

# The Survival of Gothic Rib Vaulting in the Viceroyalty of Peru

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The survival of Gothic rib vaulting in the Viceroyalty of Peru represents a significant chapter in the construction history of Spanish colonial architecture. Archival records indicate this building technology was brought to colonial Peru in the mid-sixteenth century by European architects seeking solutions for the construction of masonry vaults over the monumental spaces of church naves and chapels. Among the challenging factors were the level of expertise of the master builders, availability of construction materials, and training an indigenous labour force unfamiliar with European building methods. Even though no examples from this early period survive, extant buildings from the seventeenth and eighteenth centuries in the viceregal capital of Lima, in the former Inca imperial capital of Cuzco, and in the small northern towns of Saña and Guadalupe, show how the colonial architects were successful in overcoming these limitations to create original designs of extraordinary beauty.



Figure 1. Lima, aerial view of eastern front of the Plaza Mayor with the Cathedral in a photograph c. 1945 (courtesy of Servicio Aerofotográfico Nacional).

Of special interest in this context is the Council of Architects who met in Lima following the earthquake of October 19, 1609 in order to discuss the best structural solution for the reconstruction of the Cathedral's collapsed masonry vaults. Construction of the present edifice (**fig. 1**) had begun in 1598 upon plans by Francisco Becerra, the famous Spanish architect (Harth-Terre 1961, pp. 18-

57; Gutierrez 2000, p. 69) who had previously worked in Mexico City and Puebla, Mexico and Quito, Ecuador. The eastern end including the *capilla mayor* had just opened for worship when an earthquake in 1606 severely damaged the vaults, a condition that was only aggravated in 1609.

The arguments put forth by the leading experts offer a unique insight on architectural theory and practice and reflect important differences in their professional training. The Council of Architects led by Juan Martínez de Arzona (who had been appointed *maestro mayor* after Becerra's death in 1605) was immediately convened by the Real Audiencia to inspect the condition of the Cathedral and to advise on the best procedure to complete the works. Part of the documentation concerning this important episode discovered in the Archivo General de Indias of Seville and published by Enrique Marco Dorta in 1960 (Dorta 1960, pp. 59-67) led him to conclude: first, that the original groin vaults designed by Becerra were replaced by rib vaults upon a recommendation made by Martínez de Arzona in 1614; and secondly, that the use of the new vaulting system, in an attempt to solve the earthquake problem, marked the birth in Lima of the Gothic style at the beginning of the seventeenth century. Both of these assertions need to be reconsidered, however, in the light of additional documentation preserved in the Archivo del Cabildo Eclesiástico of Lima under the title *Autos y Pareceres en Razón del Daño Que Hizo en la Iglesia Mayor desta Ciudad de los Reyes el Temblor de 19 de octubre del año 1609 y el Remedio Que se debe tener para la continuación de la Obra* (Archivo del Cabildo Eclesiastico de Lima 1609-15, 24; San Cristobal 1996).

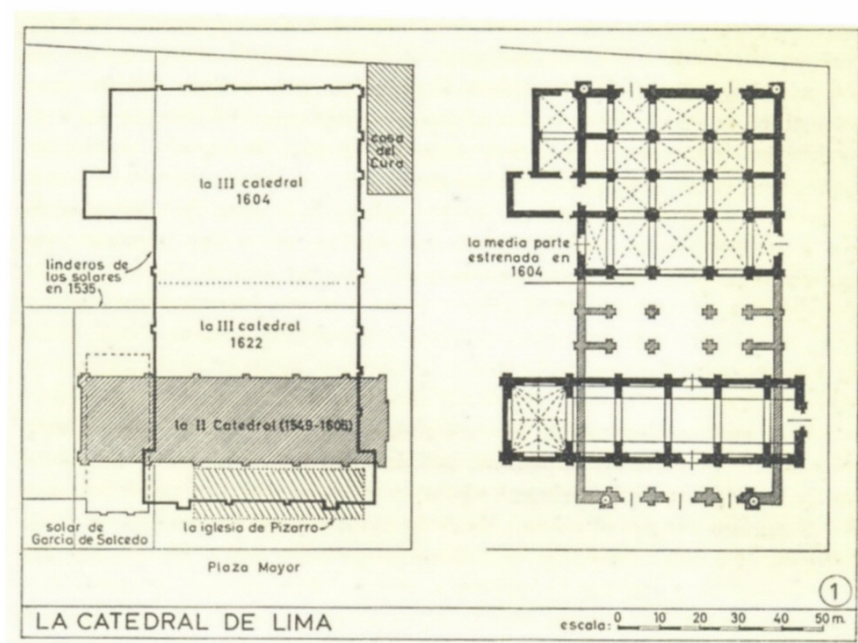


Figure 2. Lima, composite plans showing the location of the successive cathedrals erected on the eastern front of the Plaza Mayor (after E. Harth-Terré).

