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Reflections about the restoration of a rammed earth Islamic tower

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ABSTRACT: Torre Bofilla is an Islamic watchtower built at the beginning of the 13th century by the dwellers of the underlying farmstead of the same name. It is a tower made out of rammed earth filled with a small amount of lime and stone filling, with a square 6 by 6 m plan and about 18 m high. This article addresses the research carried out on the tower during the restoration works, with the preliminary reflections intended to make the restoration respect to the greatest possible degree the old fabrics and all the traces accumulated upon it both during the building stage and later, when it was plundered, abandoned and manipulated. The text will deal with the specific details of the restoration of the tower with the different systems applied in order to address the criteria and reflections made beforehand.

1 RESTORATION OF THE RAMMED EARTH: STATE OF REPAIR AND PROBLEMS

The restoration of rammed earth walls, whatever their type and materiality, represents a technical and conceptual problem that is hard to solve (Warren 1999, Mileto 2011). In the first place, the amount of mass missing from the walls tends to determine the type of intervention in most cases. If the loss of mass is limited to the external surfaces and adopts the form of a patina or superficial erosion, the structure will not be compromised and the restoration can leave these surfaces as they are so as to emphasize the age of the wall. On the other hand, if the loss of mass involves serious erosion or a lack of volume and particularly if this occurs in the lower part of the construction, the structure may be compromised to such an extent that the restoration works cannot ignore its presence and must take steps to guarantee the survival of the building.

A fairly common example of the latter situation is the loss of volume in the coping of the building, which does not usually affect the structure directly because it is at the top, although it may lead to the progressive degradation of the rest of the building, so it is necessary to deal with it in some way. Behind the wish to alleviate this degradation, we often find a desire to replace the missing volume of the building, using solutions that involve restoring old forms and crowns that attempt to satisfy both requirements at the same time.

In all cases of serious erosion and loss of volume, a question arises regarding how to act on a wall, whose cohesion, compactness and structural resistance depend, at the end of the day, not on the material itself—the earth mixed with binder or degreasing agents—but on the specific way it is applied while it is built. If the loss of volume is at the base or lateral surface of the wall, this gap can in no case be filled in using the original building technique employed when the building was erected, since it would be impossible to compact the mass added to it vertically. If the loss of volume is at the top of the wall, rammed earth may be used as the building method to fill in the gaps as long as the wall underneath is in a good state of repair.

In any case, this second option can have several consequences. In the first place, it means that the original shape of the building must be restored, although this is not strictly necessary in most cases from a structural and construction point of view, but responds rather to a desire to restore it aesthetically. In the second place, it is necessary to know the original height of the crown of the building, which is not always readily apparent. In the third place, it inevitably involves a clear contrast between the original rammed earth surface, whose patina is a token of its age, and the new surface, with its smooth, even appearance and the signs of the new formwork.

This latter consequence responds to other important criteria, such as distinguishability in restoration, as defended by Camillo Boito since 1883 (Boito 1988) and later advocated by successive theoreticians and restoration charters; the fitness and advisability of using the original building methods in restoration works; and the recuperation of these abandoned or no longer used building techniques as part of the defense of a cultural identity lost or reviled in the 20th century, and the use of possible tools to create a more sustainable and ecological new architecture.

Let us take it one step at a time. The distinguishability endorsed by Boito was a concept that arose in the context of romantic restoration, concerned with the replacement of missing parts of the building as though they were original. Distinguishability is a term with great semantic flexibility, since it covers from total contrast to the slightest subtlety (Carbonara 1997). A lot of water has flowed under the bridge since Boito's time, and new concepts have arisen such as concinnity, involving harmony between historic construction and additions during restoration, just as the gaps in a historic painting are filled in with *rigatino* technique, seeking to enhance the total reading of the painting without renouncing the distinguishability of the details added. At the present time, suitable restoration works, architectonic stratigraphy, our current knowledge of materials, the patina provided by age, the possibility of chemical characterization and, above all, our difficulty in reproducing exactly the original techniques, are a guarantee of always necessary but, in many cases, obvious distinguishability in order to ensure that our restoration is correct without being too explicit (Vegas 2011).

On the other hand, in our opinion, the use of the original building methods in the restoration—but not necessarily the reconstruction—of a historic building is always commendable and predictable, but not at the expense of contrast or an increase of distinguishability. Indeed restoration does not imply volumetric restitution or reconstruction of the building, but rather repairs at certain places, where the original techniques may and at times should be used in order to guarantee physical, chemical, structural, construction, and other kinds of compatibility. Nevertheless, as we pointed out above, on the one hand, this procedure is impossible in the restoration of rammed earth walls because it cannot be applied in a lateral direction and, on the other hand, it is feasible but produces many aesthetic side effects in the coping. The only way to guarantee the integration of additions in the upper part of a wall would be by artificially eroding the new crust, taking it into account that the destruction of the crust will inevitably trigger the degradation process of the wall.

