Proceedings of the First International Congress on Construction History, Madrid, 20th-24th January 2003, ed. S. Huerta, Madrid: I. Juan de Herrera, SEdHC, ETSAM, A. E. Benvenuto, COAM, F. Dragados, 2003.

Quincha architecture: The development of an antiseismic structural system in seventeenth century Lima

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The introduction of *quincha* construction in the City of Kings or Lima during the middle of the seventeenth century marked a decisive turning point in the devel- opment of Spanish colonial architecture along the Peruvian coast. Not only did this ingenious antiseismic structural system provide a definitive solution to the earthquake problem that had plagued several generations of builders since the founding of the viceregal capital by Francisco Pizarro in 1535, but it also permitted the creation of monumental and lofty interior spaces which paralleled and even rivaled European designs. Surprisingly, however, *quincha* construction has received only a general and inadequate treatment in the artistic literature of Spanish colonial architecture; its full impact still awaiting recognition in the history of construction. [1] In an effort to help fill this void, this paper investigates the earthquake-proof system of *quincha* and its formal implications, as a cornerstone in the history of South American colonial architecture.

In the viceroyalty of Peru, possibly no greater challenge confronted the colonial architects than that of designing buildings that could withstand the frequent earthquakes. Time and again European and viceregal architects had seen the failure of their efforts, including the anachronistic use of Gothic ribbed vaulting in the Cathedral of Lima following the earthquake of 1609 because it was believed it would provide a more resistant structural system. [2] Nevertheless, only with the construction of the church of San Francisco in 1657–74 (Fig. 1) was a more

Figure 1
Constantino de Vasconcelos and Manuel de Escobar: Lima, Church of San Francisco, west façade, 1657–74 (photo of 1973)

effective solution to the problem found through the use of the antiseismic system of construction known as *quincha* construction. Credit for this revolutionary innovation is given to its designer, the Portuguese architect Constantino de Vasconcelos (d. 1668), and his Peruvian assistant Manuel de Escobar (1639–1693), who supervised its construction until completion. [3] Vasconcelos' originality, however, consisted in adapting an ancient Pre-Columbian system of construction for the complex forms of different types of vaults that a large scale building required. The term *quincha* is in fact derived from the Quechua *kencha* and is synonymous of *bahareque*, typically used to identify the walls of primitive huts or of other simple constructions made of cane or bamboo and mud by the indigenous peoples of the continent (Fig. 2). [4] A good description of these structures is given by Bernabé Cobo in his *Historia del Nuevo Mundo* (1613–1653):

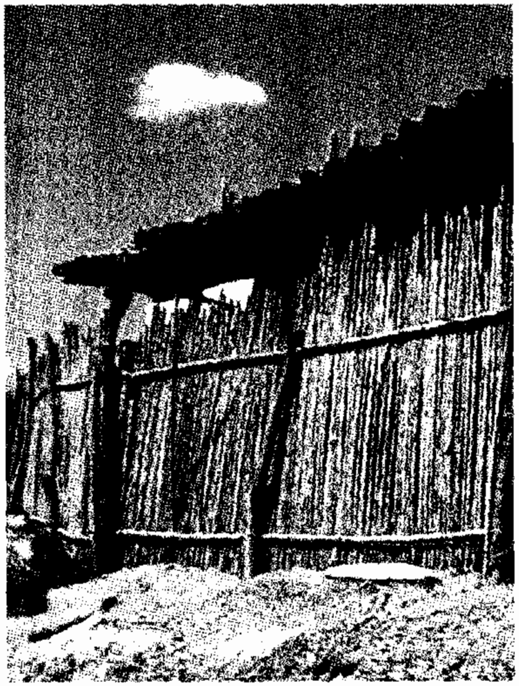


Figure 2
Primitive South America: Traditional hut showing *bahareque* or *quincha* wall construction (from Federico Vegas, *Venezuelan Vernacular*, 1985)

> On the plains of the seacoast, there are two types of houses. Some are of *bahareque* and others are of earth and adobe. Those of *bahareque* have for walls and enclosures a very tight lattice woven likewattle. In making it they set certain thick canes or poles in the ground very close together, and at about two cubits from the ground, the run a reed in between in the way of a weft, leaving on each side half of the above-mentioned poles set in the ground, which cross over that lateral reed like interweaving; at a similar distance another lateral reed is placed, and in this way with three or four lateral reeds which are crisscrossed and interwoven between those poles that stand upright, they have completed a wall more or less two estados in height. We call this type of wall *bahareque*, taking the word from the Island of Hispaniola or Tierra Firme, while the natives of this kingdom use the term *quencha*. Some daub this *bahareque* or wattle with mud; others do not. The roof is constructed over this wattle, and since in this land it never rains, the roof requires no more workmanship than a covering of branches for protection from the sun; it was made with lateral poles and a matting of reeds on top. This is not a sloping roof; rather it is flat and level like a terrace. These houses of bahareque are in the form of a square, very humble, small, and low. This is the style of the majority of the houses of small towns and settlements of the Indian fishermen who live on the coast. [5]

The arid climate of the Peruvian coast noted by Cobo made *quincha* an economic, practical and durable system of construction, except during the rare episodes of «El Niño» phenomenon which brought torrential rains and major destruction to the settlements in the region. The primary materials for *quincha* construction are wood for the structural frame and cane or bamboo for the fill-in webs. The woods most commonly used in Lima were oak (*roble*) and cedar (*cedro*), strong woods resistant to insect infestation that had to be imported from Ecuador or Central America. There are also different types of bamboo (depending on the geographic location) exhibiting physical variations most noticeable in the thickness of the stems, and in the size and distributions of the nodes, internodes, and branches of the culms. For example, the *Bambusa arundinacea* is a thick-walled bamboo with inflated nodes and heavy, solitary, thorny lower branches (Fig. 3, A); the *Bambusa textilis* is a thin-walled bamboo with cylindrical internodes, non-inflated nodes flared at the sheath scar, and branch buds lacking at the lower nodes and tardily developed above (Fig. 3, D); whereas *Bambusa vulgaris* is a moderately thick-

