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OLD METHODS FOR NEW SOLUTIONS: HISTORICAL RESTORATION OF SANTA MARIA LA MAYOR CHURCH IN RUBIELOS DE MORA

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ABSTRACT

The main goal of the patrimonial intervention in Santa Maria la Mayor, the main church of Rubielos de Mora in Spain, has a clear focus on eliminating the humidity coming from the subsoil and its related pathologies. These problems are inherent to the building's structure. Many historical buildings' foundations and walls directly contact the soil, creating a common cause for different pathologies. In our study case, this is aggravated as the church has been built on a ravine with flowing water.

The solution for the new pavement needs to solve two problems. On the one hand, a technical one to solve water access inside the church and its pathologies. On the other hand, a geometrical one, to solve a geometrically accurate mesh of industrial cut stone pavement with the irregular geometry of the church. Historically we can find different individual solutions for these problems. The presented solution comes from a different starting point to unite both problems as one, as they are related. Historically, churches were built based on layouts that tried to solve with the same method different and diverse problems. These layouts looked for spatial harmony and proportions across the church, sizing the structural elements based on numerical relationships. Iconic shapes reference iconic meanings and links between the physical and the metaphysical world, where every element found its exact place.

Following this train of thought laid by the master builders who predeceased us, the solution must be unique, coherent, and based upon the church layout. The new pavement fuses the old and the new, creating a contemporary solution for historical problems, employing historical methods with current technology. It solves humidity and geometry with a mutual solution for Santa Maria la Mayor.

KEYWORDS

Restoration; humidity; historical buildings; Rubielos de Mora; pavement.

1. INTRODUCTION

The objective of the intervention defined by the Autonomous Administration of Aragon carried out in the Church of Nuestra Señora de la Asunción in Rubielos de Mora was to eliminate the humidity from the subsoil and the replacement of the pavement due to the pathologies that it had produced in it, all with a reduced budget.

The humidity assesment is a common problem in historic buildings, aggravated in our case by its location on a ravine, still active today. The flowing wáter on the ravine was channeled, embanked and covered with a vault, to be used as a sewer and to get a suitable surface to settle the projected church plant.

A problem with two aspects, a technical-constructive one, which affects the solution, to limit and if possible eliminate the humidity. And a geometric one that is always posed when placing a regular mesh, defined by the new format of the pavement, on the irregular geometry of the existing floor of the building. The result of which defines trapezoidal and not rectangular surfaces, problem of encounters between geometries, which must always be solved.

2. CHURCH OF SANTA MARIA LA MAYOR IN RUBIELOS

Rubielos entered the Christian geopolitical area in 1204, after the dissolution of the Taifa of Albarracín; being its primitive settlement, the current neighborhood of Campanar, a rocky spur, protected by the river Nogueruelas and the Regajo ravine (currently under the church), at the point where it narrows in its path, between the mountains of Santa Barbara and Punta del Pinar. A settlement of Andalusian typology.

In the thirteenth century, the population had its first expansion on the alluvial plain, to the north, west to reach the bed of another ravine, and east to the river Nogueruelas surrounded by walls (1260). The three backbone axes of this new layout were the pre-existing medieval roads around which the urban warp was traced, that of San Antonio street, the civil axis par excellence, that of the current Félix Cebrián street, and that of José Gonzalvo-Salvador Aranda.

The area was consolidated by the construction of large palaces for the nobility of Rubielos, such as the Marquises of Villaescusa, the Counts of Creixell, and many others. Its economic prosperity in those years rested on the production of cloth, blacksmiths, and potteries, creating a wealthy industrial class who demanded new infrastructure and a church closer to the town center and more in line with its economic boom. The parish church at that time was located outside the city walls, in the convent of the Augustinian nuns. This circumstance led to the construction of a new church inside the walls in the 16th century.

The construction of the church from 1593 to 1620 was the engine of urban development that occurred in the seventeenth century, building the City Hall (Pedro de la Hoya 1571), the Lonja, civil buildings representative of the new bourgeois power, and the convent of Carmelitas Descalzas, contemporary in its construction with the church (1608-1622), is known at that time Rubielos for its prosperity with the nickname of Corte de la Sierra.

