

The Congo Museum in Tervuren

The Birth of Tile Vaulting in Belgium

Paula Fuentes

The Congo Museum (known today as the Royal Museum for Central Africa) was part of a large colonial complex planned by the Belgian King Léopold II in the municipality of Tervuren, a few kilometres from Brussels. The complex was commissioned to French architect Charles-Louis Girault (1851–1932) in 1901, but only the museum was completed. This building features vaults in many of its rooms, and the main space is covered by a two-shell dome with a span of 20 m. Different types of vaults were used, but the building is remarkable for the use of tile vaults, a technique that originated in the Mediterranean region and arrived in Belgium, with no known precedents, at the beginning of the 20th century. Tile vaults are built with light bricks, placed flatwise and forming thin surfaces. Traditionally, bricks are set with plaster mortar, in order to provide a fast and cohesive bonding during the construction that allows for the construction of the vaults with no centering. This characteristic, together with the vaults' lightness and versatility in adapting to different forms, has made tile vaulting a recurring technique over the centuries.¹

It is not only the tile vaults that make the Congo Museum so interesting. The archive of the Royal Museum for Central Africa includes priceless documentation about the museum's design and construction, including a collection of drawings for the construction donated by the architect in 1929. Later, in 1967, his son Maurice Girault donated a collection of correspondence and documents about the process of construction, including information on contracts, the chronology of the works, and problems encountered during construction (Luwel 1968).² For the present study, the main sources have been the folders containing masonry drawings (HA.01.0827.18, HA.01.0827.19, HA.01.0827.20)³ and correspondence and other documents between 1901 and 1910 (HA.01.0827.7, HA.01.0827.8 and HA.01.0827.10).⁴ For the latter, there are typewritten copies of some

of the letters sent by Girault, and some of the letters he received. It has not been always possible to follow the complete correspondence, but the documentation gives a general idea of the process.

CHARLES LOUIS GIRAULT: A FRENCH ARCHITECT IN BELGIUM

Born in Cosne (Nièvre) in 1851, Charles Girault studied architecture at the *École des Beaux-Arts* in Paris. During his studies he was awarded with several prizes, including the first *Grand Prix de Rome* in 1880. The reward was a two-year stay at the Villa Medici, the French Academy in Rome. The drawings for the restoration of the Piazza d'Oro in Hadrian's Villa would be awarded with the *Première Médaille* in the *Salon Annuel de la Société des Artistes Français* in 1888. Very interested in ancient architecture, Girault travelled to Sicily, Greece, Tunis, Istanbul, and Asia Minor.

Girault's professional career was very successful. He built several private buildings such as the Palais de l'Hygiène at the Exhibition of 1889, the tribune at Longchamp racecourse, the tomb of Louis Pasteur (in collaboration with Falguière), and the monument to Professor Georges Dieulafoy at the Hôtel-Dieu. But probably the turning point in Girault's career was the International Exhibition in Paris in 1900, when he won the competition to build the Petit Palais and was also commissioned to coordinate the works of the Grand Palais (designed by three different architects). These works gave him international recognition.

Girault was appointed General Inspector of Civil Buildings, officer of the French Legion of Honour (1900), member of the *Institut de France* (1902), and President of the *Société Centrale des Architectes* (1908–09) and of the *Académie des Beaux-Arts* (1910). He was also a member of the jury and the committee of the *Société des Artistes Français* and *Président du Comité des Congrès Internationaux*. Despite these awards, when he died his colleagues from the *École des Beaux-Arts* lamented that he was more recognized abroad than in France: "Why (...) albeit that he carried France's artistic renown abroad, was his merit only recognized beyond its borders?"⁵ (Tournaire 1932, 141). And in fact, Girault was the favourite architect of the Belgian king Léopold II, who commissioned him with some of his most ambitious projects. In 1910 Girault was appointed Commander of the Order of the Crown of Belgium and in 1912 was made a member of the *Académie Royale des Sciences, Lettres et Beaux-Arts de Belgique*. He was also member of the Royal Institute of British Architects, and in 1920, he was awarded the Gold Medal of His Majesty the King of England for the advancement of architecture. Charles Girault died in Paris in 1932.

Charles Girault and Léopold II

Léopold II had several construction projects in mind. He asked French architect Honoré Daumet (1826–1911) to realize these projects, but the architect felt too old to carry out such an important enterprise and declined the invitation, recommending to the king his best student, Charles Girault.⁶ In 1900 the king visited the International Exhibition in Paris, which included Girault's Petit Palais, and took the decision to employ Girault, who would be in charge of the colonial complex in Tervuren, the extension of Laeken Palace, the arcade of the Cinquantenaire, and a portico in Ostende. These works all progressed at around the same time.



Figure 1. Charles Girault's portrait, 1919 (HP.1968.10.6–2, RMCA Tervuren collection, Charles Girault archives).

In 1897 Tervuren hosted the Congolese section of the International Exhibition and the king had the idea of creating an avenue joining the building with the Parc du Cinquanteaire. An arcade had been commissioned to architect Gédéon Bordiau. At the king's wish, Girault started to collaborate with Bordiau, and after Bordiau's death in 1904, Girault took control of, and modified, the project. The project was finished in less than a year and inaugurated in September 1905.

The extension of the Château de Laeken, the king's official residence, started in 1902,⁷ including two wings: on the east side, reception halls and a banquet hall, and on the west, the private apartments for the king, a chapel, and several buildings such as stables and a garage. According to Combaz (1905, 264) 6000 m² of vaults were built in this extension. In particular, the *salle du manège* was covered by a tile vault, 60 mm thick, with a span of 17 m. Auguste Fabre was the specialist contractor in charge of these vaults, and Belgian contractors Charles Daussin and Gairin and Brochon collaborated with him.⁸ Girault was also in charge of a portico in Ostende, between the Chalet Royal and the Wellington hippodrome. The works started in 1907.

The king did not simply hire Girault; he was also actively involved in the projects, as described by the architect:

His Majesty examined the projects submitted to him with an open-mindedness and a critical soundness that made any collaboration easy for those who had the good fortune to be commissioned to carry them out. He liked to preview the arrangements to be adopted down to the smallest detail, and to follow their state of progress during the execution phase.⁹ (Girault 1926, 139)

The death of the king at the end of 1909 had a great impact in these projects, especially, as we will see, in Tervuren.

THE COLONIAL COMPLEX IN TERVUREN

The idea of a Congo Museum arose at the end of the 19th century, and after the International Exhibition in 1897 in Brussels the Congolese Section in Tervuren became the first colonial museum. But the collection grew quickly, and a new building was needed (Luwel 1960). The history of the complex has been studied by Luwel (1960; 1968). A summary of this history, focusing on the museum, is given below.

In October 1901 the king asked Girault to build the big colonial complex in Tervuren, including the Congo Museum, an Overseas Museum, Hall of Physical Exercises, Grand Restaurant, a decorative construction in front of the Congo Museum on the other side of the canal, and some buildings at the eastern end of the canal.¹⁰ Several meetings between Léopold II and the architect took place between October 1901 and 1903. The king was involved in the design process, examining the sketches with the architect and proposing modifications. The Congo Museum was considered the most important building of the complex: “I think that (...) the project implementation efforts should concentrate on the Congo Museum, which is the most important building in this complex, and it is therefore with the development of this monument that I intend to begin.”¹¹ In April 1903, Girault produced a document with the technical specifications of this museum.¹² *Capitaine de Génie* Thirifay was commissioned for the general direction of the works, and Ernest Wouters-Dustin was selected as general contractor (Luwel 1960, 32). In October, Baron Goffinet, *Secrétaire des Commandements du Roi*, asked Girault for the working drawings of the complex, and a description of the works and the materials to be used, so the contractor could elaborate the price schedule. He also informed him that the works could start in spring.¹³ On 24 November 1903 the architect sent Goffinet a general plan of the complex and ten drawings of the museum. The architect wanted to know if he could start with the monitoring wells and asked Wouters to order the materials. He also specified the organisation of the works (similar to the one already implemented for the Palace of Laeken) and the architect’s fees. He would have a work inspector representing him at the site.¹⁴

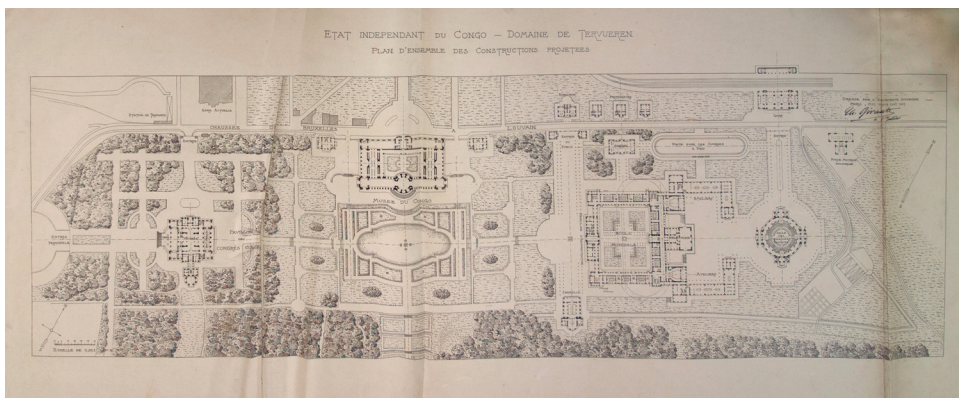


Figure 2. Plan of the Colonial Complex in Tervuren, 1908 (HA.01.0827.18, RMCA Tervuren collection, Charles Girault archives).

In January 1904 Girault received a copy of the contract signed on 31 December 1903 by Baron Goffinet on behalf of the *Domaine de la Couronne* and the *État Indépendante du Congo*, and by the general contractor, Wouters-Dustin. The contract specified that “The undersigned of the second part [Wouters] commits himself to carry out all the works to be done in Tervuren, of which the attached overall plan presented by Architect Girault gives a general idea. The Congo Museum, Overseas Museums, Colonial School, Restaurant and annex are valued in total at about fifteen million.”¹⁵ In the same month, Girault received the results of the monitoring wells and was actively working on the project in order to start the excavation in March.¹⁶ At the end of the month, he received Thirifay’s confirmation: “Everything is settled with Mr. Wouters; you can therefore order the carpentry and everything else relating to Laeken and Tervuren from him, except for the reservations made in Article 2 (I believe) of the Convention.”¹⁷ On 11 February 1904 the architect had finished the overall plan for Tervuren, “on which I have grouped, according to the King’s wishes, all the planned constructions as well as the connection to the railway line.”¹⁸ In March, Girault agreed to collaborate with architect Francotte as inspector of works; Francotte would start in April and work exclusively for the king.¹⁹ The works started and progressed quickly during 1904. In May, Girault contacted Thirifay about the stone for the columns of the courtyard,²⁰ and in a few days he would give Wouters the drawings of the iron floors and the vaults of the basement. In the same letter, he also discussed the use of sandstone from La Rochette.²¹ In September there were 150 masons working on the museum building, and 300 in December, when the basement was almost finished (Luwel 1960).



Figure 3. Royal Museum for Central Africa (Photo: P. Fuentes 2020).

In March 1905, Girault informed Wouters that the Congo Museum would be open in autumn. He had already sent the drawings of the central pavilion, and he would soon send the drawings of its roof. The next building to be constructed would be the *École Mondiale*, and the king wanted to lay its foundation stone in July, meaning that building of the main hall needed to progress as quickly as possible.²² This ceremony took place on 2 July 1905. However, Girault had already warned that the design of the *École* was still incomplete.²³ There is no documentation about the works during the summer, but the museum was not ready to open in autumn and would not be for several more years. A letter dated October 1905 shows a delay in the construction of the entablature and the walls of the courtyard. Francotte was no longer in charge of the inspection of the works, being replaced by architect Camaille.²⁴ In November the rotunda was being built and Girault sent the documentation for the construction of the dome.²⁵ At the end of the month, Girault was again concerned about a delay in the construction:

According to the news I receive from the building site, there does not seem to be much activity for the laying of this base [of the entablature of the cornice and the balustrade]; I am therefore inclined to conclude that the supply is not taking place and I am very much afraid that we will not be able to carry out the covering work any time soon. All the masonry of this building, which was perfectly dry, will once again fill up with moisture and will consequently delay the date of completion and the date on which it will be possible to prepare this part of the Museum.²⁶

Girault wrote to the inspector of works, Camaille, asking him to speed up the order of stone for the sculptures of the balustrade. He also asked to be informed of unexplained delays.²⁷ In December the dome was started. Around this time there are several notes about the construction of the vaults and the dome, which will be explained in detail below.

At the beginning of 1906, there was some correspondence about the sculpture²⁸ and the finishing of the façades: “I think the time has come to think about the refurbishment of the façades of the Congo Museum in Tervuren, as well as the execution of the stone sculpture.”²⁹ In February 1906, Girault warned Camaille that the glass should not be installed too early before the air had dried the plaster well. The dome was progressing, but there was a delay in the balustrade and the attics.³⁰ In March work on the interior finishing was about to start.³¹ In April 1906 Girault wanted to start the covering of the dome,³² and he was discussing the finishing of the stone.³³ There is no more documentation until October 1906, when we can infer that the structural work was almost finished, and electricity, water supplies and sanitation were being discussed.³⁴

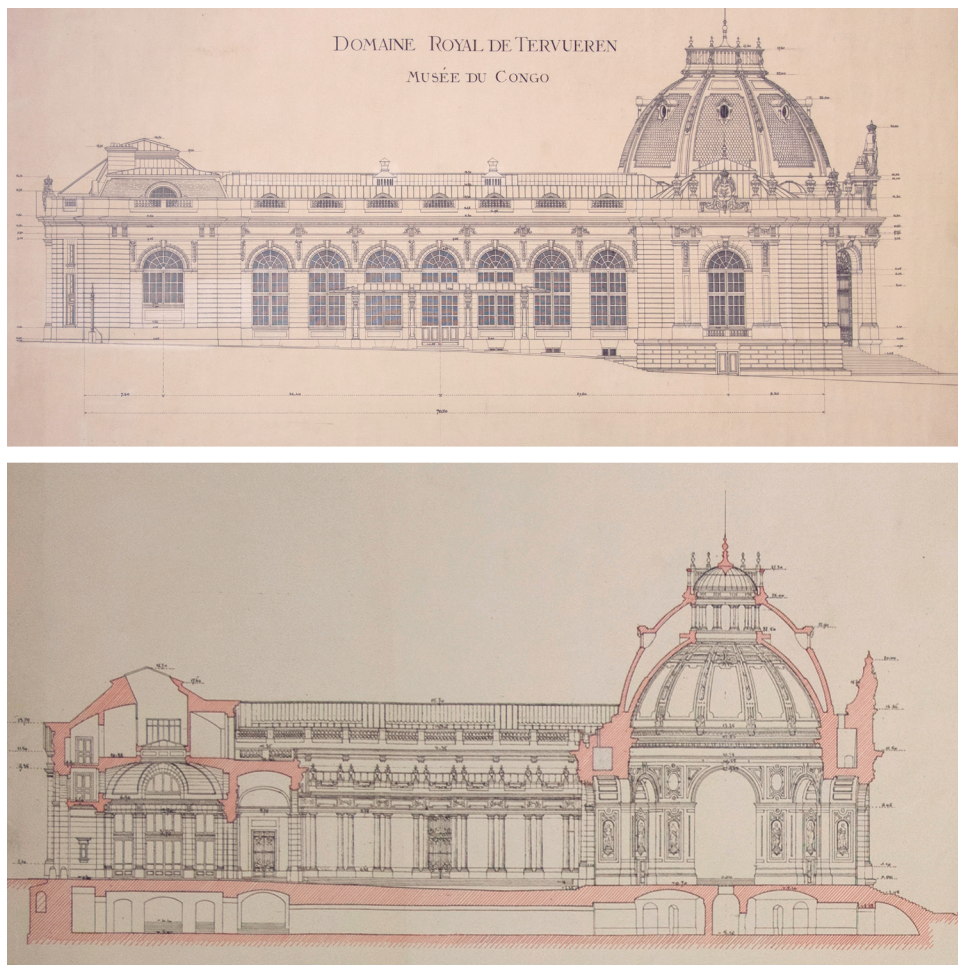


Figure 4. Lateral façade (1909) and section of the Congo Museum (n.d.) (HA.01.0827.18, RMCA Tervuren collection, Charles Girault archives).

