The construction of the medieval domes of the Basilica of St Anthony in Padua

Conference Paper

Author(s):
Diaz, Martina; Vandenabeele, Louis; Holzer, Stefan M.

Publication date:
2021

Permanent link:
https://doi.org/10.3929/ethz-b-000518488

Originally published in:
2, https://doi.org/10.1201/9781003173434

Funding acknowledgement:
185341 - The Basilica of Sant' Antonio at Padua - Deciphering the building history of a landmark pilgrimage church (SNF)

History of Construction Cultures – Mascarenhas-Mateus & Paula Pires (eds)

The construction of the medieval domes of the Basilica of St Anthony in Padua

M. Diaz, L. Vandenabeele & S.M. Holzer
Eidgenössische Technische Hochschule Zürich, Zurich, Switzerland

ABSTRACT: The Basilica of St Anthony in Padua, Italy, is one of the major pilgrimage landmarks of the 13th and 14th centuries. Its silhouette is dominated by no less than eight imposing domes composed of inner masonry shells surmounted by timber structures. In the scope of an ongoing research project, it has been established that the domes formed an integral part of the building plan from the very beginning. This paper aims at understanding the successive configurations of the timber structures and at providing a set of hypotheses about the original construction process. As archival material on the early building periods has been lost, the study is mainly based on onsite analyses, including dendrochronological dating.

1 INTRODUCTION

1.1 *Research scope*

The present study on the timber domes of the Basilica of St Anthony in Padua is part of a four-year research project on the Franciscan church, directed by professor Stefan M. Holzer (IDB, ETH Zurich) and funded by the Swiss National Science Foundation (SNSF). Historical sources date the beginning of the construction shortly after the death of St Anthony in 1231, but no documentation directly related to the 13th-century construction yard is preserved. Regarding the domes, the most ancient chronicle describing them was written by the Paduan author Giovanni da Nono in the first decades of the 14th century. The author describes seven domes from the inside (but ambiguously, only six from the outside): two on the nave, a conical "dome" on the crossing, two on the transept arms, one on the presbytery and one on the choir (Fabris 1977). The presence of these domes in the first half of the 14th century is also reflected by stone reliefs on two medieval tombs from 1329 and 1345. Furthermore, the ongoing analysis of the lower brick structures tends to confirm that the domes were included in the original project. This early planning of the domes makes their analysis and dating of primary importance to determine the erection sequence of the entire Basilica.

The closest model for St Anthony was likely the Basilica of St Mark in Venice, the five domes of which were topped by higher timber structures somewhere between the second quarter of the 13th century and the 1270s (Piana 2019). However, the medieval timber domes of St Mark's cannot be used for comparison since they were lost during a fire at the beginning of the 15th century (Piana 2019). As further discussed, the Basilica of St Anthony in Padua might thus exhibit the oldest preserved timber domes in Europe.

1.2 *State of the art*

In previous research, Lorenzoni (1981), Bresciani Alvarez (1981) and Salvatori (1981) hypothesized different timelines for the medieval worksite based on general observations and historic events. In later publications, the domes are imprecisely dated to a period spanning the second half of the 13th century and up to ca.1310, the year of a *magna et immensa mutatio* noted by archival sources and probably marking an enlargement of the Basilica (Ruzza 2016). Recently, Heinemann (2012) and Valenzano (2012) have highlighted that the domes were likely included in the original plan. However, the timber structures of St Anthony's have only been superficially described in literature (Briseghella 2012; Salvatori 1988, 1989). Their constructive features, original aspect and state of preservation have never been analysed in detail.

1.3 *Goals and methodology*

This study approaches its subject from different angles, such as the absolute dating of the domes, the identification of original elements still in place, the reconstruction of the original configuration and assumptions regarding their erection process. The methodology relies on a building archaeology approach, combining laser scanning and manual measurements. These onsite investigations have provided a precise survey of the structures (joints, repairs, transport marks, tool marks, etc.). Moreover, preliminary dendrochronological analyses have yielded the identification of original elements and later interventions.

This contribution aims at positioning the domes of St Anthony's in the panorama of medieval carpentry, hereby contributing to enhancing the limited base of knowledge about ancient timber domes. After a discussion about the current state of the domes following

DOI 10.1201/9781003173434-110

Table 1. Main dimensions of the domes

	Ø brick dome[1] [m]	H brick dome[2] [m]	H timber dome[3] [m]
d01	14.4	10.96	16.37
d02	14.46	11.09	16.09
d03	14.48	10.78	15.45
d04	14.3	10.92	34.96
d05	14.43	10.72	16.89
d06	13.95	10.36	19.01
d07	13.62	11.29	19.52
d08	14.3	6.47	11.84
min	13.62	6.47	11.84
max	14.48	11.29	34.96

[1] Internal diameter measured at the base of the brick dome.
[2] Height from the base to the upper side of the brick dome.
[3] Height from the base of the dome to the top of the roof.