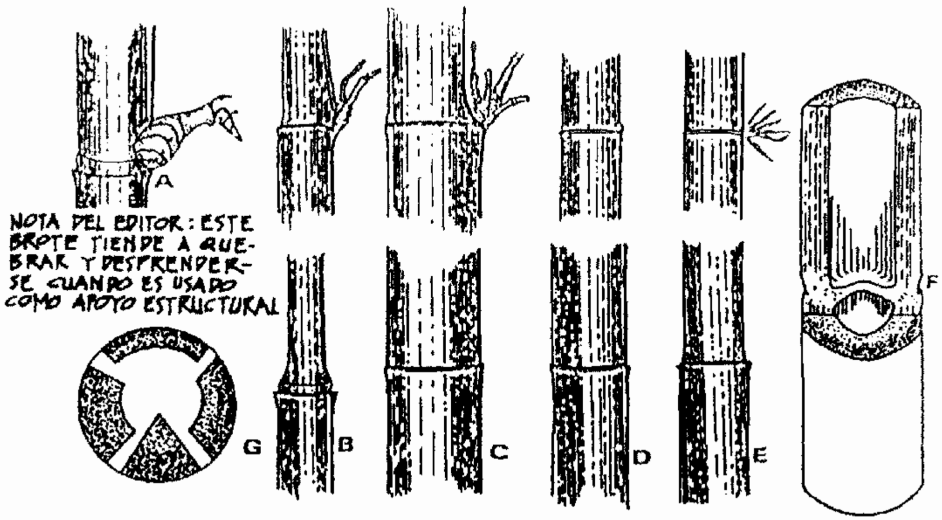


Figure 3
Examples of different bamboos with structural variations in the nodes, internodes and branches of the culms (after V. Hartkopf, *Técnicas de construcción autóctonas del Perú*)

walled bamboo, with inflated nodes, dormant branch buds below, and prominent branch complements above (Fig. 3, C). It should be noted that in all bamboos the diaphragm forms a transverse strengthening structure at each node.[6] By the time the Franciscan community commissioned Vasconcelos to design a new church to replace an earlier structure that had collapsed in 1656, his reputation as one of the leading architects of the viceroyalty had been well established. His impressive credentials as «nuevo Arquímedes en las Matemáticas, Platón en la Filosofía natural, y Diógenes Estoico en la vida de la naturaleza filosofal»—according to a contemporary source [7]—also included work as military engineer in the mercury mines of Huancavelica in 1643 and two years as a designer of fortifications in the port of Valdivia (Chile), for which he had earned the prestigious title of «cosmógrafo e ingeniero mayor». [8] The choice of Vasconcelos as the designer of the church of San Francisco was therefore understandable, but it is also clear that from the very beginning the *limeño* assistant Manuel de Escobar was given the full responsibility of the execution of the project. Thus, according to the notarial contract signed in Lima on June 14, 1659 by Escobar and don Juan Santoyo de Palma, «síndico de la fábrica de San Francisco», it is stipulated that Escobar would assume the obligation of directing and overseeing the construction of the church following the plan and design of Vasconcelos:

> Manuel de Escobar, como tal oficial de albañil, se obligó de trabajar y que trabajara en la obra de la dicha iglesia desde hoy día de la fecha de esta escritura en adelante hasta que se acabe la dicha iglesia por precio de tres pesos de a ocho reales cada día de trabajo, trabajando de manufactura personalmente y haciendo oficio de aparejador, maestrando toda la dicha obra siguiendo en todo la planta y disposición de don Constantino Basconselos [sic], sin salir de su orden en quanto a la disposición y fábrica de dicha iglesia, sin pedir más precio ni otro concierto en ningún tiempo mientras durare la dicha obra, hasta acabarse la dicha iglesia de todo punto ni poder salirse a otra obra dentro ni fuera de la dicha ciudad, sinó sólo a la de la dicha iglesia de Señor San Francisco. [9]

The details of this contract also help explain how it was possible for Escobar to carry on with the project alone after Vasconcelos' death in 1668, for by that time he had acquired sufficient experience and authority to introduce some important changes to the original design. Evidence of this is apparent from a comparison of two contemporary engravings that appear in the history of the construction of the new church of San Francisco by Fray Miguel Suárez de Figueroa and Fray Juan de Benavides.[10] One of these engravings by Pedro Nolasco Mere datable c. 1673 shows Vasconcelos' original design; whereas the other, by Benavides himself and datable c. 1674 shows the church as built by Escobar with major alterations noticeable in the heavy rustication of the twin towers and different proportions of their bases in relation to the central frontispiece.

The design and construction of the Franciscan church presented Vasconcelos and Escobar with the most serious challenge of their professional careers and gave them the opportunity to study the problem of an effective antiseismic structural system anew. The challenge involved unusual complications since the new edifice had to incorporate substantial portions of the earlier structure, including the subterranean galleries that had served as catacombs since the sixteenth century and had weakened the brick foundations. The final solution arrived at by Vasconcelos and Escobar was, from any point of view, a strike of genius. It consisted in adapting *quincha* construction to the complex forms of the roofing structures, including the dome above the transept, the vaults, and also, as will be seen later in this study, the arcades of the second story of the main cloister. These monumental forms, consisting of plaster-coated webs of bundled and matted reeds on timber frames, were reinforced by strong cane bent to produce the desired curvilinear shapes (Fig. 5). Light, yet elastic enough to survive the severe earthquakes, *quincha* allowed for flexibility of formal and spatial design. At the same time, the stucco covering gave the visual impression of masonry construction, an effect greatly enhanced by rich geometric ornamentation in relief. Thanks to this innovation, the vast and luminous interior spaces of San Francisco were able to survive virtually intact for over three hundred years.

When viewed for the first time upon their completion, the *quincha* vaults of San Francisco (Fig. 6) were appropriately compared to the Galapagos tortoise shells and to the sails of a ship blowing in the wind by Suárez de Figueroa:

> [*son como*] *las conchas del Galápago* [*que*] *muestra*[*n*] *la parte convexa, y cóncava, no en esfera, sinó en arco triunfal, y las velas de un navío con próspero viento llenas,* [*las*] *representan muy bien.*[11]

This impression must have been in sharp contrast to the interior of the other large churches in Lima that had flat wooden ceilings (*artesonados*) with Renaissance or *mudéjar* decoration or, as was the case with the Jesuit church of the college of San Pablo of 1624–34, Gothic ribbed vaulting of heavy masonry construction.

