VIRTUAL RECONSTRUCTION OF A MEDIEVAL MONASTERY USING A CAD MODEL

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ABSTRACT

A 3D Computer-Aided Design (CAD) virtual reconstruction of the medieval monastery of Santa Maria de Salzedas (Portugal) is presented. This monastery is the second largest Cistercian monastery of Portugal. However, the majority of the monastery disappeared after the extinction of the religious orders in the Age of Enlightenment without letting any vestige, and with almost no existing documentation. In order to allow visitors to better understand the monument and to assist the current conservation works, a virtual reconstruction of the medieval monastery is presented. The adopted approach for reconstruction includes the identification of an ideal plan of the Cistercian Order, comparison with similar buildings of the same period and architectonic styles, an historic study and in-situ survey to detect parts from the previous building, and definition of the modeling unit or proportion used by the builders.

Keywords: *CAD, Virtual Reality, Computer Model, Reconstruction, Conservation*

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1. INTRODUCTION

The Monastery of Santa Maria de Salzedas is located in Northern Portugal, near Douro River (district of Lamego), and was one of the most magnificent and important monasteries of the Cistercian order in the Iberian Peninsula. Due to the fact that it is mostly private property and that the condition is poor, its importance was only recently recognized, being listed as national monument since 1997.

The Monastery was founded in the 12th century. The building compound that arrived to our days (Fig. 1) is the result of the extensive works in the 16th and 18th centuries, when two new cloisters were built, the interior space of the church was remodeled and the façade was completely rebuilt (and left unfinished).

After the extinction of the religious orders in Portugal, in 1834, the monastery was dilapidated and several buildings disappeared. After this process, only minor interventions were made. In 2005 the main cloister was subjected to a major intervention due to the imminent risk of collapse; see Lourenço et al. (2008) for details.

The virtual reconstruction of monuments received much attention in the last decade, whether in the case of total physical loss of the monument, e.g. Heunecke et al. (2006), or in case of re-creating a lost human environment, e.g. Beacham and Denard (2003), or in the case of immersion in a computer generated world, e.g. Stefanescu et al. (2008), or in the case of presenting and monitoring the changes through time, e.g. Bessonnet et al. (2000). The possibilities seem unlimited, even if the difficulties in reconstructing the past are usually immense, due to the lack of drawings or written documents. The process requires significant investigations and cooperation between archeologists, art historians, architects and engineers.

This paper presents the study carried out for the creation of a three-dimensional model of the Monastery of Santa Maria of Salzedas in the medieval period. The main objective is to allow visitors to better understand the monument and to assist in the current conservation works. The medieval period is assumed here as the period between the end of the 12th century (when the construction of this abbey begun) and the beginning of the 16th century (when the first Renaissance buildings appeared in Portugal).

It is worth noting that the model cannot be considered as an exact representation of the original monastery, due to the lack of documentation and historical references of the medieval Monastery. Almost all documents and references about the medieval history of the monastery were lost during the fire in the Library of the Seminary of Viseu (Portugal), where they were stored. Studies about the monastery during the medieval period, such as archaeological excavations, do not exist and several parts of the monastery of this period disappeared without any trace.

In addition, currently, the monastic compound is in a hybrid style, with successive transformations and no documentation on those changes. It is also very difficult to recognize and isolate a clearly initial part, since the building compound was not finished during the last transformation works.

The aim of this paper is to address the methodology followed for the creation of the three-dimensional model of the medieval monastery of Santa Maria of Salzedas, under these constraints. This methodology adopts the following steps: (i) Identification of the "rules" followed by the Cistercian Order in the construction of its monasteries and the role of the "ideal plan"; (ii) Comparison of the "solutions" used in other national and international abbeys of the same period and architectonic styles; (iii) Confrontation between the few historical references and the architectural elements present in the actual monastery, in order to establish the possible medieval origin; (iv) Definition of the possible "modeling unit" or proportion used by the builders.

2 STRUCTURE AND ORGANIZATION OF THE CISTERCIAN ORDER

During the initial period of the rigid observance of the rule of Saint Benedict, the Cistercian world was centered on the first monasteries founded. The "Charter of Love", from 1119, and the Benedict Rule were the general principles of the Order (Robinson et al., 1998).

Each monastery was autonomous, even if it depended on a "mother house" or "founding abbey". The mother house had the right and the duty to preserve the observance of the rules in the "daughter houses". For example, in Portugal, the Monasteries of Tarouca, Salzedas, Lafões and Alcobaça depended directly on Clairvaux.

3 THE MEDIEVAL FABRIC

The knowledge on building materials and techniques, and structural arrangements, before mechanization or industrialization is reasonably well documented, e.g. Adam (1994), Fitchen (1989), Fitchen (1997), Mark (1993) and Viollet-le-Duc (1987). Historically, masonry structures have been conceived, basically, upon two alternative systems: (a) Lintel construction, based on the combination of columns/walls and lintels, the latter consisting of monolithic stones able to resist flexural forces. The strength is given by stone flexural (tensile) strength and additional jack arch effect; (b) Arched or vaulted construction, where the design is conceived so that stability is possible by activating only compression forces. The strength stems from geometry.

Examples of lintel construction can be found in earlier forms of construction in the Mediterranean Basin, being typical of Greek and Egyptian monumental construction. However, the system survived until rather later, as shown e.g. by the Mughal architecture in India (16th and 17th centuries). But lintel construction allows only moderate spans and many developments occurred in Europe.

The Roman style used intensively the possibilities provided by arches and vaults, with a variety of solutions (barrel vaults, cross-vaults and domes). Roman construction produced rather monolithic and massive buildings, even if also rather sensitive buildings. Demanding actions and deformations (settlements, earthquakes) have caused in many cases remarkable damage or destruction. A certain attempt towards a more rational construction was made by combining pozzolanic concrete with relieving arches and other construction devices to control force trajectories or unload delicate parts.

Subsequently, Byzantine builders erected more stylized structures composed of specialized structural members (arches, buttresses, domes) better adapted to the force trajectories. Linear members (arches, piers, buttresses) were preferred to un-specialized ones such as massive walls. Similarly, ribbed domes were preferred and domes were supported on arches by means of adequate pendentives. Instead of pozzolanic concrete, they used lime concrete (in fact, rubble masonry) or brick masonry. Rubble was normally combined with horizontal layers of brick masonry.

