

Spatial unification of Romanesque churches in Zamora and its influence on the buttress system.

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Abstract

In addition to the Cathedral in Zamora there are twenty-two Romanesque churches registered, erected between the 11th and the 13th centuries. The most common typology – visible in twelve of these churches – is a single nave, with the body wider than its chevet and without a visible transept. Of the other ten churches, originally with three naves, only one has remained intact. The other nine at some point underwent what we refer to as "spatial unification" by removing the interior columns in the interests of providing more light and clarity.

The churches of San Juan and San Ildefonso showcase this perfectly, because of their size and the diversity of solutions. The purpose of this paper is to study the consequences brought about by "spatial unification" of the buttress system, the tectonic structure and the configuration of Zamora's churches. Ultimately, this research includes archiving and planimetric activity, as well as focusing on structural stability.

Key words

Architecture Romanesque, diaphragm arches, buttress system, Zamora, Spain.

Cómo referenciar este artículo / How to reference this article:

Rodríguez Méndez, F. J. (2014). Spatial unification of Romanesque churches in Zamora and its influence on the buttress system. En J.W.P. Campbell (ed.): *Proceedings of the first conference of the Construction History Society*. Cambridge 2014, pp. 263-272.

ISBN: 978-0-9928751-0-7

Introduction

At present, besides the cathedral, there are a total of twenty Romanesque churches surveyed in the city of Zamora, mostly built between the eleventh and thirteenth centuries. The most abundant church typology – recognizable in twelve of the twenty churches – is the single nave church with the body wider than the chevet and without a visible transept. Of the remaining ten churches, originally built with three naves, only one has remained intact, the other nine being subjected at some point to what we call "spatial unification" which could be defined as the merging of the naves of a church by the elimination of internal columns for the sake of clarity. It is not, of course, a phenomenon specific to Zamora. The church of Santiago in La Coruña is a clear example of a church with three naves which, after a fire and subsequent remodelling, gave way to a fully Gothic pointed diaphragm arches' structure. Why this solution was used repeatedly in Zamora – and not in other neighbouring capitals such as Salamanca – is not an easy question to answer. Perhaps the explanation lies in the fact that, unlike those other capitals, Zamora's development was very localized in the eleventh and twelfth centuries. Churches built during this period might have been sufficient to meet the needs of future generations in both capacity and layout within the city. The few examples of Gothic architecture, today completely ruined or disappeared, consisted of monasteries located in neighbourhoods outside the walled city. This new architecture, more spacious and bright, influenced the transformation of churches inside the walled enclosure. As it was impossible to replace them with new ones – either for lack of funds or lack of adjoining lots in an already overfilled town – alteration was chosen instead.

Besides the Cathedral of Zamora, only the church of Santiago del Burgo preserves its original three-naves' layout. We will therefore make use of it in order to show the original state and characteristics of the remaining nine churches that are still standing and which formerly had three naves. Its floor plan is rectangular with the high chapel barely standing out from the nave. Its inner dimensions are of just 11.9 metres in width and 26.0 metres in length. Its chevet includes three rectangular chapels in the "Ancient Spanish"¹ style (term coined by Gómez Moreno) – the prevailing style in Zamora. The cross-section shows the slender proportions of the naves. In the central nave we find a three-to-one proportion (Fig. 1). Pillars are square and have semicircular adjoining pilasters. Their excessive size is, according to Gómez Moreno, the reason behind the fact that "they were destroyed in other churches to keep just one nave"².