The church of San Pablo designed by the Jesuit architect Martín de Aizpitarte may have in fact influenced the design of San Francisco, since both churches share the main features of a central nave flanked by single aisles with cupolas and a domed transept. But the plan by Vasconcelos (Fig. 4) is much more complex, for it is a *Caravaca* cross with a fully developed double transept in the eastern end and, in contrast to the uniform rhythmic articulation of the chapel-aisles of San Pablo, it has a triadic sequential organization of the side chapel bays and arches leading toward the main transept. Moreover, the nave of San Francisco is covered by a barrel vault supported on transverse arches and cut at each bay by lunette windows that accentuate a distinct airy feeling (Fig. 5). Here the interior wall measurements of the length of the nave (approximately 262. 48 ft.) and

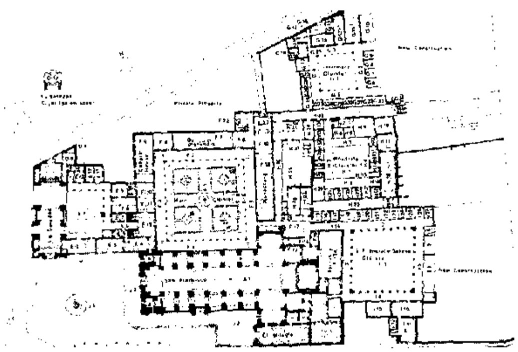


Figure 4
Lima: Church and Monastery of San Francisco, general ground floor plan in its present state (after H. Rodríguez-Camilloni and V. Pimentel Gurmendi, *Proyecto Integral para la Conservación-Restauración . . . del Convento e Iglesia de San Francisco de Lima*)

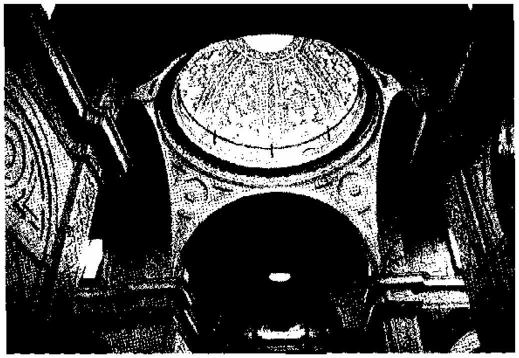


Figure 5
Lima: Church of San Francisco, interior view of dome and transept (photo before 1940 by L. A. Rozas)

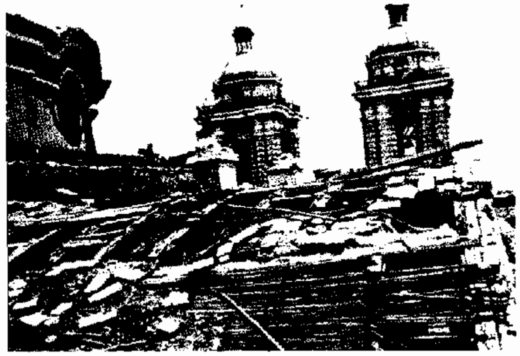


Figure 7
Lima: Church of San Francisco, exterior view of roof damaged by the earthquake of October 17, 1966 (photo of 1967 by A. Guillén)

length of the main transept (approximately 131.24 ft.) yield the simple ratio 1: 2, which is consistently used also for the height of the arcades of the nave in relation to its total height and for the width of the arches in relation to their height.[12] Thus Vasconcelos succeeded in designing the interior spaces with the classical grandeur that best suited his aesthetic ideals, while making the building structurally sound so that it would withstand future earthquakes.

Old photographs of the roof of the church of San Francisco (Fig. 7) taken after the earthquake of 1966 permit an appreciation of how *quincha* construction was adapted to the vaulting system that were required. The webs of cane fastened with leather straps to the wooden frames are visible, with exterior protection provided by thin flat tiles laid on a coat of mud (*torta de barro*). In the interior, the facing of a layer of white stucco consisting of geometric patterns of Renaissance and *mudéjar* origin is applied to the intrados of the vaults and supporting arches; and continued on the masonry piers and walls, achieving a total visual unity (Fig. 5). For the construction of the wooden frames, it is very likely that Vasconcelos would have relied on European models, such as those illustrated by Philibert De L'Orme in his *Le Premier Tome de l'Architecture* (Paris, 1567). Architectural treatises that were printed in Europe, particularly since the sixteenth century on- wards, were widely circulated in the Spanish American colonies thus providing an important didactic tool and source of inspiration for designs. As I have shown elsewhere,[13] De L'Orme may have also served as a source for some of the decorative patterns found in the interior and exterior of the church, i.e. for the heavy rustication that Escobar used in the towers. On the other hand, the structural design of the present cupolas of the twin towers which replaced their original third stories after the earthquake of 1746 (Fig. 1), appear to be derived from models in Fray Lorenzo de San Nicolás' *Arte y Uso de Arquitectura* (Madrid, 1633–64).[14] The dome of the church of San Francisco measuring approximately 36.9 ft. in diameter and rising to a height of 85 ft. up to the apex

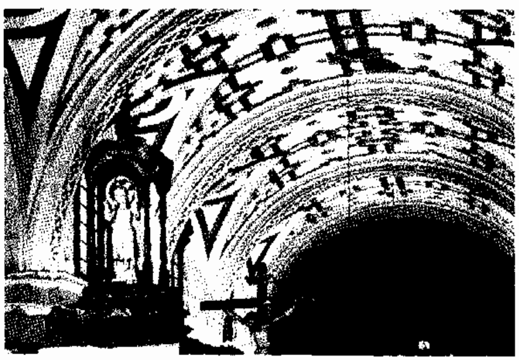


Figure 6
Lima: Church of San Francisco, interior view of nave vaults (photo of 1974 by T. Cusman)