Given this situation, the first piece of advice would be not to fill in missing parts or crusts of the rammed earth wall unless it is absolutely essential to ensure its structural conservation. If it is, given that it is not possible to reproduce the same techniques in the restoration of rammed earth walls, specific intervention methods must be created to guarantee compatibility between the historic wall and the added parts. To begin with, there are two possibilities, with their respective variations. If it is not possible to achieve a mixture of the same composition as the historic rammed earth wall with identical structural features because of the lack of good compaction, in the first place, the binder in the mixture would need to be increased to enhance the structural features of the uncompacted mixture. There is a limit to this procedure: if the rigidity of the addition mixture is increased too much, making it lose the elasticity of the historic rammed earth wall, it may become detached in the short or medium term. In the second place, there is the complex and hard-to-apply option of lateral compaction, which in any case must be carried out in very thin coats and the amount of binder should probably be augmented, as we pointed out in the first case.

2 BOFILLA TOWER

Bofilla Tower is an Islamic watchtower (Rodríguez 2008) that was erected in a hurry at the beginning of the 13th century, when the inhabitants of the area were aware of the advance of the Christians in the Reconquista, which ended in 1238 with the conquest of the town and the nearby city of Valencia (Bazzana 1978). The carbon 14 test performed on samples of timber from the putlogs and rests of the joists of the tower date it around 1210 or 1220, and this is confirmed by ceramic pieces found in the filling at the base of the tower (Fig. 1).

On the other hand, we know its construction was rather hasty because home-made formwork was used to build it—probably the planks used to build the farmstead at the foot of the tower—which were connected by means of nailed posts. The planks available were insufficient to cover the whole perimeter of the tower, so that the tower was built with a U-shaped formwork that was moved after the earth had been compacted to complete the perimeter, thus avoiding any joints at the corners that might weaken them (Fig. 2).

But the joint at the middle of the tower might also have weakened the whole structure, so they took the precaution of alternating the joints in

Figure 1. Bofilla Tower in the surrounding landscape before its restoration (Vegas & Mileto).

Figure 2. Corner of the tower that shows the continuity of the rammed earth wall (Vegas & Mileto).

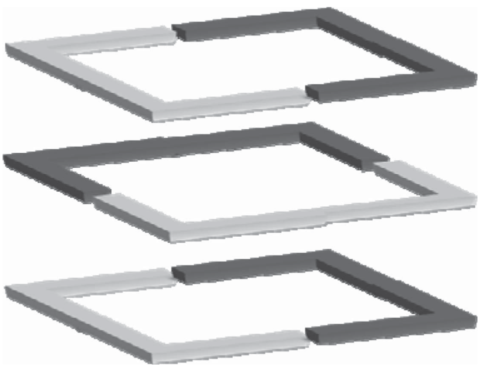

Figure 3. Building system used alternating the available U-shaped formwork (Vegas & Mileto).

the successive courses so that the entire ensemble would look well bonded, not only at the corners but all over (Figs. 3 and 4). The horizontal joints in the rammed earth were sealed *al fresco* at the top and bottom of the tower with 15 cm strips of mortar with a large lime content, which, combined with vertical strips, had the appearance of false ashlars (Fig. 5).

The three intermediate floors and the thin floor of the parapet walk (Fig. 6) were made with central girders and a large number of joists made of olive wood (Macchioni 2009), probably taken from the neighboring countryside and supplied by the local families.

In our days it is hard to think of olive wood used for joists and girders over 2 and 4 meters long, because we tend to prune olive trees to make it easier to beat them with poles when harvesting the olives. But medieval olive growing allowed the

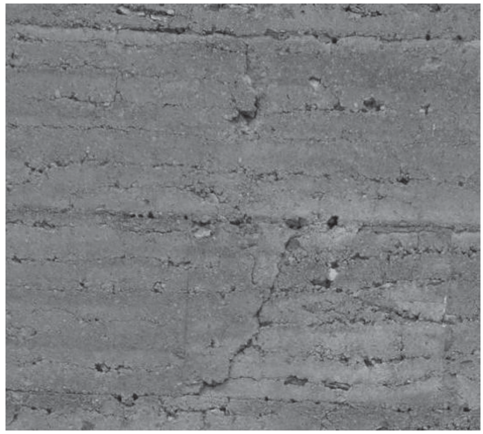

Figure 4. Successive courses showing alternatively inclined joints (Vegas & Mileto).