The use of this type of more-designed, stylized members allowed a significant reduction of the amount of material and workmanship needed.

The scarceness of material and human force in Europe during the 10-12th centuries fosters a new construction approach, denoted by Romanesque, characterized by a certain form of “material optimization”: the structure consists mostly of 2D members (walls and barrel vaults, walls are both closure and structure), complemented with linear elements (buttresses, transverse arches) to provide adequate strength. Three-leaf walls are normally used, being the external leaves made of stone and the internal leaves made of rubble masonry. The resulting structure, although not true optimal (a significant amount of material is needed to cover spans up to about 5m) shows certain redundancy and ductility. It can endure significant soil settlements and deformations without reaching collapse. Cracks, if appearing, can be easily repaired by filling or repointing the mortar joints.

Gothic construction, made possible by the advent of more sophisticated construction techniques, produces truly skeletal structures composed of arches, nerves, flying- arches, piers and buttresses. No structural 2D members exist, except for the membranes spanning across the nervures. All typical Gothic structural members had been already used by former architectural cultures (e.g. flying arches by Byzantium or cross-vaults by Rome and former medieval architecture). The specificity of Gothic architecture is in the way these members are combined to lay-out a pure skeletal structure where forces are adequately balanced and neatly channeled towards the buttresses and foundation with close to minimum material consumption. This precise adjustment allows for significant material saving, structural slenderness and clearance (compared with other architectural approaches). It is noted that the inherent complexity and large size of Gothic structures lead to documented failures and the need of many changes in design.

The medieval architecture in Portugal, which includes the Romanesque and Gothic periods, has also some Moorish art influence. This influence is clearer in the south of the country, where horseshoe arches and pierced stone tracery can be found, together with notably rich surface decorations of intricate geometrical and flowering patterns (Fletcher, 1924). However, as it will describe in the next section, the

Portuguese Cistercian architecture has more influence from the French medieval architecture.

The medieval fabric was usually anonymous and only in some cases it is possible to identify, indirectly, the master responsible for the works. In important buildings, it was normal to recruit foreign masters, since they brought the most recent architectural models and building techniques. But local workmanship would be generally used.

Medieval buildings very frequently present signatures or marks in the stone ashlars of the structural elements. It is thought that they would serve to identify and count the work of the masons involved in the construction (Coulton, 1953). The study of the marks can help to understand the construction phases, division of the work and masons. Cistercian Monasteries are particularly rich in this type of information, allowing to identify families of signs that are repeated in different constructions. This indicates the existence, at regional level, of organized workmanship groups that could have worked in different buildings.

Stone cutting was made in the construction site. In the Salzedas monastery, the stone can have been extracted from the quarries of Leomil, at a distance of twelve kilometers (Reis, 1936). The construction of a monastery was usually slow and complex, which usually would result from several phases. The success and the time required for construction would depend on the “patrons” and the main suppliers of the necessary resources. In general, during the period of construction the community would be installed around the site in temporary buildings, usually built in wood and by the workers themselves.

The construction of the monastery would typically begin by the church, as it is the most important part of the monastery. The construction of the temple would begin by the apse. In Salzedas, the construction of the church took around sixty years (1168-1225) due to the large dimension of the building. The Cistercian buildings in Portugal are notable for their ambition (Gomes, 1998), with considerable size and spans, and the introduction of the first fully Gothic structure in Portugal.

4 THE IDEAL PLAN OF THE CISTERCIAN ABBEYS

In general, it is possible to say that all Cistercian abbeys were constructed according to the same project, even if there are no two similar monasteries. The primitive monasteries of Fontenay and Clairvaux II are the common references of this ideal plan, even if Fontenay is the key example of the older and more genuine Cistercian plan.

It is noted that the Order did not define a unique model for the monasteries, so that a formal model would be established and repeated in each monastery. However, the similarities among abbeys, especially in the distribution of spaces, indicate a common or ideal plan for the monasteries (Leroux-Dhuys, 2006). The ideal plan is easily identifiable in large monasteries. In Portugal, the monastery of Alcobaça is the main example of a Cistercian monastery following this ideal plan, as it is very similar to the monastery of Clairvaux (Fig. 2).

Cistercian architecture occurs in a period of transition between Romanesque and Gothic styles, usually exhibiting characteristics of both styles. It is considered that the Cistercian Order introduced the Gothic style in Portugal, since the church of the monastery of Alcobaça is considered the first fully Gothic national building, but the style of the monastery of Salzedas is more closely associated with the Romanesque.

In general, Cistercian churches were built on a Romanesque plan, being not adorned with figural or decorative sculpture, and usually elegant. Although the plans are similar among abbeys, they are different in elevation. The spatial organization of the abbey was ruled by some functional principles, such as the separation of the reserved zone for the monks and the zone for the lay-brothers, the self-sufficiency of the community, etc. The monastery followed a basic square structure; where one of its sides, aligned along the east-west axis, was formed by the church, always in the highest part of the property. The other parts could be constructed oriented to the north or to the south, according to local relief. This is the most significant variation observed among the different monasteries (Fig 2). It is noted that the kitchen and the refectory were located in the lowest part, near to a water-course.

4.1 The Church

The church was oriented in the east-west direction, with the apse to the east. The plan was a Latin cross, with three aisles, being the side aisles lower than the central one. The total height - width ratio was around two. Usually the body of the aisles was preceded of a narthex and the transept was formed by a single nave. The aisles were divided by square pillars with engaged or truncated columns with plain capitals.

The central nave was covered by a barrel vault; while the side aisles were also covered by barrel vaults, but oriented in the transverse direction (or arching in the longitudinal direction) in order to act as buttresses of the central vault (later shown in Fig. 4). In a later period, the shape of the vaults evolved to become ribbed. The church has usually arched openings located in the walls of the lateral aisles, the apse and the façade.

Sometimes, in the side of the transept, engaged to the exterior wall, a bell tower would exist, built in stone or wood. The tower had only one square body without belfry (later shown in Fig. 9b) because the order forbid the construction of common towers, found in secular churches not-associated with a monastic life or religious order.

The church's facade was simple and without any ornament. It was divided in three parts, being the side parts lower than the central one, according to the height of the aisles. In the central and higher part of the façade, a rose window could exist to provide natural light to the nave. The portico leading to the entrance of the building was generally modestly decorated and was usually closed. In this space the benefactors of the monastery were sometimes buried.