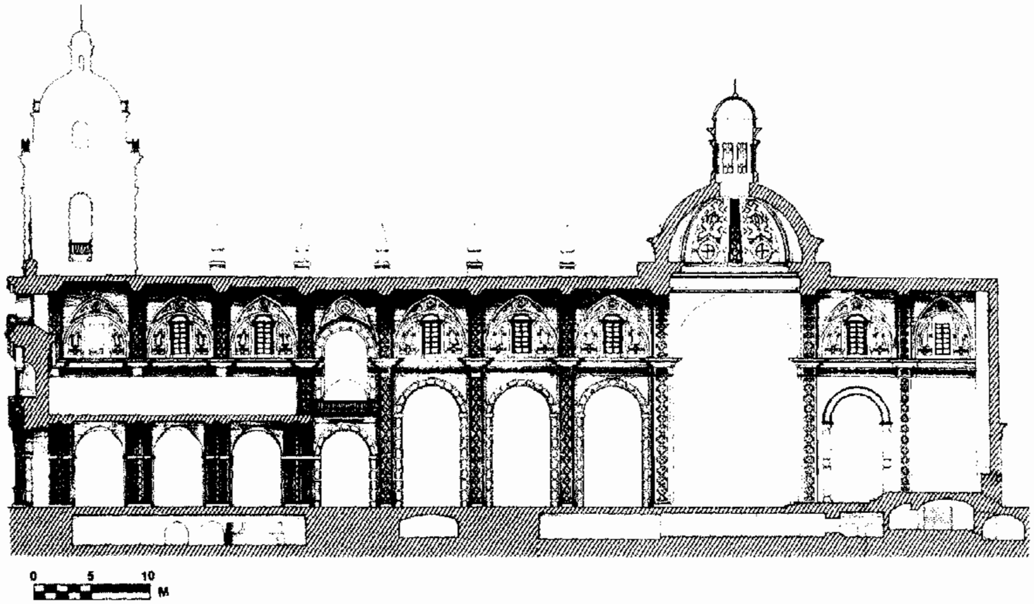


Figure 8
Lima: Church of San Francisco, longitudinal section (after H. Rodríguez-Camilloni and V. Pimentel Gurmendi)

of the intrados (excluding the lantern) dominates the interior space focusing attention on the transept and the apse with the main altar (Fig. 5). It is in itself a remarkable *quincha* structure, carefully designed with the earthquake problem in mind. The section drawing (Fig. 8) reveals it is actually a double-shell dome, with a different interior and exterior profile. Internally, the dome describes a perfect hemisphere supported on pendentives, whereas in the exterior the dome projects a massive though somewhat shallower shape resting on a cylindrical drum pierced with round windows. A greater stability was thus assured, since the exterior drum provides continuous buttressing at the critical points where the lateral thrust is most accentuated. The geometric vertical bands that cover the interior surface contributing to emphasize the effect of verticality, actually locate some of the internal wooden ribs; and small «dots» that form part of the geometric ornament are in fact pegs that help attach the stucco to the structural frame.

The design of the wooden structural frame of the dome may have been derived from the models in De L'Orme's treatise *Nouvelles Inventions pour bien bastir* (Paris, 1561), where a method of dome construction is described as follows:

> It is a very simple method, and of great use in domes, even of large diameter, the principle being that of making the several ribs in two or more thicknesses, which were cut to the curve in lengths not so great as to weaken the timber, and securing these well together by bolts or keys, and observing especially to break the joints of the several thicknesses.[15]

De L'Orme's detailed drawings (Fig. 9) also show how the wooden ribs had to be attached to the masonry structure. However, it would have still been necessary for Vasconcelos and Escobar to adapt this structural frame to *quincha* construction. And the success of the Franciscan model made the *quincha* dome the universally adopted solution throughout the Peruvian coast from the middle of the seventeenth century onwards. Other notable examples included the main dome of the church of Santo Domingo in Lima, rebuilt by the Dominican architect Fray Diego Maroto in 1678–81; the dome of the *camarín* of the

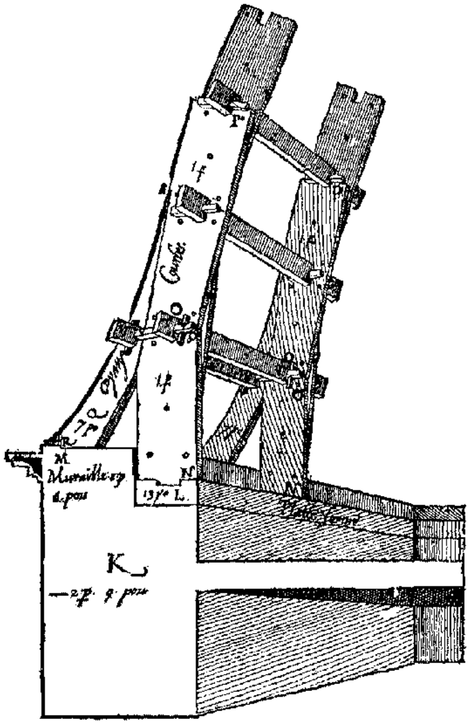


Figure 9
Philibert De L'Orme: Dome construction detail from *Nouvelles Inventions pour bien bastir* (Paris, 1561)

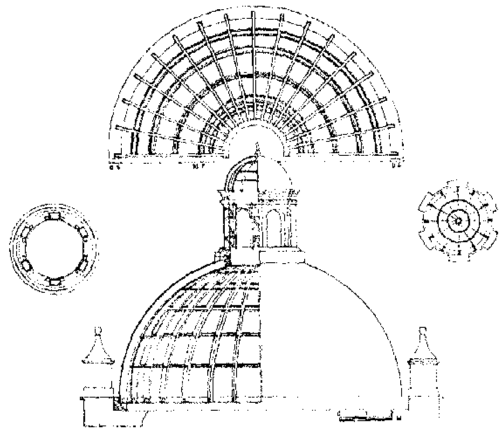


Figure 10
Trujillo, Peru: Church of San Francisco, rebuilt after 1619, analytical drawing of dome *quincha* construction for restoration project following earthquake of May 31, 1970 (after UNESCO-CRYRZA)

