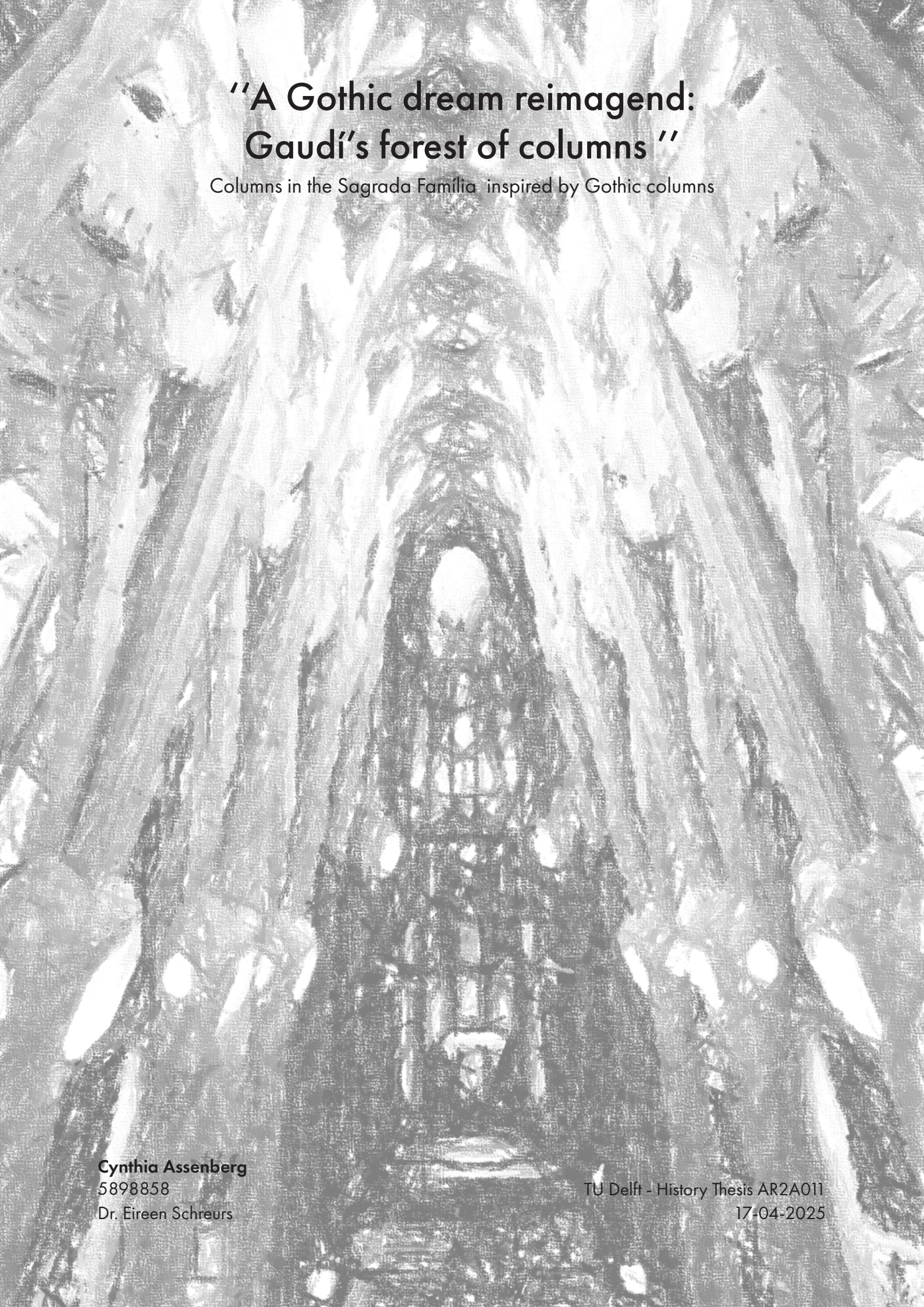


''A Gothic dream reimagend: Gaudí's forest of columns ''

Columns in the Sagrada Família inspired by Gothic columns

Cynthia Assenberg
5898858
Dr. Eireen Schreurs

TU Delft - History Thesis AR2A011
17-04-2025

ABSTRACT

Key words: Columns, Gothic architecture, Antoni Gaudí, Sagrada Família, Evolutionary

Existing studies often classify Gaudí as a modernist, this may stem from his deliberate departure from the traditional Gothic forms. This research offers a new contribution using the columns in the Sagrada Família to prove how Gaudí took inspiration from Gothic columns and thus how he relates to Gothic architectural history. While the columns are admired for their striking fusion of structure and aesthetics, their precise relationship to the Gothic tradition remains underexplored. This thesis investigates how Gothic columns inspired Gaudí's design, raising the question: 'How have the columns in the crossing of the Sagrada Família been inspired by Gothic columns in terms of structural techniques, building process and aesthetics?'

The thesis starts with secondary research into literature on Gothic architecture, Gaudi's techniques and historian's interpretations. It then moves to primary research on archival drawings, models and documentation from Barcelona, which may help to reveal hidden structural similarities or differences. Redrawing and modelling archival designs, will provide a case study with insights and makes it possible to visually compare key elements, from the Barcelona and Mallorca Cathedral with the Sagrada Família.

Gaudí's columns are influenced by the gothic column on the building process and aesthetic design and partly in the structural techniques. The building process is very similar in many ways, for example the long building period and the many architects that are involved. The aesthetic of Gaudí's column is very different, because of the structural innovations, than that of the Gothic column. Nonetheless, the aesthetic principles are remarkably similar, for example building the spiritual expressiveness. Gaudí was influenced by nature and geometry and used that to perfect the structural technique and aesthetic design principles. Gaudí is, as far as is known, the only one who used these revolutionary principles. Future research could explore how Gaudí's column design principles might be adapted and applied to contemporary architectural structures.

CONTENT

INTRODUCTION

Sagrada Família's columns inspired by Gothic columns?

'Gothic architecture is imperfect, it is half resolved, it is the style of the compass, of the formula, of the industrial repetition. Its stability is based on the permanent propping of the flying buttresses, it is a defective body that is supported by crutches.' – Antoni Gaudí.[1]

Gaudí,1852-1926, designed the columns in the Sagrada Família with innovative use of biomimicry and geometric modelling.[2] Deliberately departing from traditional Gothic forms, has led existing studies to classify Gaudí as modernist, yet this classification remains debated. Architect and researcher Jan Molema challenges the categorization of Gaudí's work, stating:

> *'Muslim-Hispanic, gothic style, Baroque, cubism, expressionism, naturalism, and evocation of the doric style. Above all stylistic categories there is, moreover , the .classification as a Modernist. Gaudí's work cannot be classified in this way, and we should add the fact that the categories used for the classification have not been interpreted in a proper way; they have either been used in an incomplete way or they cannot be used at all.'* [3]

Irénée Scalbert adds that Gaudí did indeed pay attention to Gothic architecture.

> *'Modern architects paid little attention to gothic architecture, beyond the occasional allusion to its structural prowess'. ... 'Bar one or two eccentrics such as Gaudi, gothic has had little or no impact on the architecture of the last Century.'* [4]

Additional to Molema and Scalbert I believe Gaudí could not have made the columns in the Sagrada Familia without the Gothic Style. I intend to use the columns in the Sagrada Família, as a case study, to prove how Gaudí took inspiration from Gothic columns and thus how he relates to Gothic architectural history. While the columns are admired for their striking fusion of structure and aesthetics, their precise relationship to the Gothic tradition remains underexplored and unproven. The claim by Molema that Gaudí's columns are ''Too complicated to understand'' underscores the need for a deeper understanding.[5] This research therefore offers a new contribution to the architectural history by evaluating whether Gothic design principles persist in Gaudí's innovative columns.

This thesis investigates the extent to which the columns in the crossing of the Sagrada Família have been inspired by Gothic architecture by raising the following question:

> **'How have the columns in the crossing of the Sagrada Família been inspired by Gothic columns in terms of structural techniques, building process and aesthetics?'**

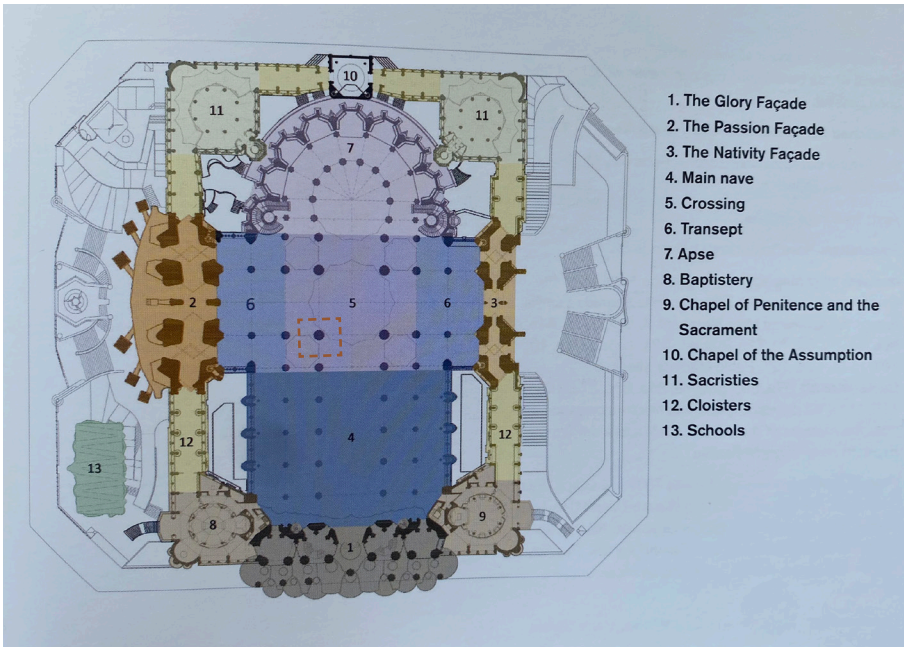
The thesis starts with secondary research into literature on Gothic architecture, 1200-1600, Gaudi's techniques,1883-1993, and historian's interpretations. This is followed by primary research on archival drawings, models and documentation from Barcelona, which may help to reveal hidden structural similarities or differences. Also adding a detailed analysis of their geometric patterns, proportions, and load bearing strategies. Visiting Barcelona to analyse the Sagrada Familia first hand, including redrawing and modelling archival designs, will provide a case study with deeper structural and aesthetic insights. By redrawing the archival designs, it is possible to visually compare key elements and trace how they have evolved over time.