4.2 The Monks’ wing

The Monks’ wing is a continuity of the transept, together with the sacristy, the Chapter House, the stair to the cells, the parlatory and the scriptorium. The first floor was fully occupied by the cells.

The Chapter House and the church were the most important spaces of the monastery, and for this reason they were the areas with more exuberant decoration. The door of the Chapter House was flanked by two wide openings; that allowed the lay-brothers to take part in the assembly. These openings were more decorated than the rest of the monastery. The Chapter House with rectangular plan was sometimes divided in two naves with six bays, covered with quadripartite vaults supported in the side walls and two columns.

4.3 The South wing

The refectory was usually located in the centre of the wing parallel to the church. The kitchen and the “calefactory” where placed at each side of the refectory. The calefactory was a small room with a chimney where the barbershop (currently hairdresser) was. In the coldest periods of the year, it was also the space where the copyists worked (scriptorium) and where the monks could remain for a while, to become warmer. The refectory was perpendicular to the cloister, on the contrary to the Benedictine monasteries. The kitchen was contiguous to the refectory, with an opening to transfer the dishes.

4.4 The Lay-Brothers’ wing

The fourth side of the monastery, parallel to the monks’ wing, was the Lay-Brothers’ bay. It was the continuation of the façade of the church, but generally it was slightly salient. In the ground floor, there was the barn, a way out for the monastery, the gatehouse and the refectory of the lay-brothers. The first floor was occupied by the dormitory.

4.5 The Cloister

The Cloister was the central space of the abbey around which all the buildings were organized. It was a space for praying, reflection and silence. Ideally of square plan, it was composed by four galleries that allowed communication between the different bodies.

5 MONASTERY OF SANTA MARIA DE SALZEDAS

The Cistercian Monastery of Santa Maria de Salzedas in Portugal was founded in the 12^{th} century. The buildings that arrived to our days (Figs. 1 and 3) are the result of intensive works in the 16^{th} to 18^{th} centuries, when the two cloisters were built, the interior space of the church was remodeled and the facade was completely rebuilt.

It is worth noting that the parts built in the period of the 12^{th} to 16^{th} century are subsequently called medieval, in order to distinguish from the buildings built during the works of the 16^{th} to 18^{th} centuries. Due to lack of precise information it is impossible to accurately date the parts.

After the extinction of the monastic orders from Portugal in 1834, the monastery was dilapidated. The south and monk's wings disappeared, as well as the small cloister. The current remainings include the church, the sacristy, the chapter house, the main cloister and part of the lay-brother's wing. In 2005, the cloister of the monastery was subjected to conservation works due to the imminent risk of collapse, Lourenço et al. (2008).

5.1 Description of the actual monastery

As other cases of Cistercian monasteries in Portugal, Salzedas' monastic compound was the engine of growth and development of the town. The church, the western side (inn) and the walls worked as the frontier between public and private areas, as well as limited the urban nucleus that grew and developed to the north and west. The eastern and southern areas of the monastery are surrounded by an extensive agricultural area that still conserves the look and the limits defined by the antique walls of the monastery (Fig. 3a; Lourenço et al, 2008).

The Monastery and Church have the typical plan of a Cistercian Abbey. It is the second largest Cistercian monastery of Portugal, with in-plan dimensions of 75.0 x 101.0 m^2. The church, with the principal façade oriented to the west, has also appreciable dimensions: the central nave of 24.4 x 37.0 m^2 and height of 19.0 m; the transept with 34.0 x 10.2 m^2; and a small uncompleted tower of 6.8 x 4.2 m^2, with the height of the principal façade.

The inn, the refectory, the dormitories, the cells, the storerooms, the barn and the garden disappeared. The Monastery has still two cloisters, where the large cloister substituted part of the two primitive cloisters. This large cloister is a classic model with its beautiful pillars and the upper closed gallery. There is a second (small) cloister located west of the large cloister, being the cloisters connected by two small doors (one in each level). As the monastery was dilapidated for many years, only few elements remain from the small cloister.

5.2 Medieval vestiges in the actual monastery

Figure 4 shows a synthesis of the parts of the 12th to 16th century construction that it is still possible to find in the actual monastery. This figure was created after a visual survey made in-situ and archaeological works carried out in the large cloister (Amado et al., 2006), which allowed to identify the original structural systems hidden in the current 16th to 18th century building, given the different texture in masonry and the different stone used. Most of the vestiges were found in the church (upon removal of plastering), while very few elements of the medieval period could be found in the cloister. This is probably due to the fact that the cloister is basically all built from scratch in the 16th to 18th centuries. In fact, it is possible to find masonry ashlars from the medieval monastery that were reused in the new structural elements.

Figure 5 shows the 12th to 16th century parts of the monastery that remains in the church; as it can see, they can be detected by a simple visual survey. The church conserves the medieval walls up to the openings of the lateral naves, with exception of the main façade, which was rebuilt in the last campaign (18th century), as shown in Fig 5c (left) where the 18th century pilasters are stopped at the level they meet the 12 to 16th century wall. The 12th to 16th century fabric is clearly visible as internal columns and arches hidden by the 18th century fabric in Fig. 5a (left and right), Fig. 5b (left) and Fig. 5c (right). The church conserves an apse chapel from the first church in the northern side of the transept (Fig. 5a center). It is semicircular and built with granite stone blocks, with two engaged columns that divide the exterior wall in three parts. In the central part, a rectangular window provides light to the interior. In this same part of the transept, in the western interior wall, there is a spiral staircase that certainly conducted to the tower of the church of the 12th century. In the outside, in the wall of the northern side of the transept, there are two closed openings (Fig. 5). The central and larger one should be Door of the Dead, now leading to the cemetery. Fig. 5b (center and left) shows 12th to 16th century columns, easily identified by the capitals.

University of Minho made a diagnosis of the stability of the cloister in 2000 (Lourenço et al., 2008). This included characterization of the foundations of the cloister by the opening of three prospecting pits (Fig. 6). From this study, it was possible to conclude that the outside walls of the cloister (18th century) were constructed on top of the medieval foundations (12th to 16th century). In particular, in the pit made close to the outside wall of the southern wing of the cloister (no. 3 in Fig. 6) the pavement of the medieval refectory was detected, in an excellent state of conservation.

On the other hand, in the pit made in centre of the small cloister (pit no. 1 in Fig. 6) it is possible to find a stone foundation, approximately aligned with the facade of the church. This was probably the foundation of the walls of the 12th to 16th century lay-brothers' wing.