church of La Merced in Lima of 1774, a design attributed to the viceroy-architect don Manuel de Amat y Junyent (1704–1782); and the dome of the church of San Francisco in Trujillo, rebuilt after 1759 and badly damaged in the earthquake of 1970 (Fig. 10). Turning attention to the main cloister of San Francisco (Fig. 11), one of the glories of Spanish colonial architecture in Lima, yet another challenge that confronted architects since the beginning of the beginning of the seventeenth century can be examined. The problem here consisted in designing an earthquake-proof two-story elevation with open arches carried on piers or columns. According to the Augustinian chronicler Antonio de la Calancha, even iron tie bars had been tried in the principal cloister of San Agustín, but all in vain.[16] Repeated failures had shown the imprac- ticality of using stone or brick as a building material in the second story arcades, as had been done in the Franciscan cloister dating from c. 1629. But when the decision was made to rebuild the church of San Francisco in 1657, and it became necessary to rebuild the second story of the main cloister, a new design that has also been attributed to Vasconcelos was used. As a result, the newly developed system of *quincha* construction was adopted for this part of the monastery, accommodating the elegant design of round arches and oval openings which may have been inspired by Sebastiano Serlio (Fig. 14) and can still be seen today. Yet another contemporary engraving by Nolasco provides irrefutable evidence that this was the original design of the cloister as rebuilt during the seventeenth century.[17] The brick arches and corresponding brick and adobe peripheral walls of the ground level (Fig. 11), on the other hand, date from the 1620s, when Bernabé Cobo witnessed the construction of «a new cloister.»[18] Conclusive proof of this fact is afforded by the mural paintings that were discovered in 1974 above the revetments of Sevillian tiles (*azulejos*) that decorate the galleries.[19] These paintings, of exceptional artistic quality, appear to date from the beginning of the seventeenth century and almost certainly can be attributed to an Italian artist belonging to the circle of Bernado Bitti

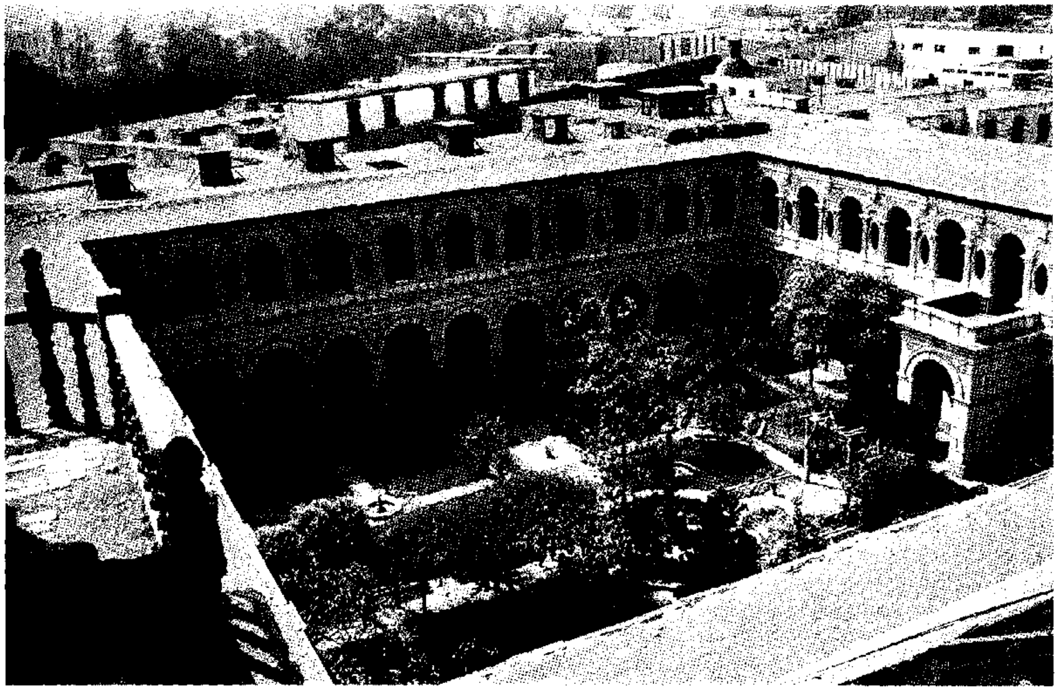
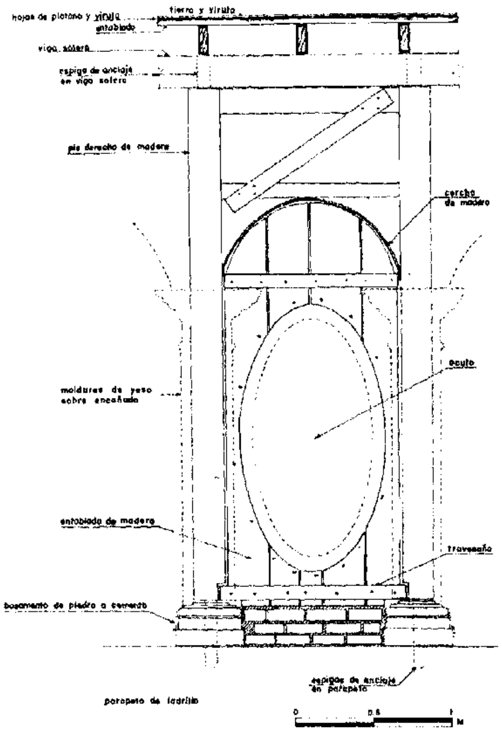


Figure 11
Lima: Main cloister of San Francisco, panoramic view (photo by Guillén)

(1548–1610), Mateo Pérez de Alesio (1540?–1632?) or Angelino Medoro (1565–1631?). The implications of this important discovery are also significant for the chronology of the church rebuilt by Vasconcelos, because it shows that the dimensions of the nave were already fixed by the pre-existing southern wall of the cloister which had to be incorporated in the new building (Fig. 4).

Thus the designers' major problem in the main cloister of San Francisco consisted in adding a second story that would achieve a satisfactory structural and stylistic integration. How this was done can be best illustrated with the help of analytical drawings (Figs. 12 and 13): On the outside, a light structure of wood, cane and plaster was effectively anchored in a brick parapet raised above the existing arcade; while the lateral bracing to the interior walls and roof consisted of wooden beams and joists. This solution provided a unified structural system which minimized the loading over the existing masonry structures with the desired flexibility. Furthermore, the adaptability of *quincha* construction to an intricate design with rich ornamentation in high relief was fully demonstrated.