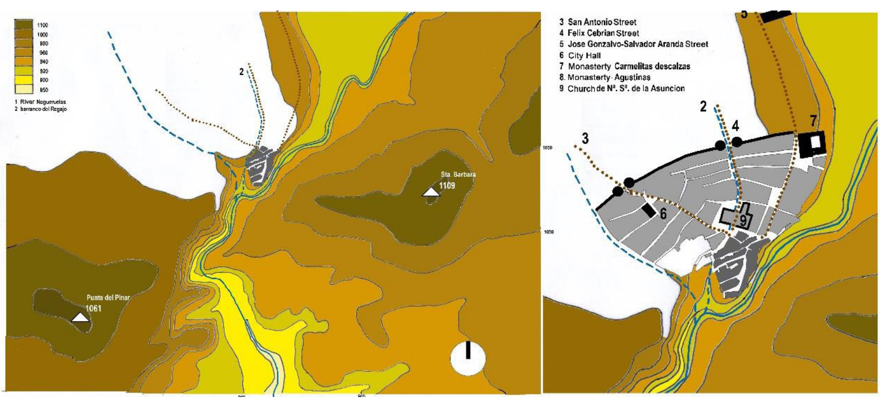


Figure 1. Rubielos de Mora geographical description

The choice for the location of the church was a free space located at the foot of the hill of Campanar, for which complex and costly works had to be done, consisting of the channeling and covering of the ravine that ran through there, the construction of the retaining wall of the current Plaza del Sol and the consequent embankment. There is a description of the place before the church's construction and the consultations made with different "master builders" about such works (Martínez, 1980).

The traces were entrusted to Pedro del Solar. Later they passed to Juan Cambra in 1604. In 1608 Pedro Ambuesa, stepson of the previous one and diocesan architect of Segorbe, seat of which depended at that time, Rubielos de Mora. He was an architect with an extensive curriculum, belonging to the circle of French master builders who built the fortifications of Peñíscola under the orders of Bautista Antonelli.

The traces correspond to a type very consolidated from the Gothic moment, a church of unique nave with chapels between buttresses. Its factories are made of masonry noting the wealth that Rubielos enjoyed at that time.

Two entrance-altarpieces under niches are designed, covered with ribbed vaulting, with lateral entrances to the pulpits, whose design is inspired by books III and IV of Sebastián Serlio, published in Spain in 1552.

In 1627, Pedro Ambuesa was contracted to finish the bell tower and reinforce the foundations. Ambuesa lightened the composition and height of the tower designed by Cambra to reduce its weight and designed and built the current lighter and more sculptural top.

It is interesting to note that, in 1617, the entire church was bricked. The remains of this primitive pavement still exist in different rooms of the church. This pavement was replaced at the end of the 19th century, beginning of the 20th century, in the central nave, by another hydraulic tile pavement, at that time of maximum novelty, drawing the via sacra and four squares for the stay of the faithful, which are finished with wooden flooring.

The importance of the church can be seen not only in the construction elements but also in a characteristic that only some cathedrals (Granada, Cordoba, Segorbe, and others) and some major collegiate churches possess. The existence of a double pulpit, one on the gospel side, reserved only for the bishop, and another on the epistle side, used for ordinary sermons by the abbot of the collegiate church or the beneficiary on duty, who might have been entrusted with the mission of preaching. Their religious function was vital during the 17th and 18th centuries since they allowed theological discussions to be held in the presence of the parishioners.

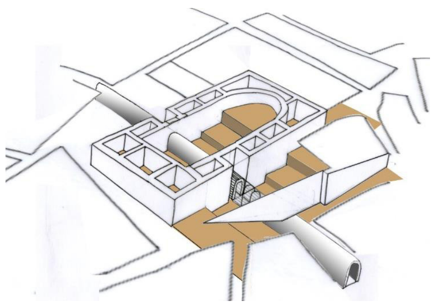


Figure 2. Church's foundations and sewer crossing it

3. CAPILLARY RISING HUMIDITY IN HISTORIC BUILDINGS. STATE OF THE QUESTION

Humidity in historic buildings is consubstantial to them both for the construction process and for the materials used and the correction of the pathologies that originate, a frequent cause for their restoration. Despite its overwhelming presence, its study has not been addressed, understanding it as a cross-cutting problem that affects several disciplines (geology, physics, chemistry, petrology, soil mechanics) until the seventies of the twentieth century. The doctoral thesis of Soledad García Morales (Morales, 1995) is a good compilation of the state of the question, providing a new methodological vision of the problem and seeking its operability. There have been other contributions since then, among which we highlight those of Toma Pipiraite (Pipiriate, 2017) and Juan Bautista Aznar Molla (Aznar, 2016). The historic building has been constructed with materials permeable to water, in vapor or liquid form. Water entry can come from the rain when beating on the walls and from the ground, whatever its origin.