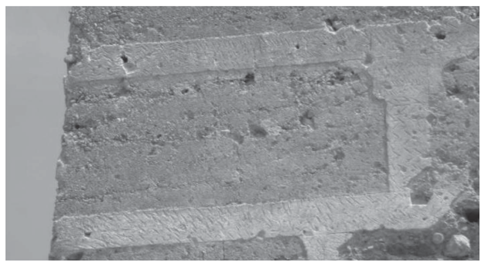

Figure 5. Strips of lime mortar sealing the joints at the top and the bottom of the tower (Vegas & Mileto).

trees to grow freely, and they grew to be 8 m tall and more, and tending flocks and plant farming were combined and olives were gathered directly from the ground when they had fallen freely. The tower was used until the early 15th century, as documented by the archaeological remains found, and from that time onwards both the tower and the farmstead underneath were abandoned while the neighboring town of Bétera grew in importance (López Elum 1994).

Before the restoration (Fig. 7), the state of conservation of its walls was relatively good, despite the loss of the roof and floors and the neglect to which the tower was condemned for some five centuries. The wooden floors had disappeared completely, probably due to a fire, of which traces could be seen. However, the intervention was urgently required mainly for two reasons: the pillaging of the stone voussoirs of the double arch at the entrance that had caused the partial collapse of the interior surface over it and the hole at the entrance to the tower at the southwest corner, which had left it suspended in the air instead

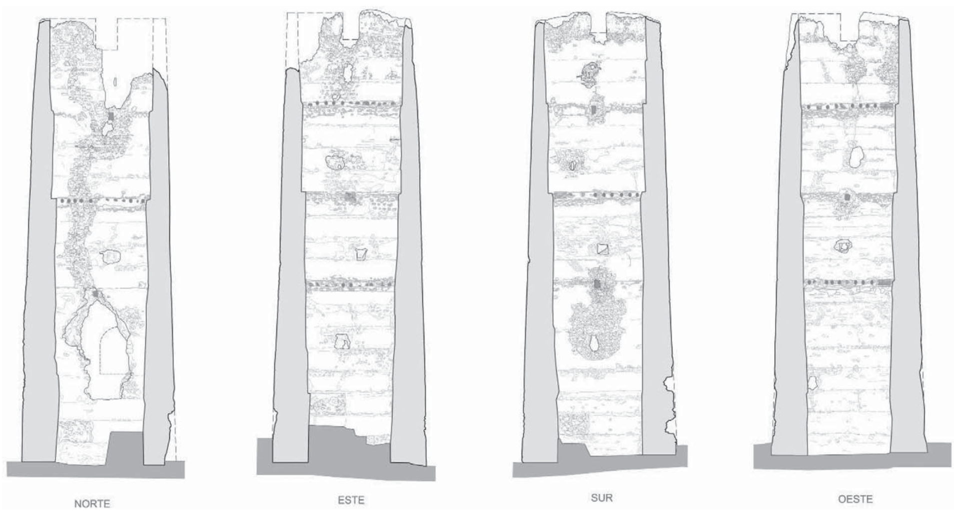

Figure 6. Traces of the disappeared wooden floors in the interior of the tower (Vegas & Mileto).

Figure 7. State of the tower before the intervention (Vegas & Mileto).

of resting on the ground. On the other hand, the south façade of the tower had lost its surface and the stone filling of the wall could be seen at the top and bottom of the tower.

3 OPTIONS ADOPTED IN THE RESTORATION

In the first place, the surfaces of the tower in a good state of repair were hand-cleaned with brushes, without attempting to leave the surface immaculate, since that would have involved unnecessary erosion of the historic surfaces. These well-conserved walls did not need further interventions, due to their healthy appearance after no fewer than eight centuries. The gaps in the rammed earth mass were another matter, and did require repairs and reintegration. Following the initial reflection, given that it was impossible to provide the historic mixture of nine parts of earth and gravel and one of lime (Kröner 2009) with a stone filling arranged in courses with the same structural features as the existing building, it was decided to improve the mixture by increasing the binder. The gaps at the southwest corner and the hole inside the north façade were filled with stone masonry bonded with mortar comprising 3 parts of earth and gravel and one of NHL-3 hydraulic lime (Fig. 8). As much local earth and gravel as possible were used, and were collected and sieved at the foot of the tower, so that the resulting mixture would not suffer from using gravel from a different place. In all the cases where it was deemed necessary, corrugated fiberglass rods were introduced to act as connectors. Perforations were drilled with the utmost care to avoid percussion, because despite the romantic appearance of the tower, several areas were found to be in danger of immediate collapse.

The stones that had fallen from the tower were used again, placed inside the wall and bonded in five successive layers that corresponded to the five historic building strata of each rammed earth module, not out of romanticism but in order to adjust the filling in of the gaps to the adjacent horizontal historic joints. Once one section of the surface was completed, it was rendered with the same mortar up to the next joint of the rammed earth module in the historic wall. The rendering limewater in the surface was absorbed with a sponge and was brushed afterwards to show up the local gravel in the mixture. Then the next module of the rammed earth wall was treated in the same way, so as to mark the natural horizontal joints between modules, corresponding to the horizontal joints between the historic modules of the wall.