1 Fuentes, The Art of Vaulting, 189
2 Information booklets, 2.
3 Molema, Gaudi the construction of dreams, 22-23.
4 Scalbert, A real living contact with the things themselves, 12-13.
5 Molema, interview.

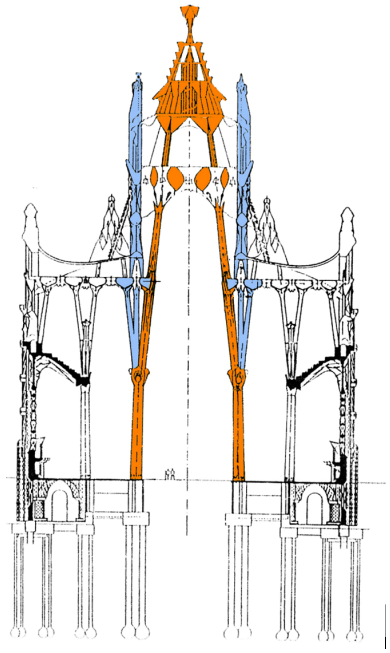
The arguments are structured following the three key aspects: structural techniques, building processes, and aesthetic design. First, it explores the structural innovations in Gaudí's columns, with particular attention to biomimicry and geometric modelling. Second, it compares the building processes of the Sagrada Família and Gothic cathedrals, including important timestamps and the roles of architects. Finally, it examines the aesthetic design of the columns, identifying points of continuity and divergence from the Gothic tradition. By doing so, this study aims to determine to what extent Gaudí's columns are a continuation, transformation, or departure from its Gothic predecessors. Finally, the argument concludes by considering how Gothic architecture shaped Gaudí's columns.

THE COLUMNS

The Sagrada Família features a complex system of columns, particularly in its central crossing, where three distinct types can be identified: the four red central columns that support the highest tower, the surrounding blue columns, and the white columns throughout the crossing. Each group differs in height, diameter, and geometric composition. In the following chapters the focus is on the red columns, because of their central role in the support system and due to their architectural and structural significance within the overall design.



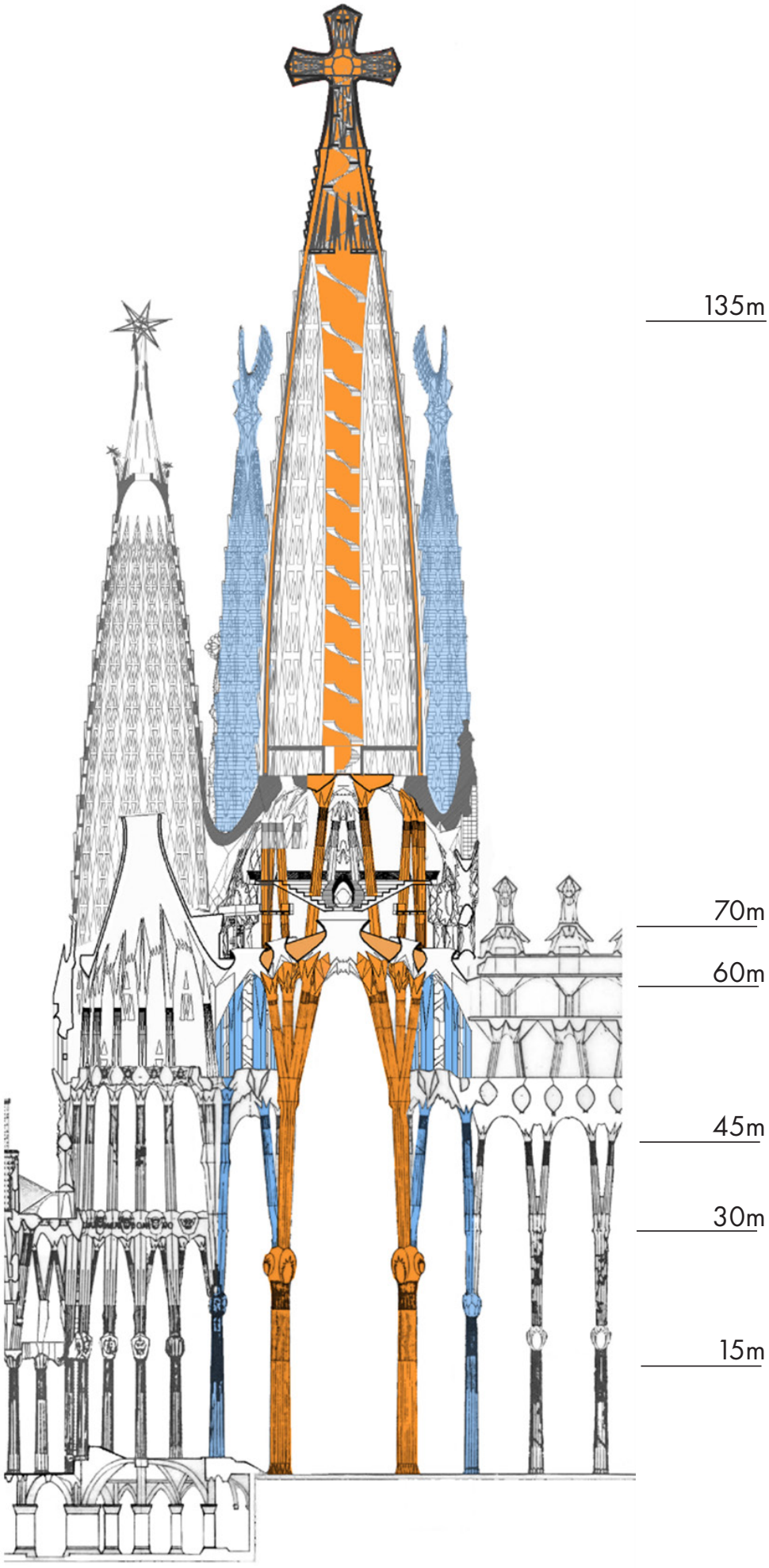
[01] Red column in the crossing supporting the main tower.



[02] The 20-meter foundation

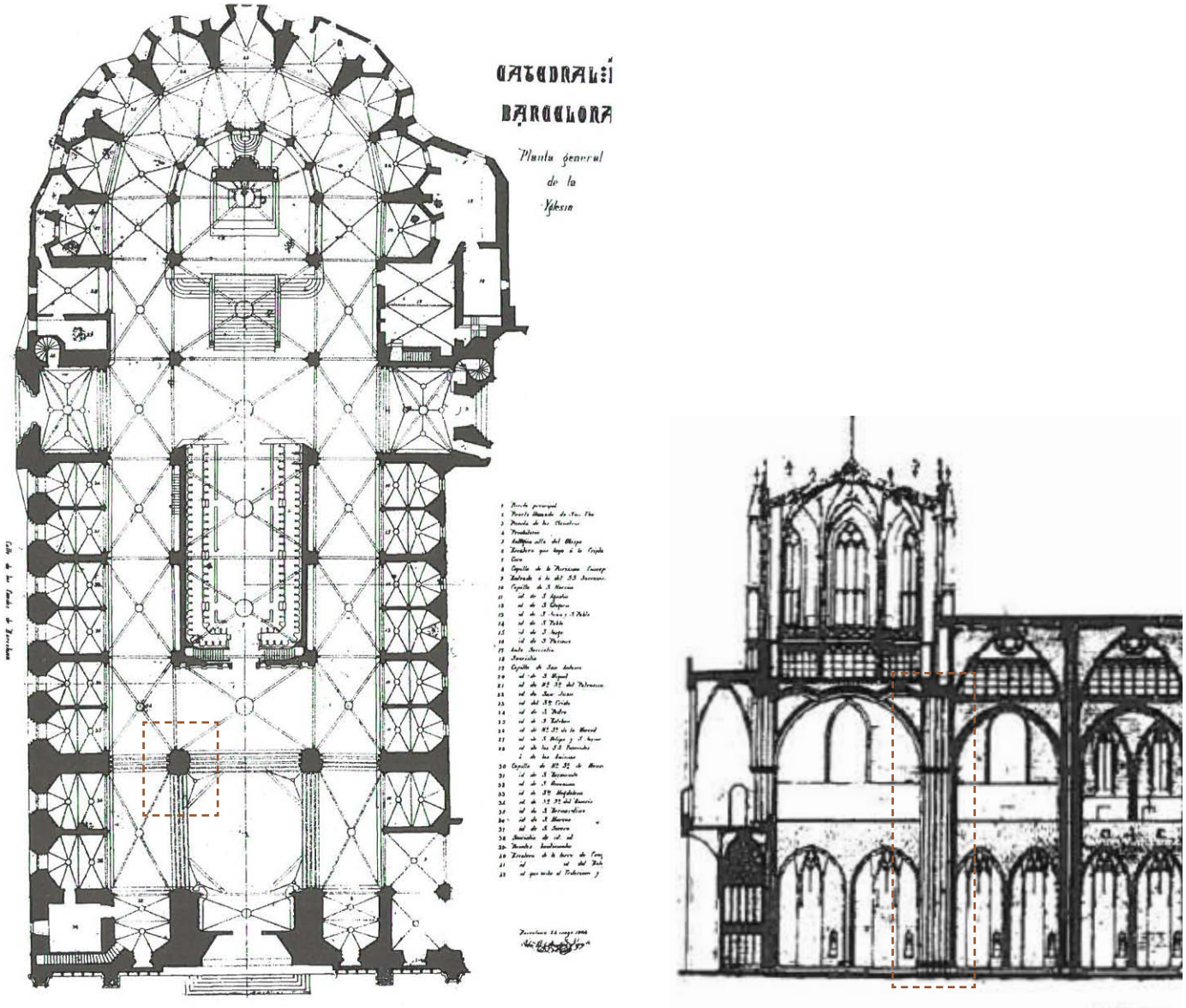
These red columns, in the crossing, supports the main tower. In the cross-sections, for instance, one can observe how loads from different towers—distinguished by the colours blue and orange in the diagram [6] — are transferred into the column and then directed downwards into foundations that reach approximately 20 meters deep. This is one-third of the total height of the columns, which rise to about 60 meters.