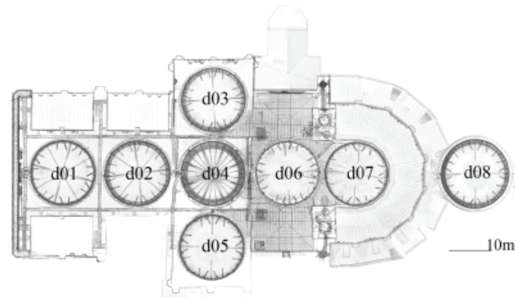

Figure 1. Plan of the domes: façade dome (d01), intermediate dome (d02), *arca* dome (d03), angel dome (d04), Chapel of St Jacob dome (d05), presbytery dome (d06), choir dome (d07), Chapel of the Relics dome (d08). D01, d02, d03 are supposed original. d04, d05, d06 and d07 suffered fire damage in 1749.

important interventions between the 16th and 19th centuries, this paper sheds light on their original configuration and a probable construction strategy. The results presented here pave the way for a finer understanding of these exceptional structures, which turn out to be unique in Europe.

2 THE DOMES OF THE BASILICA

2.1 *General description*

The imposing domes of the Basilica have dominated the skyline of Padua for centuries. On the western side, the nave is topped by two twin domes of very similar dimensions. Behind those, a truncated cone crowned by a 4-metre-high angel covers the crossing. This cone is flanked by two domes above the arms of the transept sheltering the Chapels of St Anthony and St Jacob. On the eastern part of the church, three additional domes were erected during later building phases. The dome of the presbytery was likely erected in the 14th century, while that of the choir dates back to the early 15th century and the last one was built in the 18th century over the Chapel of the Relics. Four of the eight domes were rebuilt after a fire in 1749, largely reproducing the previous layout. Consequently, only the façade dome, the intermediate dome and the *arca* dome above the Chapel of St Anthony still include 13th-century structural elements (Figure 1).

Each dome is composed of an internal masonry shell (32–43 cm) surmounted by a relatively lightweight timber structure covered by lead sheets. The main dimensions of these domes are presented in Table 1. These measurements highlight the similarities of the domes in the western part of the church (d01–d05).

Leaving aside the truncated cone of the angel dome (d04), each three-dimensional structure can be streamlined as two perpendicular frames, each composed of two diagonal struts, a short king-post and one or two collar-beams (Figure 2). In the original domes

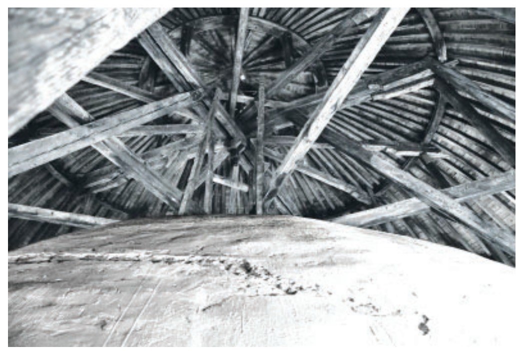

Figure 2. d02. Interior of the attic with the masonry vault and the wooden superstructure (photo: author).

(d01, d02, d03), lower collar-beams rest on top of the masonry vault, whereas this layer is absent in later structures. Intermediate struts placed at the base of the parapet support additional collar-beams, on top of which rest circular rings. These concentric rings are located on top of the parapet, at the levels of the collar-beams and close to the king-post. The slender ribs supporting the outer cover lie directly on these rings and run from the parapet to the king-post. All struts rest on short horizontal wooden supports at the level of the floor, separated from the lower masonry by a stone. The structural integrity of the timber domes mostly lies in the use of lap joints fastened by iron nails.

3 HISTORY OF REPAIRS

There is still no definitive explanation for the complete lack of original documentation related to the early building phases (Heinemann 2012; Ruzza 2016). The oldest available documents mentioning renovation works on the domes date back to the late 15th century and mostly report on their general state of conservation. Archival sources mention the supply of wood and lead for various roofing works and, in rare cases, the name of the domes concerned. Unfortunately, precise descriptions of the structures and of repair activities are missing for that period. Nevertheless, the study of archival documents related to repair campaigns permits the identification of three intense restoration periods: a first one in the mid-16th century, a second one following the fire in 1749, and a last one in the 1860s.