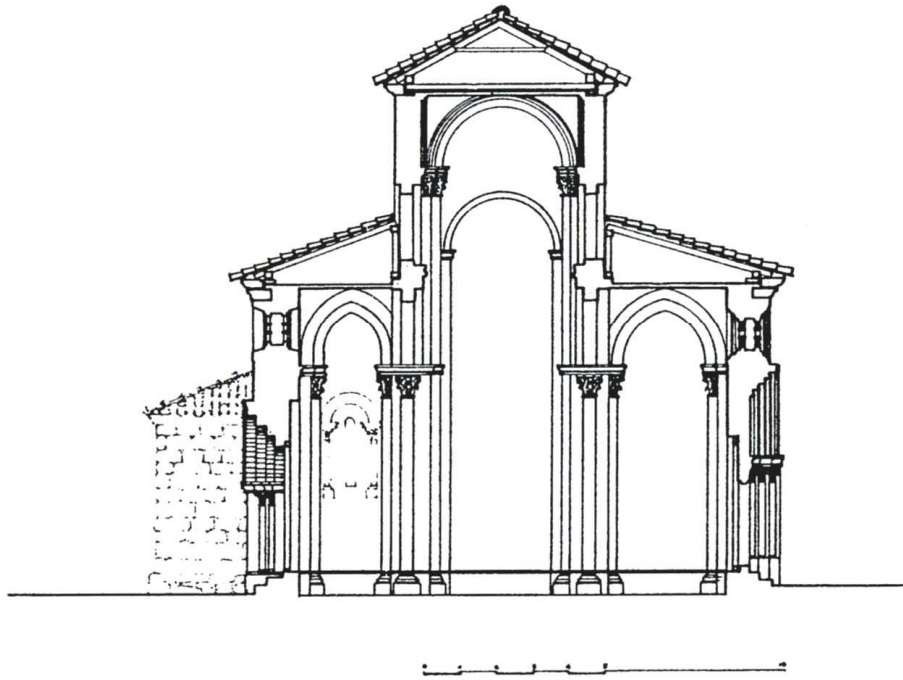


Figure 1: Church of Santiago del Burgo, Zamora. Cross-section.
 Source: *Enciclopedia del románico en Castilla y León. Zamora*, p. 443.

Most of the nine Romanesque churches (seven to be precise) where the three initial naves were merged into one can be included in the “general case”. To describe the general case I will use as an example one of the seven churches, the church of Santo Tomé. During the 15th century, a refurbishment was carried out and the four internal columns were replaced by two semicircular diaphragm arches. For Arturo Zaragozá, this system was used for economical reasons because it is the cheapest in terms of the quantity of wood needed for its construction³. Diaphragm arches and wooden roofs as a construction system had already been used with great frequency for a long time in Catalan and Galician churches and they then disseminated throughout the whole Spanish Peninsula⁴.

The “spatial unification”. The case of San Ildefonso.

This church, 18.8 metres wide and 33.7 metres long, is the biggest of the Romanesque churches still standing in the city of Zamora (excluding the Cathedral). Originally, its interior layout was of three naves in four sections completed with semi-circular apses, very similar to the current layout of the church of Santiago. It remained as such until it was profoundly altered in the 15th century. The barrel vaults, supported by side and transverse arches (which laid over columns) were replaced by ribbed vaults covering the whole width of the church.

Elements found in the church of San Ildefonso show a style which is midway between the late Gothic and the early Renaissance: elongated ribbed vaults which together compose a semicircular barrel vault of 18.4 m in diameter counterweighted by lunettes.