At the beginning of February 1907, the *École Mondiale* project was resumed, and Girault received instructions to start the design for this building.³⁵ Regarding the museum, letters from this year show the urgency to finish the building as soon as possible. But as we will see, it would still take three years to inaugurate the museum. In March 1907 the heating of the museum was being discussed,³⁶ and Liebrechts (the General Secretary of the Department of Interior, Congo Free State) urged Girault to work actively to complete the museum works.³⁷ In May 1907, Liebrechts asked Girault for the construction drawings of the *École Mondiale* and

urged again that the museum works “be pursued with the greatest energy.”³⁸ Girault replied that the works continued “methodically,” and it would be important to clarify the heating system and the completion of the façades before execution.³⁹ A cost estimate for the exterior sculpture is dated 7 May 1907, and the letters from May, June and July deal with the sculpture, the disposition of the collection in the museum, and the design of the *École Mondiale*. Discussion about this building continued in August, but the museum building is not mentioned until September, when the interior and the disposition of the collection were again discussed.⁴⁰ Copies of an article in *Le Journal de Paris*, dated 26 September 1907, and of another article (it is not known where was it published), explain that the works carried out by Wouters-Dustin for the king had been stopped during the summer and therefore the contractor asked for six million francs from the *Domaine de la Couronne du Congo*.⁴¹ However, it seems that these problems had more to do with Laeken and Ostende, where works were in fact stopped during the summer, while the *École Mondiale* had not been started.⁴² In October “the work is well under way in Tervuren and the interior installations can now be taken care of.”⁴³ On 6 November 1907, Liebrechts communicated to the architect that the works of the *École Mondiale* could start, and that he should notify the contractor.⁴⁴

In January 1908 the architect gave orders about the museum garden and there is evidence of some inactivity due to cold weather; however, he wanted to know about unexplained delays in order to urge on the contractors.⁴⁵ The architect was also dealing with the furniture.⁴⁶ In February, the contractor Monduit would start to work on the roofs of the museum.⁴⁷ In March, Girault asked Dufas (in charge of inspection of works during Camaille’s absence) to ask the contractor to put more effort into some of the outstanding works. The works were focused now on the exterior.⁴⁸ In June, Liebrechts urged the architect again to finish the museum as soon as possible. Girault replied by describing the state of the works. Only some finishing works were still pending inside, such as paint or electricity, while the works in the exterior had been delayed due to the bad weather and the “disorganisation” of the contractor.⁴⁹ In July a list of the works for the completion of the Congo Museum was sent to contractor Wouters-Dustin. The architect estimated that the contractor could complete the work in two and a half months,⁵⁰ and at the beginning of August he considered that the works to be done by Wouters-Dustin could be finished in October.⁵¹ However, at the end of October there were still some issues about the exterior works and the furniture.⁵² During the last months of the year, the correspondence deals mainly with the inscription of the frontispiece, the painting of the canopy of the covered lateral egress stairs, the glasses for the small glass-dome, and the furniture.⁵³

During 1909, works in the museum building were related to the furniture and decoration. The works were not progressing quickly, because in July 1909 a new list was written up with

the tasks to be finished by Wouters-Dustin, and again Girault considered that they should be done in two or two and a half months.⁵⁴ The contractor undertook to complete them by the end of October, “even earlier in the case of interior work.”⁵⁵ In August 1909 a new contract was signed to build the *École Mondiale*, *Hall des Exercices Physiques*, *Pavillon des Conférences* and *Congrès Coloniaux*.⁵⁶ However, at the end of the year the king died and the concern arose about the possible suspension of the works.⁵⁷ On 14 April 1910, Girault recommended that Camaille no longer take care of the museum because funding for the interior installations had run out.⁵⁸ However, the museum was almost finished, and it was inaugurated on 30 April 1910 by King Albert. By contrast, work on the *École Mondiale* and the other buildings belonging to the complex was definitively stopped on 31 May 1910.⁵⁹

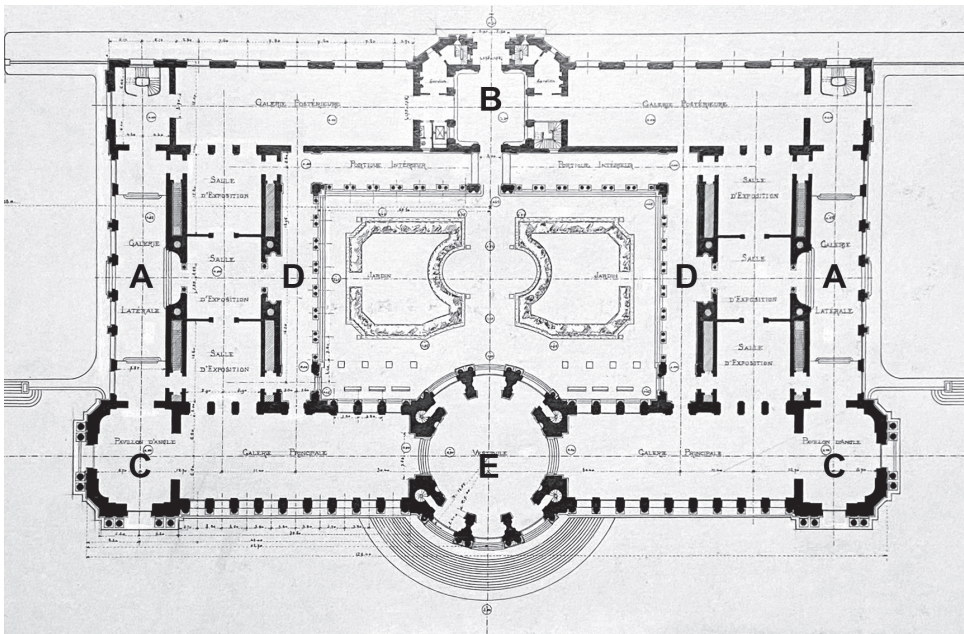


Figure 5. Plan of the Congo Museum (detail of drawing no. 654, HA.01.0827.18, RMCA Tervuren collection, Charles Girault archives).

AUGUSTE FABRE: BUILDER OF THE VAULTS

The museum is composed of the main building and two administration pavilions. The main building has a rectangular plan (ca. 125 × 70 m) with an inner courtyard (fig. 5). The resemblance to the *Petit Palais* was pointed out at the time.⁶⁰ The dome, in the middle of the main (south) gallery, was one of its most remarkable characteristics.

Several spaces in the museum are covered with vaults. Although the vaults were not among the named exceptions in Wouters-Dustin’s contract, he was not in charge of the vaults.⁶¹ The construction of the vaults and the central dome was commissioned to Auguste Fabre, who was also in charge of the horizontal slabs, as stated in a letter from the architect to Camaille: “I must draw your attention to the vaults that Mr Fabre is currently building at the Congo Museum (...).”⁶² At this point, Auguste Fabre should be introduced.

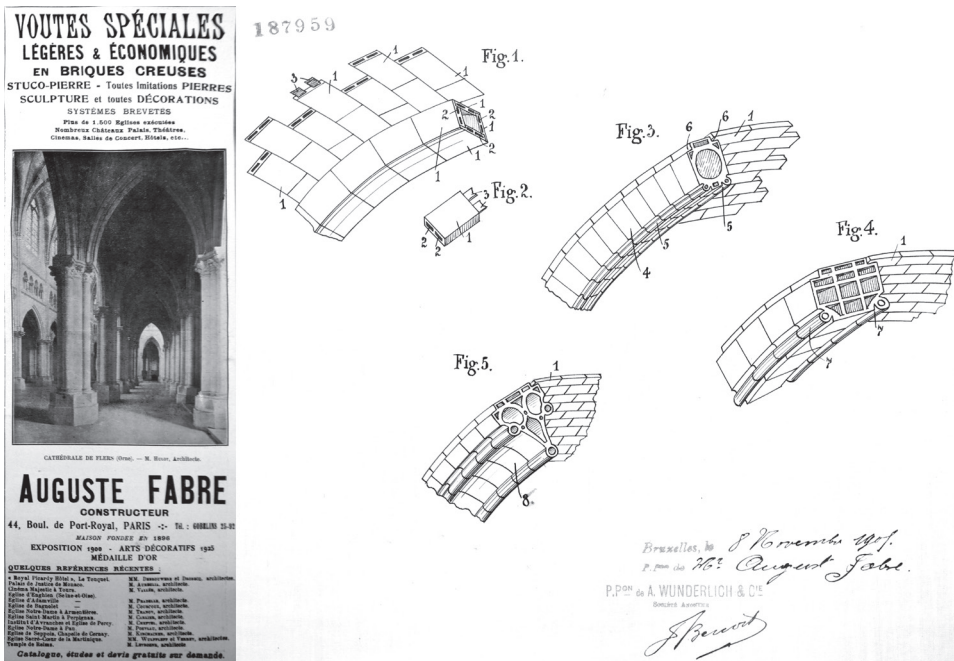


Figure 6. Left: Advertisement by Fabre (La Construction Moderne 1931); right: Patent by Auguste Fabre, 1905 (Archives Générales du Royaume 2 - dépôt J. Cuvelier, Brevets Belges).

French contractor Auguste Fabre founded his company in 1896 for the construction of light vaults in hollow bricks (fig. 6, left). He built thousands of vaults in France, Belgium and Algeria. He worked in different types of buildings, including numerous churches but also other buildings such as chapels, theatres, cinemas, and palaces. Fabre patented several systems for the construction of light vaults (Fuentes 2021c). One of these patents was concerned with the construction of tile vaults. He patented a system of ribbed vaults, using for the ribs either specially moulded bricks or four ordinary hollow bricks. For the webs in between he used the tile vault technique with flat hollow bricks (fig. 6, right). This system was built with

hollow bricks, 40 mm thick, with a weight of around 50kg/m². The vaults were built with no centering and no reinforcement. Fabre also highlighted other characteristics, such as the insulation and the good acoustics provided by the hollow bricks. In the intrados, the vaults were usually covered by a *simili-pierre*, a plaster coat imitating stone (Fabre 1905).



Figure 7. Dome of the Petit Palais under construction (Girault 1908).

Auguste Fabre and Charles Girault had already worked together on the Petit Palais for the International Exhibition in Paris in 1900. The vaults of the Petit Palais gained the attention of engineer A. da Cunha, who highlighted their speed of construction, economy and strength (Cunha 1900, 71). The central dome is especially remarkable, with a span of 24 m and a total thickness of 120 or 150 mm (fig. 7). Together with Girault, Fabre worked not only in the Congo Museum, but also in other buildings commissioned by the Belgian king such as the Royal Palace of Laeken and the Palace and Arcade of the Cinquantenaire (fig. 8). As we have seen, in these works Fabre collaborated with Belgian contractors. Charles Daussin, and Gairin and Brochon, mention in their advertisements their collaboration on the works in Laeken and Tervuren. Fabre was very likely responsible for the spread of tile vaults in

Belgium, which became very common until the middle of the 20th century, when several Belgian companies specialised in the construction of tile vaults and patents were issued (Fuentes 2021a).

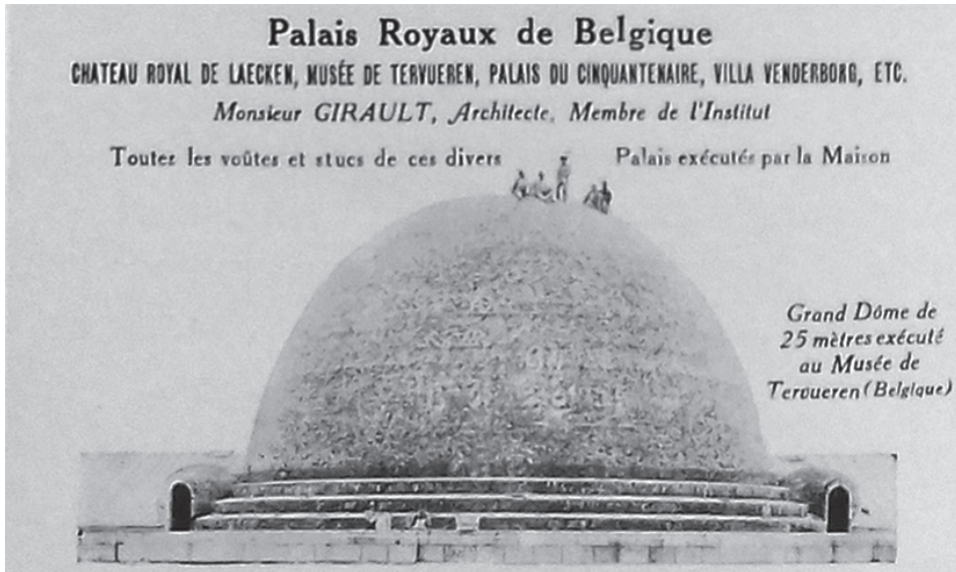


Figure 8. Booklet by Fabre (Simon Texier’s private collection).

DESCRIPTION OF THE VAULTS

There are several references to the construction of the vaults in written documents kept in the archive of the African Museum. We find a first mention in the technical specifications elaborated by the architect in April 1903. For the ground floor: “This floor forming cellars and deposits in almost all its surface will have very low-raised vaults, in Boom bricks and cement over transverse arches made of Boom bricks and cement. (...) All the vaults will be covered with clinker or ash concrete with a cement layer to level off the main floor (...).”⁶³ There is no mention of *voûtes légères*. In May 1904, when the works had already started, a short reference to the vaults was made in a letter from Girault to Thirifay: “In a few days I am going to give him [Wouters] the iron floors and the vaults of the basement floor.”⁶⁴ The description in the 1903 technical specification and a comparison with the Petit Palais suggest that the basement contained regular vaults built with solid bricks (fig. 9).



Figure 9. Vaults of the basement of the Petit Palais under construction (Girault 1908).

However, for the first floor, the description is different: “The vaulted elements: dome, gallery on the façade, end pavilions, porticos in the courtyard, entrance on the Leuven road, will consist of light vaults with or without metal reinforcement. The dome of the Rotunda will be composed of two superimposed vaults also made of masonry. All ceilings and vaults will be plastered.”⁶⁵ Examining the construction drawings, we can see that Girault is speaking about tile vaults. A first layer of bricks flatwise, which is called in the drawings *voûte de cintrage* (centering vault, see fig. 10), acts as a permanent centering for the next layers of bricks, to be placed flatwise or in a radial position, and in a different number of layers, depending on the vault. When the span is small, the first single layer is enough. The bricks are around 50 mm thick (the dimension written in the drawings is 60 mm, which probably includes the mortar). The short side must have a dimension around 100 mm and the long side around 200 mm.

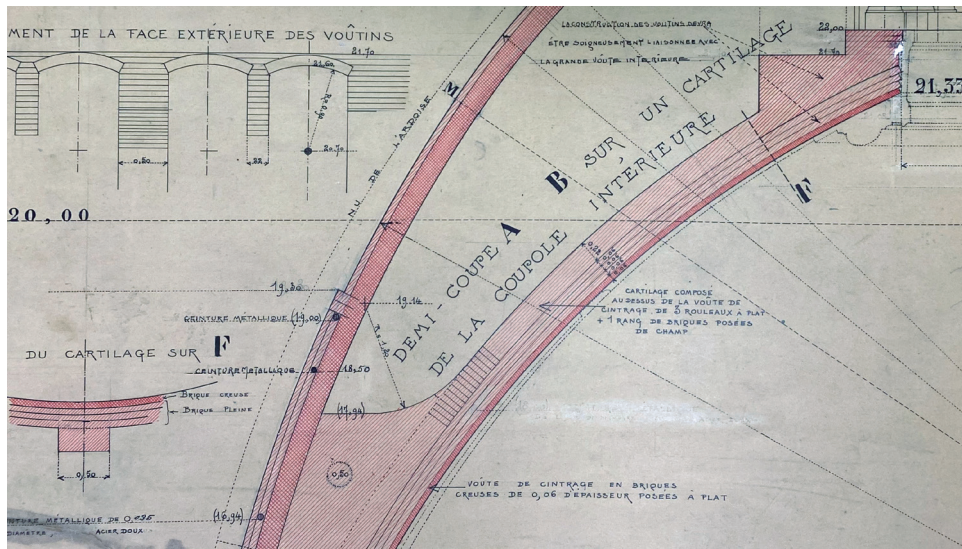


Figure 10. Construction of the first shell of the dome. Note the term *voûte de cintrage* (detail of the drawing no. 225, HA.01.0827.19, RMCA Tervuren collection, Charles Girault archives).

Lateral Galleries

While the ground floor of the lateral galleries is covered with a horizontal slab, the upper part features a slightly pointed barrel vault with lunettes (plate I, A in fig. 5). On December 1905 Girault received some photographs from Camaille from which he could see that the construction of these vaults had begun. He warned: “I see that the hollow-brick vaults of the lateral façades have been started. I hope that the springing of these vaults presses against the length of the iron beam that has been placed on the floor for this purpose, in order to neutralize the thrust of these vaults.”⁶⁶ The span is around 7 m, and they have a radius around 3.9 m. The photographs show that the vaults use a very simple means of construction (fig. 11). Once the springing of the vault is built (fig. 11, top left), a light timber platform is placed over the level of the horizontal floor, so masons can easily reach the upper part of the vault with their hands. We can see the hollow bricks stacked over this platform (fig. 11, top right). The construction of these vaults is not specified, but the drawings suggest a tile vault with only one layer of bricks (ca. 60 mm, see plate I). It can be seen in the photographs that some bricks are placed with their long side perpendicular to the vault, forming the lunettes. The form is given with very light centerings and it is possible to see



Figure 11. Vaults over the lateral galleries, under construction (HP.1968.10.6–41–44, RMCA Tervuren collection, Charles Girault archives).

some buttressing walls between the vaults and the walls. In the photographs we can also see some masons standing over the part of the vault that was already built. A very simple and temporary structure is covering the vaults, protecting them from water (fig. 11, top right). In figure 11, bottom left, the horizontal platform has been removed, and it is possible to see the iron floor and the vault finished.