In the first case, the material gets wet, and two constructive solutions have been used historically to maintain a comfortable situation inside the building. Single or double leaf walls, the latter being known as cavity walls, better or worse ventilated. We will focus on the case of single-leaf walls, as this is the solution with which the church of Rubielos was built, like so many others. The water that falls against the wall from the rain wets the exterior face of the wall, diffusing in liquid form through the interior of the wall, reaching a depth called the wet front, which advances until the precipitation ceases. If conditions are favorable, the wall begins to evaporate, releasing the water it had absorbed on both sides. This wet front depends on the material's porosity, the degree of exposure to air and sun, the relative humidity, and the outside temperature.

In the second case, the rain also infiltrates through the permeable layers of the soil until it reaches impermeable levels, clayey soils flowing through them due to gravimetric phenomena, establishing a water-saturated soil stratum. The upper part of this stratum is called the water table. The saturation level of the strata above the water table is variable, close to 100% on the surfaces closest to the water table, decreasing upwards. These are wet but not saturated soils.

The foundation absorbs this water, which rises through the inside of the walls towards the outside, to dissipate up to a height, forming a capillary base strip. The design will be correct if there is no moisture stain in the capillary base because evaporation is rapid. The effectiveness of this solution lies in adequately managing the thickness of the wall and the permeability of the material so that the wet front does not appear inside the room and so that the evaporation time is less than the climatic interval between precipitations.

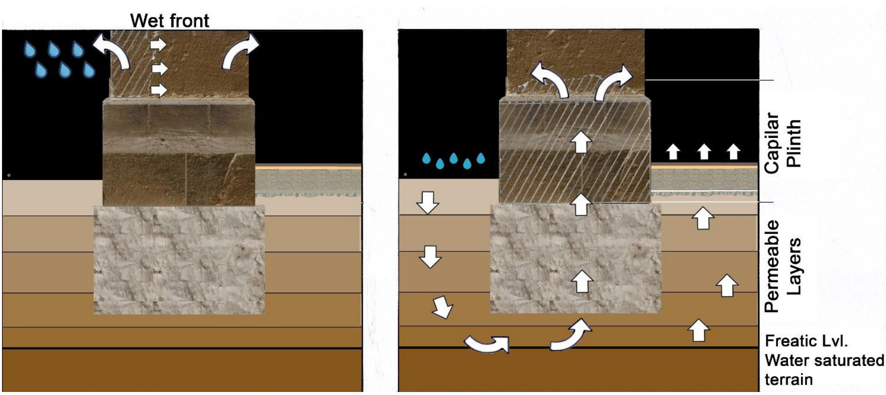


Figure 3. Humidity behavior

This solution was formally reflected in the existence of plinths thicker than the wall, up to an empirically established height.
The following graphs can represent these flows, and their quantity and movement depend on variables such as the precipitation regime, relative humidity, temperature, sunlight, wall composition, the porosity of the materials, type of soil, the existence of soluble salts, depth of the foundation, the situation of the water table, being dynamic variables and some, interrelated with each other, modify their initial values over time. The knowledge of these variables in the humidity process is ancient (Jurin's law 1684-1750), but their recent systematic study is recent. (Massari et al., 1985; Ortega, 1989).
The solutions given have depended on the knowledge of the intervening variables and the importance given to them in the whole process. However, they have always been based on balancing the moisture content of the wall with the external environment in evaporation surfaces that do not produce undesirable visual effects, such as salt deposits.
Returning to the case of churches, three solutions were generally employed. At first, buried spaces were created that functioned as aeration chambers, the crypts, and the foundation galleries between piles in the Gothic period. The effectiveness of these solutions always depended on good ventilation, which was not always easy to achieve. Later the solution of the perimeter barbican of ventilation was introduced, which has its origin in the Roman construction consisting of creating spaces in the subsoil that ventilate to the outside by what is known as the English courtyard.
Of these, the most efficient system was that of chambers between piles, but its diffusion was lesser due to the cost involved. The evolution of the first two systems led to the use of ventilated slabs, ventilated floors, and the cavity system. The Knappen system and electro-osmosis have recently been added to this typology of solutions.
This diversity of solutions now allows the designer to choose the solution or solutions, depending on the particular casuistry of the building in which he intervenes.
The most exhaustive knowledge of this process will determine the procedure's suitability to be chosen. In the works reviewed above, methods are proposed based on establishing water curves on the walls, which plot the moisture content. It is proposed to measure the temperature and humidity of the air, the temperature and humidity of the walls, the moisture content in the walls, and the salt content in the walls. This diagnosis of rising damp has been systematized in recent years. A British test standard (Pinto, 2008) is proposed to differentiate whether the moisture in a material is due to rising capillarity or hygroscopicity.
These curves obtained should be used to try to know the causes, to be able to choose a solution or set of solutions appropriate to the case, and to control its evolution and the effectiveness of the chosen solution.
When intervening in a historic building, the systematic study of the humidity of a historic building is not a generalized practice. When such a diagnosis exists, it is usually carried out based on a measurement of the humidity and temperature of the walls and sometimes of the floor slabs, which are represented as humidity level curves on elevations of the walls or sections of the wall. The state of the studies still does not provide data on the threshold of "normal moisture content" of a material, which would serve as a basis for understanding it.
It would be desirable to have these studies available prior to the intervention, over as long a period as possible and for at least one year, with data corresponding to the four seasonal moments. If it is not done previously, preparing it in the time available for drafting the project is challenging.