Mid-16th century reports attest to the decay of all seven domes (the eighth dome was only built 200 years later). Some documents reveal the presence of supervisors, carpenters and blacksmiths with Venetian background, sometimes also involved in works on the timber domes of the Abbey of Santa Giustina in Padua and St Mark's in Venice (Negri 1988; Sartori 1983). Lists of building materials include larch and lead bought on the Venetian market. A text even documents the remaking of the cover of the façade dome, including the wooden ribs and the rings. Despite the lack of any other clear descriptions, preliminary dendrochronological analyses carried out in the scope of this project have already confirmed that the secondary struts in the intermediate dome were replaced at that time.

From the beginning of the 18th century, various documents report on the poor condition of some superstructures. After the dreadful fire in 1749, reparations included the complete reconstruction of the burnt structures: the angel dome (d04), the dome of St Jacob (d05) and the domes above the presbytery and the choir (d06, d07) (Figure 3).

In the second half of the 19th century, under the Austrian government, interventions occurred in the domes above the nave (d01, d02), in the dome above the Chapel of St Anthony (d03), in the St Jacob dome (d05) and in the presbytery dome (d06). The reports mention the following tasks:

– replacement of the king-posts (d01, d02 d03, d05);
– partial renewal of the main structure (d03, d05);
– renewal of the first wooden ring (d01, d02, d03, d05, d06);
– partial replacement of ribs (d01, d02, d05);
– renewal of the external wooden boards and lead plates (in d01, d02, d03, d06);
– intervention on the masonry drums (d02, d03, d05, d06).

Carefully executed drawings show the interventions on d01, d02 and d06 (Figure 4). Moreover, the texts provide precise descriptions of the scaffoldings installed for the renovation campaign (Figure 5). The hosting of materials relied on a 30-metre-high lifting tower flanking the building. A system of pathways and platforms guaranteed the carriage and storage of materials on top of the pitched roofs. Cantilevered galleries installed in the existing putlog holes surrounded the drums, vaguely indicating what the medieval scaffoldings might have looked like.

These scattered sources leave many questions unanswered, but nevertheless provide crucial indications

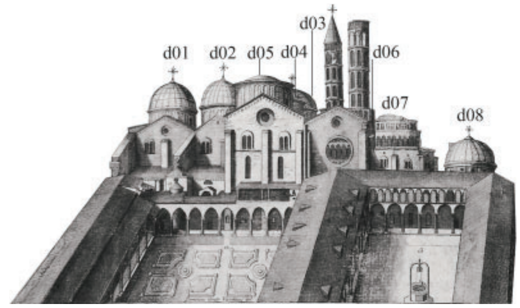

Figure 3. Depiction of the southern façade of the Basilica after the fire in 1749 with the loss of the wooden superstructures in d04, d05, d06 and d07. Based on an engraving by Cerato F. & Fossati G., 18th century (Civic Library of Padua RIP XXX/2603).

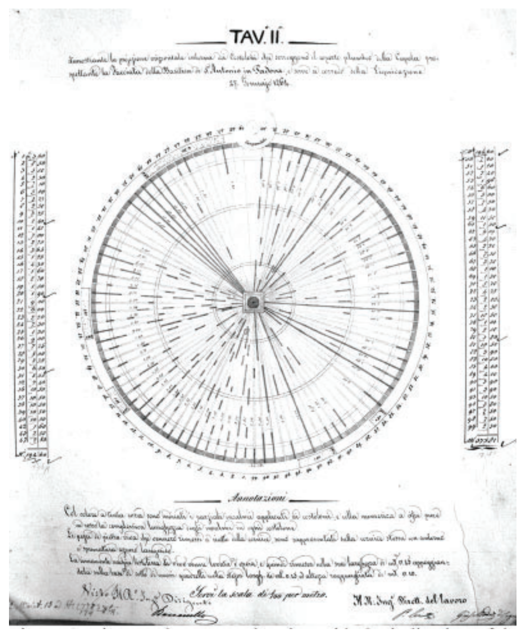

Figure 4. Nineteenth-century drawing with the indication of the ribs and king-post replacements in d01. (In the Archivio della Veneranda Arca di Sant' Antonio (ArA), fasc. 24.2068, all. 4: coloured plan G. Modaz 1864 gen. 27).

about the parts in which medieval timber could still be found.