Main Hall

The main hall of the north gallery has a squared plan with 11.60 m sides, and is covered by a cloister vault with a skylight in the centre and lunettes (plates II–III; B in fig. 5). According to drawing no. 177 (fig. 12), the vault is built with one layer of bricks flatwise (60 mm) and two layers of radial bricks (200 mm), with a total thickness of 260 mm. Over this vault, the horizontal floor is built with walls and small vaults (plates II–III). It can be seen under construction in figure 13.

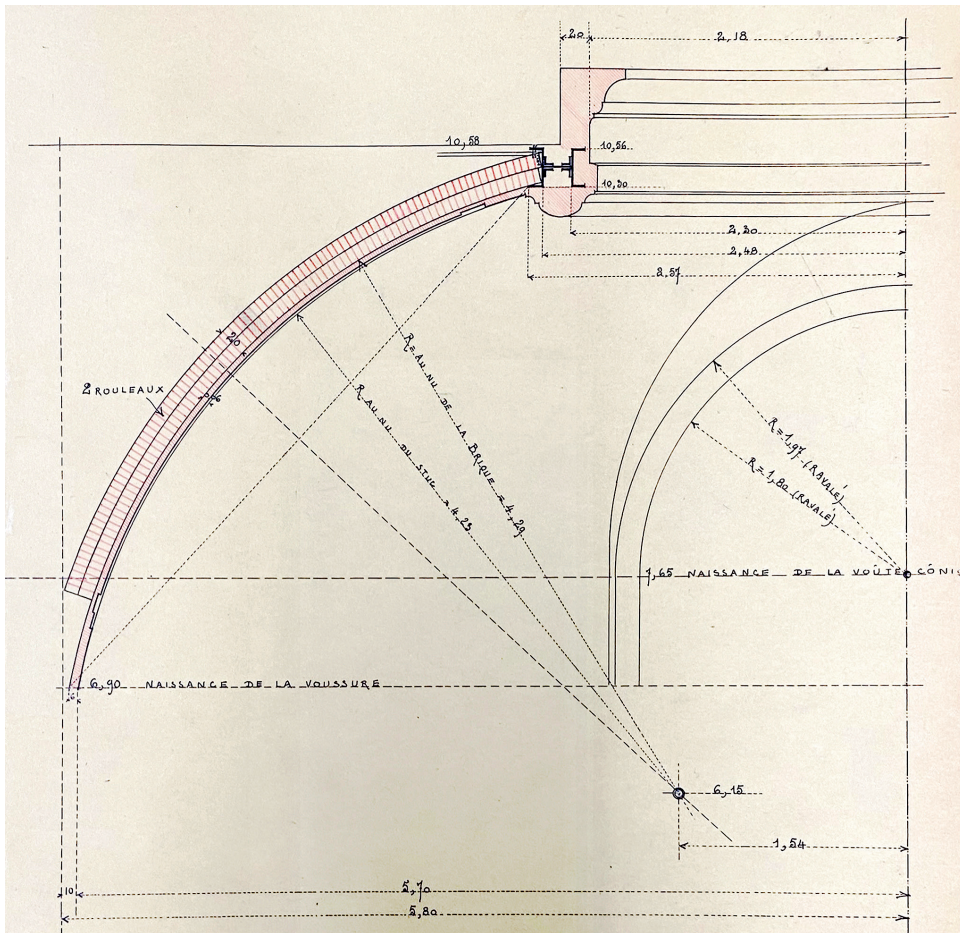


Figure 12. Construction of the vault in the hall (Detail of drawing no.177, HA.01.0827.20, RMCA Tervuren collection, Charles Girault archives).

Corner Pavilions

Two corner pavilions mark the end of the south aisle. They have a dimension of 15×11.40 m and are covered by oval barrel vaults with the longitudinal axe in the direction of the principal gallery, and a quarter of a barrel vault next to the lateral façade, with its longitudinal axe in the perpendicular direction (plate IV; C in fig. 5). Drawings no. 93 and 95 specify that they have a *voûte légère indépendante de la charpente métallique du comble*, and therefore we can conclude that they are built in the way described above, with a tile vault

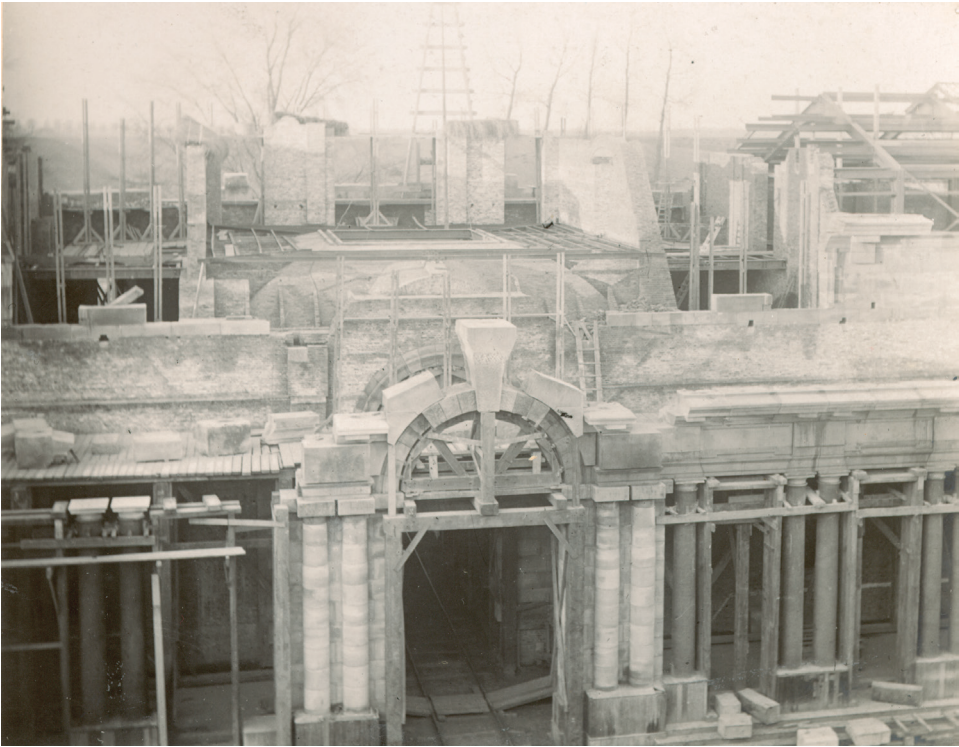


Figure 13. Main hall under construction (HP.1968.10.6–27, RMCA Tervuren collection, Charles Girault archives).

with hollow bricks as a centering, and additional layers of solid bricks. The geometry is specified in drawing no. 302 (plate IV).

Open Gallery of the Courtyard

This gallery (originally open but nowadays closed with glass) is covered by a barrel oval vault, with a span of 5.1 m (plates V–VIII, D in fig. 5). The construction is not specified, but the dimension in the drawings (fig. 15) suggests one single layer of bricks laid flat. The geometry of this vault varies in several parts, and the architect gives the necessary explanations for the geometry in plate VI – the vaults designated by the same letter have the same centering. The springings are at a height of 6.22 m. Arches C are concentric to the barrel B and have a radius 0.25 m smaller.⁶⁷ Barrel B is a semi-oval with three centres. The geometry is defined in drawing no. 114 (fig. 15). The corners of the gallery are covered by a groin



Figure 14. Open gallery of the courtyard (HP.1968.10.6–101, RMCA Tervuren collection, Charles Girault archives).

vault formed by the intersection of two barrels B. The entrance to the lateral exhibition galleries is covered by the intersection of barrel B and barrel D. Barrel D (access to the gallery) has its springings and its keystone at the same level as barrel B. The groins MN and NP (intersection of both vaults) must be straight lines in horizontal projection.⁶⁸ We can imagine that having these lines defined, the geometry in between could be achieved by a good mason with no more instructions. The detail of the geometry of the three sections (B, D, and the groins MN and NP) is given in plate VII. A different solution is given to the entrance to the main hall (B in fig. 5). The geometry is defined by contour lines in plate VIII.

The Central Dome

The dome is one of the main characteristics of this building (plates IX–XV, E in fig. 5). Situated in the axe of the museum, it divides the main gallery into two parts. It is a double

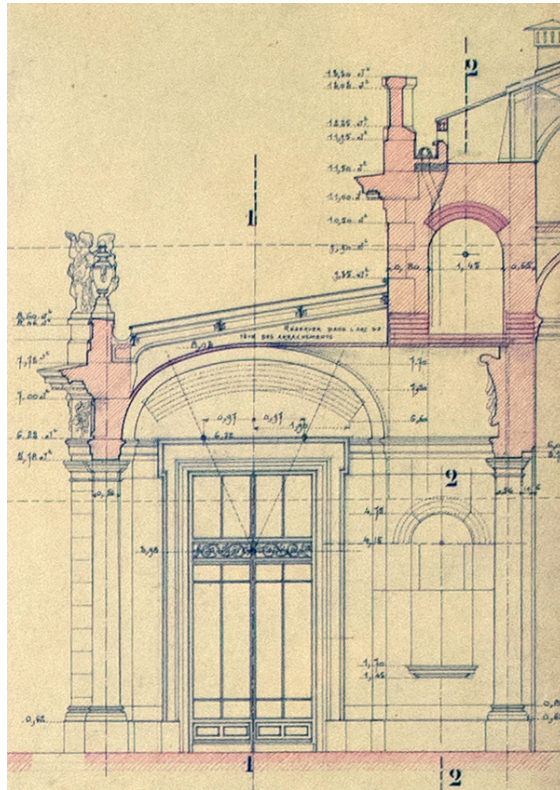


Figure 15. Gallery of the courtyard (Detail of drawing no. 114, HA.01.0827.20, RMCA Tervuren collection; Charles Girault archives).

dome, with a pointed profile and a span around 20 m. In the centre, an oculus is closed with a small metallic glazed dome (fig. 16). Its importance was remarked at the time and considered a singularity in Belgium: “The dome, open in the middle, will certainly be one of the artistic curiosities of the country.”⁶⁹

A first mention of the construction of the central dome can be found in a letter from the architect to the inspector of works, architect Camaille. On 20 November 1905, Girault had sent the dossier for the construction of the dome. He was concerned because not enough stones were being placed to build the base of the entablature. He insisted that it was important to progress as much as possible in the construction of the tambour, and on the base of the entablature, before the construction of the dome. He also remarked that the way to proceed over the arches of the rotunda was explained in drawing no. 100 (plate IX), and there



Figure 16. Dome of the Congo Museum (Photo: P. Fuentes 2020).

should be no changes. In order to have a cheaper and faster construction, brick masonry could be replaced in some parts with concrete.⁷⁰

Next day, on 21 November 1905, a letter to Camaille gives us important information about the construction of the dome and the concerns of the architect:

Sir,

I must draw your attention to the vaults currently being built by Mr Fabre at the Congo Museum.

The season we are going through is not very favourable for the execution of these works. The continuous rain and fog are soaking the plaster and could in some cases cause the fall of vaults or fragments of vaults.

It is therefore important to protect the finished structures to prevent them from being exposed to moisture for a long period of time.

For the construction of the large dome, Mr Fabre will build it with hollow bricks and plaster, without centering, followed by a certain number of layers of solid bricks covered not in plaster, but in cement.

In the first hollow brick vault, Mr Fabre will place a number of headers in order to join together the different layers constituting the thickness of the vault.

You must ensure that Mr Wouters-Dustin's bricklayers do not destroy these headers because they interfere with their brickwork.

I ask that the headers be maintained, and that the brickwork be made accordingly.

Mr. Fabre is very familiar with my methods, but if you have any concerns about the execution of these vaults, please let me know so that I can give you instructions accordingly.⁷¹

The text of this letter shows that Fabre was in charge of the construction of the vaults, and also the confidence that the architect had in him. The construction of the dome was about to start and the letter explains the general construction: a first layer of hollow bricks, joined with plaster and built without centering, was the support of a certain number of solid bricks. Girault warned that the headers should bound the different layers of brick. These additional layers were coated with cement in order to protect them from water. It seems that Fabre built the first layer, the one entailing difficulties and requiring specialized masons. The next layers of bricks were added over the first one by the general contractor's masons. Some of the vaults were already built at this point, since Girault shows his concern about the possible damage because of the water.

In February 1906 the dome was being built, and the architect asked the works inspector about the iron tie that was going to be placed in the dome, noting that the joints between the different pieces of the tie should have the same tension strength as the tie itself:

I insist in particular on the ties of the dome and draw your attention to the joints between the sections of these ties; these joints must be made in such a way that their strength in tension must be equal to the strength of the chain itself.

Could you inform me on this subject, if so far, everything has been done according to the indications of the construction drawings and the recommendations above?⁷²

Some days later, the architect asked for an estimation for the covering of the dome, in ornamented lead and slates.⁷³ In a short note on 13 February, Girault wrote that the dome is progressing – he had probably received some photographs from the works.⁷⁴ The dome must have been almost finished, and a last command was given on 17 February 1906: “I want

the dome of the Congo Museum, when the layers of solid bricks are finished, to be covered with a layer of smooth Portland cement to prevent water reaching the masonry.”⁷⁵ On 7 April the architect urged the contractor to start the works on the roof immediately. The ornamented lead should be prepared in the field and placed over a frame. Finally, the slates should be placed. He remarked that these works would last at least five or six months.⁷⁶ But on 19 May these works had not been started: “Please let me know urgently when the dome of the Congo Museum is cleared of scaffolding so that Mr Monduit can begin his roofing work.”⁷⁷ Finally, on 21 May 1906, the dome was finished, the scaffolding removed, and it was possible to cover the dome. Girault insisted on the importance of avoiding water penetration in the masonry:

My inspector informs me that the dome of the Congo Museum is finished (...) and that the scaffolding has been removed, so we can now think about the roofing work. As you know, I give great importance to ensuring that the masonry is not penetrated by dampness, which is why it is necessary to protect the masonry from the water as soon as possible.⁷⁸

A short note in September 1906 in *Le Mouvement Géographique* affirms that “the metal framework of the central dome is in place.” We can imagine that it is referring to the lantern. However, we must remember that in September 1909 the glass was not in place.

The importance of the dome is evident in the many detailed drawings by the architect. Drawing no. 225 (plate XI) describes the construction of the dome. As has been explained above, the dome is formed by two shells and has an oculus in the middle, covered by a metallic-glass structure. In the lower part (up to 18 m), the internal shell is built with five layers of bricks laid flatwise (300 mm), the first layer with hollow bricks (*voûte de cintrage*), and the others with solid bricks. The upper part has only four layers of bricks (240 mm). It has one tie of mild steel, with a diameter of 35 mm placed at a height of 15.70 m. At this height, and also at 18.00 m (coinciding with the change of thickness), there are bricks placed in the perpendicular direction, standing out from the surface. Instructions are also given in the same drawing for the construction of the external shell: “voûte de cintrage creuse: 0,22 d’épaisseur 2 rouleaux a plat, reliées par des boutisses avec vides intermédiaires” and “briques pleines posées a plat.” This was a hollow structure formed by two layers of bricks (60 mm each) placed flatwise, joined by headers (total thickness 220 mm). Over this surface there are two (up to 19.30 m) layers or one (over 19.30 m) layer of solid bricks, also placed flatwise, 60 mm thick. This second shell has four ties of mild steel, at the base of the dome (around the brick), and at 16.94 m, 18.50 m and 19.00 m, inside the first layer of solid bricks. Twelve

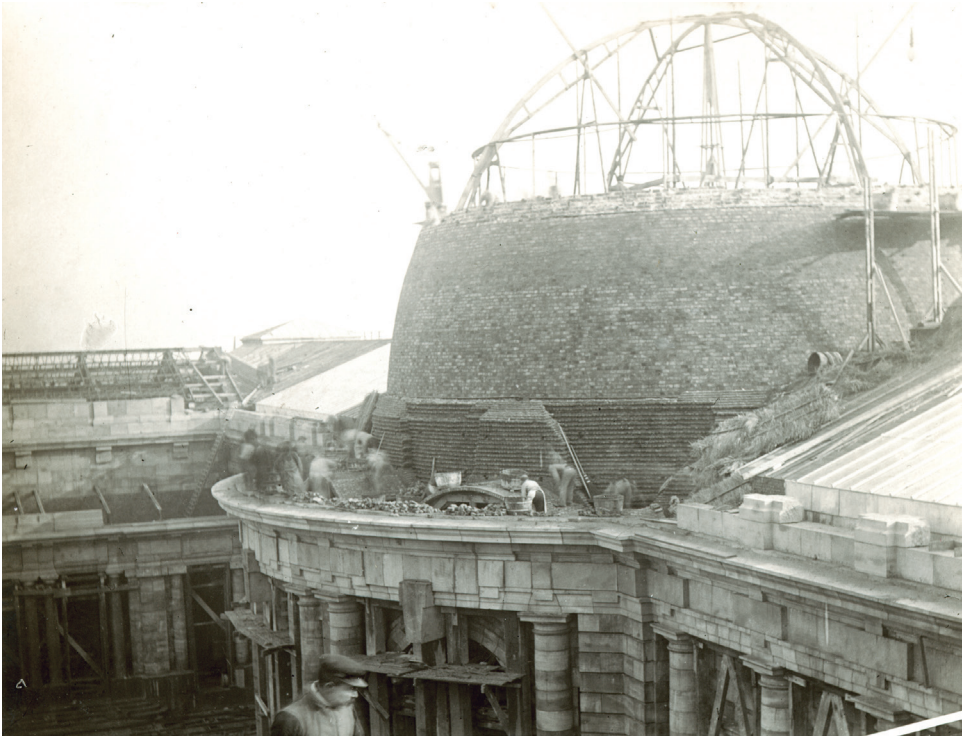


Figure 17. Central dome of the Congo Museum under construction (HP.1968.10.6–52, RMCA Tervuren collection; Charles Girault archives).

ribs, 50 cm thick, formed by one layer of radial bricks over the inner shell, connect with the external one up to a height of 17.94 m. Four staircases give access to the dome. There are two passages between the two shells, one at 18 m and another at 21.70 m. The access to this second passage is given by a metallic stair, represented in drawing no. 472 (plate XII). The outer shell has eight oculus that can be seen in drawing no. 229 (plate XIII).