Becerra's cathedral was the first completely vaulted structure built in Lima, exhibiting brick groin vaults without any decoration on Ionic piers. Such was the design to be expected of an architect who, according to George Kubler, was practicing in the "austere Vignolan *estilo desornamentado* of Spain before 1585." (Kubler and Soria 1959, p. 90) Its monumental rectangular plan consisting of a nave flanked by aisles and cryptocollateral chapels and hall church elevation with nave and aisles of equal height contrasted sharply with that of the old Cathedral of 1549-52 which stood on the eastern front of the Plaza Mayor with its major axis running parallel to it, as shown in a reconstruction by Emilio Harth-Terré (**fig. 2**)(1961, p. 22) and a drawing by the *cronista* Felipe Guamán Poma de Ayala (c.1600). (La Nueva Cronica y Buen Gobierno 1966, p. 219) The earlier structure, demolished after 1606 to give way to the new building, was modest in size and had a single nave without lateral chapels covered by a pitched roof except for the sanctuary, which carried a Gothic rib vault of brick - a feature that was used in several other sixteenth century churches in the city, such as Santa Ana (c. 1553) and La Encarnación (1562) (Ballesteros 1972, pp. 73-4, 84-6). Thus, it is important to note that a precedent for the use of the rib vault had already been established by this time.

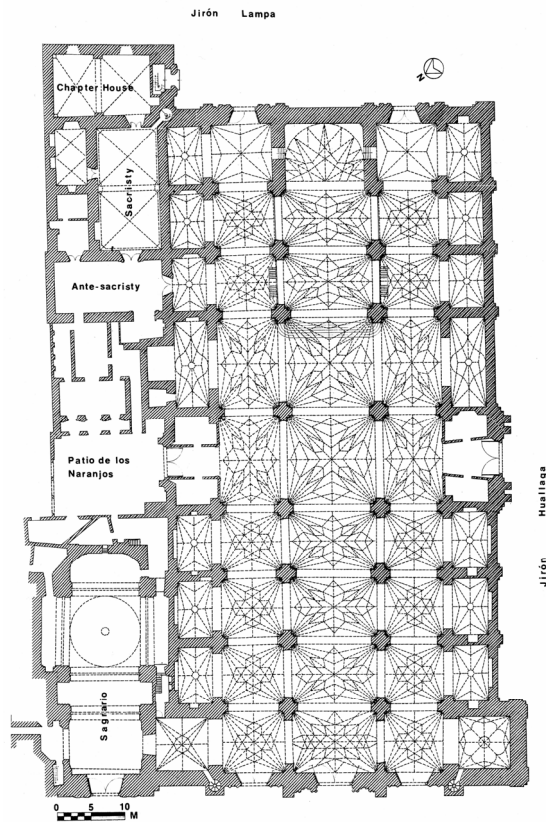


Figure 3. Lima, Cathedral, general floor plan in its present state (drawing by H. Rodríguez-Camilloni)

Despite multiple restorations dating from the colonial period and modern times, the present plan of the Cathedral of Lima (**fig. 3**) is generally believed to be an accurate reflection of Becerra's original intention. Like its contemporary Cathedral of Cuzco (also designed by Becerra according to the architect's own testimony) (Dorta 1943, pp. 7-15) it belongs to a group of sixteenth century American cathedrals derived from the model of Andrés de Vandelvira's Cathedral of Jaén, Spain, begun in 1546. Yet, even closer to the Peruvian cathedrals in the distribution of the lateral chapel, the location of the transept and the Siloeseque entablature blocks above the capital piers, is the Cathedral of Puebla, Mexico, which Becerra knew first hand. Both Puebla and Lima were also originally planned to have four towers—a scheme that links them with Juan de Herrera's project of 1580-5 for the Cathedral of Valladolid, Spain (Goitia 1947). The cruciform piers introduced in Lima (**fig. 4**) and Cuzco (**fig. 5**) by Becerra provide one distinction, however, since they have flat pilasters instead of round columns. At the same time, it is noteworthy that the plans of Lima and Cuzco (**fig. 6**) share a common parentage with the plans of a number of Spanish cathedrals (including Jaén and Valladolid) based on a duple or double-square proportion and the geometric rule for an ideal five-nave church as indicated in the late medieval manuscript of the Spanish architect Rodrigo Gil de Hontañón (active between 1521-77) (Garcia 1941, pp. 41-3).