4 DATING AND HYPOTHETICAL ORIGINAL CONFIGURATION

4.1 *Preliminary dendrochronological results*

Ongoing dendrochronological analyses aim at dating the elements through three successive sampling campaigns, in collaboration with the Laboratory Dendrodata in Verona. The dating focusses primarily on the earliest domes spared by the 1749 fire (d01, d02, d03),

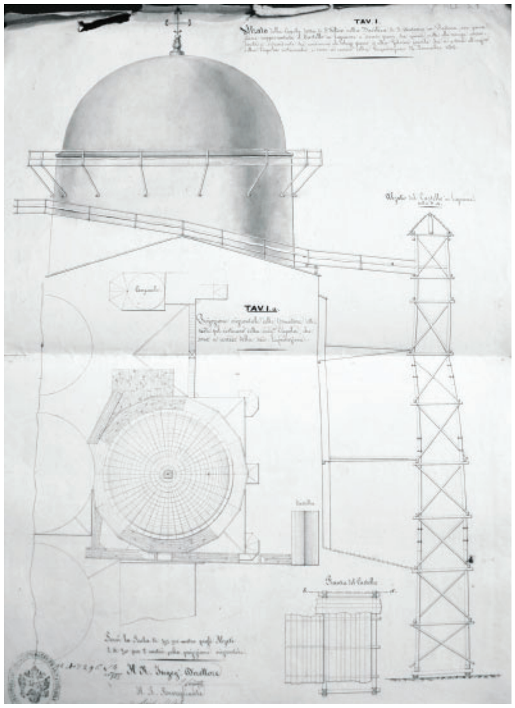

Figure 5. Nineteenth-century drawings of the lifting tower and pathways arrangement during the renovation in d05. (In ArA, fasc. 24.2069, all. 1: coloured plan G. Modaz 1864 Jan. 27).

prioritizing elements which do not show clear traces of later repairs (e.g. 18th-century shipping marks).

At this stage, the results from the first campaigns confirm the existence of beams dated back to the last quarter of the 13th century in the three considered to be the oldest domes. Due to the rare presence of bark on the elements, only two absolute datings have been obtained so far: 1282 in the dome over the Chapel of Saint Anthony (*arca* dome) (d03), and 1551 in the intermediate dome (d02). A *terminus ante quem non* has been identified for 11 other elements. As some 13th-century curves fit closely with each other, several timbers of the first construction phase could already be identified in the three surviving domes (d01, d02, d03). Two other results have confirmed the replacement of entire domes around 1750 (Pignatelli 2020). These dates thus match with the first building phase in the 13th century, with 16th-century interventions mentioned in archival documents and with the reconstruction after the fire of 1749 (Figure 6).

4.2 *Hypothetical original configuration*

In the most ancient domes (d01, d02, d03), notches are visible on the lower extremities of some collar-beams, at both levels (Figure 7). Since such notches are missing in the domes reconstructed later, their presence seems to identify original elements. In some occasions, these notches cover the whole width of the beam, whereas in other places they are positioned only on one side. In a few instances, holes from iron nails are visible on these beams in the immediate proximity of the notches. The presence of these empty joints could fit with a previous brace tightening the connection between struts and collar-beams (Figure 8b). The lack of traces on the outer struts tends to indicate their replacement in the 16th century, which is also confirmed by preliminary dendrochronological results as discussed in the previous paragraph. This kind of arrangement would align with typical solutions recurring in medieval timber frames, the stiffness of which was often insured by such short braces between inclined struts and collar-beams. However, the main struts running to the king-post are likely untouched as they are inserted between two original collars with lap joints.

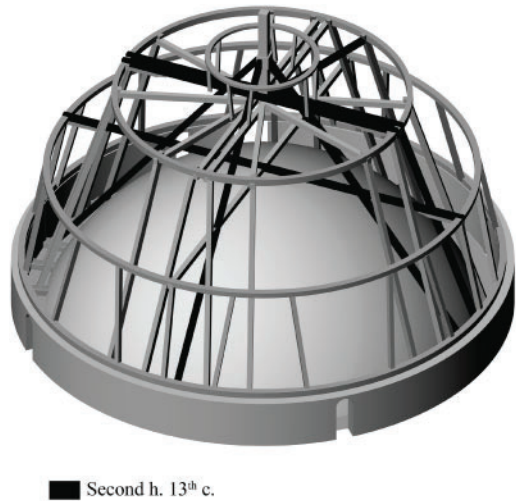

Figure 6. 3D model. Schematic identification of the dated elements during the dendro-analyses campaigns in d03. The black elements are original (3D model: author).