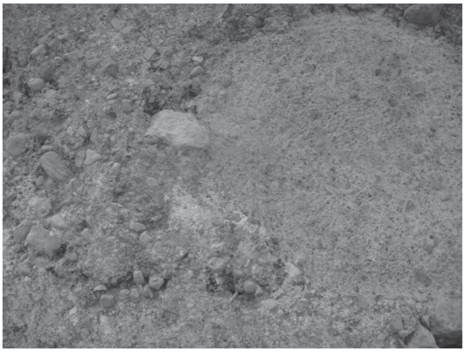

Figure 8. Integration of the gaps in the rammed earth wall (Vegas & Mileto).

Figure 9. Tower crown with consolidation and reintegration treatments (Vegas & Mileto).

As determined in the preliminary tests, once the rendering had set, the added masses slightly tinted with natural soils were the same color as the paler shade of the binder in the historic wall, not darker. From this moment on, a restorer set about giving a patina to the added mass, by splashing on with a brush natural soils with a lime base in order to guarantee good integration.

At the crown, in order to secure the surfaces in danger of immediate collapse in the north side and the merlons in the east and west sides that had lost stability due to erosion at the base, several possibilities were considered. Finally, it was decided to use the same procedure as to fill in the gaps because it ensured bonding and adherence, instead of more theoretical methods, which did not offer so much durability. The intention was not to restore the tower to its original shape, so these gaps were filled in up to the adjacent historic level and the degraded crest of the coping was respected in the areas where material did not need to be added to secure or stabilize the fabric (Fig. 9). Any attempt to outline the original shape of the upper edge was avoided at all costs, even where it was clearly the original coping, in an attempt to achieve the appearance of a hypothetical second-last course.

On the south side, in spite of the apparent seriousness of the naked appearance of the surface, the wall was deemed stable enough and it was believed it would not have conservation problems in the short and medium term unless water was retained or seeped into the fabric. In this way, the rubble that could be seen through gaps in the fabric was partially repointed only in the spots where it was necessary to drain out water. This partial repointing was carried out with the same mortar used to fill in the large gaps on the surface described above, and a final patina was applied so as to achieve greater integration.

The roof and interior frameworks of the tower were built with pine girders and joists, according to the rhythm marked by the traces on the historic walls, like the staircase (Fig. 10). It would have been logical to look for olive girders or joists or girders and joists from some wild tree like holm oak to imitate them if any of them were missing. In this case, as there were no remains, the framework was fashioned out of traditional materials like timber but with contemporary grammar.

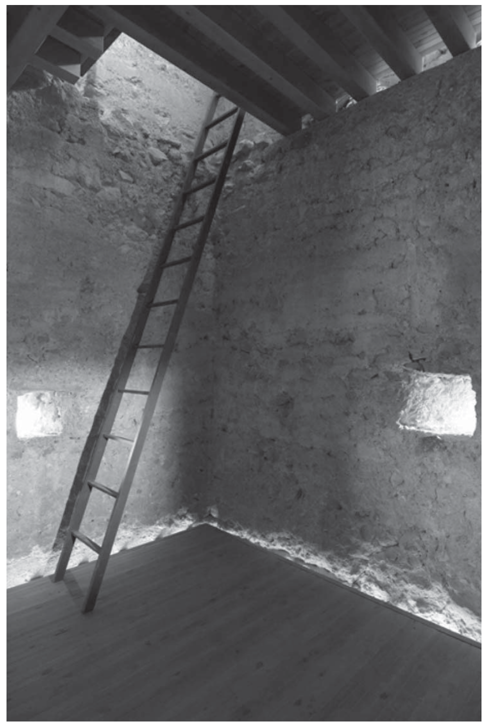

Figure 10. New floors and ladder in the interior of the tower (Baeza).

Figure 11. Bofilla Tower before and after the intervention (Vegas & Mileto/Baeza).

On the other hand, as described above, contextual integration was performed on the exterior, seeking to harmonize with the degree of degradation, patina and color of the preexisting adjacent areas to better guarantee the integration of the parts added to the building, which the authors have always given the central role in the intervention. When examined in detail, the additions have the appearance of *rigatino* in a historic painting, so that distinguishability had been guaranteed at the same time as the historic image and the value of the age of the building have been safeguarded.

NOTE

This paper is a part of the scientific research project "La restauración de la arquitectura de tapia en la Península Ibérica. Criterios, técnicas, resultados y perspectivas" (The restoration of rammed earth architecture in the Iberian Peninsula. Criteria, techniques, results and perspectives, ref. BIA 2010-18921) granted by the Ministry of Science and Innovation under the National Grant Scheme for the year 2010.

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