Figure 4. Lima, Cathedral, interior detail (photo: H. Rodríguez-Camilloni).



Figure 5. Cuzco, Cathedral, interior detail (photo: H. Rodríguez-Camilloni).

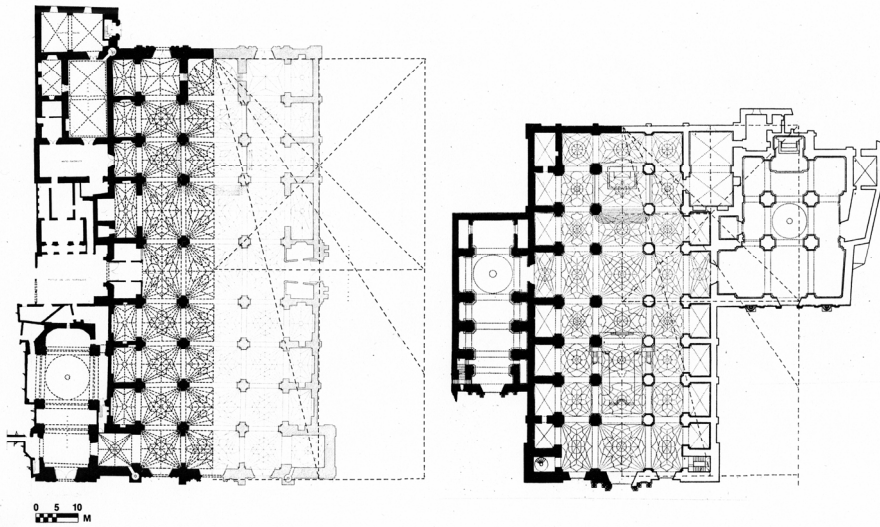


Figure 6. Lima, Cathedral (l) and Cuzco, Cathedral (r) plans with overlay of Rodrigo Gil de Hontañón's geometric construction for an ideal five-nave church (drawing by H. Rodríguez-Camilloni).

Hontañón's manuscript is the most explicit document that has come down to us which incorporates the rules of the Spanish Gothic builders. In it may be found the following instructions for the geometric construction of a five-nave church plan (**fig. 7**): Let EF be the total length of a church: using this distance as the side of the square, draw the square ABCD. Lift the perpendicular GH joining the mid-points of the sides AD and BC; and draw the diagonals BD and AC. Next draw the line EH; and it will intersect with the diagonal BD at X, which determines the total width of the church and the origin of the semicycle XX'. Divide HC into two equal parts. Join point I with E and E with J: the intersection of these two lines with XX' gives the points Y and Z which mark the subdivision of the aisles and the ambulatories of the chevet. The intersection of the diagonals AC and BD with the lines of the central nave gives the position of the transept; the junction of the line EI with the middle semicycle of the chevet gives the point M of its easternmost bay; and the junction of the line EJ with YK gives the point N which marks the subdivision of the bays west of the Transept. Finally, taking  $CO=BC/3$  and joining O and A, the intersection of AO with Z'L' at P gives the eastern limit of the springing of the vault of the apse. The simplicity of this scheme is remarkable; and it provided the designer an assurance against capriciousness by readily establishing a series of harmonious relationships between the whole and its parts.

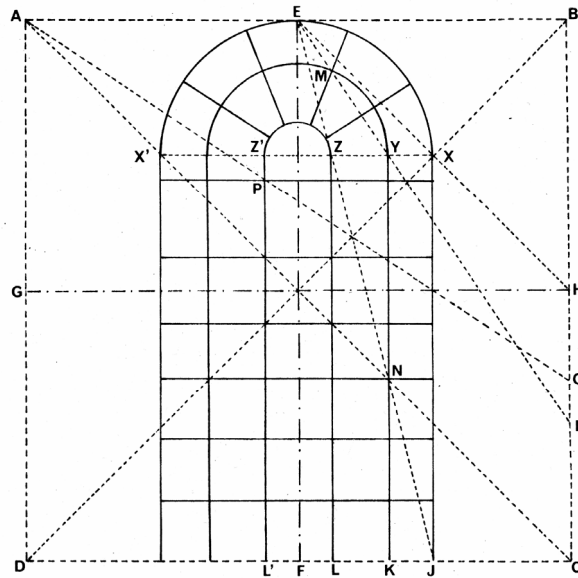


Figure 7. Rodrigo Gil de Hontañón, geometric construction for an ideal five-nave church (redrawn using different lettering by H. Rodríguez-Camilloni)