Figure 17 shows the dome during construction, and the very light centering used to build it. It can also be seen that both shells were built at the same time. The general geometry of the central dome was defined in drawing no. 225 (plate XI). The springing of the vault is at a height of 13.68 m above the floor, and it reaches a height of 21 m in the intrados of the inner shell and 24.45 m in the intrados of the outer shell. The radii were not defined in the drawing, but the centres and some points of the dome determine the geometry. The inner dome is a pointed dome, being the centres under the impost line.



Figure 18. Oculus and lantern of the dome (HP.1968.10.6–61, RMCA Tervuren collection; Charles Girault archives).

This means that the surface of the dome is not tangent to that of the tambour. The span of the inner dome is 19 m. The outer dome has an oval profile, with two centres and has a span of 20 m.

The inner oculus has a diameter of 6.00 m and the outer oculus of 6.40 m. These two oculi are joined together by twelve pairs of columns, built also with hollow bricks (fig. 18) and closed by a metallic structure. The inner decoration of the dome is drawn in drawings no. 92 (plate X) and 291.

One particularly significant and appealing drawing by Girault, drawing no. 253 (plate XIV), contains the structural analysis of the dome by means of graphic statics, signed by the architect himself (Fuentes 2021b). The study of this analysis remains beyond the scope of this work, but its importance should be pointed out, and a future work will hopefully shed more light about a singular (and unknown) method for the structural analysis of masonry domes.

CONCLUSION

The Congo Museum in Tervuren is a keystone in the history of construction at the beginning of the 20th century in Belgium, and the documentation kept in the archive is priceless. The written documents donated by the son of the architect allow us to follow the progress of the works, which progressed quickly for the structural work, but were delayed when dealing with finishing works. Although the building was planned to be finished in autumn 1905, it was only inaugurated five years later. Detailed drawings by the architect explain perfectly the construction of the building, and photographs during the construction show the process and techniques. This chapter has focused on the vaults, and the construction drawings concerned with masonry, especially those relevant to the vaults, have been analysed. However, there is still a great number of construction documentation regarding façades, carpentry, ironwork, roof, marble, etc. still unstudied. The works in Laeken, Parc du Cinquantenaire and Ostende also deserve deeper study.

The vaults of the museum were commissioned to specialist contractor Fabre, and several tile vaults were built in hollow bricks. Most of the vaults are built with a first layer of bricks placed flatwise, making a centering for the additional layers of solid bricks. This technique allowed for economical construction due to the lightness and the reduction of the auxiliary construction means.

There is no evidence of the construction of tile vaults in Belgium before the ones contained in the Congo Museum. This building was, therefore, ground-breaking in the use of this technique in the country. The construction of this type of vault would spread in Belgium for the next half century, becoming a very common technique, especially in churches. Specialist contractors built hundreds of tile vaults and issued several patents, evidencing the interest in this vault construction method.

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NOTES

1. In recent years, there has been a great interest in tile vaults among scholars, and new discoveries are being made. For the general history of tile vaults, see Zaragozá (2012). For the use of tile vaults in France and Germany in the 20th century, see the chapter by Huerta (2021) in this book. For the use of tile vaults in Belgium, see Fuentes 2021a.
2. The Charles Girault collection at the Royal Museum for Central Africa comprises a total of twenty-nine volumes, seventeen of them concerning the Congo Museum (five with correspondence and other written documents, and twelve with drawings). HA.01.0827, Royal Museum for Central Africa (RCMA) Tervuren collection, Charles Girault archives (hereafter, only the collection item code will be given). <https://hdl.handle.net/20.500.12624/001-0001-0000000805>. Accessed 5 August 2020.
3. Unfortunately, it has not been possible to consult a fourth folder containing masonry drawings: HA.01.0827.21 *Domaine Royal de Tervuren. Musée du Congo. Maçonnerie. Pavillons d'angles, façade postérieure & galerie d'exposition. Recueil des plans, coupes et élévations et détails d'exécution en six volumes*. Ch. Girault, Architecte du Gouvernement – Membre de l'Institut. Volume IV, 1905–1907. This volume presumably contains information about the construction of the vaults of the corner pavilions.
4. *Domaine Royal de Tervuren, Belgique. Création sur le domaine d'une Université Coloniale. Musée-École Mondiale-Palais des Congrès. Correspondance et documents divers 1901 à 1907*. Vol. 1. HA.01.0827.7; *Domaine Royal de Tervuren, Belgique. Création sur le domaine d'une Université Coloniale. Musée-École Mondiale-Palais des Congrès. Correspondance et documents divers 1908 à 1909*. Vol. 2. HA.01.0827.8 and *Domaine Royal de Tervuren, Belgique. Création sur le domaine d'une Université Coloniale. Musée-École Mondiale-Palais des Congrès. Correspondance et documents divers 1910*. Vol. 3. HA.01.0827.9.
5. “Porquoi a-t-il fallu que depuis lors, et bien qu'il eût porté à l'étranger le renom artistique de la France, son mérite n'ait été reconnu qu'au de là des frontières!”
6. Maurice Girault to Marcel Luwel, 27 December 1967, HA.01.0827.17.
7. Girault, *Domaine Royal de Laeken. Sommaire des Lettres et des Documents les plus importants contenus dans le Volume I, 1901 à 1904*, HA.01.0827.1.
8. According to an advert by Charles Daussin, the area of vaults built in Laeken was 12000 m² (*Index du Bâtiment* 1921, 37).
9. “Sa Majesté examinait les projets qui lui étaient soumis, avec une ampleur de vues et une justesse de critique rendant toute collaboration facile à qui avait l'heureuse fortune d'être appelé à les réaliser. Elle aimait à prévoir jusque dans les moindres détails les dispositions à adopter, et à suivre, lors de l'exécution, leur état d'avancement.”
10. Girault, *Notice par ordre chronologique sur les Esquisses, Avant-projets et Projets faits pour les constructions à édifier au Domaine de Tervuren et Correspondance échangée à ce sujet, du 28 Octobre 1901 au mois d'Avril 1910*, HA.01.0827.7, fol. 5–10.
11. “Je pense que (...) les efforts de l'étude en vue de l'exécution devraient porter sur le Musée du Congo qui est l'édifice le plus important de cet ensemble c'est donc par le développement

de ce monument que je compte commencer.” Girault to Comte d’Oultremont, 22 November 1902, HA.01.0827.7, fol. 14.

12. Girault 1903, *Domaine de Tervuren. Liste Civile, construction d’un musée du Congo. Notice descriptive*, HA.01.0827.7, fol. 15–25.

13. Baron Goffinet to Girault, 29 October 1903, HA.01.0827.7, fol. 34r–v.

14. Girault to Baron Goffinet; the letter is dated the 24 September 1903 (HA.01.0827.7, fol. 35–39), but in a later document he wrote that this letter was sent the 24 November (Girault to Goffinet, 21 January 1904, HA.01.0827.7, fol. 42–44).

15. “Le soussigné de seconde part d’engage à exécuter tous les travaux à faire à Tervuren et dont le plan d’ensemble ici joint remis par Monsieur l’Architecte Girault donne une idée Générale. Musée du Congo, Musées d’Outre-Mer, École Coloniale, Restaurant et annexe le tout évalué a Quinze Millions environ.” Contract signed by Baron Goffinet and Ernest Wouters-Dustin, 31 December 1903. HA.01.0827.7. The contract was sent by Thirifay, *capitaine du Génie*, on 14 January 1904.

16. Girault to Baron Goffinet, 21 January 1904, HA.01.0827.7, fol. 42–44.

17. “Tout est réglé avec M. Wouters; vous pouvez donc lui commander les menuiseries et tout ce qui regarde Laeken et Tervuren sauf les réserves faites dans l’article 2 (je crois) de la convention.” Thirifay to Charles Girault, 29 January 1904, HA.01.0827.7. Article 2 of the contract says: “Ces travaux comprennent tout ce que est nécessaire pour la mise sous toit et l’achèvement des bâtiments sauf: a) La menuiserie sculptée; b) l’établissement d’un système de chauffage; c) les travaux d’art et de décoration; d) les objets d’art, statues, vases, etc; e) le mobilier.”

18. “J’ai terminé le plan d’ensemble de Tervuren sur lequel j’ai groupé, selon le désir du Roi, toutes les constructions projetées ainsi que le raccordement à la ligne de chemins de fer (...).” Girault to Baron Goffinet, 11 February 1904, HA.01.0827.7, fol. 49.

19. Girault to Francotte, 26 March 1904, HA.01.0827.7, fol. 51.

20. Girault to Thirifay, 5 May 1904, HA.01.0827.7, fol. 54.

21. Girault to Thirifay, 11 May 1904, HA.01.0827.7, fol. 55 and Girault to Thirifay, 16 May 1904, HA.01.0827.7, fol. 56.

22. Girault to Ernest Wouters, 25 March 1905, HA.01.0827.7, fol. 65r–v.

23. In a letter to Comte d’Oultremont, Girault explained that the drawings of this building were still sketches, and therefore the foundation stone would be only a ceremony, but strictly speaking, it would not form part of the actual building. Girault to Comte d’Oultremont, 6 April 1905, HA.01.0827.7, fol. 66.

24. Girault to Francotte, 31 October 1905, HA.01.0827.7, fol. 76.

25. Girault to Camaille, 20 November 1905, HA.01.0827, fol. 78r–v.

26. “D’après les nouvelles que je reçois du Chantier, il ne semble pas qu’il y ait beaucoup d’activité pour la pose de ces assises ; je suis donc porté à conclure que le fourniture ne s’effectue pas et je crains fort que nous ne puissions, de sitôt, faire les travaux de couverture. Toutes les maçonneries de cet édifice qui étaient parfaitement sèches vont, de nouveau, se remplir

d'humidité et retarderont, en conséquence, la date d'achèvement et celle à laquelle il sera possible d'aménager la portion du Musée." Girault to Wouters, 27 November 1905, HA.01.0827.7, fol. 79.

27. Girault to Camaille, 18 December 1905, HA.01.0827, fol. 80r–v.

28. Girault to Thirifay, 5 January 1906, HA.01.0827, fol. 83 and Girault to Camaille, 18 January 1906, HA.01.0827.7, fol. 84.

29. "Je crois que le moment est venu de penser au ravalement des façades du Musée du Congo à Tervuren, ainsi qu'à l'exécution de la sculpture sur pierre." Girault to Wouters, 1 February 1906, HA.01.0827.7, fol. 85.

30. Girault to Camaille, 13 February 1906, HA.01.0827, fol. 89.

31. Girault to Thirifay, 14 March 1906, HA.01.0827.7, fol. 91.

32. Girault to Wouters, 7 April 1906, HA.01.0827.7, fol. 93. However, in May it had not yet started, Girault to Monduit, 21 May 1906, HA.01.0827, fol. 98.

33. Girault to Camaille, 11 April 1906, HA.01.0827, fol. 94.

34. Girault to Thirifay, 10 October 1906?, HA.01.0827.7, fol. 99–100. The question mark is in the letter.

35. Liebrechts to Girault, 9 February 1907, HA.01.0827.7, fol. 101.

36. Thirifay to Girault, 5 March 1907, HA.01.0827.7, fol. 131r–v; Liebrechts to Girault, 9 March 1907, HA.01.0827.7, fol. 138.

37. Liebrechts to Girault, 8 March 1907, HA.01.0827.7, fol. 135.

38. Liebrechts to Girault, 3 May 1907, HA.01.0827.7, fol. 141.

39. Girault to Liebrechts, 6 May 1907, HA.01.0827.7, fol. 142.

40. Liebrechts to Girault, 25 September 1907 and answer from Girault, 28 September 1907, HA.01.0827.7, fol. 198r–199r.

41. In the folder there is a transcription of *Le Journal* (1907); HA.01.0827.7, fol. 195–97.

42. "L'arrêt subit des travaux de Laeken; la non-exécution de ceux d'Ostende et de Tervuren, qui, sauf le Musée du Congo, ne sont pas commencés, ont paralysé l'activité de M. Wouters-Dustin, l'empêchement d'utiliser un matériel considérable, un grand personnel, le privent enfin d'un bénéfice prévu. Les observations du requérant sont restées sans réponse. Le 4 juin, il a reçu l'ordre de cesser complètement les travaux de Laeken. Il a du couteusement licencier un nombreux personnel, revendre avec perte une énorme quantité de matériaux" *Le Journal* (1907).

43. "Les travaux sont en bonne voie d'exécution à Tervuren et l'on peut dès maintenant se préoccuper des installations intérieures." Girault to Liebrechts, 11 October 1907, HA.01.0827.7, fol. 202r–v.

44. Liebrechts to Girault, 6 November 1907, HA.01.0827.7, fol. 205. However, the previously mentioned problems with the contractor held up the beginning of the works until July 1909, when Jean Wouters-Jacobs, son of Wouters-Dustin, took charge as contractor for the works: Girault to Delbeke, 12 July 1909, HA.01.0827.8, fol. 369–70.

45. Girault to Camaille, 17 January 1908, HA.01.0827.8, fol. 221r–v.
46. Liebrechts to Girault and Girault's reply, 18 and 20 January 1908, HA.01.0827.8, fol. 222–23.
47. Girault to Camaille, 8 February 1908, HA.01.0827.8, fol. 227.
48. Girault to Dufas, 23 March 1908, HA.01.0827.8, fol. 281. With this letter Girault sent a list of these works that is not in the archive. Dufas to Girault, 25 March 1908, HA.01.0827.8, fol. 282r–v.
49. Girault to Liebrechts, 12 June 1908, HA.01.0827.8, fol. 287–88.
50. Girault to Thirifay, 11 July 1908, HA.01.0827.8, fol. 295.
51. Girault to le Grand Maréchal, 1 August 1908, HA.01.0827.8, fol. 297r–v.
52. Girault to Camaille, 23 October 1908, HA.01.0827.8, fol. 299; Liebrechts to Girault, 28 October 1908, HA.01.0827.8, fol. 300.
53. Several items of correspondence from 6 November to 21 December 1909, HA.01.0821.8, fol. 299–308.
54. Girault to Liebrechts, 10 July 1909, HA.01.0827.8, fol. 364r–67v.
55. Wouters-Dustin to Liebrechts, 17 July 1909, HA.01.0827.8, fol. 373.
56. Contract signed on 25 August 1909 by Girault, le Ministre Plénipotentiaire et Envoyé Extraordinaire, Intendant de la Liste Civile and le Ministre des Travaux Publics, HA.01.0827.8.
57. Girault to Camille, 24 March 1910, HA.01.0827.9, fol. 521r–v.
58. Girault to Camaille, 14 April 1910, HA.01.0827.9, fol. 534.
59. Delbeke to Girault, 27 May 1910, HA.01.0827.9, fol. 540.
60. “Sa façade principale, dont l’aspect se rapproche sensiblement de celle du petit Palais des Champs Elysées, ne comporte qu’un seul étage, coupé de grandes baies. Elle est surmontée d’un dome central.” (*La Chronique des Travaux Publics* 1904); “un palais superbe, réplique quelque peu modifiée du Petit Palais, de Paris.” (*Le Mouvement Géographique* 1906).
61. For the exceptions in this contract, see note 17.
62. “Je dois attirer votre attention sur les voûtes que construit, en ce moment, Monsieur Fabre au Musée du Congo.” Girault to Monsieur Camaille, 19 December 1905, HA.01.0827.7, fol. 81r–v. In a later letter, “J’adresse au Capitaine les renseignements qu’il m’avait demandés sur les sous-détail de Monsieur Fabre pour l’exécution des hourdis du Musée du Congo.” Girault to Monsieur Camaille, 19 December 1905, HA.01.0827.7, fol. 82r–v.
63. “Cet étage formant caves et dépôts dans presque toute sa surface sera voûté très surbaissées, en briques de Boom et ciment sur arcs doubleaux en briques de Boom et ciments sur presque toute sa surface. (...) Toutes les voûtes et voûtins seront recouvertes de béton de mâchefer ou de cendrée avec chape en ciment de façon à niveler le sol de l’étage principal (...)” Girault 1903, *Domaine de Tervuren. Liste Civile, construction d’un musée du Congo. Notice descriptive*, HA.01.0827.7, fol. 15–25.
64. “Je vais, dans quelques jours, lui [Wouters] donner les planchers en fer et les voûtes de l’étage de soubassement.” Girault to Thirifay, 11 May 1904. HA.01.0827.7, fol. 55.