Measurements taken of the *quincha* elements in the Franciscan cloister before and after the earthquake of 1974[20] permit a better appreciation of the structural behavior of the system. In most cases, the tendencies of deformation appear to have been accentuated because of the deterioration of materials across time and a general lack of maintenance, particularly during the twentieth century. The degree of deformation of the arcades, with a pronounced outward bulging in their center points, may also be seen in direct relationship to the rigidity provided by the structures surrounding the cloister. For example, the southern side corresponding to the church has experienced the least distortion. In contrast, the western side that has also suffered from high percentages of water infiltration affecting the stability of the foundations and structural piers, the vertical and horizontal



Fiura 12
Lima: Main cloister of San Francisco, analytical drawing of wooden framing of upper story arcades (after H. Rodríguez-Camilloni and V. Pimentel Gurmendi)

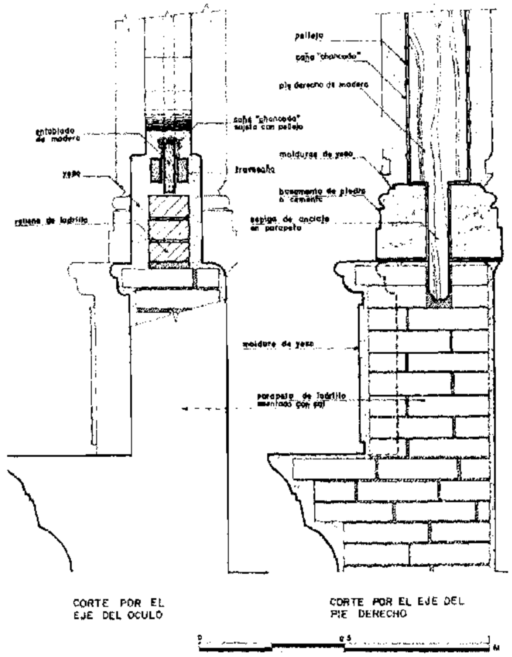


Figure 13
Lima: Main cloister of San Francisco, section drawing showing anchoring of *quincha* structure of upper story arcades (after H. Rodríguez-Camilloni and V. Pimentel Gurmendi)

deformation has been the most acute. Fortunately, a restoration project has been implemented in recent years to save the Franciscan cloister and protect it from future deterioration.[21]

The main cloister of San Francisco had a decisive influence on other Lima cloisters. The tripartite motif consisting of a semicircular arch flanked by two oval openings became a favorite model for other designs (Fig. 11). For example, it was used in the second story of the main cloister of Santo Domingo (Fig. 15) when it was rebuilt in 1678–81; and again in the «Cloister of the Doctors» of La Merced, completed around 1680. Recent research has revealed that Vasconcelos and Escobar also worked on the Mercedarian cloister between 1662 and 1668; and it is possible the work completed in the later date may have followed their original design.[22]

Indeed, the collaboration between Vasconcelos and Escobar may have extended back in time more than is known today; and it was certainly not restricted to the church of San Francisco and the Mercedarian cloister. On March 22, 1668, for instance, Escobar signed in Lima another contract to build the church and convent of the Amparadas de la Purísima Concepción (today Santa Rosa de las Monjas), «according to the plans made with the approval and consultation of don Constantino de Vasconcelos.»[23] The document makes it clear that the Portuguese architect had designed the building, and that Escobar had copied this design on paper in order to execute the work. Luckily this plan signed by Escobar has survived; and there can be no doubt that *quincha* construction was used here also, since the specifications indicate that the barrel vault of the church was to be made of oak frame, cane fill-in and stucco finish imitating masonry work («yeso,

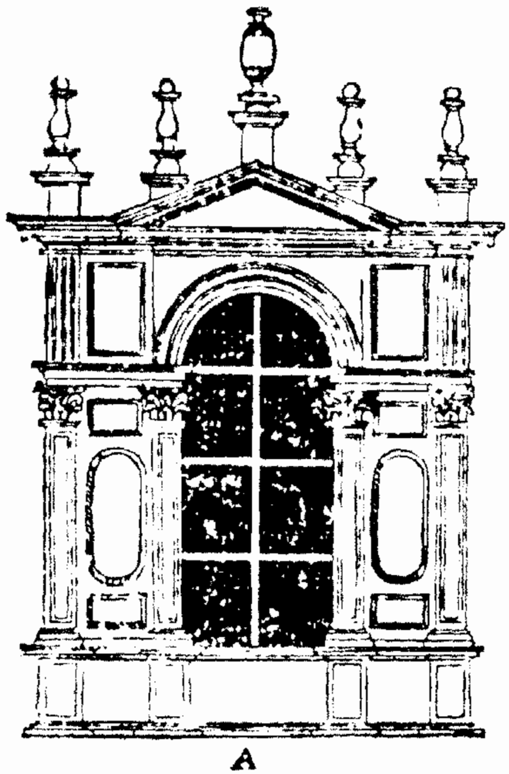


Figure 14
Sebastiano Serlio: Window design from *Libro VII*, «Delle finestre» (Vicenza, 1618)

cañas y cerchas de roble que parezca bóveda de albañilería»). When the church and convent of Sanat Rosa de las Monjas was built on this same site in 1704–08, the new buildings appear to have incorporated, at least in part, the original plan of 1668.

