve analysed up to now. A wooden elliptic structure, the bottom of the roof-terrace, is supported by four orthogonal beams (12x18,5cm); these elements are also sustained by centrings composing the four pendentives of the dome, whose become the keystone of the whole structure. The lunettes structures have been realized on this skeleton: they’re made worked the most expert hands, or to the search of lighter structures there.

A wooden madding, all up-covered by plaster, is joined to the structure, as already seen in many 18th century vaults; in the small elliptical roof-terrace, it is placed on the studs along a diagonal line, perhaps in order to less bend the wooden pieces.

CONCLUSIONS

Despite the few examples studied and the reduced possibility to examine structures contemporary to Spilamberto ones, it’s possible to formulate some useful considerations about the knowledge of its historical evolution. The comparison has emphasized the similarities and flattened the differences between the Spilamberto vaults; in the other investigated examples, also the nearby ones, it’s possible to observe the presence of new elements and the replacement of others, changes of the structural scheme with more refined ones, different plaster supports; these data mark the distance with the Rocca, and seem to be coherent with the datation to the unique construction period its vaults, or at least in a close period of time: differences can be due either to the different care and attention in the building of the wider vaults in the north “double body”; where perhaps worked the most expert hands, or to the search of lighter structures there.

Even if with the limits of a research path that is taking the first steps, some inputs can be advanced about the way this constructive technology has been used in palaces and villas in the territory of Modena. It’s possible to observe that among the huge variety of possible structures for plaster and reed vaults we can see in the Italian construction treatises and in specialized publications (Quagliarini; D’Orazio, 2005, pp. 36-52), only a few are present in Modena. For example, the centrings are never hung, and their distances are rarely superior to 1m; there aren’t further elements of stiffening, or they’re reached through a simple system either of tambocci or cross - bars; among the several types of supports for the plaster, as differently plaited reeds or little
branches, it has been possible to register only the use of the reeds lathing, a really common material in Modena, which is always built in almost the same way, and lacings of 17th century.

The main interest of investigation is about the different details used to solve the vaults each time, beginning from a layout and materials more or less similar: for example, the different ways to solve the intersection between the transversal side of vaults, or the expedients used to cover spaces that become larger and larger during the time, as the gradual spread of tamboccì and their different use, the numbers of flanked board of centnings, the kind of plaster supports.

The next step of the research is going on with the systematic investigation of plaster and reeds vaults in the same political and cultural area in the 17th and the 18th centuries, extending the study also to other types of buildings, like churches, theatres and modest houses; in a second time, the research will be spread in a wider territory and time to better understand the construction technology in its historical and chronological aspects.

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