65. “Celle voûtées: coupole, galerie sur la façade, pavillons d’extrémité, portiques dans la cour, entrée sur la route de Louvain, le seront au moyen de voûtes légères avec ou sans armature métallique. La coupole de la Rotonde sera composée de deux voûtes superposées exécutées également en maçonnerie. Toutes les plafonds et voûtes seront enduits en plâtre.” Girault 1903, *Domaine de Tervuren. Liste Civile, construction d’un musée du Congo. Notice descriptive*, HA.01.0827.7, fol. 23.

66. “...je vois que les voûtes en briques creuses sur les façades latérales sont commencées. J’espère bien que la naissance de ces voûtes butte le long de la longrine en fer qui a été disposée sur le plancher à cet effet, de manière à neutraliser la poussée de ces voûtes.” Girault to Camaille, 18 December 1905. HA.01.0827.7, fol. 80r–v.

67. “Les voûtes désignées par la même lettre ont même cintre. Leur naissance est à la cote 6,22 m. Les doubleaux C sont concentriques aux berceaux B et ont 0,25 m de moins comme rayons.” Text in drawing no. 149, HA.01.0827.19 (plate VI).

68. “Le berceau D, de même naissance et de même hauteur a la clef que B, est déterminé par la condition suivante: les deux arêtes d’intersection MN, NP se projettent suivant deux lignes droites. L’entrepreneur devra présenter l’épure de ce cintre à l’inspecteur avant toute exécution.” Text in drawing no. 149, HA.01.0827.19 (plate VI).

69. “La coupole, s’ouvrant au milieu, constituera certainement une des curiosités artistiques du pays” (*Le Matin de Bruxelles* 3 August 1907). Transcription in HA.01.0827.7, fol. 180.

70. Girault to Camaille, 20 November 1905, HA.01.0827.7, fol. 78r–v.

71. “Monsieur, Je dois attirer votre attention sur les voûtes que construit, en ce moment, Monsieur Fabre au Musée du Congo. La saison que nous traversons est peu propice à l’exécution de ces ouvrages. La pluie et le brouillard continuel détrempe les plâtres et pourraient dans certains cas, amener la chute des voûtes ou de fragments de voûtes. Il importe donc de bien protéger les ouvrages terminés, de manière à éviter qu’ils soient, pendant longtemps, sous l’action de l’humidité. Pour l’exécution de la grande coupole, Monsieur Fabre fera en briques creuses et plâtre la voûte sans cintre qui devra recevoir ensuite un certain nombre de rouleaux de briques pleines qui seront hourdées non pas en plâtre, mais en ciment. Monsieur Fabre ménagera dans la première voûte en briques creuses un certain nombre de boutisses de façon à liasonner entre eux les différents rouleaux constituant l’épaisseur de la voûte. Vous devez veiller à ce que les briqueteurs de Monsieur Wouters-Dustin ne détruisent pas ces boutisses sous prétexte qu’elles gênent leurs combinaisons de briques. Je demande que les boutisses soient maintenues et que les combinaisons soient faites en conséquence. Voulez vous veiller très particulièrement à l’exécution de ces voûtes, Monsieur Fabre est très au courant de ma façon de faire, mais si au cours de ces travaux vous aviez une inquiétude quelconque, veuillez me le faire savoir afin de recevoir de moi des instructions en conséquence.” Girault to Camaille, 18 December 1905. HA.01.0827.7, fol. 81r–v.

72. “Je vous recommande tout particulièrement les chaînages ceintures de la coupole et attire votre attention sur les jonctions des tronçons de ces chaînages, lesquelles jonctions doivent être faites de telle manière que leur travail à la traction doit être égal au travail de la mention de la chaîne elle-même. Voulez vous me répondre à ce sujet que j’usqu’ici, tout a été fait conformément aux indications des plans et aux recommandations ci-dessus.” Girault to Camaille, 5 February 1906, HA.01.0827.7, fol. 86.

73. Girault to Monduit, 9 February 1906, HA.01.0827.7, fol. 88.

74. Girault to Camaille, 13 February 1906, HA.01.0827.7, fol. 89.
75. “Je désire que la coupole du Musée du Congo, quand les rouleaux de briques pleines seront terminés, soit revêtue d’une chape en ciment de Portland bien lissée, de façon à empêcher l’humidité de gagner toutes ces maçonneries.” Girault to Camaille, 17 February 1906, HA.01.0827.7, fol. 90.
76. Girault to Wouters-Dustin, 7 April 1906, HA.01.0827.7, fol. 93.
77. “Veuillez me faire savoir d’urgence quand le dôme du Musée du Congo sera débarrassé de ses échafaudages afin que Monsieur Monduit puisse commencer son travail de couverture.” Girault to Camaille, 19 May 1906, HA.01.0827.7, fol. 97.
78. “Mon inspecteur me fait savoir que le dôme du Musée du Congo est terminé comme [la] charpente et que les échafaudages ont été enlevés, on peut donc en conséquence penser maintenant aux travaux de couverture. Vous savez l’importance que j’attache à ce que les maçonneries ne soient pas pénétrées d’humidité, d’où il s’ensuit la nécessité de ce mettre, sur ce point, hors d’eau le plus tôt possible.” Girault to Monduit, 21 May 1906, HA.01.0827.7, fol. 98.

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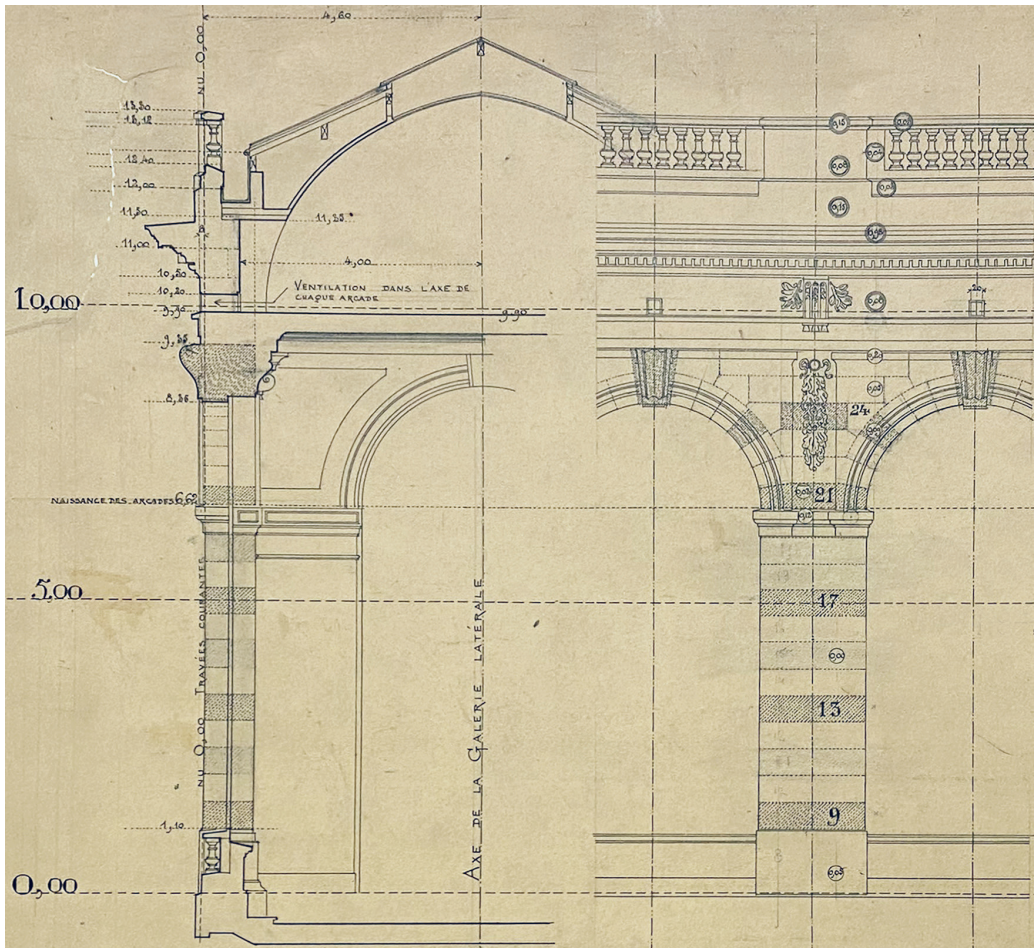
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Plates

Plate I. Lateral façade and gallery. Crown cornice and balustrade. Original scale: 1/50.
Dated 1 February 1905 (Part of drawing no. 102, HA.01.0827.18, RMCA Tervuren
collection, Charles Girault archives).



FAÇADE LATÉRALE TRAVÉES COURANTES

CORNICHE DE COURONNEMENT ET BALUSTRADE

MODIFICATION A L'IMPLANTATION PRIMITIVE (FEUILLES 12,13,14)

LA MOULURAGE EXTERIEURE RESTE CELLE DONNEE PAR LES
 DÉTAILS GRANDEUR D'EXECUTION N°60 (CORNICHE) ET N°68
 (BALUSTRADE), LES COTES DE SAILLIE PAR RAPPORT AU
 NU (0,00) ÉTANT DIMINUÉES DE 0,09, CONFORMÉMENT
 AUX COTES CONTENUES DANS DES TRIPLES CERCLES. —
 AFIN DE NE PAS DIMINUER LA LARGEUR DU CHÉNEAU,
 IL SERA DONNÉ UN DÉTAIL RECTIFIANT LE RAVALEMENT
 INTÉRIEUR DE LA BALUSTRADE

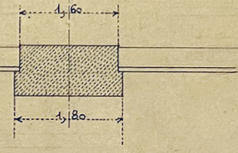


Plate II. Section through the main hall (Drawing no. 108, HA.01.0827.20, RMCA Tervuren collection, Charles Girault archives).

N^o 108

COUPE SUIVANT C D DE LA FEUILLE

N^o 105

COUPE SUIVANT E F DE LA FEUILLE

N^o 105

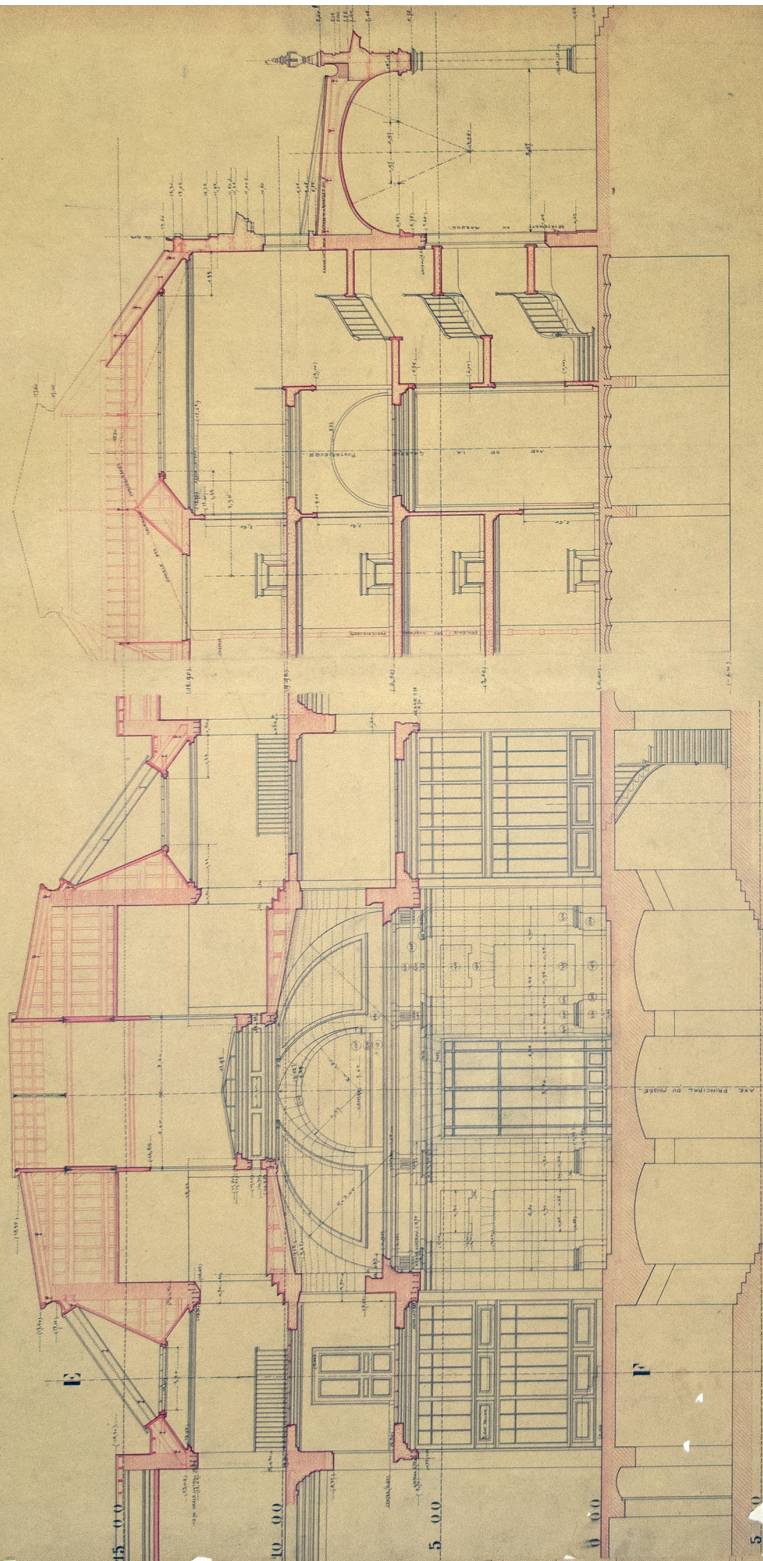


Plate III. Rear façade. Vault of the main hall. Original scales: 1/50 (left part of the drawing) and 1/20 (seccion AA, right side of the drawing). Dated 26 June 1905 (Drawing no. 177, HA.01.0827.20, RMCA Tervuren collection, Charles Girault archives). Note on section AA the composition of the vault, with one layer of bricks flatwise, and two layers in a radial position.