Figure 7. d02: notch visible on the bottom side of a collar-beam (photo: author).

In the domes above the nave (d01, d02), the upper collar-beams present an empty mortise on their upper

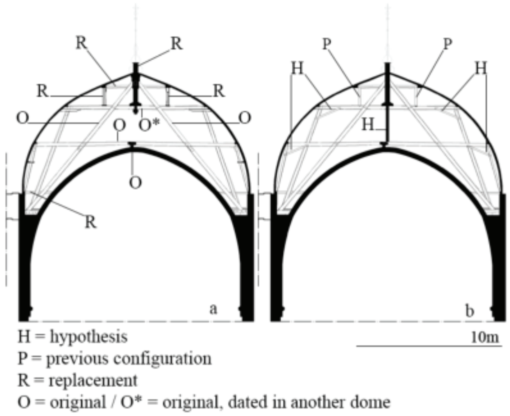

Figure 8. d02. Cross section: a) current state, b) hypothesis on the original layout (drawing: author).

Figure 9. d02: topside of the upper collar-beam with the empty joint for the previous brace position (photo: author).

face (Figure 9). This provides evidence of the installation of previous – likely vertical – posts supporting the highest ring, another hint about the early appearance of the roofs.

Eventually, 19th-century replacements mentioned in archives are clearly discernible on site. For instance, single ribs were partly replaced with double-layer elements in the façade dome. The replaced wooden boards of the cover are recognizable by similar shipping marks. The newer king-posts stop at the level of the upper collars and are encased by thick wooden boards (d01, d02, d03, d05). Cross sections of the Basilica published by Gonzati (1852) seem to suggest that the original king-posts were significantly longer. The scale of the drawing is too small to determine whether they rested directly on the beams or not. However, no clear traces of a previous connection with a post have been recorded on the collar-beams, suggesting that if the king-post was indeed longer, it simply rested on top of these beams.

At this stage, a hypothetical original configuration can thus be proposed. Collar-beams featuring

Figure 10. d01, wooden base of a strut placed between the masonry vault and the drum (photo: author).

Figure 11. d01: lower collar-beam leaning on the vault's extrados (photo: author).

notches have been confirmed as belonging to the earliest period, as well as the four main struts which were connected to a previously longer king-post. Moreover, it is likely that the outer struts supporting the end of the collars, later replaced in the 16th century, share the same position as their predecessors.

4.3 *Preliminary masonry work*

Based on onsite observations, it is possible to assume that the masonry dome was already in place when the timber structures were erected.

Firstly, the bases of the timber struts rest above the start of the dome, showing that the vaulting was at least started when the carpenters set to work. Furthermore, the timber is never embedded in the masonry but completely independent, although it is likely that the short bases are not original but have been substituted due to decay, probably in the 16th century when some struts were replaced (Figure 10).

Secondly, the lower collar-beams of the oldest domes rest directly on the vault and do not show any deflection at the centre, which tends to indicate that the vault was there before. Also, the masonry is perfectly smooth at this point. If the timber was there before, it would have been difficult to make a regular finishing at the top of the vault (Figure 11).

Eventually, considering the network of galleries connecting all the attics, it is discernible that those were part of a unitary project from the very beginning.

Hence, the dating of the wooden frames determines a *terminus ante quem* for the masonry domes in the last quarter of the 13th century.

5 MEDIEVAL CONSTRUCTION PROCESS

5.1 *Hypothetical construction sequence*

As the time span between the construction of the brick dome and timber structure is still unclear, one cannot exclude that provisional coverings protected the extradoses until the completion of the roofs. The successive construction steps might have followed this logical sequence (Figure 12):

1. erection of the principal bearing system composed of four main struts attached to the king-post;
2. triangulation with horizontal collar-beams supported by secondary struts and posts (likely from the bottom up);
3. outer skeleton and roof cover.

The first stage would have consisted in the establishment of the four main struts and the king-post, forming a stable base on which to develop the whole frame. These struts, inclined at an angle of 50 degrees, could have been temporarily maintained in position by means of gin poles until they were connected with the king-post. At that time, the king-post might have been longer. Wooden steps nailed on the main struts might have facilitated the access to higher altitudes to nail the joints, as demonstrated by those still in place (although they were likely replaced) (Figure 12b–c).