06 Faulí, interview.



[03] A longitudinal section that shows the forces of the towers that transfer to the columns in the crossing

To investigate how these columns relate to Gothic traditions, a comparative analysis is conducted with Gothic columns from cathedrals. The selected Gothic column in the cathedrals supports a central structural element, such as a spire or cimborio, making it similair in both structural function to the red column of the Sagrada Família.



[04] 1864 plans and longitudinal section of the Barcelona Cathedral (Pere loca,1998)

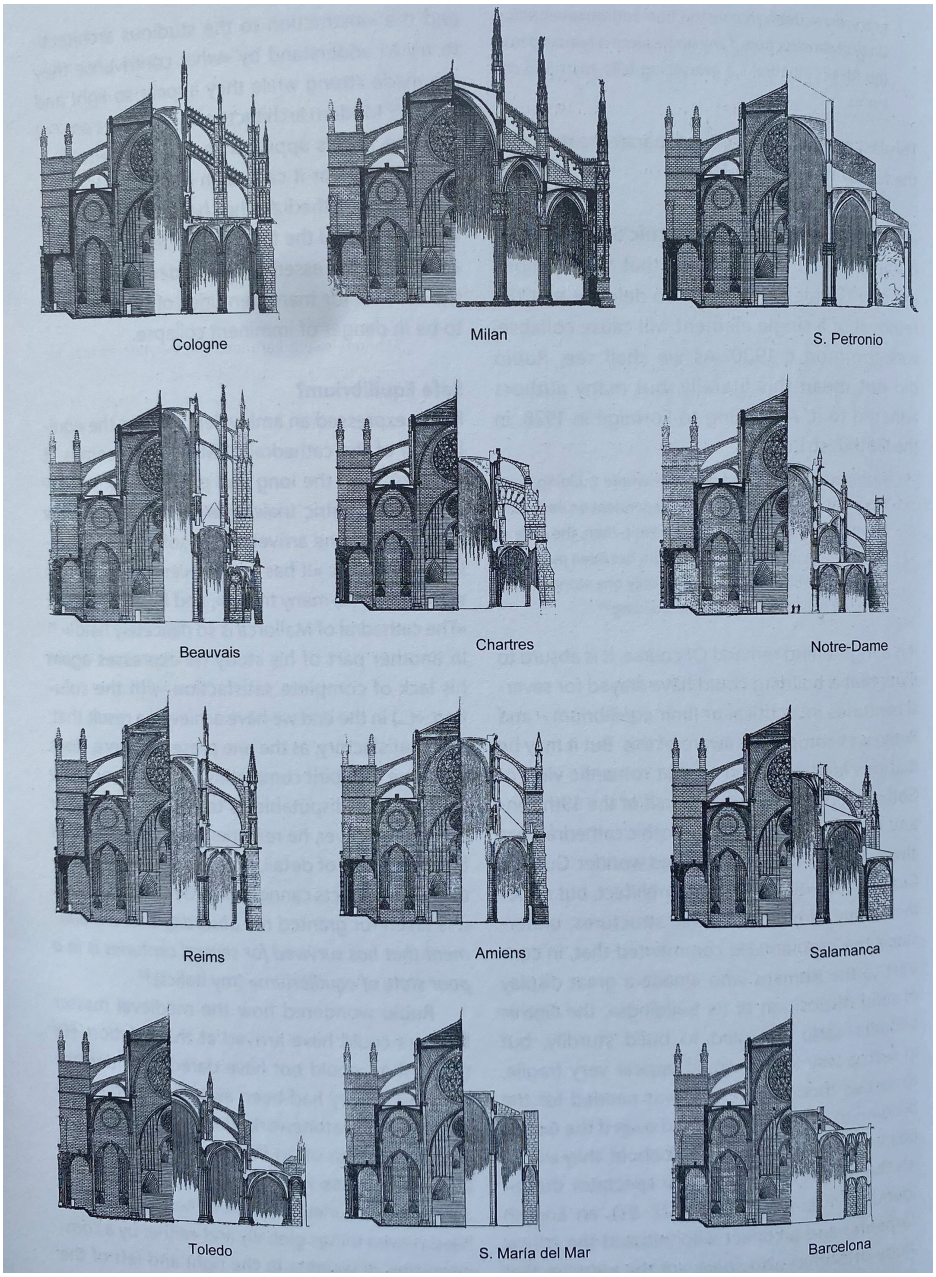
According to Joan Rubió i Bellver- assistant and first architect of Gaudí - Gothic cathedrals can be grouped into three typologies based on their spatial and structural organization. The question that comes to mind is, in which group does the Sagrada Família belong? The initial design for the Sagrada Família by Francisco de Paula del Villar fits within the second category, sharing key elements with Catalan Gothic cathedrals. The second type, which is rare, includes cathedrals where the aisles are nearly as high as the crossing, such as Barcelona Cathedral and Santa Maria del Mar. Gaudí's designs, from the first to the final design fit more within the third type, which is the most widespread type, seen in Amiens, Cologne, and Mallorca, features significantly taller crossings compared to the side aisles. [7]

07 Roca, Analysis of the structure of Gothic cathedrals application to Barcelona cathedral, 236-255

The case studies that are used for the comparison are the Barcelona Cathedral and the Mallorca cathedral. The reason for this choice is based on three aspects:

- The structural characteristics of Barcelona Cathedral provide valuable historical context—such as its wide vault spans, the close height between the central and side crossings, and the active structural role of the side vaults in countering the thrust from the central crossing—make it a rich subject for comparison.[8]
- Finally, Gaudí was part of the restoration of the Mallorca cathedral [9], what might have been an inspiration for his starting point of wanting to perfect Gothic cathedrals.
- The visit to the Barcelona cathedral and the Sagrada Família supports the comparison between the two.

As noted by Pere Roca, these aspects exemplify the unique traits of Catalan Gothic architecture and serve as a critical lens through which Gaudí's reinterpretation of Gothic principles can be examined. [10]



[05] Sections of different Gothic cathedrals and churches compared to the Mallorca Cathedral

08 Roca, Analysis of the structure of Gothic cathedrals application to Barcelona cathedral, 236-255
09 Fuentes, The Art of Vaulting, 95-190
10 Roca, Analysis of the structure of Gothic cathedrals application to Barcelona cathedral, 236-25501 bron

[06] The structural column in the Sagrada Família

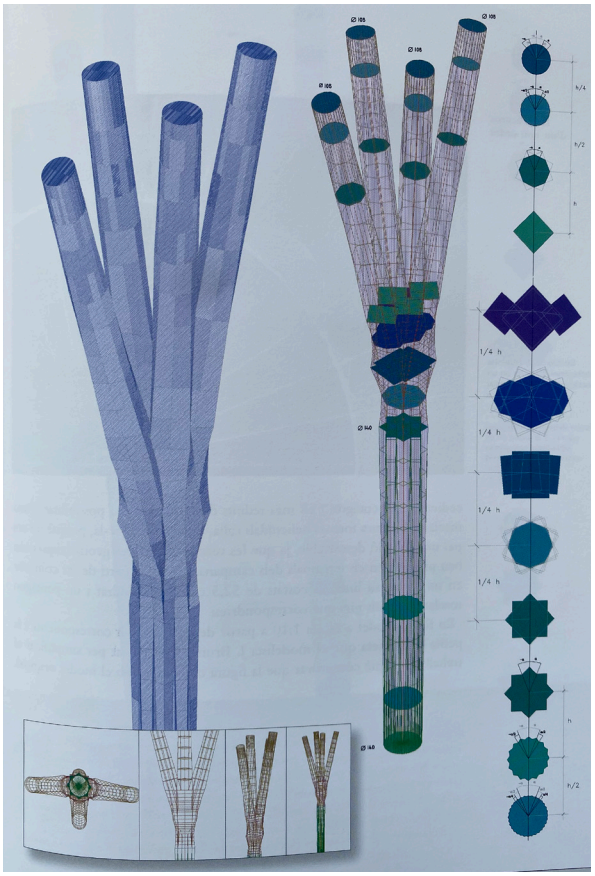
[07] The structural column in the Barcelona Cathedral

STRUCTURAL TECHNIQUES

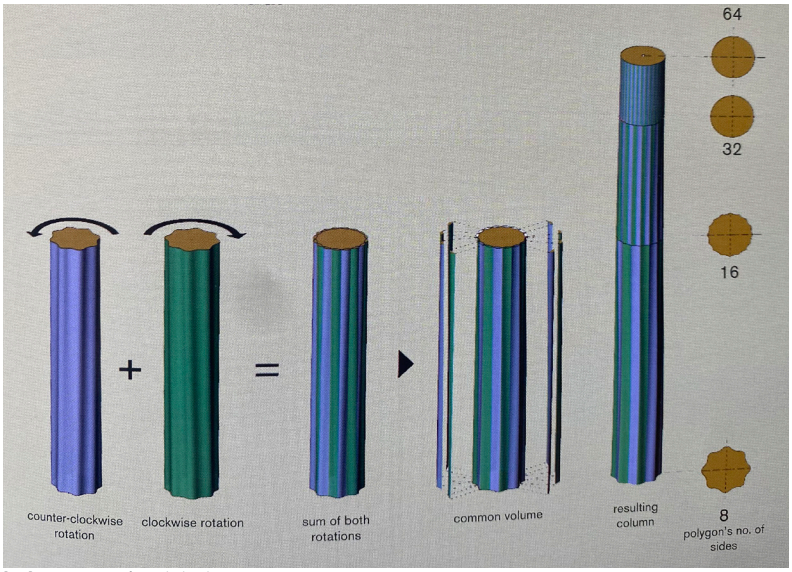
Gaudí's column

Gaudí's columns in the Sagrada Família represent a remarkable departure from the structural norms of Gothic architecture. Although it has been said that he took inspiration from Gothic forms, this has never been definitively proven—perhaps because the focus tends to be on his revolutionary innovations, where he drew inspiration from nature and geometry. In the following paragraphs, we will unravel his process in creating the columns to determine whether he was, in fact, influenced by Gothic design.