ÉCRITANT PARTIE DES FEUILLES
105, 108, 109

MUSEE DU CONGO

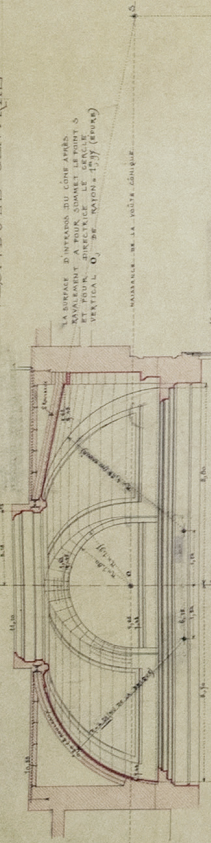
COUPE SUIVANT A.A

COUPE SUIVANT B.B

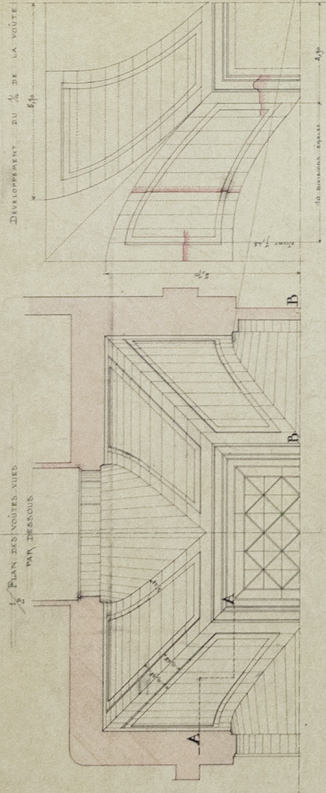
FAÇADE POSTÉRIEURE
VESTIBULE CENTRAL

LA DÉCORATION DÉPENDANT DE LA COTE
CORRESPONDANT A UN POINT DONNÉ LE POINT O
EST LE POINT DE DÉPART DE LA
COURBE. O, 200 (MÈTRES)

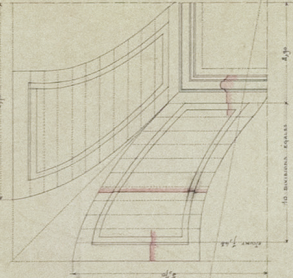
RAYON DE LA VOUTE DÉSIGNÉ



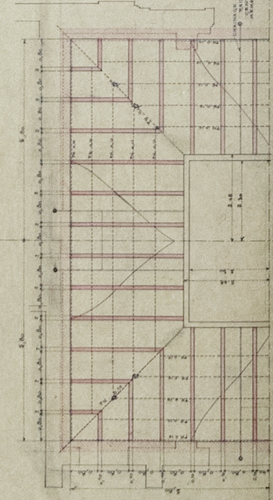
PLAN DES VOUTES VUES
PAR DESSUS



DÉVELOPPEMENT DU 1/2 DE LA VOUTE



1/2 PLAN DES VOUTES VUES PAR DESSUS ET DES MARCHES VUS PAR
LE TROUSSEAU (0,05)



ÉCHELLE DE 0,05 m

FAÇADE POSTÉRIEURE
MOTIF CENTRAL - VESTIBULE
COUPE AA DE LA FEUILLE 177

ÉCHELLE DE 0,05 m

NOTA. L'ENTRÉE DE LA VOUTE
PARIS, LE 28-AOÛT-1908

Et. Pradier
de l'Institut.

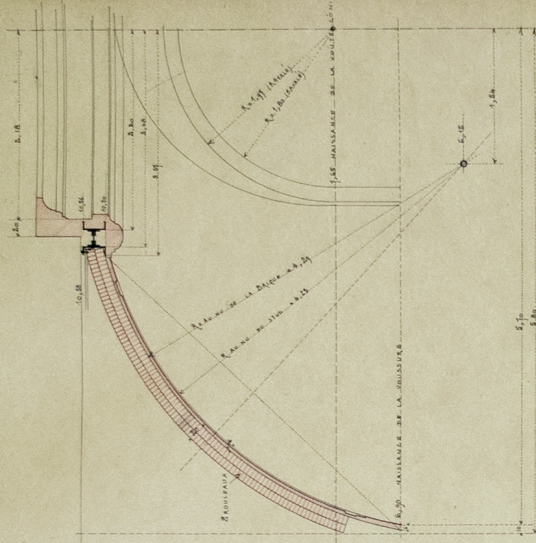
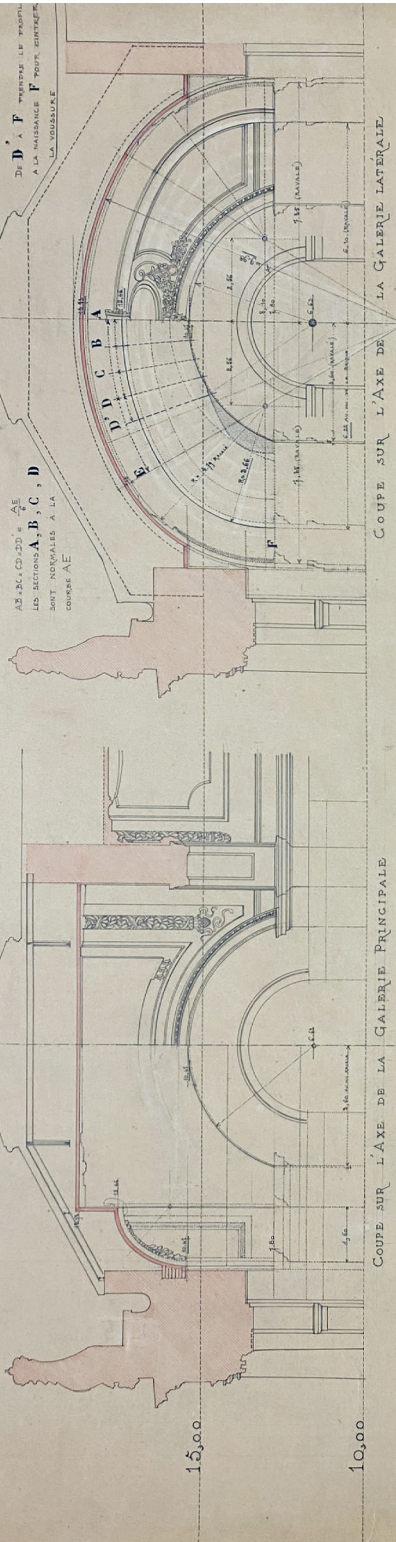


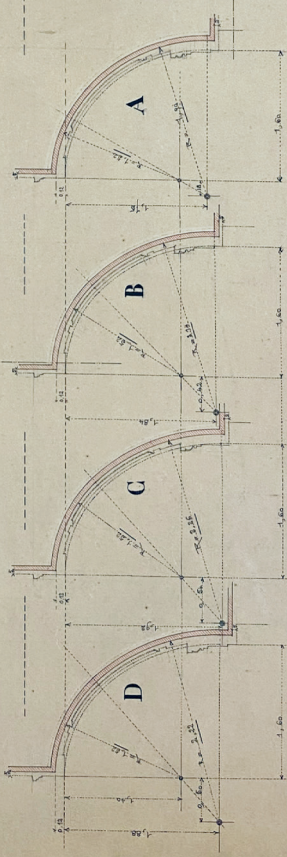
Plate IV. Vaults of the corner pavilions in the main gallery. Original scales: 1/50 (section through the axis of the main gallery, section through the axis of the lateral gallery and plan view) and 1/20 (profiles A, B, C and D of the main gallery). Dated February 1906 (Drawing no. 302, HA.01.0827.18, RMCA Tervuren collection, Charles Girault archives).

MUSÉE DU CONGO



Nota - Les dimensions sont indiquées en mètres. Les contours intérieurs comprennent le nu intérieur au angle passe non compris désignation du KVALEPART

PROFILS SUR A, B, C, D A 0,05 cm p.M



PAVILLONS D'ANGLE DE LA GALERIE PRINCIPALE
CONSTRUCTION DES VÔUTES DE L'ÉTAGE PRINCIPAL
ECHELLE DE 0,05 cm p.M

Dessiné par l'Architecte congolais
Pape, le 15 Mars 1960
G. Pape

Plate V. Courtyard gallery. Original scale: 1/20. Dated May 1905 (Drawing no. 151, HA.01.0827.20, RMCA Tervuren collection, Charles Girault archives). Note in sections AA, BB and CC the composition of the vaults, with one layer of bricks placed flatwise and one layer of bricks in a radial position.

DOMAINE ROYAL DE IERVUEREN
MUSÉE DU CONGO

PORTIQUE SUR COUR INTÉRIEURE
ACROTÈRE

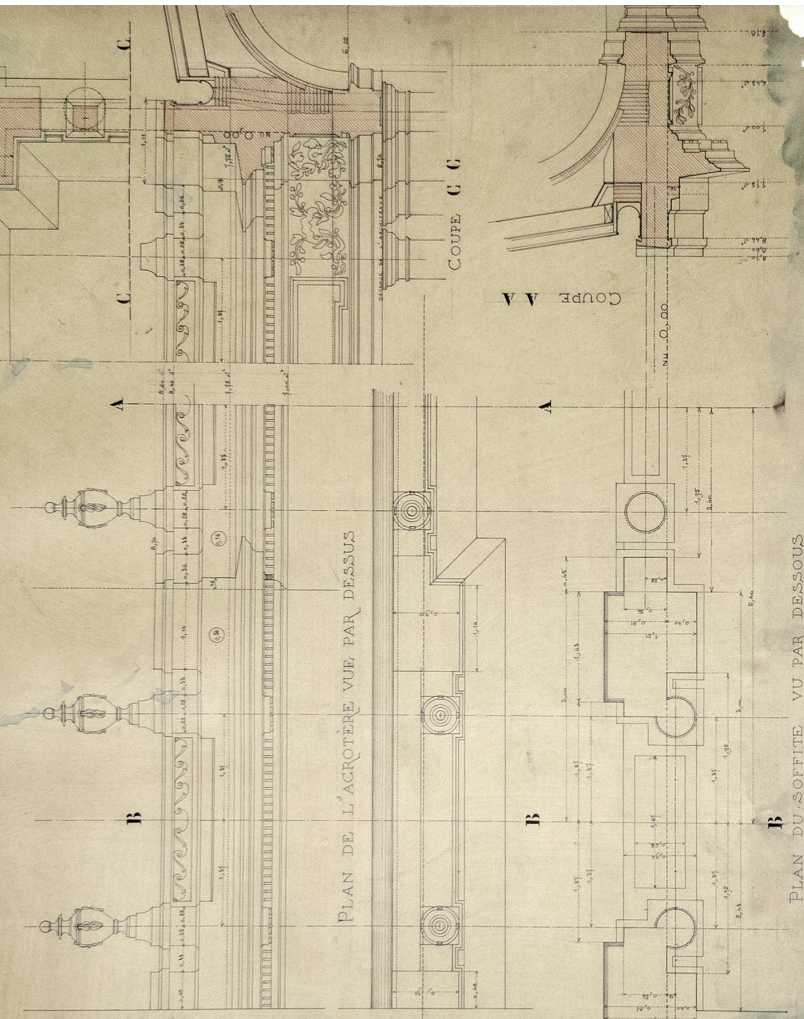
TRAVAIL DE RACCORDEMENT AVEC LA GALERIE PRINCIPALE ET PILLIER D'ANGLE

Echelle de 0.05^m par mètre

Dressé par l'Architecte Soussigné
Paris le 27 MAI 1905

*Ch. Girard
& P. Lecoq*

PLAN DE L'ACROTÈRE VUE PAR DESSUS



COUPE A A

COUPE C C

COUPE B B

PLAN DU SOFFITE VU PAR DESSOUS

Plate VI. Plan view of the main floor with the detail of ceilings and vaults. Original scale: 1/100. Dated 9 May 1905 (Drawing no. 149, HA.01.0827.19, RMCA Tervuren collection, Charles Girault archives). Note the explanation for the construction of the different vaults of the courtyard gallery (B, C, and D).

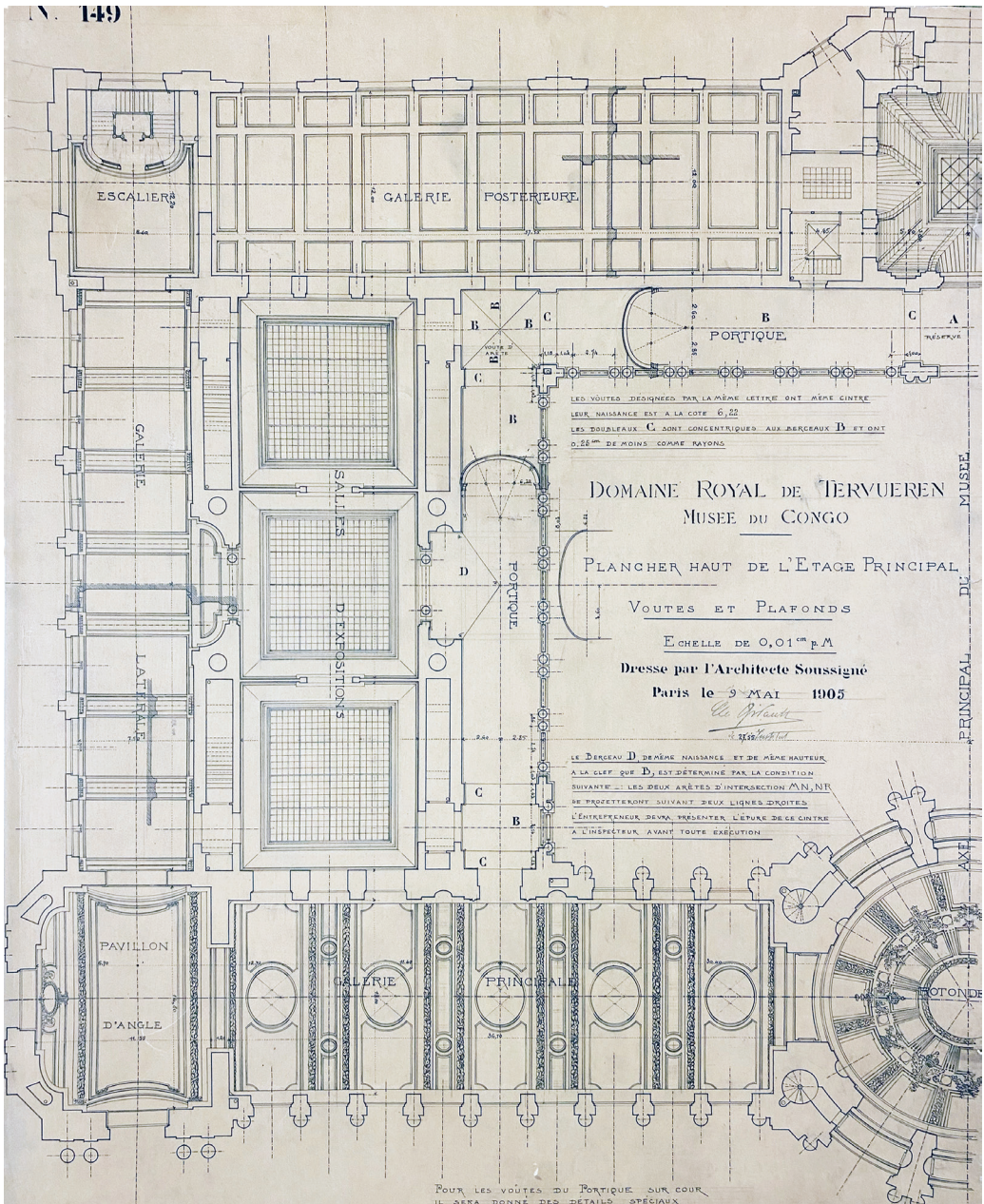
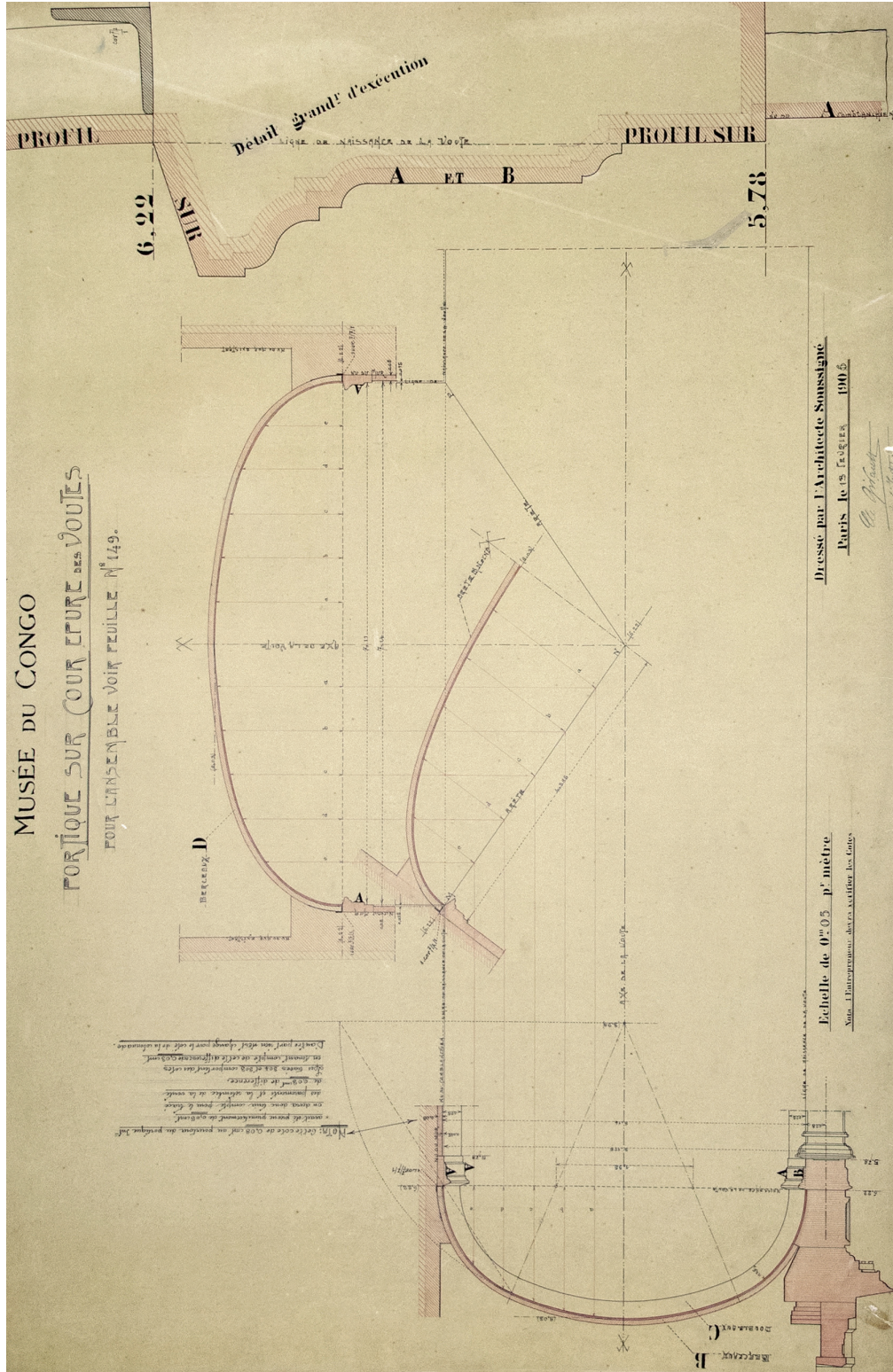


Plate VII. Geometry of the vault in the entrance from the courtyard gallery to the exhibition hall (D in plate VI). Original scale: 1/20 (Drawing no. 303, HA.01.0827.20, RMCA Tervuren collection, Charles Girault archives).