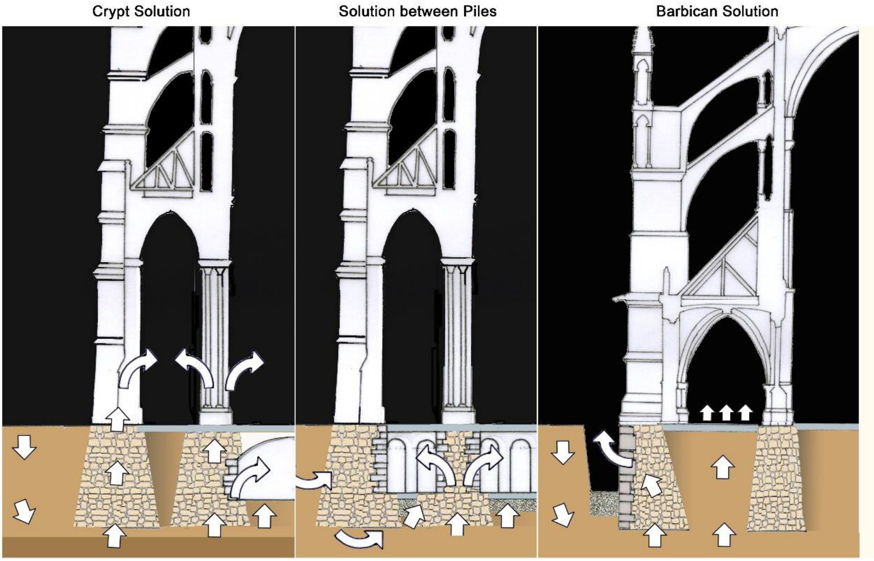


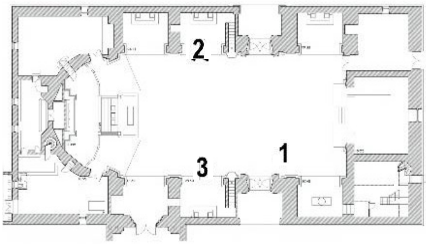
Figure 4. Historical solutions for humidity control

4. METHODS FOR HUMIDITY CONTROL IN THE CHURCH

As we have already mentioned, the two aspects of the problem are traditionally approached independently. Our starting point was to relate them from the very beginning. Conceptually it can be summarized by saying that it consisted of creating a ventilation chamber between the subfloor and the pavement, solving the necessary ventilation, giving the pavement a solution that would serve to facilitate this ventilation and, at the same time, solve the transit between regular and irregular mesh, seeking the source of inspiration in the very constructive logic created by our predecessors, based on the regulatory layouts, using which they sought to find harmony in the proportions of the spaces, to dimension the resistant elements based on easily transmittable numerical relations and to seek symbolic relations between the forms generated and the contents to which they referred, the links between the physical world and the metaphysical, not visible, but no less real for that reason. It is about establishing a new spatial order, a universe, where all the elements have a precise order and that this new order established could resolve the conflict between the parts most effectively.