It is worth to note that the construction system of the side aisles, with minor exceptions, remains practically unchanged and some ashlars present the masons' marks. According to an endoscope inspection (Lourenço et al., 2008), walls were made with large granite stones, with dry joints or a thin clay joint. An internal core of weaker mechanical characteristics was not found.

6 DEFINITION OF THE MODELING UNIT

The modeling unit is the base of the system of proportions, which was an indispensable element to provide the composition of the entire building. Sometimes, this unit coincided with some measurement in the construction. For example, the diameter of the column or the side of the pillar of square area could be used as the modeling unit. Then, other parts of the element were defined as multiple of this unit, as for example the height of the pillar or column.

The Cistercian buildings were based on the composition principle of "ad quadratum" (Virgolino, 1997), where the design of the monastery at all scales is based on the geometry of the square, as it can see in Figure 7. Therefore, the "unit" of all proportions would be equal to the side of the square.

Based on this, it was necessary to define the dimension of this "unit". In the Portuguese constructions from the beginning of the second millennium, the units of measure commonly used were the Roman palm (0.223 m) and the Roman foot (0.296 m). However, it is very likely that the Cistercian Portuguese constructions had used the “pied du Roi” or king’s foot, equivalent to 0.32484 m, since it was the standard measure used in France in that time (Virgolino, 1997).

However, the Roman foot or the king’s foot are not the basic modeling unit. Therefore, in order to define the basic modeling unit used, the church was divided by means of a reference module mesh, as depicted in Figure 7 (Amado et al., 2006). Then it was possible to observe that the basic modeling unit used in Salzedas was equal to 8 king’s feet, since the main elements of the church present values very close to integer multiples of this modeling unit. For example, the dimensions of the church in plan are 21x12 modeling units (54.6 x 31.2 m^2), while the height is equal to 5 units (13.2 m).

7 MODEL OF THE MEDIEVAL MONASTERY

The church, the cloister and the three wings (monks, refectory and lay-brothers), which together constitute the five main bodies of the monastery (the abbey’s buildings), were built at different levels, in order to adapt to the topography of the site. The church was built in a platform at a higher level. The galleries of the cloister and the wings are located two meters below the level of the church. Perpendicularly to the church, the cloister is built aligned with the direction of the slope of the ground (Fig. 8). The refectory was then built at a lower level than the cloister, according to the inspection pits made.

Figure 9 shows the three-dimensional model of the medieval monastery. The model was created on the basis of the historical documentation, in-situ survey and, in the case of insufficient information, comparison with other Cistercian monasteries (the ideal plan addressed above). The modeling unit was an important tool to define the unknown dimensions, since the proportion of the buildings must follow this unit. The model presents only part of the abbey’s buildings and does not take into account minor buildings that were part of the monastic compound as the gatehouse, support buildings, shops, mills, infirmary, etc (Fig. 9a).

A Romanesque solution is adopted as addressed before, in which the building compound is composed by simple parallelepiped, massive and juxtaposed volumes (see Fig. 9b). The walls, foundations and pillars were built with large ashlars, while the top and intermediate floors were made with barrel or quadripartite vaults, in stone or brick masonry. The roofs were of two slopes, with timber structure and tile covering.

The church of the 12th to 16th century would have similar dimensions to the actual church (18th century). The dimensions in plan would be 54.6 x 31.2 m^2 (21x12 modeling units), while the height is 13.2 m (5 units). The church would have three aisles, being the side aisles lower than the central nave (half of the height). The transept would have in plan 31.4 x 13.2 m^2 (12 x 5 units), with four semicircular chapels (two on each side). The ceiling was made with vaults, including the collateral niches. In the top central part of the façade (up to the main door), there was a rose window of 5.2 m of diameter (2 units, Fig. 10).

The medieval church had a narthex (Reis, 1936); however its real dimensions and some details are not known. Therefore, the width was established according to the base module (8 feet or one unit). The cloister was not square and its dimension in plan would be 25.3 x 31.9 m^2 (10 x 12 units), according to the medieval foundations founded in the prospecting pits (see Fig. 4). It should be supported on double flat and round columns. The chosen solution is similar to the French cloisters: Romanesque with a heavy and massive clean style.

The dimension in plan of the monks' wing was 57.2 x 8.8 m^2 (22 x 3 units). The top floor (the bedroom of the monks) was a wide space without any division and with direct access to the cloister and to the church. It is not likely that the monastery was completely covered with vaulted ceilings. Therefore, the solution found in Rueda's monastery in Spain was followed: a system of composite roof with large pointed stone arches that support the secondary timber structure of the covering.

In the ground floor, traverse walls divided the space among sacristy, chapter house, room of the monks, scriptorium and latrines. The rooms were conceived with two naves, covered with ribbed vaults. According to the ideal plan, the south wing was composed by the calefactory, refectory and the kitchen. From the vestiges founded in the actual monastery it is possible to have a clear idea of the dimensions (25 x 8.8 m^2, 10 x 3 units) and localization of the refectory. The basement of the walls and an arch that could have been part of the medieval roofing system for the medieval kitchen were discovered buried.

The reconstruction of the Lay-brothers' wing was the most difficult, since there is no reference or historical documentation about its construction. The only reference is the extension of an ashlar wall, five meters in plan, along the south wall of the church and behind the façade. Therefore, the Lay-brothers' wing was established with dimensions similar to the Monk's wing oriented according to the vestiges founded.

8 FINAL REMARKS

An attempt for the virtual reconstruction of a medieval monastery by means of a CAD model was presented. The approach is based on the available information, which is rather limited, but historical, archeological and architectonical information were combined in order to have a realistic medieval monastery. The identification of the rules and the ideal plan followed by the Cistercian Order in the construction of its monasteries was the most important factor, allowing to overcome the unknown configuration of the abbey.

In addition, the comparison of the different solutions used in other Cistercian abbeys of the same period and the comparision between the very few historical references and the architectural elements present in the actual monastery allowed to establish their possible medieval origin. It is worth to note that the "modeling unit" or geometric proportion were a main tool used by the Cistercian constructors. This facilitates the task of trying to read and discover the past. Thus, it was possible to virtually reconstruct the Cistercian monastery of the Santa Maria de Salzedas, in Portugal.