MUSÉE DU CONGO
 PORTIQUE SUR COURURE DES VOUTES
 POUR L'ENSEMBLE VOIR FEUILLE N° 149.



Dressé par l'Architecte Soussigné
 Paris le 15 JUILLET 1905

Echelle de 0^m.05 p^r mètre
 Voir l'ensemble des plans architecturaux des plans

C. P. P.

Plate VIII. Geometry of the vault in the entrance from the courtyard gallery to the main hall (A in plate VI). Original scale: 1/20. Dated 17 February 1906 (Drawing no. 304, HA.01.0827.20, RMCA Tervuren collection, Charles Girault archives).

N° 504

DOMAINE ROYAL DE TERVUIEREN
MUSÉE DU CONGO

directeur B.

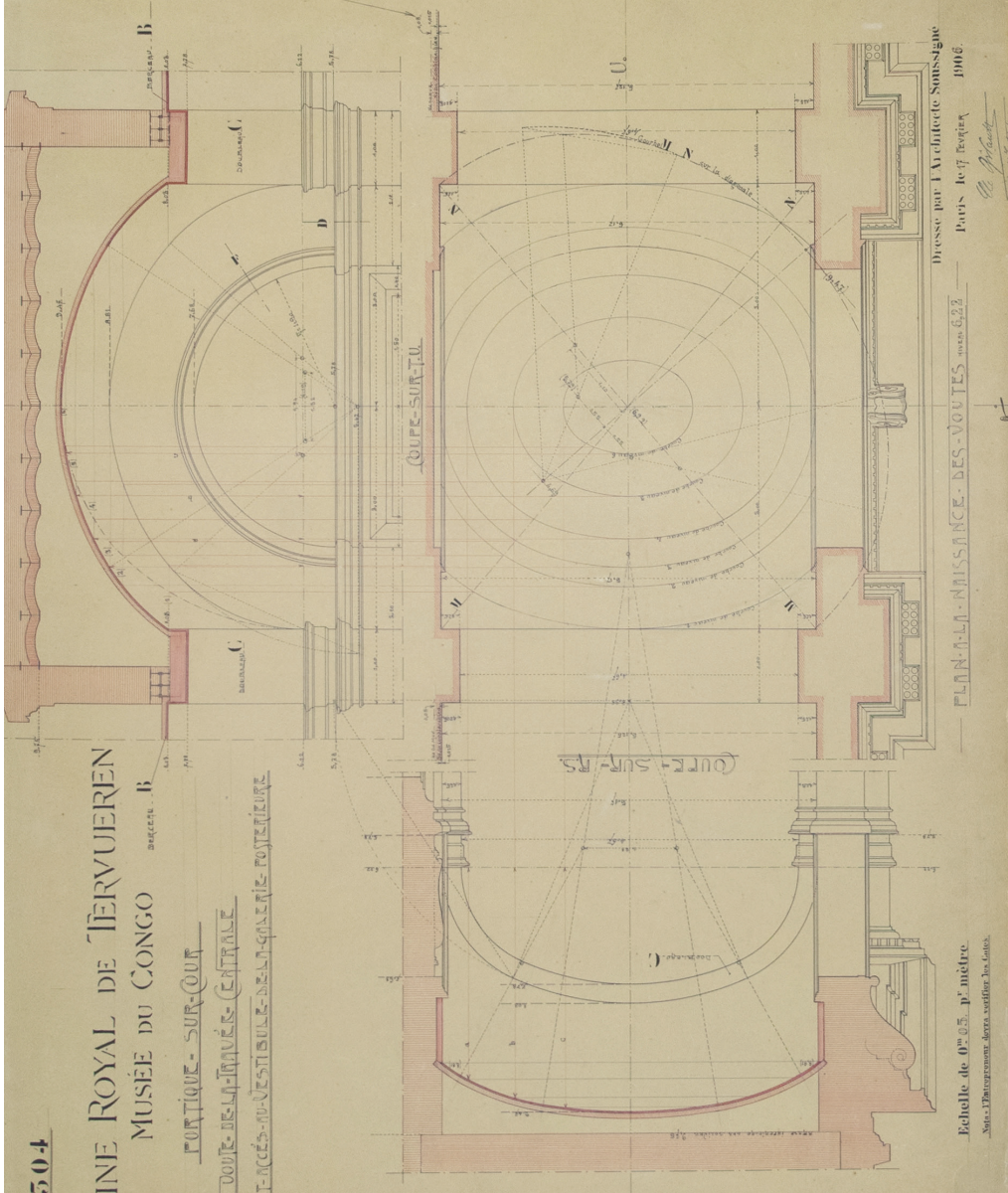
PORTIQUE-SUR-COUR

VOÛTE-DES-TRAVÈS-CENTRALE

DORMANT-ACCÈS-OUVESTIBULE-DES-LOGES-ROYALES

NOTA: Questo disegno ha relazione con i particolari del progetto per la costruzione del Museo del Congo, e con i disegni N. 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.

PROFES. DEBILIS. SUP. ET. D.
VOT. FEUILLE N° 191



PLAN DE LA NAISSANCE DES VOÛTES 1906
Dessiné par l'Architecte Soussignan
Paris, le 17 Février 1906
M. Mouton

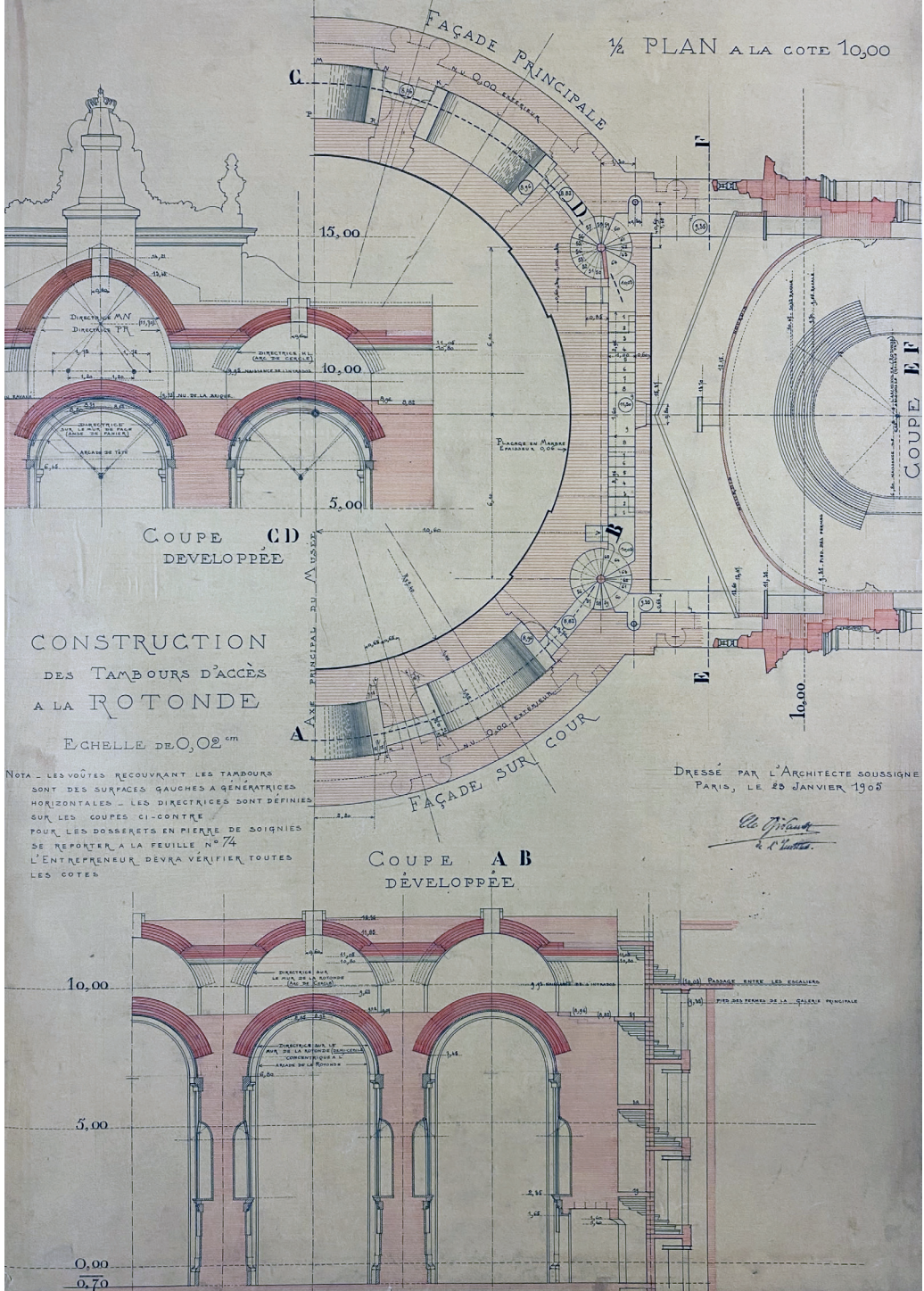
Echelle de 0^m 05 p. mètre.
Sans déduction pour les angles.

Plate IX. Construction of the tambour to access the rotunda. Original scale: 1/50.
Dated 23 January 1905 (Drawing no. 100, HA.01.0827.19, RMCA Tervuren collection,
Charles Girault archives).

N° 100

DOMAINE ROYAL DE TERVUEREN
MUSEE DU CONGO

1/2 PLAN A LA COTE 10,00



CONSTRUCTION
DES TAMBOURS D'ACCÈS
A LA ROTONDE

ECHELLE DE 0,02^m

NOTA - LES VOÛTES RECOUVRANT LES TAMBOURS
SONT DES SURFACES GAUCHES À GÉNÉRATRICES
HORIZONTALES - LES DIRECTRICES SONT DÉFINIES
SUR LES COUPES CI-CONTRE
POUR LES DOSSERETS EN PIERRE DE SOIGNÉS
DE REPORTER A LA FEUILLE N° 74
L'ENTREPRENEUR DEURA VÉRIFIER TOUTES
LES COTES

DRESSÉ PAR L'ARCHITECTE SOUSSIGNÉ
PARIS, LE 20 JANVIER 1905

O. Moland
& C. Vervaeke

Plate X. Rotunda. Section through the main axis. Original scale: 1/50. Dated 9 January 1905 (Drawing no. 92, HA.01.0827.19, RMCA Tervuren collection, Charles Girault archives).

Overleaf:

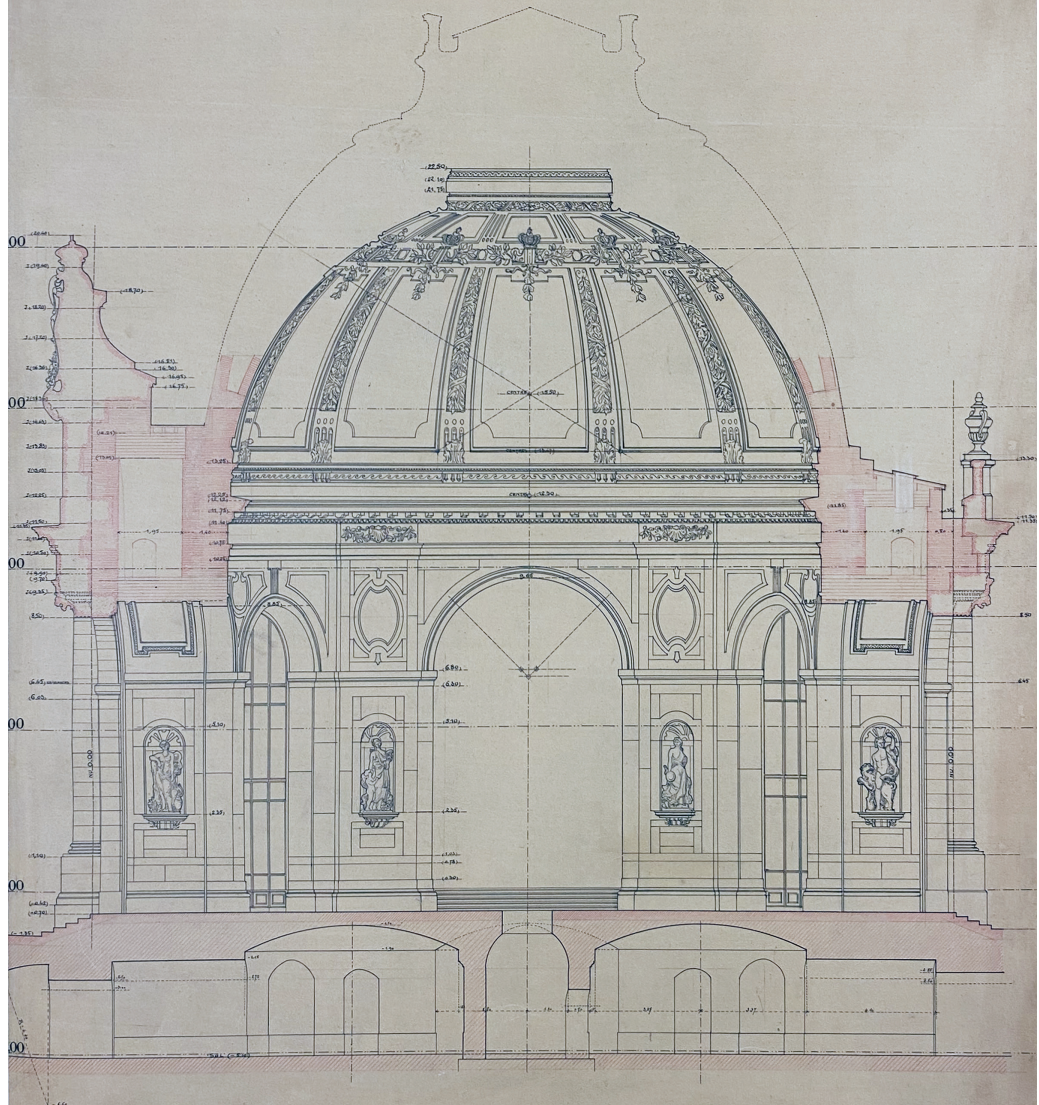
Plate XI. Construction in brick of the double dome of the rotunda. Left: Section of the double dome through the ribs; right: Section of the double dome through the shell. Original scale: 1/20. Dated 16 November 1905 (Drawing no. 225, HA.01.0827.19, RMCA Tervuren collection, Charles Girault archives).