The key innovation in Gaudí's design for the columns lies in his use of intersecting helical (Solomonic) geometries—one shape twisting to the right, the other to the left —creating columns that change in section as they rise. With the intersection, the number of edges increases as the column rises and, at the same time, the edge of the points or apices is reduced until you get a polygon close to a circle at the top. With this system a star base column, of eight straight or parabolic sides, will gradually become a cross-section of 16 points, 32 and 64 in the upper part, close to a circle. [11]



[08] 'Structural tree' column with the geometric shapes



[09] Intersection of two helical geometric rotations

In the structural trees, there are intermediate columns which include between two and five upper columns to transfer their weight to a lower column or capital. The column will gradually transform downwards with the same intersecting system of two reverse Solomonic columns, to become a regular polygon which, in turn, becomes a circle when it enters the lower capital or column. This procedure makes it possible to achieve continuity between the lines and the surface areas of different columns, as occurs in nature between the trunk and the branches of a tree. **Gaudí achieved naturalistic continuity through geometric procedures.**

11 Faulí, La Basílica de La Sagrada Família, 76-85

Faulí explains that Gaudí chose self-supporting forms that required no additional support, which is why he dismissed the flying buttresses and pillars of Gothic architecture as mere "props." Instead, he used parabolic and catenary arches to transfer weight directly to the ground. Seeking to give each structural element its most effective shape and inclination, Gaudí developed an experimental method of calculation using inverted hanging models with strings and sacks. The insights gained from the Colònia Güell chapel allowed him to design the crossings of the Sagrada Família using a more advanced system based on the same principles, what Faulí calls "structural trees."[12]

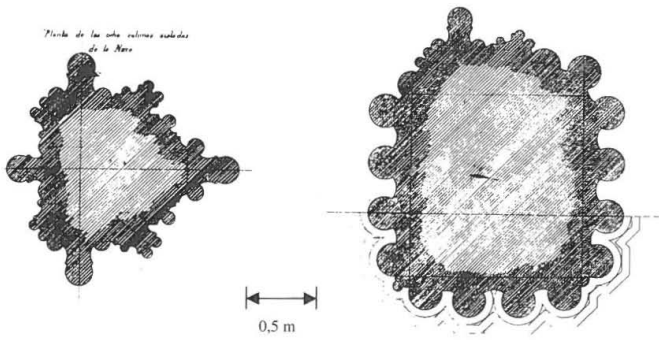
Armengol adds that while Gaudí initially worked within the Gothic Revival tradition of his predecessor del Villar, raising the ogives (Gothic arches), the Colònia Güell experience convinced him of the viability of inclined columns and a tree-like system. This evolved into a reticular spatial structure that directed forces along thrust lines. The lower columns split above the capitals and branch out at different heights, allowing each to carry a portion of the vault and roof with the optimal inclination.[13]

The columns are made of basalt and granite on the outside and filled with steel and concrete on the inside. The central column in the crossing is made of red porphyry, a volcanic rock. Although Gaudí initially intend to use only granite for the columns, building regulations at the time of construction required the use of concrete for horizontal stability.[14]

It is clear that Gaudí used calculations and geometry, which he most likely learned when he was a student, and nature in his designs for the columns. It is, however, unclear how and whether he used Gothic columns as an inspiration or if he merely saw them as something that needed to be perfected. Both might be true. Therefore, we first discover the structural techniques of Gothic columns before the comparison is made.

The Gothic column

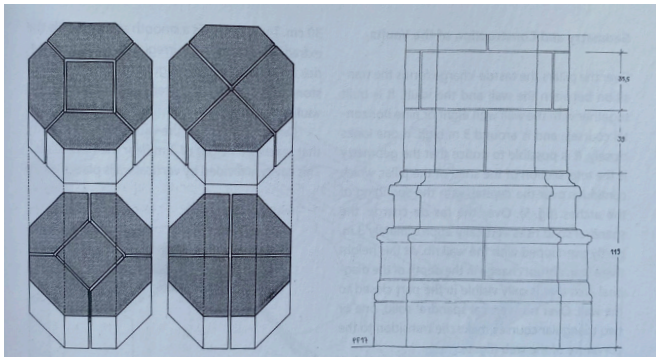
For the Gothic column, the Barcelona Cathedral,1298-1420, and Mallorca cathedral, 1229-1601, are used as case studies. The column in the Barcelona Cathedral is built of fragile masonry, and rubble at the core of the columns, and then filled with concrete on the inside.[15] The column, seen in figure 10. has an odd shape, which is hard to define. It looks like most like a triangle and an oval shaped column. It is unclear why the shape is the way it is. It might be to make the columns aestheticly pleasing, because there is no reason found that it is for structural reasons. The Mallorca cathedral, seen in figure 11, used an octogen shape, which Roca assumed was made in one of the four ways and stacked on top of each other.
Another thing that is different is the use of flying buttresses. The Mallorca cathedral uses flying buttresses to transfer the weight from the roof too the ground. The columns are thought , by Roca, to have an inclination to the centre.[16] In the Barcelona



Material	Deformation modulus (Mpa)	Poisson coefficient	Compresive strength (kPa)	Tensile strenght (kPa)	Density (kN/m3)
Ashlar masonry (*)	8000	0.2	8000	400	2,7
Rubble (**)	2500	0.2	2500	100	2,5
Concrete fill	500	0.2	500	50	1,0

(*) in piers, ribs and vault webbing
(**) at the core of piers and at vault haunches

[10] Transverse sections of the crossing piers and the piers sustaining the cimborio as represented in the 1864 plans and properties defined for the materials (Pere Roca,1998)



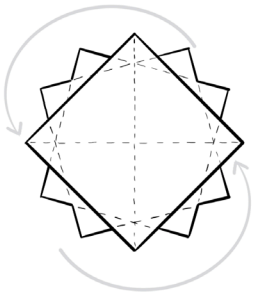
[11] Octogen shaped column in the Mallorca Cathedral, 1601

12 Faulí, La Basílica de La Sagrada Família, 76-85
13 Armengol, L''ultim, 140-145 26 Buchanan, P. (1982)
14 Faulí, La Basílica de La Sagrada Família, 94-101
15 Roca, Analysis of the structure of Gothic cathedrals application to Barcelona cathedral, 236-255

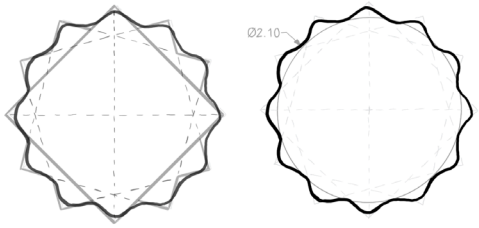
cathedral however, the flying buttresses are not needed at all. The thrust of the crossing vaults is completely retained by the aisle vaults. Where the flying buttresses exist, they are non-structural. Perhaps that is why they used the odd shape and material, concrete filling, for the Barcelona cathedral. Even though the material, shape, and weight transfer of the columns in the Barcelona cathedral and Mallorca cathedral are different, it shows that they were already testing new structural techniques. For example, not using flying buttresses, inclining the columns, or filling the columns with concrete to improve the structural aspect of Gothic columns.

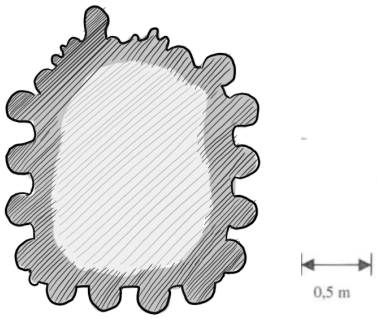
The comparison

Starting with the shape of the columns, Gaudí's columns are well thought of. It consist of multiple geometric shapes, with all unnecessary material removed. Gaudí knew exactly how big the columns had to be, how tall they could be, which shape was necessary were in the column to support the weight of the forces that rest on the columns. The same cannot be said



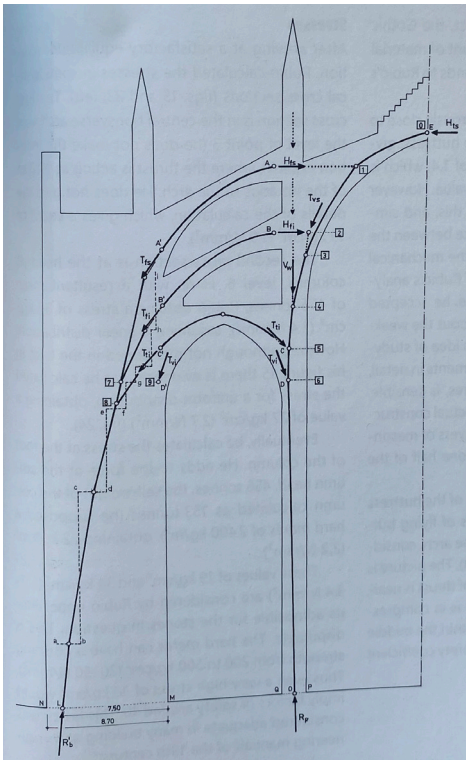
[12] How the base shape of Gaudí's columns arises in the Sagrada Família