Finally, it is worth noting that the methodology followed can be extrapolated for other monasteries or churches, not necessary from the Cistercian order. The first step is based on the identification of an ideal plan, in this particular case of the Cistercian Order. In general, the churches and monasteries were built following common rules. The second step compares similar buildings of the same period and architectonic styles in order to establish possible solutions. Step three recognizes the need to make an historical study and in-situ survey in order to detect the possible elements of the studied building. Finally, in the last step the definition of the modeling unit or proportion used by the builders is established. This unit or proportion is an important tool, since it can help to understand the relationship among the different parts of the building.

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List of Figures

Figure 1. Panoramic view of the Cistercian Monastery of Santa Maria de Salzedas.

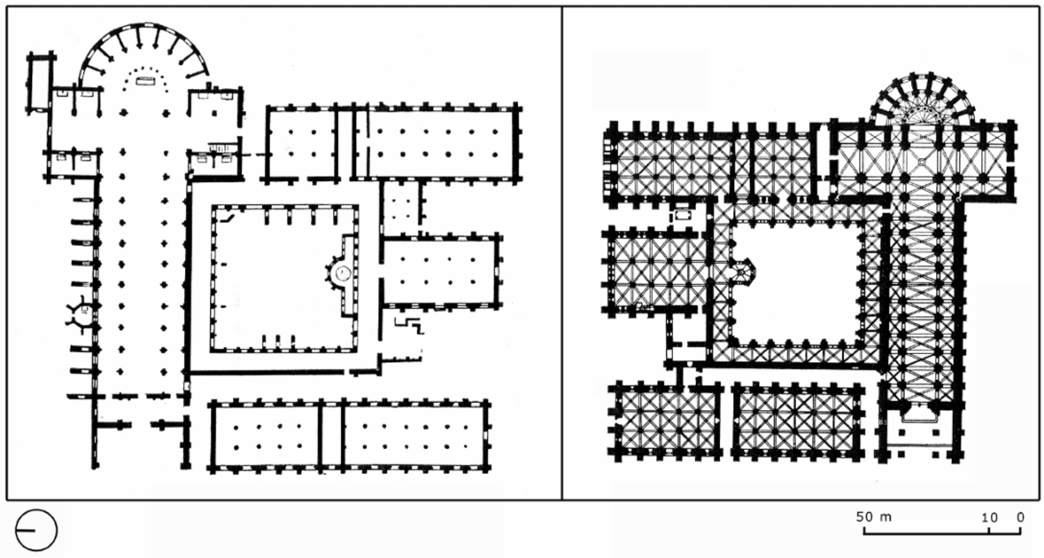
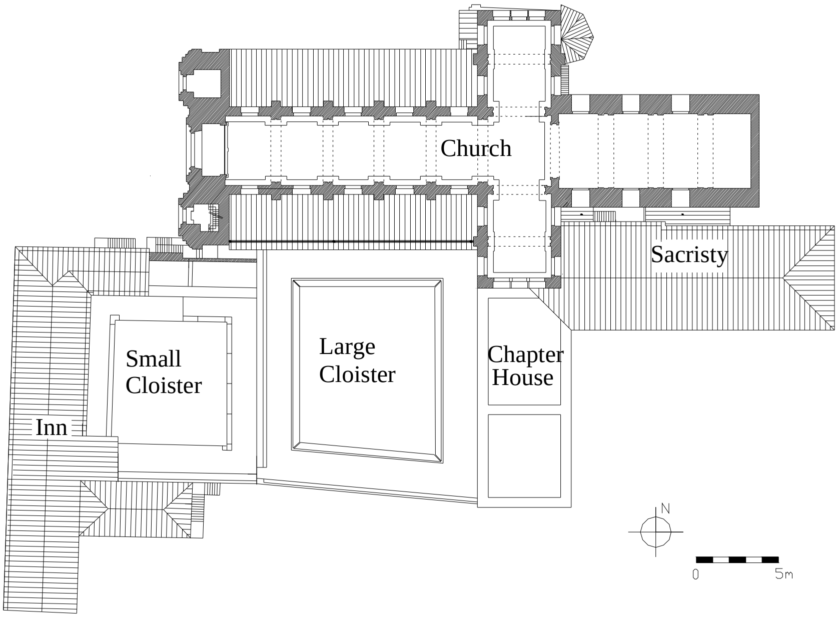


Figure 2. Plans of Clairvaux (left) and Alcobaça (right) monasteries (after Cocheril, 1972).

a) 

b) 

c) 

Figure 3. Actual monastery: a) aerial view from south-eastern side; b) ground plan; c) façade of the main cloister after the preliminary conservation works.