N° 92

DOMAINE ROYAL DE TERVUEREN MUSÉE DU CONGO

ROTONDE

COUPE SUIVANT AB DE LA FEUILLE N° 84



Echelle de 0^m.0 2 p^r mètr

Dressé par l'Architecte Soussigné
Paris le 2 JANVIER 1905

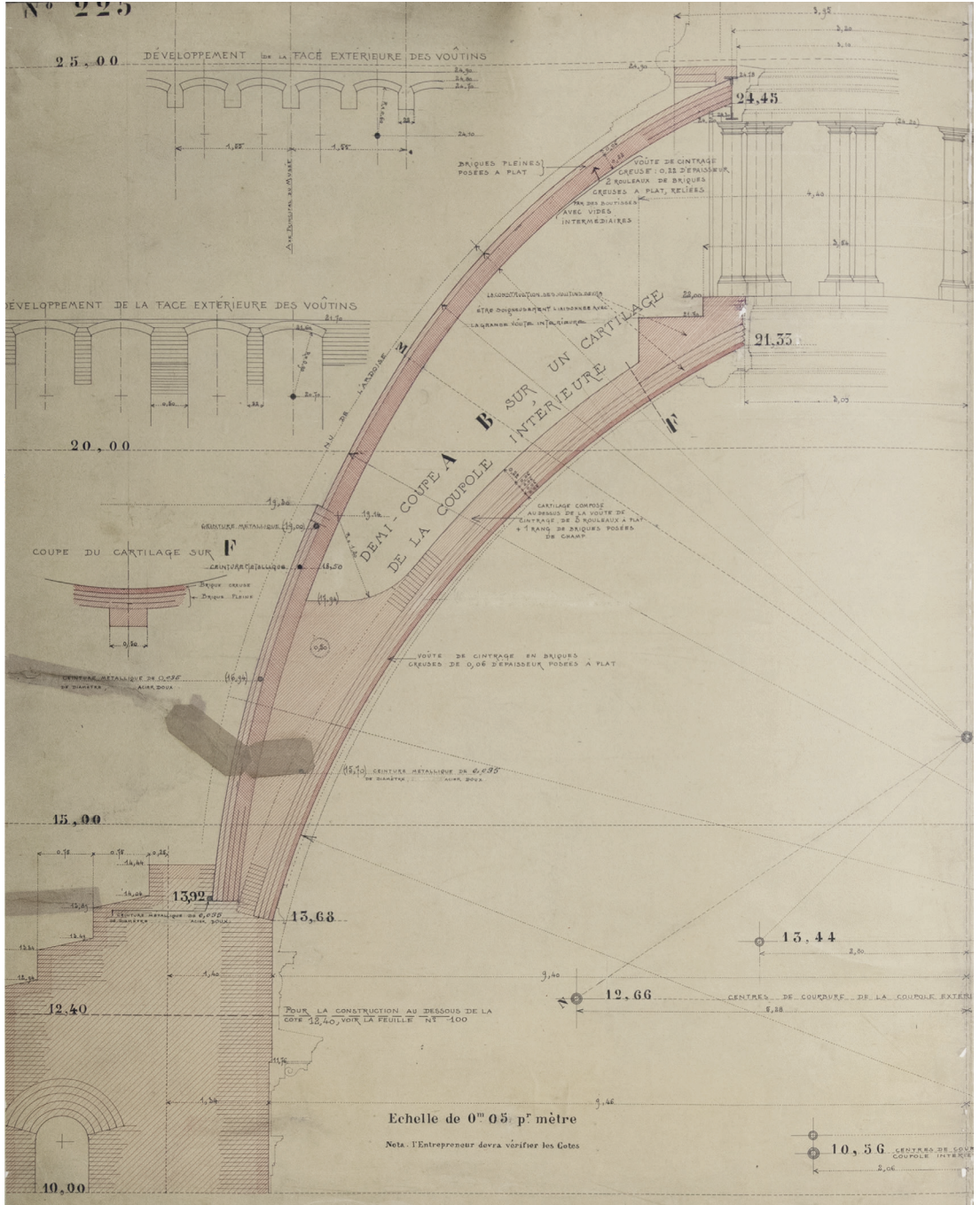


Plate XII. Rotunda. Half plan view of the external dome. Half plan view of the internal dome. Original scale: 1/50. Dated 16 November 1905 (Drawing no. 229, HA.01.0827.19, RMCA Tervuren collection, Charles Girault archives).

N^o 229

DOMAINE ROYAL DE TĒRVUEREN MUSEE DU CONGO

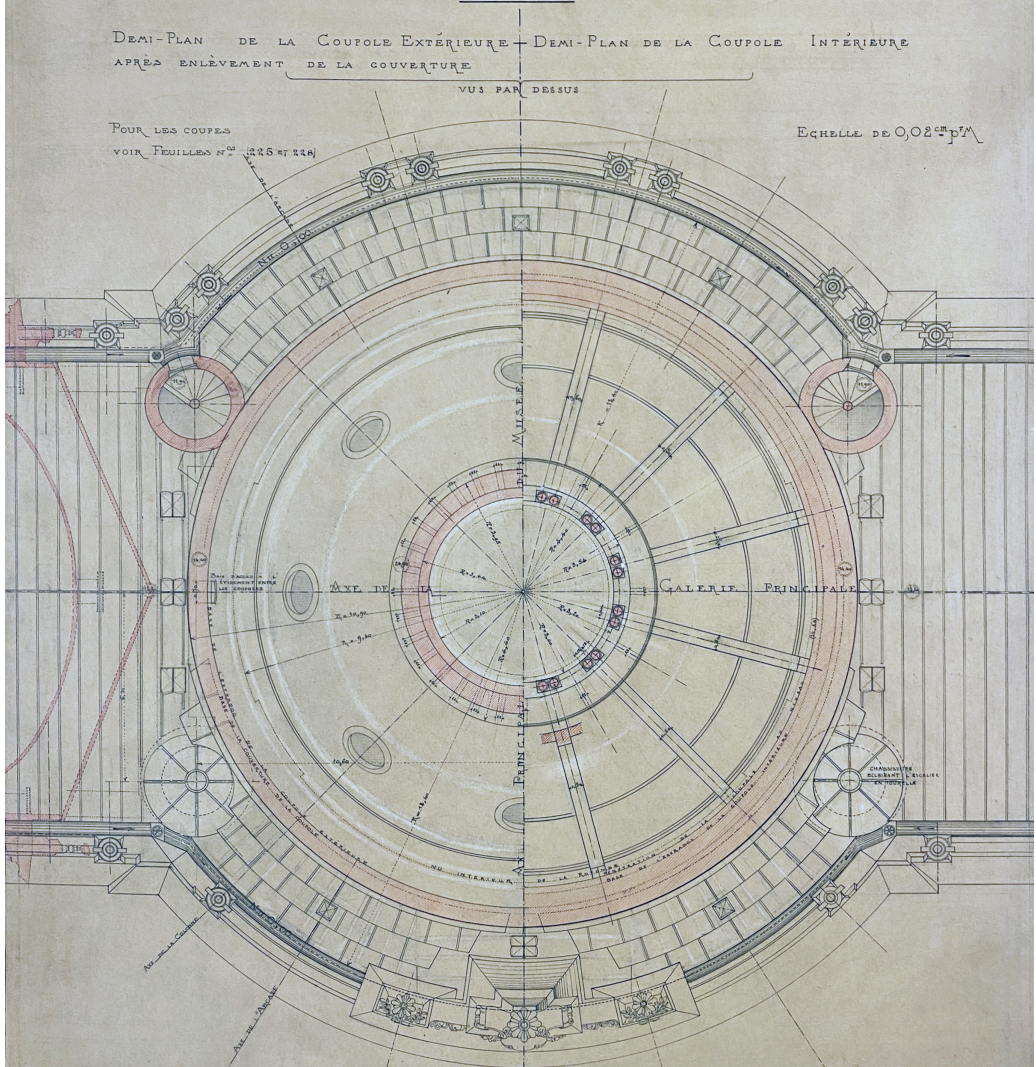
ROTONDE

DEMI-PLAN DE LA COUPOLE EXTĒRIEURE - DEMI-PLAN DE LA COUPOLE INTĒRIEURE
APRĒS ENLÈVEMENT DE LA COUVERTURE

VUS PAR DESSUS

POUR LES COUPES
VOIR FEUILLES N^{os} 225 ET 226

Echelle de 0,02 p^m



Echelle de 0^o02 p^m mètre

Nota - L'Entrepreneur devra vérifier les Cotes.

Dresse par l'Architecte Soussigne

Paris le 16 novembre 1903

FAÇADE PRINCIPALE

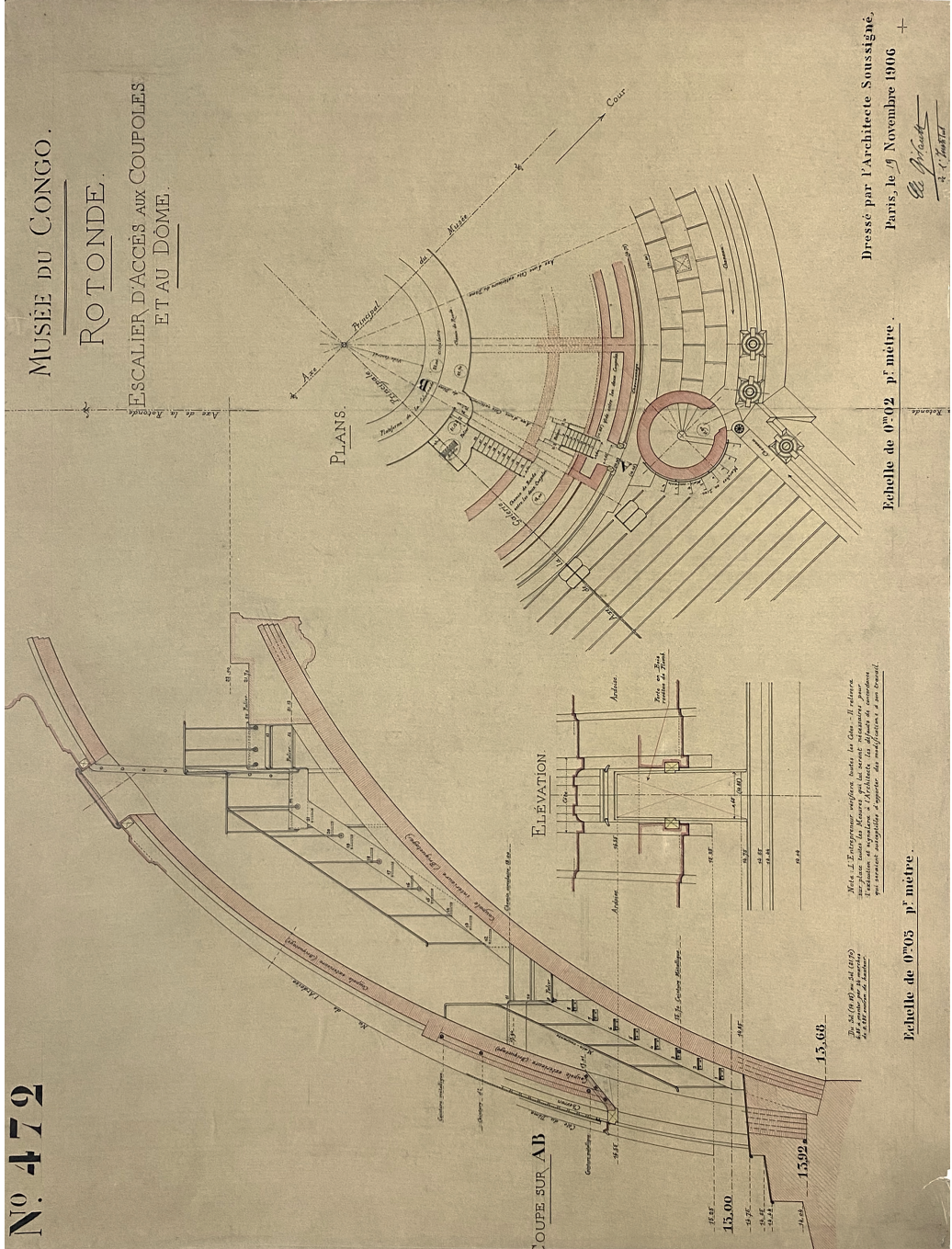
Plate XIII. Rotunda. Stairs in the space between the two shells of the dome. Original scales: 1/50 (plan view) and 1/20 (section and elevation). Dated 19 November 1906 (Drawing no. 472, HA.01.0827.19, RMCA Tervuren collection, Charles Girault archives).

N° 472

MUSÉE DU CONGO.

ROTONDE.

ESCALIER D'ACCÈS AUX COUPOLES ET AU DÔME.



Dressé par l'Architecte Soussigné, Paris, le 28 Novembre 1906

Echelle de 0/100 p. mètre.

Echelle de 0/100 p. mètre.

Nota: L'Entrepreneur devra faire la coupe et relever l'ouvrage et reporter à l'Architecte les plans de construction par ses soins.

Le 28/11/06, par l'Architecte Soussigné, à l'effet de faire passer le plan de construction à l'Entrepreneur.

Plate XIV. Structural analysis of the double brick dome. Original scale: 1/20. Dated 16 November 1905 (Drawing no. 253, HA.01.0827.19, RMCA Tervuren collection, Charles Girault archives).

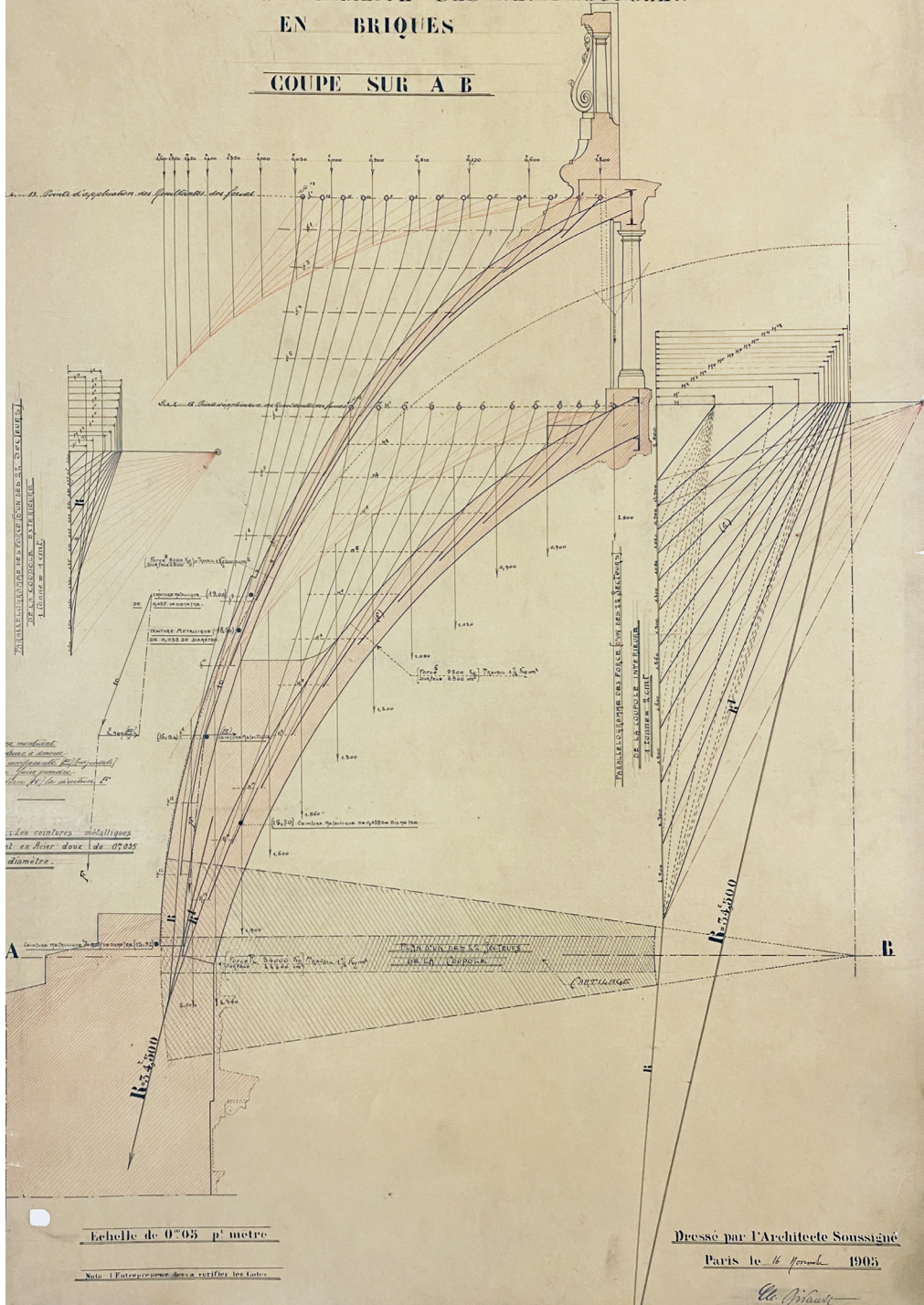
N° 255

DOMAINE ROYAL DE IERVUEREN

MUSEE DU CONGO

ETUDE DE STABILITE DES DEUX COUPOLES
EN BRIQUES

COUPE SUR A B





Brick Vaults and Beyond
The Transformation of a Historical
Structural System from 1750 to 1970

Edited by Paula Fuentes and Ine Wouters

INSTITUTO JUAN DE HERRERA
VRIJE UNIVERSITEIT BRUSSEL

The project *Brick Vaults and Beyond: The Transformation of a Historical Structural System (1830–1930)* has received funding from the European Union’s Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 833030.



© 2021 For each chapter the author(s)

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Copyediting: William Hatherell and Sara E. Wermiel

Cover illustration: Construction of the dome of the Royal Museum for Central Africa (HP.1968.10.6-52, collection RMCA Tervuren; Charles Girault archives)

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