On February 2 1604, when the eastern end of the new Cathedral of Lima was dedicated, it appears that only the first two bays of the central nave with flanking aisles and lateral chapels had been roofed, judging from the testimony supplied by Fernando Montesinos. (1906, pp. 167-8) Work

continued westward at a slow pace due to financial difficulties and the death of Becerra; but at least two additional bays, including the lateral chapels of the Immaculate Conception and St. Anne were standing when the earthquake of 1609 struck the city.

The serious damage done to the brick vaults was quickly verified by Luis de Palomares Vega, the *obrero mayor* or superintendent of the works of the Cathedral, who requested to the Real Audiencia the calling of a council of architects in order to consider the course of action to be followed in the reconstruction. This event initiated a lengthy controversy among the various architects who were consulted which lasted for six years—a period that saw the cessation of all building activity. Amongst them were Alonso Morales, Martín de Aizpirtarte, Juan del Corral, Fray Gerónimo de Villegas, Fray Sebastián Pereira, Diego Guillén and Alonso de Arenas, all with practical experience in the “art of geometry and design” (“*personas prácticas y de experiencia en el arte de geometría y de buena traza,*” according to one of the documents) (Archivo del Cabildo Eclesiástico de Lima 1609) and who had distinguished careers as designers of many of the best buildings constructed in Lima during the first decades of the seventeenth century (Ugarte 1968; Harth-Terre 1945, pp. 149-64). Their individual contributions during the polemical exchanges that were inspired by the challenge of the Cathedral of Lima in this case add significantly to our appreciation of their artistic personalities.

First to give his opinion was the *alarife* Alonso de Morales, who had built the first brick tower in the city for the church of the Mercedarians in 1589. His report, signed and dated October 24, 1609, makes it clear that the vaults that had collapsed were located towards the eastern end (“*en el testero y cabecera de la Iglesia*”), immediately behind the main altar and between the lateral chapels of the Souls and Our Lady of Copacabana. The larger chapels of St. Anne and the Immaculate Conception which Becerra may have originally intended to be the transept of the Cathedral, also suffered considerable damage in the piers and arches. Morales recommended that their supports be thickened and their wider arches reduced to the same size as those of the other chapels (Archivo del Cabildo Eclesiástico de Lima 1609). These wider arches, called *arcos zarpaneles*, were three-centred arches with a span of 38 Castilian feet (1 Castilian ft equals 27.86 cm) as opposed to the 25 ft span round arches. For the apse, he decided against the use of exterior buttresses because in his view they would have been unsightly in the space of the cemetery. Instead, he proposed a reduction in the height of the naves and the construction of chapels similar to the lateral ones so that they would work as strong buttresses adding to the solidity of the entire structure. The plans of 1665 and 1696 of the Cathedral reserved in the Archivo General de Indias (Ballesteros 1969, pl. 11, 13) show this idea was incorporated in the final solution by the construction of the apsidal chapel of St. Bartholomew at the end of the central nave.

The need for buttressing the apse of the Cathedral was also recognized by Juan del Corral, who submitted his report on October 27 accompanied by a floor plan of the eastern end (**fig. 8**). This plan is of exceptional interest because it illustrates in detail the architect’s intention for the

restoration, while at the same time providing valuable information on Becerra's original design. (Archivo de Cabildo Eclesiastico de Lima 1609) Born in Burgos, Spain in 1571, Corral had practiced the profession in Quito, Ecuador since 1601, where he had earned the prestigious title of *maestro mayor de reales fábricas*. (Harth-Terre 1945, pp. 149-64) Because of his reputation as a bridge builder, the viceroy, Don Juan de Mendoza y Luna, Marqués de Montesclaros, had summoned him to Lima in 1608 to design and build the city's Old Stone Bridge, still standing today.