Without previous data and time to obtain them, utilizing ocular inspection and thermographic photographs, it was concluded that its origin was in the phenomena of ascending capillarity. The authors gave a solution consisting of using the cavity method, ventilating by the perimeter, besides establishing crossed ventilation, that started from the gully and had its exit by the sacristy.

A modification of this solution was proposed by the Administration, for economic reasons, consisting of using a layer of the ballast of great thickness, in our case, 72 cm, which functions as a capillary base and where the spaces created hinder capillary ascent according to Jurin's law, and the air in these interstices is never saturated, due to the ventilation created at its base, by a meshed system of drainage pipes that can also serve as a drain. From the previous solution, the perimeter ventilation was maintained. The result is a more traditional variant of the ventilated floor slab.



During the execution, when carrying out the excavation works to make the box that should contain the ballast, it was discovered, since there was no historical memory or documentary news, that the central nave had functioned as a burial place, probably until 1871, when legislation was enacted for the construction of civil cemeteries, outside the towns. We were at elevation -30 cm, and if we wanted to continue descending to reach elevation -72, the current heritage legislation required an excavation in extension, which was impossible then.

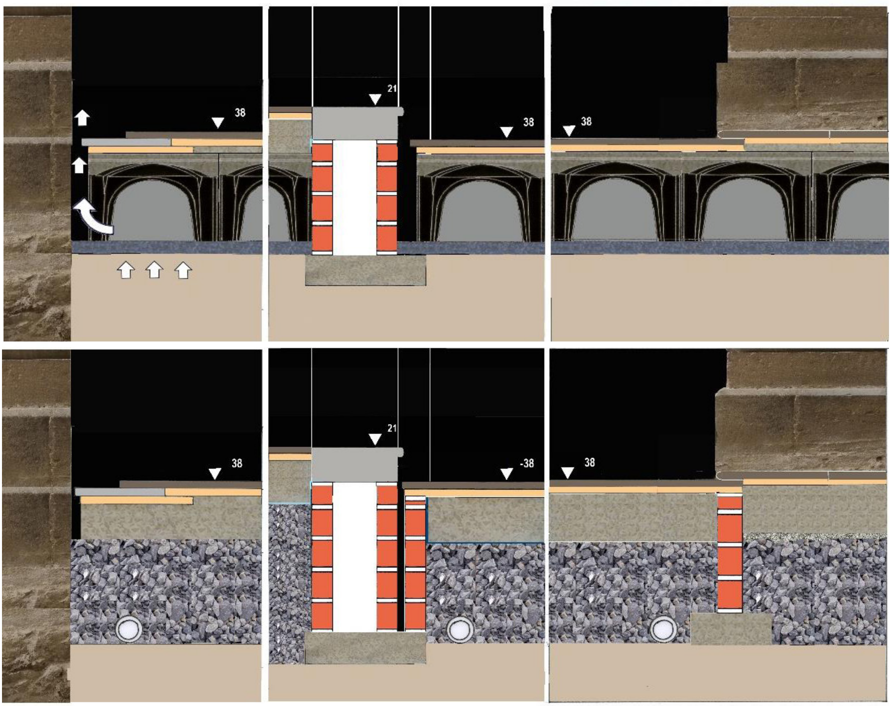


Figure 5. Proposed solutions for the church

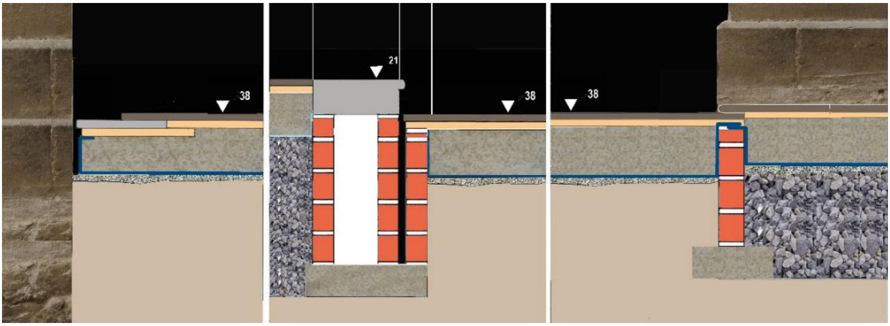


Figure 6. Executed solution for humidity control

A new modification had to be introduced, consisting of creating a cut with the ground with PVC waterproof sheeting, increasing the openings of the perimeter vents, and finishing with lime screed to mitigate the effects of salt migration, which could produce a screed made with cement, in case of punctual breakage of this sheeting. The ballast solution was maintained in the lateral chapels.