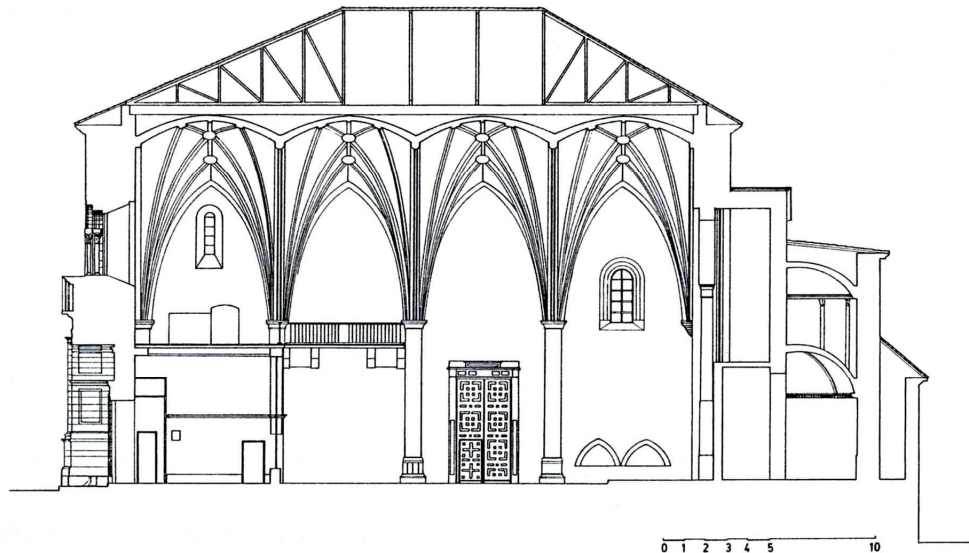


Figure 2: Church of San Ildefonso, in Zamora. Longitudinal section.
Source: *Enciclopedia del románico en Castilla y León. Zamora*, p. 430.

It is reasonable to believe that the architect in charge of San Ildefonso's works was aware of the process followed in Gerona⁵ and that the architectural solution therein employed (i.e. single nave covered with ribbed quadripartite vault) influenced his design. However, the longitudinal section of the church in Zamora (Fig.2) shows that each barrel section is, in essence, a toroidal vault with a longitudinal horizontal axis and an arch with a diameter of 10 metres. Figure 3 shows a modelling of the toroidal vaults and transverse lunettes. Unlike in the case of a barrel vault, the double curvature of a toroidal vault splits the pushing forces into both the longitudinal transverse directions of the church. The transverse pushing forces are biased toward the buttresses by the action of the lunettes, and the longitudinal pushing forces compensate one another. This is the natural evolution of ribbed vaults which were at that time (the end of 15th century) according to Arturo Zaragozá "an ancient and experimented solution" being gradually replaced by "new groined vaults in which the edges and the element made just one body"⁶. This is the case in the vaults of San Ildefonso, very similar in geometry to the sail vaults found in the church of Santo Domingo in Medina de Rioseco, designed by Juan de Nates nearly a century later⁷.



Figure 3: Church of San Ildefonso, in Zamora. Modelling of the vaults.



Figure 4: Church of San Ildefonso, in Zamora. Exterior. View from the west.
Source: *Proyecto cultural Zamora románica*.

The roof covering consisted of a filling on the vaults' extrados until it was level with the slopes of the peaked roof. All of this entailed greater loads than in the case of a roof covering made using diaphragm arches with the aggravating factor that in this case the distance the arches must cover was some 18 metres. The counterweight system needed to ensure stability affected nearby buildings. Figure 4 shows how, in order to counterweight the thrusts of the new roof covering, it was necessary to prop the church up over two adjacent palaces. The shoring was achieved without affecting the surrounding streets by using flying buttress arches in the south (right side of the figure) and through a solid corner buttress in the northwest.

Later on, the new roof covering of wood trusses forced the eave height to be raised above the toroidal vaults' keystones to allow the tie rods to pass over them.

The “spatial unification”. The case of San Juan.

The church of San Juan, called “de Puerta Nueva” [of the New Entrance], was near the wall of the first defensive enclosure and of the new entrance opened therein in order to connect with the eastern extension of the city. By the beginning of the 16th century an adjacent stretch of wall had already been demolished for some time, and the Main Square was placed in the esplanade that opened in front of the Church⁸. The church thereafter lost its free-standing nature and was gradually surrounded by buildings by the side of the square. Figure 5 shows the state of the church by 1890 with its tower – the only visible element – dominating the Main Square. The upper body or bell tower was dismantled in 1898 because it was in danger of collapsing. Currently the church stands alone again (Fig. 6) as a result of a controversial demolition of one side of the square's buildings which leaned against the church's walls.



Figure 5: Church of San Juan, in Zamora. Eastern View, c. 1890.

Figure 6: Church of San Juan, en Zamora. Eastern View, current state.