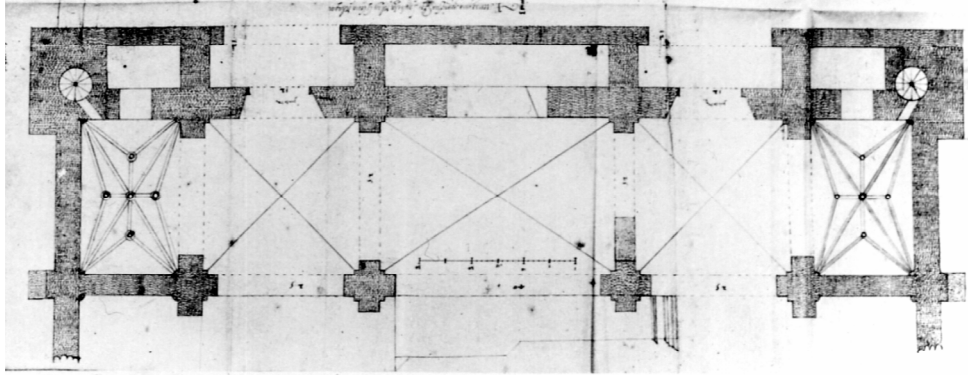


Figure 8. Juan del Corral, floor plan of the eastern end of the Cathedral of Lima, 1609 (Archivo del Cabildo Eclesiástico de Lima).

In contrast to Alonso de Morales' earlier proposal, Corral favoured the construction of six exterior buttresses projecting 12 ft from the rear wall, but decreasing in three stages before meeting the cornice, as shown in the bottom of his plan. Their spacing coincided with the axes of the interior piers, except for the outer two buttresses that were attached to the corner towers. These buttresses were in turn braced horizontally in pairs by segments of wall parallel to the eastern front. Such an arrangement would have created a row of three shallow cryptoapsidal niches opened to the interior, alternating with two niches opened to the exterior on axis with the aisles. An obvious criticism that was made of this scheme by the *maestro mayor* Martínez de Arzona was the fact that the symmetrical portals of the east façade would have remained boxed-in between the buttresses, partly hidden from view from the street.

Corral's proposal contained other valuable recommendations, however, which were to be implemented years later. One of these, also visible in the plan, was the use of *bóvedas de crucería*, that is, Gothic rib vaults, over the lateral chapels, with exactly the same design they exhibit today (figs. 3 and 8). Following the medieval tradition indicative of his training, Corral relied on a structural system with which he was familiar since he had recently used it over the *capilla mayor* and transept of the church of San Agustín in Quito in 1606 (Vargas 1972, pp. 101-5). For the nave



and aisles, on the other hand, Corral kept the groin vaults; but specified that they should be lowered by at least 10 ft and that they should be made of wood instead of brick. And even though this last suggestion was rejected at the time, here Corral anticipated the definitive structural solution that was adopted more than a century later, after the great earthquake of 1746.

Another architect who endorsed the idea of using wood to cover the naves of the Cathedral was the Jesuit Martin de Aizpitarte, best known for his design of the church of La Compañía of 1624 in Lima. (Ugarte 1956, p. 21) His report of October 1609 is also of special interest because it included two other architectural drawings. (Archivo del Cabildo Eclesiastico de Lima 1609) One drawing (**fig. 9**) shows a procedure for strengthening the three-centred arches of the lateral chapels of St. Anne and the Immaculate Conception by inserting round arches directly underneath them and filling the space in between with brick. This solution would have reduced the span of the original arches from 38 to 21 ft, a size that would have made them 4 ft narrower than those of the other lateral chapels. The other drawing shows Aizpitarte's design for exterior buttresses either of stone or brick to be built against the wall of the apse attached by means of continuous mortise and tenon joints. These would have risen 80 ft from a 12 ft square base, tapering to 9 ft at the level of the cornice.

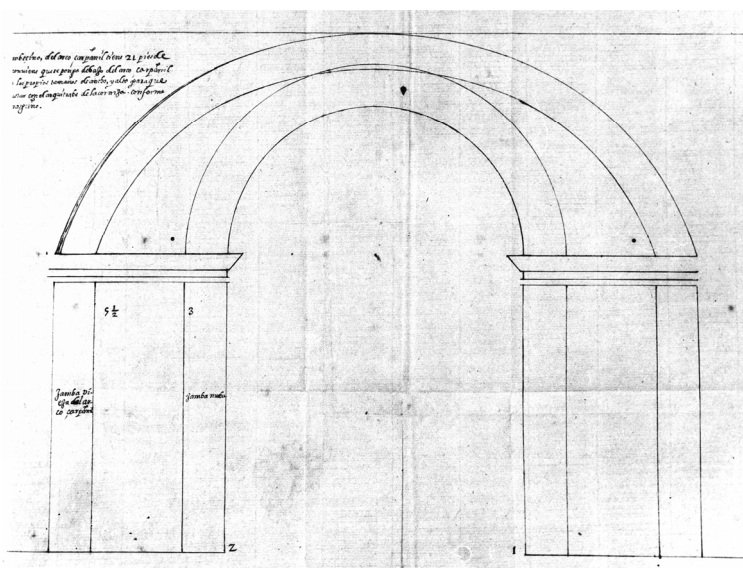


Figure 9. Martin de Aizpitarte, drawing showing a procedure for strengthening the three-centred arches of the Cathedral of Lima, 1609 (Archivo del Cabildo Eclesiástico de Lima).