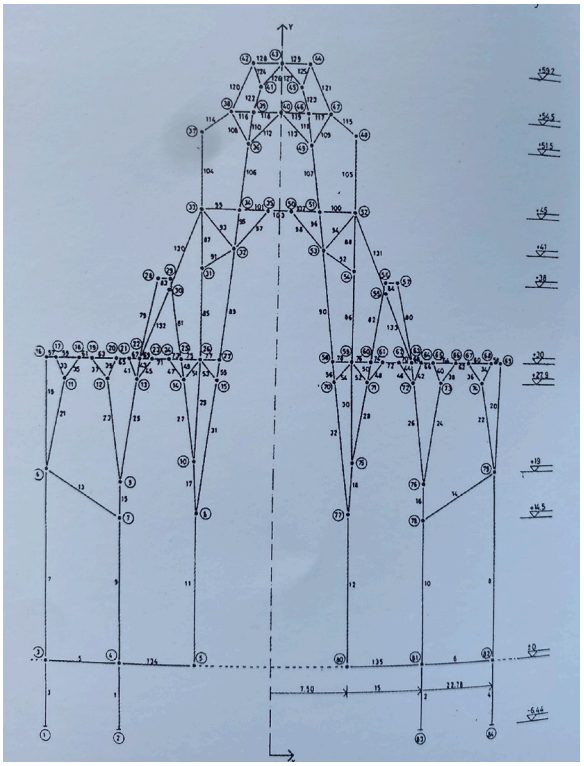


[13]The odd shape of the gothic column in the Barcelona Cathedral.

about the Gothic column. Even though they were using different shapes and materials, such as concrete, they were still over dimensioned to be sure the columns could carry the weight of the roof. As seen in the comparison ,in drawing 13.
How different the weight transfers is visible when you compare the Mallorca cathedral and the Sagrada Família. Gaudí calculated the forces by which he didn't need the flying buttresses to carry the weight to a second structure that transfers the weight to the ground. This allowed Gaudí to have more structural and aesthetic freedom in his design.

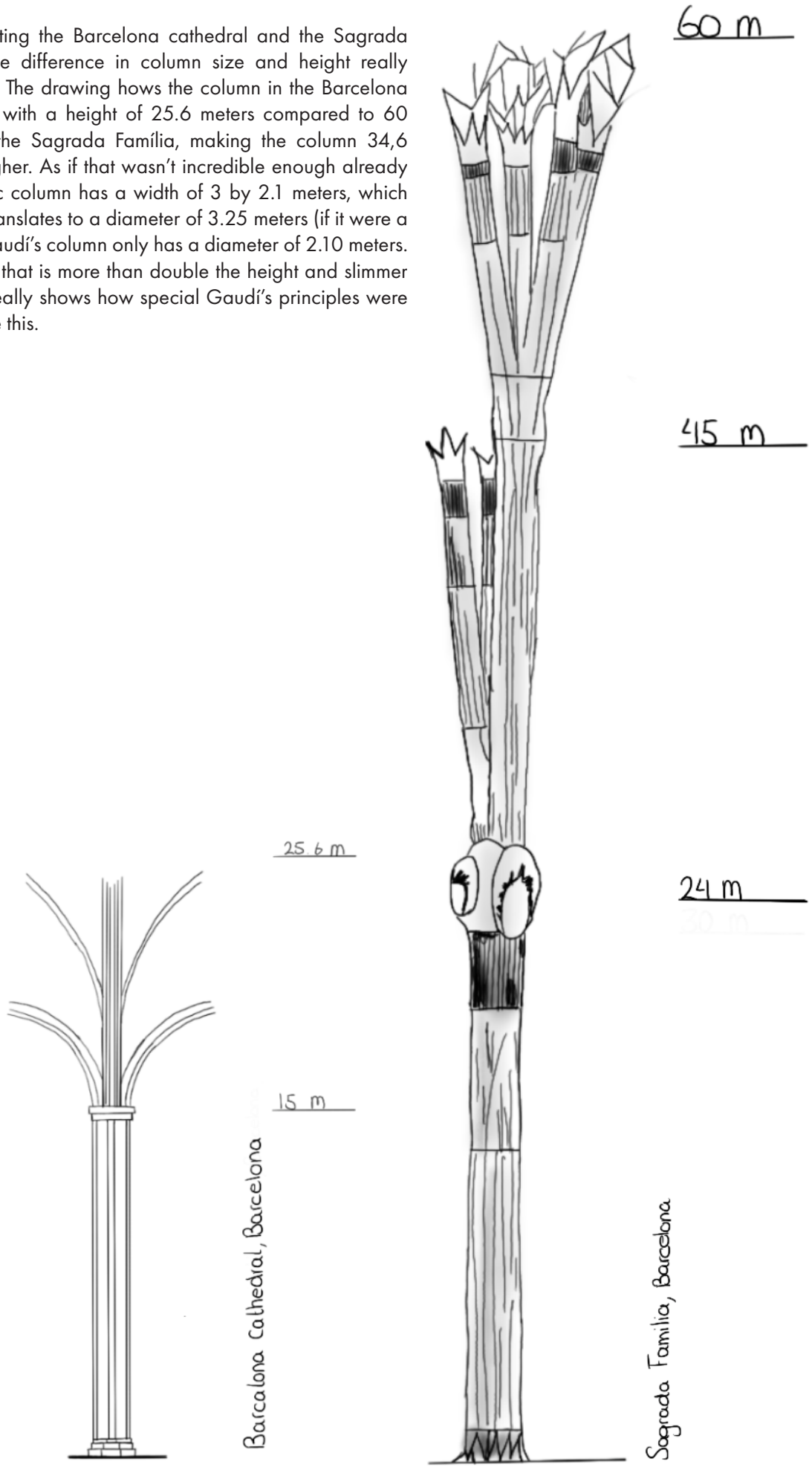


[14] Transfer of forces through the flying buttresses and the columns in the Mallorca Cathedral