5. VENTILATION AND PAVING. JUSTIFICATION OF THE PROPOSAL

The solutions historically tested basically have consisted of the new pavement mesh, established without connection with the existing elements, is altered in the perimeter, generating irregular pieces of transition that were in charge of solving the micro-encounters of rough and irregular surfaces of the historical factory, with the regular and smooth pavement.
Four areas with different characteristics and problems were defined of the church's entire surface to be paved. The first block consisted of the two sacristies, the old chapter house nd the tabernacle, which still have the original 17th-century brick pavement, altered by numerous renovations and by the salts deposited on it due to the humidity of the subsoil. After an assessment with restorers, the decision was taken not to intervene in this block because it was decided that if it were to be raised for restoration, it would mean its destruction. The second area was the wooden flooring of the choir, the original of which was lost during the Civil War (1936-39) and restored in the post-war period. Tastings were carried out to check the condition of the wood, and except for some very localized damage, which was replaced, there were no other problems.
The only action that it was decided to carry out, in addition to re-varnishing it, was to make openings to facilitate the ventilation of the space underneath it.
The third area was limited to chapel 4 EPI, which had recently been restored and which the DGP of Aragón decided not to intervene due to cost-effectiveness criteria.
Finally, the fourth area was the central nave and the rest of the side chapels, including the main chapel, the largest surface area, and problems.
The first decisions aimed to restore the lost religious symbolism by recovering the hierarchy of spaces in the Main Chapel, eliminated in the post-war restoration. Specifically, recovering the step that separated the Main Chapel from the rest of the nave. This church was born after the Council of Trent (concluded in 1563). Although this did not favor a specific architecture, the work of St. Charles Borromeo (Borromeo, 1577) gave

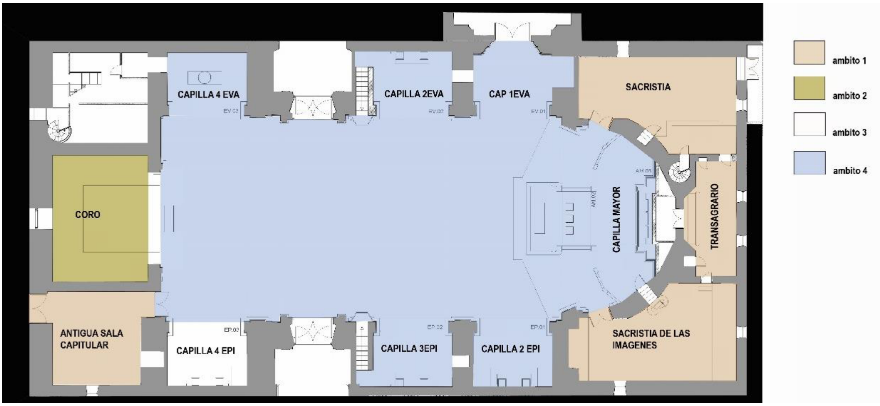


Figure 7. Santa Maria la Mayor floorplan

a series of recommendations to be taken into account in the construction of new churches and especially the most symbolic chapel of all, the Main Chapel. Separating it from the rest of the nave by a step and a low grille. In addition, this elimination made the entrance to the sacristies irregular. This restoration is completed with the opening, which was walled up, of the access to the second pulpit.

The second decision was to choose the mesh size to be implanted, defined by the module of the piece chosen. The first criterion for this was that, given that the decision had been made to ventilate the cavity space around the perimeter, a mesh whose module made this possible had to be chosen, thus relating the geometry of the floor plan to the geometry of the mesh. The problem was not difficult to solve in the central