Aizpitarte again questioned the stability of the Cathedral criticizing the excessive height and specifically condemning the width of 40 ft of the central nave, which he considered to be much too dangerous in an earthquake ridden country. Finally, regarding the materials of construction,

Aizpitarte indicated that the poor setting of the mortar could also be blamed in part for the structural failure of the piers and vaults. As he put it, there existed a problem “*por no fraguar las mezclas en esta tierra.*” (Archivo del Cabildo Eclesiastico de Lima 1609) On this issue, Aizpitarte seems to have been quite accurate since his opinion was seconded by the architects Alonso de Arenas, Fray Gerónimo de Villegas and Juan del Corral in individual reports submitted between the months of February and July 1610. Moreover, during the eighteenth century, the learned French mathematician and military engineer Louis Godin expressed himself in very similar terms after having witnessed the damages of the 1746 earthquake: “*es ...preciso advertir, que la cal de esta tierra no tiene la virtud competente de unirse con las materias de piedra oladrillo.*” (Archivo de Indias de Savilla 1746).

The last opinion to be presented in 1609 was that of the Franciscan architect Fray Sebastián Pereira, in a report dated December 2. (Archivo del Cabildo Eclesiastico de Lima 1609) Here again a concern was raised for the need for additional exterior buttresses; but for the most part, Pereira expressed a strong opposition to many of the ideas advanced by his colleagues, such as lowering the height of the naves, building chapels in the apse, or using wood for the vaults. Of greater interest, however, was his novel antiseismic proposal for digging wells around the Cathedral so that in the event of future earthquakes the earth could “breath through them,” without ruining the building. The reasoning behind this recommendation is explained by Antonio Vázquez de Espinosa, who describes the contemporary belief that earthquakes were caused by the heated vapours produced in the bowels and cavities of the earth. In his *Compendium and Description of the West Indies* (c. 1629), Espinosa wrote: “In the Indies they do not have wells, as in Spain; these might easily obviate their affliction; or at least by opening up wells in all localities in the Indies, there would be more breathing holes and fewer earthquakes.” (Espinosa 1612-29) Pereira’s suggestion must have been taken seriously, since some years later the Cabildo issued a municipal decree ordering the digging of wells in all the houses of the city (Lee and Bromley 1935-63, p. 610).

During the next five years little progress was made in the discussions and no consensus was reached on the reconstruction of the Cathedral, despite continuous efforts involving the viceroy himself, the Real Audiencia, the Cabildo Justicia y Regimiento and the Cabildo Eclesiástico. Finally, in 1614, a major breakthrough occurred when the *maestro mayor* Juan Martínez de Arzona presented new plans with a comprehensive solution for the reconstruction and completion of the Cathedral which was ultimately approved by the Council of Architects and the Real Audiencia in February of the following year. Construction was thus resumed, which culminated in the completion of the western half of the Cathedral in 1622 and its consecration in 1625 by the Archbishop Gonzalo de Ocampo (Harth-Terre 1961, p. 53).

Arzona’s executed scheme called for a reduction of about 6 ft in the height of the naves, requiring a change in the vertical proportions of the piers and the design of the transverse arches. The eastern end was in turn reduced to the same height of the lateral chapels; and the last bay of the central nave

rebuilt as the apsidal chapel of St. Bartholomew. This chapel survived until 1895-7, when the choir was moved to this location from the centre of the nave. As will be recalled, this was the solution originally suggested by Alonso de Morales in 1609, a solution which permitted the construction of more slender exterior buttresses than those proposed by Aizpitarte and others.

As shown in a comparative section drawing (**fig. 10**), the round arch of the central nave became a three-centred arch, whereas the oval arches originally used by Becerra for the aisles and lateral chapels were replaced by round arches. The unusual shape of the oval arches is known from a drawing of 1610 which the Augustinian architect Fray Gerónimo de Villegas used to illustrate the impossibility of erecting round arches directly underneath without first destroying the originals. (Dorta 1960) For his part, Juan del Corral had also commented on these arches about the same time saying that they were neither truly oval or pointed, but simply the worst arches he had ever seen either in ancient or contemporary buildings or even in theoretical writings (Dorta 1960, p. 182).