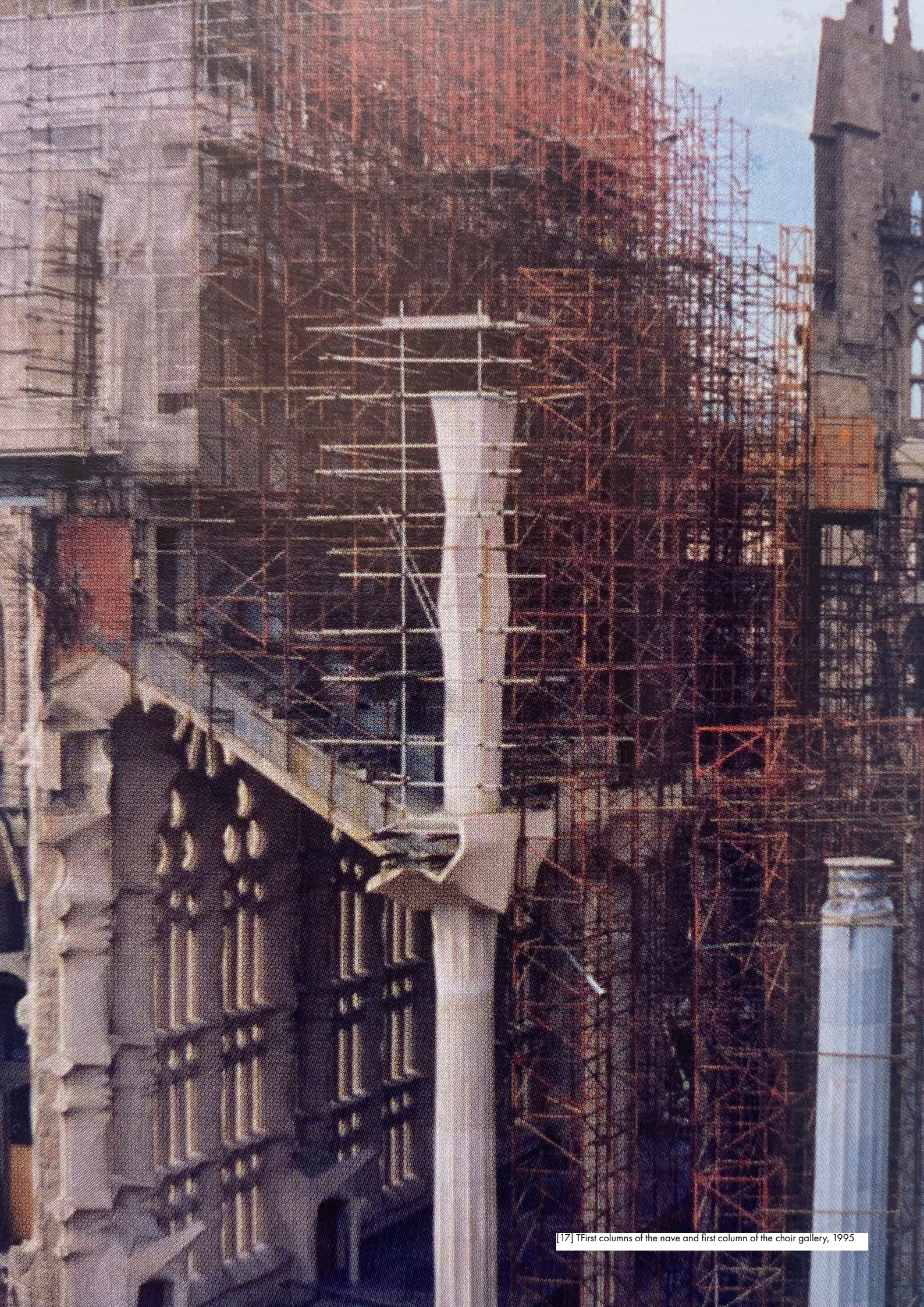


[15] Structural calculations of the Sagrada Família,1986

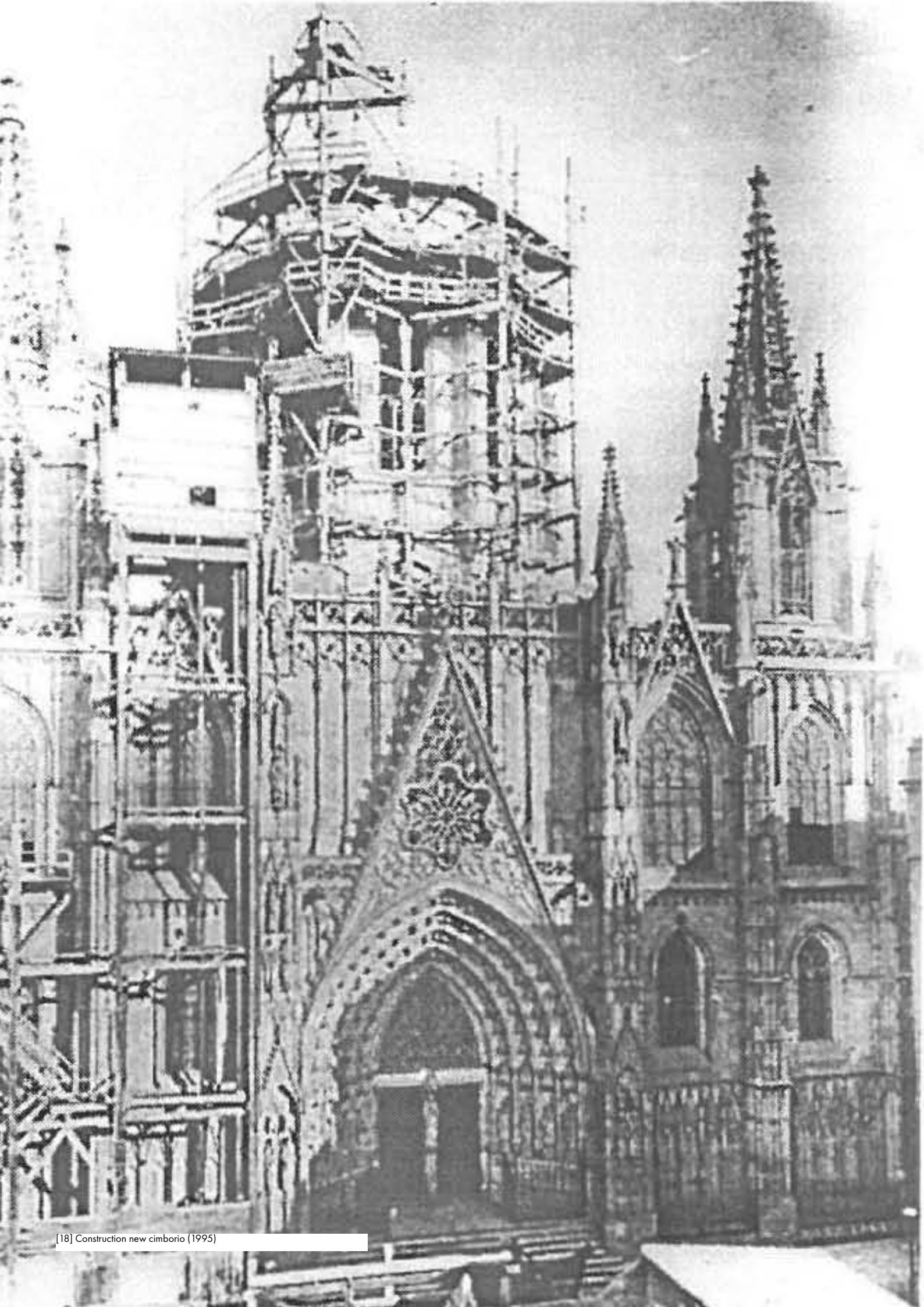
While visiting the Barcelona cathedral and the Sagrada Família the difference in column size and height really stood out. The drawing hows the column in the Barcelona cathedral with a height of 25.6 meters compared to 60 meter in the Sagrada Família, making the column 34,6 meters higher. As if that wasn't incredible enough already the Gothic column has a width of 3 by 2.1 meters, which roughly translates to a diameter of 3.25 meters (if it were a circle). Gaudí's column only has a diameter of 2.10 meters. A column that is more than double the height and slimmer as well, really shows how special Gaudí's principles were to achieve this.



[16] Height comparison



[17] TFirst columns of the nave and first column of the choir gallery, 1995



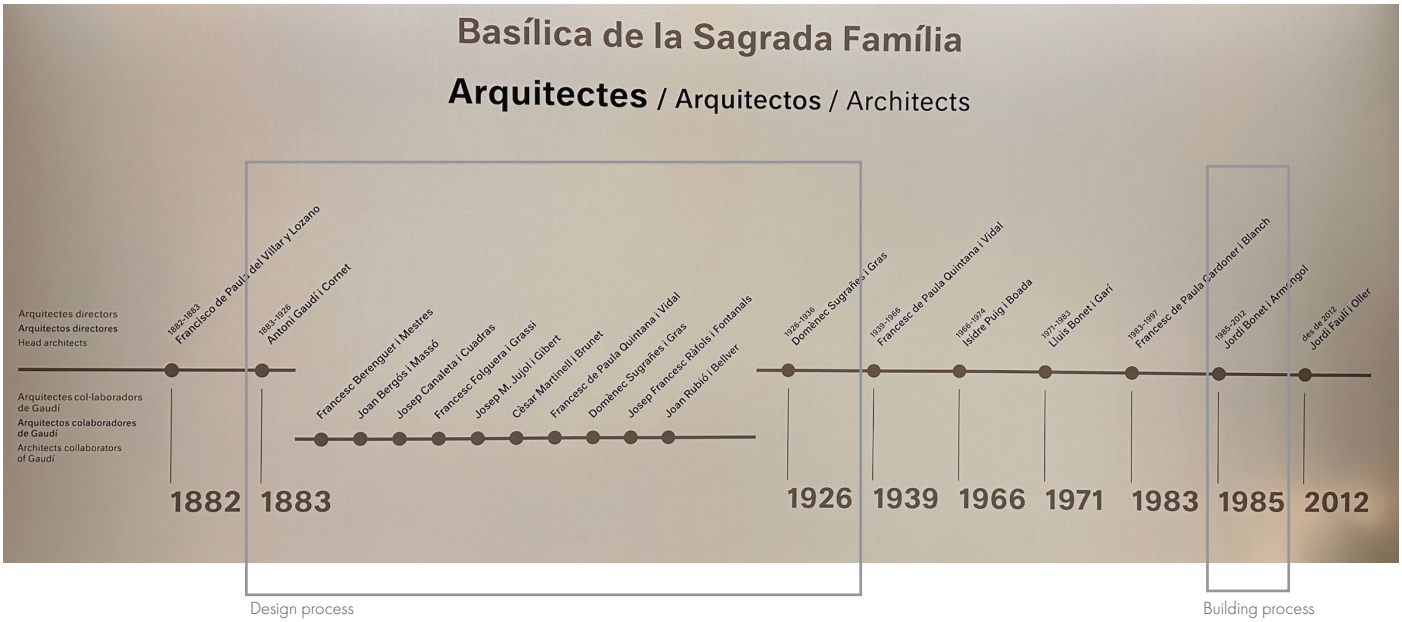
[18] Construction new cimborio (1995)

BUILDING PROCESS

Gaudí's column

''Are they still building that? When will it finally be finished?'' This was a question I was frequently asked while writing this thesis. The continuous delays in the construction process have become a familiar aspect of the Sagrada Família, influenced by a variety of factors. While such prolonged timelines may seem unusual today, they were in fact common in the context of Gothic architecture, where construction often spanned several generations. Therefore, examining the similarities and differences in the building processes offers valuable insight.

Antoni Gaudí is an extensively studied architect in modern history. His work has inspired a wealth of interpretations, theories, and assumptions—yet most of his creative process remains enigmatic. My engagement with Gaudí's world began through the perspectives of Jan Molema and Jordi Faulí i Oller, the current chief architect of the Sagrada Família, whom I had the opportunity to follow on a guided tour through the basilica. Both have devoted significant parts of their careers to exploring Gaudí's legacy. Faulí, along with his predecessors, has continued the construction of the Sagrada Família by carefully interpreting, adapting, and building upon the principles Gaudí established—particularly in the case of the columns, which form a central structural and symbolic component of the basilica.



[19] Architects of the Sagrada Família and the design and buildig process of the columns

The building process is divided into two sections, the first is the design process and the second is the building process. In case of the columns Gaudí was only part of the design process. Armengol explained that Gaudí's research work required both time and space, both of which he had due to the slow progress of construction, a consequence of the shortage of financial resources.[16]

As the sculptor Matamala explains regarding the study of the models, Gaudí reserved it for himself as research work adding that he lost all sense of time when he was making models with the model makers. Months, even years would go by before each piece was ready. 'For example, to make the model for a column he had first to draw it, then form the sections which corresponded to each completed gyration corresponding to 8,16, 32, 64 flutes. Then the model maker had to ''braid'' the flutes passing from one section to the next while setting plaster was still pliable, with the aid of a ruler. Fortunately, there still exists some original examples that demonstrate the work required. Gaudí used plaster models to study which columns

16 Armengol, L''ultim, 42

expressed movement and change, and which are highly resistant to meet the building needs. Something similar was also true for the final solutions for the column capitals or 'knots,' based on macles between the ellipsoids. Just to draw one of these capitals or 'knots' faithfully now took the best part of a year of painstaking work.[17]

''A work like this should be the offspring of a long era, the longer the better." Antoni Gaudí said to Cesar Martinell.' [18]

Gaudí knew that the Sagrada Família wouldn't be finished in his life, so he created a base of principles by which his accessors could continue his design and thus the building process. That a lot of his drawings and models were lost in a fire, in 1936, made this more difficult and time consuming, because his assessor had to redraw his work. Faulí said that Gaudí designed 8 out of the 10 columns, which were built by his successors. The columns that weren't designed yet were designed

[20] Plaster models columns

[21] Model of the knot of the column, made by the model makes in the museum of the Sagrada Famíliaprocess of the columns

by his successors on the same principles Gaudí used for the other columns.[19]
The Sagrada Família is build in segments, the nave and the crossing were built after the apse and the façade. The research on how to finish the crossing based on Gaudí's principles, made between 1883 and 1926, and the current building regulations started in 1985 and lasted until 1987. After that it took two years for the foundation of the crossing and the making of precast concrete form, called 'artificial stone.' In 1993 the first sections supporting the choir on the west side were built and in 1995 the first columns in the nave were in construction. [20] It took approximately 100 years from the start of Gaudí 's design to building the columns.