The next step would have consisted in the establishment of a first level of collar-beams just above the brick dome. These two orthogonal collar-beams placed on top of each other and attached to the struts with lap joints contributed to strengthening the two main frames (Figure 12d–f).

In the above-mentioned historical cross section dated to the mid-18th century, the length of the king-post reaches this level of lower collars in d01 (Gonzati 1852). One can suppose that it rested on the vault until the positioning of the first horizontal beam. Then it would have been shortened to place the transversal beam.

The secondary spokes are connected with nails to the main collar-beams at the centre of the dome. They exhibit a hole at this end, which indicates that they were lifted or dragged with ropes. At this stage, the minor struts were installed on the first ring above the parapet. Furthermore, all joints between struts and collars would have been reinforced by short braces, which would match with the observed empty notches. This first level could have enabled the installation of temporary working floors facilitating the construction of the upper levels (Figure 12g–i).

The stabilization of the two triangles would then have been further improved with the upper level of doubled collar-beams. These beams are attached on both sides of the king-post and the struts with lap joints and nails (Figure 13).

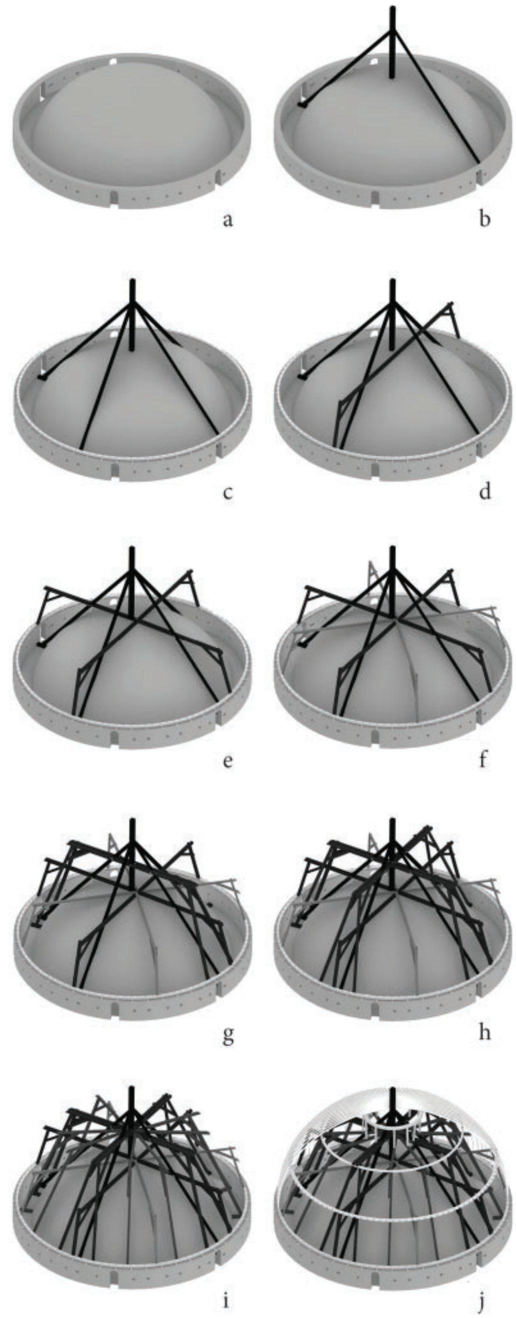

Figure 12. Construction sequence hypothesis. a) Preliminary stage with the masonry vault; b–c) placement of the main struts and king-post; d–f) placement of the lower collar-beams, resting on minor posts; g–i) placement of the upper collar-beams supported by lateral struts; j) placement of the rings and ribs (3D model: author).

Then, the outer couples of struts could have been placed to support the ends of the upper collar-beams, similarly to the current solution. It is likely that the

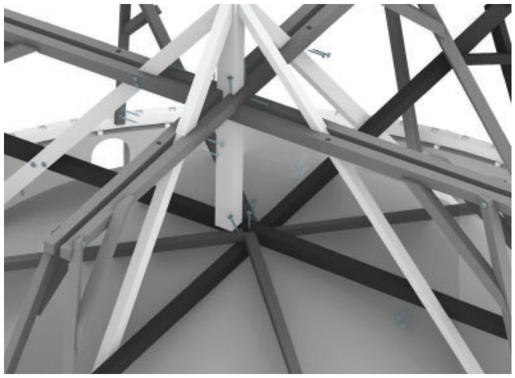

Figure 13. Nailed connections of the collar-beams with the struts and king-post (3D model: author).