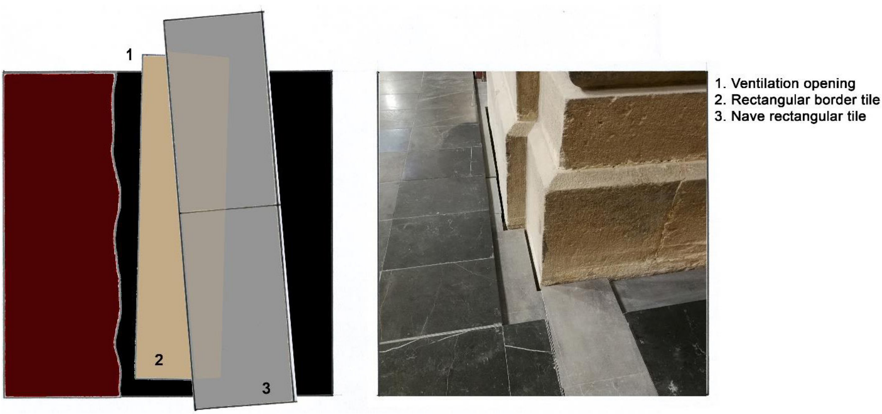


Figure 8. Pavement double-grid

nave because the irregularities were centered in a trapezoidal plan and the different widths of the pilasters. This first problem was solved by creating a contoured piece (2) parallel to the perimeter that at a lower level overlapped with the mesh of the nave. (3) This piece was separated from the edge to allow ventilation through this joint, the cavity space, and to solve the surface irregularities of the ashlars. This system also ensured that the pieces were always rectangular.

The other decision was that the mesh of the central nave should be extended towards the side chapels. This requirement made us see that the geometry of the piece was going to be defined by the conditioning factors of the geometry of each chapel in the plan, by the width of the entrance to the chapel from the central nave, by the length of the pilaster inside each chapel, by the width of each pilaster, so that the system chosen in the central nave would also be valid in all the chapels. Different attempts led us to a piece of 39 x 59 as the most suitable to solve the conditions indicated.

During the execution of the project, the system created in the project could be maintained, except in the chapel EPI 1, called Villasegura, where when the geometry was checked, it turned out to be different from the one that had been worked on in the project, presenting a solid twist, which forced us to create a particular solution. Due to the discovery of the burial crypt of the Villasegura family, the administration decided to generate another project that contemplated the conservation of the crypt due to the historical interest it represents, and no work was carried out on it.

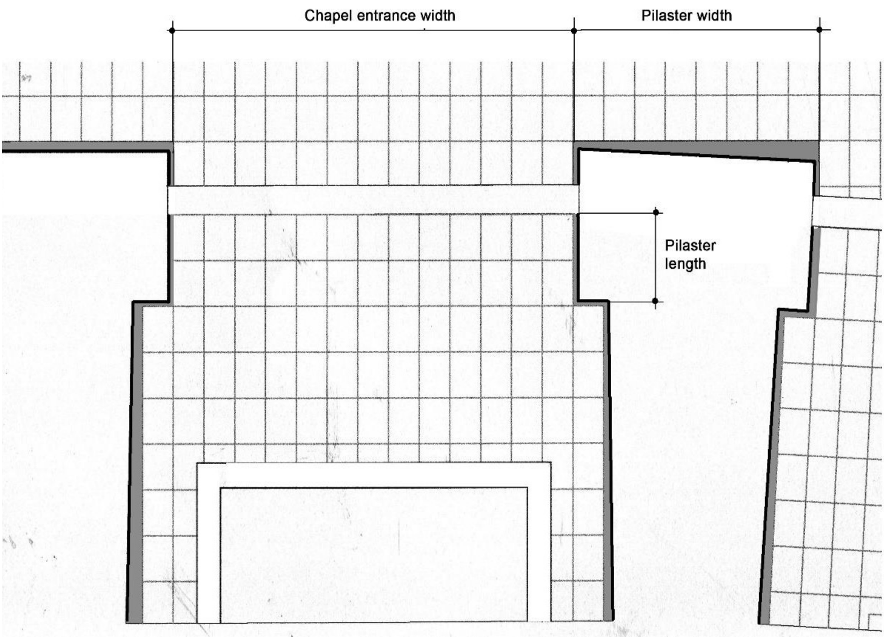


Figure 9. Examples of geometrical corrections onto one chapel

The choice of a system to solve the problem of solving uneven floors with regular meshes obeys multiple factors. As we have already mentioned, in our case, on the one hand, to solve in a simple way and with a clear formal logic, the encounters of the pavement with the existing building, establishing a link with the ventilation system of the subfloor.
After its completion, we have learned that other designers have chosen this solution, as in the Monastery of Caracedo, the church of Santa Candia in Orpi, and the hermitage of Socos de Caudiel, because in addition to the above reasons, this system translates into a balanced vision of space that contributes to dignify it.

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