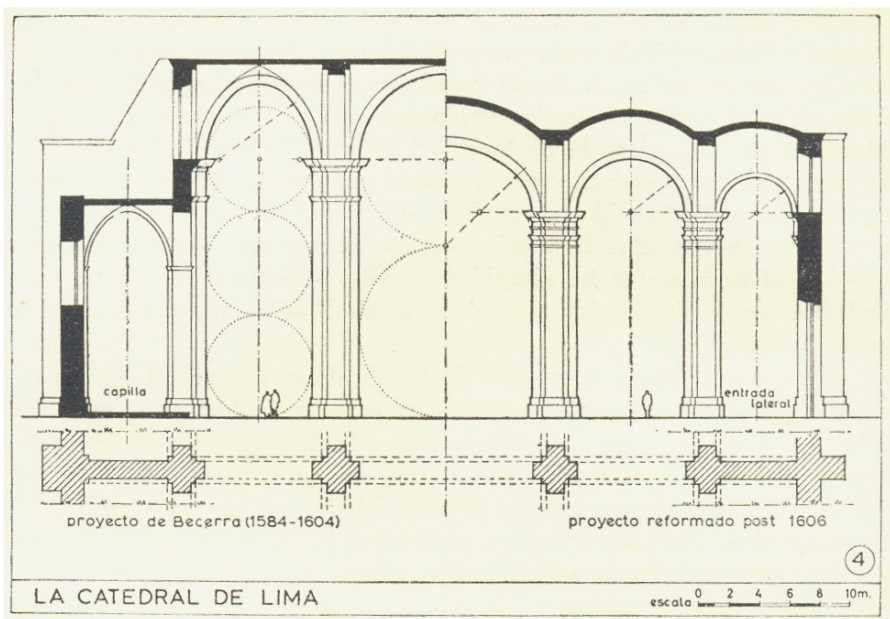


Figure 10. Lima Cathedral, comparative section showing Becerra's original design of 1584-1604 (l) and its reconfiguration after 1609 (r) (after E. Harth-Terré).

The most conspicuous transformation, however, came about with the substitution of all the groin vaults for Gothic rib vaults, a prescription that may appear surprising coming from an architect like Arrona, who had evidently been trained in the classical tradition of the Renaissance. A sampling of other works by Arrona such as the *cajonería* of 1608 for the sacristy of the Cathedral, the catafalque of 1613 for Doña Margarita de Austria, Queen of Spain, or the design of 1626 for the main portal of

the Cathedral, are enough proof of this (Wethey 1949, p. 213; Harth-Terre 1941; Leon 1613). Moreover, in the dimensions of the revised elevation of the Cathedral which can be verified in the present building (**fig. 15**), Arrona used the classic ratios of 1:2 and 4:5 for the width and height of the nave, respectively, measured from the original floor level to the springing point of the arches. The transept as built marked a new mid-point in the interior space fully expressed in the exterior massing, indicative of a centralizing tendency reminiscent of Juan de Herrera's project of 1580-1585 for the Cathedral of Valladolid. No doubt, Arrona's own preference would have been to rebuild the vaults *a la romana*, like his predecessor Becerra; but, as he conceded, experience had shown that rib vaults were the best, citing the *capilla mayor* and transept of the church of Santo Domingo (1544-7) and the *capilla mayor* of the church of La Concepción (1590) as examples of structures with rib vaults that had survived the Lima earthquakes of 1586 and 1609 (Archivo del Cabildo Eclesiastico de Lima 1609).



Figure 11. Blas de Orellana, Saña, church of San Agustín, vaulting of interior nave, 1617  
(photo of 2004: H. Rodríguez-Camilloni)

Thus beyond any stylistic considerations, rib vaulting won the consensus of the colonial architects because they believed that Gothic construction would show greater resistance to earthquakes. Even for architects who had been trained in the classical tradition of the Renaissance, the adoption of rib

vaults became a matter of structural expediency rather than a question of stylistic preference. In the process, architectural design in colonial Peru was liberated from stylistic dogma, often resulting in novel combinations. For example, contrary to what might be expected according to the medieval tradition, rib vaulting is typically not paired with the Gothic instrumentation of the pointed arch and flying buttress, but is instead found in combination with barrel vaults, domical vaults, and even hemispherical domes.