The transformation experienced by the *church of San Juan* cannot be seen only as the result of the urban evolution of its surroundings. The changes in its internal structure, also influenced by external circumstances, were the most decisive factor in the final configuration of the church. As for the 12th century Romanesque church with three naves, all that remains are the chevet structure and the north and south façades which define a floor plan of 14.4 metres in width and 25.3 metres in length. In the words of Gómez Moreno “inside the church nothing of

the source elements can now be recognized (...), the ancient naves have transformed into a single one with two huge arches running along it, supported by Gothic pillars”⁹. The pair of big side arches with a span of 14 metres is the most eye-catching element inside the church of San Juan (Figs 7 y 8). Also the tower, built upon the chancel, corresponds to an uncommon type of tower for the Romanesque period in Zamora. It is certain that the current tower is not the original one, but doubts arise as to whether its location is the original one. Historians disagree on this issue. Whereas for Jaime Nuño the tower’s location is the original one (“it can be assumed that the tower had had from the beginning the same current location and characteristics, moreover given the proximity of the wall on that side”¹⁰), Guadalupe Ramos suggests to the contrary when she states that “we are surprised by its location because there is no other case in the Romanesque in Zamora where we can find a tower in the chevet”¹¹. I will examine these two subjects in depth in the following paragraphs.

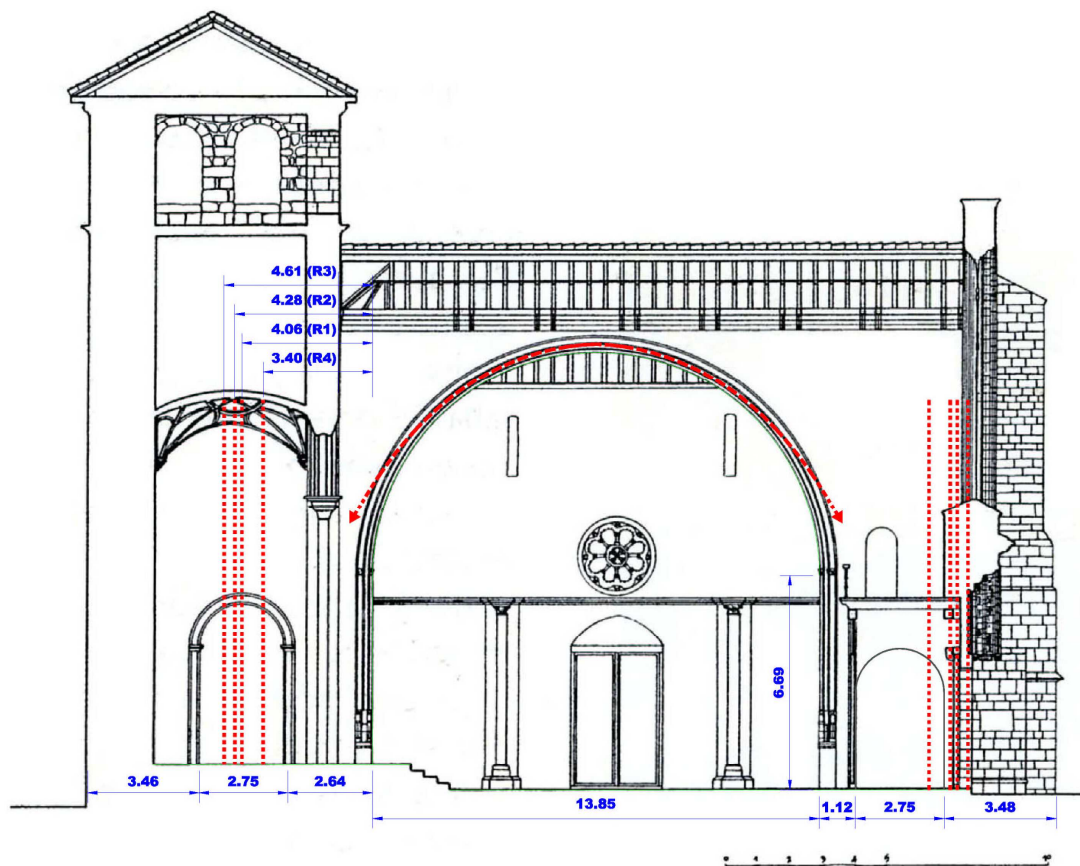


Figure 7: Church of San Juan, in Zamora. Longitudinal Section.
Source: *Enciclopedia del románico en Castilla y León. Zamora*, p. 462.