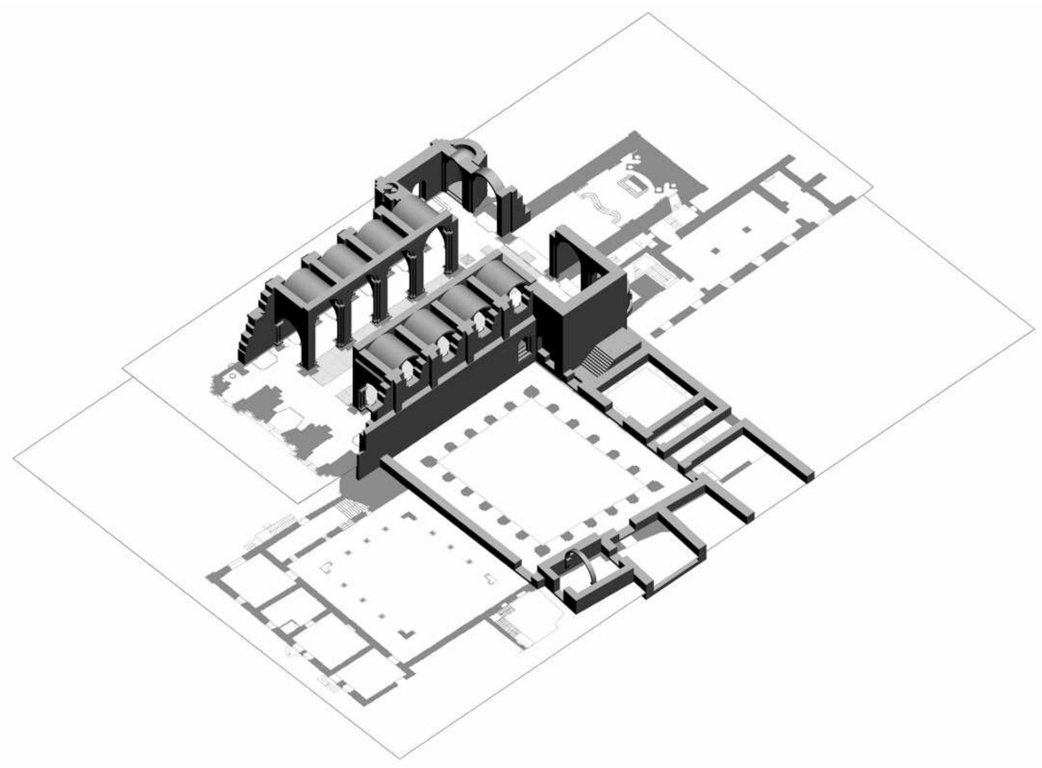


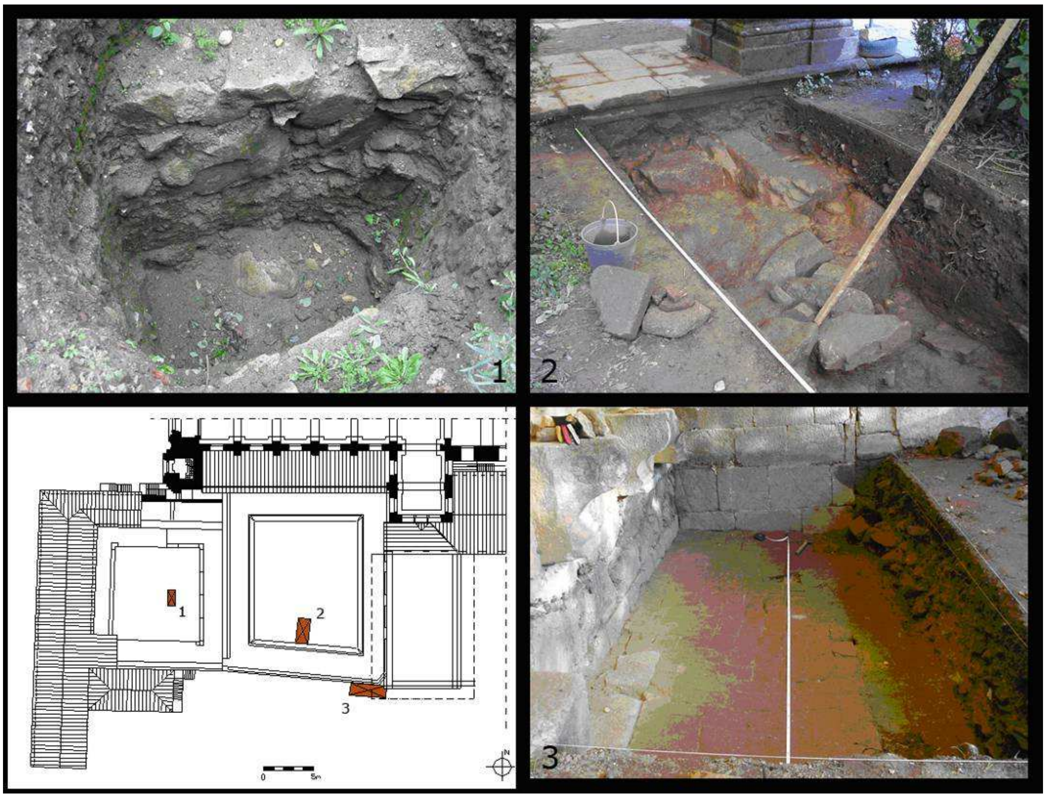
Figure 4. Medieval parts of the monastery that remains in the actual building compound.

a) 

b) 

c) 

Figure 5. Medieval parts of the monastery that remains in the church; a) north part of transept, b) main nave, c) basement of the northern wall.



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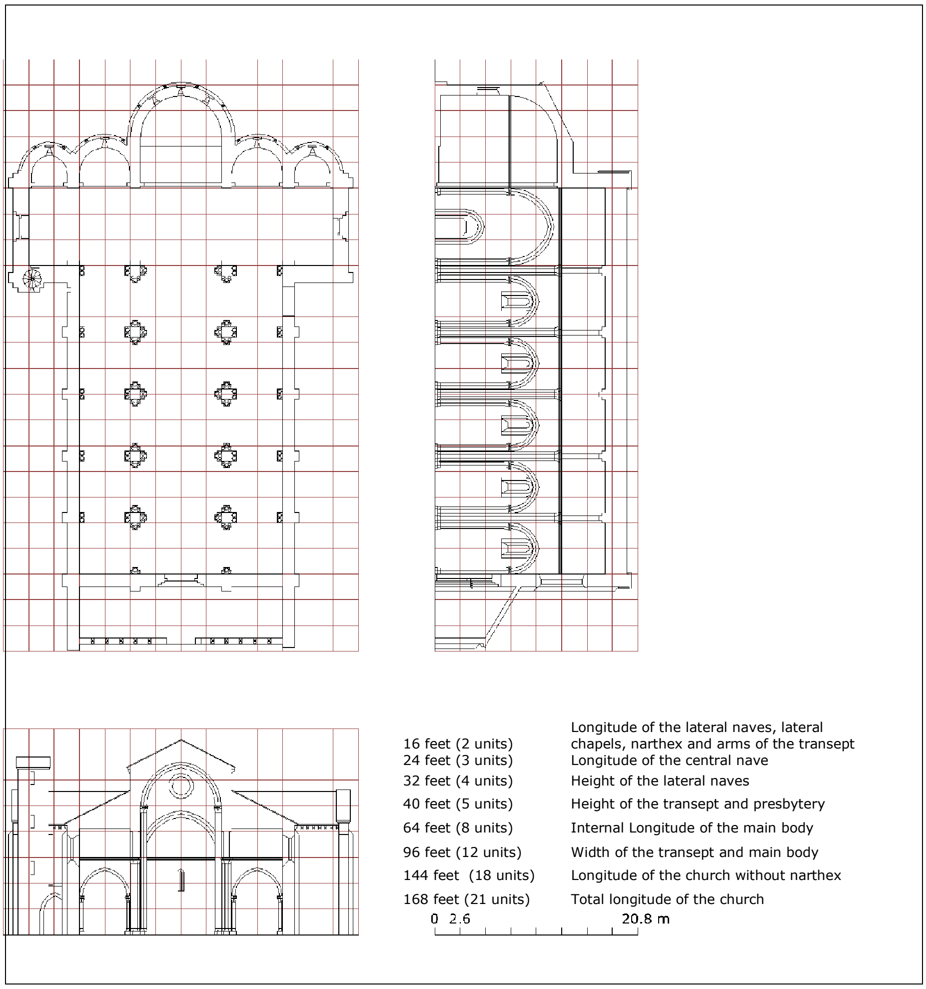


Figure 7. Reference model mesh of the medieval church.