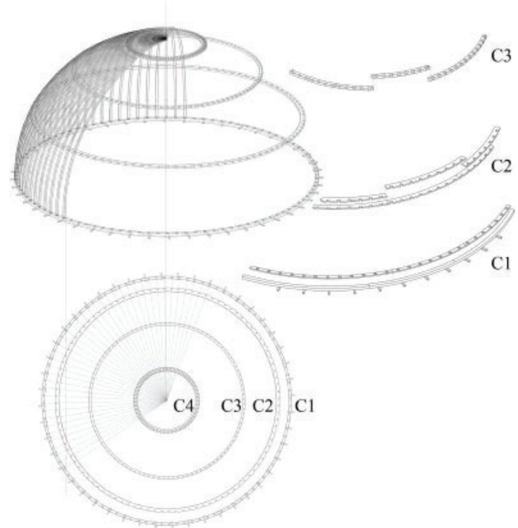

Figure 14. d02. Preassembly of the wooden rings on horizontal level. Detail of the board arrangement. C1 19th century replacement; C2 undated replacement; C3 supposed older single layer configuration (drawing: author).

following operation would have included the addition of the upper spokes by lifting these horizontal components and putting the last external struts in place.

The final stage would firstly consist of the placement of the wooden rings on the ends of the collar-beams, fixed with nails. The joints between the curved sections were likely shaped on the ground during a preliminary preassembly. Then, circular sectors of planks could have been lifted and reassembled on the collar-beams. Eventually, the last ring was placed after the installation of short vertical posts into the mortices, on the top side of the upper collar-beams (Figures 12j and 14).

Interestingly, in the second dome of the nave (d02), the third ring was seemingly not replaced in the 19th century. Unlike the more recent ones that are composed of two or three layers of nailed boards connected to the ribs with iron strips, it is a one-layer chain. The ribs are clamped in notches around its external profile following the probable original spacing.

Likewise, the settlement of the ribs included a preassembly on a horizontal level to join the segments, and their placement to match up with the notches shaped on the rings.

The construction process was concluded with the covering by an external shell. The internal wooden boards were nailed to the ribs and external lead plates were fixed on those. This external lead cover, replaced several times, assured the protection of the whole system during centuries and the exceptional preservation of 13th-century elements.

5.2 *Lifting techniques*

Despite the lack of documentation, historical depictions and descriptions can contribute to understanding ancient strategies to erect timber roofs. Furthermore, medieval scaffoldings and hoisting devices changed little over time, at least until the early modern period (Holzer 2021).

Because pre-existing putlog holes were obviously reused to secure the 19th-century provisional structures, the above depictions might give an approximate idea of the original scaffoldings in place at the end of the 13th century, when the timber domes were erected on top of the masonry shells. Machines could have been installed on top of the masonries to lift and hoist the long timbers. Windlasses are documented from the beginning of the 13th century in Western Europe (Backinsell 1980; Matthies 1992). However, despite possible speculation about the machinery used, and given the lightness of the structures, the use of simple pulley systems is not unlikely.

The complexity of the round masonries and their height from the ground would not have made the carpenters' task any easier. The lifting of timbers above the brick dome would have required devices installed on the parapet or on external platforms and maintained by ropes attached to the masonry. A first lifting device might have brought the wood up on top of the aisle's roof. A second one, resting on the drum of the dome, enabled the lifting of timbers above the parapet. The four apertures aligned with the floor of each attic likely eased the passage between the inner space and the external temporary floors. Workers could also safely reach the attics through the network of internal corridors of the church.

Unlike in most timber works, carpenters did not use assembly marks in the domes of the Basilica. This can be explained by the simplicity of the assembly relying mostly on lap joints. Connections were likely shaped on a case-by-case basis during the erection phases. Hence, this simplicity and the widespread use of iron nails might have resulted in the interchangeability of timbers, eliminating the need for marks.

6 CONCLUSION

The preliminary dendrochronological analyses confirm the presence of original elements still in place in three domes of the Basilica of St Anthony, making them the likely oldest preserved timber domes in Europe. Moreover, these results could be related to the various interventions on the domes cited in archival reports.

When brought into an overall perspective, the data gathered provides a comprehensive understanding of the original timber layout and the assembly sequence of the structural components. Despite later interventions, the preservation of the original scheme confirms the continuity of the same modus operandi between the 13th and the 18th centuries, hence shedding light on a particular niche in construction history.

ACKNOWLEDGEMENTS

The authors thank the *Veneranda Arca di Sant'Antonio* and the *Archivio della Veneranda Arca di Sant'Antonio* for their support.