Constantino de Vasconcelos and Manuel de Escobar forever changed the course of the development of Spanish colonial architecture along the Peruvian coast as time would prove the efficacy of *quincha* construction against earthquakes. The fact is that following the severe earthquake of October 20, 1687, the viceroy Conde de la Monclova ordered that no more tall houses should be built in Lima with adobe and brick; and those that would be built were to use *quincha* construction (*telares de madera*), indicating that severe penalties would be applied to any architect or builder failing to obey this regulation.[24] Later in the eighteenth century, after the devastating earthquake of 1746 this prescription won the endorsement of the eminent French military engineer Louis Godin.[25] Throughout the nineteenth and early twentieth centuries, as many houses in downtown Lima still show, walls continued to be built with wooden frames and bamboo in-fill covered with a layer of mud with gypsum or cement. Over these walls, the typical roof included a layering of materials consisting of supporting wooden beams, wood sheathing, building paper, earth-fill, building paper again, and a final coat of gravel and asphalt. And even today, the use of «improved» *quincha* construction continues to be seriously promoted through popular self-help housing manuals distributed by the Peruvian government in collaboration with the international Intermediate Technology Development Group (ITDG).[26]

As the late architectural historian Harold E. Wethey pointed out in 1949, «the important new direction taken by seventeenth century architecture in Lima came with the rebuilding of the church and monastery of an Francisco . . . the decision to adopt imitation barrel vaults constructed of cane and plaster was decisive. This expediency solved the problem of the earthquake-ridden city, and thenceforth no attempt was made to employ heavier materials.»[27] Indeed, Vasconcelos and Escobar's antiseismic system of construction became so widespread during the eighteenth century, that even the Gothic ribbed vaults of the Cathedral of Lima were rebuilt with *quincha* after the great earthquake of 1746. No wonder the seventeenth century historian Fray Antonio de Lorea had once praised Vasconcelos for his «genius and exceptional virtue»;[28] while the viceroy don Melchor de Navarra y Rocaful recorded in his *Memoria de Gobierno* of 1687 that Escobar was «a first rank architect of this city, worthy of recognition among the best in Europe».[29]

Notes

1. In this regard, the following pioneer studies may be cited: Harold E. Wethey, *Colonial Architecture and Sculpture in Peru* (Cambridge, 1949) remained ambivalent about *quincha* construction (which he does not refer to by name), even though he recognized the importance of the church of San Francisco in Lima in

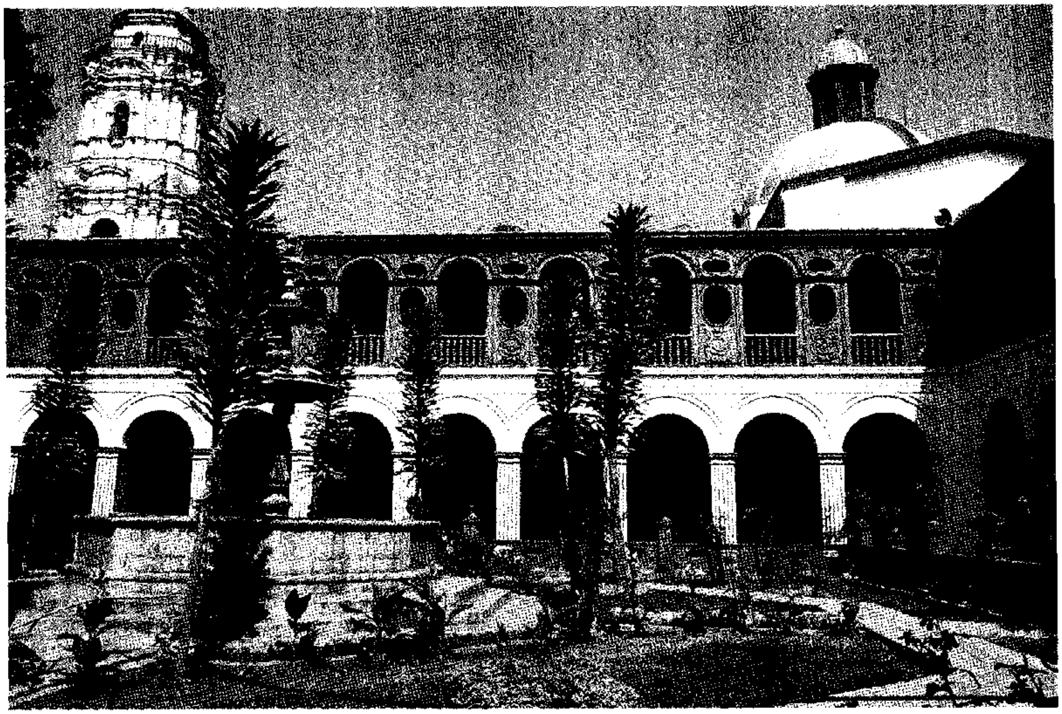


Figure 15
Lima: Main cloister of Santo Domingo, lower story, 1590–1594; second story arcades remodeled, 1678–81; and rebuilt in 1756

this context (see note 27 below). Lamenting the fact that Lima builders had not adopted as a standard solution to the earthquake problem the use of paneled wooden ceilings of Renaissance or *mudéjar* type, he stated: «Instead imitation barrel vaults of wood or of cane and plaster became the rule through out *limeño* churches from the mid-seventeenth century thereafter. Today every church in Lima has imitation vaulting and the effect is in most cases highly unsatisfactory» (p. 73). Pál Kelemen, *Baroque and Rococo In Latin America* (New York, 1951) limited himself to pointing out the «early specimens of cane and plaster vaulting» (p. 152) in the interior of the church of San Francisco in Lima. Brief but more specific references to *quincha* construction are found in Enrique Marco Dorta, *La Arquitectura Barroca en el Perú* (Madrid, 1957), p. 7: «En la costa . . . la necesidad de defenderse de los frecuentes terremotos, impuso las construcciones ligeras y elásticas, a base de estructuras de madera con muros de cerramiento de adobe o ladrillo, bóvedas y cúpulas de «quincha» – cañas y barro – y decoraciones de estuco que, a veces, imitan la fortaleza de la cantería;» and George Kubler and Martín Soria, *Art and Architecture in Spain and Portugal and their American Dominions 1500–1800* (Harmondsworth, 1959), p. 83: «On the arid Peruvian coast, the same menace [of earth quakes] was met at Lima by light and elastic construction of plastered reeds on wooden frames (*quincha*).»

2. Archivo del Cabildo Eclesiástico de Lima, *Obra de la Catedral*, I, «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» (1609–1615). In January of 1615 the *maestro mayor de la Catedral*, Juan Martínez de Arrona declared that Gothic ribbed vaulting should be used in the Cathedral because «[. . .] por la experiencia [los arquitectos] saben que la obra de crucería es la mejor, como se ve por el mucho tiempo que há que se hicieron la Capilla Mayor y crucero, con las demás capillas hornacinas del Convento del Sr. Santo Domingo, y haber pasado por ellas el temblor grande del año de [mil] quinientos y ochenta y seis, y los que más ha habido, sin recibir daño porque son de crucería.»