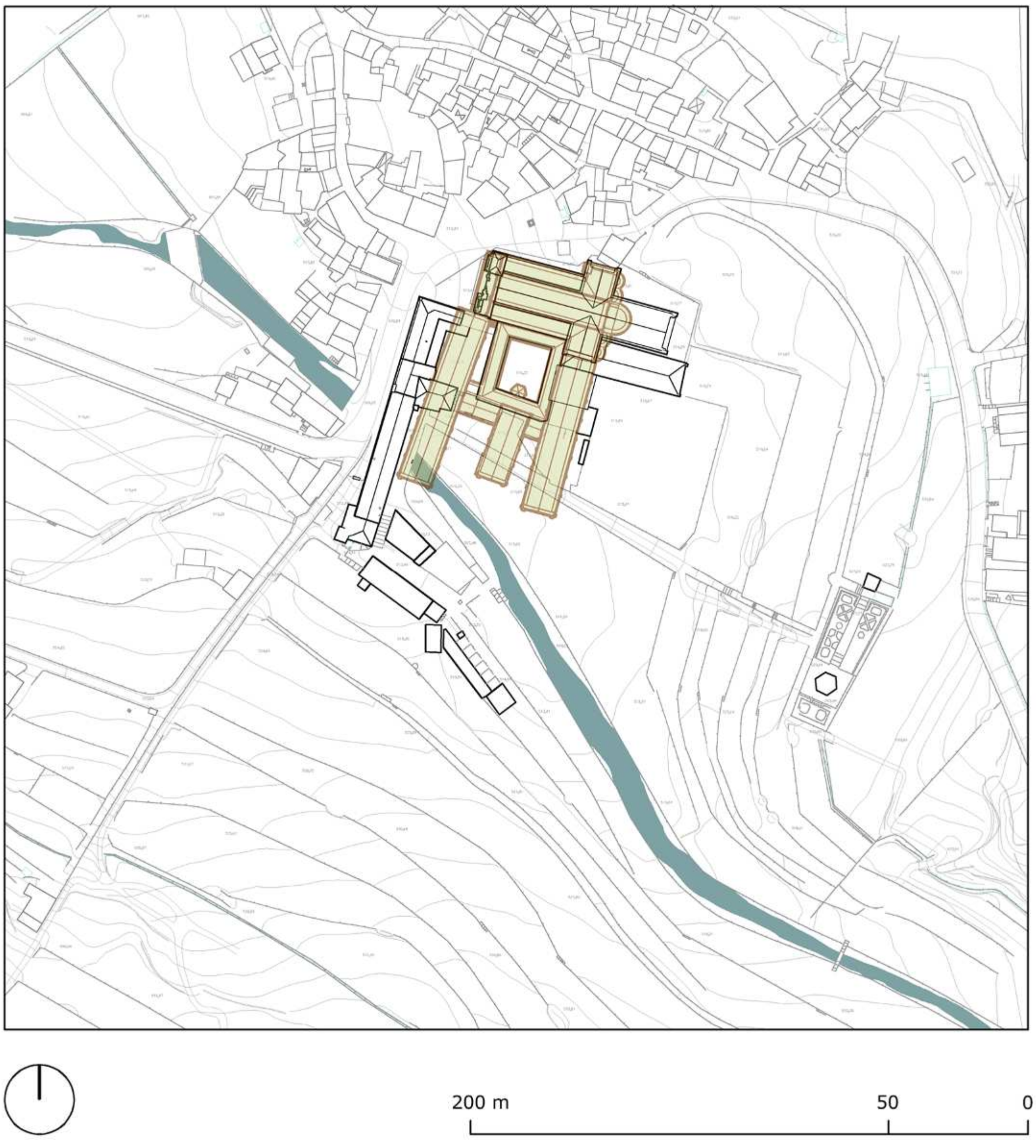
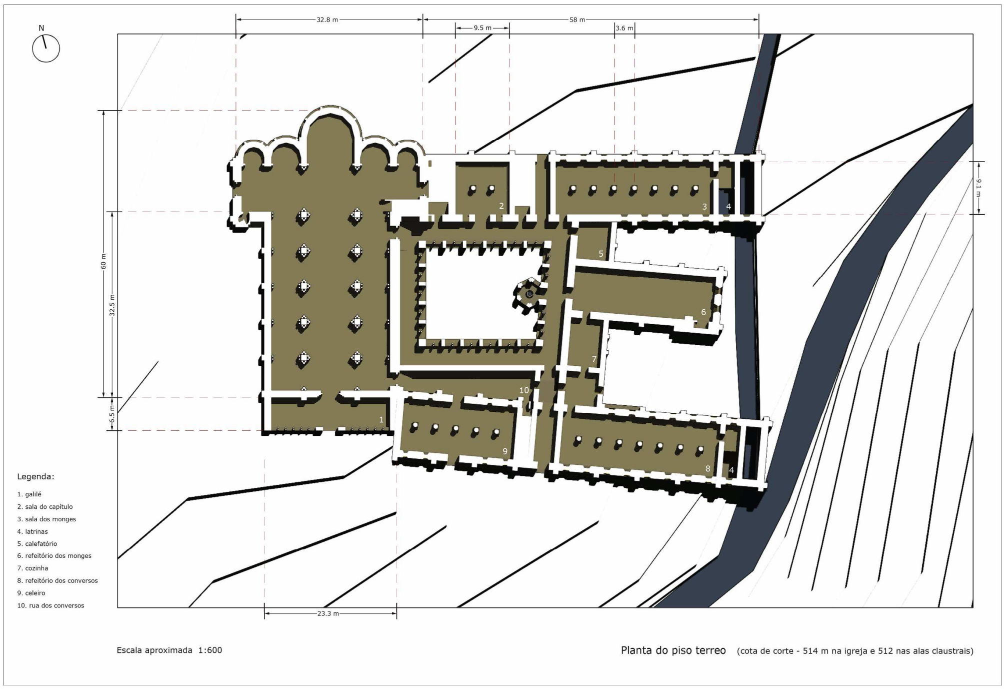
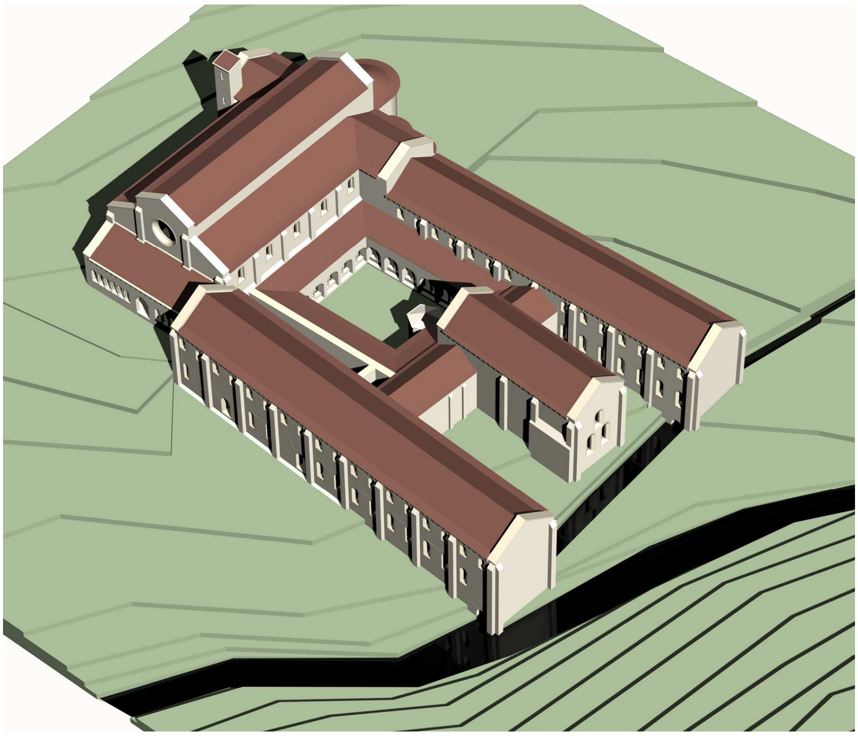