REFERENCES

Backinsell, W. G. C. 1980. Mediaeval windlasses at Salisbury, Peterborough and Tewkesbury. *South Wiltshire Industrial Archaeology Society* 7.

Bresciani Alvarez, G. 1981. La Basilica del Santo nei restauri e ampliamenti dal Quattrocento al tardo-Barocco, Il Quattrocento. In Lorenzoni, G. (ed.), *L'edificio del Santo di Padova*: 83–110. Vicenza: Neri Pozza.

Brisighella, L. 2012. Sistemi costruttivi medievali a Padova. In Baggio L. & Bertazzo L. (eds.), *Padova 1310: percorsi nei cantieri architettonici e pittorici della Basilica di Sant'Antonio in Padova*: 220–223. Padua: Centro Studi Antoniani.

Czarnowski, C. 1949. Engins de levage dans les combles d'église en Alsace. *Cahiers techniques de l'art* 2: 11–27.

Fabris, G. 1977. *Cronache e cronisti padovani*. Cittadella: Rebellato Editore.

Gonzati, B. 1852. *La Basilica di S. Antonio di Padova descritta ed illustrata*. Padua: Tipi di Antonio Bianchi.

Heinemann, B. 2012. *Der Santo in Padua. Raum städtischer, privater und ordenspolitischer Inszenierung*. Bonn: Rheinischen Freiderich-Willhelms-Universität.

Holzer, S. M. 2021. *Geheimnisse der Bautechnikgeschichte – Gerüste und Hilfskonstruktionen im historischen Baubetrieb*. Berlin: Ernst & Sohn.

Lorenzoni, G. 1981. Cenni per una storia della fondazione della Basilica alla luce dei documenti (con ipotesi interpretative). In Lorenzoni, G. (ed.), *L'edificio del Santo di Padova*: 17–30. Vicenza: Neri Pozza.

Matthies, A. L. 1992. Medieval Treadwheels: Artists' Views of Building Construction. *Technology and Culture* 33(3): 510–547.

Mazzi, G. 1981. Il Santo come costante nell'iconografia urbana di Padova. In Gorini, G. (ed.) *S. Antonio 12315–1981 il suo tempo il suo culto e la sua città*: 396–397. Padova: Signum.

Negri, D. 1988. La cupola sul coro della Basilica del Santo. *Il Santo* 28: 235–244.

Piana, M. 2019. Le sovracupole lignee di San Marco, dalle origini alla caduta della repubblica. In E. Vio (ed.), *La Basilica di Venezia. San Marco. Arte Storia Conservazione* 2: 189–199. Venice: Marsilio.

Pignatelli, O. 2020. *Indagini dendrocronologiche sulle strutture lignee delle cupole della Basilica del Santo a Padova*. Unpublished report.

Ruzza, S. 2016. *La Basilica di Sant'Antonio. Itinerario artistico e religioso*. Padua: Centro Studi Antoniani.

Salvatori, M. 1981. Costruzione della Basilica dall'origine al secolo XIV. In Lorenzoni G. (ed.), *L'edificio del Santo di Padova*: 3–81. Vicenza: Neri Pozza.

Salvatori, M. 1988. The Wooden Superstructures of the Domes of the St. Anthony's Basilica in Padua. In International Association for Shell and Spatial Structures, *Domes from Antiquity to the present:* 227–232. Istanbul: Mimar Sinan Üniversitesi.

Salvatori, M. 1989. Strutture, vicende e restauri delle calotte lignee soprastanti le otto cupole in muratura della basilica di S. Antonio di Padova. In Tampone, G. (ed.) *Il restauro del legno*: 57–61. Florence: Nardini Editore.

Sartori, A. 1983. Basilica e Convento del Santo. In Luisetto, G. (ed.), *Archivio Sartori. Documenti di storia e arte francescana* 1: 109–123. Padua: Centro Studi Antoniani.

Tyghem van F. 1966. Op en om de middeleeuwse bouwwerf. In *Verhandelingen van de Koninklijke Vlaamse Academie voor Wetenschappen, Letteren, en Schone Kunsten van België. Klasse der Schone Kunsten*: 213–229.

Valenzano, G. 2012. Il cantiere architettonico del Santo nel 1310. In Baggio, L. & Bertazzo, L. (eds.), *Padova 1310. Percorsi nei cantieri architettonici e pittorici della Basilica di Sant'Antonio in Padova*: 65–78. Padua: Centro Studi Antoniani.