3. See Humberto Rodríguez-Camilloni, «Constantino de Vasconcelos» in *Encyclopedia of Latin American & Caribbean Art* (London, 2000), pp. 682–683. Abundant biographical information on Escobar may be found in Emilio Harth-Terré, *Artífices en el Virreinato del Perú* (Lima, 1945), pp. 199–222.
4. Recent archaeological work at Caral in the Supe river valley of the northern coast of Peru dating from 3000–1500 B.C. has revealed one of the earliest examples of *quincha* wall construction. Cf. Ruth Shady Solís, *et.al.*, *La Ciudad Sagrada de Caral-Supe* (Lima, 1999).
5. Bernabé Cobo, *Inca Religion and Customs*, English trans. by Roland Hamilton (Austin, 1990), pp. 190–191.
6. Cf. Volker Hartkopf, *Técnicas de construcción autóctonas del Perú* (Washington, D.C., 1985), p. 124.
7. Fray Miguel Suárez de Figueroa, *Templo de N. Grande Patriarca, San Francisco de la Provincia de los doze apóstoles de el Perú en la Ciudad de los Reyes arruinado, restaurado, y engrandecido de la providencia Divina,* published together with *Visita y declaración que hizo el P. Fray Juan de Benavides, ministro legal y honesta persona del Santo Tribunal de la Inquisición y sacristán mayor del Convento Grande de N.P.S. Francisco, en la residencia del Rmo. P.D. Luis Zerbela, padre perpetuo de la Provincia de Santiago, y de todas las del Perú, del tiempo que fue comisario general de ellas* (Lima, 1675), f. 4v.
8. Fray Miguel de Aguirre, *Población de Baldivia, Motivos, y medios para aquella fundación . . .* (Lima, 1647), ff. 35v.-36.
9. Archivo General de la Nación, Lima, Marcelo Antonio de Figueroa, Escribano Público, Prot. 631, Lima, 14 de junio de 1659, ff. 2300–2301v.
10. Suárez de Figueroa and Benavides, *op. cit.*, reproduced in Humberto Rodríguez-Camilloni, «El Conjunto Monumental de San Francisco de Lima en los Siglos XVII y XVIII,» *Boletín del Centro de Investigaciones Históricas y Estéticas*, Universidad Central de Venezuela, Facultad de Arquitectura y Urbanismo, No. 14 (Caracas, septiembre 1972), pp. 42–43.
11. Suárez de Figueroa, *op. cit.*, f. 12.
12. The majestic interior of San Francisco led the late Peruvian art historian Jorge Bernales Ballesteros, *Lima, la Ciudad y sus Monumentos* (Seville, 1972) to label the church the key example of «the great *limeño* Spanish colonial baroque [architecture].» However, it is important to note that all the significant spatial relationships of the interior are governed by classical proportions.
13. Humberto Rodríguez-Camilloni, «Forma y Espacio en la Arquitectura Religiosa de la Capital del Virreinato del Perú Durante los Siglos XVII y XVIII,» in *Arquitectura Colonial Iberoamericana*, E. Armitano, ed. (Caracas, 1997), pp. 287–318.
14. See in particular San Nicolás' drawing for the wooden frame of a cupola on an octagonal drum reproduced in George Kubler, *Arquitectura de los Siglos XVII y XVIII, Ars Hispaniae*, XIV (Madrid, 1957), Fig. 107, p. 78.
15. This is an excerpt of De L'Orme's text as summarized in English translation by Joseph Gwilt, *The Encyclopedia of Architecture* (London, 1867), p. 612. For the widespread use of De L'Orme's method of dome construction in North America during the late eighteenth and early nineteenth centuries, see Douglas Harnsberger, «In Delorme's Manner,» Association for Preservation Technology, *APT Bulletin*, XIII, No. 4 (1981), pp. 1–8.
16. Fray Antonio de la Calancha, *Chronica Moralizada del Orden de S. Agustin en el Peru*, I (Barcelona, 1638), p. 250.
17. This engraving is also reproduced in Rodríguez-Camilloni, «El Conjunto Monumental de San Francisco de Lima,» *op. cit.*, p. 42.
18. Bernabé Cobo, *Fundación de Lima* (1629) in *Obras del Padre Bernabé Cobo* II, *Biblioteca de Autores Españoles*, XCII (Madrid, 1964), p. 421.
19. Fully documented in Humberto Rodríguez-Camilloni and Víctor Pimentel Gurmendi, *Proyecto Integral para la Conservación-Restauración y Adecuación Museológica del Conjunto Monumental del Convento e Iglesia de San Francisco de Lima*, unpublished restoration project (Lima, 1975).
20. *Ibid.*
21. This work, completed in 1989, followed the specifications in Rodríguez-Camilloni and Pimentel Gurmendi, *op.cit.*
22. Cf. Antonio San Cristóbal, *Arquitectura virreynal religiosa de Lima* (Lima, 1988), pp. 316–319.
23. Archivo General de la Nación, Lima, Andrés Roncal Pimentel, Escribano Público, Prot. 1682, Lima, 22 de marzo de 1668, ff. 188–192v. A copy of the original ground floor plan signed by Manuel de Escobar is attached.
24. Archivo Histórico de la Municipalidad de Lima, *Libro I de cédulas y provisiones* (1568–1781), f. 101. The document in question corresponds to a proclamation by the viceroy Conde de la Monclova dated 1699.
25. Archivo General de Indias, Seville, Audiencia de Lima, leg. 511, «*Testimonio de los Autos Seguidos en el Supremo Gobierno del Perú, sobre la Reedificación de las Casas Altas Arruinadas en la Ciudad de Lima, con Ocasión del Terremoto Acaecido el Año de 1746.*»
26. Intermediate Technology Development Group, *Construyamos con Quincha Mejorada* (Lima, 1993).
27. Wethey, *op. cit.*, p. 17.
28. Fray Antonio de Lorea, *Santa Rosa. . . . Historia de su admirable vida y virtudes* (Madrid, 1671), f. 7.
29. Manuel A. Fuentes, ed., *Memorias de los Virreyes que han gobernado el Perú durante el tiempo del Coloniaje Español*, II (Lima, 1859), p. 372.