Figure 8. The medieval abbey in the plan of the actual monastery (shaded).



a)



b)

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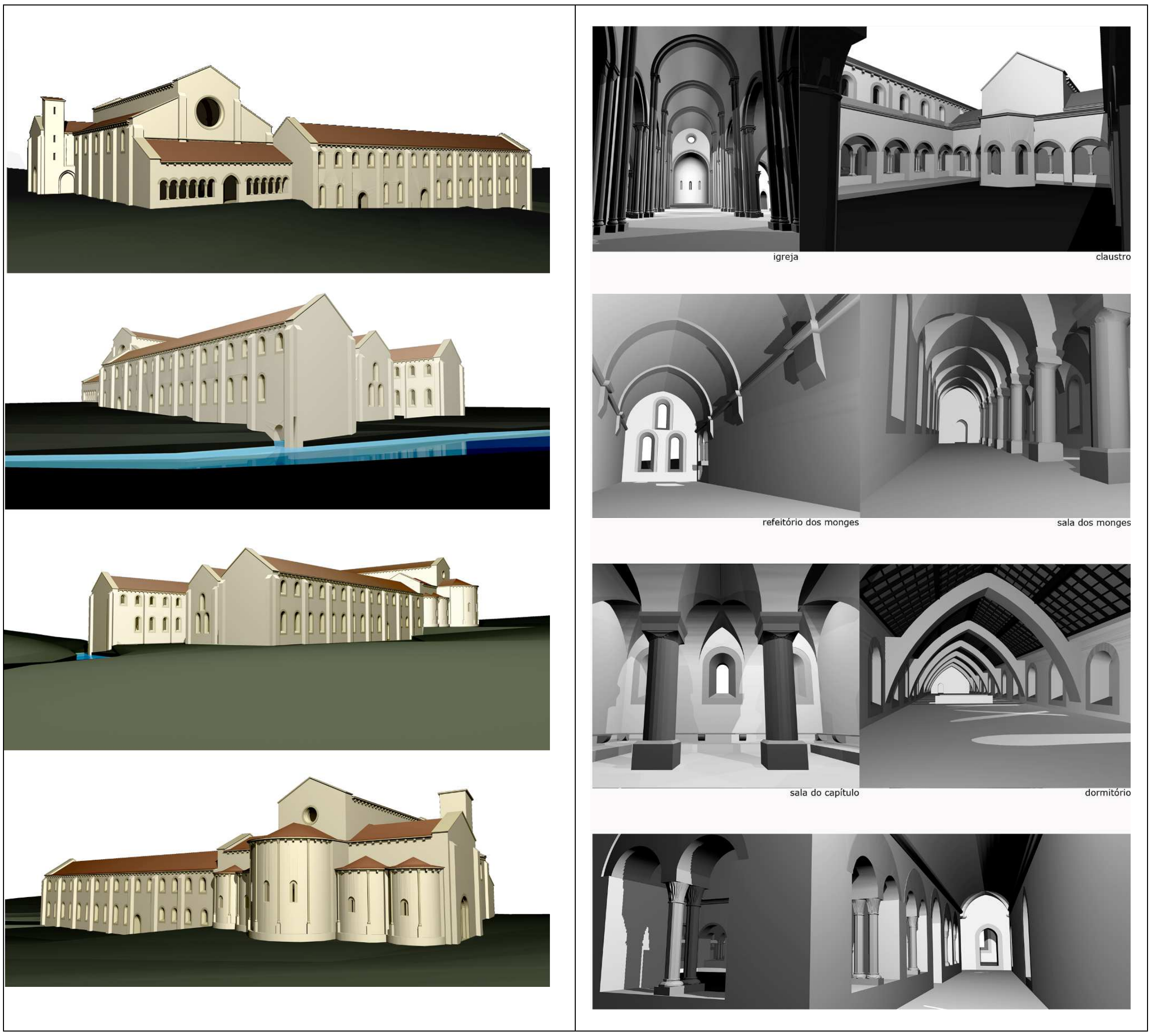

Figure 10. Exterior and interior looking from different sides.