When contemplating the elegant solution used inside the church, the question that arises is this: why have diaphragm arches laid out transversally to the longitudinal axis of the nave not

been used in the church of San Juan as they have in most other “unified” churches in Zamora? To explain the reasons behind such a choice it is necessary to take into consideration the urban evolution of this particular area. With the construction in the 13th century of the second walled enclosure, the stretch of the first wall running in front of the church lost its functionality and was finally demolished. Houses were gradually built around the perimeter of the church until it was completely enclosed. This situation remained unchanged until recently.

The enclosed layout of the church prevented the thrusts’ counterweight to come from the sides as happens with other renovated churches. This is the most likely explanation for the longitudinal layout of the arches which replaced the rows of columns. The longitudinal layout made it possible to counterweight the thrusts on both sides of the arch by means of large blocks of the same thickness, drilled only into the essential wall voids (Fig. 8). Whereas at the foot of the church the huge buttress walls delimit the inner hallway and support the upper gallery, they frame the main chapel and support the tower in the chevet. The advantages of this layout are twofold. First, both the choir gallery and the tower in the chevet contribute with their loads to provide stability to the church as a whole. Moreover, this solution did not affect adjacent buildings (nor did it at the time affect the wall) and it could be applied wholly from within the church. Thus, in our opinion, it is reasonable to think that the tower layout over the chancel is not the original one and that the tower must have been built at the same time as the side arches as a solution for improving counterweight, avoiding at the same time works on the outer side of the building. The uncommon buttress located at the south-west corner, (Fig. 8) hides within it a spiral staircase which may well be the remains of the ancient tower which from that position could also have served as a watchtower.

The successive renovation works undergone by the church of San Juan have been carefully studied by Luis Vasallo Toranzo in his article dedicated to the intervention of Rodrigo Gil de Hontañón¹². Vasallo recognizes that “the work done by Rodrigo Gil is difficult to define” because of the difficulty in interpreting “obscure and fragmented circumstances” and due to the later ruination of the building. This being so, the precious documentation recovered from the Zamora Provincial Historical Archive provides an understanding of a highly confusing process.

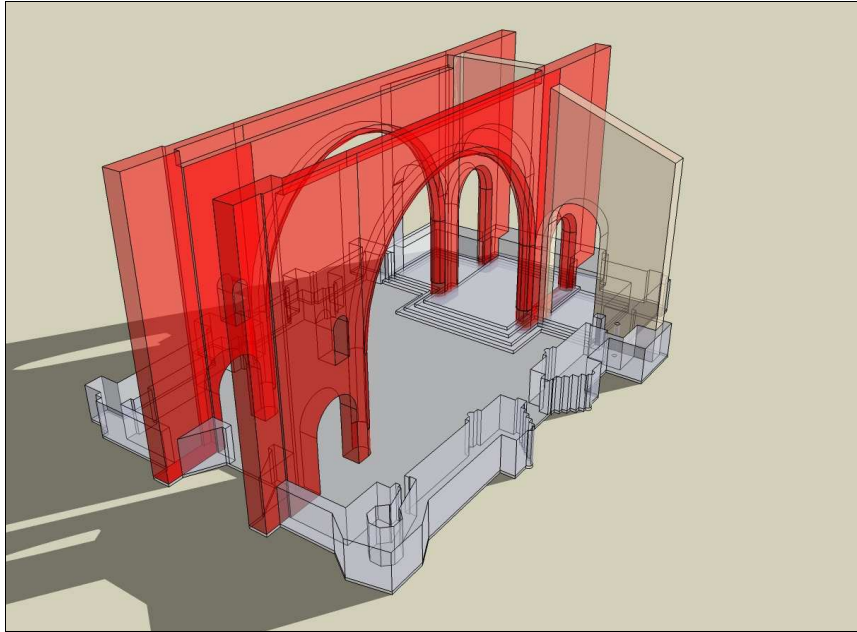


Figure 8: Church of San Juan, in Zamora. Modelling of side arches.