The granite and basalt columns have been cut using computer-controlled machinery thanks to the equations that derive the helicoid that generate them. Later a new machinary has been introduced which copies them in stone at full scale from a plaster model.[21] The outside layer of the granite columns was made in a special machine that first cut out the twist in one direction and then it would go the other way around to cut the twist for the other side. 3D printing was not possible then, that would have been an easier solution.

17Armengol, L''ultim, 42
18 Armengol, L''ultim, 61
19 Faulí, interview.
20 Armengol, L''ultim, 104-145
21 Armengol, L''ultim, 145

The design evolution of column , from 1882 until 1923, displayed in the Sagrada Família museum. The models are made by Gaudí's accessors in the model-making workshop in the museum of the Sagrada Família. The models clearly show how Villar's design evolved step by step with every discovery Gaudí made. From Villar's design to a round column, a one-sided-twist-column and a double-sided-twist-column the design goth higher and slimmer with every innovative discovery in the columns.

[22] Del Villar's project – 1882-1883 – Gothic style, second type.

[23] First version Gaudí – 1890-1914 – Round column

[24] Second version Gaudí – 1914-1919 – One sided twist column

[25] Third and final version Gaudí – 1921-1923 – Double sided twist column.

The Gothic column

The Gothic building process is one that last centuries. For example, the Barcelona Cathedral,1298-1420, and Mallorca cathedral, 1229-1601. According to Pere Roco, the construction of the crossings of the Barcelona Cathedral begun in 1298 and lasted for more than a century. As usual, the apse was constructed first, being finished in 1327 while the construction of the entire crossing continued until 1417. In 1422 the work stopped, leaving the comborio unfinished. Barcelona Cathedral constituted an innovative construction in which the specific devices of Gothic architecture were efficiently adapted to climate and cultural idiosyncrasy of its southern context. The further development of these new dispositions that were to lead to the conception of very diaphanous constructions such as the Basilica of Sta. Maria del Mar (1329 – 1383), also in Barcelona, or, later in history, Mallorca Cathedral (1229-1601), which is considered by some specialist, Rubió and Mark as the epitome of all Gothic architecture.[22] Between 1903-1915 Gaudí worked with Rubió on the restoration of the Mallorca cathedral.[23] This shows how Gaudí engaged in Gothic cathedrals and how that could have let to insights in what does and does not work in the aspects of Gothic columns.

The comparison

The building process of the Sagrada Família and the Gothic columns is very similar. The design and construction process are intertwined. The construction process goes in phases and is temporarily halted when new discoveries are made. External factors, like fires, and finances have a big influence on the process. In both cathedrals there are many architects and collaborators who work, over the century long building period, to achieve the most define design and structure. Gaudí just as Gothic architects was not only inspired by new discovery in his innovations, but he also implemented them straight away. Showing that Gaudí doesn't oppose to the Gothic building process but that he embraces it.

22 Roca, Analysis of the structure of Gothic cathedrals application to Barcelona cathedral, 242-243
23 Fuentes, The Art of Vaulting 174

[26] Interior, Sagrada Família

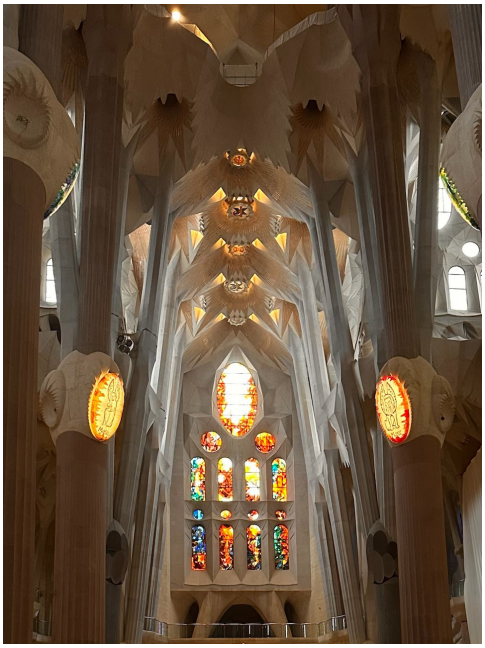
[27] Interior, Barcelona Cathedral

AESTHETIC

Gaudí's column

The column in Gaudí's design is a clear reference to nature in many aspects. Often referred to as "structural trees,."[24] these columns reflect the tree-like structure due to their height, the branching at the top, and the knot-like feature added purely for aesthetic purposes. Gaudí wanted to build taller to reach God, this was possible with his structural innovations. The knot conceals the twisting that occurs beneath it. Within the knot, several shapes converge from the 'branches' of the tree, each twisting towards the central form, or the 'star,' of the column below. This twisting process typically creates new shapes, such as triangles or circles. A similar branching process occurs in nature when a tree begins to spread its limbs. Although it has never been proven that Gaudí was consciously aware of this, the reference to nature is evident in every detail of the columns. Whether consciously or unconsciously, Gaudí achieved a perfect imitation of nature in the design of these columns. As Armengol stated:

''Nature is my master'' Gaudí's capacity for observation is well know. He himself explained that this was a consequence of his weakness of health since childhood. The contemplation of nature, besides giving him pure pleasure, also helped him form ideas enabling him to reach such insights as 'architecture creates the organism and that is why the latter must have a law in consonance with those of nature'' These ideas matured over time ''Everything comes from nature's great book.'' ''This tree next to my studio: this is my master.''[25]



[28] Gaudí's columns in the Sagrada Família

[29] Nature's continuitiy in the columns

The structural trees and the references to nature as described are very clear in the aesthetic of the columns. But it's unclear whether there is a reference to Gothic columns aesthetically. Therefore, a gothic column in the Barcelona cathedral is analysed and compared to Gaudí's red column.

24 Faulí, La Basílica de La Sagrada Família, 76-81
25 Armengol, L''ultim, 54
26 Fithcen, The construction of Gothic Cathedrals, 86
27 Fithcen, The construction of Gothic Cathedrals, 2
28 Scalbert, A real living contact with the things themselves, 44

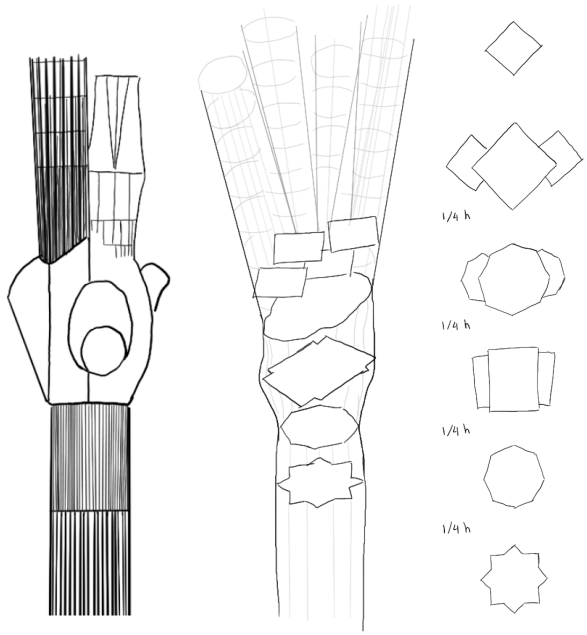
The Gothic column

Fitchen describes the Gothic design as 'the Gothic cathedral builders aim as achieving maximum natural lighting and maximum height, with a thoroughly integrated organic design that expressed their creative imagination.'[26] In pursuing of a leaner construction to allow more wall area for windows, the individual ribs at the high vault's springing points were placed so close that many of their moldings merged, leaving no room for each rib to stand as a separate block. It has been said that the builders set themselves seemingly "impossible" structural problems and solved them with clever, resourceful techniques. Their solutions integrated engineering techniques seamlessly with aesthetic goals, this approach stemmed from their search for expressive, unprecedented forms. Although their aim was spiritual expressiveness, it was reached only gradually through numerous innovations, adjustments, and modifications over an extended period, marked by many fumbling's and hesitations as they worked toward materializing that vision.[27]

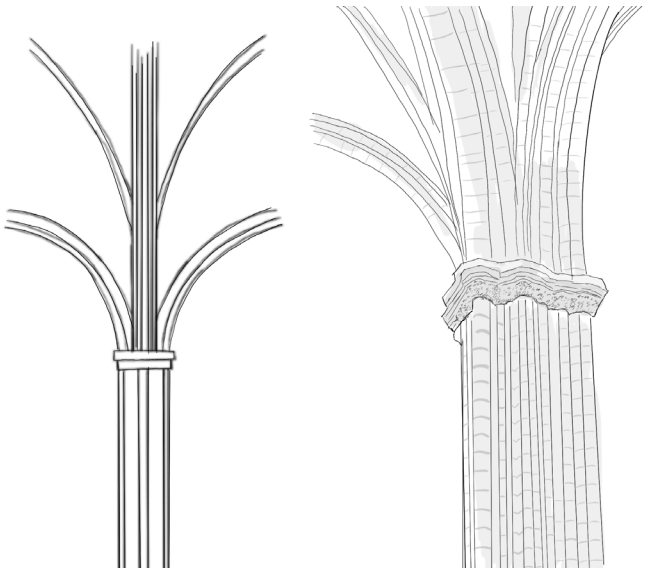
Scalbert adds to this stating that discontinuities are welcome in gothic design: in every other style of architecture discontinuities are shocking, and rarely welcome. But in gothic they are not only tolerated but are integral to its conception.[28]

The comparison

Both Gaudí and gothic design pursued spiritual expressiveness, through light, symbolism, and height 'to reach God', using nature as a blueprint. Both strive for an organic integration of form and structure. However, Gaudí was ahead of his time, with his clear vision based on nature, mathematics and geometry compared to the Gothic design which gradually evolved over the centuries, with trial and error. This led to achieving fluid continuity in Gaudí's columns compared to gothic columns which often had discontinuities in sharp junctions meeting the vaults, as seen in de drawing.