Similar structural considerations were probably the main reason why Gothic rib vaulting continued to be used throughout the seventeenth and eighteenth centuries in Peru, notably by Blas de Orellana at the churches of San Agustín in Saña (1617) (**fig. 11**) (Harth-Terre 1964, pp. 7-24) and Nuestra Señora de Guadalupe in Guadalupe (1619) (**fig. 12**) (Wethey 1949, p.120); by Francisco Domínguez de Chávez y Arellano at the church of San Francisco in Cuzco (1649) (**fig. 13**); and by Juan Bautista Egidiano at the church of La Compañía, also in Cuzco (1651-68) (**fig. 14**). Egidiano's church—one of the high points of Spanish colonial architecture in the Americas—demonstrated that *opus modernum* construction could be harmoniously adapted to Renaissance and Baroque spatial designs (Wethey 1949, pp. 58-60; Mesa and Gisbert 1971, pp. 68-86).

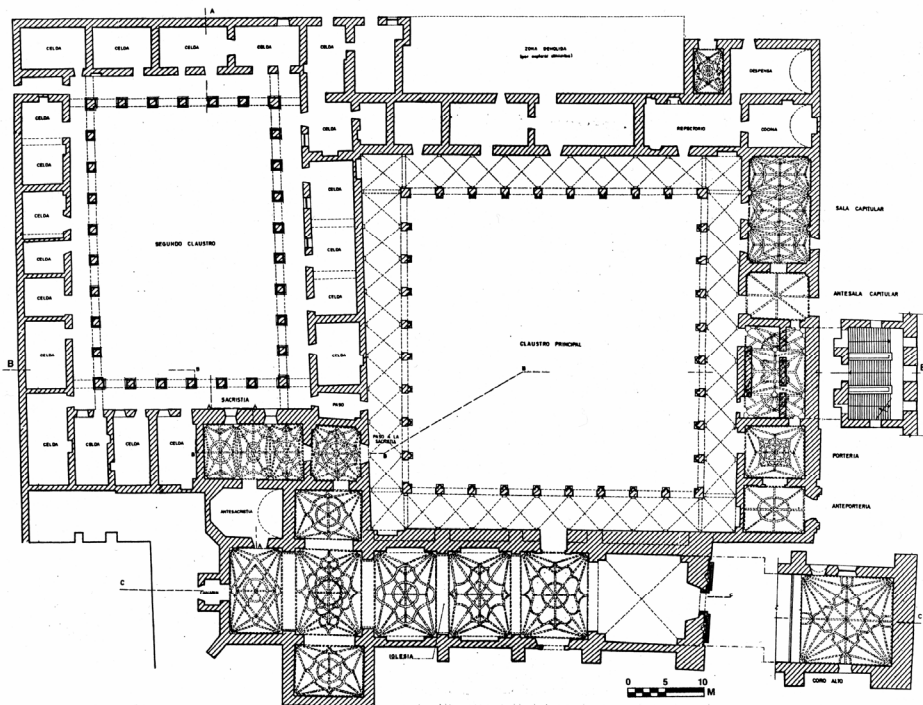


Figure 12. Guadalupe, Nuestra Señora de Guadalupe, general floor plan of church and cloister, 1620 (drawing by H. Rodríguez-Camilloni)



Figure 13. Francisco Domínguez de Chávez y Arellano, Cuzco, church of San Francisco, interior detail of rib vaulting, 1649 (photo: H. Rodríguez-Camilloni)



Figure 14. Juan Bautista Egidiano, Cuzco, church of La Compañía, interior detail of dome and rib vaulting over apse, 1651-68 (photo: H. Rodríguez-Camilloni).



Figure 15. Lima Cathedral, interior nave showing wooden rib vaulting of 1751-8 (photo: H. Rodríguez-Camilloni)

Even though the effectiveness of rib vaulting to resist earthquakes may have proved illusory across the years, its undeniable aesthetic appeal must have increasingly captured the imagination of designers and the public alike. Not surprisingly, when the definitive antiseismic structural solution was found in *quincha* construction (Rodríguez-Camilloni 2003, pp. 1741-52), and the brick rib vaults of the Cathedral of Lima were finally rebuilt in wood by the Scottish architect Alejandro Campobello in 1751-1758 (**fig. 15**) (Harth-Terre 1951, p. III), it is almost certain the emphasis had shifted from structural to aesthetic considerations.

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