The starting point is an undocumented intervention at an unknown date (we will suppose it dates from the end of the 15th century) in which the four central pillars were removed and replaced by two large side arches. Since the early 16th century the church, already renovated, and its tower, needed to be repaired frequently. Vasallo explains that “in 1531 the tower and one of the side arches (the one located at the epistle side) were in danger of crumbling” and that because Rodrigo Gil was at that moment in the city of Zamora working on a different project, he was required by the City Council to take care of its reparation. Gil de Hontañón, who was barely thirty and was starting his career as an independent professional, was already a celebrated and esteemed architect. Once the architect’s fees – considered by all as excessive – were accepted, the agreement was executed on September 1553.

In June 1532 Rodrigo Gil completed the works. Prior to delivery and subsequent payment, the council demanded an inspection of the works by independent architects¹³. The report’s conclusion – which was repeated a year later with the same results – was favorable for Rodrigo Gil, except with regard to the execution of a particular detail. According to the authors of the report, the toral pillar had not been sufficiently dismantled, while some cracked elements were visible and not sufficiently bonded. It would therefore be necessary (as specified in the conditions) to fasten again the newly-built side arch to the arch situated between the two chapels, at a height of eight courses. In the opinion of the previously mentioned author, Luis Vasallo, “Rodrigo Gil’s intervention in the church of San Juan was

not very successful." Although the architect went as far as to pawn "his life and personal assets" to ensure the future integrity of the church, in 1559 the tower collapsed. It should be clarified that, in Gil de Hontañón's defence, this time the affected side was the gospel side, whose side arch had not been touched in the repair works of 1531. In particular, this side arch had been re-built by different stone-carvers "in the image and likeness of the arch of the epistle side" (which had been re-built by Gil in 1531) and both arches are still in place today. The reconstruction of the tower over the chancel (regardless of this location being the original one or, as suggested by Ramos de Castro and supported by us, the new one) ended in 1579.

It would be inexcusable not to apply the geometric rules attributed to Gil de Hontañón in the case of the side arch used by him in the church of *San Juan*. For the implementation of the four geometric rules attributed to the great Spanish architect we have followed the interpretation of Santiago Huerta¹⁴. The rules are based on (sometimes somewhat convoluted) geometric constructions which provide the abutment's thickness according to the span of the semicircular arch they support. The thickness obtained by applying each of the four rules are, respectively, 4.06 metres (1st rule), 4.28 metres (2nd rule), 4.61 metres (3rd rule) and 3.40 metres (4th rule). The outer edges of the abutment which result from the application of the four rules are represented in figure 7. The thrust lines have also been included, using graphic statics and joining the intersection points of the resulting lines from the thrust of each voussoir to the contact planes between the voussoirs.

Several conclusions can be drawn by observing the drawing and the lines obtained. The first is that the arch moulding is extremely thin: all graphic constructions have an arch moulding of the same size as the abutment but here it is only of 2 Castilian feet, i.e., not even one-sixth of the smallest abutment (3.4 metres resulting from rule n°4). But from an aesthetic point of view and also from a construction viewpoint, an arch with a 3.4 metre moulding could not be adopted. It is the reduced load the arch must support that makes a 0.56 metres moulding viable as only a couple of courses cross over the side arch's keystone. On the other hand, the Mudejar wooden roof, whose load the arch must also support, uses the lightest roof solution possible.

The thickness of the abutments situated on both sides of the arch are below 3.4 metres which is the measure required by the fourth rule. Although it is questionable that in this unusual case the rules were applied, the thickness measurement calculated by means of the fourth rule is

confirmed by the first rule of Derand (published by Derand in 1643 but frequently used in the early Renaissance) which, if applied, has a result of 3.46 metres, almost the same result as the previous one reached using Gil's rule¹⁵. Indeed, 3.46 metres is the exact measure of the church porch's blocks located on both sides of the arch. This leads us to believe that the architect made sure that the holes drilled on the abutments left room at their edges for blocks of the magnitude required by Derand's rule. The line of thrust, because the arch moulding is so thin, exceeds its limits and reaches up to the haunches even though the arch supported very reduced loads. Stability is ensured on the left side by the vertical loads coming from the tower and on the right side thanks to the weight of the gallery and the western end.