[30] Gaudí's knot where the columns twist behind the aesthetic knot before the branches reach out



[31] A gothic junction of the column meeting the vault with ornamentation.

26 Fithcen, The construction of Gothic Cathedrals, 86
27 Fithcen, The construction of Gothic Cathedrals, 2
28 Scalbert, A real living contact with the things themselves, 44

CONCLUSION

While the Gothic column influenced Gaudí's columns in the Sagrada Família, the extent of this influence varies for each aspect. Returning to the central question: 'How have the columns in the crossing of the Sagrada Família been inspired by Gothic columns in terms of structural techniques, building process and aesthetics?'
The columns are not really influenced in the structural techniques. Gaudí worked on perfecting the Gothic by spending many years on models & calculations to use less material, make a slimmer and higher column. His principles of twisting the column in both directions, shaping it as a tree is completely new and revolutionary in his time and even now, a 140 years later.

However, the building process of the columns in the Sagrada Familia is not as revolutionary, it is very similar to the building process of gothic columns. In many aspects: a century goes by to finish the building, a lot of architects, collaborators and sculptors worked on it during those years, and the financial or other issues that stops the building process. Gothic cathedrals took so long because these factors influenced the building process, almost unconsciously. Gaudí was aware that his lifework wasn't going to be finished and so he had said that his accessors should finish it. And thus, I assume that he was aware in this way that the Gothic building process was not something that needed to be perfected but could be followed instead.

The aesthetic design of Gaudí's column is very different than that of the Gothic column, this is mostly because of the structural innovations from geometry and nature. The aesthetic principles nonetheless are very similar. The principles in gothic architecture and Gaudi are both to work vertically so close to God and the light as possible. Gaudí extended these principles with building even higher. But that was only possible by his new innovations. So, the purpose of the aesthetic design is the same. Gaudí was indeed inspired by the gothic columns on aesthetics, but did perfect them in his own way. The knot which is purely added for decoration is designed with ellipses and so Gaudí does distinguish himself in this way from gothic ornaments on the columns.

In conclusion, Gaudí's columns in the Sagrada Família ere influenced by Gothic columns in terms of the building process, aesthetic design, and party in the structural techniques. Gaudí perfected the structural technique and aesthetic design with his principles. Principles that, as far as is know, only Gaudí has employed. This is surprising, considering the potential they offer. When I asked Faulí why these principles, which have existed for over 140 years, have not been more widely adopted, he responded: ''I really don't know, the possibilities are infinite.''[29] It is understandable that the Sagrada Família, with its high costs and building timeline spanning decades might discourage other architects from following in Gaudí's footsteps. However, with the advancements in technology of fabricating the complex columns, the evolution of Gaudí's principles is just beginning. Inspired by nature and geometry, Gaudí reimagined and 'perfected' the Gothic columns in multiple ways. I hope his innovations will continue to inspire current and future architects to study and apply these principles in their own designs. Future research could explore how Gaudi's columns might be adapted and applied to contemporary architectural structures.

29 Faulí, interview.

BIBLIOGRAPHY

Armengol, Jordi Bonet i. *L''ultim/ The Essential.* Barcelona, 2000.

Eaude, Micheal. *"Catalonia Cultural History."* 2007. Books.google.nl. <https://books.google.nl/books?id=h7u_BAAAQBAJ&lpg=PA1908&hl=nl&pg=PA1908#v=onepage&q&f=false>.

Faulí, Jordi. *La Basílica de La Sagrada Família. Barcelona*: P&M Ediciones, 2023.
—. The Basilica of the Sagrada Família. Editorial Palacois y Museos, 2022.

Faulí, Jordi. 2025. Interview by author, Barcelona, March 6, 2025

Fithcen, John. *The construction of Gothic Cathedrals*. Great Britain: University press, Oxford, 1961.

Huearta, Santiago. *Structural Design in the work of Gaudi*. Madrid: Universidad Politecnica de Madrid, 2006.

Imani, Marzieh. "*Bio-inspired Design approach Analysis:* a case study of Antoni Gaudí and Santiago Calatrava." 2017.

Information booklets: 4. Architecture of the Sagrada Familia . (2022, July). Retrieved from Basílica de la Sagrada Família: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://sagradafamilia.org/documents/20142/1205286/SF_Booklet_04_20240405_digital_AF.pdf/29d08418-9034-2d14-58fb-b6a5d0c3ff09

Mark Burry, Jordi Coll Grifoll, Joseph Gómez Serrano. *Sagrada Família s.XXI*. Barcelona: Edicions UPC, 2008.

Molema, Jan. *Antoni Gaudí een weg tot oorspronkelijkheid.* Delft: TU Delft, 1987.
—. *Gaudí the construction of dreams*. Post Editions, 2007.

Molema, Jan. 2025. Interview by author, Delft, Februari 14, 2025

Paula Fuentes, Anke Wunderwald. *The Art of Vaulting,* Design and Construction in the Mediterranean Gothic. Basel: Birkhäuser Verlag GmbH, 2019.

Pere Roca, Lara Pellgrini, Eugenio Onate and Alex Hanganu. *Analysis of the structure of Gothic cathedrals application to Barcelona cathedral.* Barcelona: Universitat Politecnica de Catalunya, 1998.

Scalbert, Irénée. *A real living contact with the things themselves.* Zurich: Park Books, 2018.

IMAGE CREDITS

[00] Front page, edited photo by the author, March 2025
[01] Faulí, Jordi. Cross-sections, interview, March 6, 2025
[02] Faulí, Jordi, 2022, La Basílica de La Sagrada Família, 2025. Barcelona: Editorial Palacois y Museos.
[03] Faulí, Jordi. Cross-sections, interview, March 6, 2025
[04] Fuentes ,Paula, Comparison of Mallorca cathedral with other churches and Cathedrals, 2016. In Paula Fuentes, Anke Wunderwald, Comparison of Mallorca cathedral with other churches and Cathedrals, The Art of Vaulting, Design and Construction in the Mediterranean Gothic. (Basel: Birkhäuser Verlag GmbH), 192.
[05] Fuentes ,Paula, Comparison of Mallorca cathedral with other churches and Cathedrals, 2016. In Paula Fuentes, Anke Wunderwald, Comparison of Mallorca cathedral with other churches and Cathedrals, The Art of Vaulting, Design and Construction in the Mediterranean Gothic. (Basel: Birkhäuser Verlag GmbH).
[06] Photo by the author, March 2025
[07] Photo by the author, March 2025
[08] Faulí, Jordi, 2022, La Basílica de La Sagrada Família, 2025. Barcelona: Editorial Palacois y Museos.
[09] Faulí, Jordi, 2022, La Basílica de La Sagrada Família, 2025. Barcelona: Editorial Palacois y Museos.
[10] Pere Roca, Lara Pellgrini, Eugenio Onate and Alex Hanganu. Analysis of the structure of Gothic cathedrals application to Barcelona cathedral. Barcelona: Universitat Politecnica de Catalunya, 1998
[11] Fuentes ,Paula, Comparison of Mallorca cathedral with other churches and Cathedrals, 2016. In Paula Fuentes, Anke Wunderwald, Comparison of Mallorca cathedral with other churches and Cathedrals, The Art of Vaulting, Design and Construction in the Mediterranean Gothic. (Basel: Birkhäuser Verlag GmbH)
[12] Drawing by the author, April 2025
[13] Drawing by the author, April 2025
[14] Fuentes ,Paula, Comparison of Mallorca cathedral with other churches and Cathedrals, 2016. In Paula Fuentes, Anke Wunderwald, Comparison of Mallorca cathedral with other churches and Cathedrals, The Art of Vaulting, Design and Construction in the Mediterranean Gothic. (Basel: Birkhäuser Verlag GmbH).
[15] Faulí, Jordi, 2022, La Basílica de La Sagrada Família, 2025. Barcelona: Editorial Palacois y Museos.
[16] Drawing by the author, April 2025
[17] Faulí, Jordi, 2022, La Basílica de La Sagrada Família, 2025. Barcelona: Editorial Palacois y Museos.
[18] Pere Roca, Lara Pellgrini, Eugenio Onate and Alex Hangan, 1998. Analysis of the structure of Gothic cathedrals application to Barcelona cathedral. Barcelona: Universitat Politecnica de Catalunya,.
[19] Timeline Arquitectes, Basilica de La Sagrada Familia, 2025, Museum the Sagrada Familia, Barcelona
[20] Molema, Jan,2007. Gaudi the construction of dreams. Post Editions.
[21] Plaster model knot, Basilica de La Sagrada Familia, 2025, Museum the Sagrada Familia, Barcelona
[22-25] Models of sections of the columns in the design process, Basilica de La Sagrada Familia, 2025, Museum the Sagrada Familia, Barcelona
[26] Photo by the author, Sagrada Família, March 2025
[27] Photo by the author, Barcelona Cathedral, March 2025
[28] Photo by the author, Sagrada Família, March 2025
[29] Armengol, Jordi Bonet, 2000 Nature's continuity L''ultim/ The Essential. Barcelona.
[30] Drawing by the author, the knot of Gaudí's column, April 2025
[31] Drawing by the author, the junction and ornamentation of the Gothic column, April 2025