Conclusions

There is no doubt that in Zamora, by the end of the 15th century, the idea of carrying out spatial unification of the old Romanesque churches gained shaped and momentum. Of the ten churches which today remain standing and which originally had three naves, only one has kept its original layout: the church of Santiago del Burgo. The other nine churches have suffered alterations which eliminated the inner pillars in order to create a clear space dedicated to religious worship. The general procedure was used in seven cases and consisted of replacing rows of pillars with transverse diaphragm arches. In the church of *San Ildefonso* the spatial unification was achieved through the construction of stellar vaults with toroidal geometry. This solution generated great horizontal thrusts and it was necessary to prop up the church over the adjacent palaces using buttresses and flying buttresses. Finally in the church of *San Juan de Puerta Nueva*, a lighter solution was chosen, consisting of replacing the rows of pillars with large, longitudinal side arches. The counterweight elements could not stand above the adjacent façades' perimeter because of the enclosed layout of the church and according to Guadalupe Ramos de Castro it was necessary to change the tower to its current location over the chancel in order to contribute its own weight to the building's stability.

¹ M. Gómez Moreno, *Catálogo Monumental de España. Provincia de Zamora*, Madrid: Ministerio de Instrucción Pública y Bellas Artes, 1927. p. 150.

² Gómez Moreno, (Note 1) p. 150.

³ A. Zaragoza Catalán, *Naves de arcos diafragma y techumbre de madera en la arquitectura civil valenciana*, pp. 551-555 in S. Huerta (ed.), *Actas del Primer Congreso Nacional de Historia de la Construcción*, Madrid: I. Juan de Herrera, 1996.

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- ⁴ L. Torres Balbás, *Naves cubiertas con armadura de madera sobre arcos perpiaños a partir del siglo XIII*, Archivo Español de Arte, Vol. 34, Madrid: C.S.I.C., 1960. pp. 13-43.
- ⁵ S. Huerta, *Mecánica de las bóvedas de la Catedral de Gerona*, pp. 179-204 in M. Llorens (ed.), Seminari sobre l'estudi i la restauració estructural de les catedral gòtiques de la corona catalana-aragonesa, Girona 2001, Girona: Universitat de Girona, 2004.
- ⁶ A. Zaragoza Catalán, *A propósito de las bóvedas de crucería y otras bóvedas medievales*, Anales de Historia del Arte, Vol. Extr., 2008, pp. 99-126.
- ⁷ S. Huerta Fernández, *Mechanics of masonry vaults: The equilibrium approach*, pp. 47-69 in P.B. Lourenço (ed.), Historical Constructions, Guimaraes, 2001.
- ⁸ F.J. Rodríguez Méndez, *Plan Director de las murallas de Zamora. Algunas aportaciones al conocimiento del Monumento*, pp. 557-570 in Actas del IV Congreso Internacional "Restaurar la Memoria", Valladolid 2004, Valladolid: Junta de Castilla y León, 2006.
- ⁹ Gómez Moreno, (Note 1) p. 159.
- ¹⁰ M. A. García Guinea y J. M. Pérez González (dirs.), *Enciclopedia del románico en Castilla y León. Zamora*, Aguilar de Campoó: Fundación Santa María la Real, 2002. p. 465.
- ¹¹ G. Ramos de Castro, *El Arte Románico en la provincia de Zamora*, Zamora: Diputación Provincial, 1977. p. 176.
- ¹² L. Vasallo Toranzo, *Una nueva obra de Rodrigo Gil de Hontañón en Zamora: la reforma de la iglesia de San Juan de Puerta Nueva*, Boletín del Seminario de Estudios de Arte y Arqueología, Vol. 59, Valladolid: Junta de Castilla y León, 1993, pp. 313-320.
- ¹³ Vasallo, (Nota 12) p. 317-318.
- ¹⁴ S. Huerta Fernández, *The medieval 'scientia' of structures: the rules of Rodrigo Gil de Hontañón*, pp. 567-585 in A. Becchi (ed.), Towards a History of Construction, Berlin: Birkhäuser Verlag, 2002.
- ¹⁵ Huerta, (Note 14) p. 571-572.